M3 Junction 9 Improvement

Scheme Number: TR010055

6.3 Environmental Statement Appendix 13.1 - Drainage Strategy Report - Part 1of 2

APFP Regulation 5(2)(a)

Planning Act 2008

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

Volume 6

November 2022

Infrastructure Planning

Planning Act 2008

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

M3 Junction 9 Improvement
Development Consent Order 202[x]

6.3 ENVIRONMENTAL STATEMENT- APPENDIX 13.1: DRAINAGE STRATEGY REPORT

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference:	TR010055
Application Document Reference:	6.3
BIM Document Reference:	HE551511-VFK-HDG-X-XXXX-XX-RP-CD-0001
Author:	M3 Junction 9 Improvement Project Team, Highways England

Version	Date	Status of Version
Rev 0	November 2022	Application Submission

M3 Junction 9 Improvements

Stage 3b – Drainage Strategy Report

November 2022

Doc ref: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
Revision: C01

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

M3 Junction 9 Improvements

Stage 3b – Drainage Strategy Report

On behalf of **National Highways**

Project Ref: 48176 | Rev: C01 | Date: November 2022

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: Caversham Bridge House, Waterman Place, Reading, Berkshire RG1 8DN
T: +44 (0)118 950 0761 E: PBA.Reading@stantec.com

Document Control Sheet

Project Name: M3 J9 Stage 3b

Project Ref: 48176

Report Title: Drainage Strategy Report

Doc Ref: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001

Date: December 2021

	Name	Position	Signature	Date
Prepared by:	P. Rogers	Drainage Engineer	PR	19.01.2021
Reviewed by:	A. Champion	Principal Engineer	AC	19.01.2021
Approved by:	T. Allen	Associate	TRA	19.01.2021
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
P01	19.01.2021	First Issue - Draft	PR	AC	TRA
P02	28.05.2021	2nd Issue	PR	AC	TRA
P03	18.10.2021	3rd Issue	PR	AC	TRA
P04	25.10.2021	Calculations added, figure updated	PR	AC	TRA
P05	14.12.2021	Figure and Table references, latest drawings appended	PR	AC	TRA
P06	07.07.2022	Revised to suit Omission of Managed Motorway Scheme Appendices D, F, G, J, L and N amended.	RR / JH	LC	MF
P07	26.08.2022	Volker Fitzpatrick review comments added	JH	LC	MF
C01	01.11.2022	Approved – Track changes removed from previous revision P07	JH	LC	MF

Volkerfitzpatrick Limited and National Highways). Stantec accepts no duty or responsibility (including in negligence) to any party other than the Client, Volkerfitzpatrick Limited and National Highways, and disclaims all liability of any nature whatsoever to any such party in respect of this report

Contents

1 Introduction 5
1.1 Purpose of this Report 5
1.2 Limitations of this Report 5
1.3 Location & Context 6
1.4 Background to Proposals 6
2 Stakeholders and Consultation 7
2.1 Historical discussions & Key Issues 7
2.2 Environment Agency 9
2.3 Hampshire County Council 9
2.4 National Highways 10
2.1 Consenting Procedures 10
3 Hydrogeological Context 11
3.1 Hydrology 11
3.2 Geology 11
3.3 Typical Anticipated Infiltration Rates 12
4 Existing Drainage 13
4.1 Overview 13
4.2 Existing Highway Drainage Catchments 13
4.3 Offsite Highway Drainage Catchments 13
4.4 Existing Drainage Assets 14
4.5 Watercourses and Related Features 16
5 Highway Proposals 17
5.1 Global Carriageway Areas summary 17
5.2 Proposed Catchments & Discharge Rates 17
5.3 Rationale for Discharge Rates 18
5.4 Comparison of Proposed Discharge Rate to Greenfield Runoff Rates 19
6 Proposed Drainage & Attenuation 22
6.1 General approach 22
6.2 Extended Detention Basins 22
6.3 Geocellular Tanks 22
6.4 Flow Controls 23
7 Storm Water Design Parameters 24
7.1 Hydraulic Calculations 25
7.2 Exceedance Flows & Network Resilience 25
7.3 Drain-Down Times 26
8 Pollution Mitigation 28
8.1 Proposed Runoff Treatment Management Train 28
8.2 Requirements for discharges to a SSSI or SAC 29
8.3 Hydrogeological Risk Assessment 29
9 External Catchments 30

9.1 Overland Flow Routes 30
9.2 Interception of Overland flows above cuttings 31
10 Maintenance........ 32

Figures

Figure 1.2 – M3J9 Improvements Scheme Location Plan 5
Figure 5.5 – Main Rivers & Ordinary Watercourses........ 17

Tables

Table 2.1 – Historical Key Issues and current scheme approach 9
Table 4.4 - Existing Drainage Catchments........ 15
Table 5.2 – Global M3J9 Drained Areas Summary........ 18
Table 5.4 – Proposed Catchment Areas & Discharge Rates Summary 21
Table 6.4 – Summary of new Attenuation Structures........ 23
Table 7.3 – Summary of Half-Drain Times and Attenuation Capacity after 24 hrs 28
Table 8.1 – Runoff Treatment Management Train 28
Table 9.1 – Overland Catchments – Existing Runoff Characteristics 31

Appendices

Appendix A Historical Consultation Minutes
Appendix B Specification for Infiltration Testing
Appendix C Consultation Minutes
Appendix D Schematic Drainage Plan
Appendix E Summary of Infiltration Rate Assessment
Appendix F Drainage Drawings
Appendix G Drainage Calculations
Appendix H Overland Catchment Calculations
Appendix I Technical Note: Proposed M3J9 Runoff Pollution Assessment Method and Control Measures.
Appendix J – Hydrogeological Risk Assessment:
Appendix K – Technical Note: Decommissioning and Renovation of Existing Highway Soakaways
Appendix L – Technical Note: Drainage Network Resilience to Critical-Location Blockages
Appendix M – M3J9 Improvements, PCF Stage 3B – Ground Investigation Report
Appendix N – Technical Note: Climate Change allowances applied to Drainage Design & Exceedance
Appendix O – Consenting Requirements Layout and Table
Appendix P – Technical Note: Proposed Drainage Amendments Following the Omission of the Managed Motorway Scheme

1 Introduction

1.1 Purpose of this Report

This report is prepared by Stantec, who are undertaking the highway design of M3 Junction 9 (M3J9) Improvements Scheme. The report the outlines the preliminary design for surface water drainage serving the M3J9 Improvements Scheme. This document is live and subject to ongoing consultations with statutory consultees regarding drainage approach and design parameters, and will be verified by geotechnical site investigation results.

1.2 Limitations of this Report

Matters relating to the geometric and construction materials design for the new M3J9 carriageway alignments are not covered by this report.

The location of the Scheme is shown on Figure 1.2 below.

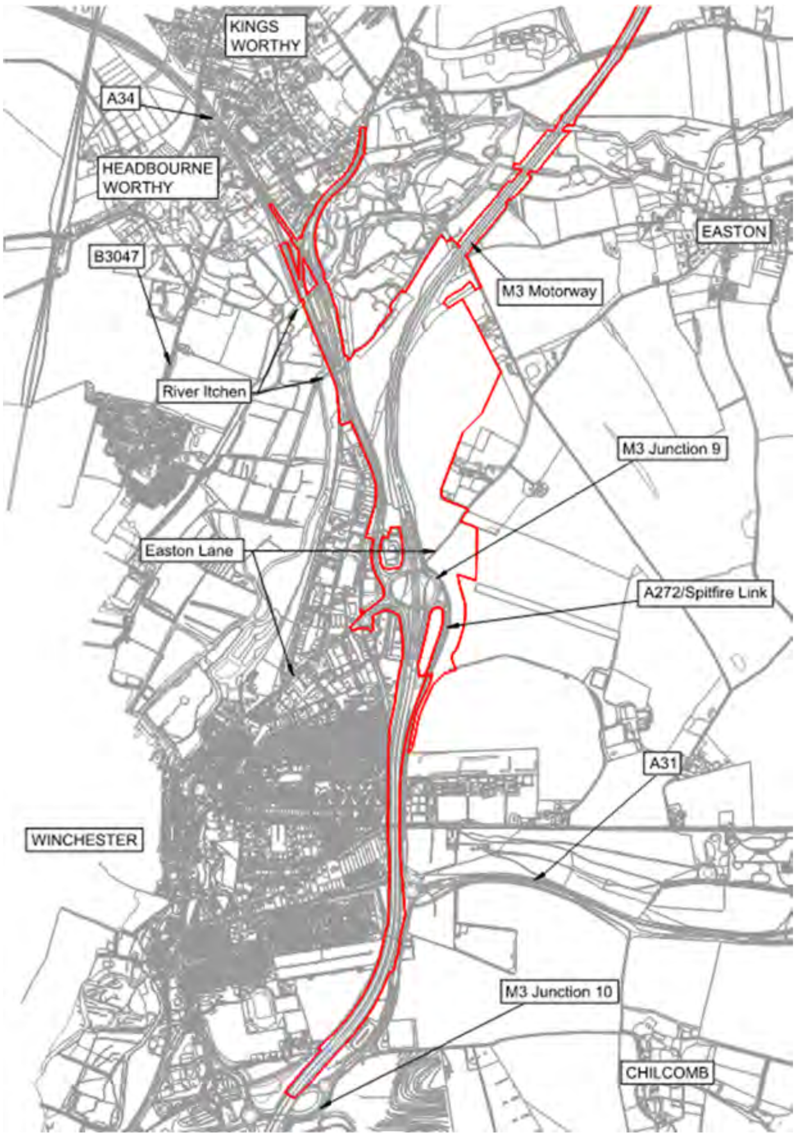


Figure 1.2 – M3J9 Improvements Scheme Location Plan

1.3 Location & Context

M3 Junction 9 is a key transport interchange which connects South Hampshire (facilitating an intensive freight generating industry) and the wider sub-region, with London via the M3 and the Midlands/North via the A34 (which also links to the principal east-west A303 corridor).

A significant volume of traffic currently uses the grade separated, partially signalised circulatory junction (approximately 6,000 vehicles per hour during the peak periods), which acts as a bottleneck on the local highway network and causes significant delay throughout the day. Northbound and southbound movements between the M3 and the A34 are particularly intensive, causing queues on the northbound exit-slip of the M3, which affect highway safety during peak periods.

M3 Junction 9 is located on the eastern edge of Winchester, in the Winnall area. The land-use immediately to the west of the scheme is urban, commercial and industrial, comprising Wykeham Trade Park, Winnall Industrial Estate and domestic housing. Immediately to the north, south and east, land-use comprises undeveloped flood plain, arable farmland and woodland. With the exception of Winchester, there are no major settlements within approximately 1 km of the scheme.

The land to the east is primarily greenfield, the majority of which lies within the South Downs National Park (SDNP). The River Itchen and associated flood plain is located north and west of the scheme. The River Itchen Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) abut the scheme to the north and west.

Following the ministerial statement on 12th January 2022, the government paused the roll out of all new all lane running (ALR) schemes. As the M3 Junction 9 Improvement Scheme tied-in to a new ALR scheme, minor design development has been undertaken.

Although the ALR scheme is formally paused, National Highways are planning to upgrade the existing central reservation barrier to concrete, to deliver safety benefits. These works will be known as the M3 Junction 9 to 14 Safety Barrier Improvement Scheme, which will be implemented prior to construction of the M3 Junction 9 Improvement Scheme.

1.4 Background to Proposals

A previous M3J9 Improvements scheme was proposed in 2019 by Jacobs Consulting Engineers. The Jacobs scheme has since been discontinued. An alternative scheme proposed by Stantec is being considered, which is the subject of this report.

At the time of writing, geotechnical assumptions are undergoing verification by new investigation works by VolkerFitzpatrick/Stantec.

2 Stakeholders and Consultation

The designers, Stantec, on behalf of their client National Highways (NH) have held initial consultation meetings with statutory authorities, namely the Environment Agency (EA) and Hampshire County Council (HCC). Meetings have also been held with National Highways in order to agree the design approach, design parameters, network resilience and Operation & Maintenance criteria.

2.1 Historical discussions & Key Issues

During the previous Jacobs scheme, discussions were held between the designers and the EA and HCC. Copies of historical minutes are also included in Appendix A. A summary of the historical Key Issues arising from the previous scheme meetings, and how those are now being addressed in the new Stantec scheme, are listed in Table 2.1 below.

A separate document, namely the Statement of Common Ground with the Environment Agency, should be referred to as the main reference for confirmation of the Key Issues across all disciplines identified by the EA in the DCO process, and how they are being addressed by the designers of this scheme, on behalf of NH.

Ref	Key Issue raised by EA (during historical scheme)	How current Stantec Scheme addresses the Key Issue
1	Min 450 dia for new culverts under highway.	Existing 300mm dia. culvert @ marker 101/6 to be retained, but its overland catchment is proposed to be removed by highway earthworks. Extended portion of existing culvert under the widened M3 corridor to be 450 dia.
2	100-yr + 40CC exceedance flow paths to be identified	100-year + 40CC exceedance flow paths identified on drainage drawings.
3	Attenuation design to 100-yr + 20CC (& Check for 40CC)	Attenuation basins designed to contain the 100-year + 40CC design event without flooding
4	Discharge rate for new 'offline carriageway' to be 1-yr greenfield	All drainage serving new + existing carriageway and cutting areas is designed to discharge at the long-term storage rate of 2 l/s/ha.
5	Discharge rate for new 'online carriageway' to be limited to discharge rate from existing carriageway	All drainage serving existing, overlaid carriageway + local widenings to existing carriageway is to be retained and modified to contain run off volumes at existing brownfield discharge rates.
6	Minimum restricted discharge at any outfall to be 5 l/s	Minimum discharge rate used at any outfall is 2 l/s
7	SuDS and Pollution Control Maintenance strategies to be reviewed by HCC	SuDS Maintenance has been proposed in the separate Pollution Control Technical Note in Appendix I of this report.
8	Existing subway flooding to be remedied	Drainage serving subways now proposed to be by gravity to a positive outfall, and not to a local soakaway in the subway low point
9	Surface Water Construction Management Plan (CMP) required for the DCO	Refer CMP provided separately by Volker Fitzpatrick

10	Ponds to be lined to avoid groundwater contamination	Ponds to be lined where a high risk to groundwater is identified through the HEWRAT screening and subsequent, separate, Hydrogeological Risk Assessment (HgRA) by Stantec
11	Effects of dewatering on the Itchen to be identified/mitigated	Dewatering below groundwater levels is not expected within the M3J9 scheme. Management of local perched water is covered in the separate CMP
12	Rain Gardens suggested by NH.	Extended Detention Basins, with wet and dry vegetated habitats, are proposed as the main form of treatment and attenuation
13	Memorandum of Understanding (MoU) re: outfalls, exists between EA and NH	The contents of any existing MoU have not been raised by the EA or NH.
14	EA to consider the maintenance strategy of the drainage system (+ pollution control components)	Pollution Control measures and SuDS Maintenance are included in the separate Pollution Control Technical Note (Appendix I of this report)
15	Cavities record to be referenced	The Cavities Record has been referenced and considered in the Hydrogeological Risk Assessment, which is included in this document
16	EA seek reassurance that there is no interception of groundwater by underpass	As 11, structures are above groundwater levels.
17	Existing soakaways to be reused will require assessment	Retention and renovation of existing soakaways is detailed in a Soakaway Renovation Technical Note (Appendix K of this report). Existing soakaways are only proposed to be retained where they continue to serve retained highway, subject to testing and renovation
18	Decommissioning of soakaways to be undertaken to EA standards	The assessment of hazards, risks and proposed mitigation during removal or renovation of existing soakaways is detailed in the Soakaway Renovation Technical Note (Appendix K of this report).
19	Waste licence required for soakaway sediment removal, including WAC testing, to be referenced in the CEMP/CMP	
20	EA infiltration tool to be used for assessment of groundwater protection from pollution	A HEWRAT screening and a separate Hydrogeological Risk Assessment (HgRA) has been undertaken by Stantec, which includes use of the EA Infiltration Tool
21	HEWRAT assessment concluded that no further Pollution Control measures required, other than in attenuation pond	A HEWRAT screening in the Pollution Control Technical Note (Appendix I of this report) identifies drainage assets that require further assessment, which has been undertaken in a separate HgRA by Stantec
22	HEWRAT assessment concluded that further spillage mitigation not required (to be reviewed)	
23	Environment Statement (ES) to assess construction activities within the SPZ.	Construction activities have been assessed in the Environment Statement , separate to this document
24	Kings Worthy and Winchester groundwater flooding are high on stakeholders agenda	Refer to the Stantec FRA HE551511-VFK-EGN-X_XXXX_XX-RP-LE-0005 for the assessment and mitigation of risks to groundwater levels in the project study area.

25	Abstraction licence required for any dewatering	Licencing for any dewatering to be included in the CMP provided separately by Volker Fitzpatrick

Table 2.1 – Historical Key Issues and current scheme approach

2.2 Environment Agency

The Environment Agency's (EA) regulatory, licencing and advisory powers and duties derive from the following key Acts and Regulations;

- Environment Act 1995
- Environmental Permitting (England & Wales) Regulations 2010
- Water Resources Act 1991
- Flood and Water Management Act 2010
- Salmon & Freshwater Fisheries Act 1975
- The Planning Act 2008 (the 2008 Act) and secondary legislation made under the 2008 Act
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003

The Flood and Water Management Act gives the Environment Agency a strategic overview role for fluvial and coastal flooding and erosion. They also have direct responsibility for the prevention, mitigation and remedying of flood damage for main rivers and coastal areas.

The works are adjacent to, pass over and discharge to the River Itchen, which is Main River and under the Environment Agency regulatory control.

Meetings have been held with the Environment Agency on 24th February and 4th October 2021. Minutes are included in Appendix C.

2.3 Hampshire County Council

Hampshire County Council (HCC) is the designated Lead Local Flood Authority (LLFA) for the scheme. The Flood and Water Management Act gives the LLFA responsibility for the management of local flooding from surface water (overland) flows, groundwater and ordinary watercourses. The LLFA is Hampshire County Council.

Highway drainage ditches alongside the A33/A34, within the Itchen flood plain, are classed as Ordinary Watercourses. Ordinary Watercourses are under the regulatory control of the LLFA and any new connections to the ditches alongside NH highway will be subject to approval by the LLFA through the Ordinary Watercourse Consent process.

An initial consultation meeting was held with Hampshire County Council LLFA on 2nd June 2021. Minutes are included in Appendix C.

Hampshire County Council are also the Highway Authority for some parts of the M3J9 scheme, namely Easton Lane and the A272 'Spitfire Link' road. At present the whole scheme's drainage is designed to be compliant with the NH DMRB standards listed in Section 3.4.

2.4 National Highways

M3J9 is primarily a National Highways (NH) asset. NH will be owner and operator over the lifetime of the scheme. HCC Highways currently operate, and will continue to operate, the peripheral elements known as Easton Lane and the A272 Spitfire Link.

The following National Highways DMRB design documents and relevant design guides have been considered in the preparation of this Drainage Strategy:

Design Documents

- CG 501 - Design of highway drainage systems

- CD 521 - Hydraulic design of road edge surface water channels and outlets

- CD 522 Drainage of runoff from natural catchments

- CD 532 - Vegetated drainage systems for highway runoff

- CD 530 Design of Soakaways

- GD 301 Smart Motorways *(now termed Managed Motorways)*

- The SuDS Manual, CIRIA Report C753 (2015)

- LA 113 - Road drainage and the water environment

- EA R&D Report P2-159/TR2 Guidance Manual for Constructed Wetlands

2.1 Consenting Procedures

Activities that require consenting from statutory or non-statutory bodies fall into the following categories:

- Discharge to Groundwater

- Discharge to Ordinary Watercourses

- Discharge to Main River

- Discharge to (surface water) sewers

- Overland flows

Permanent Works

All required consenting for Highway Drainage permanent works has been detailed in drawings HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0517 – Water Resources, Land Drainage & Groundwater Consenting Layout and drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0522_Water Resources Consenting Table, both of which are included in Appendix O.

Temporary Works

Consenting for temporary drainage works will fall into similar categories, and will be identified in the Construction and Environmental Management Plan, which is being prepared separately.

3 Hydrogeological Context

3.1 Hydrology

For full details of the assessment of flood risk and mitigation for the M3J9 study area, refer to the Stantec report 'M3 Junction 9 Improvement, Flood Risk Assessment', Stantec document ref: HE551511-VFK-EGN-X_XXXX_XX-RP-LE-0005.

Overview of Flood Risk

The FRA report above finds that the drainage proposals are acceptable and concludes that (*text extracted*):

(i) *The site is located within Flood Zone 1 'Low Probability', Flood Zone 2 'Medium Probability' and Flood Zone 3 'High Probability' of the River Itchen.*

(ii) *The proposed scheme is classified as 'Essential Infrastructure'. PPG Table 3 confirms that such development is appropriate within Flood Zone 3 subject to the Sequential Test and Exception Test being carried out.*

(iii) *The proposed scheme will not encroach upon the floodplain, and therefore will not result in a loss in flood storage.*

(iv) *The surface water network produced for the proposed scheme will discharge runoff to ground, and to the river at long-term storage rates (2 l/s/ha) with attenuation provided within extended detention basins and oversized pipes.*

(v) *Pollution control is provided via Pollution Control Devices (PCDs), sediment forebays, vegetated detention basins and grassed swales.*

3.2 Geology

For full details of the geotechnical assessment of M3J9, please refer to Stantec report 'M3 Junction 9 Improvement, PCF Stage 3B – Ground Investigation Report, May 2021', document ref: HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0001-C01.

Below is a brief summary to provide the hydrogeological context for the Drainage Strategy.

Typical Geology

Chalk bedrock is close to the existing ground surface where the scheme lies outside flood plain. Groundwater was recorded as steady in three locations, at approximately 38m AOD, which is the approximate water level in the River Itchen. The lowest carriageway level in the proposed scheme outside floodplain is approximately 44m AOD, and comprises the northern approach of the proposed A33 Southbound underpass.

The large majority of new carriageway is out of floodplain. Within floodplain, chalk bedrock is overlain by alluvium, river terrace and sandy/gravelly head deposits. The lowest carriageway in floodplain is approximately 40m AOD. Almost all carriageway proposed within floodplain is existing carriageway on embankment that is proposed to be overlaid.

The Alluvium and River Terrace Deposits are classified as Secondary 'A' Aquifer by the EA, and capable of supporting water supply at a local scale, and in some cases forming an important source of base flow to rivers. The Head Deposits are classified as Secondary Aquifer (undifferentiated). Peat deposits have also been found in a number of boreholes in the wider vicinity of Junction 9.

3.3 Typical Anticipated Infiltration Rates

A provisional design infiltration rate of 1 x 10^{-6} m /s has been assumed within the chalk bedrock, based on an interpretative assessment of percolation rates obtained during previous geotechnical test results (Appendix E - Summary of Infiltration Rate Assessment). The same infiltration rate of 1 x 10^{-6} m/s has been assumed to be present in superficial deposits overlying the chalk bedrock. Supplementary Infiltration rate testing, to BRE 365, will be undertaken to support the detailed design of proposed infiltration basins and soakaways. Refer to Appendix B for the Specification for Infiltration Testing.

It is proposed that existing soakaways, which are to be retained or abandoned, are also tested to verify infiltration performance and storage capacity. Please refer to Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CH-0003 - Decommissioning and Renovation of Existing Highway Soakaways, which is included in Appendix K.

Generally, infiltration rates are low, and it is expected that infiltration alone will not be sufficient to dispose of all runoff volumes practically. Draw-down of basins via infiltration alone would be prohibitively long, with typical half-drain times in the larger detention basins exceeding 24 hours. For this reason, Stantec's approach for the scheme is to discharge highway runoff to ground where possible within extended detention basins, which are supplemented by controlled, gravity outfalls to the River Itchen. This reduces the half-drain times in detention basins to typically 1 day in the 30-yr critical-duration storm event. Refer to Section 8.4 for further discussion and demonstration of drain-down times.

4 Existing Drainage

4.1 Overview

The assessment of the existing highway drainage was undertaken using information available on the National Highways Drainage Data Management System database (HAGDMS). Some further drainage and topographical survey work has been undertaken to supplement the HAGDMS data, such as invert levels, diameters and pipeline connectivity. At the time of writing, further CCTV and topographical survey work is ongoing to fully verify the HAGDMS and as-built information.

4.2 Existing Highway Drainage Catchments

Existing highway catchments are shown in drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0515 Existing Highway Surface Water Catchments Overview Plan, which is included in Appendix F. A Summary of existing catchment characteristics is indicated in Table 4.4 below, which is an extract of aforementioned drawing.

4.3 Offsite Highway Drainage Catchments

The M3 corridor immediately to the south of M3J9 was scheduled to be upgraded to an All Lane Running motorway (ALR) under a Managed Motorway Project (MMP) contract. Despite the governmental pause of all new ALR schemes, National Highways are planning to continue with elements of the scheme through a phased approach to deliver safety benefits to the M3 network. The subsequent M3 Junction 9 to 14 Safety Barrier Improvement Scheme will therefore upgrade the existing central reserve barrier to concrete with works commencing onsite during 2022.

The M3 Junction 9 to 14 Safety Barrier Improvement Scheme proposes to maintain existing carriageway runoff flows within retained/proposed M3 drainage in the verge and central reserve, which pass those flows forward (to the north) into the M3J9 works area. The original highway drainage, which was typically constructed in the 1960s - 1980s, is being upgraded to cater for flow volumes generated by modern rainfall data, and to meet modern design standards. The Safety Barrier Improvement Scheme designers have provided details of the schemes proposed drainage network to the M3J9 team.

The Safety Barrier Improvement Scheme areas of carriageway and cutting that lie upslope to the south of M3J9, have been included in the drained area of the M3J9 design. The MMP network, including in-line attenuation and orifice plates has been incorporated into the M3J9 hydraulic model, to accurately represent the effect of the incoming MMP flow rates and volumes on the M3J9 proposals.

Any surface flooding during significant design events that is apparent within the Safety Barrier Improvement Schemes area is outside the scope of this document and has not been resolved in the M3J9 proposals. M3 carriageway levels indicate that any Safety Barrier Improvement Scheme surface flooding would be conveyed over the carriageway surface to the north, into the M3J9 works area. The M3J9 hydraulic model accounts for this by assuming that surface flooding is reintroduced to network flows when water levels within the system fall enough to allow it. As such, any volumes of surface flooding within the Safety Barrier Improvement Scheme area are retained in the schemes drainage area and then passed through the network to the M3J9 drainage network area. M3J9 hydraulic modelling therefore accounts for all runoff volumes generated in the Safety Barrier Improvement Scheme area, which are accommodated in M3J9 attenuation volumes.

The containment of overland exceedance flows which may arise in the Safety Barrier Improvement Scheme area during significant events, will be required to be identified and resolved by the schemes design team at the detail design stage. Any significant Safety Barrier Improvement Scheme surface flows during exceedance events that are shown by the MMP schemes designers to leave the schemes area will need to be included in the M3J9 detailed-design calculations for carriageway surface drainage, such as gully spacings, gratings, open channels and slot drains.

4.4 Existing Drainage Assets

Highway Drainage

The existing M3J9 highway drainage system is predominantly piped, with carriageway run-off captured by channels, gullies, trench drains and ditches, then conveyed to soakaway trenches or soakaway chambers. 80% of the M3J9 scheme area, lying to the south of the River Itchen, drains to infiltration features.

The remaining 20% of the existing M3J9 carriageway and cuttings area, which comprises 3.4ha of A33/A34 carriageway lying to the north of the River Itchen, drains to the River Itchen or its immediate floodplain, via highway drainage ditches.

For details of the existing highway drainage catchments, refer to the following M3J9 drawings in Appendix F.

- HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0515 Existing Highway Surface Water Catchments Overview Plan

i. Existing Soakaways

Existing highway soakaways serving the M3J9 mainline carriageway, verge & diverge lanes and gyratory are maintained by National Highways. Soakaway features draining two carriageways off the M3J9 gyratory fall under Hampshire CC's ownership; Easton Lane; and the A272 Spitfire Link Road.

The National Highways online asset database (HAGDMS) shows the condition status of all existing highway soakaways as 'low risk' or 'risk addressed'. At the time of writing, the performance of existing NH/HCC soakaways is assumed to be adequate for retention where appropriate within the scheme, such as retained verge lanes and retained gyratory exit carriageway. It is proposed that all soakaways that are retained, will be assessed and tested to confirm performance and capacity.

Please refer to Appendix KL - Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0003 - Renovation and Decommissioning of Existing Highway Soakaways, for details of the methodology for testing and renovation of existing highway infiltration drainage.

ii. Existing Pollution Control

One pollution control device (PCD) exists in the existing M3J9 area, which is located just upstream of River outfall 8, on drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0515 in appendix F. The PCD serves Existing Catchment 8, the A33 southbound approach to M3J9 from the northwest, and is located on the southern bank of the River Itchen. The PCD comprises an open ditch of approximately 60m^3 capacity, which terminates in a penstock, a full-retention interceptor and a 300m dia. piped outfall to the River Itchen. The PCD is intended to be retained, subject to inspection and renovation (details included in Appendix K). Flows from the new scheme will pass through new PCDs, will be attenuated and treated in extended detention basins, passing through the retained PCD and existing river outfall.

Catchment No.	Catchment Area (ha)		Total Net Catchment (ha) note 2	Outfalls to	Notes
	Impermeable	Permeable			
1	0.581		0.581	River Outfall 1	via NH ditch in floodplain
2	0.208		0.208	River Outfall 2	via NH ditch in floodplain
3	0.115		0.115	River Outfall 3	via NH ditch in floodplain
4	0.325		0.325	River Outfall 4	via NH ditch in floodplain
5	0.295		0.295	River Outfall 5	via NH ditch in floodplain
6	0.374		0.374	Soakage Trench/River	Overflow from soakage trench to R. Itchen
7	0.656		0.656	River Outfall 7	via NH ditch in floodplain
8	0.487	0.401	0.567	River Outfall 8	via PCD east of A33 SB
9	1.121	0.070	1.135	Soakaway Trench	Soakage trench alongside Industrial units
10	0.277		0.277	Soakaway Trench/Chamber	Soakaway Trench/chamber located in NH depot area
11	0.678		0.678	Soakaway Chambers	Soakaway chambers around gyratory (incl Tesco subway)
12	2.893	2.090	3.311	Soakaway Trench	M3 corridor
13	1.290	1.346	1.559	Soakaway Trench	M3SB to existing overland flow basin
14	0.359		0.359	Soakaway Trench	Soakaway chambers around gyratory
15	0.231		0.231	Soakaway Chambers	NH Soakaway chambers on Easton Lane
16	0.984		0.984	Soakaway Trench	A272 'Spitfire' link road
17	0.762		0.762	Soakaway Trench	M3 corridor
18	1.502	0.487	1.599	Offline Soakaway Chambers/Trenches south of M3J9, with some throughflow to M3J9	SMP drained area, incoming to M3J9 network
TOTALS	**13.14**	**4.39**	**14.02**		

Table 4.4 - Existing Drainage Catchments

Table 4.4 Notes
1. Permeable catchments comprise cuttings draining to carriageway
2. Runoff coefficient of permeable catchments assumed to be 20%
3 Runoff coefficient of impermeable catchments assumed to be 100%

Overland Drainage

Existing overland flows from SDNP to the east of M3J9 are captured in existing soakaway trenches against the eastern side of the existing M3 earthworks, or piped under the M3 corridor via an existing 300mm dia. culvert. Refer to Section 9 for further information on existing external catchment overland flow rates and volumes.

iii. Existing culverts

- A 300m dia piped culvert passes under the M3, just north of marker post 101/6. This culvert conveys overland flow from approximately 13.9ha of arable land east of the M3, to the River Itchen floodplain to the west.

  The existing culvert has a capacity of 255 l/s. The peak 100-year overland flow from the 13.9ha overland catchment has been calculated as 30 l/s and the culvert would therefore be considered suitable to retain. However, it is proposed to impound the existing overland catchment with new M3J9 fill deposition earthworks to the east of the M3, so the existing culvert will be retained without any flows, apart from exceedance, overland flows from Basin 6, in events exceeding 100-year + 40%CC

  Due to the proposed widening of the mainline carriageway, the existing culvert will be extended from the upstream and downstream ends to ensure that access is maintained under the M3. The condition of the existing culvert will be confirmed by further drainage survey. The extended length of the culvert will be approximately 110m, and so an intermediate manhole will be incorporated in the verge of the M3NB on-slip carriageway in order to m maintain a maximum culvert length of 76m between access points.

4.5 Watercourses and Related Features

The River Itchen flows in a south-westerly direction towards Winchester, comprising several channels, with tributaries and land drainage, or highway drainage ditches within its flood plain.

i. Main River

The Itchen is classed as Main River at the location where the main river channel crosses under the A33 & A34 southbound approaches to the M3J9 (Figure 5.5).

ii. Ordinary Watercourses

All other watercourse channels and ditches on floodplain are either highway drainage ditches alongside the A33 & A34 highway embankments, or are ditches draining pasture. All watercourse channels and highway ditches are confirmed by HCC (LLFA) as Ordinary Watercourses under their regulation (Figure 5.5). Ditches that drain the A33/A34 highways are also recorded as National Highways drainage assets on the HAGDMS online database (Figure 5.5).

The river channels flow through the River Itchen Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI) and the South Downs National Park (SDNP). The northern part of the M3J9 works lies adjacent to the River Itchen SSSI and SAC. The A34 and A33 cross the River Itchen flood plain to the south of Kings Worthy village, approximately 1km north west of M3 Junction 9. The M3 motorway crosses the River Itchen to the east of Kings Worthy, approximately 2km north of Junction 9, outside of the M3J9 works. To the south of Junction 9, the River Itchen continues to flow in a south-westerly direction from Winchester towards Southampton Water and The Solent, approximately 20km downstream of the scheme.

The scheme is also located near Nuns Walk Stream (Figure 4.5), a tributary of the River Itchen classed as main river, which flows in a southerly direction approximately 250m to the north-west of the scheme. Nuns Walk Stream continues to flow in a southerly direction to join the River Itchen approximately 1.25km to the south-west of the M3J9 scheme.

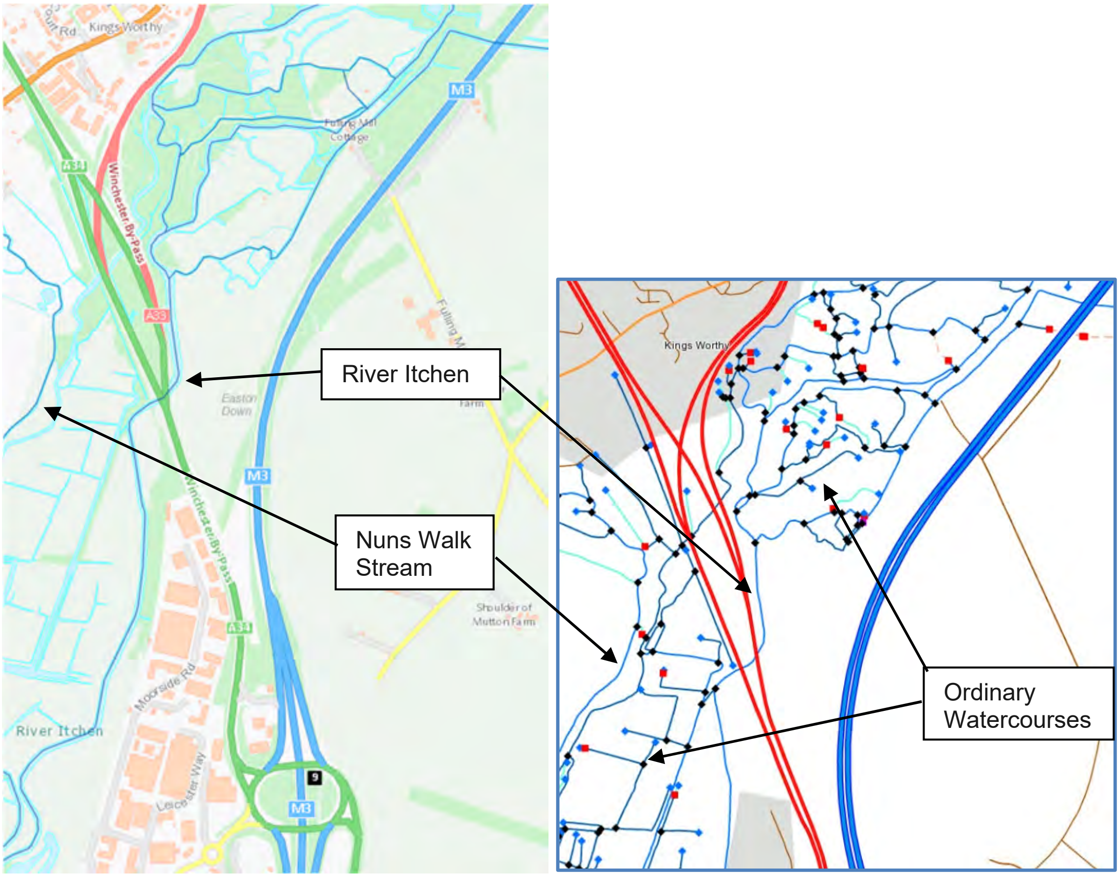


Figure 5.5 – Main Rivers & Ordinary Watercourses

5 Highway Proposals

5.1 Global Carriageway Areas summary

Areas of new, retained and abandoned carriageway across the whole scheme are indicated in Table 5.2 and drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512_Drainage Schematic Plan, which is included in Appendix D.

5.2 Proposed Catchments & Discharge Rates

Proposed M3J9 Highway Catchment areas and discharge rates are summarised in Table 5.2 and in drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 Catchment Overview Plan in Appendix F.

Retained (overlaid) Carriageway (ha)	Abandoned Carriageway (ha)	New (additional) Carriageway (ha)	Proposed Carriageway to River Itchen (ha)	Proposed carriageway to soakaways (ha)	Area of Cutting draining to carriageway drainage (ha)
12.3 *1,2	**1.1**	**9.1** *1,2	**14.3** *1,2	**7.1** *3	**10.5** *1

*1 (includes M3 Junction 9 to 14 Safety Barrier Improvements Scheme which contributes inflows to M3J9)

*2 (includes new A33/A34 verge modifications north of River Itchen)

*3 (includes existing M3 Junction 9 to 14 Safety Barrier Improvements Scheme & A272 areas to retained soakaway trenches)

Table 5.2 – Global M3J9 Drained Areas Summary

5.3 Rationale for Discharge Rates

Previous scheme discussions with EA and HCC had established the following limiting-runoff criteria:

a) For new carriageway areas alongside existing, retained carriageway (i.e. 'online' carriageway), which increase an area drained to retained, existing highway drainage, the existing discharge rate from the existing carriageway area is to be retained.

b) For wholly new carriageway areas (ie new 'offline' carriageway), the discharge of drained carriageway is to be limited to the equivalent greenfield runoff rates.

The large majority (80%) of the existing M3J9 interchange drains to existing soakage features, such as soakaway trenches and pits, which were constructed in the 1970s and 1980s. Most runoff to ground drains to one significant soakaway trench, running parallel to the single low-point in the M3 within the scheme, near the National Highways depot (For a location plan, refer to Figure 5 in Appendix I; Technical Note - *Proposed M3J9 Runoff Pollution Assessment Method and Control Measures*). It is Stantec's view that the current capacity of the existing soakage infrastructure serving the M3J9 would not be able to be justified using current standards of infiltration design.

The new Stantec scheme proposes to construct a new M3 off-slip highway embankment over the existing M3 soakaway trench above, which will render the soakaway obsolete.

A review of geotechnical information (Table 9.6 in Appendix M - HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0001) indicates that soil infiltration rates in underlying Alluvium and Chalk are expected to be at the lower limit of practical use (1×10^{-6} m/s). As discussed in Section 3.2, it is considered unlikely that infiltration rates will be sufficient to allow infiltration-only drainage features to practically dispose of new M3J9 runoff volumes to ground in the space that is available within National Highways ownership and out of Flood Zone 3.

It is therefore anticipated that runoff volumes from the proposed M3J9 areas will primarily discharge to the River Itchen and that infiltration will be maximised during conveyance and attenuation, wherever possible.

Consequently, new M3J9 drainage will result in an increase in the volume of runoff to the watercourse network from the existing condition, which is akin to greenfield as most existing runoff drains to ground, albeit without complying to current design standards. As such, new highway runoff will fall into the category of 'Long-Term Storage', as defined in The SuDS Manual, Section 3.3.1, Part b), Clause 1. The discharge of Long-Term Storage volumes of runoff is limited to 2 l/s/ha.

In summary, Stantec propose to discharge runoff in accordance with the following principles:

1) Highway runoff that is conveyed to a new outfall to the River Itchen is to be attenuated as Long-Term Storage and limited to 2 l/s/ha.

2) Existing carriageway which is retained and overlaid (with no increase in drained area) is to be discharged at existing runoff rates through existing highway drainage infrastructure.

3) Widenings to existing carriageway shall drain onto the existing carriageway surface, which shall continue to discharge via the existing carriageway drainage infrastructure. The existing drainage infrastructure will be modified to maintain existing discharge rates. Where crossfalls dictate, existing carriageway draining onto new widenings shall be treated in a similar way; modify existing highway drainage to achieve no increase in existing discharge rates and no-flooding in the DMRB critical duration design event of 5-year + 20%CC design event.

5.4 Comparison of Proposed Discharge Rate to Greenfield Runoff Rates

Section 10 of this report identifies 210ha of overland flow catchments to the east that are intercepted by the existing M3J9 earthworks, which drain to ground. The same catchments will continue to be intercepted by the proposed M3J9 scheme and drain to ground. Proposals for the disposal of overland flows to the east of M3J9 are proposed in Section 9.

Existing 100-yr greenfield runoff rates per hectare of overland flow are calculated in the range 1.5 l/s/ha – 1.80 l/s/ha, with an average overland flow rate/hectare of 1.7 l/s/ha (Table 9.1 & Appendix H).

In order to demonstrate that a proposed discharge rate of 2 l/s/ha for the M3J9 works does not result in an increase of flow to the River Itchen above natural catchment flows, the following reasoning is offered.

The total footprint of new M3J9 highway works draining west to the Itchen = 18.65ha

The total overland catchment intercepted by M3J9 = 206.40 ha

<u>Considering the 100-yr condition</u>

The natural catchment 100-yr overland flow that would pass the western edge of the works = (206.4 + 18.65)ha x 1.7 l/s/ha = **382.6 l/s**

In the presence of the M3J9 works, the 100-yr overland flow passing the western edge of the works = 18.65 ha x 2 l/s = **37.3 l/s**.

The presence of the M3J9 works therefore result in a 90% reduction in the natural 100-yr overland flow contribution to the River Itchen passing the western edge of the works, after accounting for a proposed discharge rate of 2 l/s/ha from the works themselves.

Considering the 1-yr condition.

The natural catchment 1-yr overland flow passing the western edge of the works = (206.4 + 18.65)ha x 0.46 l/s/ha = 103.5 **l/s**

In the presence of the M3J9 works, the 1-yr overland flow passing the western edge of the works = 18.65 ha x 2 l/s = **37.3 l/s**.

The presence of the M3J9 works result in a 64% reduction in the natural 1-yr overland flow contribution to the River Itchen passing the western edge of the works, after accounting for a proposed discharge rate of 2 l/s/ha from the works themselves.

The above calculations apply to areas that fall under Principle 1), above, which are areas to the south and east of the River Itchen, and are treated as new discharges to river.

Works to the A33 and A34, west and north of the River Itchen, which are on embankment as they pass over flood plain, comprise the removal of carriageway and overlaying retained, existing carriageway, with local widenings for accesses, resulting in a slight reduction in carriageway area. In this area, Principles 2) and 3) above are proposed, which are to maintain existing carriageway drainage infrastructure and limit discharge to the existing flow rates.

Catchment	Colour	Catchment Type	Catchment Area (ha)	Total Net Catchment (ha)	Outfalls to	Notes
1	Red	Impermeable	0.45	0.58	Basin 1	Attenuation in Basin 1 + restricted outflow @ 4.0 l/s to Basin 2
		Permeable	0.65			
2	Orange	Impermeable	0.16	0.16	Basin 2	Attenuation and Infiltration in Basin 1 + restricted overflow @ 2.0 l/s to River Itchen Outfall 1
		Permeable	0.00			
3	Purple	Impermeable	0.47	0.52	River Itchen (Outfall 2)	Attenuation in geocell + restricted outflow @ 6.0 l/s to River Itchen
		Permeable	0.27			
4	Green	Impermeable	0.91	1.20	Basin 3C	Attenuation + Infiltration in Basin 3C + restricted outflow @ 29.3 l/s to River Itchen
		Permeable	1.45			
5	Blue	Impermeable	0.98	1.24	Basin 3B	Attenuation + Infiltration in Basin 3B + restricted outflow via 200mm dia. pipe to Basin 3C
		Permeable	1.31			
6	Yellow	Impermeable	1.06	1.12	Basin 3A	Attenuation in Basin 3A + restricted outflow via 200mm dia. pipe to Basin 3B
		Permeable	0.30			
7	Pink	Impermeable	5.22	5.59	Basin 4	Attenuation in Basin 4 + restricted outflow @ 125 l/s to Basin 3A
		Permeable	1.82			
8	Dark Blue	Impermeable	0.18	0.18	Soakaway	Recommission or replace existing HCC highway drainage soakaways (Easton Lane)
		Permeable	0.00			
9	Blue	Impermeable	0.95	1.05	Soakaway	Recommission or replace existing HCC highway drainage soakaways (A272 Spitfire Link)
		Permeable	0.49			
10	Purple	Impermeable	0.95	1.05	Soakaway	Recommission or replace existing NH highway drainage soakaways (M3 (Safety Barrier Improvement Scheme) mainline)
		Permeable	0.5			
11	Mustard	Impermeable	0.02	0.02	Soakaway	Recommission or replace existing NH highway drainage soakaways (M3 Gyratory)
		Permeable	0.00			
12	Peach	Impermeable	0.08	0.18	Soakaway	Attenuation and Infiltration in Basin 5
		Permeable	0.49			
13	Lime Green	Impermeable	0.08	0.12	Soakaway	Attenuation in Basin 4 + restricted outflow @ 125 l/s to Basin 3A
		Permeable	0.18			
14	Green	Impermeable	0.94	0.98	Existing M3 Drainage	Upsize (to 450mm/900mm dia.) 200m of M3 central reserve highway drainage + new 185mm dia throttle pipe at tie-in to existing highway drainage.
		Permeable	0.18			
15	Cyan	Impermeable	1.63	2.19	Basin 5	Upsize (to 600mm dia) 98m of M3 verge highway drainage + new 150mm dia throttle pipe at tie-in to existing highway drainage.
		Permeable	2.80			
16		Impermeable	3.34	3.34	Highway Drainage ditches	Retain or modify existing A33/A34 carriageway drainage and retain NH drainage ditches, soakaway trench and outfalls.
		Permeable	0.00			
TOTALS		Impermeable	16.84	18.86	Groundwater + R. Itchen	East of River Itchen; new highway at 2l/s/ha
		Permeable	10.10			West of River Itchen; existing highway @ extg rates

Table 5.4 – Proposed Catchment Areas & Discharge Rates Summary

Table 5.4 Notes:

1) Permeable catchment comprises cuttings draining to carriageway.
2) Runoff coefficient of permeable catchments (cuttings) assumed to be 20%
3) Runoff coefficient of impermeable catchments (c'way) assumed to be 100%

6 Proposed Drainage & Attenuation

6.1 General approach

Refer to the HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 Drainage Schematic Plan in Appendix F for details of proposed highway drainage networks.

The design approach can be categorised into three approaches:

a) New carriageway is to be served by new surface and below-ground highway drainage

b) Where hardening of the central reserve and widening of the carriageway edge are constructed over existing surface or below-ground highway drainage, then that highway drainage will be replaced, as required, to maintain performance and access. Existing highway drainage will be modified, where required, at tie-ins to existing drainage in order to maintain existing discharge rates and no-flooding capacity.

c) Where existing carriageway is overlaid only, then existing surface and below-ground highway drainage is retained.

All new drainage conveys run-off to extended detention basins (EDBs), which infiltrate to ground where the National Highways Water Risk Assessment Tool (HEWRAT) screening and subsequent HgRA, allows. Refer to Section 9.3 for a summary of the HgRA. The HEWRAT screening of risk is included in the Technical Note: Proposed M3J9 Runoff Pollution Assessment Method and Control Measures (Appendix I).

Runoff volumes are attenuated in extended detention basins as far as space and acceptable draw-down times allow. Runoff volumes that are unable to drain to ground within a practical time period are discharged to river at the long-term storage rate of 2 l/s/ha.

Treatment of run-off before discharge is proposed; please refer to Section 9 – Pollution Mitigation.

It should be noted, the design and construction of the M3 Junction 9 Safety Barrier Improvement Scheme was instigated after the M3 J9 scheme received Stage 3 technical approval. Amendments to the proposed M3 J9 have therefore been required to facilitate the revised highway tie in and subsequent additional catchment areas. Details of the proposed drainage design are described in Technical Note HE551511-VFK-HGN-W_XXXX_XX-TN-CH-0014 provided in Appendix P.

6.2 Extended Detention Basins

The M3J9 scheme proposes 6no. new detention basins which are summarised in Table 6.4 below

6.3 Geocellular Tanks

One geocellular attenuation structure is proposed to serve existing and new A33/A34 highway areas close to the River Itchen, where highways levels are too low to drain runoff to EDBs.

A permeable cycle/footpath and/or infiltrating swale are proposed over the geocellular tank, which provide filtration treatment of runoff before entering the geocellular tank.

6.4 Flow Controls

At new river outfalls, it is proposed to use Vortex Flow Controls to minimise upstream attenuation and reduce the risk of blockage. Between basins, flows are controlled in either vortex controls, or, where backflows between basins are required to be facilitated, in 200mm diameter pipes.

The total new highway area, including cuttings, which drains to river is 18.65 ha, which yields an overall allowable flow limit of 37.3 l/s, based on 2 l/s/ha. The overall allowable flow has been apportioned approximately pro rata across new outfalls depending on the new catchment area being discharged to river.

Basin ref.	Type	Source	Storage Volume	Outfall	Comments
1	EDB (**lined**)	Highway	1,536 m^3	To Basin 2	4 l/s flow control
2	EDB (unlined)	Highway	5,540 m^3	To ground + river	To river @ 2 l/s
3A	EDB **(lined)**	Highway	4,365 m^3	To Basin 3B	200mm dia. pipe outlet
3B	EDB (unlined)	Highway	3,020 m^3	To ground + Basin 3C	200mm dia. pipe outlet
3C	EDB (unlined)	Highway	7,650 m^3	To ground + River Itchen	To river @ 29.3 l/s
4	EDB **(lined)**	Highway	2,400 m^3	To Basin 3A	125 l/s flow control. Primary settlement for M3 corridor runoff
5	EDB (unlined)	Rural overland flow + Highway	6,785 m^3	To ground	Serves 2.3 ha of highway + 76.5 ha of overland catchment
6	EDB (unlined)	Rural overland flow	1,058 m^3	To ground	Serves 14 ha of overland catchment.
7	Geocell tank (lined)	Highway	380 m^3	To River Itchen	To river @ 6 l/s

Notes:

1. EDB = Extended Detention Basin

Table 6.4 – Summary of new Attenuation Structures

7 Storm Water Design Parameters

Rainfall Data

2013 FEH point location rain data has been used in calculations, as issued by the UK Centre for Ecology and Hydrology.

Pipe Size Design Criteria

The following return periods and flow criteria have been used when designing pipe sizes:

2 years – no pipe surcharge

5 years + 20% CC – no surface flooding in carriageway

5 years + 40% CC – sensitivity testing for surface flooding in carriageway

30 years + 40%CC – no overtopping of storage structures.

100 years + 40%CC – no flooding outside the National Highways boundary

Climate Change

Generally, 40% Climate Change has been applied to all rainfall events to size attenuation features and test for exceedance flooding. A more detailed account of the application of climate change allowances in the design is given in Appendix N – Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001 Climate Change allowances applied to Drainage Design & Exceedance.

Drained Areas

All positively-drained impermeable areas and infiltration basin footprints have been accounted for in pipework and attenuation calculations.

Permeable Cutting Slope areas draining to adjacent carriageway have been accounted for in highway drainage and attenuation calculations.

The full extent of overland catchment areas (permeable and impermeable) are accounted for in overland infiltration basin calculations. Overland flow volumes, which are impounded by the highway improvements scheme earthworks, but not drained by highway drainage, have been calculated using FEH Catchment Characteristics and ReFH2 software (v 3.2) by Wallingford HydroSolutions.

PIMP Coefficient

A PIMP value of 100% has been used in hydraulic calculations for highway drainage.

Runoff Coefficients

A runoff coefficient of 1.0 has been used for all positively-drained hard surfaces for the calculation of pipework sizes and attenuation volumes.

A runoff coefficient of 0.2 has been used for all permeable cutting slope surfaces that drain to adjacent carriageway for the calculation of pipework sizes and attenuation volumes.

It should be noted that SPRHost values (specific runoff coefficient) in the range 4%-10% are indicated in FEH catchment characteristics for the M3J9 area. As such, the design assumption of a 20% runoff coefficient for drained cuttings is considered sufficiently conservative for short-term and long-term conditions.

Minimum velocity

A minimum self-cleansing flow velocity of 0.75 m/s in the 1-year design event has been used to design conveyance pipework.

7.1 Hydraulic Calculations

Microdrainage computational fluid dynamics software (ver. 2020.1.3) has been used to model the proposed storm water network in the design conditions above. Refer to Appendix G for a summary of the Microdrainage calculations for the drainage networks and attenuation structures during the following design events

- 5yr + 20%CC (for no carriageway-flooding)
- 5yr + 40%CC (for no carriageway-flooding sensitivity to climate change)
- 100-year + 40%CC (for attenuation design)

7.2 Exceedance Flows & Network Resilience

Routes of exceedance flows from the drainage network are considered in two scenarios

a) Overwhelming of the network, which is otherwise operating normally, during storm events that exceed the design criteria.

b) Surcharging to surface which arises from deficiencies in network operation (ie. blockages) during normal design events. Refer to Section 8.3 below for details.

   An assessment has been made of the effect of 50% pipe blockages at the following critical locations in the M3J9 drainage network. These locations have been chosen for assessment because there would be no out-flow route if network capacity were compromised by a blockage.

   - Low point in the A34 Southbound approach to the A34 underpass (western portal)
   - Low point at the A33 NB approach to the A33 underpass (southern portal)
   - Low point drainage exit of M3 Mainline
   - Outlet of Basin 4 (M3 mainline)
   - Low point of WCH (east of gyratory)
   - Low point of WCH (west of gyratory)
   - Drainage exit from low point of M3SB diverge in cutting
   - Drainage exit of geocellular storage in WCH between A34N and A34S
   - Drainage exit from low point at M3NB diverge.

Exceedance flows arising from Scenario a) are considered in Appendix N: Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001 Climate Change allowances applied to Drainage Design & Exceedance

Exceedance flows arising from Scenario b) are considered in Appendix L; Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0002 Drainage Network Resilience to Critical-Location Blockages

7.3 Drain-Down Times

BRE Digest 365 – Soakaway Design states that *'the soakaway should discharge from full to half-volume within 24 hours, in readiness for subsequent storm inflow'.*

BRE 365 recommends that soakaways are designed to a return period of 10 years in areas that can tolerate surface flooding, and to 100 years in areas where surface flooding would result in damage to buildings or utility infrastructure. The return period, or duration, of the '*subsequent storm inflow'* following the design event, is not specified in BRE 365, so it is unclear what event the 24hrs' draw-down is intended to accommodate. The BRE 365 rule would only be meaningful if a storage feature fully fills during the design event, and if the design event duration is, typically, less than 24 hours. The design events that result in the highest water levels in M3J9 basins are often greater than 1 day and in some cases, are up to 7 days long. Some basins in M3J9 do not fully fill in a design storm, nor do they each fill to their highest in the same design event. Furthermore, many of the M3J9 infiltration features (extended detention basins) interact dynamically in series, and catchment areas are shared across a number of these interacting basins. All of these factors make the half-drain calculation meaningless for individual components, and more applicable to the system as a whole.

DMRB document CD 530 – Soakaway design, recognises these aspects and allows the 50% attenuation volume (after 24 hrs draw-down) to be present also within the network, upstream of the attenuating feature.

Notwithstanding the issues of applicability of the BRE 365 half-drain rule, Table 7.3 indicates an assessment of the draw-down times in basins and available attenuation volumes, following the specific 100-year design event, which results in the highest water levels.

All basins that drain new highway are able to meet the BRE 365 general draw-down rule. There are two basins whose catchments comprise either entirely overland area (Basin 6) or a combination of highway and overland areas (Basin 5). These basins are formed in the natural landscape, or in areas of M3J9 fill-deposition, and are primarily required to intercept overland flow from an arable landscape. In these basins, the extent of draw-down is less than 50% after 24 hrs. Basin 5 has 30% fee volume 24 hrs after the design event, Basin 6 has 20% fee basin volume. In order to put into context the free basin capacity that is available after 24 hrs, the following rationale is offered.

The critical-duration design event for Basins 5 and 6 is the 100-year, 6-hour storm, which has a rainfall depth of 60.6mm (FEH Web Service data at SU 49800 30800). The separate storm event that would produce runoff equivalent to the available attenuation volume at 24 hrs after the design event, has been calculated, as below:

<u>Basin 5</u>

- Rainfall depth of 30% x 60.6mm would be yielded typically by a 30-year, 15-minute event, or a 1-year, 6-hour event.

<u>Basin 6</u>

- Rainfall depth of 20% x 60.60mm would be yielded by a 5-year, 15-minute event, or a 1-year, 90-minute event.

The designer, Stantec, proposes that the demonstrated capacity for follow-up events is appropriate for the following reasons:

1. Conservatively, the likelihood of a 100-year event followed immediately by a 5-year event is in the order of a 1 in 500 years event, not accounting for the no. of days in a year, which would make it less likely. This is a design standard that is much in excess of the 100-year design criterion.

2. The existing low points in the landscape against the M3J9 embankment, which currently drain the same catchments, which Basins 5 and 6 would replace, currently show no evidence of prolonged standing water. It is therefore evident that the infiltration rates in these locations are better than the conservative assumption used so far (1 x 10^{-6} m/s) and that the rural-runoff volume calculated using ReFH2 modelling, is less than predicted. It is therefore likely that 50% draw-down times would be more rapid in reality.

Infiltration rates are to be verified with site investigation. Their impact on drain-down times will be checked when results available. Half drain-down times are indicated in Table 7.3 below based on the current infiltration rate assumption.

Basin ref.	Type	Volume	Critical-duration Design Event (max. level)	Time to reach half-empty level	Vol. of attenuation available @ 24hrs + vol of upstream network	Compliance with A) *half-drain within 24 hrs' or,* *B) 50% volume available @ 24hrs incl. upstream network*	Comment
1	EDB (lined)	1,536 m^3	M100-1day	1.8 days	998m^3 above 49.305 m + 48m^3 upstream	Complies with B)	Primary settlement for A33/A34/M3 merge
2	EDB (infiltrating)	5,540 m^3	M100-7days	4.7 days	3,862m^3 above 41.995m + 1,568m^3 upstream	Complies with B)	To ground and to river @ 2 l/s
3A	EDB (lined)	4,365 m^3	M100-24hrs	10 hrs	n/a	Complies with A)	
3B	EDB (infiltrating)	3,020 m^3	M100-36hrs	26 hours	n/a	Complies with A)	
3C	EDB (infiltrating)	7,650 m^3	M100-4days	2.3 days	3,107m^3 above 42.419m + 10,978m^3 upstream	Complies with B)	To river @ 29.3 l/s. would need to increase to at least 44.3 l/s to half-drain in 24 hrs.
4	EDB (lined)	2,400 m^3	M100-4hrs	4 hrs	n/a	Complies with A)	
5	EDB (infiltrating)	6,785 m^3	M100-6hrs	9.5 days	1,521m^3 above 52.867m + 503m^3 upstream	30% attenuation vol. available at 24hrs following 100-year design event (approximate equivalent of a 30-year, 15-minute storm).	To ground @ 1x10^{-6}m/s (tbc). Serves 2.3 ha of highway + 76.5 ha of overland catchment
6	EDB (infiltrating)	1,058 m^3	M100-6hrs	4.5 days	122m^3 above 65.706m 94m^3 upstream	20% attenuation vol. available at 24hrs following 100-year design event (approximate equivalent of a 5-year, 15-minute storm).	To ground @ 1x10^{-6} m/s. Serves 14 ha of overland catchment.

7	Geocell tank (lined)	380 m^3	M100-10hrs	19 hrs	n/a	Complies with A)	@ 6 l/s to river

Table 7.3 – Summary of Half-Drain Times and Attenuation Capacity after 24 hrs

Table 7.3 Notes:

1) EDB = Extended Detention Basin
2) A Factor of Safety of 2.0 has been applied to all infiltration rates in the design of attenuation.
3) Design Infiltration rate of 1 x 10^{-6} m/s to be verified by site investigation.

8 Pollution Mitigation

The Stantec Technical Note ***Proposed M3J9 Runoff Pollution Assessment Method and Control Measures*** (Appendix I - Ref: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003) has been prepared to give a comprehensive account of the assessment and mitigation of pollution risk from highway runoff. For details of the proposed M3J9 runoff treatment methods, please refer to the Technical Note above, and also to the M3J9 drainage drawings in Appendix F.

For the purposes of this report, an overview of the proposed runoff treatment is given below in Table 8.1.

8.1 Proposed Runoff Treatment Management Train

Table 8.1 below summarises the components proposed to form a run-off management train:

Source	New highway (runoff to river via EDBs)	New highway (runoff to river via geocell tank)	Overlays and local widenings to existing carriageway (runoff to river via existing highway drainage)	New/Existing carriageway (runoff to groundwater in EDBs).
Treatment	Catchpits + PCD + Sediment Forebays	Catchpits + PCD+ Sediment Forebays + swale + unsaturated zone over geocell tank		Catchpits + PCD + Sediment Forebays
Attenuation + Treatment	EDBs (incl. Surface Flow Wetland) + swale	Geocellular Attenuation Tank	existing drainage ditches alongside highway embankments.	Filtration and bio-degradation in macrophyte (root zone) layer and unsaturated zone
Outfall	2 l/s/ha to River Itchen	2 l/s/ha to River Itchen	Existing (brownfield) runoff rate to existing highway drainage	Infiltration at 1 x 10^{-6} m/s

Table 8.1 – Runoff Treatment Management Train

8.2 Requirements for discharges to a SSSI or SAC

The HEWRAT screening in the Technical Note: Proposed M3J9 Runoff Pollution Assessment Method and Control Measures, indicates one EDB (Basin 3A), which potentially presents a High Risk to groundwater and one EDB (Basin 4), which potentially presents a Medium Risk to groundwater. HEWRAT outputs also indicate that EA approval is required for flows within areas of SAC or SSSI. Refer to the separate Stantec HgRA report (Appendix J) for a refined risk assessment of runoff discharges, which concludes that risk to controlled waters from highway runoff pollution is low.

8.3 Hydrogeological Risk Assessment

In order to provide a more detailed assessment of hazards to controlled waters, where the HEWRAT screening identifies elevated levels of risk, a separate Hydrogeological Risk Assessment (HgRA) has been undertaken. Please refer to Stantec document 330610074R1 M3 Junction 9 DQRA, included in Appendix J of this document.

The HgRA has followed the Environment Agency's Remedial Targets Methodology (RTM). A Level 2 assessment has being undertaken, which considers attenuation processes within the unsaturated zone and dilution within the saturated zone. The input to the RTM is source concentrations for acute and chronic risk is based on HEWRAT Step 2 output (i.e. representative concentrations within the Extended Drainage Basins). Outputs from the RTM model are predicted concentrations at the identified receptors. A sensitivity analysis is provided to demonstrate the effect of uncertain parameters on the assessment. The objective of the RTM assessment is to assess the degree of risk posed to groundwater from the EDBs, which are installed over superficial deposits or directly over chalk and have a variety of unsaturated zone thicknesses.

Where the HEWRAT screening indicates a High Risk to groundwater, it is proposed that the EDB will be lined, thus preventing discharge to groundwater. On this basis the HgRA has been undertaken to further assess the risk from the un-lined EDBs. The conclusions of the HgRA are as follwos:

- Acute risk from soluble contaminants present in the EDBs has been assessed as low. The contaminant concentrations in the EDBs, as derived from the HEWRAT assessment are below the UK DWS and thus pose no significant risk to groundwater.
- The models demonstrate that none of the EDBs are likely to result in an impact on groundwater from determinands present within the sediment lining the base of the EDBs (chronic risk).
- For the hazardous PAH compounds, the aqueous source term concentration leached from the EDB sediments is limited by the determinand pure phase solubility and the fact that these determinands are highly sorbed onto the sediment matrix. Thus, concentrations leaching from the sediment are modest. The HgRA model shows that there is likely to be a sufficient thickness of unsaturated zone, comprising material with sufficient organic carbon content to provide sufficient attenuation and ensure that there is no discharge of PAH compounds to the water table.
- Copper and cadmium also sorb highly to the EDB sediment such that aqueous concentrations in the EDBs are unlikely to reach concentrations that would cause pollution of groundwater. Predicted aqueous source term zinc concentrations are higher, but attenuation within the unsaturated zone, combined with dilution in the receiving groundwater is sufficient to ensure there is no pollution by this determinand.
- Once the following data from site-investigation works are available, the HgRA should be reviewed and updated based on the complete dataset.

- Time series data on the depth of the water table, to provide more confidence on the unsaturated zone thickness at each of these structures.

- Infiltration tests at the proposed EDB locations, which will inform the unsaturated zone hydraulic conductivity.

- testing for organic carbon fraction, which will refine the DQRA model and inform predictions of the risk to groundwater from the Scheme's drainage design.

9 External Catchments

9.1 Overland Flow Routes

Three overland flow routes, from existing rural catchments W, X and Y, are intercepted by the M3J9 Improvements scheme. Drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0514 - Overland Flow Catchment Plan (Appendix F) indicates catchment areas and the locations where flow routes are intercepted by the M3J9 scheme. Table 9.1 indicates the 1-year and 100-year runoff rates and volumes at those locations. All characteristics have been calculated using ReFH2 software and FEH Catchment parameters. Refer to Appendix H for ReFH2 calculation summaries for each overland catchment.

Refer to Section 8.3 Drain-Down Times, for discussion on the ability of overland catchments to drain to ground to the east of the M3J9 scheme.

Catchment W

Overland flow from Catchment W (13.9ha) currently passes under the M3 though the existing 300mm dia. culvert at marker 101/6. It is proposed to maintain and extend the existing culvert from the upstream end and downstream ends in 450mm dia pipe, to the extent of the new widened M3 corridor. Catchment W is proposed to be intercepted by a future landscape bund running alongside a public right of way that runs along the top of an area of fill deposition, parallel to the widened M3. The new landscaping will reduce the area drained through the culvert to a negligible amount. Catchment W will drain overland to proposed infiltration Basin 6, then through a depth of engineered filter media within the wider, fill deposition to the underlying natural chalk (refer to the Drainage Schematic Layout in Appendix F).

Catchment X

Overland flow from Catchment X (76.5ha) currently accumulates in the valley bottom of Catchment X impounded by, and to the east of, the existing M3 southbound carriageway. Overland flow from Catchment X will continue to be impounded by a proposed landscape bund to the east of the proposed M3 Southbound off-slip embankment. It is proposed to allow the impounded runoff volume to infiltrate into near surface geology via proposed infiltration Basin 5, formed by the existing topography of the natural landscape.

If monitoring post-construction indicates excessive draw-down times, drainage of the accumulated overland flow volumes in Basins 5 to near surface soils will be facilitated by the installation of either an infiltration blanket or deeper soakaway features. Infiltration rates are to be verified by further geotechnical investigation.

Catchment Y

Catchment Y (116ha) is an existing overland catchment that drains to an existing soakaway trench alongside the A272 'Spitfire Link' Road (east exit from the gyratory). It is not proposed to modify the provision for Catchment Y, which falls outside of the M3J9 Improvements scheme.

Catchment	Descr.	Area	1-year Runoff rate		100-year Runoff rate		100-year Runoff Volume	Disposal
		(ha)	(l/s)	l/s/ha	(l/s)	l/s/ha	(m^3)	
W	Arable Farmland	13.9	7	0.50	25	1.8	290	Overland runoff volume collected in Infiltration Basin 6, against landscaping bund set back from new M3-SB-diverge cutting. Existing 300mm dia, culvert @ 101/6 to be extended to extent of new embankment, but catchment to culvert will be cut off by new fill-deposition. No overland flow proposed in retained culvert.
X	Arable Farmland	76.5	42	0.55	141	1.8	4,900	To continue to be accommodated by infiltration Basin 5 in the existing valley bottom.
Y	Arable Farmland	116	47	0.41	169	1.5	2,230	No change. Outside M3J9 works. Overland runoff volume to continue to be disposed to ground via NH soakaway trench
			Ave	**0.46**	**Ave**	**1.7**		

Table 9.1 – Overland Catchments – Existing Runoff Characteristics

9.2 Interception of Overland flows above cuttings

Where overland catchments are intercepted by cuttings, landscaped bunds are proposed, setback from and parallel to the top of cutting, with cut-off swales on the upslope side. Overland flows will be intercepted by the swales and conveyed to infiltration basins 5 and 6, for disposal to ground.

10 Maintenance

The Stantec M3J9 Technical Note *Proposed M3J9 Runoff Pollution Assessment Method and Control Measures* (Appendix I Ref: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003) has been prepared to give a comprehensive account of the assessment and mitigation of pollution risk from highway runoff. The Technical Note includes details of the proposed Maintenance Schedule for the M3J9 proposed drainage system.

Please also refer to the Scheme drainage drawings in Appendices D & F for locations of components requiring critical periodic operational checks such as catchpits, sediment forebays, basins, geocellular tanks and flow control chambers. A Sediment management regime is proposed to maintain attenuation volumes and minimise the build-up of contaminants. The sediment removal regime will need to be adjusted to suit the actual, monitored rates of sediment accumulation, once the M3J9 highway drainage is operational.

Appendix A Historical Consultation Minutes

Jacobs/Environment Agency – 13/06/2019

Jacobs/Hampshire County Council – 27/06/2019

Environment Agency - EIA scoping response - 19/11/2020

Meeting Minutes

1180 Eskdale Road
Winnersh, Wokingham
Reading RG41 5TU
United Kingdom
T +44 (0)118 946 7000
F +44 (0)118 946 7001
www.jacobs.com

Subject	**Drainage and Water Environment Meeting**		
Project	M3 Junction 9 Junction Improvements		
Project No.	B229H180	**File**	HE551511-JAC-EWE-0_00_00-MI-LE-0001
Prepared by	Simon Palmer	**Phone No.**	01189467443
Location	Jacobs Winnersh	**Date/Time**	13/06/2019 11:00
Participants	[redacted]: Environmental Coordination Jacobs (LW) [redacted]: WFD Jacobs (SP) [redacted] Hydrogeology Jacobs (MB) [redacted]: Drainage Design Jacobs (JT) [redacted]: Aquatic Ecology Jacobs (JB) [redacted]: Flood Risk Jacobs (DS) [redacted] Water Quality Jacobs (MU) [redacted]: Sustainable Places Advisor Environment Agency (AR) [redacted]: Fisheries, Biodiversity and Geomorphology Environment Agency (JB) [redacted]: Groundwater Environment Agency (MC) [redacted]: Groundwater Environment Agency (SR)		
Copies to	B229H180, Simon Hewitt (SH) Paul Waite (PW),		

Notes		**Action**
1.0	**Pre-meeting** - MC flagged recent (2019) spillage incident associated with a vehicle within vicinity of junction 9. - MB stated that this should be recorded on HADDMS.	MC to provide further details. SP to check HADDMS and flag for uploading if not on system.
2.0	**Scheme update** - LW provided brief update on scheme and programme. Consultation to commence on 2nd July and run for 8 weeks (extended due to holiday period). 1st week will include stakeholder briefing. - DCO application to be issued early 2020.	

	- Changes to red line boundary due to biodiversity mitigation, gantries, signage and construction compound. No change since scoping.	
3.0	- MC at scoping stage checked for dolines and other karstic features in area but area not thought a risk. MD confirmed that such risks would also be picked up in project team desk studies. - MC queried whether underpass would intercept groundwater levels as EA contours suggest levels could be quite near the surface. - MB stated that current evidence including preliminary GI suggests that groundwater levels are lower than suggested by EA groundwater contours so underpass not thought to intercept ground water level, Fluctuations in levels are relatively low due to central valley location/presence of River Itchen. - MC queried depth of subways. LW to confirm.	LW to confirm depths of proposed subways.
4.0	**Drainage update** - JT summarized current drainage strategy. - MC queried whether condition of existing soakaways would be assessed. - JT confirmed that there had been a CCTV and connectivity survey, but that further work to be done to confirm which existing soakaways would be reused and which ones would be replaced. Only existing soakaways marked for reuse will receive condition assessment. - MB queried methodology / guidance from EA for decommissioning soakaways. - MC confirmed that he would provide this guidance. - MB clarified that no drainage works will be within any source protection zones. Only impacts associated with gantries and signage. - JT confirmed that only catchment 1 will discharge to the River Itchen. The permeable and impermeable contributing catchment areas will increase however discharge will be limited to existing runoff rate, attenuated via a pond (exact location to be confirmed). All other catchments are to discharge to soakaways or infiltration trenches. A cut off/infiltration ditch is proposed at one location to intercept natural catchment surface runoff as well as receive highway drainage. - AR queried whether the outfall to River Itchen could be replaced with discharge to ground. - JT confirmed that standard practice was to, where possible, maintain drainage to existing conditions which is the approach adopted for the scheme.	MC to provide guidance on decommissioning of soakaways.
5.0	**Water Quality Assessment** - MB set out that water quality assessment was being undertaken at earlier than normal stage due to high sensitivity of groundwater and	

	River Itchen as receptors. Methods being carried out In accordance with Highways England guidance HD45/09 – Routine runoff: Discharges to River Itchen - assessment using HAWRAT (HD45/09; Method A) – Routine runoff: Discharges to groundwater, 2 stage: using • Stage 1: Screening assessment (HD45/09; Method C) • Stage 2: EA infiltration tool – Accidental spillage (to surface water and groundwater) HD45/09; Method D - MB explained that HD45/09 methods were developed jointly by HE and EA, based on direct research and monitoring, and is nationally recognised as best practice for highways scheme water quality assessment and design. - MB explained that Method C provides a qualitative screening tool to screen out low risk catchments for further assessment. Tool has been applied to the worst case catchment within scheme. Results show that catchment is (lower end) medium risk. - AR queried if medium risk was across the whole scheme. - MB confirmed that only the worst case catchment had been assessed at this stage so other catchments may be same or lower risk. - MB explained that a further quantitative assessment has been carried out using the EA infiltration tool based on dissolved pollutants copper and zinc. Results have shown that there is a low risk of groundwater pollution suggesting pollution treatment measures are typically not required. - MB explained that the HAWRAT assessment of catchment 1 discharging to River Itchen passes against Water Framework Directive Environmental Quality Standards (EQS) for copper and zinc. Dilution is accounted for based on the River Itchen Q95. Due to the bifurcation of the channel sensitivity testing was carried out on Q95, but a pass against EQS thresholds was shown for all flow rates. Results also pass against runoff specific thresholds for range of other pollutants including hydrocarbons. Results demonstrate no further treatment required beyond what is proposed (including attenuation pond). - For context, MB outlined HE priority outfall assessment strategy which showed that Junction 9 outfalls on a national scale are considered low risk. - SR queried whether this accounted for the sensitivity of receptors. - MB confirmed that this accounted for a range of variables including catchment area, traffic load, depth to groundwater, etc.	

	- MB confirmed that key receptor was the River Itchen as the main groundwater flow direction is to the River Itchen. - EA confirmed this was acceptable. - MB outlines spillage risk assessment (HD45/09 Method D). Results show that junction is at very low risk (<1:1000) and therefore typically spillage mitigation measures are not required. Threshold for mitigation measures discharging to a protected site is 1:200. - MC queries whether further water quality sampling was proposed. - MB confirmed that spot sampling probably of limited value but that background water quality levels would be obtained from the EA where required. - AR queried whether there was baseline runoff quality information for the junction. - MB explained that HAWRAT model produces runoff concentrations based on monitoring undertaken at multiple locations when the model was developed and that this was used as a proxy for concentrations from the junction. - MU confirmed that preliminary findings suggested copper at 0.02 micrograms/l and zinc at 0.05 micrograms/l even with highly conservative dilution factor within River Itchen of 10% of Q95. - JB queried whether the more stringent revised common standards for monitoring water quality standards had been used for the Itchen SAC. - AR requested that the ES specifically highlights construction activities within the source protection zones. - LW confirmed that gantries were proposed within the SPZ. MB confirmed that a piling risk assessment would be provided to ensure no significant impacts to SPZ. Construction compound also within SPZ and impacts dealt with within code of construction practice.	SP/LW to ensure that activities within SPZs are properly highlighted within the ES JB to provide via AR, the revised CSM water quality standards.
6.0	**Groundwater monitoring** - MB outlined ongoing ground investigation and explained that 6 boreholes were being developed and fitted with data loggers to provide ground water level record. Limitations include missing of the winter period.	
7.0	**Flood Risk** - DS explained that as the scheme stands currently, only works within flood zones are associated with a possible headwall refurbishment for the outfall to the River Itchen and installation of gantries/signage although road level unlikely to be within flood zone (tbc). Neither of which would have a significant impact to flood risk and therefore no hydraulic modelling is being carried out.	

	- AR confirmed that fluvial flood risk was not a primary consideration/concern to the EA. - MB outlined that scheme will not affect groundwater flooding but that Kings Worthy and Winchester are highly sensitive areas and so likely to be high on the agenda of stakeholders. This will be covered off within the ES.	
8.0	**WFD** - SP explained that stand alone WFD assessment would be provided covering ground and surface water bodies. Assessment will draw upon surface and groundwater quality risk assessments and piling risk assessment however as risk currently appears low, no specific assessments are required to specific WFD biological elements (macrophytes, invertebrates etc). - MB confirmed that these biological elements are accounted for in setting of EQS levels. - SP explained that planning inspectorate scoping opinion response requested agreement of methodology for hydromorphology assessment with EA. - SP set out that no significant hydromorphological effects were anticipated as impacts to River Itchen limited to the possible headwall refurbishment draining catchment 1 and any change in peak discharge from this catchment. Peak discharge rates are to be attenuated to no more than existing rates. Therefore, no specific hydromorphological assessment is proposed. SP requested confirmation that this was appropriate. - EA agreed that no specific hydromorphological assessment was required. - AR queried whether risk of Otters crossing the carriageway had been addressed. - LW confirmed that surveys had shown that Otters were passing below the road via the road bridges over the River Itchen and were unlikely to use the carriageway so no further mitigation provided. - LW confirmed that all ecological surveys complete with exception of a remaining bird survey visit and bat tree survey. Great Crested Newt E-DNA surveys had come back negative.	
9.0	**AOB** - MB requested confirmation that methodology for water quality assessments were acceptable. - MC requested documentation of methodology to facilitate review and approval. - MB confirmed Jacobs would provide preliminary/draft water quality report with methodology and initial findings. Note that findings are based upon current drainage strategy which is currently at an early stage of design.	MB to provide preliminary groundwater risk

	- MC queried whether total petroleum hydrocarbons and polycyclic aromatic hydrocarbons should be considered. - MB confirmed that PAH are predominantly fixed to sediments. The risks associated with sediments are assessed within the HAWRAT tool. - AR queried whether there was a need for dewatering, as any such activity would need an abstraction license from the EA, as DCO schemes are not exempt. - MB thought that based on preliminary GI results, this was probably not required. - SR queried whether any part of the scheme suffered from high groundwater levels requiring pumped drainage as elsewhere on the A34. - SR queried whether soakaway testing would be carried out on existing soakaways. - JT confirmed any reused soakaways would need to be condition assessed. - MB raised that any soakaway sediment removal would require a special waste license. - AR confirmed that this would be held by the waste carrier. - MB agreed and highlighted that waste acceptance criteria testing would be required on soakaway material which should be referenced in the construction environmental management plan (CEMP).	assessment report. JT to check whether any part of scheme required pumped drainage due to high groundwater levels. LW/SP to ensure reference is made to waste acceptance criteria testing in CEMP.

creating a better place
for people and wildlife

Environment Agency

BY EMAIL:
M3Junction9@planninginspectorate.gov.uk
The Planning Inspectorate
Environmental Services
Central Operations
Temple Quay House
2 The Square
Bristol
BS1 6PN

Our ref: HA/2020/122667/01
Your ref: TR010055-000100

Date: 19 November 2020

Dear Sir or Madam,

M3 JUNCTION 9 IMPROVEMENT - EIA SCOPING NOTIFICATION AND CONSULTATION REG 11.

Thank you for consulting the Environment Agency on the above Scoping Opinion. Our comments are set out below.

Introduction

Overall, we are generally pleased with the scope of the report and the range of topics that have been proposed to be included within the Environmental Statement (ES).

Our primary concerns regarding the scheme relate to the protection of groundwater, and protection/enhancement of the ecological balance and species within the River Itchen and surrounding areas (including biodiversity net gain). The River Itchen is a designated Main River, and the river and the associated floodplain is a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI).

In regard to flood risk, the majority of works are to take place in Flood Zone 1 areas. It seems that only minor works are taking place within the section of road that is located in Flood Zone 3 (i.e. the section of road crossing the River Itchen). Therefore, flood risk is of lesser concern to us at this stage. This may change if later design stages determine that more extensive work will be required within Flood Zone 3.

Our more detailed comments are split into the following three categories based on matters of most concern to us:

1. Protection of groundwater
2. Ecology/biodiversity – River Itchen
3. Flood risk

Environment Agency
Oving Road, Chichester, West Sussex, PO20 2AG.
Customer services line: 03708 506 506
[redacted]

Cont/d..

1. Protection of groundwater

It is our understanding that the applicant proposes to change various aspects of the project including improvements/construction of new bridge structures and reconfiguration of roundabouts and highways.

The proposed operational area rests upon the Seaford, Lewes Nodular, Holywell Nodular and Zig Zag Chalk formations, designated as Principal Aquifers by us. These formations are overlain by Head and Alluvial deposits in some locations, designated as unproductive and Secondary A aquifers respectively by us.

The north east operational area intersects Source Protection Zones 1 and 2 for the Easton public groundwater supply, as well as numerous smaller, private abstraction nearby.

Hydrogeological Risk Assessment

Given the sensitivity of the groundwater environment beneath the IAB, we would expect the Applicant to produce a Hydrogeological Risk Assessment for the development. This assessment would focus on groundwater and receptors that are dependent upon groundwater and potential risks of contamination (land contamination, drainage, piling and excavation).

We note that the Applicant has installed monitoring wells around the proposed site to obtain groundwater levels and groundwater quality. The data sets obtained by these wells could provide the basis for a hydrogeological risk assessment.

Land contamination

With the increased scope for excavation and penetrative works, there is a risk of the mobilisation of potentially contaminated material. There is a risk that unknown contamination could be mobilised into shallow groundwater. Groundwater may then act as a potential pathway to sensitive receptors, in this case ecological receptors or public water supply boreholes.

In addition to the findings of the phase 2 site investigation. We would expect an extensive watching brief around any significant earthworks to ascertain contaminated material and initiate remediation and verification of the site prior to any intrusive works occurring.

Drainage

We support the proposal to assess the use of SuDS in the drainage strategy and hope to see further information within the ES.

Whilst we would not object to the use of SuDs at this site, we expect the Applicant to incorporate a suitable level of pollution prevention measures into the drainage design to ensure that groundwater and drinking water supplies are protected.

With regards to clean roof water, we have no objection to this being discharged to ground. However surface water drainage from car parking areas and roads has the potential to contain pollutants and hazardous substances. We would expect a risk assessment to be carried out to determine the level of treatment required prior to the water from these areas being discharged to ground.

Cont/d..

In Section 14.2.24, the Applicant discusses the travel times in groundwater based upon Source Protection Zone designations. We would remind the Applicant that groundwater travel times in Chalk can be a lot faster than conventional flow rates and that any contamination released in a Source Protection Zone 2 could travel to a sensitive receptor, through groundwater in much shorter period than the prescribed 400 days.

Piling and excavation

It is assumed that with the changes in the proposal that there will be the need for piled foundations and excavations to support the new, proposed structures and reconfigurations. As explained in the comments on land contamination above, these works can liberate contaminated material into groundwater, putting sensitive receptors at risk.

Additionally, they also increase the risk of turbidity. Piling operations and excavations can induce sediment loads into groundwater, this sediment then moves with groundwater flow and had the potential to carry harmful bacteria, and can result in the shutdown of a public water supply.

As such we would expect the Applicant to produce a Foundation Risk Assessment, focusing on the potential hazards of piling/excavation activities on local groundwater, and the methods that might mitigate the risk of those hazards having a detrimental impact.

Dewatering

The scoping report suggests that temporary de-watering may be required in order for construction activities to take place and mentions permits may be required. For information, dewatering is generally no longer exempt from needing an abstraction licence. However there still remains a small scale dewatering exemption in place under Section 5, Part 2 of the Water Abstraction and Impounding (Exemptions) Regulations 2017. Details on this exemption can be found on the following web page: [redacted]

If the exemption cannot be complied, with then an abstraction licence will need to applied for. The licensing process can be fairly lengthy, therefore we recommend early pre-application discussions with us.

An environmental permit may also be required to cover the discharge from the scheme.

Additionally an abstraction licence and/or environmental permit may be required if the cuttings or other works are assessed to intercept groundwater on a longer term basis, and if more permanent passive or active groundwater management mitigation measures will be required. It is understood that groundwater levels are currently being monitored which could be used to assess groundwater levels extremes at the site (if taken over a number of years). As above, we recommend early pre-application discussions with us.

2. Ecology/biodiversity – River Itchen

In relation to Chapter 9 of the report (entitled 'Biodiversity'), we have the following comments:

Table 9-1 (Freshwater Fish and Invertebrates)

We have previously made available to Highways England a copy of a report regarding a Brook Lamprey Condition Assessment for the River Itchen SAC. This should be utilised in regard to the ES. In addition, Environment Agency fish and macroinvertebrate data is now available as open data on the gov.uk website [redacted]

Table 9-1 (Otter)

We have previously discussed with the Applicant reports we have received about recent otter deaths reported on motorways where open central reservation barriers have been replaced with closed concrete ones (M27 and M4/5). Given the close proximity of a recent report of an otter death (on the M27), we strongly recommend that there is scoped in further assessments of otter and other mammal movements in the project area, and the risk of them crossing the roads, with a view to minimising the risks of injuries and fatalities.

Section 9.3

Potential impacts during construction should also include changes in surface water flows (quantity and quality) which lead to or are connected to aquatic habitats.

Section 9.4

We welcome the aim of delivering biodiversity net gain, but feel this shouldn't be an aim but a requirement of the scheme to deliver against the Applicant's own commitments in their biodiversity plan, alongside the aims of national planning policy.

We would welcome further opportunities to discuss biodiversity net gain possibilities in the area of the project. There have been historic discussions about this aspect, with other organisations in attendance (Natural England, South Downs National Park Authority and the Hampshire & Isle of Wight Wildlife Trust), but these did not reach any conclusion as such.

Drainage designs should also ensure no likelihood of detrimental changes in quantity of surface water entering the River Itchen and associated wetland habitat, not just focus on quality of the surface water.

Section 9.5.4

The ES should include changes to surface water flows as a potential for significant effect on the River Itchen SSSI/SAC and other priority habitats.

Section 9.6.10

We welcome the use of the Biodiversity Net Gain metric when assessing biodiversity net gains and losses and that this will be made available to consultees.

Cont/d..

If a Flood Risk Activity Permit (or other permits are required from us), then we will become a Competent Authority under the Habitat Regulations. We request, therefore, that the findings of the Habitats Regulation Assessment (HRA) are presented to us and we are able to review the HRA at the earliest possible opportunity.

In relation to Chapter 16 (entitled 'Cumulative Effects') we have the following comments:

Table 16-1

We consider that there are a number of 'Potential interrelationships between topics' that have been missed from this table. For example, the potential receptor of statutory designated sites has a potential interrelationship with soils and geology, yet this is not ticked (and yet it is for the River Itchen). Climate also has a potential interrelationship with biodiversity with regards to changes in rainfall (and therefore run-off/flooding patterns). This should be re-assessed for the purposes of the cumulative effects chapter of the ES.

3. Flood Risk

As set out in the introduction, we understand that relatively minor works (such as changing road markings) will be undertaken in the section of road within Flood Zone 3 (i.e. the section of the road crossing the River Itchen). Should this change during the detailed design phases, then further considerations will need to be taken account to ensure that flood risk is not increased elsewhere, and we would expect to be specifically consulted in this regard.

We are pleased that a Flood Risk Assessment will be undertaken (Section 5.4.1 of the report), and we would recommend that the 'worst case scenario' is considered for the Flood Risk Assessment (Section 2.6.1 of the report). It should be borne in mind that Climate Change Allowances have been updated in accordance with UKCP18, and the Flood Risk Assessment is likely to need to take account of those.

The latest information and guidance about UKCP18 can be accessed here – [redacted]

Guidance of when and how local planning authorities, developers and their agents should use climate change allowances in flood risk assessments can be found here - [redacted]

In addition to the above, our updated flood model for the River Itchen was completed in 2019.

Both new climate change allowances and the new model should be taken account of in terms of the baseline information for the Flood Risk Assessment, and we would encourage the Applicant to consult with us further in this regard.

Flood Risk Activity Permit

In the report, there is mention of possible works on or near the River Itchen (Sections 9.4.2 and 14.2.20). Any proposed works or structures in, under, over or within 8 metres of the river bank is likely to require a Flood Risk Activity Permit from us under the Environmental Permitting (England and Wales) Regulations 2016.

Further details about Flood Risk Activity Permits can be found on the GOV.UK website using the following link - [redacted].

As construction details are developed, we would recommend early consultation with us regarding any applications for any Flood Risk Activity Permits.

Final comments

Pollution Prevention

All precautions must be taken to avoid discharges and spills to the ground both during and after construction. Ultimately, we would expect to see a Construction Environmental Management Plan (CEMP) specifying any pollution prevention measures that will be incorporated into any works.

Further details regarding pollution prevention for the long-term maintenance of the road post construction should also be included within the ES.

Surface Water

It should be noted that responsibility for surface water matters in terms of quantity and flow lies with the Lead Local Flood Authority (Hampshire County Council). We recommend that they are consulted in regard to the drainage proposals related to surface water.

Our considerations in regard to surface water relate to the potential mobilisation of contaminants, which may impact the Main River and/or groundwater.

Please do not hesitate to contact me using the contact details shown below should any queries arise from the above response.

Yours faithfully,

Miss Anna Rabone
Sustainable Places Advisor

Direct dial: [redacted]
Direct e-mail: [redacted]

Our opinion is based on the information available to us at the time of the request. If, at the time of the submission of the formal DCO, there have been changes to environmental risk(s) or evidence, and/or planning policy, our position may change.

End

JACOBS

Meeting Minutes

1180 Eskdale Road
Winnersh, Wokingham
Reading RG41 5TU
United Kingdom
T +44 (0)118 946 7000
F +44 (0)118 946 7001
www.jacobs.com

Subject	**Drainage and Flood Risk Meeting**		
Project	M3 Junction 9 Junction Improvements		
Project No.	B229H180	**File**	HE551511-JAC-HDG-0_00_00-MI-D-0002
Prepared by	Liz Austin	**Phone No.**	0113 389 1722
Location	Hampshire County Council offices	**Date/Time**	27/06/19 / 10:30
Participants	[redacted] (LA) - [redacted] (GK) - [redacted], [redacted] (VW) – [redacted] (HCC).		
Copies to	B229H180, [redacted] (SH) [redacted] (PW), [redacted] (PJ), [redacted] (JF), [redacted] (MS)	**Apologies**	

Notes		Action
1.0	**Objective of the meeting** LA explained that the purpose of the meeting was to review the design criteria that had been sent prior to the meeting and to find out if Hampshire County Council, as Lead Local Flood Authority, had any specific requirements.	
2.0	**Design Criteria - Flood Risk** VW explained that she had reviewed the flood records prior to the meeting and there has only been flooding to residential gardens recently. VW stated the last significant flooding was in 2014/15 and that it was mainly attributed to groundwater. LA asked VW if there were any minor watercourses or land drainage in the scheme location that would be affected by the scheme. VW confirmed that there were none. The main flood risk for the scheme is from surface water. VW stated that surface water flooding on the carriageway was the responsibility of the highway authority (Highways England or Hampshire Highways). LA highlighted two areas at high risk of surface water flooding on the eastern side of the scheme: 1) At marker post 101/6 +33m – upstream of a 300mm diameter culvert (according to HADDMS). VW explained that current standards state a	LA

	minimum 450mm diameter for culverts. Culvert sizes will be looked at during preliminary design. 2) A272 (approx. 400m south of junction 9) – there is a natural depression into which the local road drainage outfalls towards. LA asked if there was a culvert under the road or an infiltration measure? VW to check. VW reaffirmed the requirement of 1 in 100 year + 40% climate change surface water excess flow paths for the exceedance plan.	VW
3.0	**Design Criteria - Drainage** LA explained that the drainage design will be based on DMRB as outlined in the design criteria issued prior to the meeting. VW confirmed that HCC agreed with the design criteria: a) Attenuation of 1 in 100yr storm +20% Climate Change uplift factor (and assessed against a +40% Climate Change). b) Allowable discharge rates are to be limited to 1 in 1 year greenfield runoff for offline sections. c) Allowable discharge rates are to be limited to the existing highway peak runoff rates for existing online sections. d) Restricted discharge rate of 5l/s. LA asked if there were any requirements for betterment and if FEH data was the preferred rainfall data to use for the drainage design? VW confirmed that HCC did not have any official betterment requirements but stated designing to current standards and limiting discharge rates to 5l/s minimum would be an improvement. VW stated that their review of the design, as part of the DCO application, would be based on FEH rainfall data. FEH data should be used for the design and will need to be purchased from [redacted] Number of catchments to be determined and cost to be approved. The majority of the existing drainage assets are soakaways and infiltration trenches, LA suggested that infiltration may be incorporated into the drainage design depending on the results of the drainage survey and GI. VW reiterated the requirement for pollution control prior to discharge to the ground. VW stated that maintenance regimes for all SUDS and pollution control measures would be reviewed by HCC therefore a copy of the maintenance requirement plans would need to be included within the drainage strategy.	LA

	VW to provide a copy of the checklist HCC use when reviewing planning applications. VW emphasized the need for effective drainage of the subways within the junction as the existing subways have been subject to flooding.	VW
4.0	**AOB** VW stated that a construction surface water management plan will need to be included as part of the DCO submission. Jacobs construction and drainage teams to collaborate on this. A follow up meeting with the EA and Hampshire CC to be arranged once a design has been produced. March/April 2019.	LA, JF

Appendix B Specification for Infiltration Testing

HE551511-VFK-HDG-X_XXXX_XX-RQ-CD-0002 Drainage Infiltration Testing Requirements

M3 Junction 9 Improvements

Drainage Infiltration Testing Requirements

On behalf of **Highways England**

Project Ref: 48176 | Rev: P04 | Date: September 2021

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address:
T: E:

Document Control Sheet

Project Name: **M3 J9 Improvements**

Project Ref: **48176**

Report Title: **Drainage Infiltration Testing Requirements**

Doc Ref: **HE551511-VFK-HDG-X_XXXX_XX-RQ-CD-0002**

Date: **December 2020**

	Name	Position	Signature	Date
Prepared by:	P. Rogers	Drainage Engineer		21.12.2020
Reviewed by:	A. Champion	Principal Engineer		21.12.2020
Approved by:	T. Allen	Associate		21.12.2020
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
P01	21.12.2020	First Issue	PR	AC	TRA
P02	19.07.2021	2nd Issue	PR	AC	TRA
P03	01.09.2021	Feature type INF 24, 25 & 28 amended to manholes	AC	AC	TRA
P04	08.09.2021	INF 5, 6, 14 & 15 amended to suit Basin revision	AC	AC	TRA

This page is intentionally blank

1 Infiltration Testing

1.1 Overview

1.1.1 The Drainage Strategy seeks to infiltrate surface water run-off to ground where possible. Minimal data is currently available regarding infiltration rates on which to form a basis for detailed drainage design.

1.1.2 The aim of the infiltration testing is to identify infiltration rates from new soakage features such as swales and detention basins, which will influence surface attenuation volumes and subsequent basin sizes and earthworks. The assumed values for infiltration so far, are at the lower design limit of 1×10^{-6} m/s. Infiltration rates are likely to be variable, and higher infiltration rates may be identified with the proposed range of testing locations.

1.1.3 At each location, 3 No. tests to BRE 365 will be required, at the same level of the permanent infiltration surface, which is typically 1.5m – 2.5m below finished road or landscaping levels.

1.1.4 Test locations and depths will be informed as the geology at formation level is exposed and identified, and as attenuation or infiltration areas are better defined at the detail design stage.

1.1.5 The schedule provides the purpose of each test, which is either required for use at detailed design stage for existing infiltration areas or is required for construction/validation of proposed infiltration areas.

1.2 Scope and Specification

1.2.1 This document covers the testing of natural strata at new soakaway locations (new-design testing), and the method of testing existing soakaways to verify capacity (verification-testing).

1.2.2 New-Design Testing

For design-testing, guidance on the method for undertaking soil infiltration testing is given in BRE Digest DG 365 (2016).

Each new-design test needs to comprise the following:

- Machine excavate (e.g. JCB 3CX) a trial pit between 1m and 3m long and 0.3m and 1m wide.
- The trial pits are expected to be generally between 1.0m and 2.0m deep, but this is dependent on the geology encountered.
- The trial pit sides need to trimmed.
- If there is a risk of collapse of the sides of the trial pits, then they need to be backfilled with gravel and a vertical observation tube installed.
- The trial pits are then filled with water and allowed to drain fully whilst recording the time and water level at close intervals.
- This needs to be done 3 times at each location on the same or consecutive days.
- Infiltration testing uses a lot of water, so a water bowser or tanker will likely be required.
- The water used must meet the requirements of the Water Supply (Water Quality) Regulations 2018 to avoid introducing potential contamination into the underlying aquifers.

1.2.3 Verification-Testing

For existing soakaway verification-testing, the method for undertaking infiltration testing is proposed below, and is subject to agreement with the asset owner, either Highways England or Hampshire County Council.

Any testing works to Hampshire County Council Assets are to be undertaken within existing Section Agreements between Highways England and Hampshire County Council.

Each verification-test needs to comprise the following:

- For soakaway chamber assets, take 3no. 1kg samples of silt from within the base of the chamber.
- For soakaway trenches, take 3no. 1kg silt samples at the centre of 1/3 sections, at ¾ depth of the soakaway feature. This will require local excavation and reinstatement of the soakaway trench.
- For soakaway trenches, also take a 5kg sample of the aggregate matrix to determine void ratio.
- Test all silt samples for Waste Acceptance Criteria.
- For Soakaway chambers, remove all silt from within the chamber. Inspect and clean infiltration surfaces, replacing any clogged, accessible geotextiles. Dispose of all removed silt to a suitably licensed facility.
- Assess the available volume of each existing soakage feature to be tested. Make available enough clean water (bowser) to fill each soakage feature.
- Fill the soakage feature to full capacity and record draw-down times from 100%, through 75%, 50% to 25% capacity. This may require an inspection well being installed to soakage trenches to enable water levels to be monitored, if no inspection well already exists.

1.2.4 An Infiltration Testing Requirements layout and a Testing Schedule drawing are provided within Appendix A, showing the testing locations, reference numbers, Eastings, Northings and testing levels.

1.2.5 Infiltration testing needs to be coordinated with proposed ground levels and timed when grading and phasing allows testing to be undertaken at the permanent infiltration level.

1.2.6 Infiltration areas are subject to final highway alignment detail design.

1.2.7 Connections between infiltration areas subject to final Drainage design.

1.2.8 Soil Testing:

- To get best value out of the *new-design testing* trial pits, the soils encountered need to be described in accordance with BS5930:2015 and chalk described in accordance with CIRIA C574 and then engineering logs produced.
- Soil samples should be taken at 1m depth intervals comprising 2 large bulk bags in each of the pits for future laboratory testing.

- A set of 3 hand shear vane tests should be undertaken at 0.5m depth intervals in any cohesive strata encountered.
- All soil, descriptions, sampling and testing in a trial pit is to be undertaken to full depth, before water is introduced for BRE 365 testing.

1.2.9 The Geotechnical Contractor is to submit Risk Assessment, Method Statements and Programme of Works for review, prior to the Works.

1.2.10 Key H&S hazards:

- Excavation depths > 1m.

- Working close to live carriageway.

1.2.11 Key Design hazards:

- Creating soft spots at formation within future carriageway (Geo. Contractor to keep *new-design testing* out of carriageway)

2 Deliverables

2.1 Results Schedule

2.1.1 Infiltration Testing Results to be submitted in tabulated format including:

- Test Reference (as per Testing Requirements and Schedule), including test reference location plan.
- Date of Test (DD/MM/YYYY)
- Easting (OS grid m)
- Northing (OS grid m)
- Ground level (mAOD)
- Trial Pit (or existing soakaway chamber/trench) base level (mAOD)
- Trial Pit (or existing soakaway chamber/trench) dimensions (mm)
- Infiltration Test Result 01,
- Infiltration Test Result 02,
- Infiltration Test Result 03,
- Void ratio result for stone matrix samples taken from soakaway trenches.
- Average infiltration rate from Tests 01, 02 and 03, at each location.
- Record any water strikes.
- Record soil descriptions, sampling and testing as the specification above, at each *new-design testing* location.
- Record any damage or required maintenance to existing soakaway structures at each *verification-testing* location.

Appendix A - Drawings

KEY:

- ★ # INFILTRATION TEST WITHIN EXISTING SOAKAWAY TRENCH
- ✪ # INFILTRATION TEST WITHIN EXISTING SOAKAWAY MANHOLE
- INDICATIVE AREAS OF NEW OUT-OF-CARRIAGEWAY INFILTRATION FEATURES
- ⌖ # INFILTRATION TEST AT LOCATION OF PROPOSED SOAKAGE FEATURE. (REFER TO SCHEDULE FOR TYPE AND BASE LEVEL)

NOTES:

1. INFILTRATION TESTS FOR NEW SOAKAGE FEATURES NEED TO TO BE COORDINATED WITH PROPOSED LEVELS AND TIMED DURING GRADING AND PHASING TO ALLOW TESTING TO BE UNDERTAKEN AT THE PERMANENT INFILTRATION LEVEL.
2. INFILTRATION AREAS SUBJECT TO FINAL HIGHWAY DESIGN ALIGNMENT DESIGN.
3. CONNECTIONS BETWEEN INFILTRATION AREAS SUBJECT TO FINAL DRAINAGE DESIGN.
4. REFER TO DRAWING NO.HE551511-VFK-HDG-X_XXXX_XX-SH-CD-0001 DRAINAGE INFILTRATION TESTING SCHEDULE FOR COORDINATES, DEPTHS FOR TESTING AND NOTES OF CONSTRAINTS
5. INFILTRATION TESTS FOR NEW SOAKAGE FEATURES TO BE UNDERTAKEN IN ACCORDANCE WITH BRE DG 365 (2016).
6. INFILTRATION TESTS FOR GEO. CONTRACTOR TO SUBMIT RAMS FOR APPROVAL PRIOR TO THE WORKS. KEY HAZARDS - EXCAVATION DEPTHS > 1M AND WORKING CLOSE TO LIVE CARRIAGEWAY, AND DISPOSE OF CONTAMINATED SILTS.
7. SEPARATE RISK ASSESSMENTS AND METHOD STATEMENTS TO BE PREPARED BY CONTRACTOR AND AGREED WITH HE OR HCC (DEPENDANT ON OWNERSHIP) PRIOR TO WORKS BEING UNDERTAKEN. EXISTING HIGHWAYS ENGLAND SECTION AGREEMENTS AND PROCESSES TO BE FOLLOWED.
8. TESTING RAMS TO BE APPROVED BY EA, PARTICULARLY WITH REGARD TO DISPOSAL OF CONTAMINATED SILTS FROM EXISTING SOAKAWAY CHAMBERS & TRENCHES, WHICH WILL REQUIRE WAC TESTING BEFORE SUITABLE DISPOSAL.
9. LOCATIONS INF1-6 AND 8-16 ARE IN UNDISTURBED AREAS AND COULD CONTAIN ARCHAEOLOGICAL REMAINS. PRIOR TO UNDERTAKING ANY EXCAVATION FOR INFILTRATION TESTING REFERENCE MUST BE MADE TO THE ARCHAEOLOGICAL MITIGATION STRATEGY.

Rev.	Date	Description	Drawn	Chk'd	App'd
P05	08.09.21	INF 5, 6, 14, 15 COORDINATES UPDATED	MP	AC	TRA
P04	01.09.21	INF 24, 25 & 28 TRENCHES AMENDED AS MANHOLES	AC	AC	TRA
P03	29.06.21	TESTING ON EXISTING SOAKAWAYS CLARIFIED	GP	AC	TRA
P02	25.05.21	INFILTRATION BASIN LAYOUT UPDATED	NK	AC	TRA
P01	04.12.20	FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE INFILTRATION AREAS AND INFILTRATION TESTING REQUIREMENTS

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20	Date: 02.12.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HDG - Location X_XXXX_XX - Type DR - Role CD - Number 0506

Project Ref. No. 48176

Revision P05

Infiltration Test Ref:	Type of Test	Road Ref	E	N	EGL (mAOD)	FRL/FGL (mAOD)	Test formation level (mAOD)	Depth (m) to Test formation, from EGL	test result 01 (m/s)	test result 02 (m/s)	test result 03 (m/s)	Average Test result (m/s)	Purpose of Test	Notes
INF 1	BRE 365	A33 (infiltr area)	449,465.384	131,481.663	43.539	39.369	39.069	4.470					New Soakaway Design	Basin 1 base infiltration (See note 11)
INF 2	BRE 365	A33 (infiltr area)	449,458.873	131,440.137	43.607	39.369	39.069	4.538					New Soakaway Design	Basin 1 base infiltration (See note 11)
INF 3	BRE 365	A33 (infiltr area)	449,514.153	131,400.760	50.567	48.604	48.304	2.263					New Soakaway Design	Basin 2 base infiltration (See note 11)
INF 4	BRE 365	A33 (infiltr area)	449,513.523	131,371.840	50.061	48.604	48.304	1.757					New Soakaway Design	Basin 2 base infiltration (See note 11)
INF 5	BRE 365	Overland infiltration basin	449,822.088	130,842.662	51.096	EGL	50.096	1.000					New Soakaway Design	Infilt'n basin in extg valley (Test min. 1m deep from EGL) (See notes 8 and 11)
INF 6	BRE 365	Overland infiltration basin	449,830.280	130,788.393	51.328	EGL	50.328	1.000					New Soakaway Design	Infilt'n basin in extg valley (Test min. 1m deep from EGL) (See note 9 and 11)
INF 10	BRE 365	A34 NB	449,380.737	131,317.575	42.278	40.850	40.550	1.728					New Soakaway Design	Proposed Infiltration Basin 3C (See note 12)
INF 11	BRE 365	A34 NB	449,421.998	131,237.905	43.114	40.850	40.550	2.564					New Soakaway Design	Proposed Infiltration Basin 3C (See note 12)
INF 12	BRE 365	A34 NB	449,457.757	131,194.028	43.534	42.075	41.775	1.759					New Soakaway Design	Proposed Infiltration Basin 3B (See note 12)
INF 13	BRE 365	A34 NB	449,484.143	131,132.407	44.170	42.075	41.775	2.395					New Soakaway Design	Proposed Infiltration Basin 3B (See note 12)
INF 14	BRE 365	M3 SB Diverge	449,718.618	131,505.362	63.463	EGL	62.463	1.000					New Soakaway Design	Proposed Infiltration Basin 6 (See note 11)
INF 15	BRE 365	M3 SB Diverge	449,713.805	131,455.112	63.519	EGL	62.519	1.000					New Soakaway Design	Proposed Infiltration Basin 6 (See note 11)
INF 16	BRE 365	A34 NB bottom of embankment	449,571.801	130,834.084	46.956	EGL	45.956	1.000					New Soakaway Design	Existing Soakaway Trench (See note 12)
INF 18	BRE 365	Easton Lane	449,578.531	130,408.111	60.432			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 19	BRE 365	Easton Lane	449,542.390	130,392.786	60.284			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 20	BRE 365	Easton Lane	449,521.846	130,375.194	60.210			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 21	BRE 365	Easton Lane	449,513.415	130,356.853	59.909			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 22	BRE 365	Easton Lane	449,493.414	130,382.689	60.235			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 23	BRE 365	Easton Lane	449,482.976	130,382.644	59.814			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 24	BRE 365	M3 Northbound	449,642.902	130,156.307	58.155			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 25	BRE 365	M3 Northbound	449,654.958	130,127.124	63.188			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 26	BRE 365	M3 Northbound	449,647.572	130,058.669	64.420			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 27	BRE 365	M3 Northbound	449,641.026	130,023.992	65.292			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 28	BRE 365	M3 Northbound	449,618.767	129,972.025	60.101			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 29	BRE 365	A272	449,730.444	130,086.410	56.950			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench (See note 7)
INF 30	BRE 365	A272	449,760.615	130,066.778	55.678			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench (See note 7)
INF 31	BRE 365	A272	449,750.173	130,038.562	55.806			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench (See note 7)
INF 32	BRE 365	A33	449,348.849	131,743.575	40.544			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench

NOTES:

1. INFILTRATION TESTS NEED TO TO BE COORDINATED WITH PROPOSED LEVELS AND TIMED DURING GRADING AND PHASING TO ALLOW TESTING TO BE UNDERTAKEN AT THE PERMANENT INFILTRATION LEVEL.
2. INFILTRATION AREAS SUBJECT TO FINAL HIGHWAY DESIGN ALIGNMENT DESIGN.
3. CONNECTIONS BETWEEN INFILTRATION AREAS SUBJECT TO FINAL DRAINAGE DESIGN.
4. REFER TO DRAWING NO.HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0506 DRAINAGE INFILTRATION AREAS AND INFILTRATION TESTING REQUIREMENTS.
5. ALL INFILTRATION TESTS TO BE UNDERTAKEN IN ACCORDANCE WITH BRE DG 365 (2016).
6. GEO. CONTRACTOR TO SUBMIT RAMS FOR APPROVAL PRIOR TO THE WORKS. KEY HAZARDS - EXCAVATION DEPTHS > 1M AND WORKING CLOSE TO LIVE CARRIAGEWAY.
7. HAMPSHIRE COUNTY COUNCIL ASSET. WORKS TO BE UNDERTAKEN UNDER EXISTING HIGHWAYS ENGLAND SECTION AGREEMENTS WITH HAMPSHIRE COUNTY COUNCIL.
8. OVERHEAD POWER CABLE IN LOCAL VICINITY. THE CONTRACTOR SHOULD CONSULT HSE GUIDANCE NOTE GS6 AVOIDING DANGER FROM OVERHEAD POWER LINES AND LIAISE WITH SCOTTISH AND SOUTHERN ELECTRICITY NETWORKS.
9. BELOW GROUND GAS MAIN IN LOCAL VICINITY. THE GAS MAIN IS SPUN IRON AND SHOULD BE IDENTIFIABLE BY CAT SCANNING OR SIMILAR OTHER NON-INTRUSIVE METHODS.
10. CONTRACTOR TO REFER TO ALL EXISTING AND PROPOSED UTILITY RECORDS PRIOR TO UNDERTAKING SITE INVESTIGATIONS.
11. TESTING PROVIDED AS PART OF GROUND INVESTIGATION SCOPE REPORT (GISR) (REF. HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0002).
12. LOCATIONS ARE OBSTRUCTED BY EXISTING HIGHWAY OR ECOLOGY. THESE REQUIRE SITE OCCUPATION AND/OR ADDITIONAL VEGETATION CLEARANCE. CONTRACTOR'S METHOD STATEMENT TO INCLUDE MEASURES TO ADDRESS THE ECOLOGICAL CONSIDERATIONS. MINIMISE VEGETATION CLEARANCE. DORMOUSE METHOD STATEMENT AND ECOLOGICAL SITE SUPERVISION LIKELY TO BE REQUIRED.
13. LOCATIONS INF1-6 AND 8-16 ARE IN UNDISTURBED AREAS AND COULD CONTAIN ARCHAEOLOGICAL REMAINS. PRIOR TO UNDERTAKING ANY EXCAVATION FOR INFILTRATION TESTING REFERENCE MUST BE MADE TO THE ARCHAEOLOGICAL MITIGATION STRATEGY.

Rev.	Date	Description	Drawn	Chk'd	App'd
P05	08.09.21	INF 5, 6, 14, 15 COORDINATES UPDATED	MP	AC	TRA
P04	31.08.21	INF 24, 25, 28 TRENCHES AMENDED TO MANHOLES	MP	AC	TRA
P03	29.06.21	ALL EXISTING INFILTRATION SYSTEMS ADDED	GP	AC	TRA
P02	25.05.21	EXISTING SOAKAWAYS ADDED	NK	AC	TRA
P01	04.12.20	FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE INFILTRATION TESTING SCHEDULE

Scale	Designed	Drawn	Checked	Approved
N/A	N/A	ME	AC	TRA
Original Size A1	Date 02.12.20	Date 02.12.20	Date 02.12.20	Date 02.12.20

Drawing Number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE551511 - VFK -HDG- X_XXXX_XX - SH - CD - 0001

Project Ref. No. 48176

Revision P05

Appendix C Consultation Minutes

Stantec / Arup – 02/06/2021 ref:2021.05.05 Drainage-TA_001 - Final

Stantec / LLFA (HCC) - 02/06/2021 ref: HE551511-VFK-EGN-X_XXXX_XX-MI-LE-0001_Meeting with Hampshire County Council's Surface Water Management Team

Stantec / EA – 04/10/2021 ref: DRAFT_ M3J9 EA Meeting Minutes

NOTES

Meeting Title: **M3 J9 – Drainage TA coordination meeting**

Attendees: [redacted] (Stantec), [redacted] (QVA Consulting, [redacted] (Arup), [redacted] (Arup)

Apologies: [redacted] Stantec),

cc: [redacted] (Stantec),

Date of Meeting: **05th** May 2021 (Teams call)

Job Number: 48716-Drainage-TA_001

Item	Subject	Actions / Comment
1.	AC and PR provided general overview of the scheme as presented in recent meeting with Highways England (HE). Meeting today was to discuss further concept and detail in relation to the design.	
2.	Proposed location of Basin 6 was accepted with an explanation of the existing overland flow route with discharge to ground and overflow through 300mm dia culvert under M3. AC explained the culvert would be extended either end with 450mm sized elements. AC added that the standards require 1200mm dia culverts provided for lengths greater than 12m this is to be captured on departure application. AM explained on other schemes the DAS process is undertaken earlier at Stage 3 rather than Stage 5 to clarify HE position of key departures. Highways Team to consider DAS approach. *<u>Post meeting clarification</u>:* *East side extension 11m proposed with 300mm dia to match and join.* *West side extension >12m provided at MH with 450mm dia circular culvert.*	**AC/TRA**
3.	Proposed location of Basin 5 was explained and accepted. The intercepting factor being the embankment of the eastern gyratory approach.	
4.	SO queried low spots on scheme roads and where exceedance routes would flow. The scheme proposal needs to demonstrate to HE the provision for exceedance routes or increased provision for redundancy in drainage network for "Vulnerable Areas". The % of redundancy, return period (level of service) is not prescriptively defined within DMRB (see CG 501 section 5), so the designer should assess the risks and define the provision. A Performance Requirements technical note should be prepared to present this provision. Tech Note to also include return periods and factors of safety for soakaway design for WCH routes in trapped cuttings. Consider reviewing perimeter drainage provision around cuttings adjacent to overland flow areas such as area east of WCHR and junction 9 roundabout ?	**AC/PR**
5.	Basin sizing was queried, PR explained overland flows were sized to REH2 with basins comfortably sized to relatively poor infiltration rates of $1x10^{-6}$m/s.	
6.	SO queried Flood Risk and stated the LLFA is responsible for surface water management and risks concerning fluvial and groundwater under the FWMA. AC explained how the scheme to date had been progressing on the basis of EA	

Stantec

NOTES

Item	Subject	Actions / Comment
	consent due, to main rivers such as the River Itchen being subject to EA consent. However, engagement will be made with HCC LLFA. SO deemed our approach was sensible but would require sign-off by LLFA. AD added that AMP(HE) may have knowledge of former LLFA engagement from earlier design stages. The existing predominantly drains to ground, albeit the level of performance for existing soakaways is not known. The LLFA will be interested in relative changes to the balance of flood risk and may challenge the move away from discharge to ground to discharge to surface water. Their local SWM policy (and DMRB) would require the hierarchy of discharge to be to ground first, so they may require you to justify this. Key to this is demonstrating how the existing (baseline) system operates. A scheme plan summarising existing catchments, outfalls, discharge points and flow paths is a recommended tool for describing the baseline against which the relative impacts of the scheme would be assessed. This is likely to be reported in the FRA. Recommend cross-checking with the FRA/draft FRA, to ensure the drainage strategy and FRA align.	**AC**
7.	The basin design strategy and detail were reviewed including the HEWRAT assessments and pollution prevention measures. SO was content with the breadth of measures provided and the detail developed was sufficient and appropriate for this stage of design adding that a Maintenance Repair Strategy Statement is required for submittal at stage 3. HE SES and OD teams will require input into that statement. A draft statement should be prepared for review with HE and its attendance merits including HE people primarily concerned with water quality such as Michael Whitehead and Ben Hewlet due to the scheme sensitive receptors. The current standards are quite different to older standards in terms of the more landscape orientated measures required to be provided. These newer styles of features require different maintenance requirements compared to the traditional infrastructure that the Ops depts would be used to, and their scope may be challenged by those HE depts. The sediment/silt accumulation appears to be the most onerous element to be maintained, AC proposed a review be undertaken of the proposed maintenance schedule to factor in silt interception at filter trenches, trapped gullies, trapped entry into forebays and the forebays themselves. The aspiration being to demonstrate robustly that maintenance has been designed out or minimised where possible from the basins themselves.	**AC/PR** **PR**
8.	SO suggested review of CD 535 - Drainage asset data and risk management which covers assessment of existing scheme asset maintenance risks, the standard may present other deliverables to be actioned. Only added in recent months but other tasks may include updating and validating HE's asset database in particular Priority Assets. Same data may be required for CPF 5.1c metric scoring.	
9.	Date of next meeting to be considered by both parties on review of delivery programme dates.	

Stantec

MINUTES

Meeting Title: M3 Junction 9 update meeting with the Environment Agency

Attendees: [redacted]
(AR) (Environment Agency)
(JB) (Environment Agency)
(TW) (Environment Agency)
(TK) (VolkerFitzpatrick (VFP))
(JM) (Stantec)
(SK) (Stantec)
(AC) (Stantec)
(PR) (QVA/Stantec)
(RS) (Stantec)
(KR) (Stantec)
(RC) (Stantec)

Apologies:

cc: [redacted] National Highways), [redacted] (Stantec), [redacted] (VFP), [redacted] (VFP), [redacted] (Stantec)

Date of Meeting: 04/10/2021

Job Name: M3 Junction 9 Improvement Scheme

Item	Subject	Actions
1.	Introductions & safety moment	
	JM explained the importance of acknowledging the change in weather conditions and seasons when driving and especially when cycling, noting the importance to wear the correct reflective gear. Introductions were made, notably the presence of RC who will work alongside JM in the delivery of the SoCGs in collaboration with the Environment Agency	
2.	Drainage strategy – outfalls	
	<u>Road drainage and the water environment & biodiversity</u> JM explained that the purpose of the meeting was to share and agree upon the drainage design strategy. JM showed extracts from the Drainage Outfall Methodology Optioneering Report, focusing on the three proposed drainage outfalls. He explained that the eastern outfall is pre-existing, however, it does require cleaning. The two new outfalls required to facilitate the proposed operational drainage strategy would require temporary works within the River Itchen. This would require the use of temporary dams within the river to isolate the river bank, followed by dewatering of the isolated areas to allow safe working access to the locations. JM identified that the Applicant had considered various methods to install the temporary works, including the use of sand bags, a framed cofferdam, a water filled cofferdam, limpet cofferdam or a sheet pile cofferdam.	

MINUTES

Item	Subject	Actions
	JM explained that the framed cofferdam is the Applicant's preferred option as it avoided the requirement for piling within the River Itchen. Furthermore, the dewatering process would take place with measures to reduce opportunity for introducing sediment back into the river. JB expressed her relief that pilling was a method that would not be used to isolate the banks as it is intrusive. JB stated that without having pre-read the proposals, she would only speculate at this stage, however, in principle she felt that the use of a framed cofferdam was the preferable option. JB asked if there would be an impact of fish migration when reducing the width of the channels. In addition, she noted the importance of assessing the impact on brook lamprey larvae. JB further explained the need to ensure a fish friendly pump is used when undertaking any dewatering process. Furthermore, JB noted the need to see a detailed methodology to ensure that water quality was being assessed and managed throughout any dewatering activities. JM explained that the optioneering report, which described the installation methodology, would form part of the application for Development Consent. Finally, JB asked about flood conveyance, and if works would take place during a flood, as this would have an impact due to channel width reduction. In response JM confirmed that the team did have a record of the dates of sensitive periods in terms of fish migration, and that any works would be focused around avoiding these periods. JM also confirmed that a fish friendly water pump would be used and that works would not take place during any flooding event. JB asked if the Project Team had encountered any angling impacts (especially upstream impacts) and noted the importance of this recreational activity. JM noted this and will share with the wider project team.	
3.	WfD and FRA & WfD matters and temporary works	
	SK provided an overview of the road drainage and WfD and FRA. SK noted that the risks of flooding was very low on this project, explaining that there is a minimal impact on the WCH pathway, therefore no flood compensation is required. SK noted that the WfD is a live document, and she will provide updates as and when necessary. In addition, the current draft requires updating to include the latest information around outfalls and the new footbridge. Furthermore, SK explained that the Environmental Mitigation Plan needs to be added, allowing the EA to provide further input/review. AR asked if the DCO application and flood risk activity permits would be packaged together. Stating that if this was the case then she would want to see a detailed methodology of how these works were being undertaken.	

MINUTES

Item	Subject	Actions
	Action: SK to share a detailed methodology of temporary works. JB noted that the EA is classified as a competent authority and would be assessing both the HRA and SSSI assessments. JM confirmed that all of the above would be packaged into the DCO application. SK provided an overview of the proposed new bridge, explaining that the idea was to minimise works in the river by inserting a pre-constructed bridge that would be put in place via the use of cranes. Adding that a pontoon may be required for access, and only for a couple of days at most. JB stated that using a pontoon for a couple of days would not pose an issue, however, when craning in a ready-made structure it is imperative to ensure no debris is dropped into the river and watercourse. JB asked that this information is outlined in the method statement.	**Project Team**
4.	Hydrology licence requirements	
	RS provided an overview of hydrology requirements, noting that his team were working in parallel with the Geology works, in reviewing the carriage drainage system.	
5.	Electrofishing requirements	
	JM explained that the use of electrofishing is entirely dependent on the dewatering method to be deployed. JM requested confirmation as to whether the EA required the electrofishing to be undertaken prior to the works within the River Itchen taking place. JB confirmed that electrofishing was required.	
6.	Previous information that was agreed to be shared	
	SK reminded JB that, after the previous project team meeting held with the WA, certain items of information were promised to be passed from the EA to the Applicant. JB advised that this information would be passed on once located.	
7.	Geology, soils and hydrology	
	<u>Contamination</u> KR provided a summary of the geology and soils chapters, outlining how risks have been assessed. KR explained the results of the contamination desktop study, which showed a low risk of contamination due to the project, additionally an existing landfill was identified during the study. In addition, Ground Investigation data (a quantitative risk assessment) revealed low risk of contamination, and low levels of	

Item	Subject	Actions
	metals were identified close to the existing landfill site. After further assessment it was concluded that this is a low risk to controlled water. KR explained that further monitoring is currently taking place. KR noted that the water environment is incredibly sensitive, as outlined in the responses to the public consultation. TW agreed about the sensitivities and noted that there are no major contamination sources in the area. However, TW did make reference to a pollution incident caused by an accident on Junction 9 which resulted in pollution detected within the associated soakaway. KR was not aware of this incident and confirmed that the GI samples had not shown any evidence of hydrocarbon contamination. **<u>Action:</u>** TW agreed to share the exact location with KR, to allow for a crosscheck.	**TW**
	<u>Hydrogeology</u> RS explained that the designs were to a high standard, with the bulk of the drainage going into a lined basin, with a sediment trapping function, which then overflows into an unlined secondary basin, which then flows into the ground. Excess water would then be routed through to the Itchen. RS noted that the HEWRAT tool (National Highways tool) was used to assess hydrogeology risks. He reported that a medium level of risk was reported, and therefore further assessment is ongoing. The further assessment is based on the site-specific data available from ground investigation. The findings of the further assessment are that the risk to groundwater from the un-lined drainage basins is low. RS noted that the Chalk groundwater flow direction under the drainage basins is south westerly, towards the river. Chalk groundwater discharges to the river, via the superficial deposits that underlie the river. RS explained that Stantec have devised their own tool to assess risk, which allows for multiple contaminations to be placed into one spreadsheet. TW requested a copy of the model (not a printout), so that he could assess the adequacy. **<u>Action:</u>** RS to provide TW a copy of the Stantec risk tool and details of its validation.	**RS**
	JB asked for clarification of the tertiary treatment provided. PR confirmed that Basins 2 and 3C had 50m of swale between those last, extended detention basins and their river outfall, to provide tertiary treatment, and that the third river outfall comprised an infiltrating swale over a filter layer, over a geocellular tank, which provided sufficient filtration treatment at source (to comply with the SuDS Manual) before the attenuation and outfall. TW asked if 3 separate assessments have been undertaken for alluvials, structured chalk and unstructured chalk. RS explained that only 1 assessment per basin had been undertaken with a worst-case scenario.	

MINUTES

Item	Subject	Actions
	A brief group discussion around micro plastics took place, with PR concluding that National Highways' research had been reviewed, but it was still in its infancy. Findings are yet to be published, and do not yet influence policy, or recommend mitigation measures. He noted that other similar research in Europe was finding that microplastics tend to be trapped in basin sediments and macrophyte (rootzone) layers and that current best practice was to allow MPs to be captured in this way within basins, then periodically remove and dispose of MP-loaded sediments/vegetation at suitably licenced waste sites.	
8.	Statement of Common Ground (SoCG)	
	JM provided an overview of the Statement of Common Grounds, and the team's intended approach, to start compiling to allow PINs good visibility ahead of the application submission. AR expressed an appreciation for this pro-active approach, noting that she requires visibility of a draft environmental statement in order to provide comments. JM noted this, and explained that the SoCG is an iterative process, and one that we will work with collaboratively with the EA. **Action:** JM to share the EA SoCG template with the EA.	**JM**
9.	AOB	
	AR asked if the DCO submission was still being submitted early next year (2022). JM confirmed this was the case.	

Stantec

MINUTES

Meeting Title: M3J9 Improvement – Meeting with Hampshire County Council's Surface Water Management Team

Attendees: [redacted] (Stantec), [redacted] (QVA Consulting), [redacted] (Stantec), [redacted] (Stantec), [redacted] (Stantec), [redacted] (HCC), [redacted] (HCC), [redacted] ([redacted],

Apologies: [redacted] (Arup), [redacted] (V[redacted], [redacted] (Stantec),

cc: [redacted] (Stantec), [redacted] (Stantec)

Date of Meeting: 2nd June 2021

Job Number: 48176

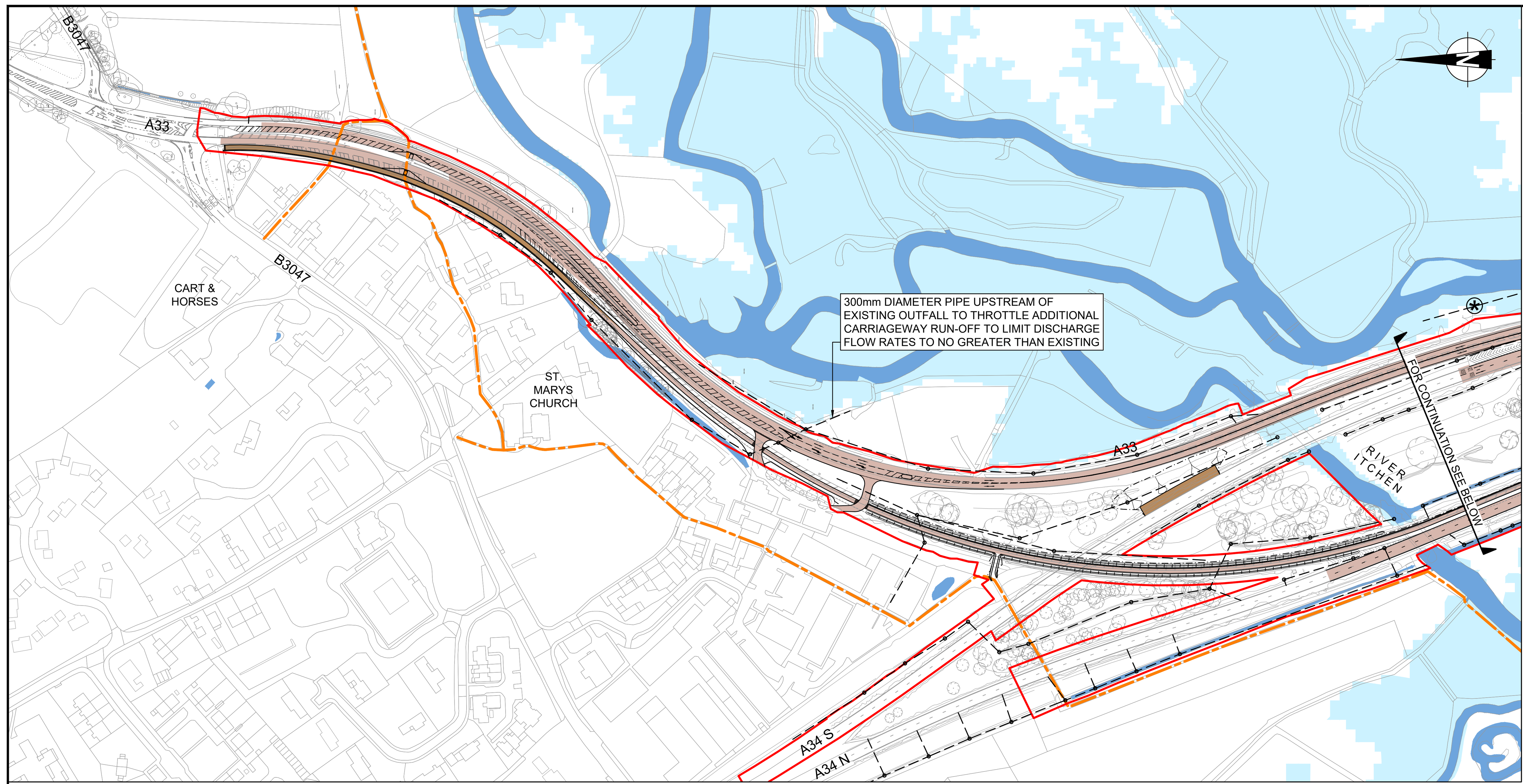
Item	Subject	Actions
1. Welcome & Introductions	**AC** opened the meeting explaining the purpose to present the scheme and open discussions with Hampshire County Council (HCC) as the Lead Local Flood Authority (LLFA) with each attendee introducing themselves and their role. **AC** apologised to **SR** for not sending the pertinent drawings in advance of the meeting (as had been planned) but would provide an overview of the scheme and follow the meeting with drawings. **SR** understood the reasons, accepted the apology and was happy to proceed on this basis.	**AC** *(Actioned)*
2. Proposed Drainage	**AC** provided a brief run-through of the previous M3 Junction 9 Improvements Drainage and Flood Risk Meeting minutes between HCC LLFA (Vicki Westall) and Jacobs (dated 27/6/2019). **AC** followed with an overview of the M3 J9 Stantec Drainage Scheme Proposals. This included an explanation of the highway spillage control measures, water quality measures, attenuation basins, infiltration basins and discharge points into the River Itchen. **AC** emphasised the primary method of discharge was to ground where possible but due to geology and infiltration rates this was not fully possible without controlled discharge into the River Itchen. **PR** provided further clarity on designed return period rates being 1 in 100 yr + 40% Climate Change, assumed infiltration rates and proposed infiltration testing locations and verification testing of existing soakaway features being retained.	

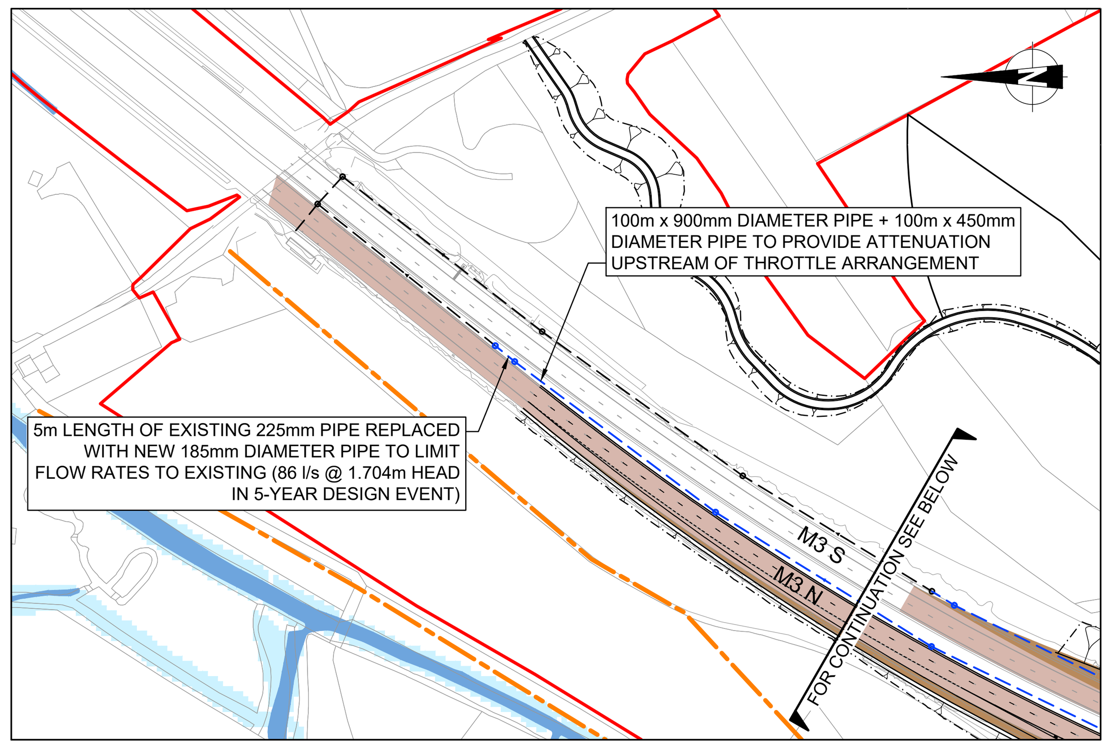
Item	Subject	Actions
3. HCC Remit	**PR** and **AC** explained that there were two new road drainage connections to watercourse designated as Main River, subject to Environment Agency (EA) consent. However, Highways England river network records indicate that Highways England road drainage ditches are indicated as secondary river, which connect to Primary River. **AC** asked whether highway ditches would be classed as Ordinary Watercourse for consenting purposes. **SR** explained that unless the element connected to was either a sewer pipe or a Main River, all other features which convey surface water are defined as Ordinary Watercourses, including ditches only taking highway runoff, Any new connection to these or any works that affect the capacity of that watercourse would be subject to the liaison/consent of HCC within their remit as the LLFA (in their capacity as issuers of consents for works and as planning consultee). **SR** added that HCC as LLFA would be a Statutory Consultee within the DCO submission, it would be the Planning Inspectorate which in effect grants permission. **PR** queried the elements which HCC as LLFA would be concerned with. **SR** explained that any element which affected surface water flooding or groundwater quality, or its risk management would be of consideration to HCC. **PR** summarised this being mainly pluvial flows rather than fluvial, with EA concerned with fluvial flows. **SR** agreed adding that if the fluvial flows affected surface water flooding, then HCC would also be interested. SR to issue HCC's Ordinary Watercourse consenting guidance and SW checklist for reference. SR to issue contact details for HCC Highways, in order that Stantec/VF can liaise regarding verification testing of existing HCC highway drainage soakage features (Easton Lane and A272 'Spitfire' link.	 **SR** *(Actioned)* **SR** *(Actioned)*
4. HCC initial view	**SR** was generally happy with the proposals and did not raise objections, subject to a few points as follows below: • Discharge Rates of 2 l/s/ha not an issue for HCC, but SR noted that rates need to be acceptable to EA also. (Post meeting Note: EA have not raised an objection to the proposed 2 l/s/ha, which was discussed in the previous EA meeting). • Principle of discharge rates based on 2 l/s/ha seemed appropriate to HCC. • The arrangement of the Motorway Upgrades connection from South is ok with orifice plate restricting the discharge to existing levels into the M3 J9 scheme. **SR** asked that details of	

Item	Subject	Actions
	flow rates and restrictions be added to drawings. • An additional simple ditch replacement plan would be beneficial to present and explain where existing ditches are being replaced and to demonstrate that catchments are suitably addressed. Ordinary Watercourse Consent plan & schedule to be prepared. • Infiltration Testing based on previous Ground Investigations has identified a design rate of 1 10^{-6} m/s. The timeframe of new testing should be clarified to review how this relates to DCO submittal dates. **AA** clarified Ground Investigation testing dates between October 2021 and April 2022, Groundwater monitoring will continue until Summer 2022. **SR** said this did not appear to be a problem. • A detailed list of submittal proposals would be beneficial, to understand depth of calculations and design undertaken to develop the proposed scheme. • Due to the significant construction extents and duration, further detail is required on the management of construction runoff and watercourse pollution resulting from Temporary Works. **JM** added that Natural England and EA had both raised similar considerations, and that the scheme was being developed cognisant of this matter, with proposals to be captured in EMP1 with the DCO	**AC/PR** **AC/PR**
5. AOB	**JM** suggested commencement of "Statements of Common Ground" as this would be useful by both parties, **SR** suggested liaison required through HCC Neil Massie. **AC** to forward copies of drawings (HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 to 0516) and previous minutes (Jacobs ref: HE551511-JAC-HDG-0_00_00-MI-D-0002) to SR.	**JM** **AC** *(Actioned)*

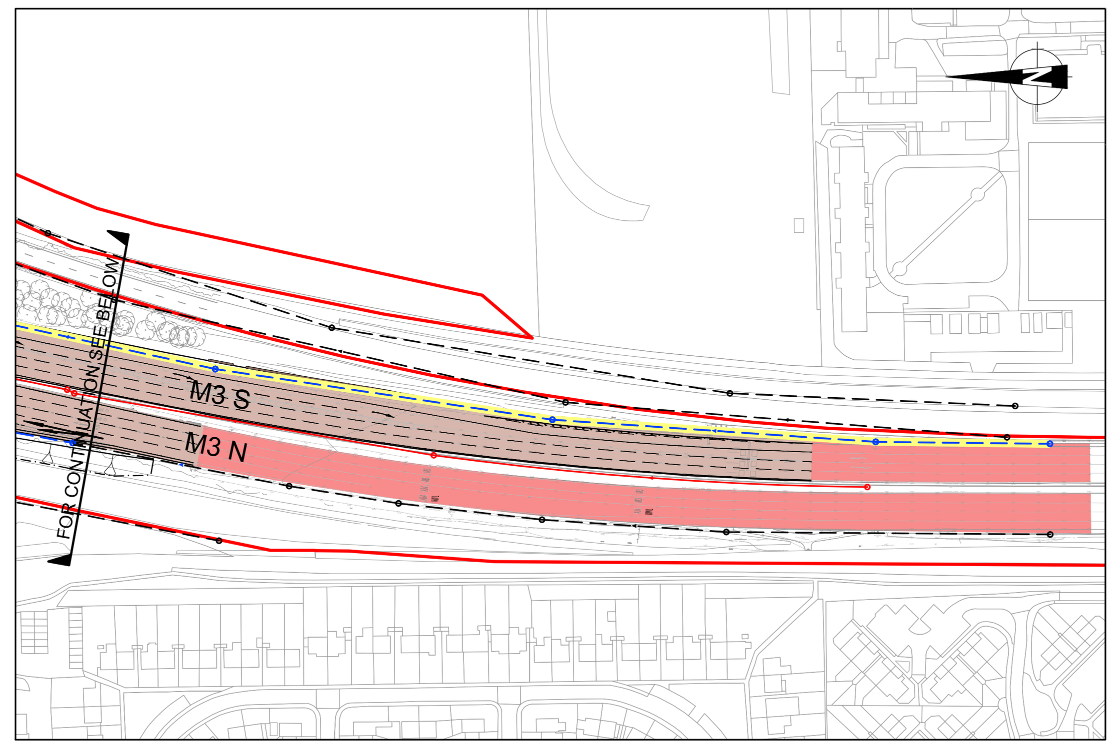
Appendix D Schematic Drainage Plan

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 Drainage Schematic Plan





INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- EXISTING FOOTPATH / PUBLIC RIGHT OF WAY
- PROPOSED HIGHWAY DRAINAGE NETWORK
- PROPOSED HIGHWAY DRAINAGE (INSTALLED AS PART OF M3 JUNCTION 9 TO 14 SAFETY BARRIER IMPROVEMENT SCHEME WORKS)
- PROPOSED ADDITIONAL DRAINAGE TO BE INSTALLED AS PART OF THE M3 JUNCTION 9 IMPROVEMENT SCHEME (FOLLOWING THE MANAGED MOTORWAY GOVERNMENT PAUSE)
- RETAINED EXISTING HIGHWAY DRAINAGE
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- PROPOSED GEOCELLULAR ATTENUATION
- 1 PROPOSED INFILTRATION BASIN AND REFERENCE NUMBER
- 4 PROPOSED LINED BASIN AND REFERENCE NUMBER
- PROPOSED GRASSED BASIN (ALL GRASSED EXCEPT BASIN 2 AND 3C)
- PROPOSED SWALE
- EXISTING CARRIAGEWAY AND DRAINAGE FEATURES TO BE RETAINED
- PROPOSED NEW CARRIAGEWAY / FOOTWAY / CYCLEWAY AREAS
- PROPOSED PENSTOCK
- PROPOSED SEDIMENT FOREBAY
- PROPOSED FLOW CONTROL MANHOLE
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED

CONFIDENTIAL
THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENTS REFER TO DRAWING NUMBERS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515 AND STANDARD NOTES.
6. FOR DETAIL OF M3 JUNCTION 9-14 MOTORWAY UPGRADE DRAINAGE DESIGN REFER TO MOTORWAY UPGRADE SCHEME DRAWING NUMBERS HE549338-JAC-HDG-S1-DN-MAINL-DR-CD-0002 TO 003.
7. PROPOSED DRAINAGE SCHEMATIC SHOWN IS SUBJECT TO REVIEW BY THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. PROPOSED RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
9. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING. THESE SHALL BE DETAILED DURING SGAR 5 (DETAILED DESIGN).
11. CONTROL OF RUN-OFF AND SEDIMENT DURING CONSTRUCTION IS TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING. THIS IS TO BE DEVELOPED DURING SGAR 5 (DETAILED DESIGN).
12. PROPOSED FORM OF DRAINAGE SYSTEM REQUIRED TO COLLECT THE SURFACE WATER RUN-OFF FROM THE CARRIAGEWAY SURFACE (eg. GULLIES, FILTER DRAINS ETC.) IS TO BE DETERMINED DURING SGAR 5 (DETAILED DESIGN).

SEDIMENT FOREBAY AREA SCHEDULE

BASIN	FOREBAY AREA (m^2)	FOREBAY DEPTH OF FREEBOARD (mm)
1	10	150
2	40	300
3A	40	300
3B	40	300
3C	135	300
4	36	300
5	36	300

0 50 100 150 200 250m

SCALE 1:2500

Rev.	Date	Description	Drawn	Chk'd	App'd
P04	28.06.22	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	JH	LC	TRA
P03	24.11.21	ISSUED FOR S3 SUBMISSION	IJ	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	RG	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN PROPOSED SURFACE WATER DRAINAGE SCHEMATIC PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size	Date 28.05.21	Date 28.05.21	Date 28.05.21	Date 28.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HDG - Location X_XXXX_XX - Type DR - Role CD - Number 0512

Project Ref. No. 48176

Revision P04

Appendix E Summary of Infiltration Rate Assessment

48176-2000-TN0005

Job Name:	M3 Junction 9 Improvements
Job No:	48176/2000
Note No:	TN0005
Date:	13th October 2020
Prepared By:	J. Harvey & A. Desai
Checked by:	A. Champion & T. Allen
Subject:	**Summary of Infiltration Rate Assessment**

1. Introduction

1.1. Stantec have been appointed through the DIP framework to undertake the Stage 3B design of the M3 Junction 9 Improvement scheme.

1.2. The scheme is situated within the county of Hampshire. M3 Junction 9 is a key strategic route interchange which connects South Hampshire and the ports of Southampton and Portsmouth with the wider sub region. It also connects the region to London and the north-west via the M3, the Midlands and the North via the A34.

1.3. The proposed scheme follows the Stage 3A design undertaken by Jacobs, which involves the complete reconfiguration of the M3 Junction 9 interchange and A34 / A33 connections, with new dedicated slip roads, etc. to improve capacity and journey times.

1.4. The purpose of this Technical Note (TN005) is to summarise the review of the Factual Ground Investigation Report (FGIR) Revision 2 produced by Osbornes to assess the likely infiltration rates at the site to inform the Stage 3B proposed surface water drainage design.

2. Factual Ground Investigation Report

2.1. The FGIR (reference 17486/FGIR/Rev 1.02, dated July 2020) was provided to Stantec on 11th September 2020. The ground investigation was undertaken by Osbornes on behalf of Jacobs and Highway's England as the Principal Designer and Client for the M3 Junction 9 Improvements scheme.

2.2. As part of the investigations, a variety of monitoring, in-situ testing and laboratory testing were undertaken. Although such testing included groundwater monitoring, boreholes sampling and insitu variable head permeability tests, BRE DG 365 soil infiltration testing was not undertaken.

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
48176/2000/TN005	-	13.10.20	JH / AD	AC	TRA	MF

T: E:

2.3. Of the ground investigations a total of 54 dynamic sampling boreholes with rotary core follow on, windowless sampler boreholes and machine excavated trial pits were undertaken; these ranged from 4.00m to 30.00m in depth. An extract from the FGIR showing the location of the exploratory holes is provided in Appendix A.

2.4. The ground investigation generally identified the site to be underlain by the Seaford Chalk Formation ranging in CIRIA grades Dm to A. In the eastern and southern parts of the scheme the Seaford Chalk Formation is near surface overlain by Made Ground and some Head Deposits. The area between the M3 and A34 incorporating the River Itchen identified between 6m and 10m of Head Deposits and/or Alluvium overlying the Seaford Chalk Formation..

2.5. Only the results of 5 variable head permeability tests undertaken in boreholes have been provided in the FGIR. A copy of the test results is provided in Appendix A and summarised in the Table 1 below.

Table 1. Summary of the FGIR variable head permeability tests.

Location	Test Depth Range (m bgl)	Geology as per logs (m bgl)	Water Level Fall (m)	Test Duration (sec)	Result
DS104	0 - 4	0.3-3.0 sandy gravelly clay (Alluvium) 3.0-4.0 No description (Alluvium)	0.96	3600 (1 hr)	Insufficient fall in water to calculate permeability.
DS107	0 - 4	0.4-1.2 Structureless chalk 1.7-4.0 Chalk Grade B2	2.78	3600	1.48×10^{-6} m/s
DS109	0 - 3	0.5-1.2 Structureless chalk 1.2-3.0 Chalk Grade B2	1.31	3600	Insufficient fall in water to calculate permeability.
DS210	0 - 4	0-1.7 Structureless chalk (Grade Dc) 1.7 -4.0 Chalk Grade B2	1.52	9000 (2.5 hr)	Insufficient fall in water to calculate permeability.
DS301	5.7 – 10.15	5.7-7.0 Chalk Grade A3-A4 7.0-10.15 Chalk Grade A3	4.42	1800	7.6×10^{-6} m/s (Note the result in factual report is 8.2 x 10^{-6} m/s because start and end test water levels have been entered incorrectly)

2.6. It has been identified that the permeability calculated from the variable head permeability tests has been determined using the wrong method. The FGIR states the tests were undertaken in accordance with BS EN ISO 22282-2:2012 and calculated using the Hvorslev method. However, Section B.4.2 of the British Standard states 'The Hvorslev method can only be applied below the water table', yet the FGIR notes the boreholes were dry prior to the commencement of the tests. Therefore the permeability results provided are not considered to be appropriate.

3. Infiltration Rates

3.1. Given that the majority of the existing and proposed surface water drainage is to discharge to ground via infiltration features (i.e. soakaway trenches and chambers), the lack of infiltration testing presents a significant risk to the design of the proposed surface water drainage.

3.2. As this testing is unlikely to be undertaken and/or results processed prior to the PCF Stage 3B deadline (December 2020). Stantec has undertaken a review of the FGIR and of current design guidance in order to determine a preliminary infiltration rate for the scheme. The following documents were assessed:

- Factual Ground Investigation Report Rev 1.02;
- CIRIA Engineering in Chalk (C574);
- BRE DG365 Soakaway Design.

3.3. Both guidance documents state the permeability and infiltration rates of chalk is highly variable and dependent upon:

- The position of the measurement relative to the water table,
- The inflow rate,
- The degree of fracturing, weathering and dissolution, and
- The scale at which the permeability is measured.

3.4. Given the variability of the infiltration rates within chalk and the impact this would have upon the proposed drainage design, the process of assuming a conservative singular infiltration rate for the scheme is likely to prove detrimental and would likely result in a heavily over engineered design. Given the significance of the surrounding area (SAC, SSSI etc) and the stakeholders involved, this would likely render the scheme unfeasible.

3.5. Soil infiltration rates have, therefore, been derived using the soil infiltration calculation as stated within BRE DG 365 using the raw data recorded from the variable head permeability tests undertaken as part of the ground investigation. A summary of the results is presented in Table 2 below.

Table 2. Summary of calculated soil infiltration rates.

Location	Test Depth Range (m bgl)	Geology as per logs (m bgl)	Soil Infiltration - Calculated (m/s)	Soil Infiltration (m/hr)
DS104	0 - 4	0.3-3.0 sandy gravelly clay (Alluvium) 3.0-4.0 No description (Alluvium)	9.5×10^{-6}	3.4×10^{-2}
DS107	0 - 4	0.4-1.2 Structureless chalk 1.7-4.0 Chalk Grade B2	1.4×10^{-5}	5.2×10^{-2}
DS109	0 - 3	0.5-1.2 Structureless chalk 1.2-3.0 Chalk Grade B2	2.8×10^{-5}	1.0×10^{-1}
DS210	0 - 4	0-1.7 Structureless chalk (Grade Dc) 1.7 -4.0 Chalk Grade B2	4.2×10^{-6}	1.5×10^{-2}
DS301	5.7 – 10.15	5.7-7.0 Chalk Grade A3-A4 7.0-10.15 Chalk Grade A3	1.1×10^{-4}	4.1×10^{-1}

3.6. It should be noted the soil infiltration rates provided in Table 2 were derived from the variable head permeability tests which were not undertaken in accordance with BRE DG 365 and therefore do not provide a true representation of the Site's infiltration rates.

4. Conclusion

4.1. In the interim, until appropriate soil infiltration testing in accordance with BRE DG 365 can be undertaken, a factor of safety is to be applied to the infiltration rates to ensure the scheme is not over reliant upon the derived infiltration rates. As such, an infiltration rate in the order of a magnitude lower than calculated is to be adopted for use in the preliminary Stage 3B surface water drainage design; these rates are summarised in Table 3 below.

4.2. It should be noted that given the derived infiltration rates are based upon the FGIR variable head permeability tests, their localised proximity in relation to the extent of the scheme is not representative. The infiltration rates have, therefore, been categorised based upon the underlying geology rather than location.

Table 3. Adopted infiltration rates.

Underlying Geology	**Soil Infiltration (m/s)**	**Soil Infiltration (m/hr)**
Chalk Grade A	1×10^{-5}	2×10^{-2}
Chalk Grade B (where encountered within the top 2m)	1×10^{-6}	2×10^{-3}
Alluvium / Head Deposits	1×10^{-6}	2×10^{-3}

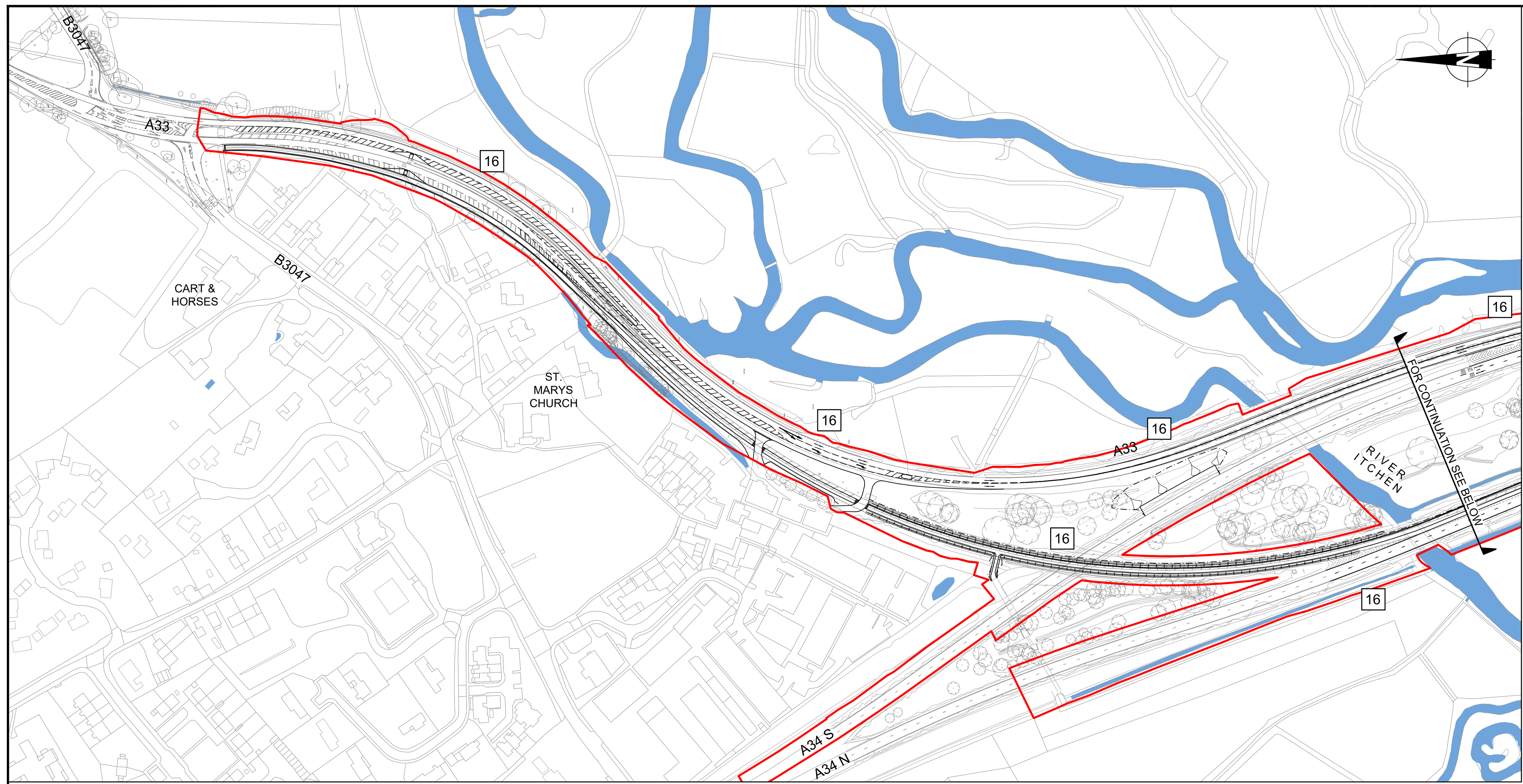
Appendix A

Appendix F Drainage Drawings

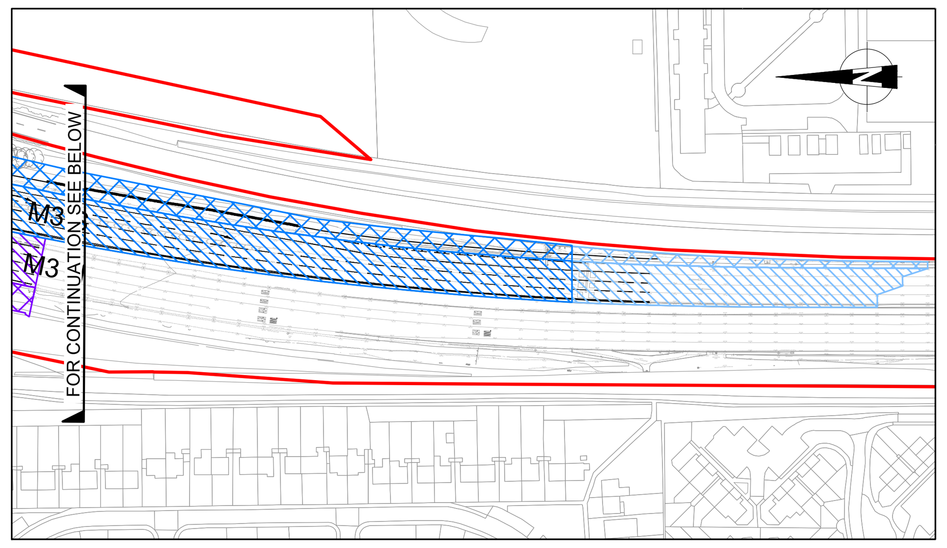
HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 Catchment Overview Plan

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0514 Overflow Catchment Plan

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0515 Existing Highway Surface Water Catchments Overview Plan



INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

CATCHMENT SCHEDULE

PROPOSED CATCHMENT AREA	COLOUR	CATCHMENT TYPE	CATCHMENT AREA (ha)	TOTAL NET CATCHMENT AREA (ha)	OUTFALLS TO	NOTES
1		IMPERMEABLE	0.45	0.58	BASIN 1	ATTENUATION IN BASIN 1 & RESTRICTED OUTFLOW @ 4.0 l/s TO BASIN 2
		PERMEABLE	0.65			
2		IMPERMEABLE	0.16	0.16	BASIN 2	ATTENUATION AND INFILTRATION IN BASIN 1 & RESTRICTED OVERFLOW @ 2.0 l/s TO RIVER ITCHEN OUTFALL 1
	NOT USED	PERMEABLE	0.00			
3		IMPERMEABLE	0.47	0.52	RIVER ITCHEN (OUTFALL 2)	ATTENUATION IN GEOCELL & RESTRICTED OUTFLOW @ 6.0 l/s TO RIVER ITCHEN
		PERMEABLE	0.27			
4		IMPERMEABLE	0.91	1.20	BASIN 3C	ATTENUATION AND INFILTRATION IN BASIN 3C & RESTRICTED OUTFLOW @ 29.3 l/s TO RIVER ITCHEN
		PERMEABLE	1.45			
5		IMPERMEABLE	0.98	1.24	BASIN 3B	ATTENUATION AND INFILTRATION IN BASIN 3B & RESTRICTED OUTFLOW VIA 200mm DIA. PIPE TO BASIN 3C
		PERMEABLE	1.31			
6		IMPERMEABLE	1.06	1.12	BASIN 3A	ATTENUATION IN BASIN 3A & RESTRICTED OUTFLOW VIA 200mm DIA. PIPE TO BASIN 3B
		PERMEABLE	0.30			
7		IMPERMEABLE	5.22	5.59	BASIN 4	ATTENUATION IN BASIN 4 & RESTRICTED OUTFLOW @ 125 l/s TO BASIN 3A
		PERMEABLE	1.82			
8		IMPERMEABLE	0.18	0.18	SOAKAWAY	RECOMMISSION OR REPLACE EXISTING HAMPSHIRE COUNTY COUNCIL HIGHWAY DRAINAGE SOAKAWAYS (EASTON LANE)
	NOT USED	PERMEABLE	0.00			
9		IMPERMEABLE	0.95	1.05	SOAKAWAY	RECOMMISSION OR REPLACE EXISTING HAMPSHIRE COUNTY COUNCIL HIGHWAY DRAINAGE SOAKAWAYS (A272 SPITFIRE LINK)
		PERMEABLE	0.49			
10		IMPERMEABLE	0.95	1.05	SOAKAWAY	RECOMMISSION OR REPLACE EXISTING NATIONAL HIGHWAYS HIGHWAY DRAINAGE SOAKAWAYS (M3 (MMP) MAINLINE)
		PERMEABLE	0.5			
11		IMPERMEABLE	0.02	0.02	SOAKAWAY	RECOMMISSION OR REPLACE EXISTING NATIONAL HIGHWAYS HIGHWAY DRAINAGE SOAKAWAYS (M3 J9 GYRATORY)
	NOT USED	PERMEABLE	0.00			
12		IMPERMEABLE	0.08	0.18	SOAKAWAY	ATTENUATION AND INFILTRATION IN BASIN 5
		PERMEABLE	0.49			
13		IMPERMEABLE	0.08	0.12	SOAKAWAY	ATTENUATION IN BASIN 4 & RESTRICTED OUTFLOW @ 125 l/s TO BASIN 3A
		PERMEABLE	0.18			
14		IMPERMEABLE	0.94	0.98	EXISTING M3 DRAINAGE	UPSIZE (TO 450mm/900mm DIA.) 200m OF M3 CENTRAL RESERVE HIGHWAY DRAINAGE & NEW 185mm DIA. THROTTLE PIPE AT TIE-IN TO EXISTING HIGHWAY DRAINAGE
		PERMEABLE	0.18			
15		IMPERMEABLE	1.63	2.19	BASIN 5	UPSIZE (TO 600mm dia) 98m OF M3 VERGE HIGHWAY DRAINAGE & NEW 150mm DIA. THROTTLE PIPE AT TIE-IN TO EXISTING HIGHWAY DRAINAGE
		PERMEABLE	2.80			
16		IMPERMEABLE	3.34	3.34	HIGHWAY DRAINAGE DITCHES	RETAIN OR MODIFY EXISTING A33/A34 CARRIAGEWAY DRAINAGE & RETAIN NATIONAL HIGHWAYS DRAINAGE DITCHES, SOAKAWAY TRENCH & OUTFALLS
	NOT USED	PERMEABLE	0.00			
TOTALS		IMPERMEABLE	16.84	18.86	GROUNDWATER & RIVER ITCHEN	EAST OF RIVER ITCHEN; NEW HIGHWAY @ 2 l/s/ha
		PERMEABLE	10.10			WEST OF RIVER ITCHEN; EXISTING HIGHWAY @ EXISTING RATES

NOTES:
1. PERMEABLE CATCHMENT COMPRISES OF CUTTINGS DRAINING TO CARRIAGEWAY
2. RUNOFF COEFFICIENT OF PERMEABLE CATCHMENTS (CUTTINGS) ASSUMED TO BE 20%
3. RUNOFF COEFFICIENT OF IMPERMEABLE CATCHMENTS (CARRIAGEWAY) ASSUMED TO BE 100%

CONFIDENTIAL
THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR DETAILS OF THE M3 JUNCTION 9-14 MOTORWAY UPGRADE SCHEME DRAINAGE DESIGN REFER TO MMP DRAWING NUMBERS HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007.
6. PROPOSED SCHEME SHOWN IS SUBJECT TO REVIEW WITH THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
7. SUITABILITY OF RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
8. DRAWING SHALL BE READ IN CONJUNCTION WITH THE FOLLOWING:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
   - DECOMMISSIONING AND RENOVATION OF EXISTING HIGHWAY SOAKAWAYS TECHNICAL NOTE REF: HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0003
9. FOR MORE INFORMATION ON THE PROPOSED DRAINAGE SCHEME REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.
10. FOR OVERLAND FLOW CATCHMENT PLAN REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0514.

0 50 100 150 200 250m

SCALE 1:2500

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- RIVER ITCHEN
- PROPOSED GEOCELLULAR ATTENUATION
- EXISTING AREA OF ONLINE CARRIAGEWAY SURFACE WATER CURRENTLY DRAINED TO EXISTING HIGHWAY DRAINAGE (UNATTENUATED)
- PROPOSED POINT OF DISCHARGE FROM RESPECTIVE COLOURED CATCHMENT AREA. REFER TO CATCHMENT SCHEDULE AND RELATED NOTES FOR DETAILS
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED
- EXISTING / PROPOSED OUTFALL TO RIVER ITCHEN
- RETAINED OUTFALL INTO EXISTING HIGHWAY SURFACE WATER NETWORK

Rev.	Date	Description	Drawn	Chk'd	App'd
P04	20.06.22	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	JH	LC	MF
P03	24.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	RG	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status
S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client
national highways

Project Title
M3 JUNCTION 9 IMPROVEMENT

Drawing Title
SGAR 3 PRELIMINARY DESIGN
PROPOSED HIGHWAY SURFACE WATER CATCHMENTS
OVERVIEW PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: Size	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21

Drawing Number
HE PIN | Originator | Volume | Location | Type | Role | Number
HE551511 - VFK -HDG- X_XXXX_XX - DR - CD - 0513

Project Ref. No. 48176

Revision P04

CONFIDENTIAL

THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

OVERLAND CATCHMENT SUMMARY

CATCHMENT	AREA (ha)	Q100(l/s)	V100(m³)	OUTFALL TO	NOTES
W	14.00	27	440	NEW INFILITRATION BASIN	
X	77.50	146	1880	NEW INFILTRATION BASIN	
Y	119.00	220	2170	EXISTING SOAKAWAY TRENCH	

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. SCHEME IS SUBJECT TO PRELIMINARY DESIGN AT STAGE 3 AND SUBJECT TO CHANGE PENDING DESIGN DEVELOPMENT.
6. PROPOSED SCHEME SHOWN IS SUBJECT TO REVIEW WITH THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
7. SUITABILITY OF RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
8. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE FOLLOWING:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
   - DECOMMISSIONING AND RENOVATION OF EXISTING HIGHWAY SOAKAWAYS TECHNICAL NOTE REF: HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0003
9. FOR MORE INFORMATION ON THE PROPOSED DRAINAGE SCHEME PLEASE REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.
10. FOR HIGHWAY CATCHMENT OVERVIEW PLAN REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513.

KEY

- DEVELOPMENT CONSENT ORDER BOUNDARY
- OVERLAND CATCHMENT AND PROPOSED DISCHARGE LOCATION
- PROPOSED BASIN

0 100 200 300 400 500m

SCALE 1:5000

Rev.	Date	Description	Drawn	Chk'd	App'd
P03	24.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	NK	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

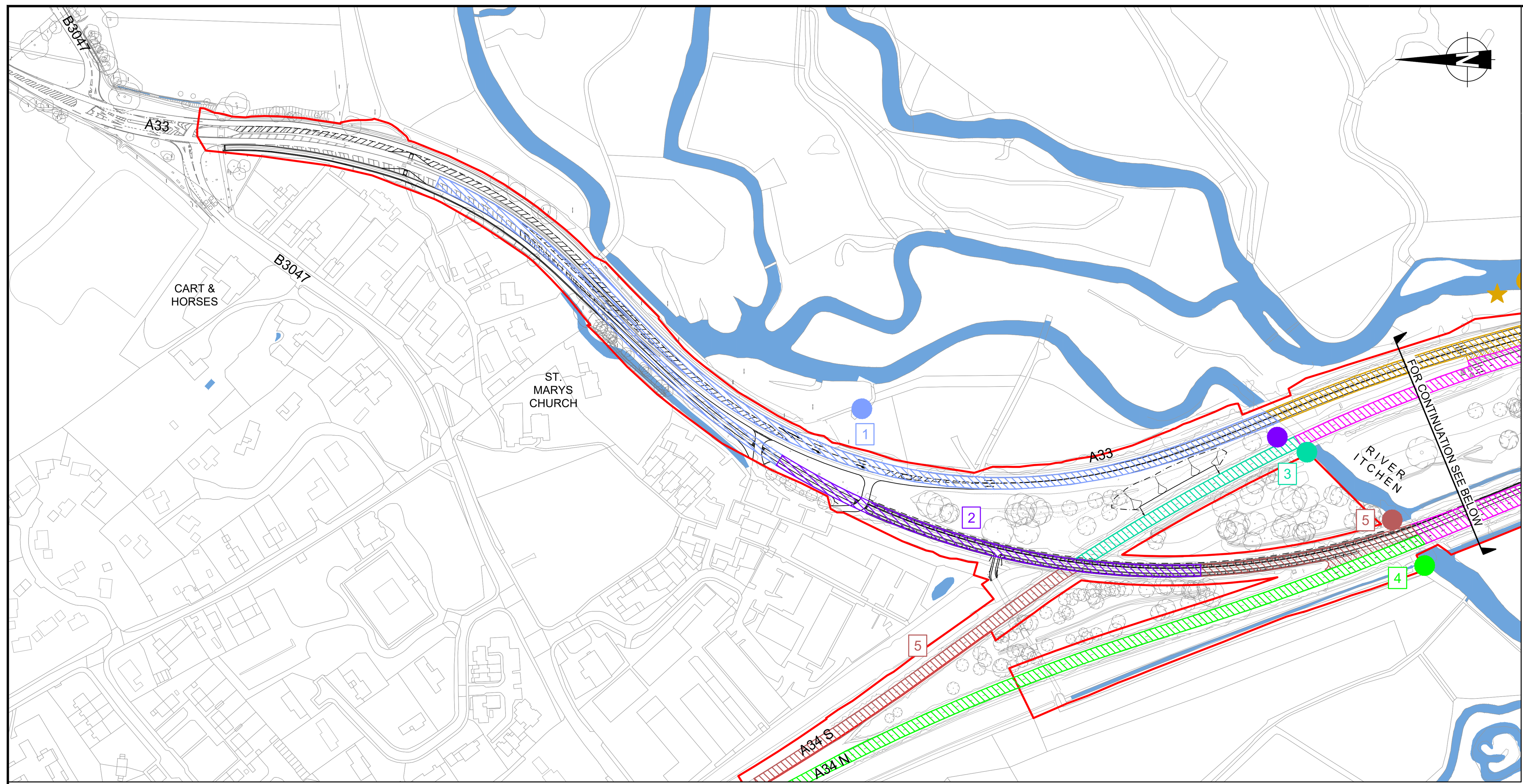
Drawing Title: SGAR 3 PRELIMINARY DESIGN EXISTING OVERLAND FLOW CATCHMENT PLAN AND PROPOSED DISCHARGE LOCATIONS

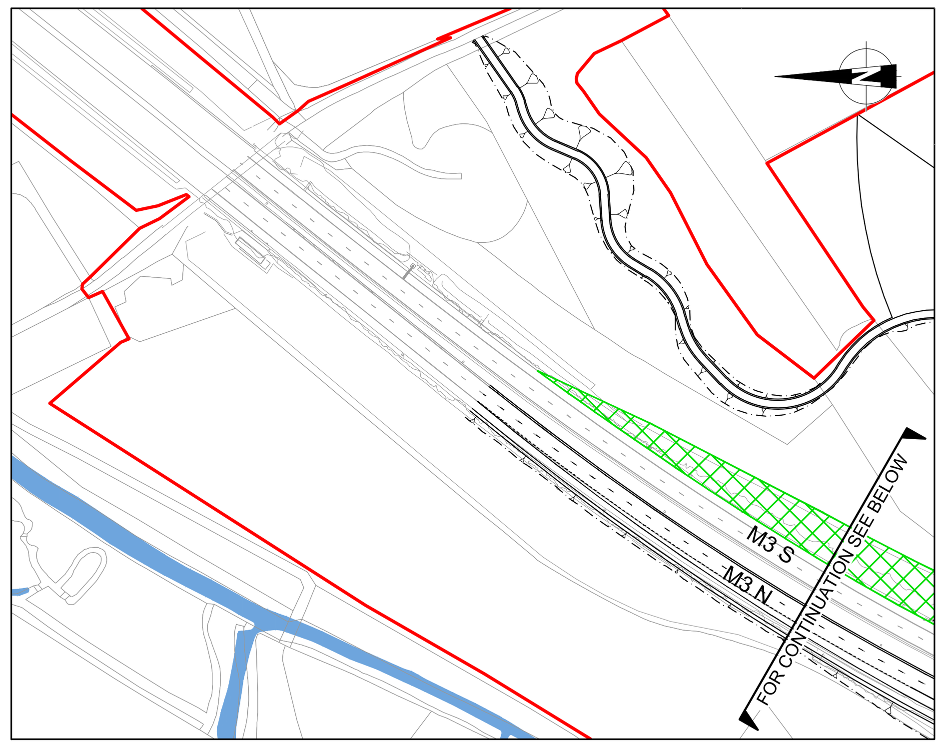
Scale	Designed	Drawn	Checked	Approved
1:50000	PR	NK	AC	TRA
Original Size A1	Date 28.05.21	Date 28.05.21	Date 28.05.21	Date 28.05.21

Drawing Number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE551511 - VFK -HDG- X_XXXX_XX - DR - CD - 0514

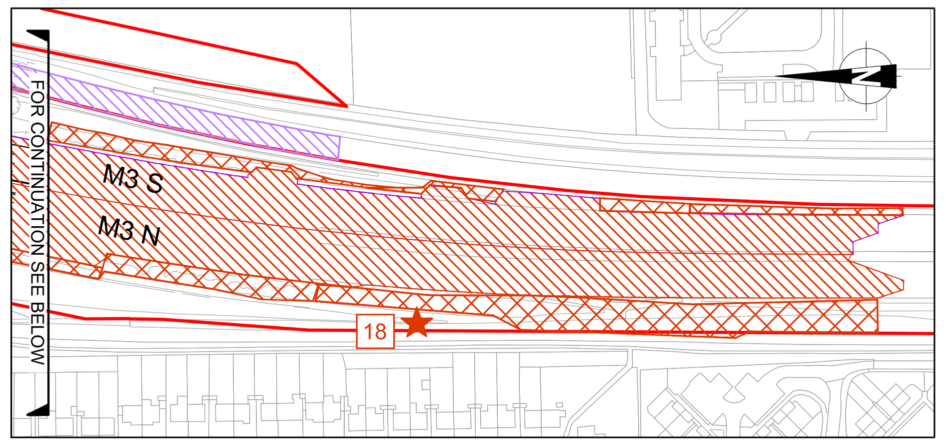
Project Ref. No. 48176

Revision P03





INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

CATCHMENT SCHEDULE

EXISTING CATCHMENT AREA	COLOUR	CATCHMENT TYPE	CATCHMENT AREA (ha)	TOTAL NET CATCHMENT AREA (ha)	OUTFALLS TO	NOTES
1		IMPERMEABLE	0.58	0.58	RIVER OUTFALL 1	VIA NATIONAL HIGHWAY DITCH IN FLOODPLAIN
	NOT USED	PERMEABLE	0.00			
2		IMPERMEABLE	0.21	0.21	RIVER OUTFALL 2	VIA NATIONAL HIGHWAY DITCH IN FLOODPLAIN
	NOT USED	PERMEABLE	0.00			
3		IMPERMEABLE	0.12	0.12	RIVER OUTFALL 3	VIA NATIONAL HIGHWAY DITCH IN FLOODPLAIN
	NOT USED	PERMEABLE	0.00			
4		IMPERMEABLE	0.33	0.33	RIVER OUTFALL 4	VIA NATIONAL HIGHWAY DITCH IN FLOODPLAIN
	NOT USED	PERMEABLE	0.00			
5		IMPERMEABLE	0.30	0.30	RIVER OUTFALL 5	VIA NATIONAL HIGHWAY DITCH IN FLOODPLAIN
	NOT USED	PERMEABLE	0.00			
6		IMPERMEABLE	0.37	0.37	SOAKAGE TRENCH / RIVER OUTFALL 6	OVERFLOW FROM SOAKAGE TRENCH TO RIVER ITCHEN
	NOT USED	PERMEABLE	0.00			
7		IMPERMEABLE	0.66	0.66	RIVER OUTFALL 7	VIA NATIONAL HIGHWAY DITCH IN FLOODPLAIN
	NOT USED	PERMEABLE	0.00			
8		IMPERMEABLE	0.49	0.57	RIVER OUTFALL 8	VIA NATIONAL HIGHWAY PCD EAST OF A33 SB
		PERMEABLE	0.40			
9		IMPERMEABLE	1.12	1.14	SOAKAWAY TRENCH	SOAKAGE TRENCH ALONGSIDE INDUSTRIAL UNITS
		PERMEABLE	0.07			
10		IMPERMEABLE	0.28	0.28	SOAKAWAY TRENCH / CHAMBER	SOAKAWAY TRENCH/CHAMBER LOCATED IN NATIONAL HIGHWAY DEPOT AREA
	NOT USED	PERMEABLE	0.00			
11		IMPERMEABLE	0.68	0.68	SOAKAWAY CHAMBERS	SOAKAWAY CHAMBERS AROUND GYRATORY (INCL. TESCO SUBWAY)
	NOT USED	PERMEABLE	0.00			
12		IMPERMEABLE	2.89	3.33	SOAKAWAY TRENCH	M3 CORRIDOR
		PERMEABLE	2.16			
13		IMPERMEABLE	1.29	1.56	SOAKAWAY TRENCH	M3SB TO EXISTING OVERLAND FLOW BASIN
		PERMEABLE	1.35			
14		IMPERMEABLE	0.36	0.36	SOAKAWAY TRENCH	SOAKAWAY CHAMBERS AROUND GYRATORY
	NOT USED	PERMEABLE	0.00			
15		IMPERMEABLE	0.23	0.23	SOAKAWAY CHAMBERS	HAMPSHIRE COUNTY COUNCIL SOAKAWAY CHAMBERS ON EASTON LANE
	NOT USED	PERMEABLE	0.00			
16		IMPERMEABLE	0.98	0.98	SOAKAWAY TRENCH	HAMPSHIRE COUNTY COUNCIL SOAKAWAY TRENCHES ON A272 'SPITFIRE' LINK ROAD
	NOT USED	PERMEABLE	0.00			
17		IMPERMEABLE	0.76	0.76	SOAKAWAY TRENCH	M3 CORRIDOR
	NOT USED	PERMEABLE	0.00			
18		IMPERMEABLE	1.50	1.60	OFFLINE SOAKAWAY CHAMBERS/TRENCHES SOUTH OF M3 J9, WITH SOME THROUGHFLOW TO M3 J9	MOTORWAY UPGRADE SCHEME DRAINED AREA, INCOMING TO M3 J9 NETWORK
		PERMEABLE	0.49			
TOTALS		IMPERMEABLE	13.14	14.03		
		PERMEABLE	4.47			

NOTES:

1. PERMEABLE CATCHMENTS COMPRISE OF CUTTING SLOPES DRAINING TO CARRIAGEWAY.
2. RUN-OFF COEFFICIENT OF PERMEABLE CATCHMENTS ASSUMED TO BE 20%

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR OVERLAND FLOW CATCHMENT PLAN REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0514.

0 50 100 150 200 250m

SCALE 1:2500

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- RIVER ITCHEN
- IMPERMEABLE CATCHMENT
- PERMEABLE CATCHMENT
- CATCHMENT REFERENCE NUMBER
- EXISTING SOAKAWAY TRENCH
- EXISTING SOAKAWAY CHAMBER
- EXISTING OUTFALL TO RIVER

REFER TO CATCHMENT SCHEDULE FOR COLOURING

COLOURED TO MATCH RESPECTIVE CATCHMENT AREA

CONFIDENTIAL

THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

Rev.	Date	Description	Drawn	Chk'd	App'd
P03	24.11.21	ISSUED FOR S3 SUBMISSION	lјj	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	RG	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN EXISTING HIGHWAY SURFACE WATER CATCHMENTS OVERVIEW PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: A1	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21

Drawing Number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE551511 - VFK -HDG- X_XXXX_XX - DR - CD - 0515

Project Ref. No.: 48176

Revision: P03

Appendix G Drainage Calculations

5yr + 20%CC (for no carriageway-flooding)

1) Highway Drainage to Outfalls A & 8 (Ex)
2) Highway Drainage to Outfall B
3) Highway Drainage to Basin 5
4) Retained & Modified Highway Drainage to A33, A34 & M3 North of M3J9.

5yr + 40%CC (for no carriageway-flooding sensitivity to climate change)

5) Highway Drainage to Outfalls A & 8 (Ex)
6) Highway Drainage to Outfall B
7) Highway Drainage to Basin 5
8) Retained & Modified Highway Drainage to A33, A34 & M3 North of M3J9.

100-year + 40%CC (for attenuation design)

9) Highway Drainage to Outfalls A & 8 (Ex)
10) Highway Drainage to Outfall B
11) Highway Drainage to Basin 5
12) Retained & Modified Highway Drainage to A33, A34 & M3 North of M3J9. **(n/a)**

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for New works to Basins 2 & 3C

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S314.009	SOutfall W of bridges	41.000	40.054	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S336.010	SM3 CR tie in 01	58.228	55.203	56.200	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S341.001	S	53.487	52.685	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S342.002	SEx O_Fall SU4931_4049c	38.191	37.631	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S347.012	S	58.068	53.978	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S350.000	SSU4929_6199b	58.753	54.920	0.000	1200	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S351.001	S227	53.105	51.073	0.000	1350	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S352.006	S193	56.113	54.334	0.000	1200	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S355.001	S	66.661	64.226	0.000	0	0

Online Controls for New works to Basins 2 & 3C

Orifice Manhole: S47, DS/PN: S321.002, Volume (m³): 28.2

Diameter (m) 0.240 Discharge Coefficient 0.600 Invert Level (m) 56.653

Orifice Manhole: S61, DS/PN: S323.007, Volume (m³): 67.7

Diameter (m) 0.160 Discharge Coefficient 0.600 Invert Level (m) 55.488

Hydro-Brake® Optimum Manhole: S71, DS/PN: S320.006, Volume (m³): 19.2

Unit Reference	MD-SHE-0414-1250-2500-1250
Design Head (m)	2.500
Design Flow (l/s)	125.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	414
Invert Level (m)	51.393
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.500	124.9	Kick-Flo®	1.707	103.8
Flush-Flo™	0.790	124.3	Mean Flow over Head Range	-	106.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	11.2	0.800	124.3	2.000	112.0	4.000	157.0	7.000	206.5
0.200	40.4	1.000	123.2	2.200	117.4	4.500	166.3	7.500	213.6
0.300	78.8	1.200	121.0	2.400	122.4	5.000	175.1	8.000	220.4
0.400	113.5	1.400	117.4	2.600	127.3	5.500	183.5	8.500	227.1
0.500	120.0	1.600	110.4	3.000	136.5	6.000	191.5	9.000	233.5
0.600	122.7	1.800	106.5	3.500	147.1	6.500	199.1	9.500	239.8

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Unit Reference	MD-SHE-0214-2930-2400-2930
Design Head (m)	2.400
Design Flow (l/s)	29.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	40.850
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.400	29.3	Kick-Flo®	1.466	23.1
Flush-Flo™	0.693	29.2	Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	0.800	29.1	2.000	26.8	4.000	37.4	7.000	49.1
0.200	20.9	1.000	28.5	2.200	28.1	4.500	39.6	7.500	50.7
0.300	26.1	1.200	27.2	2.400	29.3	5.000	41.7	8.000	52.3
0.400	27.8	1.400	24.6	2.600	30.4	5.500	43.7	8.500	53.9
0.500	28.7	1.600	24.1	3.000	32.6	6.000	45.5	9.000	55.4
0.600	29.1	1.800	25.5	3.500	35.1	6.500	47.3	9.500	56.9

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m³): 5.8

Unit Reference	MD-SHE-0082-4000-2000-4000
Design Head (m)	2.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	48.604
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	4.0	Kick-Flo®	0.729	2.5
Flush-Flo™	0.356	3.1	Mean Flow over Head Range	-	3.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	3.0	1.000	2.9	2.200	4.2	4.500	5.8	7.500	7.4
0.300	3.1	1.200	3.2	2.400	4.3	5.000	6.1	8.000	7.7
0.400	3.1	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	3.1	1.600	3.6	3.000	4.8	6.000	6.7	9.000	8.1
0.600	2.9	1.800	3.8	3.500	5.2	6.500	6.9	9.500	8.3

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m³): 10.9

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	41.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m^3): 10.9

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.8	7.000	4.9
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	1.9	1.200	2.2	2.400	3.0	5.000	4.2	8.000	5.2
0.400	1.9	1.400	2.3	2.600	3.1	5.500	4.4	8.500	5.4
0.500	1.8	1.600	2.5	3.000	3.3	6.000	4.6	9.000	5.5
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.7

Orifice Manhole: S261, DS/PN: S352.004, Volume (m^3): 38.1

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 60.425

Depth/Flow Relationship Manhole: S256, DS/PN: S355.001, Volume (m^3): 50.4

Invert Level (m) 64.300

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.700	0.0000	1.300	0.0000	1.900	0.0000	2.500	0.0000
0.200	0.0000	0.800	0.0000	1.400	0.0000	2.000	0.0000	2.600	0.0000
0.300	0.0000	0.900	0.0000	1.500	0.0000	2.100	0.0000	2.700	0.0000
0.400	0.0000	1.000	0.0000	1.600	0.0000	2.200	0.0000	2.800	0.0000
0.500	0.0000	1.100	0.0000	1.700	0.0000	2.300	0.0000	2.900	0.0000
0.600	0.0000	1.200	0.0000	1.800	0.0000	2.400	0.0000	3.000	0.0000

Offline Controls for New works to Basins 2 & 3C

Pipe Manhole: SSMP CR010, DS/PN: S323.004, Loop to PN: S337.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	60.041

Pipe Manhole: S61, DS/PN: S323.007, Loop to PN: S339.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	55.488

Pipe Manhole: S71, DS/PN: S320.006, Loop to PN: S315.009

Diameter (m)	0.450	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	40.000	Upstream Invert Level (m)	54.650

Weir Manhole: S98, DS/PN: S314.004, Loop to PN: S314.005

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 45.200

Pipe Manhole: S106, DS/PN: S331.005, Loop to PN: S331.007

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	200.0	Coefficient of Contraction	0.600
Length (m)	16.500	Upstream Invert Level (m)	43.514

Weir Manhole: S114, DS/PN: S314.006, Loop to PN: S314.007

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.900

Pipe Manhole: S98, DS/PN: S335.002, Loop to PN: S334.015

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	27.5	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	43.032

Pipe Manhole: S99, DS/PN: S335.003, Loop to PN: S334.014

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	57.0	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	42.850

Weir Manhole: S154, DS/PN: S314.008, Loop to PN: S314.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.150

Pipe Manhole: S262, DS/PN: S336.006, Loop to PN: S350.000

Diameter (m)	0.225	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	59.809

Weir Manhole: S261, DS/PN: S352.004, Loop to PN: S321.000

Discharge Coef 0.544 Width (m) 1.800 Invert Level (m) 61.255

Storage Structures for New works to Basins 2 & 3C

Infiltration Basin Manhole: S71, DS/PN: S320.006

Invert Level (m) 51.479 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	350.0	0.600	479.6	1.200	629.5	1.800	799.7	2.400	990.4
0.100	370.2	0.700	503.1	1.300	656.4	1.900	830.1	2.500	1024.1
0.200	390.9	0.800	527.3	1.400	684.0	2.000	861.0	2.600	1058.4
0.300	412.2	0.900	552.0	1.500	712.1	2.100	892.5	2.700	1093.3
0.400	434.1	1.000	577.2	1.600	740.7	2.200	924.6	2.800	1128.8
0.500	456.5	1.100	603.1	1.700	769.9	2.300	957.2	2.900	1164.8

Infiltration Basin Manhole: S98, DS/PN: S314.004

Invert Level (m) 43.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	561.0	0.501	1078.9	1.001	1603.0	1.501	2133.4	2.001	2670.1
0.101	664.1	0.601	1183.2	1.101	1708.6	1.601	2240.2	2.101	2778.2
0.201	767.4	0.701	1287.8	1.201	1814.4	1.701	2347.3	2.201	2886.5
0.301	871.0	0.801	1392.6	1.301	1920.5	1.801	2454.7	2.301	2995.1
0.401	974.8	0.901	1497.7	1.401	2026.8	1.901	2562.3	2.400	3102.9

Infiltration Basin Manhole: S114, DS/PN: S314.006

Invert Level (m) 42.075 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1171.8	0.501	1373.1	1.001	1580.7	1.501	1794.5	1.925	1980.8
0.101	1211.6	0.601	1414.1	1.101	1623.0	1.601	1838.0		
0.201	1251.6	0.701	1455.4	1.201	1665.5	1.701	1881.8		
0.301	1291.9	0.801	1496.9	1.301	1708.2	1.801	1925.8		
0.401	1332.4	0.901	1538.7	1.401	1751.3	1.901	1970.1		

Infiltration Basin Manhole: S154, DS/PN: S314.008

Invert Level (m) 40.850 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2392.3	0.501	2716.7	1.001	3047.3	1.501	3384.2	2.001	3727.4
0.101	2456.7	0.601	2782.3	1.101	3114.2	1.601	3452.3	2.101	3796.8
0.201	2521.3	0.701	2848.2	1.201	3181.3	1.701	3520.7	2.201	3866.4
0.301	2586.2	0.801	2914.3	1.301	3248.7	1.801	3589.4	2.301	3936.3
0.401	2651.3	0.901	2980.7	1.401	3316.3	1.901	3658.2	2.400	4005.7

Infiltration Basin Manhole: S84, DS/PN: S343.006

Invert Level (m) 48.383 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Infiltration Basin Manhole: S84, DS/PN: S343.006

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	325.0	0.600	496.5	1.200	704.1	1.800	948.0	2.400	1228.0
0.100	351.1	0.700	528.6	1.300	742.3	1.900	992.1	2.500	1278.2
0.200	378.1	0.800	561.7	1.400	781.4	2.000	1037.3		
0.300	406.2	0.900	595.8	1.500	821.5	2.100	1083.5		
0.400	435.3	1.000	630.9	1.600	862.7	2.200	1130.7		
0.500	465.4	1.100	667.0	1.700	904.8	2.300	1178.8		

Infiltration Basin Manhole: S106, DS/PN: S343.009

Invert Level (m) 40.988 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1300.0	0.600	1624.8	1.200	1985.9	1.800	2383.1	2.400	2816.5
0.100	1351.6	0.700	1682.5	1.300	2049.6	1.900	2452.8	2.500	2892.3
0.200	1404.3	0.800	1741.2	1.400	2114.3	2.000	2523.6		
0.300	1457.9	0.900	1800.8	1.500	2180.0	2.100	2595.3		
0.400	1512.5	1.000	1861.5	1.600	2246.7	2.200	2668.0		
0.500	1568.2	1.100	1923.2	1.700	2314.4	2.300	2741.8		

Infiltration Basin Manhole: S256, DS/PN: S355.001

Invert Level (m) 64.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.600	338.0	1.200	891.0	1.800	1600.0	2.400	1600.0
0.100	32.0	0.700	417.0	1.300	1006.0	1.900	1600.0	2.500	1600.0
0.200	78.0	0.800	501.0	1.400	1200.0	2.000	1600.0		
0.300	133.0	0.900	588.0	1.500	1400.0	2.100	1600.0		
0.400	195.0	1.000	676.0	1.600	1600.0	2.200	1600.0		
0.500	264.0	1.100	766.0	1.700	1600.0	2.300	1600.0		

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Offline Controls	11	Number of Time/Area Diagrams	0
Number of Online Controls	8	Number of Storage Structures	7	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.411
FEH Rainfall Version	1999	E (1km)	0.294
Site Location	GB 449350 131500 SU 49350 31500	F (1km)	2.313
C (1km)	-0.025	Cv (Summer)	1.000
D1 (1km)	0.429	Cv (Winter)	1.000
D2 (1km)	0.273		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S314.000	S32	15 Summer	5	+20%					49.876	-0.068	0.000	0.58
S314.001	S33	15 Summer	5	+20%					48.808	-0.043	0.000	0.83
S315.000	S31	15 Summer	5	+20%					59.356	-0.094	0.000	0.29
S315.001	S32	15 Summer	5	+20%					58.258	-0.076	0.000	0.47
S316.000	S26	15 Summer	5	+20%					63.391	-0.102	0.000	0.22
S316.001	S27	15 Summer	5	+20%					63.153	-0.090	0.000	0.33
S316.002	S28	15 Summer	5	+20%					62.773	-0.060	0.000	0.66
S316.003	S29	15 Summer	5	+20%					62.464	-0.108	0.000	0.51
S316.004	S30	15 Summer	5	+20%					59.681	-0.100	0.000	0.77
S316.005	S31	15 Summer	5	+20%					59.535	-0.148	0.000	0.50
S316.006	S32	15 Summer	5	+20%					59.387	-0.055	0.000	1.00
S316.007	S33	15 Summer	5	+20%					59.298	-0.060	0.000	0.99
S316.008	S9	15 Summer	5	+20%					59.125	-0.137	0.000	0.53
S317.000	S33	15 Summer	5	+20%					63.237	-0.135	0.000	0.34
S317.001	S34	15 Summer	5	+20%					62.682	-0.149	0.000	0.49
S317.002	S35	15 Summer	5	+20%					62.587	-0.174	0.000	0.36
S317.003	S36	15 Summer	5	+20%					62.413	-0.176	0.000	0.33
S317.004	S38	15 Summer	5	+20%					60.270	-0.175	0.000	0.36
S317.005	S39	15 Summer	5	+20%					59.617	-0.133	0.000	0.59
S317.006	S40	15 Summer	5	+20%					59.328	-0.136	0.000	0.58
S317.007	S41	15 Summer	5	+20%					59.188	-0.063	0.000	0.95
S318.000	S12	15 Summer	5	+20%					60.951	-0.111	0.000	0.16
S318.001	S13	15 Summer	5	+20%					60.677	-0.101	0.000	0.24
S318.002	S14	15 Summer	5	+20%					60.170	-0.084	0.000	0.40
S318.003	S15	15 Summer	5	+20%					59.697	-0.080	0.000	0.44
S319.000	S30	15 Summer	5	+20%					59.643	-0.107	0.000	0.18
S319.001	S31	15 Summer	5	+20%					59.316	-0.100	0.000	0.25
S318.004	S176	15 Summer	5	+20%	5/15 Summer				59.159	0.014	0.000	1.11
S316.009	S18	15 Summer	5	+20%					59.077	-0.002	0.000	1.00
S316.010	S36	15 Summer	5	+20%					58.855	-0.019	0.000	0.95

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S314.000	S32			21.3	OK	
S314.001	S33			30.8	OK	
S315.000	S31			9.0	OK	
S315.001	S32			17.1	OK	
S316.000	S26			4.8	OK	
S316.001	S27			7.7	OK	
S316.002	S28			11.2	OK	
S316.003	S29			41.2	OK	
S316.004	S30			48.6	OK	
S316.005	S31			56.9	OK	
S316.006	S32			63.0	OK	
S316.007	S33			69.7	OK	
S316.008	S9			72.7	OK	
S317.000	S33			26.6	OK	
S317.001	S34			30.1	OK	
S317.002	S35			33.6	OK	
S317.003	S36			50.1	OK	
S317.004	S38			56.3	OK	
S317.005	S39			61.6	OK	
S317.006	S40			63.4	OK	
S317.007	S41			67.0	OK	
S318.000	S12			4.2	OK	
S318.001	S13			6.1	OK	
S318.002	S14			9.7	OK	
S318.003	S15			11.1	OK	
S319.000	S30			4.0	OK	
S319.001	S31			5.3	OK	
S318.004	S176			15.6	SURCHARGED	
S316.009	S18			145.1	OK	
S316.010	S36			158.9	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S316.011	S37	15 Summer	5	+20%	5/15 Summer				58.469	0.052
S316.012	S36	15 Summer	5	+20%					58.139	-0.183
S316.013	S37	15 Summer	5	+20%					57.157	-0.213
S315.002	S34	30 Summer	5	+20%					56.047	-0.150
S315.003	S28	30 Summer	5	+20%					53.804	-0.181
S315.004	S29	30 Summer	5	+20%					52.092	-0.182
S315.005	S30	30 Summer	5	+20%	5/15 Summer				50.673	0.153
S315.006	S72	30 Summer	5	+20%					50.191	-0.125
S315.007	S73	15 Summer	5	+20%					49.544	-0.152
S315.008	S8	30 Summer	5	+20%					48.892	-0.153
S320.000	S1	15 Summer	5	+20%					59.676	-0.043
S320.001	S2	15 Summer	5	+20%					58.066	-0.044
S320.002	S3	15 Summer	5	+20%					55.183	-0.094
S320.003	S4	15 Summer	5	+20%					54.199	-0.064
S321.000	S45	15 Summer	5	+20%					59.047	-0.449
S321.001	S46	15 Summer	5	+20%					57.989	-0.444
S321.002	S47	30 Summer	5	+20%	5/15 Summer				57.347	0.394
S321.003	S48	30 Summer	5	+20%					56.623	-0.191
S321.004	S74	30 Summer	5	+20%					55.688	-0.183
S321.005	S75	30 Summer	5	+20%					55.059	-0.200
S321.006	S76	30 Summer	5	+20%					54.527	-0.182
S321.007	S77	30 Summer	5	+20%					53.685	-0.182
S322.000	S94	15 Summer	5	+20%					54.483	-0.032
S322.001	S95	15 Summer	5	+20%					54.065	-0.072
S322.002	S96	15 Summer	5	+20%					53.784	-0.151
S322.003	S97	15 Summer	5	+20%					53.557	-0.083
S322.004	S98	15 Summer	5	+20%					53.366	-0.157
S321.008	S58	180 Summer	5	+20%	5/60 Summer				53.108	0.034
S323.000	S54	15 Summer	5	+20%					67.398	-0.020
S323.001	SSMP CR012	15 Summer	5	+20%					66.601	-0.062
S323.002	SSMP CR011	60 Summer	5	+20%					64.108	-0.445
S323.003	SSMP CRS4	60 Summer	5	+20%	5/15 Summer	5/15 Summer			64.047	1.518
S323.004	SSMP CR010	15 Summer	5	+20%			5/15 Summer	24	60.156	-0.335
S323.005	SSMP CR009	15 Summer	5	+20%					58.522	-0.799
S323.006	SSMP 1106	15 Summer	5	+20%					57.325	-0.771
S323.007	S61	15 Summer	5	+20%	5/15 Summer		5/15 Summer	24	56.251	0.388
S323.008	S79	15 Summer	5	+20%					54.500	-0.284
S323.009	S63	30 Summer	5	+20%					54.134	-0.296
S323.010	S80	30 Summer	5	+20%					53.802	-0.274
S323.011	S81	15 Summer	5	+20%					53.370	-0.249
S323.012	S66	30 Summer	5	+20%					53.174	-0.254
S321.009	SSMP CR004	120 Winter	5	+20%	5/60 Summer				52.987	0.011
S324.000	S67	15 Summer	5	+20%					54.683	-0.091
S324.001	S68	15 Summer	5	+20%					53.877	-0.079
S324.002	S69	15 Summer	5	+20%					53.480	-0.013
S325.000	S12	15 Summer	5	+20%					59.892	-0.102
S325.001	S13	15 Summer	5	+20%					59.180	-0.100
S325.002	S19	15 Summer	5	+20%					58.308	-0.098
S325.003	S78	15 Summer	5	+20%					57.045	-0.105
S324.003	S78	180 Summer	5	+20%					53.047	-0.180
S324.004	S70	120 Winter	5	+20%					52.994	0.000
S321.010	S243	240 Summer	5	+20%					52.876	0.000
S321.011	S72	180 Summer	5	+20%	5/180 Summer				52.763	0.000
S321.012	S244	180 Summer	5	+20%	5/120 Summer				52.700	0.051
S321.013	S63	180 Summer	5	+20%	5/15 Summer				52.687	0.251
S320.004	S5	180 Summer	5	+20%	5/30 Summer				52.678	0.268
S326.000	S249	15 Summer	5	+20%					59.359	-0.062
S326.001	S251	15 Summer	5	+20%					58.638	-0.131
S326.002	S251	15 Summer	5	+20%					56.575	-0.066
S326.003	S78	15 Summer	5	+20%	5/15 Summer				55.964	0.148

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S316.011	S37	0.000	1.32			159.0	SURCHARGED	
S316.012	S36	0.000	0.52			164.3	OK	
S316.013	S37	0.000	0.39			164.4	OK	
S315.002	S34	0.000	0.66			180.8	OK	
S315.003	S28	0.000	0.53			190.1	OK	
S315.004	S29	0.000	0.52			198.3	OK	
S315.005	S30	0.000	1.35			204.8	SURCHARGED	
S315.006	S72	0.000	0.78			209.3	OK	
S315.007	S73	0.000	0.66			207.3	OK	
S315.008	S8	0.000	0.65			209.9	OK	
S320.000	S1	0.000	0.85			29.2	OK	
S320.001	S2	0.000	0.81			34.5	OK	
S320.002	S3	0.000	0.62			44.2	OK	
S320.003	S4	0.000	0.87			70.3	OK	
S321.000	S45	0.000	0.14			117.2	OK*	
S321.001	S46	0.000	0.15			114.1	OK	
S321.002	S47	0.000	0.97			90.9	SURCHARGED	
S321.003	S48	0.000	0.48			89.6	OK	
S321.004	S74	0.000	0.52			90.2	OK	
S321.005	S75	0.000	0.44			90.8	OK	
S321.006	S76	0.000	0.51			90.6	OK	
S321.007	S77	0.000	0.52			93.8	OK	
S322.000	S94	0.000	0.92			15.9	OK	
S322.001	S95	0.000	0.76			28.7	OK	
S322.002	S96	0.000	0.47			37.2	OK	
S322.003	S97	0.000	0.84			45.6	OK	
S322.004	S98	0.000	0.46			48.8	OK	
S321.008	S58	0.000	0.38			78.3	SURCHARGED	
S323.000	S54	0.000	0.89			49.1	OK	
S323.001	SSMP CR012	0.000	0.88			111.9	OK	
S323.002	SSMP CR011	0.000	0.11			113.1	OK	
S323.003	SSMP CRS4	47.035	1.29			33.3	FLOOD	14
S323.004	SSMP CR010	0.000	0.15	12.4		71.0	OK	
S323.005	SSMP CR009	0.000	0.03			71.3	OK	
S323.006	SSMP 1106	0.000	0.05			114.9	OK	
S323.007	S61	0.000	0.21	66.4		43.9	SURCHARGED	
S323.008	S79	0.000	0.28			60.3	OK	
S323.009	S63	0.000	0.25			60.2	OK	
S323.010	S80	0.000	0.32			92.1	OK	
S323.011	S81	0.000	0.52			132.0	OK	
S323.012	S66	0.000	0.52			130.5	OK	
S321.009	SSMP CR004	0.000	0.57			141.2	SURCHARGED	
S324.000	S67	0.000	0.73			77.2	OK	
S324.001	S68	0.000	0.90			127.1	OK	
S324.002	S69	0.000	1.00			137.7	OK	
S325.000	S12	0.000	0.23			6.3	OK	
S325.001	S13	0.000	0.24			8.0	OK	
S325.002	S19	0.000	0.26			9.0	OK	
S325.003	S78	0.000	0.19			10.8	OK	
S324.003	S78	0.000	0.32			70.1	OK	
S324.004	S70	0.000	0.23			71.7	OK	
S321.010	S243	0.000	0.46			215.5	OK	
S321.011	S72	0.000	0.52			242.0	SURCHARGED	
S321.012	S244	0.000	0.50			243.9	SURCHARGED	
S321.013	S63	0.000	0.79			235.4	SURCHARGED	
S320.004	S5	0.000	0.57			251.2	SURCHARGED	
S326.000	S249	0.000	0.75			35.6	OK	
S326.001	S251	0.000	0.55			72.9	OK	
S326.002	S251	0.000	0.90			107.1	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.003	S78	0.000	1.14			100.7	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S326.004	S77	15 Summer	5	+20%	5/15 Summer				55.369	0.045	0.000	1.05
S326.005	S80	15 Summer	5	+20%					54.762	-0.119	0.000	0.80
S327.000	S60	15 Summer	5	+20%					54.703	-0.150	0.000	0.00
S326.006	S243	15 Summer	5	+20%					52.905	-0.093	0.000	0.81
S328.000	S81	15 Summer	5	+20%					58.996	-0.150	0.000	0.00
S328.001	S251	15 Summer	5	+20%					58.773	-0.168	0.000	0.39
S328.002	S82	15 Summer	5	+20%					57.801	-0.177	0.000	0.34
S328.003	S253	15 Summer	5	+20%					56.755	-0.058	0.000	0.97
S328.004	S86	15 Summer	5	+20%					55.630	-0.267	0.000	0.34
S328.005	S82	15 Summer	5	+20%					54.598	-0.269	0.000	0.34
S328.006	S89	15 Summer	5	+20%					53.567	-0.269	0.000	0.34
S329.000	S66	15 Summer	5	+20%	5/15 Summer				53.887	0.133	0.000	1.00
S329.001	S67	15 Summer	5	+20%	5/15 Summer				53.384	0.099	0.000	0.71
S329.002	S68	15 Summer	5	+20%	5/15 Summer				53.331	0.366	0.000	1.34
S326.007	S244	180 Summer	5	+20%	5/60 Summer				52.803	0.173	0.000	0.38
S326.008	S246	180 Summer	5	+20%	5/15 Summer				52.674	0.290	0.000	1.00
S330.000	S6	15 Summer	5	+20%	5/15 Summer				55.571	0.021	0.000	0.90
S330.001	S7	15 Summer	5	+20%					54.013	-0.106	0.000	0.75
S330.002	S121	15 Summer	5	+20%					53.205	-0.090	0.000	0.81
S320.005	S71	180 Summer	5	+20%	5/15 Summer				52.667	0.336	0.000	0.60
S320.006	S71	180 Summer	5	+20%	5/15 Summer			0	52.652	0.871	0.000	0.15
S315.009	S42	30 Summer	5	+20%					47.635	-0.192	0.000	0.62
S315.010	S48	30 Summer	5	+20%	5/15 Summer				46.274	0.304	0.000	4.02
S314.002	S41	30 Summer	5	+20%	5/15 Summer				45.422	0.172	0.000	1.42
S314.003	S34	30 Summer	5	+20%					44.753	-0.210	0.000	0.67
S314.004	S98	720 Summer	5	+20%	5/15 Summer			0	44.263	1.213	0.000	2.40
S331.000	S50	15 Summer	5	+20%	5/15 Summer				53.086	0.278	0.000	1.07
S331.001	S51	15 Summer	5	+20%					52.001	-0.037	0.000	0.91
S331.002	S52	15 Summer	5	+20%					48.140	-0.127	0.000	0.39
S331.003	S100	15 Summer	5	+20%					45.434	-0.109	0.000	0.52
S331.004	S53	15 Summer	5	+20%					43.656	-0.099	0.000	0.77
S331.005	S106	15 Summer	5	+20%				0	43.459	-0.055	0.000	1.00
S332.000	S50	15 Summer	5	+20%					45.674	-0.103	0.000	0.21
S332.001	S165	15 Summer	5	+20%					44.079	-0.128	0.000	0.37
S332.002	S166	15 Summer	5	+20%					43.703	-0.185	0.000	0.31
S331.006	S54	15 Summer	5	+20%					43.290	-0.243	0.000	0.43
S331.007	S106	15 Summer	5	+20%					43.195	-0.235	0.000	0.46
S331.008	S109	15 Summer	5	+20%					43.063	-0.216	0.000	0.52
S331.009	S110	960 Summer	5	+20%					42.954	-0.140	0.000	0.11
S331.010	S111	960 Summer	5	+20%	5/720 Summer				42.954	0.019	0.000	0.26
S314.005	S37	960 Summer	5	+20%	5/480 Summer				42.954	0.137	0.000	0.20
S314.006	S114	960 Summer	5	+20%	5/60 Summer			0	42.758	0.508	0.000	1.08
S333.000	S69	15 Summer	5	+20%	5/15 Summer				54.186	0.183	0.000	1.06
S333.001	S70	15 Summer	5	+20%					53.398	-0.078	0.000	0.74
S333.002	S71	15 Summer	5	+20%					52.087	-0.106	0.000	0.54
S333.003	S72	15 Summer	5	+20%					47.159	-0.092	0.000	0.65
S334.000	S60	15 Summer	5	+20%					54.449	-0.148	0.000	0.41
S334.001	S61	15 Summer	5	+20%					53.847	-0.150	0.000	0.50
S334.002	S62	15 Summer	5	+20%					53.777	-0.142	0.000	0.52
S334.003	S63	15 Summer	5	+20%					53.536	-0.172	0.000	0.37
S334.004	S64	15 Summer	5	+20%					52.872	-0.171	0.000	0.38
S334.005	S65	15 Summer	5	+20%					51.782	-0.148	0.000	0.49
S334.006	S58	15 Summer	5	+20%					50.519	-0.242	0.000	0.27
S334.007	S54	15 Summer	5	+20%					49.197	-0.240	0.000	0.27
S334.008	S55	15 Summer	5	+20%					45.763	-0.227	0.000	0.33
S334.009	S100	15 Summer	5	+20%					45.031	-0.231	0.000	0.31
S334.010	S101	15 Summer	5	+20%					43.833	-0.208	0.000	0.41
S334.011	S102	15 Summer	5	+20%					42.900	-0.359	0.000	0.22
S335.000	S96	15 Summer	5	+20%					44.426	-0.052	0.000	0.74
S335.001	S97	15 Summer	5	+20%					44.039	-0.065	0.000	0.58

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.004	S77			94.9	SURCHARGED	
S326.005	S80			94.6	OK	
S327.000	S60			0.0	OK	
S326.006	S243			94.3	OK	
S328.000	S81			0.0	OK	
S328.001	S251			45.9	OK	
S328.002	S82			44.6	OK	
S328.003	S253			123.1	OK	
S328.004	S86			122.8	OK	
S328.005	S82			121.0	OK	
S328.006	S89			120.7	OK	
S329.000	S66			38.7	SURCHARGED	
S329.001	S67			48.4	SURCHARGED	
S329.002	S68			48.2	SURCHARGED	
S326.007	S244			144.6	SURCHARGED	
S326.008	S246			142.5	SURCHARGED	
S330.000	S6			54.8	SURCHARGED	
S330.001	S7			107.0	OK	
S330.002	S121			124.8	OK	
S320.005	S71			409.9	SURCHARGED	
S320.006	S71	0.0	86	124.3	SURCHARGED	
S315.009	S42			332.4	OK	
S315.010	S48			334.4	SURCHARGED	
S314.002	S41			347.2	SURCHARGED	
S314.003	S34			346.4	OK	
S314.004	S98	0.0	275	83.1	SURCHARGED*	
S331.000	S50			18.9	SURCHARGED	
S331.001	S51			37.2	OK	
S331.002	S52			49.9	OK	
S331.003	S100			50.0	OK	
S331.004	S53			57.5	OK	
S331.005	S106	0.0		55.9	OK	
S332.000	S50			8.4	OK	
S332.001	S165			19.8	OK	
S332.002	S166			26.7	OK	
S331.006	S54			78.1	OK	
S331.007	S106			80.5	OK	
S331.008	S109			81.2	OK	
S331.009	S110			16.6	OK	
S331.010	S111			21.2	SURCHARGED	
S314.005	S37			95.5	SURCHARGED*	
S314.006	S114	0.0	353	61.4	SURCHARGED*	
S333.000	S69			45.9	SURCHARGED	
S333.001	S70			58.2	OK	
S333.002	S71			72.8	OK	
S333.003	S72			85.1	OK	
S334.000	S60			34.4	OK	
S334.001	S61			35.0	OK	
S334.002	S62			41.4	OK	
S334.003	S63			49.8	OK	
S334.004	S64			63.1	OK	
S334.005	S65			82.5	OK	
S334.006	S58			87.8	OK	
S334.007	S54			103.3	OK	
S334.008	S55			109.1	OK	
S334.009	S100			108.9	OK	
S334.010	S101			108.3	OK	
S334.011	S102			107.6	OK	
S335.000	S96			13.8	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.001	S97			18.5	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S335.002	S98	15 Summer	5	+20%				0	42.944	-0.088	0.000
S335.003	S99	15 Summer	5	+20%				0	42.767	-0.077	0.000
S334.012	S100	15 Summer	5	+20%					42.523	-0.253	0.000
S334.013	S69	15 Summer	5	+20%					42.499	-0.224	0.000
S334.014	S137	15 Summer	5	+20%					42.436	-0.242	0.000
S334.015	S72	15 Summer	5	+20%					42.360	-0.273	0.000
S334.016	S74	15 Summer	5	+20%					42.294	-0.271	0.000
S333.004	S73	1440 Winter	5	+20%					42.074	-0.343	0.000
S333.005	S114	1440 Winter	5	+20%	5/480 Summer				42.074	0.229	0.000
S314.007	S154	1440 Winter	5	+20%	5/240 Summer				42.074	0.568	0.000
S314.008	S154	1440 Winter	5	+20%	5/180 Summer			0	41.951	0.739	0.000
S314.009	S163	1440 Winter	5	+20%					40.736	-0.305	0.000
S336.000	S163	15 Summer	5	+20%	5/15 Summer				67.761	0.099	0.000
S336.001	S219	15 Summer	5	+20%					66.735	-0.070	0.000
S336.002	S220	15 Summer	5	+20%					65.736	-0.068	0.000
S336.003	S221	15 Summer	5	+20%					64.748	-0.080	0.000
S336.004	S64	15 Summer	5	+20%					63.537	-0.061	0.000
S336.005	S223	30 Summer	5	+20%					61.192	-0.018	0.000
S337.000	S218	15 Summer	5	+20%					60.091	-0.146	0.000
S336.006	S262	15 Summer	5	+20%			5/15 Summer	24	59.937	-0.097	0.000
S336.007	S266	30 Summer	5	+20%	5/15 Summer	5/15 Summer			59.370	0.932	1.786
S336.008	S267	30 Summer	5	+20%	5/15 Summer	5/15 Summer			58.528	0.876	1.420
S338.000	S143	15 Summer	5	+20%					61.068	-0.082	0.000
S338.001	S144	15 Summer	5	+20%					60.674	-0.053	0.000
S338.002	S145	15 Summer	5	+20%					58.774	-0.035	0.000
S338.003	S146	30 Summer	5	+20%					55.887	-0.193	0.000
S339.000	S173	30 Summer	5	+20%	5/15 Summer				56.264	0.392	0.000
S336.009	S261	30 Summer	5	+20%	5/15 Summer				55.845	0.038	0.000
S340.000	S82	15 Summer	5	+20%					59.501	-1.207	0.000
S340.001	S183	15 Summer	5	+20%					56.927	-1.207	0.000
S336.010	S262	15 Winter	5	+20%					55.746	0.000	0.000
S341.000	S113	15 Summer	5	+20%					58.429	-0.271	0.000
S341.001	S114	15 Summer	5	+20%					54.479	-0.264	0.000
S342.000	S299	15 Summer	5	+20%					39.086	-1.207	0.000
S342.001	S300	15 Summer	5	+20%					38.550	-0.300	0.000
S343.000	S247	15 Summer	5	+20%	5/15 Summer				51.563	0.088	0.000
S343.001	S80	15 Summer	5	+20%	5/15 Summer				51.354	0.035	0.000
S343.002	S81	15 Summer	5	+20%					51.095	-0.097	0.000
S343.003	S82	15 Summer	5	+20%					50.959	-0.118	0.000
S344.000	S88	15 Summer	5	+20%					60.063	-0.107	0.000
S344.001	S89	15 Summer	5	+20%					58.292	-0.121	0.000
S344.002	S90	15 Summer	5	+20%					55.109	-0.063	0.000
S344.003	S264	15 Summer	5	+20%					54.794	-0.071	0.000
S344.004	S59	15 Summer	5	+20%					53.612	-0.157	0.000
S344.005	S60	15 Summer	5	+20%					52.335	-0.114	0.000
S344.006	S61	15 Summer	5	+20%					51.797	-0.107	0.000
S344.007	S62	15 Summer	5	+20%	5/15 Summer				50.808	0.040	0.000
S343.004	S83	15 Summer	5	+20%	5/15 Summer				50.256	0.131	0.000
S343.005	S64	15 Summer	5	+20%	5/15 Summer				49.886	0.655	0.000
S343.006	S84	1440 Summer	5	+20%	5/30 Summer				49.148	0.465	0.000
S343.007	S85	15 Summer	5	+20%					43.823	-0.339	0.000
S345.000	S87	15 Summer	5	+20%					49.094	-0.067	0.000
S345.001	S88	15 Summer	5	+20%					46.850	-0.058	0.000
S345.002	S89	15 Summer	5	+20%					44.828	-0.046	0.000
S345.003	S270	15 Summer	5	+20%					43.668	-0.042	0.000
S343.008	S87	15 Summer	5	+20%					41.864	-0.270	0.000
S346.000	S78	15 Summer	5	+20%					44.345	-0.063	0.000
S346.001	S79	15 Summer	5	+20%					43.719	-0.064	0.000
S346.002	S80	15 Summer	5	+20%					42.947	-0.032	0.000
S346.003	S81	15 Summer	5	+20%					42.008	-0.111	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.002	S98	0.66	0.0		24.0	OK	
S335.003	S99	0.76	0.0		23.7	OK	
S334.012	S100	0.50			153.5	OK	
S334.013	S69	0.67			151.5	OK	
S334.014	S137	0.66			149.0	OK	
S334.015	S72	0.58			153.2	OK	
S334.016	S74	0.57			156.7	OK	
S333.004	S73	0.03			20.8	OK	
S333.005	S114	0.06			20.8	SURCHARGED	
S314.007	S154	0.20			79.6	SURCHARGED	
S314.008	S154	0.12	0.0	906	29.2	SURCHARGED*	
S314.009	S163	0.04			29.2	OK	
S336.000	S163	0.77			11.0	SURCHARGED	
S336.001	S219	0.50			10.3	OK	
S336.002	S220	0.55			12.6	OK	
S336.003	S221	0.44			12.3	OK	
S336.004	S64	0.64			18.4	OK	
S336.005	S223	1.00			27.3	OK	
S337.000	S218	0.26			12.3	OK	
S336.006	S262	0.60	13.7		47.0	OK	
S336.007	S266	1.04			69.4	FLOOD	3
S336.008	S267	1.23			83.0	FLOOD	4
S338.000	S143	0.42			9.2	OK	
S338.001	S144	0.72			21.1	OK	
S338.002	S145	0.93			34.6	OK	
S338.003	S146	0.42			54.9	OK	
S339.000	S173	1.06			74.1	SURCHARGED	
S336.009	S261	1.06			194.3	SURCHARGED	
S340.000	S82	0.00			0.0	OK	
S340.001	S183	0.00			0.0	OK	
S336.010	S262	1.17			188.4	OK*	
S341.000	S113	0.02			5.0	OK	
S341.001	S114	0.03			7.8	OK	
S342.000	S299	0.00			0.0	OK	
S342.001	S300	0.00			0.0	OK*	
S343.000	S247	1.15			18.6	SURCHARGED	
S343.001	S80	1.14			17.8	SURCHARGED	
S343.002	S81	0.61			24.5	OK	
S343.003	S82	0.45			34.3	OK	
S344.000	S88	0.50			37.0	OK	
S344.001	S89	0.42			47.5	OK	
S344.002	S90	0.87			66.1	OK	
S344.003	S264	0.82			67.9	OK	
S344.004	S59	0.44			77.3	OK	
S344.005	S60	0.68			104.1	OK	
S344.006	S61	0.73			111.0	OK	
S344.007	S62	1.16			111.1	SURCHARGED	
S343.004	S83	1.30			144.9	SURCHARGED	
S343.005	S64	1.92			141.4	SURCHARGED	
S343.006	S84	0.01		1184	3.1	SURCHARGED	
S343.007	S85	0.02			5.6	OK	
S345.000	S87	0.59			31.0	OK	
S345.001	S88	0.69			35.5	OK	
S345.002	S89	0.80			35.5	OK	
S345.003	S270	0.83			35.1	OK	
S343.008	S87	0.18			40.9	OK	
S346.000	S78	0.63			15.0	OK	
S346.001	S79	0.61			19.3	OK	
S346.002	S80	0.96			28.6	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S346.003	S81	0.51			28.7	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S343.009	S106	1440 Winter	5	+20%	5/360 Summer				41.342	0.129
S343.010	S79	1440 Winter	5	+20%					40.416	-0.201
S343.011	S300	1440 Winter	5	+20%					38.826	-0.415
S342.002	S245	1440 Winter	5	+20%					37.975	-0.514
S347.000	S251	15 Summer	5	+20%					63.486	-0.058
S347.001	S252	15 Summer	5	+20%					63.200	-0.035
S347.002	S253	15 Summer	5	+20%					62.957	-0.031
S347.003	S251	15 Summer	5	+20%					62.454	-0.082
S347.004	S71	15 Summer	5	+20%					61.451	-0.081
S347.005	S252	15 Summer	5	+20%					59.997	-0.070
S347.006	S73	15 Summer	5	+20%					58.414	-0.143
S347.007	S200	15 Summer	5	+20%					57.333	-0.115
S347.008	S254	15 Summer	5	+20%					56.521	-0.123
S347.009	S202	15 Summer	5	+20%					55.883	-0.176
S347.010	S198	15 Summer	5	+20%					55.053	-0.162
S347.011	S306	15 Summer	5	+20%	5/15 Summer				54.624	0.116
S348.000	S277	15 Summer	5	+20%					63.803	-0.097
S348.001	S278	15 Summer	5	+20%					63.436	-0.066
S348.002	S279	15 Summer	5	+20%					63.124	-0.066
S349.000	S280	15 Summer	5	+20%					63.394	-0.077
S348.003	S280	15 Summer	5	+20%					62.966	-0.095
S348.004	S281	15 Summer	5	+20%					62.866	-0.079
S348.005	S282	15 Summer	5	+20%					62.733	-0.096
S348.006	S283	15 Summer	5	+20%					62.476	-0.103
S348.007	S284	15 Summer	5	+20%					62.122	-0.098
S348.008	S285	15 Summer	5	+20%					61.727	-0.112
S348.009	S286	15 Summer	5	+20%					61.081	-0.116
S348.010	S216	15 Summer	5	+20%					60.943	-0.157
S348.011	S103	15 Summer	5	+20%					57.893	-0.169
S348.012	S218	15 Summer	5	+20%					54.851	-0.166
S347.012	S305	15 Summer	5	+20%	5/15 Summer				54.469	0.094
S350.000	S220	15 Summer	5	+20%					59.728	-0.187
S351.000	SSU4931_9196a	15 Summer	5	+20%					51.243	-0.375
S351.001	S226	15 Summer	5	+20%					51.124	-0.450
S352.000	SSMP East Start	15 Summer	5	+20%					67.632	-0.093
S352.001	S187	15 Summer	5	+20%					66.420	-0.128
S352.002	S188	15 Summer	5	+20%					64.582	-0.078
S352.003	SSMP SBK3	15 Summer	5	+20%					62.295	-0.419
S352.004	S261	15 Summer	5	+20%	5/15 Summer		5/15 Summer	17	61.369	0.794
S353.000	S261	15 Summer	5	+20%					67.200	-0.150
S353.001	S262	15 Summer	5	+20%					64.208	-0.150
S353.002	S262	15 Summer	5	+20%					60.988	-0.150
S352.005	S303	15 Summer	5	+20%					57.496	-0.079
S354.000	S265	15 Summer	5	+20%					67.557	-0.068
S354.001	S266	15 Summer	5	+20%	5/15 Summer				66.313	0.026
S354.002	S267	15 Summer	5	+20%					63.350	-0.059
S354.003	S309	15 Summer	5	+20%					58.487	-1.186
S352.006	S304	15 Summer	5	+20%					54.462	-1.122
S355.000	S255	15 Summer	5	+20%					73.500	-0.543
S355.001	S256	15 Summer	5	+20%					64.300	-0.300

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S343.009	S106	0.000	0.02			1.9	SURCHARGED	
S343.010	S79	0.000	0.03			1.9	OK	
S343.011	S300	0.000	0.02			1.9	OK	
S342.002	S245	0.000	0.00			1.9	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S347.000	S251	0.000	0.36			3.2	OK	
S347.001	S252	0.000	0.74			5.6	OK	
S347.002	S253	0.000	0.80			6.4	OK	
S347.003	S251	0.000	0.42			13.3	OK	
S347.004	S71	0.000	0.42			16.2	OK	
S347.005	S252	0.000	0.54			20.9	OK	
S347.006	S73	0.000	0.28			26.6	OK	
S347.007	S200	0.000	0.47			32.2	OK	
S347.008	S254	0.000	0.61			52.7	OK	
S347.009	S202	0.000	0.36			52.8	OK	
S347.010	S198	0.000	0.43			51.9	OK	
S347.011	S306	0.000	0.46			52.0	SURCHARGED	
S348.000	S277	0.000	0.27			6.1	OK	
S348.001	S278	0.000	0.57			10.1	OK	
S348.002	S279	0.000	0.60			10.3	OK	
S349.000	S280	0.000	0.48			12.1	OK	
S348.003	S280	0.000	0.59			20.6	OK	
S348.004	S281	0.000	0.75			27.3	OK	
S348.005	S282	0.000	0.60			31.9	OK	
S348.006	S283	0.000	0.56			36.2	OK	
S348.007	S284	0.000	0.61			39.7	OK	
S348.008	S285	0.000	0.50			43.0	OK	
S348.009	S286	0.000	0.67			48.7	OK	
S348.010	S216	0.000	0.43			71.0	OK	
S348.011	S103	0.000	0.39			83.1	OK	
S348.012	S218	0.000	0.41			82.7	OK	
S347.012	S305	0.000	1.82			142.1	SURCHARGED	
S350.000	S220	0.000	0.07			13.6	OK	
S351.000	SSU4931_9196a	0.000	0.00			0.0	OK	
S351.001	S226	0.000	0.00			0.0	OK	
S352.000	SSMP East Start	0.000	0.60			39.7	OK	
S352.001	S187	0.000	0.55			72.3	OK	
S352.002	S188	0.000	0.82			115.1	OK	
S352.003	SSMP SBK3	0.000	0.19			147.3	OK	
S352.004	S261	0.000	0.66	117.4		28.3	FLOOD RISK	
S353.000	S261	0.000	0.00			0.0	OK	
S353.001	S262	0.000	0.00			0.0	OK	
S353.002	S262	0.000	0.00			0.0	OK	
S352.005	S303	0.000	0.46			28.3	OK	
S354.000	S265	0.000	0.68			37.9	OK	
S354.001	S266	0.000	0.94			64.8	SURCHARGED	
S354.002	S267	0.000	0.88			86.7	OK	
S354.003	S309	0.000	0.01			100.8	OK	
S352.006	S304	0.000	0.02			128.8	OK	
S355.000	S255	0.000	0.00			0.0	OK	
S355.001	S256	0.000	0.00			0.0	OK*	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Between A33_34 to Itchen

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for Between A33_34 to Itchen

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S213.005	SItchen (btwn brdgs)	38.683	38.291	39.000	0	0

QVA Consulting		Page 2
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 13:12 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Online Controls for Between A33_34 to Itchen

Hydro-Brake® Optimum Manhole: S79, DS/PN: S213.005, Volume (m³): 4.0

Unit Reference	MD-SHE-0101-6000-2000-6000
Design Head (m)	2.000
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	38.563
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	6.0	Kick-Flo®	0.900	4.1
Flush-Flo™	0.438	5.2	Mean Flow over Head Range	-	4.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	1.200	4.7	3.000	7.3	7.000	10.8
0.200	4.7	1.400	5.1	3.500	7.8	7.500	11.2
0.300	5.1	1.600	5.4	4.000	8.3	8.000	11.5
0.400	5.2	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.2	2.000	6.0	5.000	9.2	9.000	12.2
0.600	5.1	2.200	6.3	5.500	9.7	9.500	12.5
0.800	4.7	2.400	6.5	6.000	10.1		
1.000	4.3	2.600	6.8	6.500	10.5		

QVA Consulting		Page 3
43 Denmark Road Carshalton Surrey SM5 2JE		Micro Drainage
Date 22/10/2021 13:12 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S213.000	S152	15 Summer	5	+20%					43.440
S213.001	S153	15 Summer	5	+20%					41.735
S213.002	S154	720 Summer	5	+20%					39.505
S213.003	S77	720 Summer	5	+20%					39.505
S213.004	S78	720 Summer	5	+20%	5/15 Summer				39.505
S214.000	S96	15 Summer	5	+20%					41.312
S215.000	S94	15 Summer	5	+20%					41.615
S215.001	S95	15 Summer	5	+20%					40.741
S215.002	S96	15 Summer	5	+20%					40.379

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S213.000	S152	-0.120	0.000	0.44			35.6	OK	
S213.001	S153	-0.165	0.000	0.41			54.8	OK	
S213.002	S154	-1.491	0.000	0.00			9.4	OK*	
S213.003	S77	-1.320	0.000	0.00			5.9	OK*	
S213.004	S78	0.526	0.000	0.10			6.2	SURCHARGED	
S214.000	S96	-0.136	0.000	0.33			27.6	OK	
S215.000	S94	-0.084	0.000	0.40			13.2	OK	
S215.001	S95	-0.045	0.000	0.83			15.4	OK	
S215.002	S96	-0.112	0.000	0.49			18.5	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S214.001	S97	15 Summer	5	+20%					40.267
S213.005	S79	720 Summer	5	+20%	5/15 Summer				39.506

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S214.001	S97	-0.132	0.000	0.35			47.1	OK	
S213.005	S79	0.642	0.000	0.04			5.2	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for M3 SB to Basin 5

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for M3 SB to Basin 5

Outfall Pipe Number	**Outfall Name**	**C. Level (m)**	**I. Level (m)**	**Min I. Level (m)**	**D,L (mm)**	**W (mm)**
S100.002	S60	49.806	49.300	0.000	1200	0

Online Controls for M3 SB to Basin 5

Depth/Flow Relationship Manhole: S103, DS/PN: S100.002, Volume (m³): 222.3

Invert Level (m) 49.800

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

Storage Structures for M3 SB to Basin 5

Infiltration Basin Manhole: S103, DS/PN: S100.002

Invert Level (m) 49.800 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.900	791.0	1.800	2320.0	2.700	4062.0
0.100	3.0	1.000	994.0	1.900	2507.0	2.800	4270.0
0.200	32.0	1.100	1104.0	2.000	2692.0	2.900	4481.0
0.300	90.0	1.200	1270.0	2.100	2878.0	3.000	4695.0
0.400	176.0	1.300	1439.0	2.200	3067.0	3.100	4910.0
0.500	281.0	1.400	1609.0	2.300	3258.0	3.200	5130.0
0.600	392.0	1.500	1781.0	2.400	3452.0	3.300	5354.0
0.700	515.0	1.600	1954.0	2.500	3652.0	3.400	5583.0
0.800	647.0	1.700	2130.0	2.600	3856.0		

QVA Consulting		Page 4
43 Denmark Road Carshalton Surrey SM5 2JE		Micro Drainage
Date 22/10/2021 13:12 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

Simulation Criteria

Areal Reduction Factor 1.000   Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0   MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0   Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500   Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0   Number of Storage Structures 1
Number of Online Controls 1   Number of Time/Area Diagrams 0
Number of Offline Controls 0   Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S100.000	S2	15 Summer	5	+20%					54.310
S101.000	S5	15 Summer	5	+20%					62.146
S101.001	S7	15 Summer	5	+20%					60.801
S101.002	S8	15 Summer	5	+20%					59.804
S101.003	S9	15 Summer	5	+20%					59.621
S101.004	S5	15 Summer	5	+20%					59.587
S101.005	S7	15 Summer	5	+20%					59.462
S101.006	S28	15 Summer	5	+20%					59.297
S101.007	S30	15 Summer	5	+20%					59.149
S101.008	S10	15 Summer	5	+20%					58.846

QVA Consulting		Page 5
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 13:12 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S100.000	S2	0.000	0.000	1.00			187.6	SURCHARGED*	
S101.000	S5	-0.071	0.000	0.54			19.8	OK	
S101.001	S7	-0.069	0.000	0.57			21.9	OK	
S101.002	S8	-0.103	0.000	0.54			20.5	OK	
S101.003	S9	-0.055	0.000	0.72			19.0	OK	
S101.004	S5	-0.036	0.000	0.99			26.9	OK	
S101.005	S7	-0.111	0.000	0.65			34.0	OK	
S101.006	S28	-0.124	0.000	0.62			32.0	OK	
S101.007	S30	-0.160	0.000	0.44			31.7	OK*	
S101.008	S10	-0.322	0.000	0.02			31.5	OK	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S101.009	S11	15 Summer	5	+20%					53.973
S100.001	S58	15 Summer	5	+20%					51.822
S102.000	S47	15 Summer	5	+20%	5/15 Summer				60.134
S102.001	S48	15 Summer	5	+20%					59.451
S103.000	S249	15 Summer	5	+20%	5/15 Summer				60.870
S103.001	S6	15 Summer	5	+20%	5/15 Summer				60.238
S103.002	S250	15 Summer	5	+20%					59.663
S103.003	S80	15 Summer	5	+20%					59.306
S102.002	S49	15 Summer	5	+20%					58.669
S102.003	S50	15 Summer	5	+20%					56.588
S102.004	S51	15 Summer	5	+20%					53.973
S102.005	S12	15 Summer	5	+20%	5/15 Summer				52.409
S104.000	S54	15 Summer	5	+20%					54.291
S104.001	S55	15 Summer	5	+20%					53.885
S104.002	S56	15 Summer	5	+20%					53.223
S104.003	S53	15 Summer	5	+20%					52.332
S102.006	S52	15 Summer	5	+20%					52.089
S105.000	S56	15 Summer	5	+20%					63.596
S105.001	S57	15 Summer	5	+20%					63.175
S105.002	S58	15 Summer	5	+20%					62.719
S105.003	S59	15 Summer	5	+20%					62.426
S105.004	S60	15 Summer	5	+20%					62.238
S105.005	S61	15 Summer	5	+20%					59.132
S105.006	S62	15 Summer	5	+20%					58.228
S106.000	S76	15 Summer	5	+20%					60.785
S105.007	S63	15 Summer	5	+20%					57.994
S105.008	S64	15 Summer	5	+20%					55.491
S105.009	S56	15 Summer	5	+20%					54.194
S105.010	S57	15 Summer	5	+20%					53.788
S105.011	S58	15 Summer	5	+20%					53.329
S105.012	S59	15 Summer	5	+20%					52.881
S102.007	S10	15 Summer	5	+20%	5/15 Summer				51.996
S100.002	S103	1440 Winter	5	+20%	5/15 Summer				51.414

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S101.009	S11	-0.316	0.000	0.03			31.6	OK	
S100.001	S58	-1.147	0.000	0.02			192.3	OK	
S102.000	S47	0.121	0.000	1.02			42.8	SURCHARGED	
S102.001	S48	-0.091	0.000	0.81			79.6	OK	
S103.000	S249	0.280	0.000	1.20			51.5	SURCHARGED	
S103.001	S6	0.061	0.000	1.06			45.7	SURCHARGED	
S103.002	S250	-0.100	0.000	0.76			71.8	OK	
S103.003	S80	-0.146	0.000	0.52			72.3	OK	
S102.002	S49	-0.260	0.000	0.37			180.7	OK	

QVA Consulting		Page 7
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 13:12 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S102.003	S50	-0.264	0.000	0.35			208.4	OK	
S102.004	S51	-0.218	0.000	0.51			250.6	OK	
S102.005	S12	0.023	0.000	1.06			237.0	SURCHARGED	
S104.000	S54	-0.058	0.000	0.64			10.9	OK	
S104.001	S55	-0.032	0.000	0.95			19.4	OK	
S104.002	S56	-0.113	0.000	0.48			32.7	OK	
S104.003	S53	-0.093	0.000	0.64			32.9	OK	
S102.006	S52	-0.116	0.000	0.63			238.5	OK	
S105.000	S56	-0.083	0.000	0.41			8.8	OK	
S105.001	S57	-0.086	0.000	0.36			8.5	OK	
S105.002	S58	-0.051	0.000	0.76			12.2	OK	
S105.003	S59	-0.123	0.000	0.40			15.3	OK	
S105.004	S60	-0.135	0.000	0.33			22.6	OK	
S105.005	S61	-0.180	0.000	0.32			37.7	OK	
S105.006	S62	-0.169	0.000	0.39			38.1	OK	
S106.000	S76	-0.100	0.000	0.25			10.3	OK	
S105.007	S63	-0.203	0.000	0.23			49.3	OK	
S105.008	S64	-0.181	0.000	0.33			61.6	OK	
S105.009	S56	-0.112	0.000	0.70			72.6	OK	
S105.010	S57	-0.070	0.000	0.93			88.4	OK	
S105.011	S58	-0.073	0.000	0.92			97.7	OK	
S105.012	S59	-0.069	0.000	0.94			109.9	OK	
S102.007	S10	0.017	0.000	1.19			329.4	SURCHARGED	
S100.002	S103	1.314	0.000	0.00		3466	0.0	SURCHARGED*	

QVA Consulting		Page 1
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 17:32 File 2021 09 28 A33_34_M3	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for M3 North of 101/6

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S334.012	16.956	0.005	3391.2	0.005	0.00	0.0	38.100	\/	31	Pipe/Conduit	
S337.000	78.507	0.891	88.2	0.184	2.00	0.0	0.600	o	300	Pipe/Conduit	
S338.004	42.589	0.150	283.9	0.073	0.00	0.0	0.600	o	600	Pipe/Conduit	
S338.005	19.080	0.001	19079.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S339.000	9.397	1.307	7.2	0.016	2.00	0.0	0.600	o	150	Pipe/Conduit	
S338.006	19.154	0.100	191.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S340.000	17.003	0.230	73.9	0.011	2.00	0.0	0.600	o	150	Pipe/Conduit	
S341.000	5.050	0.130	38.8	0.013	2.00	0.0	0.600	o	150	Pipe/Conduit	
S340.001	63.653	0.390	163.2	0.055	0.00	0.0	0.600	o	150	Pipe/Conduit	
S340.002	66.208	0.659	100.5	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	
S340.003	66.190	0.659	100.5	0.055	0.00	0.0	0.600	o	225	Pipe/Conduit	
S340.004	80.621	0.802	100.5	0.097	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S334.012	43.77	4.78	37.953	0.298	0.0	0.0	0.0	0.56	1491.8	53.0
S337.000	60.02	2.78	38.710	0.184	0.0	0.0	0.0	1.68	118.4	39.9
S338.004	57.05	3.03	38.250	0.273	0.0	0.0	0.0	1.44	407.2	56.2
S338.005	42.94	4.94	38.100	0.273	0.0	0.0	0.0	0.17	47.2«	56.2
S339.000	71.88	2.04	39.802	0.016	0.0	0.0	0.0	3.78	66.8	4.1
S338.006	42.04	5.12	38.100	0.289	0.0	0.0	0.0	1.76	496.5	56.2
S340.000	68.05	2.24	40.400	0.011	0.0	0.0	0.0	1.17	20.7	2.8
S341.000	71.66	2.05	40.300	0.013	0.0	0.0	0.0	1.62	28.6	3.5
S340.001	51.67	3.60	40.170	0.080	0.0	0.0	0.0	0.78	13.9«	14.9
S340.002	45.68	4.44	39.705	0.130	0.0	0.0	0.0	1.30	51.9	21.5
S340.003	41.27	5.29	39.046	0.185	0.0	0.0	0.0	1.30	51.9	27.6
S340.004	37.20	6.32	38.388	0.283	0.0	0.0	0.0	1.30	51.9	37.9

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S337.001	15.065	0.156	96.6	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S337.002	15.065	0.156	96.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S342.000	3.978	0.068	58.5	0.024	2.00	0.0	0.600	o	150	Pipe/Conduit	
S342.001	45.446	0.458	99.1	0.039	0.00	0.0	0.600	o	150	Pipe/Conduit	
S342.002	20.592	0.322	64.0	0.035	0.00	0.0	0.600	o	150	Pipe/Conduit	
S342.003	19.035	1.323	14.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S342.005	9.271	0.000	0.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S353.000	95.090	0.540	176.1	0.019	2.00	0.0	0.600	o	150	Pipe/Conduit	
S353.001	88.899	0.390	227.9	0.021	0.00	0.0	0.600	o	150	Pipe/Conduit	
S354.001	17.967	0.230	78.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S355.000	55.182	0.600	92.0	0.014	2.00	0.0	0.600	o	150	Pipe/Conduit	
S356.000	15.452	2.111	7.3	0.010	2.00	0.0	0.600	o	150	Pipe/Conduit	
S357.000	8.187	2.066	4.0	0.027	2.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S337.001	36.86	6.42	37.742	0.756	0.0	0.0	0.0	2.48	700.8	100.6
S337.002	36.34	6.58	37.587	0.756	0.0	0.0	0.0	1.60	113.1	100.6
S342.000	71.69	2.05	40.200	0.024	0.0	0.0	0.0	1.32	23.3	6.1
S342.001	59.77	2.80	40.132	0.063	0.0	0.0	0.0	1.01	17.8	13.6
S342.002	56.62	3.07	39.673	0.098	0.0	0.0	0.0	1.26	22.2	20.1
S342.003	55.39	3.19	39.352	0.098	0.0	0.0	0.0	2.67	47.2	20.1
S342.005	38.04	6.08	38.020	0.604	0.0	0.0	0.0	0.15	10.5«	102.8
S353.000	47.86	4.10	40.010	0.019	0.0	0.0	0.0	0.75	13.3	3.3
S353.001	37.12	6.34	39.400	0.040	0.0	0.0	0.0	0.66	11.7	5.4
S354.001	56.52	3.08	38.790	0.000	0.0	0.0	0.0	1.78	125.9	0.0
S355.000	58.84	2.88	39.600	0.014	0.0	0.0	0.0	1.05	18.5	3.0
S356.000	71.32	2.07	40.039	0.010	0.0	0.0	0.0	3.75	66.2	2.5
S357.000	72.01	2.03	39.613	0.027	0.0	0.0	0.0	3.91	30.7	7.1

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S356.002	28.540	0.150	190.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S359.000	10.784	1.046	10.3	0.038	2.00	0.0	0.600	o	150	Pipe/Conduit	
S360.000	19.057	3.499	5.4	0.024	2.00	0.0	0.600	o	150	Pipe/Conduit	
S361.000	10.668	3.015	3.5	0.014	2.00	0.0	0.600	o	100	Pipe/Conduit	
S356.003	3.177	0.011	288.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S356.004	3.177	0.011	288.8	0.000	0.00	0.0	0.600	\/	31	Pipe/Conduit	
S362.000	12.955	0.120	108.0	0.045	2.00	0.0	0.600	o	150	Pipe/Conduit	
S362.001	72.730	0.300	242.4	0.051	0.00	0.0	0.600	o	150	Pipe/Conduit	
S362.002	85.477	0.380	224.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S362.003	13.144	1.450	9.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S364.000	17.153	0.020	857.6	0.049	2.00	0.0	0.600	o	150	Pipe/Conduit	
S365.000	14.815	0.150	98.8	0.000	2.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S356.002	42.66	4.99	36.730	0.061	0.0	0.0	0.0	1.76	498.2	9.4
S359.000	71.56	2.06	38.988	0.038	0.0	0.0	0.0	3.16	55.8	9.7
S360.000	71.23	2.07	40.388	0.024	0.0	0.0	0.0	4.35	76.8	6.1
S361.000	71.85	2.04	40.100	0.014	0.0	0.0	0.0	4.14	32.5	3.7
S356.003	42.32	5.06	36.270	0.421	0.0	0.0	0.0	0.76	30.4«	64.4
S356.004	42.24	5.08	36.260	0.421	0.0	0.0	0.0	3.37	8968.3	64.4
S362.000	68.39	2.22	40.200	0.045	0.0	0.0	0.0	0.97	17.1	11.2
S362.001	47.77	4.11	40.080	0.096	0.0	0.0	0.0	0.64	11.3«	16.5
S362.002	37.42	6.25	39.780	0.096	0.0	0.0	0.0	0.67	11.8«	16.5
S362.003	37.20	6.32	39.400	0.096	0.0	0.0	0.0	3.37	59.5	16.5
S364.000	59.15	2.85	40.100	0.049	0.0	0.0	0.0	0.34	5.9«	10.4
S365.000	68.02	2.24	39.620	0.000	0.0	0.0	0.0	1.01	17.9	0.0

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S366.000	89.997	0.490	183.7	0.115	2.00	0.0	0.600	o	225	Pipe/Conduit	
S366.001	23.760	0.167	142.0	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	
S366.002	23.714	0.119	200.0	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	
S366.003	47.834	0.239	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S363.007	38.745	0.394	98.4	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S362.006	3.371	0.159	21.2	0.000	0.00	0.0	0.600	\/	31	Pipe/Conduit	
S368.000	81.993	0.560	146.4	0.185	2.00	0.0	0.600	o	225	Pipe/Conduit	
S368.001	99.705	0.490	203.5	0.135	0.00	0.0	0.600	o	225	Pipe/Conduit	
S368.002	97.877	1.120	87.4	0.190	0.00	0.0	0.600	o	600	Pipe/Conduit	
S368.003	10.445	0.173	60.4	0.100	0.00	0.0	0.600	o	150	Pipe/Conduit	
S368.004	87.612	1.448	60.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S368.005	97.656	2.030	48.1	0.121	0.00	0.0	0.600	o	225	Pipe/Conduit	
S368.006	99.887	2.460	40.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S368.007	14.618	0.080	182.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S369.000	100.363	0.500	200.7	0.178	2.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S366.000	51.97	3.56	40.500	0.115	0.0	0.0	0.0	0.96	38.2	21.6
S366.001	49.12	3.92	39.930	0.146	0.0	0.0	0.0	1.10	43.5	25.9
S366.002	46.24	4.35	39.763	0.179	0.0	0.0	0.0	0.92	36.6	29.9
S366.003	41.60	5.22	39.644	0.179	0.0	0.0	0.0	0.92	36.6	29.9
S363.007	38.63	5.92	38.037	0.638	0.0	0.0	0.0	2.46	694.3	89.0
S362.006	36.91	6.40	36.879	0.734	0.0	0.0	0.0	12.46	33195.3	98.0
S368.000	54.64	3.27	59.960	0.185	0.0	0.0	0.0	1.08	42.9	36.5
S368.001	42.21	5.09	59.400	0.321	0.0	0.0	0.0	0.91	36.3«	48.9
S368.002	39.45	5.71	58.910	0.511	0.0	0.0	0.0	2.61	736.8	72.7
S368.003	38.92	5.85	57.790	0.611	0.0	0.0	0.0	1.30	22.9«	85.8
S368.004	36.36	6.57	57.617	0.611	0.0	0.0	0.0	2.02	143.1	85.8
S368.005	33.85	7.43	56.170	0.732	0.0	0.0	0.0	1.89	75.2«	89.5
S368.006	31.87	8.24	54.140	0.732	0.0	0.0	0.0	2.06	81.9«	89.5
S368.007	31.40	8.45	51.530	0.732	0.0	0.0	0.0	1.16	82.0«	89.5
S369.000	49.88	3.82	60.370	0.178	0.0	0.0	0.0	0.92	36.5	32.0

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S369.001	99.267	0.500	198.5	0.149	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S369.002	100.879	1.674	60.2	0.271	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S369.003	100.502	1.704	59.0	0.184	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S369.004	99.240	1.767	56.2	0.124	0.00	0.0	0.600	o	900	Pipe/Conduit	🔒
S369.005	9.911	0.142	69.8	0.238	0.00	0.0	0.600	o	185	Pipe/Conduit	🔒
S369.006	89.836	1.956	45.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S368.008	13.587	0.250	54.3	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S369.001	39.87	5.61	59.870	0.327	0.0	0.0	0.0	0.92	36.8«	47.1
S369.002	36.25	6.61	59.358	0.598	0.0	0.0	0.0	1.69	67.1«	78.3
S369.003	34.37	7.24	57.475	0.782	0.0	0.0	0.0	2.65	421.7	97.0
S369.004	33.32	7.63	55.385	0.905	0.0	0.0	0.0	4.19	2662.7	108.9
S369.005	33.02	7.75	53.618	1.144	0.0	0.0	0.0	1.38	37.1«	136.4
S369.006	31.24	8.53	53.476	1.144	0.0	0.0	0.0	1.94	76.9«	136.4
S368.008	31.04	8.62	51.450	1.876	0.0	0.0	0.0	2.46	272.0	210.3

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S334.012	S Ex 5	38.507	37.948	39.500	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S337.002	S Ex 1B	39.053	37.431	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S342.005	S Ex 4	38.952	38.020	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S356.004	SSU4931_3052 (Ex 7)	37.030	36.249	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S362.006	SSU4931 3576d (Ex outfall 6)	37.934	36.720	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S368.008	SSU4931 8898 (Ex M3 Nrth)	53.121	51.200	0.000	1350	0

QVA Consulting		Page 7
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 17:32 File 2021 09 28 A33_34_M3	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	5
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S334.012	S237	15 Summer	5	+20%					38.115
S337.000	S114	15 Summer	5	+20%					38.873
S338.004	S115	15 Summer	5	+20%					38.455
S338.005	S116	15 Summer	5	+20%					38.418
S339.000	S117	15 Summer	5	+20%					39.833
S338.006	S117	15 Summer	5	+20%					38.262
S340.000	S137	15 Summer	5	+20%					40.446
S341.000	S138	15 Summer	5	+20%					40.436
S340.001	S119	15 Summer	5	+20%	5/15 Summer				40.431

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S334.012	S237	-1.045	0.000	0.03			61.4	OK	
S337.000	S114	-0.137	0.000	0.52			59.1	OK	
S338.004	S115	-0.395	0.000	0.17			66.4	OK*	
S338.005	S116	-0.282	0.000	0.54			56.3	OK	
S339.000	S117	-0.119	0.000	0.10			5.6	OK	
S338.006	S117	-0.438	0.000	0.16			57.1	OK	
S340.000	S137	-0.104	0.000	0.21			4.0	OK	
S341.000	S138	-0.014	0.000	0.19			4.2	OK	
S340.001	S119	0.111	0.000	1.11			15.0	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S340.002	S120	15 Summer	5	+20%				
S340.003	S121	15 Summer	5	+20%				
S340.004	S122	15 Summer	5	+20%	5/15 Summer			
S337.001	S115	15 Summer	5	+20%				
S337.002	S33	15 Summer	5	+20%	5/15 Summer			
S342.000	S142	15 Summer	5	+20%				
S342.001	S136	15 Summer	5	+20%				
S342.002	S137	15 Summer	5	+20%	5/15 Summer			
S342.003	S138	15 Summer	5	+20%				
S342.005	S140	60 Summer	5	+20%				
S353.000	S62	15 Summer	5	+20%				
S353.001	S63	15 Summer	5	+20%				
S354.001	S117	60 Summer	5	+20%				
S355.000	S66	15 Summer	5	+20%				
S356.000	S63	15 Summer	5	+20%				
S357.000	S178	15 Summer	5	+20%				
S356.002	S339	15 Summer	5	+20%				
S359.000	S49	15 Summer	5	+20%				
S360.000	S48	15 Summer	5	+20%				
S361.000	S50	15 Summer	5	+20%				
S356.003	SSU4931 3052	30 Summer	5	+20%	5/15 Summer			
S356.004	S101	30 Summer	5	+20%				
S362.000	S94	15 Summer	5	+20%	5/15 Summer			
S362.001	S43	15 Summer	5	+20%	5/15 Summer			
S362.002	S118	15 Summer	5	+20%	5/15 Summer			
S362.003	S120	15 Summer	5	+20%				
S364.000	S116	15 Summer	5	+20%	5/15 Summer			
S365.000	S406	15 Summer	5	+20%				
S366.000	S125	15 Summer	5	+20%	5/15 Summer			
S366.001	S126	15 Summer	5	+20%				
S366.002	S409	15 Summer	5	+20%	5/15 Summer			
S366.003	S410	15 Summer	5	+20%	5/15 Summer			
S363.007	SSU4931 3268	15 Summer	5	+20%				
S362.006	S128	15 Summer	5	+20%				
S368.000	SSU4931 6344	15 Summer	5	+20%	5/15 Summer			
S368.001	SSU4931 6654	15 Summer	5	+20%	5/15 Summer			
S368.002	SSU4931 6963	30 Summer	5	+20%				
S368.003	SSU4931 7372	30 Summer	5	+20%	5/15 Summer			
S368.004	S133	30 Summer	5	+20%				
S368.005	SSU4931 7980	30 Summer	5	+20%				
S368.006	SSU4931 8488	30 Summer	5	+20%				
S368.007	SSU4931_9196a	60 Summer	5	+20%				
S369.000	SSU4931 6145	15 Summer	5	+20%	5/15 Summer			
S369.001	SSU4931 6454	15 Summer	5	+20%	5/15 Summer			
S369.002	SSU4931 6764	30 Summer	5	+20%	5/15 Summer			
S369.003	SSU4931 7273	15 Summer	5	+20%				
S369.004	SSU4931 7781	15 Summer	5	+20%				

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S340.002	S120	39.817	-0.113	0.000	0.48			24.2
S340.003	S121	39.186	-0.086	0.000	0.67			33.8
S340.004	S122	38.716	0.104	0.000	0.94			47.3
S337.001	S115	38.020	-0.322	0.000	0.32			125.9
S337.002	S33	37.993	0.106	0.000	1.33			126.0
S342.000	S142	40.277	-0.073	0.000	0.51			8.4
S342.001	S136	40.247	-0.035	0.000	0.89			15.4
S342.002	S137	39.831	0.008	0.000	1.02			21.4
S342.003	S138	39.425	-0.077	0.000	0.48			21.3
S342.005	S140	38.266	-0.054	0.000	1.00			41.2
S353.000	S62	40.086	-0.074	0.000	0.43			5.7
S353.001	S63	39.509	-0.041	0.000	0.88			10.1
S354.001	S117	39.004	-0.086	0.000	0.01			0.9
S355.000	S66	39.654	-0.096	0.000	0.27			5.0
S356.000	S63	40.062	-0.127	0.000	0.06			3.5
S357.000	S178	39.653	-0.060	0.000	0.34			9.6
S356.002	S339	36.807	-0.523	0.000	0.04			15.3
S359.000	S49	39.040	-0.098	0.000	0.27			13.3
S360.000	S48	40.422	-0.116	0.000	0.12			8.4
S361.000	S50	40.127	-0.073	0.000	0.16			5.0
S356.003	SSU4931 3052	36.595	0.100	0.000	1.65			49.2
S356.004	S101	36.371	-1.096	0.000	0.01			49.1
S362.000	S94	40.568	0.218	0.000	0.71			11.0
S362.001	S43	40.537	0.307	0.000	1.34			14.9
S362.002	S118	40.022	0.092	0.000	1.10			12.8
S362.003	S120	39.449	-0.101	0.000	0.24			12.8
S364.000	S116	40.408	0.158	0.000	3.60			15.9
S365.000	S406	39.620	-0.150	0.000	0.00			0.0
S366.000	S125	40.750	0.025	0.000	0.88			33.0
S366.001	S126	40.155	0.000	0.000	0.87			35.0
S366.002	S409	40.039	0.051	0.000	1.17			39.4
S366.003	S410	39.898	0.029	0.000	1.05			36.8
S363.007	SSU4931 3268	38.215	-0.422	0.000	0.19			111.6
S362.006	S128	36.905	-1.181	0.000	0.02			118.1
S368.000	SSU4931 6344	60.564	0.378	0.000	1.02			42.4
S368.001	SSU4931 6654	60.240	0.615	0.000	1.40			49.8
S368.002	SSU4931 6963	59.108	-0.402	0.000	0.12			79.0
S368.003	SSU4931 7372	59.054	1.114	0.000	2.73			56.0
S368.004	S133	57.750	-0.167	0.000	0.40			56.0
S368.005	SSU4931 7980	56.337	-0.058	0.000	0.89			65.5
S368.006	SSU4931 8488	54.295	-0.070	0.000	0.82			65.4
S368.007	SSU4931_9196a	51.767	-0.063	0.000	0.95			65.1
S369.000	SSU4931 6145	61.041	0.446	0.000	1.05			37.7
S369.001	SSU4931 6454	60.728	0.633	0.000	1.22			44.0
S369.002	SSU4931 6764	59.982	0.399	0.000	1.11			73.2
S369.003	SSU4931 7273	57.631	-0.294	0.000	0.26			104.9

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S369.004	SSU4931 7781	55.521	-0.764	0.000	0.05			129.4

PN	US/MH Name	Status	Level Exceeded
S340.002	S120	OK	
S340.003	S121	OK	
S340.004	S122	SURCHARGED	
S337.001	S115	OK	
S337.002	S33	SURCHARGED	
S342.000	S142	OK	
S342.001	S136	OK	
S342.002	S137	SURCHARGED	
S342.003	S138	OK	
S342.005	S140	FLOOD RISK*	
S353.000	S62	OK	
S353.001	S63	OK	
S354.001	S117	OK	
S355.000	S66	OK	
S356.000	S63	OK	
S357.000	S178	OK	
S356.002	S339	OK*	
S359.000	S49	OK	
S360.000	S48	OK	
S361.000	S50	OK	
S356.003	SSU4931 3052	SURCHARGED*	
S356.004	S101	OK	
S362.000	S94	SURCHARGED	
S362.001	S43	FLOOD RISK	
S362.002	S118	SURCHARGED	
S362.003	S120	OK	
S364.000	S116	SURCHARGED	
S365.000	S406	OK	
S366.000	S125	SURCHARGED	
S366.001	S126	OK	
S366.002	S409	SURCHARGED	
S366.003	S410	SURCHARGED	
S363.007	SSU4931 3268	OK	
S362.006	S128	OK	
S368.000	SSU4931 6344	SURCHARGED	
S368.001	SSU4931 6654	SURCHARGED	
S368.002	SSU4931 6963	OK	
S368.003	SSU4931 7372	SURCHARGED	
S368.004	S133	OK	
S368.005	SSU4931 7980	OK	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Status	Level Exceeded
S368.006	SSU4931 8488	OK	
S368.007	SSU4931_9196a	OK	
S369.000	SSU4931 6145	SURCHARGED	
S369.001	SSU4931 6454	SURCHARGED	
S369.002	SSU4931 6764	SURCHARGED	
S369.003	SSU4931 7273	OK	
S369.004	SSU4931 7781	OK	

QVA Consulting		Page 13
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 17:32 File 2021 09 28 A33_34_M3	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S369.005	SSU4931 6144	60 Summer	5	+20%	5/15 Summer			
S369.006	S142	60 Summer	5	+20%	5/15 Summer			
S368.008	SSU4931 8997	60 Summer	5	+20%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S369.005	SSU4931 6144	55.322	1.519	0.000	2.69			86.0	SURCHARGED
S369.006	S142	54.297	0.596	0.000	1.14			86.0	SURCHARGED
S368.008	SSU4931 8997	51.696	-0.129	0.000	0.76			149.1	OK

PN	US/MH Name	Level Exceeded
S369.005	SSU4931 6144	
S369.006	S142	
S368.008	SSU4931 8997	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for New works to Basins 2 & 3C

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S314.009	SOutfall W of bridges	41.000	40.054	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S336.010	SM3 CR tie in 01	58.228	55.203	56.200	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S341.001	S	53.487	52.685	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S342.002	SEx O_Fall SU4931_4049c	38.191	37.631	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S347.012	S	58.068	53.978	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S350.000	SSU4929_6199b	58.753	54.920	0.000	1200	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S351.001	S227	53.105	51.073	0.000	1350	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S352.006	S193	56.113	54.334	0.000	1200	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S355.001	S	66.661	64.226	0.000	0	0

Online Controls for New works to Basins 2 & 3C

Orifice Manhole: S47, DS/PN: S321.002, Volume (m³): 28.2

Diameter (m) 0.240 Discharge Coefficient 0.600 Invert Level (m) 56.653

Orifice Manhole: S61, DS/PN: S323.007, Volume (m³): 67.7

Diameter (m) 0.160 Discharge Coefficient 0.600 Invert Level (m) 55.488

Hydro-Brake® Optimum Manhole: S71, DS/PN: S320.006, Volume (m³): 19.2

Unit Reference	MD-SHE-0414-1250-2500-1250
Design Head (m)	2.500
Design Flow (l/s)	125.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	414
Invert Level (m)	51.393
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	124.9	Kick-Flo®	1.707	103.8
Flush-Flo™	0.790	124.3	Mean Flow over Head Range	-	106.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	11.2	0.800	124.3	2.000	112.0	4.000	157.0	7.000	206.5
0.200	40.4	1.000	123.2	2.200	117.4	4.500	166.3	7.500	213.6
0.300	78.8	1.200	121.0	2.400	122.4	5.000	175.1	8.000	220.4
0.400	113.5	1.400	117.4	2.600	127.3	5.500	183.5	8.500	227.1
0.500	120.0	1.600	110.4	3.000	136.5	6.000	191.5	9.000	233.5
0.600	122.7	1.800	106.5	3.500	147.1	6.500	199.1	9.500	239.8

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Unit Reference	MD-SHE-0214-2930-2400-2930
Design Head (m)	2.400
Design Flow (l/s)	29.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	40.850
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.400	29.3	Kick-Flo®	1.466	23.1
Flush-Flo™	0.693	29.2	Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m^3): 1.1

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	0.800	29.1	2.000	26.8	4.000	37.4	7.000	49.1
0.200	20.9	1.000	28.5	2.200	28.1	4.500	39.6	7.500	50.7
0.300	26.1	1.200	27.2	2.400	29.3	5.000	41.7	8.000	52.3
0.400	27.8	1.400	24.6	2.600	30.4	5.500	43.7	8.500	53.9
0.500	28.7	1.600	24.1	3.000	32.6	6.000	45.5	9.000	55.4
0.600	29.1	1.800	25.5	3.500	35.1	6.500	47.3	9.500	56.9

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m^3): 5.8

Unit Reference	MD-SHE-0082-4000-2000-4000
Design Head (m)	2.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	48.604
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	4.0	Kick-Flo®	0.729	2.5
Flush-Flo™	0.356	3.1	Mean Flow over Head Range	-	3.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	3.0	1.000	2.9	2.200	4.2	4.500	5.8	7.500	7.4
0.300	3.1	1.200	3.2	2.400	4.3	5.000	6.1	8.000	7.7
0.400	3.1	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	3.1	1.600	3.6	3.000	4.8	6.000	6.7	9.000	8.1
0.600	2.9	1.800	3.8	3.500	5.2	6.500	6.9	9.500	8.3

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m^3): 10.9

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	41.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m³): 10.9

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.8	7.000	4.9
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	1.9	1.200	2.2	2.400	3.0	5.000	4.2	8.000	5.2
0.400	1.9	1.400	2.3	2.600	3.1	5.500	4.4	8.500	5.4
0.500	1.8	1.600	2.5	3.000	3.3	6.000	4.6	9.000	5.5
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.7

Orifice Manhole: S261, DS/PN: S352.004, Volume (m³): 38.1

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 60.425

Depth/Flow Relationship Manhole: S256, DS/PN: S355.001, Volume (m³): 50.4

Invert Level (m) 64.300

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.700	0.0000	1.300	0.0000	1.900	0.0000	2.500	0.0000
0.200	0.0000	0.800	0.0000	1.400	0.0000	2.000	0.0000	2.600	0.0000
0.300	0.0000	0.900	0.0000	1.500	0.0000	2.100	0.0000	2.700	0.0000
0.400	0.0000	1.000	0.0000	1.600	0.0000	2.200	0.0000	2.800	0.0000
0.500	0.0000	1.100	0.0000	1.700	0.0000	2.300	0.0000	2.900	0.0000
0.600	0.0000	1.200	0.0000	1.800	0.0000	2.400	0.0000	3.000	0.0000

Offline Controls for New works to Basins 2 & 3C

Pipe Manhole: SSMP CR010, DS/PN: S323.004, Loop to PN: S337.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	60.041

Pipe Manhole: S61, DS/PN: S323.007, Loop to PN: S339.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	55.488

Pipe Manhole: S71, DS/PN: S320.006, Loop to PN: S315.009

Diameter (m)	0.450	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	40.000	Upstream Invert Level (m)	54.650

Weir Manhole: S98, DS/PN: S314.004, Loop to PN: S314.005

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 45.200

Pipe Manhole: S106, DS/PN: S331.005, Loop to PN: S331.007

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	200.0	Coefficient of Contraction	0.600
Length (m)	16.500	Upstream Invert Level (m)	43.514

Weir Manhole: S114, DS/PN: S314.006, Loop to PN: S314.007

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.900

Pipe Manhole: S98, DS/PN: S335.002, Loop to PN: S334.015

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	27.5	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	43.032

Pipe Manhole: S99, DS/PN: S335.003, Loop to PN: S334.014

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	57.0	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	42.850

Weir Manhole: S154, DS/PN: S314.008, Loop to PN: S314.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.150

Pipe Manhole: S262, DS/PN: S336.006, Loop to PN: S350.000

Diameter (m)	0.225	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	59.809

Weir Manhole: S261, DS/PN: S352.004, Loop to PN: S321.000

Discharge Coef 0.544 Width (m) 1.800 Invert Level (m) 61.255

Storage Structures for New works to Basins 2 & 3C

Infiltration Basin Manhole: S71, DS/PN: S320.006

Invert Level (m) 51.479 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	350.0	0.600	479.6	1.200	629.5	1.800	799.7	2.400	990.4
0.100	370.2	0.700	503.1	1.300	656.4	1.900	830.1	2.500	1024.1
0.200	390.9	0.800	527.3	1.400	684.0	2.000	861.0	2.600	1058.4
0.300	412.2	0.900	552.0	1.500	712.1	2.100	892.5	2.700	1093.3
0.400	434.1	1.000	577.2	1.600	740.7	2.200	924.6	2.800	1128.8
0.500	456.5	1.100	603.1	1.700	769.9	2.300	957.2	2.900	1164.8

Infiltration Basin Manhole: S98, DS/PN: S314.004

Invert Level (m) 43.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	561.0	0.501	1078.9	1.001	1603.0	1.501	2133.4	2.001	2670.1
0.101	664.1	0.601	1183.2	1.101	1708.6	1.601	2240.2	2.101	2778.2
0.201	767.4	0.701	1287.8	1.201	1814.4	1.701	2347.3	2.201	2886.5
0.301	871.0	0.801	1392.6	1.301	1920.5	1.801	2454.7	2.301	2995.1
0.401	974.8	0.901	1497.7	1.401	2026.8	1.901	2562.3	2.400	3102.9

Infiltration Basin Manhole: S114, DS/PN: S314.006

Invert Level (m) 42.075 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1171.8	0.501	1373.1	1.001	1580.7	1.501	1794.5	1.925	1980.8
0.101	1211.6	0.601	1414.1	1.101	1623.0	1.601	1838.0		
0.201	1251.6	0.701	1455.4	1.201	1665.5	1.701	1881.8		
0.301	1291.9	0.801	1496.9	1.301	1708.2	1.801	1925.8		
0.401	1332.4	0.901	1538.7	1.401	1751.3	1.901	1970.1		

Infiltration Basin Manhole: S154, DS/PN: S314.008

Invert Level (m) 40.850 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2392.3	0.501	2716.7	1.001	3047.3	1.501	3384.2	2.001	3727.4
0.101	2456.7	0.601	2782.3	1.101	3114.2	1.601	3452.3	2.101	3796.8
0.201	2521.3	0.701	2848.2	1.201	3181.3	1.701	3520.7	2.201	3866.4
0.301	2586.2	0.801	2914.3	1.301	3248.7	1.801	3589.4	2.301	3936.3
0.401	2651.3	0.901	2980.7	1.401	3316.3	1.901	3658.2	2.400	4005.7

Infiltration Basin Manhole: S84, DS/PN: S343.006

Invert Level (m) 48.383 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Infiltration Basin Manhole: S84, DS/PN: S343.006

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	325.0	0.600	496.5	1.200	704.1	1.800	948.0	2.400	1228.0
0.100	351.1	0.700	528.6	1.300	742.3	1.900	992.1	2.500	1278.2
0.200	378.1	0.800	561.7	1.400	781.4	2.000	1037.3		
0.300	406.2	0.900	595.8	1.500	821.5	2.100	1083.5		
0.400	435.3	1.000	630.9	1.600	862.7	2.200	1130.7		
0.500	465.4	1.100	667.0	1.700	904.8	2.300	1178.8		

Infiltration Basin Manhole: S106, DS/PN: S343.009

Invert Level (m) 40.988 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1300.0	0.600	1624.8	1.200	1985.9	1.800	2383.1	2.400	2816.5
0.100	1351.6	0.700	1682.5	1.300	2049.6	1.900	2452.8	2.500	2892.3
0.200	1404.3	0.800	1741.2	1.400	2114.3	2.000	2523.6		
0.300	1457.9	0.900	1800.8	1.500	2180.0	2.100	2595.3		
0.400	1512.5	1.000	1861.5	1.600	2246.7	2.200	2668.0		
0.500	1568.2	1.100	1923.2	1.700	2314.4	2.300	2741.8		

Infiltration Basin Manhole: S256, DS/PN: S355.001

Invert Level (m) 64.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.600	338.0	1.200	891.0	1.800	1600.0	2.400	1600.0
0.100	32.0	0.700	417.0	1.300	1006.0	1.900	1600.0	2.500	1600.0
0.200	78.0	0.800	501.0	1.400	1200.0	2.000	1600.0		
0.300	133.0	0.900	588.0	1.500	1400.0	2.100	1600.0		
0.400	195.0	1.000	676.0	1.600	1600.0	2.200	1600.0		
0.500	264.0	1.100	766.0	1.700	1600.0	2.300	1600.0		

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Offline Controls	11	Number of Time/Area Diagrams	0
Number of Online Controls	8	Number of Storage Structures	7	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.411
FEH Rainfall Version	1999	E (1km)	0.294
Site Location	GB 449350 131500 SU 49350 31500	F (1km)	2.313
C (1km)	-0.025	Cv (Summer)	1.000
D1 (1km)	0.429	Cv (Winter)	1.000
D2 (1km)	0.273		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S314.000	S32	15 Summer	5	+40%					49.885	-0.059	0.000	0.68
S314.001	S33	15 Summer	5	+40%					48.820	-0.030	0.000	0.97
S315.000	S31	15 Summer	5	+40%					59.361	-0.089	0.000	0.34
S315.001	S32	15 Summer	5	+40%					58.265	-0.069	0.000	0.55
S316.000	S26	15 Summer	5	+40%					63.395	-0.098	0.000	0.26
S316.001	S27	15 Summer	5	+40%					63.158	-0.085	0.000	0.39
S316.002	S28	15 Summer	5	+40%					62.783	-0.050	0.000	0.77
S316.003	S29	15 Summer	5	+40%					62.476	-0.096	0.000	0.59
S316.004	S30	15 Summer	5	+40%					59.705	-0.076	0.000	0.89
S316.005	S31	15 Summer	5	+40%					59.551	-0.132	0.000	0.58
S316.006	S32	15 Summer	5	+40%	5/15 Summer				59.475	0.033	0.000	1.13
S316.007	S33	15 Summer	5	+40%	5/15 Summer				59.386	0.027	0.000	1.10
S316.008	S9	15 Summer	5	+40%	5/15 Summer				59.278	0.016	0.000	0.58
S317.000	S33	15 Summer	5	+40%					63.245	-0.127	0.000	0.40
S317.001	S34	15 Summer	5	+40%					62.697	-0.135	0.000	0.58
S317.002	S35	15 Summer	5	+40%					62.598	-0.162	0.000	0.42
S317.003	S36	15 Summer	5	+40%					62.424	-0.165	0.000	0.39
S317.004	S38	15 Summer	5	+40%					60.281	-0.163	0.000	0.41
S317.005	S39	15 Summer	5	+40%					59.635	-0.116	0.000	0.68
S317.006	S40	15 Summer	5	+40%					59.362	-0.102	0.000	0.67
S317.007	S41	15 Summer	5	+40%	5/15 Summer				59.268	0.017	0.000	1.11
S318.000	S12	15 Summer	5	+40%					60.955	-0.107	0.000	0.18
S318.001	S13	15 Summer	5	+40%					60.682	-0.096	0.000	0.28
S318.002	S14	15 Summer	5	+40%					60.177	-0.077	0.000	0.47
S318.003	S15	15 Summer	5	+40%					59.704	-0.073	0.000	0.52
S319.000	S30	15 Summer	5	+40%					59.647	-0.103	0.000	0.21
S319.001	S31	15 Summer	5	+40%					59.321	-0.095	0.000	0.29
S318.004	S176	15 Summer	5	+40%	5/15 Summer				59.203	0.058	0.000	1.31
S316.009	S18	15 Summer	5	+40%	5/15 Summer				59.155	0.076	0.000	1.11
S316.010	S36	15 Summer	5	+40%	5/15 Summer				58.961	0.087	0.000	1.03

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S314.000	S32			24.9	OK	
S314.001	S33			36.0	OK	
S315.000	S31			10.5	OK	
S315.001	S32			20.0	OK	
S316.000	S26			5.6	OK	
S316.001	S27			9.0	OK	
S316.002	S28			13.0	OK	
S316.003	S29			48.1	OK	
S316.004	S30			56.6	OK	
S316.005	S31			66.3	OK	
S316.006	S32			71.4	SURCHARGED	
S316.007	S33			77.0	SURCHARGED	
S316.008	S9			80.4	SURCHARGED	
S317.000	S33			31.1	OK	
S317.001	S34			35.1	OK	
S317.002	S35			39.1	OK	
S317.003	S36			58.4	OK	
S317.004	S38			65.6	OK	
S317.005	S39			71.8	OK	
S317.006	S40			72.8	OK	
S317.007	S41			77.9	SURCHARGED	
S318.000	S12			4.9	OK	
S318.001	S13			7.1	OK	
S318.002	S14			11.3	OK	
S318.003	S15			13.0	OK	
S319.000	S30			4.7	OK	
S319.001	S31			6.2	OK	
S318.004	S176			18.5	SURCHARGED	
S316.009	S18			161.2	SURCHARGED	
S316.010	S36			173.2	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S316.011	S37	15 Summer	5	+40%	5/15 Summer				58.500	0.083
S316.012	S36	15 Summer	5	+40%					58.150	-0.172
S316.013	S37	15 Summer	5	+40%					57.166	-0.204
S315.002	S34	15 Summer	5	+40%					56.061	-0.136
S315.003	S28	15 Summer	5	+40%					53.814	-0.171
S315.004	S29	15 Summer	5	+40%					52.102	-0.172
S315.005	S30	30 Summer	5	+40%	5/15 Summer				50.743	0.223
S315.006	S72	30 Summer	5	+40%					50.207	-0.109
S315.007	S73	30 Summer	5	+40%					49.559	-0.137
S315.008	S8	30 Summer	5	+40%					48.907	-0.138
S320.000	S1	15 Summer	5	+40%					59.689	-0.031
S320.001	S2	15 Summer	5	+40%					58.079	-0.031
S320.002	S3	15 Summer	5	+40%					55.197	-0.080
S320.003	S4	15 Summer	5	+40%					54.242	-0.021
S321.000	S45	15 Summer	5	+40%					59.063	-0.433
S321.001	S46	15 Summer	5	+40%					58.007	-0.426
S321.002	S47	30 Summer	5	+40%	5/15 Summer				57.594	0.641
S321.003	S48	30 Summer	5	+40%					56.636	-0.178
S321.004	S74	30 Summer	5	+40%					55.702	-0.169
S321.005	S75	30 Summer	5	+40%					55.070	-0.189
S321.006	S76	30 Summer	5	+40%					54.540	-0.169
S321.007	S77	30 Summer	5	+40%					53.699	-0.168
S322.000	S94	15 Summer	5	+40%	5/15 Summer				54.567	0.052
S322.001	S95	15 Summer	5	+40%					54.078	-0.059
S322.002	S96	15 Summer	5	+40%					53.798	-0.137
S322.003	S97	15 Summer	5	+40%					53.581	-0.058
S322.004	S98	15 Summer	5	+40%					53.379	-0.144
S321.008	S58	180 Summer	5	+40%	5/30 Summer				53.154	0.079
S323.000	S54	15 Summer	5	+40%	5/15 Summer				67.583	0.165
S323.001	SSMP CR012	15 Summer	5	+40%	5/15 Summer				66.786	0.123
S323.002	SSMP CR011	60 Summer	5	+40%					64.135	-0.418
S323.003	SSMP CRS4	120 Summer	5	+40%	5/15 Summer	5/15 Summer			64.069	1.540
S323.004	SSMP CR010	15 Summer	5	+40%			5/15 Summer	24	60.164	-0.327
S323.005	SSMP CR009	15 Summer	5	+40%					58.526	-0.795
S323.006	SSMP 1106	15 Summer	5	+40%					57.334	-0.762
S323.007	S61	30 Summer	5	+40%	5/15 Summer		5/15 Summer	24	56.343	0.480
S323.008	S79	15 Summer	5	+40%					54.510	-0.274
S323.009	S63	30 Summer	5	+40%					54.142	-0.288
S323.010	S80	30 Summer	5	+40%					53.815	-0.261
S323.011	S81	15 Summer	5	+40%					53.395	-0.224
S323.012	S66	30 Summer	5	+40%					53.198	-0.231
S321.009	SSMP CR004	240 Summer	5	+40%	5/30 Summer				53.091	0.114
S324.000	S67	15 Summer	5	+40%					54.713	-0.061
S324.001	S68	15 Summer	5	+40%	5/15 Summer				54.002	0.046
S324.002	S69	15 Summer	5	+40%	5/15 Summer				53.557	0.063
S325.000	S12	15 Summer	5	+40%					59.896	-0.098
S325.001	S13	15 Summer	5	+40%					59.184	-0.096
S325.002	S19	15 Summer	5	+40%					58.312	-0.094
S325.003	S78	15 Summer	5	+40%					57.048	-0.102
S324.003	S78	15 Summer	5	+40%					53.067	-0.160
S324.004	S70	180 Summer	5	+40%	5/180 Summer				52.996	0.002
S321.010	S243	180 Summer	5	+40%	5/120 Summer				52.989	0.112
S321.011	S72	180 Summer	5	+40%	5/60 Summer				52.975	0.212
S321.012	S244	180 Summer	5	+40%	5/30 Summer				52.963	0.314
S321.013	S63	180 Summer	5	+40%	5/15 Summer				52.951	0.515
S320.004	S5	180 Summer	5	+40%	5/30 Summer				52.943	0.533
S326.000	S249	15 Summer	5	+40%					59.405	-0.016
S326.001	S251	15 Summer	5	+40%					58.655	-0.115
S326.002	S251	15 Summer	5	+40%	5/15 Summer				56.768	0.127
S326.003	S78	15 Summer	5	+40%	5/15 Summer				56.076	0.260

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S316.011	S37	0.000	1.43			172.9	SURCHARGED	
S316.012	S36	0.000	0.56			179.6	OK	
S316.013	S37	0.000	0.42			180.0	OK	
S315.002	S34	0.000	0.72			196.2	OK	
S315.003	S28	0.000	0.57			205.9	OK	
S315.004	S29	0.000	0.56			214.6	OK	
S315.005	S30	0.000	1.47			223.5	SURCHARGED	
S315.006	S72	0.000	0.85			228.3	OK	
S315.007	S73	0.000	0.72			228.8	OK	
S315.008	S8	0.000	0.72			232.1	OK	
S320.000	S1	0.000	0.99			34.1	OK	
S320.001	S2	0.000	0.95			40.2	OK	
S320.002	S3	0.000	0.73			51.5	OK	
S320.003	S4	0.000	0.99			80.4	OK	
S321.000	S45	0.000	0.17			140.8	OK*	
S321.001	S46	0.000	0.18			138.0	OK	
S321.002	S47	0.000	1.08			100.8	SURCHARGED	
S321.003	S48	0.000	0.53			99.7	OK	
S321.004	S74	0.000	0.58			100.8	OK	
S321.005	S75	0.000	0.49			101.2	OK	
S321.006	S76	0.000	0.58			101.5	OK	
S321.007	S77	0.000	0.58			105.4	OK	
S322.000	S94	0.000	1.01			17.4	SURCHARGED	
S322.001	S95	0.000	0.86			32.6	OK	
S322.002	S96	0.000	0.55			43.1	OK	
S322.003	S97	0.000	0.96			52.3	OK	
S322.004	S98	0.000	0.53			56.4	OK	
S321.008	S58	0.000	0.46			94.3	SURCHARGED	
S323.000	S54	0.000	1.00			54.7	SURCHARGED	
S323.001	SSMP CR012	0.000	0.98			124.5	SURCHARGED	
S323.002	SSMP CR011	0.000	0.12			131.8	OK	
S323.003	SSMP CRS4	69.167	1.29			33.3	FLOOD	17
S323.004	SSMP CR010	0.000	0.16	13.8		79.4	OK	
S323.005	SSMP CR009	0.000	0.03			79.7	OK	
S323.006	SSMP 1106	0.000	0.06			130.6	OK	
S323.007	S61	0.000	0.23	79.7		46.8	SURCHARGED	
S323.008	S79	0.000	0.31			66.5	OK	
S323.009	S63	0.000	0.28			66.7	OK	
S323.010	S80	0.000	0.36			104.4	OK	
S323.011	S81	0.000	0.60			151.8	OK	
S323.012	S66	0.000	0.59			149.4	OK	
S321.009	SSMP CR004	0.000	0.66			163.7	SURCHARGED	
S324.000	S67	0.000	0.85			90.0	OK	
S324.001	S68	0.000	1.01			143.5	SURCHARGED	
S324.002	S69	0.000	1.13			156.1	SURCHARGED	
S325.000	S12	0.000	0.26			7.4	OK	
S325.001	S13	0.000	0.28			9.4	OK	
S325.002	S19	0.000	0.30			10.5	OK	
S325.003	S78	0.000	0.22			12.5	OK	
S324.003	S78	0.000	0.73			160.9	OK	
S324.004	S70	0.000	0.31			95.3	SURCHARGED	
S321.010	S243	0.000	0.63			294.5	SURCHARGED	
S321.011	S72	0.000	0.59			273.5	SURCHARGED	
S321.012	S244	0.000	0.54			260.9	SURCHARGED	
S321.013	S63	0.000	0.84			249.6	SURCHARGED	
S320.004	S5	0.000	0.61			268.7	SURCHARGED	
S326.000	S249	0.000	0.87			41.3	OK	
S326.001	S251	0.000	0.64			85.1	OK	
S326.002	S251	0.000	0.96			113.8	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.003	S78	0.000	1.22			107.5	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S326.004	S77	15 Summer	5	+40%	5/15 Summer				55.454	0.129	0.000
S326.005	S80	15 Summer	5	+40%					54.777	-0.104	0.000
S327.000	S60	15 Summer	5	+40%					54.703	-0.150	0.000
S326.006	S243	240 Summer	5	+40%	5/120 Summer				53.087	0.089	0.000
S328.000	S81	15 Summer	5	+40%					58.996	-0.150	0.000
S328.001	S251	15 Summer	5	+40%					58.786	-0.155	0.000
S328.002	S82	15 Summer	5	+40%					57.812	-0.166	0.000
S328.003	S253	15 Summer	5	+40%	5/15 Summer				56.959	0.146	0.000
S328.004	S86	15 Summer	5	+40%					55.638	-0.259	0.000
S328.005	S82	15 Summer	5	+40%					54.608	-0.259	0.000
S328.006	S89	15 Summer	5	+40%					53.576	-0.260	0.000
S329.000	S66	15 Summer	5	+40%	5/15 Summer				54.035	0.280	0.000
S329.001	S67	15 Summer	5	+40%	5/15 Summer				53.595	0.310	0.000
S329.002	S68	15 Summer	5	+40%	5/15 Summer				53.469	0.504	0.000
S326.007	S244	240 Summer	5	+40%	5/30 Summer				53.072	0.442	0.000
S326.008	S246	180 Summer	5	+40%	5/15 Summer				52.940	0.556	0.000
S330.000	S6	15 Summer	5	+40%	5/15 Summer				55.768	0.219	0.000
S330.001	S7	15 Summer	5	+40%					54.036	-0.084	0.000
S330.002	S121	15 Summer	5	+40%					53.226	-0.069	0.000
S320.005	S71	180 Summer	5	+40%	5/15 Summer				52.933	0.602	0.000
S320.006	S71	180 Summer	5	+40%	5/15 Summer			0	52.920	1.138	0.000
S315.009	S42	30 Summer	5	+40%					47.646	-0.181	0.000
S315.010	S48	30 Summer	5	+40%	5/15 Summer				46.321	0.350	0.000
S314.002	S41	30 Summer	5	+40%	5/15 Summer				45.480	0.230	0.000
S314.003	S34	30 Summer	5	+40%					44.759	-0.204	0.000
S314.004	S98	720 Winter	5	+40%	5/15 Summer			0	44.435	1.385	0.000
S331.000	S50	15 Summer	5	+40%	5/15 Summer				53.254	0.447	0.000
S331.001	S51	15 Summer	5	+40%					52.029	-0.009	0.000
S331.002	S52	15 Summer	5	+40%					48.146	-0.120	0.000
S331.003	S100	15 Summer	5	+40%					45.442	-0.101	0.000
S331.004	S53	15 Summer	5	+40%					43.684	-0.071	0.000
S331.005	S106	15 Summer	5	+40%	5/15 Summer		5/15 Summer	3	43.517	0.003	0.000
S332.000	S50	15 Summer	5	+40%					45.678	-0.099	0.000
S332.001	S165	15 Summer	5	+40%					44.088	-0.119	0.000
S332.002	S166	15 Summer	5	+40%					43.714	-0.175	0.000
S331.006	S54	15 Summer	5	+40%					43.301	-0.232	0.000
S331.007	S106	15 Summer	5	+40%					43.210	-0.220	0.000
S331.008	S109	1440 Winter	5	+40%					43.094	-0.185	0.000
S331.009	S110	1440 Summer	5	+40%					43.094	0.000	0.000
S331.010	S111	1440 Summer	5	+40%	5/480 Summer				43.092	0.157	0.000
S314.005	S37	1440 Summer	5	+40%	5/360 Summer				43.092	0.275	0.000
S314.006	S114	1440 Summer	5	+40%	5/60 Summer			0	42.896	0.646	0.000
S333.000	S69	15 Summer	5	+40%	5/15 Summer				54.355	0.352	0.000
S333.001	S70	15 Summer	5	+40%					53.411	-0.065	0.000
S333.002	S71	15 Summer	5	+40%					52.096	-0.097	0.000
S333.003	S72	15 Summer	5	+40%					47.171	-0.080	0.000
S334.000	S60	15 Summer	5	+40%					54.464	-0.133	0.000
S334.001	S61	15 Summer	5	+40%					53.862	-0.134	0.000
S334.002	S62	15 Summer	5	+40%					53.793	-0.126	0.000
S334.003	S63	15 Summer	5	+40%					53.548	-0.160	0.000
S334.004	S64	15 Summer	5	+40%					52.884	-0.159	0.000
S334.005	S65	15 Summer	5	+40%					51.797	-0.133	0.000
S334.006	S58	15 Summer	5	+40%					50.531	-0.230	0.000
S334.007	S54	15 Summer	5	+40%					49.209	-0.228	0.000
S334.008	S55	15 Summer	5	+40%					45.776	-0.214	0.000
S334.009	S100	15 Summer	5	+40%					45.044	-0.218	0.000
S334.010	S101	15 Summer	5	+40%					43.849	-0.193	0.000
S334.011	S102	15 Summer	5	+40%					42.914	-0.346	0.000
S335.000	S96	15 Summer	5	+40%					44.438	-0.041	0.000
S335.001	S97	15 Summer	5	+40%					44.048	-0.056	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.004	S77	1.13			102.7	SURCHARGED	
S326.005	S80	0.87			102.4	OK	
S327.000	S60	0.00			0.0	OK	
S326.006	S243	0.44			50.9	SURCHARGED	
S328.000	S81	0.00			0.0	OK	
S328.001	S251	0.45			53.5	OK	
S328.002	S82	0.40			52.1	OK	
S328.003	S253	1.06			134.6	SURCHARGED	
S328.004	S86	0.38			134.5	OK	
S328.005	S82	0.37			134.4	OK	
S328.006	S89	0.37			134.0	OK	
S329.000	S66	1.10			42.8	SURCHARGED	
S329.001	S67	0.72			49.2	SURCHARGED	
S329.002	S68	1.51			54.1	SURCHARGED	
S326.007	S244	0.38			144.6	SURCHARGED	
S326.008	S246	1.16			164.9	SURCHARGED	
S330.000	S6	1.00			60.8	SURCHARGED	
S330.001	S7	0.84			119.4	OK	
S330.002	S121	0.94			144.3	OK	
S320.005	S71	0.70			475.3	SURCHARGED	
S320.006	S71	0.15	0.0	105	124.3	SURCHARGED	
S315.009	S42	0.66			354.1	OK	
S315.010	S48	4.28			355.7	SURCHARGED	
S314.002	S41	1.52			372.1	SURCHARGED	
S314.003	S34	0.72			372.8	OK	
S314.004	S98	2.50	0.0	302	86.7	SURCHARGED*	
S331.000	S50	1.17			20.5	SURCHARGED	
S331.001	S51	1.00			40.9	OK	
S331.002	S52	0.44			55.6	OK	
S331.003	S100	0.59			55.7	OK	
S331.004	S53	0.86			64.4	OK	
S331.005	S106	1.12	0.1		62.7	SURCHARGED	
S332.000	S50	0.25			9.9	OK	
S332.001	S165	0.43			23.1	OK	
S332.002	S166	0.36			31.2	OK	
S331.006	S54	0.48			86.2	OK	
S331.007	S106	0.51			89.5	OK	
S331.008	S109	0.06			8.9	OK	
S331.009	S110	0.10			14.2	OK	
S331.010	S111	0.22			18.1	SURCHARGED	
S314.005	S37	0.20			95.6	SURCHARGED*	
S314.006	S114	1.04	0.0	461	59.5	SURCHARGED*	
S333.000	S69	1.17			50.7	SURCHARGED	
S333.001	S70	0.84			66.3	OK	
S333.002	S71	0.61			82.4	OK	
S333.003	S72	0.74			96.4	OK	
S334.000	S60	0.48			40.1	OK	
S334.001	S61	0.59			40.9	OK	
S334.002	S62	0.61			48.2	OK	
S334.003	S63	0.44			58.2	OK	
S334.004	S64	0.44			73.8	OK	
S334.005	S65	0.58			96.1	OK	
S334.006	S58	0.31			102.2	OK	
S334.007	S54	0.32			120.3	OK	
S334.008	S55	0.38			127.1	OK	
S334.009	S100	0.37			127.0	OK	
S334.010	S101	0.48			126.5	OK	
S334.011	S102	0.25			125.5	OK	
S335.000	S96	0.86			16.1	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.001	S97	0.67			21.6	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S335.002	S98	15 Summer	5	+40%				0	42.959	-0.073	0.000
S335.003	S99	15 Summer	5	+40%				0	42.785	-0.059	0.000
S334.012	S100	15 Summer	5	+40%					42.566	-0.210	0.000
S334.013	S69	15 Summer	5	+40%					42.539	-0.185	0.000
S334.014	S137	15 Summer	5	+40%					42.475	-0.203	0.000
S334.015	S72	15 Summer	5	+40%					42.393	-0.240	0.000
S334.016	S74	15 Summer	5	+40%					42.327	-0.238	0.000
S333.004	S73	1440 Winter	5	+40%					42.221	-0.197	0.000
S333.005	S114	1440 Winter	5	+40%	5/360 Summer				42.221	0.376	0.000
S314.007	S154	1440 Winter	5	+40%	5/240 Summer				42.221	0.715	0.000
S314.008	S154	1440 Winter	5	+40%	5/180 Summer			0	42.105	0.893	0.000
S314.009	S163	720 Summer	5	+40%					40.736	-0.305	0.000
S336.000	S163	15 Summer	5	+40%	5/15 Summer				67.905	0.243	0.000
S336.001	S219	15 Summer	5	+40%					66.741	-0.064	0.000
S336.002	S220	15 Summer	5	+40%					65.743	-0.061	0.000
S336.003	S221	15 Summer	5	+40%					64.754	-0.074	0.000
S336.004	S64	30 Summer	5	+40%					63.546	-0.052	0.000
S336.005	S223	30 Summer	5	+40%	5/15 Summer				61.428	0.218	0.000
S337.000	S218	15 Summer	5	+40%					60.096	-0.141	0.000
S336.006	S262	30 Summer	5	+40%			5/15 Summer	24	59.967	-0.067	0.000
S336.007	S266	30 Summer	5	+40%	5/15 Summer	5/15 Summer			59.376	0.938	7.442
S336.008	S267	30 Summer	5	+40%	5/15 Summer	5/15 Summer			58.531	0.879	4.126
S338.000	S143	15 Summer	5	+40%					61.074	-0.076	0.000
S338.001	S144	15 Summer	5	+40%					60.686	-0.042	0.000
S338.002	S145	15 Summer	5	+40%	5/15 Summer				58.896	0.087	0.000
S338.003	S146	30 Summer	5	+40%					55.909	-0.171	0.000
S339.000	S173	60 Summer	5	+40%	5/15 Summer				56.262	0.389	0.000
S336.009	S261	15 Summer	5	+40%	5/15 Summer				55.864	0.057	0.000
S340.000	S82	15 Summer	5	+40%					59.501	-1.207	0.000
S340.001	S183	15 Summer	5	+40%					56.927	-1.207	0.000
S336.010	S262	15 Winter	5	+40%					55.746	0.000	0.000
S341.000	S113	15 Summer	5	+40%					58.429	-0.271	0.000
S341.001	S114	15 Summer	5	+40%					54.480	-0.264	0.000
S342.000	S299	15 Summer	5	+40%					39.086	-1.207	0.000
S342.001	S300	15 Summer	5	+40%					38.550	-0.300	0.000
S343.000	S247	15 Summer	5	+40%	5/15 Summer				51.666	0.191	0.000
S343.001	S80	15 Summer	5	+40%	5/15 Summer				51.400	0.081	0.000
S343.002	S81	15 Summer	5	+40%					51.107	-0.086	0.000
S343.003	S82	15 Summer	5	+40%					50.968	-0.108	0.000
S344.000	S88	15 Summer	5	+40%					60.075	-0.095	0.000
S344.001	S89	15 Summer	5	+40%					58.302	-0.110	0.000
S344.002	S90	15 Summer	5	+40%					55.152	-0.020	0.000
S344.003	S264	15 Summer	5	+40%					54.813	-0.052	0.000
S344.004	S59	15 Summer	5	+40%					53.623	-0.146	0.000
S344.005	S60	15 Summer	5	+40%					52.354	-0.095	0.000
S344.006	S61	15 Summer	5	+40%					51.818	-0.087	0.000
S344.007	S62	15 Summer	5	+40%	5/15 Summer				50.875	0.108	0.000
S343.004	S83	15 Summer	5	+40%	5/15 Summer				50.518	0.393	0.000
S343.005	S64	15 Summer	5	+40%	5/15 Summer				50.099	0.867	0.000
S343.006	S84	1440 Summer	5	+40%	5/30 Summer				49.270	0.587	0.000
S343.007	S85	15 Summer	5	+40%					43.826	-0.336	0.000
S345.000	S87	15 Summer	5	+40%					49.102	-0.058	0.000
S345.001	S88	15 Summer	5	+40%					46.860	-0.048	0.000
S345.002	S89	15 Summer	5	+40%					44.840	-0.034	0.000
S345.003	S270	15 Summer	5	+40%					43.684	-0.026	0.000
S343.008	S87	15 Summer	5	+40%					41.874	-0.259	0.000
S346.000	S78	15 Summer	5	+40%					44.354	-0.054	0.000
S346.001	S79	15 Summer	5	+40%					43.729	-0.055	0.000
S346.002	S80	15 Summer	5	+40%	5/15 Summer				43.061	0.083	0.000
S346.003	S81	15 Summer	5	+40%					42.014	-0.105	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.002	S98	0.77	0.0		28.0	OK	
S335.003	S99	0.88	0.0		27.7	OK	
S334.012	S100	0.58			178.3	OK	
S334.013	S69	0.77			176.0	OK	
S334.014	S137	0.76			173.7	OK	
S334.015	S72	0.67			178.0	OK	
S334.016	S74	0.67			182.6	OK	
S333.004	S73	0.03			24.3	OK	
S333.005	S114	0.07			24.3	SURCHARGED	
S314.007	S154	0.21			83.0	SURCHARGED	
S314.008	S154	0.12	0.0		29.2	SURCHARGED*	
S314.009	S163	0.04			29.2	OK	
S336.000	S163	0.89			12.8	SURCHARGED	
S336.001	S219	0.59			12.0	OK	
S336.002	S220	0.62			14.2	OK	
S336.003	S221	0.50			14.2	OK	
S336.004	S64	0.72			21.0	OK	
S336.005	S223	1.09			29.8	SURCHARGED	
S337.000	S218	0.29			13.7	OK	
S336.006	S262	0.65	17.9		50.7	OK	
S336.007	S266	1.04			69.6	FLOOD	5
S336.008	S267	1.23			83.0	FLOOD	5
S338.000	S143	0.49			10.8	OK	
S338.001	S144	0.84			24.5	OK	
S338.002	S145	1.01			37.7	SURCHARGED	
S338.003	S146	0.49			63.7	OK	
S339.000	S173	1.11			77.5	SURCHARGED	
S336.009	S261	1.14			207.6	SURCHARGED	
S340.000	S82	0.00			0.0	OK	
S340.001	S183	0.00			0.0	OK	
S336.010	S262	1.27			203.9	OK*	
S341.000	S113	0.02			5.0	OK	
S341.001	S114	0.04			8.3	OK	
S342.000	S299	0.00			0.0	OK	
S342.001	S300	0.00			0.0	OK*	
S343.000	S247	1.28			20.7	SURCHARGED	
S343.001	S80	1.29			20.0	SURCHARGED	
S343.002	S81	0.69			27.8	OK	
S343.003	S82	0.51			39.3	OK	
S344.000	S88	0.59			43.1	OK	
S344.001	S89	0.49			55.5	OK	
S344.002	S90	1.00			75.6	OK	
S344.003	S264	0.94			77.7	OK	
S344.004	S59	0.51			90.0	OK	
S344.005	S60	0.79			120.4	OK	
S344.006	S61	0.84			128.1	OK	
S344.007	S62	1.34			128.2	SURCHARGED	
S343.004	S83	1.44			160.4	SURCHARGED	
S343.005	S64	2.16			159.5	SURCHARGED	
S343.006	S84	0.01		1333	3.1	SURCHARGED	
S343.007	S85	0.02			6.6	OK	
S345.000	S87	0.69			36.2	OK	
S345.001	S88	0.80			41.4	OK	
S345.002	S89	0.93			41.4	OK	
S345.003	S270	0.97			40.9	OK	
S343.008	S87	0.21			48.0	OK	
S346.000	S78	0.73			17.5	OK	
S346.001	S79	0.71			22.5	OK	
S346.002	S80	1.04			30.9	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S346.003	S81	0.55			31.1	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S343.009	S106	1440 Winter	5	+40%	5/240 Summer				41.390	0.177
S343.010	S79	1440 Winter	5	+40%					40.416	-0.201
S343.011	S300	1440 Summer	5	+40%					38.826	-0.415
S342.002	S245	1440 Winter	5	+40%					37.975	-0.514
S347.000	S251	15 Summer	5	+40%					63.490	-0.055
S347.001	S252	15 Summer	5	+40%					63.208	-0.027
S347.002	S253	15 Summer	5	+40%					62.965	-0.023
S347.003	S251	15 Summer	5	+40%					62.461	-0.076
S347.004	S71	15 Summer	5	+40%					61.458	-0.074
S347.005	S252	15 Summer	5	+40%					60.005	-0.062
S347.006	S73	15 Summer	5	+40%					58.422	-0.135
S347.007	S200	15 Summer	5	+40%					57.343	-0.105
S347.008	S254	15 Summer	5	+40%					56.541	-0.103
S347.009	S202	15 Summer	5	+40%					55.893	-0.166
S347.010	S198	15 Summer	5	+40%					55.066	-0.149
S347.011	S306	15 Summer	5	+40%	5/15 Summer				54.671	0.163
S348.000	S277	15 Summer	5	+40%					63.807	-0.093
S348.001	S278	15 Summer	5	+40%					63.445	-0.057
S348.002	S279	15 Summer	5	+40%					63.133	-0.057
S349.000	S280	15 Summer	5	+40%					63.401	-0.070
S348.003	S280	15 Summer	5	+40%					62.980	-0.081
S348.004	S281	15 Summer	5	+40%					62.883	-0.062
S348.005	S282	15 Summer	5	+40%					62.747	-0.082
S348.006	S283	15 Summer	5	+40%					62.489	-0.090
S348.007	S284	15 Summer	5	+40%					62.135	-0.085
S348.008	S285	15 Summer	5	+40%					61.738	-0.101
S348.009	S286	15 Summer	5	+40%					61.103	-0.094
S348.010	S216	15 Summer	5	+40%					60.956	-0.144
S348.011	S103	15 Summer	5	+40%					57.905	-0.157
S348.012	S218	15 Summer	5	+40%					54.863	-0.154
S347.012	S305	15 Summer	5	+40%	5/15 Summer				54.517	0.142
S350.000	S220	15 Summer	5	+40%					59.736	-0.179
S351.000	SSU4931_9196a	15 Summer	5	+40%					51.243	-0.375
S351.001	S226	15 Summer	5	+40%					51.124	-0.450
S352.000	SSMP East Start	15 Summer	5	+40%					67.646	-0.079
S352.001	S187	15 Summer	5	+40%					66.438	-0.110
S352.002	S188	15 Summer	5	+40%					64.642	-0.018
S352.003	SSMP SBK3	15 Summer	5	+40%					62.308	-0.406
S352.004	S261	15 Summer	5	+40%	5/15 Summer		5/15 Summer	20	61.384	0.809
S353.000	S261	15 Summer	5	+40%					67.200	-0.150
S353.001	S262	15 Summer	5	+40%					64.208	-0.150
S353.002	S262	15 Summer	5	+40%					60.988	-0.150
S352.005	S303	15 Summer	5	+40%					57.496	-0.079
S354.000	S265	15 Summer	5	+40%					67.576	-0.049
S354.001	S266	15 Summer	5	+40%	5/15 Summer				66.532	0.245
S354.002	S267	15 Summer	5	+40%					63.360	-0.049
S354.003	S309	15 Summer	5	+40%					58.489	-1.184
S352.006	S304	15 Summer	5	+40%					54.463	-1.121
S355.000	S255	15 Summer	5	+40%					73.500	-0.543
S355.001	S256	15 Summer	5	+40%					64.300	-0.300

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S343.009	S106	0.000	0.02			1.9	SURCHARGED	
S343.010	S79	0.000	0.03			1.9	OK	
S343.011	S300	0.000	0.02			1.9	OK	
S342.002	S245	0.000	0.00			1.9	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S347.000	S251	0.000	0.42			3.7	OK	
S347.001	S252	0.000	0.86			6.5	OK	
S347.002	S253	0.000	0.94			7.5	OK	
S347.003	S251	0.000	0.49			15.4	OK	
S347.004	S71	0.000	0.49			18.9	OK	
S347.005	S252	0.000	0.63			24.4	OK	
S347.006	S73	0.000	0.33			31.0	OK	
S347.007	S200	0.000	0.55			37.6	OK	
S347.008	S254	0.000	0.71			61.3	OK	
S347.009	S202	0.000	0.41			61.4	OK	
S347.010	S198	0.000	0.50			60.3	OK	
S347.011	S306	0.000	0.54			60.6	SURCHARGED	
S348.000	S277	0.000	0.31			7.1	OK	
S348.001	S278	0.000	0.66			11.7	OK	
S348.002	S279	0.000	0.70			12.0	OK	
S349.000	S280	0.000	0.56			14.1	OK	
S348.003	S280	0.000	0.68			24.0	OK	
S348.004	S281	0.000	0.88			31.8	OK	
S348.005	S282	0.000	0.70			37.2	OK	
S348.006	S283	0.000	0.66			42.2	OK	
S348.007	S284	0.000	0.71			46.3	OK	
S348.008	S285	0.000	0.58			50.1	OK	
S348.009	S286	0.000	0.78			56.8	OK	
S348.010	S216	0.000	0.50			82.6	OK	
S348.011	S103	0.000	0.45			96.7	OK	
S348.012	S218	0.000	0.47			96.1	OK	
S347.012	S305	0.000	2.13			165.7	SURCHARGED	
S350.000	S220	0.000	0.09			18.1	OK	
S351.000	SSU4931_9196a	0.000	0.00			0.0	OK	
S351.001	S226	0.000	0.00			0.0	OK	
S352.000	SSMP East Start	0.000	0.70			46.3	OK	
S352.001	S187	0.000	0.64			84.3	OK	
S352.002	S188	0.000	0.96			135.4	OK	
S352.003	SSMP SBK3	0.000	0.22			170.3	OK	
S352.004	S261	0.000	0.67	140.2		28.5	FLOOD RISK	
S353.000	S261	0.000	0.00			0.0	OK	
S353.001	S262	0.000	0.00			0.0	OK	
S353.002	S262	0.000	0.00			0.0	OK	
S352.005	S303	0.000	0.46			28.5	OK	
S354.000	S265	0.000	0.80			44.2	OK	
S354.001	S266	0.000	1.01			69.7	SURCHARGED	
S354.002	S267	0.000	0.95			93.4	OK	
S354.003	S309	0.000	0.01			109.9	OK	
S352.006	S304	0.000	0.02			138.4	OK	
S355.000	S255	0.000	0.00			0.0	OK	
S355.001	S256	0.000	0.00			0.0	OK*	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Between A33_34 to Itchen

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for Between A33_34 to Itchen

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S213.005	SItchen (btwn brdgs)	38.683	38.291	39.000	0	0

Online Controls for Between A33_34 to Itchen

Hydro-Brake® Optimum Manhole: S79, DS/PN: S213.005, Volume (m³): 4.0

Unit Reference	MD-SHE-0101-6000-2000-6000
Design Head (m)	2.000
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	38.563
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	6.0	Kick-Flo®	0.900	4.1
Flush-Flo™	0.438	5.2	Mean Flow over Head Range	-	4.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	1.200	4.7	3.000	7.3	7.000	10.8
0.200	4.7	1.400	5.1	3.500	7.8	7.500	11.2
0.300	5.1	1.600	5.4	4.000	8.3	8.000	11.5
0.400	5.2	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.2	2.000	6.0	5.000	9.2	9.000	12.2
0.600	5.1	2.200	6.3	5.500	9.7	9.500	12.5
0.800	4.7	2.400	6.5	6.000	10.1		
1.000	4.3	2.600	6.8	6.500	10.5		

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S213.000	S152	15 Summer	5	+40%					43.451
S213.001	S153	15 Summer	5	+40%					41.748
S213.002	S154	720 Summer	5	+40%					39.654
S213.003	S77	720 Summer	5	+40%					39.654
S213.004	S78	720 Summer	5	+40%	5/15 Summer				39.654
S214.000	S96	15 Summer	5	+40%					41.320
S215.000	S94	15 Summer	5	+40%					41.621
S215.001	S95	15 Summer	5	+40%					40.753
S215.002	S96	15 Summer	5	+40%					40.390

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S213.000	S152	-0.110	0.000	0.51			41.6	OK	
S213.001	S153	-0.152	0.000	0.48			63.9	OK	
S213.002	S154	-1.342	0.000	0.00			11.0	OK*	
S213.003	S77	-1.171	0.000	0.00			5.9	OK*	
S213.004	S78	0.675	0.000	0.10			6.0	SURCHARGED	
S214.000	S96	-0.129	0.000	0.38			32.2	OK	
S215.000	S94	-0.078	0.000	0.47			15.4	OK	
S215.001	S95	-0.032	0.000	0.97			17.9	OK	
S215.002	S96	-0.100	0.000	0.58			21.6	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S214.001	S97	15 Summer	5	+40%					40.276
S213.005	S79	720 Summer	5	+40%	5/15 Summer				39.656

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S214.001	S97	-0.124	0.000	0.41			54.9	OK	
S213.005	S79	0.792	0.000	0.04			5.2	SURCHARGED	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for M3 SB to Basin 5

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for M3 SB to Basin 5

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S100.002	S60	49.806	49.300	0.000	1200	0

Online Controls for M3 SB to Basin 5

Depth/Flow Relationship Manhole: S103, DS/PN: S100.002, Volume (m³): 222.3

Invert Level (m) 49.800

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

Storage Structures for M3 SB to Basin 5

Infiltration Basin Manhole: S103, DS/PN: S100.002

Invert Level (m) 49.800 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.900	791.0	1.800	2320.0	2.700	4062.0
0.100	3.0	1.000	994.0	1.900	2507.0	2.800	4270.0
0.200	32.0	1.100	1104.0	2.000	2692.0	2.900	4481.0
0.300	90.0	1.200	1270.0	2.100	2878.0	3.000	4695.0
0.400	176.0	1.300	1439.0	2.200	3067.0	3.100	4910.0
0.500	281.0	1.400	1609.0	2.300	3258.0	3.200	5130.0
0.600	392.0	1.500	1781.0	2.400	3452.0	3.300	5354.0
0.700	515.0	1.600	1954.0	2.500	3652.0	3.400	5583.0
0.800	647.0	1.700	2130.0	2.600	3856.0		

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coefficient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S100.000	S2	15 Summer	5	+40%					54.310
S101.000	S5	15 Summer	5	+40%					62.154
S101.001	S7	15 Summer	5	+40%					60.810
S101.002	S8	15 Summer	5	+40%					59.817
S101.003	S9	15 Summer	5	+40%					59.671
S101.004	S5	15 Summer	5	+40%	5/15 Summer				59.630
S101.005	S7	15 Summer	5	+40%					59.478
S101.006	S28	15 Summer	5	+40%					59.312
S101.007	S30	15 Summer	5	+40%					59.160
S101.008	S10	15 Summer	5	+40%					58.849

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S100.000	S2	0.000	0.000	1.05			196.5	SURCHARGED*	
S101.000	S5	-0.063	0.000	0.63			23.1	OK	
S101.001	S7	-0.060	0.000	0.67			25.5	OK	
S101.002	S8	-0.090	0.000	0.63			23.9	OK	
S101.003	S9	-0.005	0.000	0.76			20.2	OK	
S101.004	S5	0.007	0.000	1.09			29.6	SURCHARGED	
S101.005	S7	-0.095	0.000	0.73			38.3	OK	
S101.006	S28	-0.109	0.000	0.70			36.4	OK	
S101.007	S30	-0.149	0.000	0.50			36.0	OK*	
S101.008	S10	-0.319	0.000	0.02			36.1	OK	

QVA Consulting		Page 6
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 14:38 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S101.009	S11	15 Summer	5	+40%					53.976
S100.001	S58	15 Summer	5	+40%					51.825
S102.000	S47	15 Summer	5	+40%	5/15 Summer				60.281
S102.001	S48	15 Summer	5	+40%					59.472
S103.000	S249	15 Summer	5	+40%	5/15 Summer				61.041
S103.001	S6	15 Summer	5	+40%	5/15 Summer				60.319
S103.002	S250	15 Summer	5	+40%					59.677
S103.003	S80	15 Summer	5	+40%					59.315
S102.002	S49	15 Summer	5	+40%					58.682
S102.003	S50	15 Summer	5	+40%					56.601
S102.004	S51	15 Summer	5	+40%					53.991
S102.005	S12	15 Summer	5	+40%	5/15 Summer				52.476
S104.000	S54	15 Summer	5	+40%					54.302
S104.001	S55	15 Summer	5	+40%	5/15 Summer				53.944
S104.002	S56	15 Summer	5	+40%					53.231
S104.003	S53	15 Summer	5	+40%					52.341
S102.006	S52	30 Summer	5	+40%					52.200
S105.000	S56	15 Summer	5	+40%					63.602
S105.001	S57	15 Summer	5	+40%					63.181
S105.002	S58	15 Summer	5	+40%					62.730
S105.003	S59	15 Summer	5	+40%					62.436
S105.004	S60	15 Summer	5	+40%					62.245
S105.005	S61	15 Summer	5	+40%					59.142
S105.006	S62	15 Summer	5	+40%					58.240
S106.000	S76	15 Summer	5	+40%					60.790
S105.007	S63	15 Summer	5	+40%					58.002
S105.008	S64	15 Summer	5	+40%					55.502
S105.009	S56	15 Summer	5	+40%					54.216
S105.010	S57	15 Summer	5	+40%	5/15 Summer				53.890
S105.011	S58	15 Summer	5	+40%					53.402
S105.012	S59	15 Summer	5	+40%	5/15 Summer				52.952
S102.007	S10	15 Summer	5	+40%	5/15 Summer				52.073
S100.002	S103	1440 Winter	5	+40%	5/15 Summer				51.520

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S101.009	S11	-0.312	0.000	0.03			36.2	OK	
S100.001	S58	-1.144	0.000	0.02			208.4	OK	
S102.000	S47	0.268	0.000	1.14			47.5	SURCHARGED	
S102.001	S48	-0.071	0.000	0.91			89.8	OK	
S103.000	S249	0.450	0.000	1.31			56.5	SURCHARGED	
S103.001	S6	0.142	0.000	1.15			49.3	SURCHARGED	
S103.002	S250	-0.086	0.000	0.84			79.3	OK	
S103.003	S80	-0.137	0.000	0.57			79.7	OK	
S102.002	S49	-0.246	0.000	0.42			203.1	OK	

QVA Consulting		Page 7
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 14:38 File 2021 10 13 FEH M5 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S102.003	S50	-0.250	0.000	0.40			235.9	OK	
S102.004	S51	-0.199	0.000	0.58			285.2	OK	
S102.005	S12	0.091	0.000	1.22			271.4	SURCHARGED	
S104.000	S54	-0.047	0.000	0.74			12.7	OK	
S104.001	S55	0.026	0.000	1.02			20.8	SURCHARGED	
S104.002	S56	-0.105	0.000	0.54			36.6	OK	
S104.003	S53	-0.084	0.000	0.72			36.6	OK	
S102.006	S52	-0.004	0.000	0.72			271.6	OK	
S105.000	S56	-0.077	0.000	0.47			10.2	OK	
S105.001	S57	-0.080	0.000	0.43			9.9	OK	
S105.002	S58	-0.039	0.000	0.89			14.2	OK	
S105.003	S59	-0.114	0.000	0.47			17.9	OK	
S105.004	S60	-0.128	0.000	0.38			26.1	OK	
S105.005	S61	-0.170	0.000	0.37			44.0	OK	
S105.006	S62	-0.158	0.000	0.45			44.4	OK	
S106.000	S76	-0.095	0.000	0.29			12.0	OK	
S105.007	S63	-0.195	0.000	0.27			57.6	OK	
S105.008	S64	-0.171	0.000	0.38			72.0	OK	
S105.009	S56	-0.090	0.000	0.82			84.7	OK	
S105.010	S57	0.033	0.000	1.04			99.7	SURCHARGED	
S105.011	S58	-0.001	0.000	1.00			106.8	OK	
S105.012	S59	0.002	0.000	1.02			118.9	SURCHARGED	
S102.007	S10	0.094	0.000	1.37			377.9	SURCHARGED	
S100.002	S103	1.420	0.000	0.00		3737	0.0	SURCHARGED*	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for M3 North of 101/6

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for M3 North of 101/6

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S334.012	16.956	0.005	3391.2	0.005	0.00	0.0	38.100	\/	31	Pipe/Conduit	🔒
S337.000	78.507	0.891	88.2	0.184	2.00	0.0	0.600	o	300	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S334.012	43.77	4.78	37.953	0.298	0.0	0.0	0.0	0.56	1491.8	53.0
S337.000	60.02	2.78	38.710	0.184	0.0	0.0	0.0	1.68	118.4	39.9

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S338.004	42.589	0.150	283.9	0.073	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S338.005	19.080	0.001	19079.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S339.000	9.397	1.307	7.2	0.016	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S338.006	19.154	0.100	191.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S340.000	17.003	0.230	73.9	0.011	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S341.000	5.050	0.130	38.8	0.013	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S340.001	63.653	0.390	163.2	0.055	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S340.002	66.208	0.659	100.5	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S340.003	66.190	0.659	100.5	0.055	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S340.004	80.621	0.802	100.5	0.097	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S337.001	15.065	0.156	96.6	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S337.002	15.065	0.156	96.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S342.000	3.978	0.068	58.5	0.024	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S342.001	45.446	0.458	99.1	0.039	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S342.002	20.592	0.322	64.0	0.035	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S338.004	57.05	3.03	38.250	0.273	0.0	0.0	0.0	1.44	407.2	56.2
S338.005	42.94	4.94	38.100	0.273	0.0	0.0	0.0	0.17	47.2«	56.2
S339.000	71.88	2.04	39.802	0.016	0.0	0.0	0.0	3.78	66.8	4.1
S338.006	42.04	5.12	38.100	0.289	0.0	0.0	0.0	1.76	496.5	56.2
S340.000	68.05	2.24	40.400	0.011	0.0	0.0	0.0	1.17	20.7	2.8
S341.000	71.66	2.05	40.300	0.013	0.0	0.0	0.0	1.62	28.6	3.5
S340.001	51.67	3.60	40.170	0.080	0.0	0.0	0.0	0.78	13.9«	14.9
S340.002	45.68	4.44	39.705	0.130	0.0	0.0	0.0	1.30	51.9	21.5
S340.003	41.27	5.29	39.046	0.185	0.0	0.0	0.0	1.30	51.9	27.6
S340.004	37.20	6.32	38.388	0.283	0.0	0.0	0.0	1.30	51.9	37.9
S337.001	36.86	6.42	37.742	0.756	0.0	0.0	0.0	2.48	700.8	100.6
S337.002	36.34	6.58	37.587	0.756	0.0	0.0	0.0	1.60	113.1	100.6
S342.000	71.69	2.05	40.200	0.024	0.0	0.0	0.0	1.32	23.3	6.1
S342.001	59.77	2.80	40.132	0.063	0.0	0.0	0.0	1.01	17.8	13.6
S342.002	56.62	3.07	39.673	0.098	0.0	0.0	0.0	1.26	22.2	20.1

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S342.003	19.035	1.323	14.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S342.005	9.271	0.000	0.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S353.000	95.090	0.540	176.1	0.019	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S353.001	88.899	0.390	227.9	0.021	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S354.001	17.967	0.230	78.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S355.000	55.182	0.600	92.0	0.014	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S356.000	15.452	2.111	7.3	0.010	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S357.000	8.187	2.066	4.0	0.027	2.00	0.0	0.600	o	100	Pipe/Conduit	🔒
S356.002	28.540	0.150	190.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S359.000	10.784	1.046	10.3	0.038	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S360.000	19.057	3.499	5.4	0.024	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S361.000	10.668	3.015	3.5	0.014	2.00	0.0	0.600	o	100	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S342.003	55.39	3.19	39.352	0.098	0.0	0.0	0.0	2.67	47.2	20.1
S342.005	38.04	6.08	38.020	0.604	0.0	0.0	0.0	0.15	10.5«	102.8
S353.000	47.86	4.10	40.010	0.019	0.0	0.0	0.0	0.75	13.3	3.3
S353.001	37.12	6.34	39.400	0.040	0.0	0.0	0.0	0.66	11.7	5.4
S354.001	56.52	3.08	38.790	0.000	0.0	0.0	0.0	1.78	125.9	0.0
S355.000	58.84	2.88	39.600	0.014	0.0	0.0	0.0	1.05	18.5	3.0
S356.000	71.32	2.07	40.039	0.010	0.0	0.0	0.0	3.75	66.2	2.5
S357.000	72.01	2.03	39.613	0.027	0.0	0.0	0.0	3.91	30.7	7.1
S356.002	42.66	4.99	36.730	0.061	0.0	0.0	0.0	1.76	498.2	9.4
S359.000	71.56	2.06	38.988	0.038	0.0	0.0	0.0	3.16	55.8	9.7
S360.000	71.23	2.07	40.388	0.024	0.0	0.0	0.0	4.35	76.8	6.1
S361.000	71.85	2.04	40.100	0.014	0.0	0.0	0.0	4.14	32.5	3.7

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S356.003	3.177	0.011	288.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S356.004	3.177	0.011	288.8	0.000	0.00	0.0	0.600	\/	31	Pipe/Conduit	🔒
S362.000	12.955	0.120	108.0	0.045	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S362.001	72.730	0.300	242.4	0.051	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S362.002	85.477	0.380	224.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S362.003	13.144	1.450	9.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S364.000	17.153	0.020	857.6	0.049	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S365.000	14.815	0.150	98.8	0.000	2.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S366.000	89.997	0.490	183.7	0.115	2.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S366.001	23.760	0.167	142.0	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S366.002	23.714	0.119	200.0	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S366.003	47.834	0.239	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S363.007	38.745	0.394	98.4	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S362.006	3.371	0.159	21.2	0.000	0.00	0.0	0.600	\/	31	Pipe/Conduit	🔒
S368.000	81.993	0.560	146.4	0.185	2.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S356.003	42.32	5.06	36.270	0.421	0.0	0.0	0.0	0.76	30.4«	64.4
S356.004	42.24	5.08	36.260	0.421	0.0	0.0	0.0	3.37	8968.3	64.4
S362.000	68.39	2.22	40.200	0.045	0.0	0.0	0.0	0.97	17.1	11.2
S362.001	47.77	4.11	40.080	0.096	0.0	0.0	0.0	0.64	11.3«	16.5
S362.002	37.42	6.25	39.780	0.096	0.0	0.0	0.0	0.67	11.8«	16.5
S362.003	37.20	6.32	39.400	0.096	0.0	0.0	0.0	3.37	59.5	16.5
S364.000	59.15	2.85	40.100	0.049	0.0	0.0	0.0	0.34	5.9«	10.4
S365.000	68.02	2.24	39.620	0.000	0.0	0.0	0.0	1.01	17.9	0.0
S366.000	51.97	3.56	40.500	0.115	0.0	0.0	0.0	0.96	38.2	21.6
S366.001	49.12	3.92	39.930	0.146	0.0	0.0	0.0	1.10	43.5	25.9
S366.002	46.24	4.35	39.763	0.179	0.0	0.0	0.0	0.92	36.6	29.9
S366.003	41.60	5.22	39.644	0.179	0.0	0.0	0.0	0.92	36.6	29.9
S363.007	38.63	5.92	38.037	0.638	0.0	0.0	0.0	2.46	694.3	89.0
S362.006	36.91	6.40	36.879	0.734	0.0	0.0	0.0	12.46	33195.3	98.0
S368.000	54.64	3.27	59.960	0.185	0.0	0.0	0.0	1.08	42.9	36.5

Network Design Table for M3 North of 101/6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S368.001	99.705	0.490	203.5	0.135	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S368.002	97.877	1.120	87.4	0.190	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S368.003	10.445	0.173	60.4	0.100	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S368.004	87.612	1.448	60.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S368.005	97.656	2.030	48.1	0.121	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S368.006	99.887	2.460	40.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S368.007	14.618	0.080	182.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S369.000	100.363	0.500	200.7	0.178	2.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S369.001	99.267	0.500	198.5	0.149	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S369.002	100.879	1.674	60.2	0.271	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S369.003	100.502	1.704	59.0	0.184	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S369.004	99.240	1.767	56.2	0.124	0.00	0.0	0.600	o	900	Pipe/Conduit	🔒
S369.005	9.911	0.142	69.8	0.238	0.00	0.0	0.600	o	185	Pipe/Conduit	🔒
S369.006	89.836	1.956	45.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S368.008	13.587	0.250	54.3	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S368.001	42.21	5.09	59.400	0.321	0.0	0.0	0.0	0.91	36.3«	48.9
S368.002	39.45	5.71	58.910	0.511	0.0	0.0	0.0	2.61	736.8	72.7
S368.003	38.92	5.85	57.790	0.611	0.0	0.0	0.0	1.30	22.9«	85.8
S368.004	36.36	6.57	57.617	0.611	0.0	0.0	0.0	2.02	143.1	85.8
S368.005	33.85	7.43	56.170	0.732	0.0	0.0	0.0	1.89	75.2«	89.5
S368.006	31.87	8.24	54.140	0.732	0.0	0.0	0.0	2.06	81.9«	89.5
S368.007	31.40	8.45	51.530	0.732	0.0	0.0	0.0	1.16	82.0«	89.5
S369.000	49.88	3.82	60.370	0.178	0.0	0.0	0.0	0.92	36.5	32.0
S369.001	39.87	5.61	59.870	0.327	0.0	0.0	0.0	0.92	36.8«	47.1
S369.002	36.25	6.61	59.358	0.598	0.0	0.0	0.0	1.69	67.1«	78.3
S369.003	34.37	7.24	57.475	0.782	0.0	0.0	0.0	2.65	421.7	97.0
S369.004	33.32	7.63	55.385	0.905	0.0	0.0	0.0	4.19	2662.7	108.9
S369.005	33.02	7.75	53.618	1.144	0.0	0.0	0.0	1.38	37.1«	136.4
S369.006	31.24	8.53	53.476	1.144	0.0	0.0	0.0	1.94	76.9«	136.4
S368.008	31.04	8.62	51.450	1.876	0.0	0.0	0.0	2.46	272.0	210.3

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S334.012	S Ex 5	38.507	37.948	39.500	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S337.002	S Ex 1B	39.053	37.431	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S342.005	S Ex 4	38.952	38.020	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S356.004	SSU4931_3052 (Ex 7)	37.030	36.249	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S362.006	SSU4931 3576d (Ex outfall 6)	37.934	36.720	0.000	0	0

Free Flowing Outfall Details for M3 North of 101/6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S368.008	SSU4931 8898 (Ex M3 Nrth)	53.121	51.200	0.000	1350	0

QVA Consulting		Page 7
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 17:38 File 2021 09 28 A33_34_M3	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

Simulation Criteria

Areal Reduction Factor 1.000   Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0   MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0   Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500   Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0   Number of Storage Structures 0
Number of Online Controls 0   Number of Time/Area Diagrams 0
Number of Offline Controls 0   Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S334.012	S237	15 Summer	5	+40%					38.122
S337.000	S114	15 Summer	5	+40%					38.889
S338.004	S115	15 Summer	5	+40%					38.480
S338.005	S116	15 Summer	5	+40%					38.443
S339.000	S117	15 Summer	5	+40%					39.835
S338.006	S117	15 Summer	5	+40%					38.274
S340.000	S137	15 Summer	5	+40%					40.520
S341.000	S138	15 Summer	5	+40%	5/15 Summer				40.514
S340.001	S119	15 Summer	5	+40%	5/15 Summer				40.510

QVA Consulting		Page 8
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 17:38 File 2021 09 28 A33_34_M3	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S334.012	S237	-1.038	0.000	0.04			71.8	OK	
S337.000	S114	-0.121	0.000	0.61			69.0	OK	
S338.004	S115	-0.370	0.000	0.19			75.3	OK*	
S338.005	S116	-0.257	0.000	0.61			63.6	OK	
S339.000	S117	-0.117	0.000	0.11			6.6	OK	
S338.006	S117	-0.426	0.000	0.19			64.6	OK	
S340.000	S137	-0.030	0.000	0.22			4.3	OK	
S341.000	S138	0.064	0.000	0.20			4.5	SURCHARGED	
S340.001	S119	0.190	0.000	1.19			16.1	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S340.002	S120	15 Summer	5	+40%				
S340.003	S121	15 Summer	5	+40%				
S340.004	S122	30 Summer	5	+40%	5/15 Summer			
S337.001	S115	15 Summer	5	+40%				
S337.002	S33	15 Summer	5	+40%	5/15 Summer			
S342.000	S142	15 Summer	5	+40%				
S342.001	S136	15 Summer	5	+40%	5/15 Summer			
S342.002	S137	15 Summer	5	+40%	5/15 Summer			
S342.003	S138	15 Summer	5	+40%				
S342.005	S140	30 Summer	5	+40%				
S353.000	S62	15 Summer	5	+40%				
S353.001	S63	15 Summer	5	+40%				
S354.001	S117	60 Summer	5	+40%				
S355.000	S66	15 Summer	5	+40%				
S356.000	S63	15 Summer	5	+40%				
S357.000	S178	15 Summer	5	+40%				
S356.002	S339	15 Summer	5	+40%				
S359.000	S49	15 Summer	5	+40%				
S360.000	S48	15 Summer	5	+40%				
S361.000	S50	15 Summer	5	+40%				
S356.003	SSU4931 3052	30 Summer	5	+40%	5/15 Summer			
S356.004	S101	30 Summer	5	+40%				
S362.000	S94	15 Summer	5	+40%	5/15 Summer			
S362.001	S43	15 Summer	5	+40%	5/15 Summer			
S362.002	S118	15 Summer	5	+40%	5/15 Summer			
S362.003	S120	30 Summer	5	+40%				
S364.000	S116	15 Summer	5	+40%	5/15 Summer			
S365.000	S406	15 Summer	5	+40%				
S366.000	S125	15 Summer	5	+40%	5/15 Summer			
S366.001	S126	15 Summer	5	+40%	5/15 Summer			
S366.002	S409	15 Summer	5	+40%	5/15 Summer			
S366.003	S410	15 Summer	5	+40%	5/15 Summer			
S363.007	SSU4931 3268	15 Summer	5	+40%				
S362.006	S128	15 Summer	5	+40%				
S368.000	SSU4931 6344	15 Summer	5	+40%	5/15 Summer			
S368.001	SSU4931 6654	15 Summer	5	+40%	5/15 Summer			
S368.002	SSU4931 6963	60 Summer	5	+40%				
S368.003	SSU4931 7372	60 Summer	5	+40%	5/15 Summer			
S368.004	S133	60 Summer	5	+40%				
S368.005	SSU4931 7980	30 Summer	5	+40%				
S368.006	SSU4931 8488	30 Summer	5	+40%				
S368.007	SSU4931_9196a	60 Summer	5	+40%	5/30 Summer			
S369.000	SSU4931 6145	15 Summer	5	+40%	5/15 Summer			
S369.001	SSU4931 6454	30 Summer	5	+40%	5/15 Summer			
S369.002	SSU4931 6764	30 Summer	5	+40%	5/15 Summer			
S369.003	SSU4931 7273	15 Summer	5	+40%				
S369.004	SSU4931 7781	60 Summer	5	+40%				

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S340.002	S120	39.824	-0.106	0.000	0.53			26.8
S340.003	S121	39.221	-0.050	0.000	0.75			37.5
S340.004	S122	38.905	0.292	0.000	1.02			51.5
S337.001	S115	38.082	-0.260	0.000	0.35			140.3
S337.002	S33	38.057	0.170	0.000	1.47			139.8
S342.000	S142	40.307	-0.043	0.000	0.57			9.3
S342.001	S136	40.289	0.007	0.000	0.96			16.7
S342.002	S137	39.904	0.081	0.000	1.12			23.4
S342.003	S138	39.430	-0.072	0.000	0.53			23.5
S342.005	S140	38.278	-0.042	0.000	1.00			41.2
S353.000	S62	40.094	-0.066	0.000	0.49			6.4
S353.001	S63	39.522	-0.028	0.000	1.00			11.5
S354.001	S117	39.009	-0.081	0.000	0.01			1.0
S355.000	S66	39.658	-0.092	0.000	0.32			5.8
S356.000	S63	40.064	-0.125	0.000	0.07			4.0
S357.000	S178	39.657	-0.056	0.000	0.40			11.2
S356.002	S339	36.813	-0.517	0.000	0.05			17.9
S359.000	S49	39.045	-0.093	0.000	0.31			15.5
S360.000	S48	40.424	-0.113	0.000	0.14			9.9
S361.000	S50	40.129	-0.071	0.000	0.19			5.8
S356.003	SSU4931 3052	36.621	0.126	0.000	1.81			54.1
S356.004	S101	36.371	-1.096	0.000	0.01			54.2
S362.000	S94	40.694	0.344	0.000	0.74			11.5
S362.001	S43	40.671	0.441	0.000	1.45			16.2
S362.002	S118	40.085	0.155	0.000	1.17			13.6
S362.003	S120	39.451	-0.099	0.000	0.25			13.6
S364.000	S116	40.469	0.219	0.000	4.10			18.1
S365.000	S406	39.620	-0.150	0.000	0.00			0.0
S366.000	S125	40.875	0.150	0.000	0.98			36.7
S366.001	S126	40.229	0.074	0.000	0.95			37.9
S366.002	S409	40.108	0.120	0.000	1.24			41.8
S366.003	S410	39.940	0.071	0.000	1.13			39.5
S363.007	SSU4931 3268	38.220	-0.417	0.000	0.20			118.3
S362.006	S128	36.906	-1.180	0.000	0.02			123.5
S368.000	SSU4931 6344	60.775	0.589	0.000	1.09			45.6
S368.001	SSU4931 6654	60.534	0.909	0.000	1.56			55.4
S368.002	SSU4931 6963	59.329	-0.181	0.000	0.12			80.6
S368.003	SSU4931 7372	59.233	1.293	0.000	2.92			59.8
S368.004	S133	57.755	-0.162	0.000	0.43			59.7
S368.005	SSU4931 7980	56.350	-0.045	0.000	0.98			72.1
S368.006	SSU4931 8488	54.306	-0.059	0.000	0.90			71.8
S368.007	SSU4931_9196a	51.834	0.004	0.000	1.05			71.6
S369.000	SSU4931 6145	61.268	0.673	0.000	1.13			40.5
S369.001	SSU4931 6454	61.126	1.031	0.000	1.28			46.1
S369.002	SSU4931 6764	60.399	0.816	0.000	1.22			80.1
S369.003	SSU4931 7273	57.637	-0.287	0.000	0.28			112.6

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S369.004	SSU4931 7781	55.711	-0.574	0.000	0.05			126.7

PN	US/MH Name	Status	Level Exceeded
S340.002	S120	OK	
S340.003	S121	OK	
S340.004	S122	SURCHARGED	
S337.001	S115	OK	
S337.002	S33	SURCHARGED	
S342.000	S142	OK	
S342.001	S136	SURCHARGED	
S342.002	S137	SURCHARGED	
S342.003	S138	OK	
S342.005	S140	FLOOD RISK*	
S353.000	S62	OK	
S353.001	S63	OK	
S354.001	S117	OK	
S355.000	S66	OK	
S356.000	S63	OK	
S357.000	S178	OK	
S356.002	S339	OK*	
S359.000	S49	OK	
S360.000	S48	OK	
S361.000	S50	OK	
S356.003	SSU4931 3052	SURCHARGED*	
S356.004	S101	OK	
S362.000	S94	FLOOD RISK	
S362.001	S43	FLOOD RISK	
S362.002	S118	SURCHARGED	
S362.003	S120	OK	
S364.000	S116	SURCHARGED	
S365.000	S406	OK	
S366.000	S125	SURCHARGED	
S366.001	S126	SURCHARGED	
S366.002	S409	SURCHARGED	
S366.003	S410	SURCHARGED	
S363.007	SSU4931 3268	OK	
S362.006	S128	OK	
S368.000	SSU4931 6344	FLOOD RISK	
S368.001	SSU4931 6654	SURCHARGED	
S368.002	SSU4931 6963	OK	
S368.003	SSU4931 7372	SURCHARGED	
S368.004	S133	OK	
S368.005	SSU4931 7980	OK	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Status	Level Exceeded
S368.006	SSU4931 8488	OK	
S368.007	SSU4931_9196a	SURCHARGED	
S369.000	SSU4931 6145	FLOOD RISK	
S369.001	SSU4931 6454	FLOOD RISK	
S369.002	SSU4931 6764	FLOOD RISK	
S369.003	SSU4931 7273	OK	
S369.004	SSU4931 7781	OK	

QVA Consulting		Page 13
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 17:38 File 2021 09 28 A33_34_M3	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 North of 101/6

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S369.005	SSU4931 6144	60 Summer	5	+40%	5/15 Summer	5/60 Summer		
S369.006	S142	60 Summer	5	+40%	5/15 Summer			
S368.008	SSU4931 8997	60 Summer	5	+40%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S369.005	SSU4931 6144	55.624	1.821	1.523	2.80			89.6	FLOOD
S369.006	S142	54.512	0.811	0.000	1.19			89.5	SURCHARGED
S368.008	SSU4931 8997	51.707	-0.118	0.000	0.81			158.2	OK

PN	US/MH Name	Level Exceeded
S369.005	SSU4931 6144	1
S369.006	S142	
S368.008	SSU4931 8997	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for New works to Basins 2 & 3C

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S314.009	SOutfall W of bridges	41.000	40.054	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S336.010	SM3 CR tie in 01	58.228	55.203	56.200	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S341.001	S	53.487	52.685	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S342.002	SEx O_Fall SU4931_4049c	38.191	37.631	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S347.012	S	58.068	53.978	0.000	0	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S350.000	SSU4929_6199b	58.753	54.920	0.000	1200	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S351.001	S227	53.105	51.073	0.000	1350	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S352.006	S193	56.113	54.334	0.000	1200	0

Free Flowing Outfall Details for New works to Basins 2 & 3C

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S355.001	S	66.661	64.226	0.000	0	0

Online Controls for New works to Basins 2 & 3C

Orifice Manhole: S47, DS/PN: S321.002, Volume (m³): 28.2

Diameter (m) 0.240 Discharge Coefficient 0.600 Invert Level (m) 56.653

Orifice Manhole: S61, DS/PN: S323.007, Volume (m³): 67.7

Diameter (m) 0.160 Discharge Coefficient 0.600 Invert Level (m) 55.488

Hydro-Brake® Optimum Manhole: S71, DS/PN: S320.006, Volume (m³): 19.2

Unit Reference	MD-SHE-0414-1250-2500-1250
Design Head (m)	2.500
Design Flow (l/s)	125.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	414
Invert Level (m)	51.393
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.500	124.9	Kick-Flo®	1.707	103.8
Flush-Flo™	0.790	124.3	Mean Flow over Head Range	-	106.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	11.2	0.800	124.3	2.000	112.0	4.000	157.0	7.000	206.5
0.200	40.4	1.000	123.2	2.200	117.4	4.500	166.3	7.500	213.6
0.300	78.8	1.200	121.0	2.400	122.4	5.000	175.1	8.000	220.4
0.400	113.5	1.400	117.4	2.600	127.3	5.500	183.5	8.500	227.1
0.500	120.0	1.600	110.4	3.000	136.5	6.000	191.5	9.000	233.5
0.600	122.7	1.800	106.5	3.500	147.1	6.500	199.1	9.500	239.8

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Unit Reference	MD-SHE-0214-2930-2400-2930
Design Head (m)	2.400
Design Flow (l/s)	29.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	40.850
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.400	29.3	Kick-Flo®	1.466	23.1
Flush-Flo™	0.693	29.2	Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	0.800	29.1	2.000	26.8	4.000	37.4	7.000	49.1
0.200	20.9	1.000	28.5	2.200	28.1	4.500	39.6	7.500	50.7
0.300	26.1	1.200	27.2	2.400	29.3	5.000	41.7	8.000	52.3
0.400	27.8	1.400	24.6	2.600	30.4	5.500	43.7	8.500	53.9
0.500	28.7	1.600	24.1	3.000	32.6	6.000	45.5	9.000	55.4
0.600	29.1	1.800	25.5	3.500	35.1	6.500	47.3	9.500	56.9

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m³): 5.8

Unit Reference	MD-SHE-0082-4000-2000-4000
Design Head (m)	2.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	48.604
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	4.0	Kick-Flo®	0.729	2.5
Flush-Flo™	0.356	3.1	Mean Flow over Head Range	-	3.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	3.0	1.000	2.9	2.200	4.2	4.500	5.8	7.500	7.4
0.300	3.1	1.200	3.2	2.400	4.3	5.000	6.1	8.000	7.7
0.400	3.1	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	3.1	1.600	3.6	3.000	4.8	6.000	6.7	9.000	8.1
0.600	2.9	1.800	3.8	3.500	5.2	6.500	6.9	9.500	8.3

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m³): 10.9

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	41.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m^3): 10.9

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.8	7.000	4.9
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	1.9	1.200	2.2	2.400	3.0	5.000	4.2	8.000	5.2
0.400	1.9	1.400	2.3	2.600	3.1	5.500	4.4	8.500	5.4
0.500	1.8	1.600	2.5	3.000	3.3	6.000	4.6	9.000	5.5
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.7

Orifice Manhole: S261, DS/PN: S352.004, Volume (m^3): 38.1

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 60.425

Depth/Flow Relationship Manhole: S256, DS/PN: S355.001, Volume (m^3): 50.4

Invert Level (m) 64.300

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.700	0.0000	1.300	0.0000	1.900	0.0000	2.500	0.0000
0.200	0.0000	0.800	0.0000	1.400	0.0000	2.000	0.0000	2.600	0.0000
0.300	0.0000	0.900	0.0000	1.500	0.0000	2.100	0.0000	2.700	0.0000
0.400	0.0000	1.000	0.0000	1.600	0.0000	2.200	0.0000	2.800	0.0000
0.500	0.0000	1.100	0.0000	1.700	0.0000	2.300	0.0000	2.900	0.0000
0.600	0.0000	1.200	0.0000	1.800	0.0000	2.400	0.0000	3.000	0.0000

Offline Controls for New works to Basins 2 & 3C

Pipe Manhole: SSMP CR010, DS/PN: S323.004, Loop to PN: S337.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	60.041

Pipe Manhole: S61, DS/PN: S323.007, Loop to PN: S339.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	55.488

Pipe Manhole: S71, DS/PN: S320.006, Loop to PN: S315.009

Diameter (m)	0.450	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	40.000	Upstream Invert Level (m)	54.650

Weir Manhole: S98, DS/PN: S314.004, Loop to PN: S314.005

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 45.200

Pipe Manhole: S106, DS/PN: S331.005, Loop to PN: S331.007

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	200.0	Coefficient of Contraction	0.600
Length (m)	16.500	Upstream Invert Level (m)	43.514

Weir Manhole: S114, DS/PN: S314.006, Loop to PN: S314.007

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.900

Pipe Manhole: S98, DS/PN: S335.002, Loop to PN: S334.015

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	27.5	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	43.032

Pipe Manhole: S99, DS/PN: S335.003, Loop to PN: S334.014

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	57.0	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	42.850

Weir Manhole: S154, DS/PN: S314.008, Loop to PN: S314.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.150

Pipe Manhole: S262, DS/PN: S336.006, Loop to PN: S350.000

Diameter (m)	0.225	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	59.809

Weir Manhole: S261, DS/PN: S352.004, Loop to PN: S321.000

Discharge Coef 0.544 Width (m) 1.800 Invert Level (m) 61.255

Storage Structures for New works to Basins 2 & 3C

Infiltration Basin Manhole: S71, DS/PN: S320.006

Invert Level (m) 51.479 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	350.0	0.600	479.6	1.200	629.5	1.800	799.7	2.400	990.4
0.100	370.2	0.700	503.1	1.300	656.4	1.900	830.1	2.500	1024.1
0.200	390.9	0.800	527.3	1.400	684.0	2.000	861.0	2.600	1058.4
0.300	412.2	0.900	552.0	1.500	712.1	2.100	892.5	2.700	1093.3
0.400	434.1	1.000	577.2	1.600	740.7	2.200	924.6	2.800	1128.8
0.500	456.5	1.100	603.1	1.700	769.9	2.300	957.2	2.900	1164.8

Infiltration Basin Manhole: S98, DS/PN: S314.004

Invert Level (m) 43.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	561.0	0.501	1078.9	1.001	1603.0	1.501	2133.4	2.001	2670.1
0.101	664.1	0.601	1183.2	1.101	1708.6	1.601	2240.2	2.101	2778.2
0.201	767.4	0.701	1287.8	1.201	1814.4	1.701	2347.3	2.201	2886.5
0.301	871.0	0.801	1392.6	1.301	1920.5	1.801	2454.7	2.301	2995.1
0.401	974.8	0.901	1497.7	1.401	2026.8	1.901	2562.3	2.400	3102.9

Infiltration Basin Manhole: S114, DS/PN: S314.006

Invert Level (m) 42.075 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1171.8	0.501	1373.1	1.001	1580.7	1.501	1794.5	1.925	1980.8
0.101	1211.6	0.601	1414.1	1.101	1623.0	1.601	1838.0		
0.201	1251.6	0.701	1455.4	1.201	1665.5	1.701	1881.8		
0.301	1291.9	0.801	1496.9	1.301	1708.2	1.801	1925.8		
0.401	1332.4	0.901	1538.7	1.401	1751.3	1.901	1970.1		

Infiltration Basin Manhole: S154, DS/PN: S314.008

Invert Level (m) 40.850 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2392.3	0.501	2716.7	1.001	3047.3	1.501	3384.2	2.001	3727.4
0.101	2456.7	0.601	2782.3	1.101	3114.2	1.601	3452.3	2.101	3796.8
0.201	2521.3	0.701	2848.2	1.201	3181.3	1.701	3520.7	2.201	3866.4
0.301	2586.2	0.801	2914.3	1.301	3248.7	1.801	3589.4	2.301	3936.3
0.401	2651.3	0.901	2980.7	1.401	3316.3	1.901	3658.2	2.400	4005.7

Infiltration Basin Manhole: S84, DS/PN: S343.006

Invert Level (m) 48.383 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Infiltration Basin Manhole: S84, DS/PN: S343.006

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	325.0	0.600	496.5	1.200	704.1	1.800	948.0	2.400	1228.0
0.100	351.1	0.700	528.6	1.300	742.3	1.900	992.1	2.500	1278.2
0.200	378.1	0.800	561.7	1.400	781.4	2.000	1037.3		
0.300	406.2	0.900	595.8	1.500	821.5	2.100	1083.5		
0.400	435.3	1.000	630.9	1.600	862.7	2.200	1130.7		
0.500	465.4	1.100	667.0	1.700	904.8	2.300	1178.8		

Infiltration Basin Manhole: S106, DS/PN: S343.009

Invert Level (m) 40.988 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1300.0	0.600	1624.8	1.200	1985.9	1.800	2383.1	2.400	2816.5
0.100	1351.6	0.700	1682.5	1.300	2049.6	1.900	2452.8	2.500	2892.3
0.200	1404.3	0.800	1741.2	1.400	2114.3	2.000	2523.6		
0.300	1457.9	0.900	1800.8	1.500	2180.0	2.100	2595.3		
0.400	1512.5	1.000	1861.5	1.600	2246.7	2.200	2668.0		
0.500	1568.2	1.100	1923.2	1.700	2314.4	2.300	2741.8		

Infiltration Basin Manhole: S256, DS/PN: S355.001

Invert Level (m) 64.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.600	338.0	1.200	891.0	1.800	1600.0	2.400	1600.0
0.100	32.0	0.700	417.0	1.300	1006.0	1.900	1600.0	2.500	1600.0
0.200	78.0	0.800	501.0	1.400	1200.0	2.000	1600.0		
0.300	133.0	0.900	588.0	1.500	1400.0	2.100	1600.0		
0.400	195.0	1.000	676.0	1.600	1600.0	2.200	1600.0		
0.500	264.0	1.100	766.0	1.700	1600.0	2.300	1600.0		

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Offline Controls	11	Number of Time/Area Diagrams	0
Number of Online Controls	8	Number of Storage Structures	7	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.411
FEH Rainfall Version	1999	E (1km)	0.294
Site Location	GB 449350 131500 SU 49350 31500	F (1km)	2.313
C (1km)	-0.025	Cv (Summer)	1.000
D1 (1km)	0.429	Cv (Winter)	1.000
D2 (1km)	0.273		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S314.000	S32	15 Summer	100	+40%	100/15 Summer	100/15 Summer			51.117	1.173	4.228
S314.001	S33	15 Summer	100	+40%	100/15 Summer	100/15 Summer			50.917	2.066	2.094
S315.000	S31	15 Summer	100	+40%	100/15 Summer				59.683	0.233	0.000
S315.001	S32	15 Summer	100	+40%	100/15 Summer				59.418	1.084	0.000
S316.000	S26	15 Summer	100	+40%	100/15 Summer				64.323	0.830	0.000
S316.001	S27	15 Summer	100	+40%	100/15 Summer	100/15 Summer			64.255	1.012	1.339
S316.002	S28	15 Summer	100	+40%	100/15 Summer	100/15 Summer			64.256	1.423	0.019
S316.003	S29	15 Summer	100	+40%	100/15 Summer	100/15 Summer			63.980	1.408	8.613
S316.004	S30	15 Summer	100	+40%	100/15 Summer				61.394	1.613	0.000
S316.005	S31	15 Summer	100	+40%	100/15 Summer				61.096	1.413	0.000
S316.006	S32	15 Summer	100	+40%	100/15 Summer	100/15 Summer			60.694	1.252	1.798
S316.007	S33	15 Winter	100	+40%	100/15 Summer	100/15 Summer			60.250	0.892	14.192
S316.008	S9	15 Summer	100	+40%	100/15 Summer	100/15 Summer			59.966	0.704	0.672
S317.000	S33	15 Summer	100	+40%	100/15 Summer				63.644	0.272	0.000
S317.001	S34	15 Summer	100	+40%	100/15 Summer				63.531	0.699	0.000
S317.002	S35	15 Summer	100	+40%	100/15 Summer				63.474	0.714	0.000
S317.003	S36	15 Summer	100	+40%	100/15 Summer				63.386	0.796	0.000
S317.004	S38	15 Summer	100	+40%	100/15 Summer				61.336	0.891	0.000
S317.005	S39	15 Summer	100	+40%	100/15 Summer	100/15 Summer			60.556	0.805	8.369
S317.006	S40	30 Summer	100	+40%	100/15 Summer	100/15 Summer			60.148	0.684	8.889
S317.007	S41	30 Summer	100	+40%	100/15 Summer	100/15 Summer			59.935	0.684	27.288
S318.000	S12	15 Summer	100	+40%					60.987	-0.075	0.000
S318.001	S13	15 Summer	100	+40%	100/15 Summer				60.951	0.173	0.000
S318.002	S14	15 Summer	100	+40%	100/15 Summer				60.804	0.550	0.000
S318.003	S15	15 Summer	100	+40%	100/15 Summer				60.340	0.563	0.000
S319.000	S30	15 Winter	100	+40%	100/15 Summer				60.234	0.484	0.000
S319.001	S31	15 Winter	100	+40%	100/15 Summer				60.208	0.792	0.000
S318.004	S176	15 Winter	100	+40%	100/15 Summer				60.153	1.008	0.000
S316.009	S18	30 Summer	100	+40%	100/15 Summer	100/15 Summer			59.839	0.759	24.962
S316.010	S36	15 Summer	100	+40%	100/15 Summer				59.638	0.764	0.000

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S314.000	S32	0.90			33.0	FLOOD	4
S314.001	S33	1.22			45.3	FLOOD	3
S315.000	S31	0.79			24.3	SURCHARGED	
S315.001	S32	1.32			47.7	FLOOD RISK	
S316.000	S26	0.65			13.8	FLOOD RISK	
S316.001	S27	0.81			18.8	FLOOD	3
S316.002	S28	1.64			27.9	FLOOD	1
S316.003	S29	1.04			84.4	FLOOD	3
S316.004	S30	1.70			107.8	SURCHARGED	
S316.005	S31	1.25			141.6	FLOOD RISK	
S316.006	S32	2.32			146.5	FLOOD	3
S316.007	S33	1.74			122.1	FLOOD	6
S316.008	S9	0.98			135.0	FLOOD	4
S317.000	S33	1.04			81.2	SURCHARGED	
S317.001	S34	1.45			88.3	SURCHARGED	
S317.002	S35	0.99			92.6	SURCHARGED	
S317.003	S36	0.96			146.1	FLOOD RISK	
S317.004	S38	1.03			163.5	FLOOD RISK	
S317.005	S39	1.27			133.5	FLOOD	4
S317.006	S40	1.04			113.4	FLOOD	5
S317.007	S41	1.58			110.6	FLOOD	7
S318.000	S12	0.50			13.4	OK	
S318.001	S13	0.75			19.2	SURCHARGED	
S318.002	S14	1.01			24.7	FLOOD RISK	
S318.003	S15	0.89			22.5	FLOOD RISK	
S319.000	S30	0.42			9.2	FLOOD RISK	
S319.001	S31	0.65			14.0	FLOOD RISK	
S318.004	S176	1.89			26.8	FLOOD RISK	
S316.009	S18	1.52			220.2	FLOOD	7
S316.010	S36	1.47			246.6	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S316.011	S37	15 Summer	100	+40%	100/15 Summer				58.711	0.294
S316.012	S36	15 Summer	100	+40%					58.317	-0.005
S316.013	S37	15 Summer	100	+40%	100/15 Summer				57.712	0.341
S315.002	S34	15 Summer	100	+40%	100/15 Summer				57.301	1.104
S315.003	S28	15 Summer	100	+40%	100/15 Summer				56.036	2.052
S315.004	S29	15 Summer	100	+40%	100/15 Summer	100/15 Summer			54.395	2.121
S315.005	S30	30 Summer	100	+40%	100/15 Summer	100/15 Summer			52.847	2.327
S315.006	S72	15 Winter	100	+40%	100/15 Summer				51.705	1.389
S315.007	S73	30 Summer	100	+40%	100/15 Summer				50.507	0.811
S315.008	S8	30 Summer	100	+40%	100/15 Summer				49.601	0.556
S320.000	S1	15 Summer	100	+40%	100/15 Summer	100/15 Summer			60.651	0.932
S320.001	S2	15 Summer	100	+40%	100/15 Summer	100/15 Summer			59.188	1.078
S320.002	S3	15 Summer	100	+40%	100/15 Summer				56.852	1.575
S320.003	S4	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.675	1.413
S321.000	S45	15 Summer	100	+40%					59.496	0.000
S321.001	S46	30 Winter	100	+40%	100/15 Summer				59.030	0.597
S321.002	S47	30 Winter	100	+40%	100/15 Summer	100/15 Summer			58.777	1.824
S321.003	S48	60 Winter	100	+40%	100/15 Summer				57.131	0.317
S321.004	S74	60 Winter	100	+40%	100/15 Summer				56.572	0.701
S321.005	S75	120 Summer	100	+40%	100/15 Summer				56.146	0.887
S321.006	S76	120 Summer	100	+40%	100/15 Summer				55.865	1.156
S321.007	S77	60 Winter	100	+40%	100/15 Summer				55.263	1.396
S322.000	S94	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.419	0.904
S322.001	S95	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.221	1.084
S322.002	S96	30 Summer	100	+40%	100/15 Summer	100/15 Summer			54.930	0.995
S322.003	S97	60 Summer	100	+40%	100/15 Summer	100/15 Summer			54.797	1.157
S322.004	S98	30 Summer	100	+40%	100/15 Summer				54.799	1.276
S321.008	S58	30 Summer	100	+40%	100/15 Summer				54.686	1.611
S323.000	S54	15 Summer	100	+40%	100/15 Summer	100/15 Summer			68.474	1.056
S323.001	SSMP CR012	15 Summer	100	+40%	100/15 Summer	100/15 Summer			68.297	1.634
S323.002	SSMP CR011	120 Winter	100	+40%	100/60 Summer				64.607	0.054
S323.003	SSMP CRS4	120 Winter	100	+40%	100/15 Summer	100/15 Summer			64.339	1.810
S323.004	SSMP CR010	15 Summer	100	+40%			100/15 Summer	24	60.282	-0.209
S323.005	SSMP CR009	15 Summer	100	+40%					58.618	-0.703
S323.006	SSMP 1106	15 Summer	100	+40%					57.691	-0.405
S323.007	S61	15 Summer	100	+40%	100/15 Summer	100/15 Summer	100/15 Summer	24	57.564	1.701
S323.008	S79	30 Summer	100	+40%	100/15 Summer				55.360	0.576
S323.009	S63	30 Summer	100	+40%	100/15 Summer				55.231	0.801
S323.010	S80	30 Summer	100	+40%	100/15 Summer				55.075	0.999
S323.011	S81	30 Summer	100	+40%	100/15 Summer				54.924	1.304
S323.012	S66	30 Summer	100	+40%	100/15 Summer				54.727	1.299
S321.009	SSMP CR004	240 Winter	100	+40%	100/15 Summer				54.569	1.593
S324.000	S67	15 Summer	100	+40%	100/15 Summer	100/15 Summer			56.613	1.838
S324.001	S68	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.403	1.447
S324.002	S69	60 Summer	100	+40%	100/15 Summer	100/15 Summer			54.843	1.350
S325.000	S12	15 Summer	100	+40%					59.940	-0.054
S325.001	S13	15 Summer	100	+40%					59.236	-0.044
S325.002	S19	15 Summer	100	+40%					58.370	-0.036
S325.003	S78	15 Summer	100	+40%					57.096	-0.054
S324.003	S78	120 Summer	100	+40%	100/15 Summer	100/15 Summer			54.474	1.247
S324.004	S70	240 Winter	100	+40%	100/15 Summer	100/15 Summer			54.464	1.471
S321.010	S243	240 Winter	100	+40%	100/15 Summer	100/15 Summer			54.459	1.582
S321.011	S72	240 Winter	100	+40%	100/15 Summer				54.449	1.686
S321.012	S244	240 Winter	100	+40%	100/15 Summer				54.438	1.789
S321.013	S63	240 Winter	100	+40%	100/15 Summer				54.425	1.989
S320.004	S5	240 Winter	100	+40%	100/15 Summer				54.416	2.006
S326.000	S249	15 Summer	100	+40%	100/15 Summer	100/15 Summer			60.386	0.965
S326.001	S251	15 Summer	100	+40%	100/15 Summer	100/15 Summer			59.668	0.898
S326.002	S251	30 Summer	100	+40%	100/15 Summer	100/15 Summer			57.928	1.286
S326.003	S78	15 Summer	100	+40%	100/15 Summer				56.958	1.141

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S316.011	S37	0.000	2.05			247.3	SURCHARGED	
S316.012	S36	0.000	0.88			281.2	OK	
S316.013	S37	0.000	0.63			266.2	SURCHARGED	
S315.002	S34	0.000	1.27			345.7	SURCHARGED	
S315.003	S28	0.000	0.97			349.6	FLOOD RISK	
S315.004	S29	1.458	0.94			358.9	FLOOD	3
S315.005	S30	1.799	2.44			370.4	FLOOD	3
S315.006	S72	0.000	1.42			382.3	SURCHARGED	
S315.007	S73	0.000	1.19			376.6	SURCHARGED	
S315.008	S8	0.000	1.18			379.8	SURCHARGED	
S320.000	S1	6.621	1.10			37.9	FLOOD	4
S320.001	S2	3.376	1.17			49.9	FLOOD	4
S320.002	S3	0.000	1.05			74.6	FLOOD RISK	
S320.003	S4	4.026	1.78			143.9	FLOOD	3
S321.000	S45	0.000	0.34			279.1	SURCHARGED*	
S321.001	S46	0.000	0.29			219.7	SURCHARGED	
S321.002	S47	27.150	1.69			157.5	FLOOD	7
S321.003	S48	0.000	0.82			153.1	SURCHARGED	
S321.004	S74	0.000	0.84			147.2	SURCHARGED	
S321.005	S75	0.000	0.72			147.2	FLOOD RISK	
S321.006	S76	0.000	0.85			149.9	FLOOD RISK	
S321.007	S77	0.000	0.88			160.3	SURCHARGED	
S322.000	S94	3.633	1.41			24.4	FLOOD	5
S322.001	S95	1.509	1.68			63.3	FLOOD	4
S322.002	S96	1.854	0.96			75.8	FLOOD	5
S322.003	S97	18.503	1.33			72.4	FLOOD	9
S322.004	S98	0.000	0.78			83.1	FLOOD RISK	
S321.008	S58	0.000	0.96			198.5	SURCHARGED	
S323.000	S54	23.425	1.48			81.2	FLOOD	6
S323.001	SSMP CR012	37.531	1.30			165.5	FLOOD	5
S323.002	SSMP CR011	0.000	0.15			163.8	SURCHARGED	
S323.003	SSMP CRS4	339.499	1.33			34.5	FLOOD	23
S323.004	SSMP CR010	0.000	0.55	24.0		266.2	OK	
S323.005	SSMP CR009	0.000	0.11			265.2	OK	
S323.006	SSMP 1106	0.000	0.18			426.8	OK	
S323.007	S61	30.492	0.37	174.4		75.4	FLOOD	4
S323.008	S79	0.000	0.69			146.1	SURCHARGED	
S323.009	S63	0.000	0.50			117.5	SURCHARGED	
S323.010	S80	0.000	0.71			203.5	FLOOD RISK	
S323.011	S81	0.000	1.30			328.5	FLOOD RISK	
S323.012	S66	0.000	1.08			270.7	FLOOD RISK	
S321.009	SSMP CR004	0.000	0.95			236.3	FLOOD RISK	
S324.000	S67	14.920	1.26			133.9	FLOOD	4
S324.001	S68	43.877	1.45			206.2	FLOOD	7
S324.002	S69	16.321	1.52			209.9	FLOOD	7
S325.000	S12	0.000	0.73			20.5	OK	
S325.001	S13	0.000	0.84			27.8	OK	
S325.002	S19	0.000	0.92			32.3	OK	
S325.003	S78	0.000	0.70			39.5	OK	
S324.003	S78	14.738	0.84			183.7	FLOOD	16
S324.004	S70	249.245	0.35			108.6	FLOOD	21
S321.010	S243	191.979	0.75			347.3	FLOOD	21
S321.011	S72	0.000	0.74			344.9	SURCHARGED	
S321.012	S244	0.000	0.75			363.3	SURCHARGED	
S321.013	S63	0.000	1.22			361.9	FLOOD RISK	
S320.004	S5	0.000	0.90			398.7	SURCHARGED	
S326.000	S249	8.847	1.19			56.7	FLOOD	5
S326.001	S251	19.285	0.91			121.6	FLOOD	5
S326.002	S251	32.754	1.32			156.2	FLOOD	7

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.003	S78	0.000	1.59			140.7	FLOOD RISK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S326.004	S77	15 Summer	100	+40%	100/15 Summer				55.930	0.605
S326.005	S80	120 Summer	100	+40%	100/15 Summer				54.933	0.051
S327.000	S60	15 Summer	100	+40%					54.703	-0.150
S326.006	S243	240 Winter	100	+40%	100/15 Summer				54.647	1.650
S328.000	S81	15 Summer	100	+40%	100/15 Summer				60.551	1.405
S328.001	S251	15 Summer	100	+40%	100/15 Summer	100/15 Summer			60.552	1.611
S328.002	S82	15 Summer	100	+40%	100/15 Summer				59.645	1.666
S328.003	S253	15 Summer	100	+40%	100/15 Summer	100/15 Summer			58.738	1.925
S328.004	S86	15 Summer	100	+40%					55.698	-0.199
S328.005	S82	60 Summer	100	+40%	100/60 Summer				54.908	0.041
S328.006	S89	240 Winter	100	+40%	100/15 Summer				54.660	0.825
S329.000	S66	60 Summer	100	+40%	100/15 Summer	100/15 Summer			54.691	0.937
S329.001	S67	15 Summer	100	+40%	100/15 Summer	100/15 Summer			54.743	1.458
S329.002	S68	15 Summer	100	+40%	100/15 Summer	100/15 Summer			54.963	1.998
S326.007	S244	180 Winter	100	+40%	100/15 Summer				54.579	1.948
S326.008	S246	240 Winter	100	+40%	100/15 Summer				54.413	2.029
S330.000	S6	15 Summer	100	+40%	100/15 Summer	100/15 Summer			56.505	0.955
S330.001	S7	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.502	1.382
S330.002	S121	60 Summer	100	+40%	100/15 Summer				54.754	1.458
S320.005	S71	240 Winter	100	+40%	100/15 Summer				54.405	2.074
S320.006	S71	240 Winter	100	+40%	100/15 Summer			0	54.387	2.605
S315.009	S42	15 Winter	100	+40%	100/15 Summer				47.952	0.125
S315.010	S48	15 Winter	100	+40%	100/15 Summer				46.789	0.819
S314.002	S41	15 Winter	100	+40%	100/15 Summer				46.000	0.750
S314.003	S34	960 Summer	100	+40%	100/15 Summer				45.491	0.528
S314.004	S98	960 Summer	100	+40%	100/15 Summer		100/480 Summer	10	45.284	2.234
S331.000	S50	15 Summer	100	+40%	100/15 Summer	100/15 Summer			53.944	1.136
S331.001	S51	15 Summer	100	+40%	100/15 Summer	100/15 Summer			53.384	1.346
S331.002	S52	15 Summer	100	+40%					48.198	-0.069
S331.003	S100	15 Summer	100	+40%	100/15 Summer				46.148	0.605
S331.004	S53	15 Summer	100	+40%	100/15 Summer				44.693	0.939
S331.005	S106	15 Summer	100	+40%	100/15 Summer		100/15 Summer	22	44.086	0.572
S332.000	S50	15 Summer	100	+40%					45.720	-0.058
S332.001	S165	15 Summer	100	+40%	100/15 Summer				44.609	0.401
S332.002	S166	15 Summer	100	+40%	100/15 Summer				44.136	0.247
S331.006	S54	15 Summer	100	+40%	100/15 Summer				44.038	0.505
S331.007	S106	15 Summer	100	+40%	100/15 Summer				43.999	0.569
S331.008	S109	1440 Winter	100	+40%	100/15 Summer				43.938	0.659
S331.009	S110	1440 Winter	100	+40%	100/15 Summer				43.938	0.844
S331.010	S111	1440 Winter	100	+40%	100/15 Summer				43.938	1.003
S314.005	S37	1440 Winter	100	+40%	100/120 Summer				43.938	1.121
S314.006	S114	1440 Winter	100	+40%	100/15 Summer			0	43.743	1.493
S333.000	S69	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.019	1.016
S333.001	S70	15 Summer	100	+40%	100/15 Summer				54.937	1.461
S333.002	S71	15 Summer	100	+40%	100/15 Summer				53.458	1.265
S333.003	S72	15 Summer	100	+40%	100/15 Summer	100/15 Summer			49.004	1.753
S334.000	S60	15 Summer	100	+40%	100/15 Summer				55.405	0.808
S334.001	S61	15 Summer	100	+40%	100/15 Summer				54.488	0.491
S334.002	S62	15 Summer	100	+40%	100/15 Summer				54.418	0.499
S334.003	S63	15 Summer	100	+40%	100/15 Summer				54.179	0.471
S334.004	S64	15 Summer	100	+40%	100/15 Summer				53.746	0.703
S334.005	S65	15 Summer	100	+40%	100/15 Summer				52.782	0.852
S334.006	S58	15 Summer	100	+40%					50.625	-0.137
S334.007	S54	15 Summer	100	+40%					49.323	-0.114
S334.008	S55	15 Summer	100	+40%	100/15 Summer				46.126	0.136
S334.009	S100	15 Summer	100	+40%	100/15 Summer				45.514	0.252
S334.010	S101	15 Summer	100	+40%	100/15 Summer				44.608	0.566
S334.011	S102	15 Summer	100	+40%	100/15 Summer				43.653	0.394
S335.000	S96	15 Summer	100	+40%	100/15 Summer				45.321	0.842
S335.001	S97	15 Summer	100	+40%	100/15 Summer				44.973	0.869

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.004	S77	0.000	1.47			133.0	SURCHARGED	
S326.005	S80	0.000	1.11			131.6	SURCHARGED	
S327.000	S60	0.000	0.00			0.0	OK	
S326.006	S243	0.000	0.65			75.1	SURCHARGED	
S328.000	S81	0.000	0.88			8.0	SURCHARGED	
S328.001	S251	7.634	0.98			115.9	FLOOD	3
S328.002	S82	0.000	0.88			115.0	FLOOD RISK	
S328.003	S253	44.013	1.70			214.9	FLOOD	5
S328.004	S86	0.000	0.60			214.9	OK	
S328.005	S82	0.000	0.60			214.8	SURCHARGED	
S328.006	S89	0.000	0.25			88.7	SURCHARGED	
S329.000	S66	41.764	0.92			35.7	FLOOD	15
S329.001	S67	16.166	0.68			46.3	FLOOD	8
S329.002	S68	0.310	2.26			81.1	FLOOD	2
S326.007	S244	0.000	0.62			237.5	SURCHARGED	
S326.008	S246	0.000	1.38			197.4	SURCHARGED	
S330.000	S6	21.130	1.20			72.8	FLOOD	5
S330.001	S7	16.524	1.19			169.9	FLOOD	5
S330.002	S121	0.000	1.24			189.8	FLOOD RISK	
S320.005	S71	0.000	0.97			657.9	FLOOD RISK	
S320.006	S71	0.000	0.16	0.0		136.3	FLOOD RISK	
S315.009	S42	0.000	0.94			498.7	SURCHARGED	
S315.010	S48	0.000	6.04			501.8	SURCHARGED	
S314.002	S41	0.000	2.25			551.4	SURCHARGED	
S314.003	S34	0.000	0.45			233.8	SURCHARGED*	
S314.004	S98	0.000	2.56	35.3	516	88.7	FLOOD RISK*	
S331.000	S50	9.719	1.49			26.3	FLOOD	6
S331.001	S51	7.643	1.17			47.8	FLOOD	5
S331.002	S52	0.000	0.82			104.2	OK	
S331.003	S100	0.000	1.01			95.9	SURCHARGED	
S331.004	S53	0.000	1.63			122.2	FLOOD RISK	
S331.005	S106	0.000	1.42	83.7		79.5	FLOOD RISK	
S332.000	S50	0.000	0.69			27.3	OK	
S332.001	S165	0.000	1.40			75.5	SURCHARGED	
S332.002	S166	0.000	1.17			100.9	SURCHARGED	
S331.006	S54	0.000	0.94			170.1	SURCHARGED*	
S331.007	S106	0.000	1.24			219.7	SURCHARGED	
S331.008	S109	0.000	0.11			17.3	SURCHARGED	
S331.009	S110	0.000	0.12			17.7	SURCHARGED	
S331.010	S111	0.000	0.28			22.6	SURCHARGED	
S314.005	S37	0.000	0.24			118.9	FLOOD RISK*	
S314.006	S114	0.000	1.13	0.0		64.5	FLOOD RISK*	
S333.000	S69	19.145	1.65			71.5	FLOOD	5
S333.001	S70	0.000	1.16			91.5	SURCHARGED	
S333.002	S71	0.000	0.94			127.0	SURCHARGED	
S333.003	S72	1.751	1.18			154.2	FLOOD	3
S334.000	S60	0.000	1.25			103.8	FLOOD RISK	
S334.001	S61	0.000	1.05			72.6	SURCHARGED	
S334.002	S62	0.000	1.20			94.4	SURCHARGED	
S334.003	S63	0.000	0.87			116.5	SURCHARGED	
S334.004	S64	0.000	0.93			155.8	FLOOD RISK	
S334.005	S65	0.000	1.31			219.0	FLOOD RISK	
S334.006	S58	0.000	0.72			237.5	OK	
S334.007	S54	0.000	0.80			302.6	OK	
S334.008	S55	0.000	0.95			317.2	SURCHARGED	
S334.009	S100	0.000	0.89			308.9	SURCHARGED	
S334.010	S101	0.000	1.15			304.4	SURCHARGED	
S334.011	S102	0.000	0.64			318.9	SURCHARGED	
S335.000	S96	0.000	1.49			28.0	FLOOD RISK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.001	S97	0.000	1.30			41.7	FLOOD RISK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S335.002	S98	15 Summer	100	+40%	100/15 Summer		100/15 Summer	8	43.196	0.164
S335.003	S99	15 Summer	100	+40%	100/15 Summer		100/15 Summer	11	43.270	0.426
S334.012	S100	15 Summer	100	+40%	100/15 Summer				43.415	0.640
S334.013	S69	15 Summer	100	+40%	100/15 Summer				43.342	0.618
S334.014	S137	15 Summer	100	+40%	100/15 Summer				43.249	0.571
S334.015	S72	15 Summer	100	+40%	100/15 Summer				43.120	0.487
S334.016	S74	1440 Winter	100	+40%	100/15 Summer				43.043	0.478
S333.004	S73	1440 Winter	100	+40%	100/15 Summer				43.043	0.625
S333.005	S114	1440 Winter	100	+40%	100/15 Summer				43.043	1.198
S314.007	S154	1440 Winter	100	+40%	100/15 Summer				43.043	1.537
S314.008	S154	1440 Winter	100	+40%	100/60 Summer			0	42.948	1.736
S314.009	S163	480 Summer	100	+40%					40.736	-0.305
S336.000	S163	15 Summer	100	+40%	100/15 Summer	100/15 Summer			69.157	1.495
S336.001	S219	15 Summer	100	+40%	100/15 Summer				67.163	0.358
S336.002	S220	30 Summer	100	+40%	100/15 Summer				66.352	0.548
S336.003	S221	30 Summer	100	+40%	100/15 Summer				65.635	0.807
S336.004	S64	15 Summer	100	+40%	100/15 Summer	100/15 Summer			65.104	1.506
S336.005	S223	15 Summer	100	+40%	100/15 Summer	100/15 Summer			62.668	1.458
S337.000	S218	15 Summer	100	+40%	100/15 Summer				60.362	0.125
S336.006	S262	15 Summer	100	+40%	100/15 Summer		100/15 Summer	24	60.289	0.255
S336.007	S266	30 Winter	100	+40%	100/15 Summer	100/15 Summer			59.442	1.004
S336.008	S267	30 Winter	100	+40%	100/15 Summer	100/15 Summer			58.572	0.920
S338.000	S143	15 Summer	100	+40%	100/15 Summer				61.951	0.801
S338.001	S144	15 Summer	100	+40%	100/15 Summer	100/15 Summer			61.694	0.967
S338.002	S145	15 Summer	100	+40%	100/15 Summer	100/15 Summer			59.830	1.021
S338.003	S146	15 Summer	100	+40%	100/15 Summer				56.551	0.471
S339.000	S173	15 Summer	100	+40%	100/15 Summer				57.121	1.248
S336.009	S261	15 Summer	100	+40%	100/15 Summer				56.288	0.481
S340.000	S82	15 Summer	100	+40%					59.501	-1.207
S340.001	S183	15 Summer	100	+40%					56.927	-1.207
S336.010	S262	15 Summer	100	+40%	100/15 Summer				55.927	0.181
S341.000	S113	15 Summer	100	+40%					58.429	-0.271
S341.001	S114	15 Summer	100	+40%					54.496	-0.247
S342.000	S299	15 Summer	100	+40%					39.086	-1.207
S342.001	S300	15 Summer	100	+40%					38.550	-0.300
S343.000	S247	15 Summer	100	+40%	100/15 Summer	100/15 Summer			53.633	2.159
S343.001	S80	15 Summer	100	+40%	100/15 Summer				53.106	1.787
S343.002	S81	15 Summer	100	+40%	100/15 Summer				52.695	1.503
S343.003	S82	15 Summer	100	+40%	100/15 Summer				52.490	1.414
S344.000	S88	15 Summer	100	+40%	100/15 Summer	100/15 Summer			61.059	0.890
S344.001	S89	15 Summer	100	+40%	100/15 Summer	100/15 Summer			59.213	0.801
S344.002	S90	15 Summer	100	+40%	100/15 Summer	100/15 Summer			56.620	1.448
S344.003	S264	15 Summer	100	+40%	100/15 Summer				56.150	1.285
S344.004	S59	15 Summer	100	+40%	100/15 Summer				54.435	0.666
S344.005	S60	15 Summer	100	+40%	100/15 Summer	100/15 Summer			53.476	1.027
S344.006	S61	15 Summer	100	+40%	100/15 Summer				52.907	1.002
S344.007	S62	15 Summer	100	+40%	100/15 Summer				52.305	1.538
S343.004	S83	15 Summer	100	+40%	100/15 Summer				51.751	1.626
S343.005	S64	30 Summer	100	+40%	100/15 Summer	100/15 Summer			50.601	1.370
S343.006	S84	1440 Winter	100	+40%	100/15 Summer				49.936	1.252
S343.007	S85	15 Summer	100	+40%					43.861	-0.301
S345.000	S87	15 Summer	100	+40%	100/15 Summer	100/15 Summer			49.973	0.813
S345.001	S88	15 Summer	100	+40%	100/15 Summer	100/15 Summer			47.929	1.022
S345.002	S89	15 Winter	100	+40%	100/15 Summer				45.926	1.052
S345.003	S270	15 Summer	100	+40%	100/15 Summer				44.403	0.693
S343.008	S87	15 Summer	100	+40%					41.902	-0.232
S346.000	S78	15 Summer	100	+40%	100/15 Summer	100/15 Summer			45.230	0.822
S346.001	S79	15 Summer	100	+40%	100/15 Summer	100/15 Summer			44.742	0.958
S346.002	S80	15 Summer	100	+40%	100/15 Summer	100/15 Summer			43.942	0.963
S346.003	S81	15 Summer	100	+40%					42.042	-0.077

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.002	S98	0.000	1.10	67.2		40.0	SURCHARGED	
S335.003	S99	0.000	0.95	51.5		29.8	SURCHARGED	
S334.012	S100	0.000	1.18			367.1	SURCHARGED	
S334.013	S69	0.000	1.54			349.3	SURCHARGED	
S334.014	S137	0.000	1.71			389.1	SURCHARGED	
S334.015	S72	0.000	1.73			460.5	SURCHARGED	
S334.016	S74	0.000	0.12			32.9	SURCHARGED	
S333.004	S73	0.000	0.06			47.3	SURCHARGED	
S333.005	S114	0.000	0.14			47.3	FLOOD RISK	
S314.007	S154	0.000	0.27			104.9	FLOOD RISK	
S314.008	S154	0.000	0.12	0.0		29.2	SURCHARGED*	
S314.009	S163	0.000	0.04			29.2	OK	
S336.000	S163	2.601	1.56			22.3	FLOOD	3
S336.001	S219	0.000	0.91			18.7	SURCHARGED	
S336.002	S220	0.000	0.95			21.7	SURCHARGED	
S336.003	S221	0.000	0.78			22.1	SURCHARGED	
S336.004	S64	1.122	1.02			29.4	FLOOD	4
S336.005	S223	6.453	1.49			40.9	FLOOD	6
S337.000	S218	0.000	0.48			22.7	SURCHARGED	
S336.006	S262	0.000	0.74	87.6		57.9	SURCHARGED	
S336.007	S266	73.073	1.06			70.6	FLOOD	14
S336.008	S267	45.271	1.24			83.6	FLOOD	14
S338.000	S143	0.000	0.78			17.3	FLOOD RISK	
S338.001	S144	7.416	1.01			29.6	FLOOD	5
S338.002	S145	10.104	1.16			43.3	FLOOD	7
S338.003	S146	0.000	1.06			139.0	SURCHARGED	
S339.000	S173	0.000	2.50			174.4	SURCHARGED	
S336.009	S261	0.000	1.99			364.1	SURCHARGED	
S340.000	S82	0.000	0.00			0.0	OK	
S340.001	S183	0.000	0.00			0.0	OK	
S336.010	S262	0.000	2.26			363.0	SURCHARGED*	
S341.000	S113	0.000	0.02			5.0	OK	
S341.001	S114	0.000	0.07			17.2	OK	
S342.000	S299	0.000	0.00			0.0	OK	
S342.001	S300	0.000	0.00			0.0	OK*	
S343.000	S247	0.175	2.57			41.6	FLOOD	1
S343.001	S80	0.000	1.90			29.5	FLOOD RISK	
S343.002	S81	0.000	1.31			52.8	FLOOD RISK	
S343.003	S82	0.000	1.12			86.1	FLOOD RISK	
S344.000	S88	2.337	1.10			81.1	FLOOD	2
S344.001	S89	1.775	0.91			101.9	FLOOD	2
S344.002	S90	15.121	1.50			114.0	FLOOD	5
S344.003	S264	0.000	1.35			111.9	SURCHARGED	
S344.004	S59	0.000	0.85			149.1	SURCHARGED	
S344.005	S60	12.317	1.25			189.8	FLOOD	5
S344.006	S61	0.000	1.27			192.7	FLOOD RISK	
S344.007	S62	0.000	2.02			193.7	SURCHARGED	
S343.004	S83	0.000	2.44			270.7	SURCHARGED	
S343.005	S64	31.644	2.59			191.4	FLOOD	7
S343.006	S84	0.000	0.01			3.3	SURCHARGED	
S343.007	S85	0.000	0.09			24.2	OK	
S345.000	S87	3.976	1.00			52.4	FLOOD	2
S345.001	S88	2.803	1.09			55.8	FLOOD	3
S345.002	S89	0.000	1.15			51.2	FLOOD RISK	
S345.003	S270	0.000	1.20			50.9	SURCHARGED	
S343.008	S87	0.000	0.31			71.0	OK	
S346.000	S78	0.285	1.08			25.9	FLOOD	1
S346.001	S79	1.302	1.00			31.6	FLOOD	3
S346.002	S80	4.750	1.46			43.3	FLOOD	5

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S346.003	S81	0.000	0.77			43.3	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S343.009	S106	1440 Summer	100	+40%	100/30 Summer				41.726
S343.010	S79	360 Summer	100	+40%					40.416
S343.011	S300	360 Summer	100	+40%					38.826
S342.002	S245	360 Summer	100	+40%					37.975
S347.000	S251	15 Summer	100	+40%	100/15 Summer				64.091
S347.001	S252	15 Summer	100	+40%	100/15 Summer				64.080
S347.002	S253	15 Summer	100	+40%	100/15 Summer				63.816
S347.003	S251	15 Summer	100	+40%	100/15 Summer				63.264
S347.004	S71	15 Summer	100	+40%	100/15 Summer				62.509
S347.005	S252	15 Summer	100	+40%	100/15 Summer				61.393
S347.006	S73	15 Summer	100	+40%	100/15 Summer				59.479
S347.007	S200	15 Summer	100	+40%	100/15 Summer				59.027
S347.008	S254	15 Summer	100	+40%	100/15 Summer				58.032
S347.009	S202	15 Summer	100	+40%	100/15 Summer				56.467
S347.010	S198	15 Summer	100	+40%	100/15 Summer				55.887
S347.011	S306	15 Summer	100	+40%	100/15 Summer	100/15 Summer			55.114
S348.000	S277	15 Summer	100	+40%	100/15 Summer				64.549
S348.001	S278	15 Summer	100	+40%	100/15 Summer				64.527
S348.002	S279	15 Summer	100	+40%	100/15 Summer				64.189
S349.000	S280	15 Summer	100	+40%	100/15 Summer				64.106
S348.003	S280	15 Summer	100	+40%	100/15 Summer				64.030
S348.004	S281	15 Summer	100	+40%	100/15 Summer				63.943
S348.005	S282	15 Summer	100	+40%	100/15 Summer	100/15 Summer			63.676
S348.006	S283	15 Summer	100	+40%	100/15 Summer				63.327
S348.007	S284	15 Summer	100	+40%	100/15 Summer	100/15 Summer			62.946
S348.008	S285	15 Summer	100	+40%	100/15 Summer				62.562
S348.009	S286	15 Summer	100	+40%	100/15 Summer				62.025
S348.010	S216	15 Summer	100	+40%	100/15 Summer	100/15 Summer			61.822
S348.011	S103	15 Summer	100	+40%	100/15 Summer				58.635
S348.012	S218	15 Summer	100	+40%	100/15 Summer				55.684
S347.012	S305	15 Summer	100	+40%	100/15 Summer				55.006
S350.000	S220	15 Summer	100	+40%					59.793
S351.000	SSU4931_9196a	15 Summer	100	+40%					51.243
S351.001	S226	15 Summer	100	+40%					51.124
S352.000	SSMP East Start	15 Summer	100	+40%	100/15 Summer	100/15 Summer			68.482
S352.001	S187	15 Summer	100	+40%	100/15 Summer	100/15 Summer			67.997
S352.002	S188	15 Summer	100	+40%	100/15 Summer	100/15 Summer			66.318
S352.003	SSMP SBK3	15 Summer	100	+40%					62.394
S352.004	S261	15 Summer	100	+40%	100/15 Summer	100/15 Summer	100/15 Summer	24	61.457
S353.000	S261	15 Summer	100	+40%					67.200
S353.001	S262	15 Summer	100	+40%					64.208
S353.002	S262	15 Summer	100	+40%					60.988
S352.005	S303	15 Summer	100	+40%					57.498
S354.000	S265	15 Summer	100	+40%	100/15 Summer	100/15 Summer			67.974
S354.001	S266	15 Winter	100	+40%	100/15 Summer	100/15 Summer			67.506
S354.002	S267	15 Summer	100	+40%	100/15 Summer	100/15 Summer			65.148
S354.003	S309	15 Summer	100	+40%					58.505
S352.006	S304	15 Summer	100	+40%					54.479
S355.000	S255	15 Summer	100	+40%					73.500
S355.001	S256	15 Summer	100	+40%					64.300

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S343.009	S106	0.513	0.000	0.02			1.9	SURCHARGED	
S343.010	S79	-0.201	0.000	0.03			1.9	OK	
S343.011	S300	-0.415	0.000	0.02			1.9	OK	
S342.002	S245	-0.514	0.000	0.00			1.9	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S347.000	S251	0.546	0.000	0.71			6.3	FLOOD RISK	
S347.001	S252	0.846	0.000	1.36			10.3	FLOOD RISK	
S347.002	S253	0.828	0.000	1.43			11.4	SURCHARGED	
S347.003	S251	0.728	0.000	0.95			30.2	SURCHARGED	
S347.004	S71	0.977	0.000	0.92			35.2	SURCHARGED	
S347.005	S252	1.326	0.000	1.22			47.2	SURCHARGED	
S347.006	S73	0.922	0.000	0.68			63.7	SURCHARGED	
S347.007	S200	1.579	0.000	1.17			79.9	SURCHARGED	
S347.008	S254	1.388	0.000	1.75			151.4	SURCHARGED	
S347.009	S202	0.408	0.000	0.87			128.1	SURCHARGED	
S347.010	S198	0.672	0.000	1.05			126.8	SURCHARGED	
S347.011	S306	0.606	9.924	1.35			150.8	FLOOD	4
S348.000	S277	0.649	0.000	0.69			15.6	FLOOD RISK	
S348.001	S278	1.025	0.000	1.28			22.6	FLOOD RISK	
S348.002	S279	0.999	0.000	1.23			21.3	SURCHARGED	
S349.000	S280	0.635	0.000	1.15			29.2	FLOOD RISK	
S348.003	S280	0.969	0.000	1.00			35.2	FLOOD RISK	
S348.004	S281	0.998	0.000	1.47			53.2	FLOOD RISK	
S348.005	S282	0.847	0.450	1.18			62.5	FLOOD	1
S348.006	S283	0.748	0.000	1.06			67.9	FLOOD RISK	
S348.007	S284	0.726	1.188	1.32			86.4	FLOOD	2
S348.008	S285	0.723	0.000	1.13			97.0	FLOOD RISK	
S348.009	S286	0.828	0.000	1.53			111.3	FLOOD RISK	
S348.010	S216	0.722	1.894	1.04			169.6	FLOOD	2
S348.011	S103	0.573	0.000	0.98			208.7	FLOOD RISK	
S348.012	S218	0.667	0.000	1.03			208.8	SURCHARGED	
S347.012	S305	0.631	0.000	4.06			316.3	FLOOD RISK	
S350.000	S220	-0.122	0.000	0.43			87.6	OK	
S351.000	SSU4931_9196a	-0.375	0.000	0.00			0.0	OK	
S351.001	S226	-0.450	0.000	0.00			0.0	OK	
S352.000	SSMP East Start	0.757	9.387	0.97			64.3	FLOOD	4
S352.001	S187	1.449	15.199	0.94			124.3	FLOOD	5
S352.002	S188	1.658	25.652	1.32			185.5	FLOOD	5
S352.003	SSMP SBK3	-0.320	0.000	0.43			327.2	OK	
S352.004	S261	0.882	2.168	0.69	279.3		29.6	FLOOD	3
S353.000	S261	-0.150	0.000	0.00			0.0	OK	
S353.001	S262	-0.150	0.000	0.00			0.0	OK	
S353.002	S262	-0.150	0.000	0.00			0.0	OK	
S352.005	S303	-0.077	0.000	0.48			29.6	OK	
S354.000	S265	0.349	16.538	0.82			45.4	FLOOD	6
S354.001	S266	1.219	26.961	1.19			82.2	FLOOD	7
S354.002	S267	1.739	5.369	1.18			116.4	FLOOD	4
S354.003	S309	-1.168	0.000	0.01			185.3	OK	
S352.006	S304	-1.105	0.000	0.03			213.5	OK	
S355.000	S255	-0.543	0.000	0.00			0.0	OK	
S355.001	S256	-0.300	0.000	0.00			0.0	OK*	

QVA Consulting		Page 1
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 18:24 File 2021 10 13 FEH M100 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Between A33_34 to Itchen

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 449550 130900 SU 49550 30900
C (1km)	-0.027
D1 (1km)	0.417
D2 (1km)	0.301
D3 (1km)	0.398
E (1km)	0.305
F (1km)	2.304
Maximum Rainfall (mm/hr)	500
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.750
Maximum Backdrop Height (m)	2.500
Min Design Depth for Optimisation (m)	0.900
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Between A33_34 to Itchen

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S213.004	8.654	0.054	161.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S213.005	9.182	0.272	33.8	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S213.004	51.21	3.65	38.679	0.307	0.0	0.0	0.0	1.24	87.4	57.9
S213.005	50.76	3.71	38.563	0.481	0.0	0.0	0.0	2.72	191.9	88.2

Free Flowing Outfall Details for Between A33_34 to Itchen

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S213.005	SItchen (btwn brdgs)	38.683	38.291	39.000	0	0

Online Controls for Between A33_34 to Itchen

Hydro-Brake® Optimum Manhole: S79, DS/PN: S213.005, Volume (m³): 4.0

Unit Reference	MD-SHE-0101-6000-2000-6000
Design Head (m)	2.000
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	38.563
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	6.0	Kick-Flo®	0.900	4.1
Flush-Flo™	0.438	5.2	Mean Flow over Head Range	-	4.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	1.200	4.7	3.000	7.3	7.000	10.8
0.200	4.7	1.400	5.1	3.500	7.8	7.500	11.2
0.300	5.1	1.600	5.4	4.000	8.3	8.000	11.5
0.400	5.2	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.2	2.000	6.0	5.000	9.2	9.000	12.2
0.600	5.1	2.200	6.3	5.500	9.7	9.500	12.5
0.800	4.7	2.400	6.5	6.000	10.1		
1.000	4.3	2.600	6.8	6.500	10.5		

QVA Consulting		Page 4
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 18:24 File 2021 10 13 FEH M100 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S213.004	S78	480 Winter	100	+40%	100/15 Summer				40.877
S213.005	S79	480 Winter	100	+40%	100/15 Summer				40.885

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S213.004	S78	1.898	0.000	0.10			6.3	SURCHARGED	
S213.005	S79	2.022	0.000	0.05			6.4	FLOOD RISK	

Online Controls for M3 SB to Basin 5

Depth/Flow Relationship Manhole: S103, DS/PN: S100.002, Volume (m^3): 222.3

Invert Level (m) 49.800

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

Storage Structures for M3 SB to Basin 5

Infiltration Basin Manhole: S103, DS/PN: S100.002

Invert Level (m) 49.800 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00360 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00360

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.900	791.0	1.800	2320.0	2.700	4062.0
0.100	3.0	1.000	994.0	1.900	2507.0	2.800	4270.0
0.200	32.0	1.100	1104.0	2.000	2692.0	2.900	4481.0
0.300	90.0	1.200	1270.0	2.100	2878.0	3.000	4695.0
0.400	176.0	1.300	1439.0	2.200	3067.0	3.100	4910.0
0.500	281.0	1.400	1609.0	2.300	3258.0	3.200	5130.0
0.600	392.0	1.500	1781.0	2.400	3452.0	3.300	5354.0
0.700	515.0	1.600	1954.0	2.500	3652.0	3.400	5583.0
0.800	647.0	1.700	2130.0	2.600	3856.0		

QVA Consulting		Page 3
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 22/10/2021 18:22 File 2021 10 13 FEH M100 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S100.002	S103	10080 Summer	100	+40%	100/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S100.002	S103	52.180	2.080	0.000	0.00		7259	0.0	SURCHARGED*

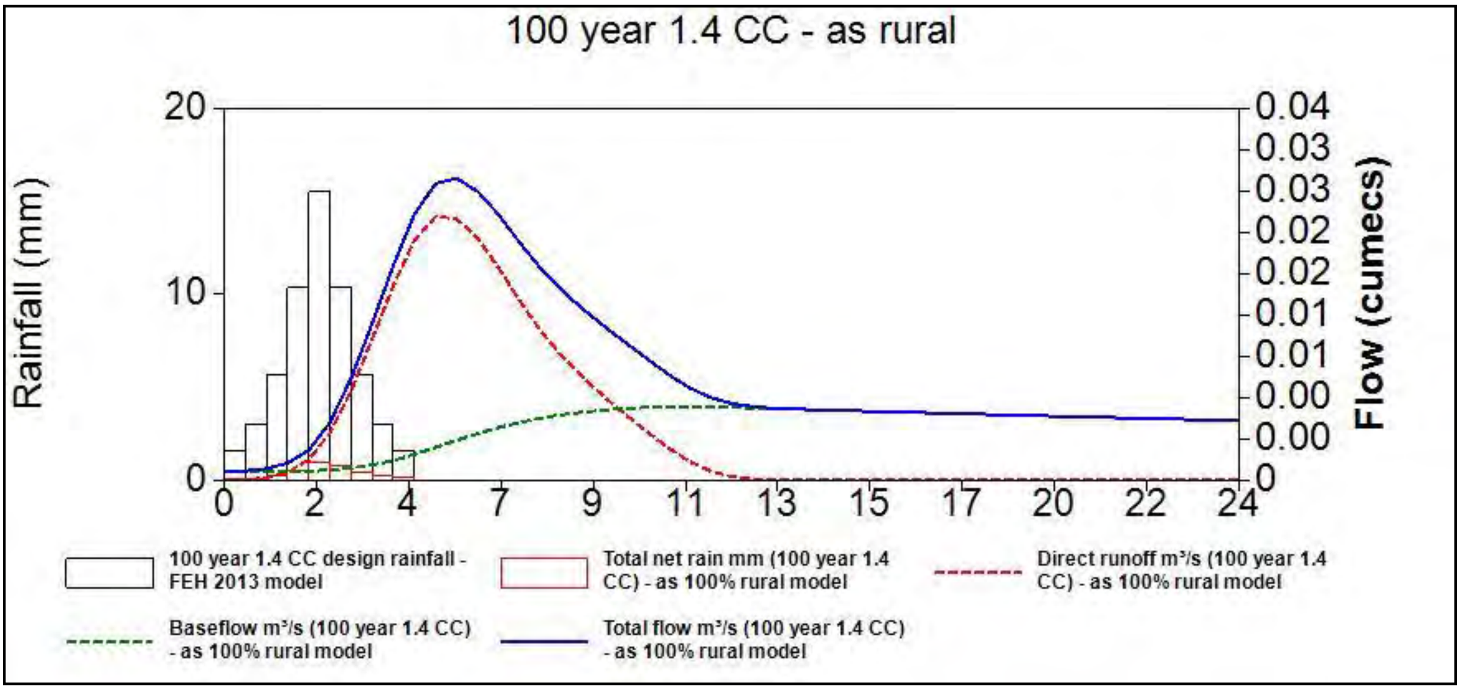
Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Level Exceeded
S100.002	S103	

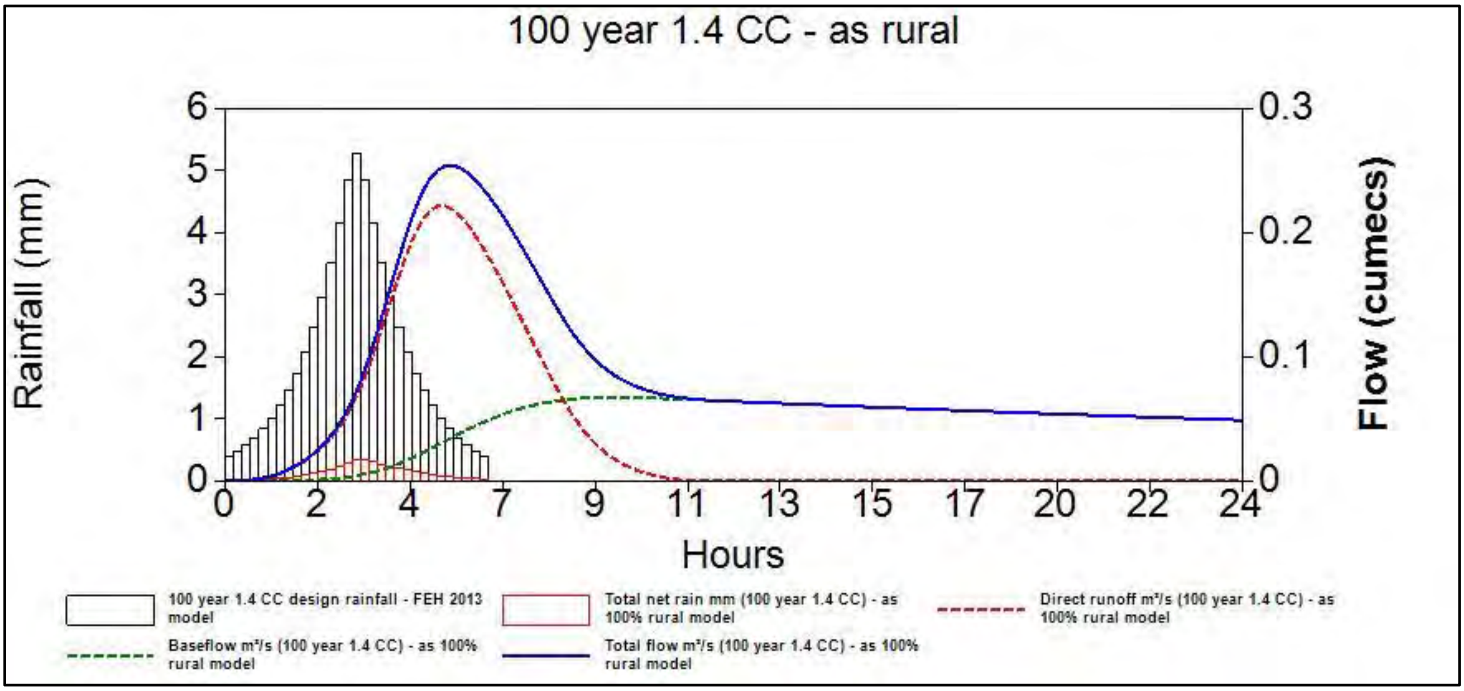
Appendix H Overland Catchment Calculations

Overland Catchment Calculations (ReFH2)

Overland Catchment W (rural flows to Basin 6):



Overland Catchment X (rural flows to Basin 5):



Appendix I Technical Note: *Proposed M3J9 Runoff Pollution Assessment Method and Control Measures.*

HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003 Pollution Prevention

TECHNICAL NOTE

Job Name: M3 Junction 9 Improvement Scheme

Job No: 48176/2000

Note No: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003

Date: March 2021 (updated May 2022)

Revision: P02

Prepared By: P. Rogers / A. Champion

Checked by: T. Allen

Subject: **Proposed M3J9 Runoff Pollution Assessment Method and Control Measures.**

Contents

1. Executive Summary 2
2. Introduction 2
3. Project Overview 3
4. Methodologies 4
5. Baseline Drainage 7
6. Proposed Drainage 9
7. Proposed Mitigation Measures 10
8. Maintenance Schedule 13
9. References 18

Figures

Figure 4.2 – Composition of Polymers in Ponds 6
Figure 4.2a – Distribution of Polymers in Ponds 6
Figure 5 – Existing M3 soakage feature 9
Figure 7.3 - Pollutant Removal Rates (Table 3.3 -EA Guidance Manual for Constructed Wetlands R&D Technical Report P2-159/2003) 12

Tables

Table 3 – Existing and Proposed Carriageway Areas Summary 3
Table 4 – Assessment Methodologies 4
Table 7.6 – Microplastics: Risks and Mitigation 13
Table 8 – Proposed Sediment Removal Regine 14
Table 8.1 – Maintenance Schedule 18
Table 9 – Full List of References and Citations 19

Appendices

Appendix A Geotechnical Logs
Appendix B HEWRAT baseline results for existing M3 drainage
Appendix C HEWRAT Proposed Drainage Results - Summary Table and Individual Basin results
Appendix D Proposed M3J9 Drainage Schematic Plan
Appendix E Hydrogeological Risk Assessment (HgRA)

1. Executive Summary

The control of pollution within the M3 Junction 9 Improvement Scheme (M3J9), includes runoff volume from a portion of the proposed M3 Junction 9 to 14 Safety Barrier Improvement Scheme immediately to the south, which drains into M3J9. This document does not address pollution control within the M3 Junction 9 – 14 Safety Barrier Improvement Schemes drainage which lies outside the M3J9 works area.

The M3J9 Improvement Scheme substantially reduces the existing discharge of M3J9 highway runoff to groundwater, and replaces it with a combination of either discharge to groundwater and discharge to the River Itchen, following treatment, attenuation and detention.

Soluble contaminants, Total Suspended Solids and Spillage pollution risks have been assessed using the HEWRAT v2.0.4 tool. Mitigation measures are included in the assessment.

A Hydrogeological Risk Assessment (HgRA) has been undertaken to supplement the HEWRAT screening assessment. In this Technical Note, a brief summary of the HgRA conclusions has been provided.

A literature review of current research into Microplastics pollution of stormwater has been undertaken.

Insoluble Microplastics have been assessed and mitigated as portion of the Total Suspended Solids pollution category. Also, a qualitative Source-Pathway-Receptor methodology of risk assessment has been applied to Microplastics. Mitigation measures are included in the assessment.

Standards of compliance for the mitigation for Microplastics have been proposed, or it has been indicated where further consultation is required with regulatory bodies.

Assessments of pollution risk for the baseline (existing) and the proposed stormwater drainage conditions have been undertaken, which indicate that a beneficial effect is provided by the proposed M3J9 drainage networks.

The maintenance of SUDS Mitigation Measures is indicated in a Maintenance Schedule.

2. Introduction

This document sets out the methodology and results of the assessment and mitigation of pollution within highway runoff from the M39 Improvement Scheme.

The categories of pollution considered in this document are:

1. Copper, Zinc, Cadmium, Total Polyaromatic Hydrocarbons (PAH), Pyrene, Fluoranthene, AntHgRAcene, Phenanthrene, which are the suite of contaminants in the Highway England Water Risk Assessment Tool v. 2.0.4 (HEWRAT.

2. Total Suspended Solids (TSS)

3. HGV-load spillage (unspecified liquids)

4. Microplastics (MPs)

This Technical Note should be read in conjunction with the M3J9 Improvement Scheme Stage 3 – Drainage Strategy Report (DSR) and highway drainage drawings, prepared by Stantec.

Refer to Section 9 for a full list of citation references and abbreviations.

3. Project Overview

The M3J9 scheme runs north-south, and lies immediately to the east of Winchester, centred in the Winnall area and extending north to Headbourne Worthy.

Abutting the west of the scheme are commercial and light industrial land uses associated with the Wykeham Trade Park and Winnall Industrial Estate, which fall away from the M3J9 towards the River Itchen.

Land rises to the east of the M3J9 and comprises entirely arable land or woodland, with a low density of minor agricultural settlements. 206 hectares (ha) of arable land draining overland to the west is intercepted by the M3J9 earthworks. 192 ha of the intercepted flow drains to ground on the eastern side of the M3J9 scheme. 14 ha of overland flow passes under the M3J9 earthworks in an existing 300mm dia culvert.

Proposed modifications to M3J9 comprise the introduction of new on/off slip-roads to both northbound and southbound sides of the M3, new link roads between A33/A34/A272 and M3 roads and a new overhead gyratory above the M3 corridor. Junction 9 is located in a low spot of the M3, towards which a total of approximately 2km of the existing M3 corridor drains.

A separate Safety Barrier Improvement Scheme is currently being constructed immediately to the south of M3J9. The Improvement Scheme to the mainline M3 will extend into the M3J9 Improvement scheme works boundary.

A summary of retained, removed and proposed carriageway areas is given in Table 3

Retained (overlaid) Carriageway (ha)	Abandoned Carriageway (ha)	New (additional) Carriageway (ha)	Proposed Carriageway to River Itchen (ha)	Proposed carriageway to soakaways (ha)	Area of Cutting draining to carriageway drainage (ha)
12.3 *1,2	**1.1**	**9.1** *1,2	**14.3** *1,2	**7.1** *3	**10.5** *1

*1 (includes the M3 Junction 9 to 14 Safety Barrier Improvement Scheme which contributes inflows to M3J9)

*2 (includes new A33/A34 verge modifications north of River Itchen)

*3 (includes existing M3 Junction 9 to 14 Safety Barrier Improvement Scheme & A272 areas to retained soakaway trenches)

Table 3 – Existing and Proposed Carriageway Areas Summary

3.1. M3 Junction 9 – 14 Safety Barrier Improvement Scheme Implications

Safety barrier improvements to the M3 are under construction to the south of M3J9 between Junctions 9 to 14. The proposed improvements comprise hardening of the central reserve, installation of a new concrete safety barrier and improvements to the existing highway drainage to account for the increase in hard surfaces. Approximately 2.9ha of the Safety Barrier Improvement Scheme enhancements drain into the M3J9 project area, resulting in an overall drained area of 16.3ha passing through the main M3J9 drainage network to the River Itchen. Carriageway areas in Table 3, and in the HEWRAT assessments in this Technical Note, include the additional Safety Barrier Improvement Schemes drained area.

4. Methodologies

The methods of assessment of risk to groundwater and to watercourses, from the 4no. pollution categories above, are indicated in Table 2 below.

(Note: Refer to Table 9 for full list of references and citation abbreviations).

Pollutant Type	Nature of impact	Assessment Method	Primary Reference(s)	Citation Ref.
1. HEWRAT suite of pollutants	Acute impact - Soluble pollutants	HEWRAT v2.0.4 + Supplementary HGRA	Defined in LA 113 Road drainage and the water environment (DMRB)	LA113
2. Total Suspended Solids (TSS)	Chronic impact - sediment	HEWRAT v2.0.4 + Supplementary HGRA		
3. HGV-load Spillage	Acute Impact (rare single event)	HEWRAT v2.0.4		
4. Microplastics (MP)	Acute impacts – soluble pollutants	Review of current research + apply a qualitative source-pathway-receptor (S-P-R) assessment.	DEFRA Report 14784 - *Investigating the sources and pathways of synthetic fibre and vehicle tyre wear contamination into the marine environment*	DEFRA
			National Highways Task 1-902 Final project Report (2020) *Investigation of 'microplastics' from brake and tyre wear in road runoff*	MPBTW 2020
	Chronic Impact - sediments		*Microplastics in urban and highway stormwater retention ponds* - Science of the Total Environment 671 (2019) 992–1000	TE 2019
			Retention of microplastics in sediments of urban and highway stormwater retention ponds - Environmental Pollution 255 (2019) 113335	EP 2019
			Microplastics in a Stormwater Pond - Water 2019, 11, 1466; doi:10.3390/w11071466 (Water 2019)	Water 2019

Table 4 – Assessment Methodologies

4.1. Hydrogeological Risk Assessment

In order to provide a more detailed assessment of hazards to controlled waters, where the HEWRAT screening identifies elevated levels of risk, a separate Hydrogeological Risk Assessment (HgRA) has been undertaken of the proposed highway drainage only. Please refer to Stantec document 330610074R1 M3 Junction 9 DQRA, included in Appendix E of this document. A summary of the HgRA is as follows:

The HgRA has followed the Environment Agency's Remedial Targets Methodology (RTM). A Level 2 assessment has being undertaken, which considers attenuation processes within the unsaturated zone and dilution within the saturated zone. The input to the RTM is source concentrations for acute and chronic risk is based on HEWRAT Step 2 output (i.e. representative concentrations within the Extended Drainage Basins). Outputs from the RTM model are predicted concentrations at the identified receptors. A sensitivity analysis is provided to demonstrate the effect of uncertain parameters on the assessment. The objective of the RTM assessment is to assess the degree of risk posed to groundwater from the EDBs, which are installed over superficial deposits or directly over chalk and have a variety of unsaturated zone thicknesses.

Where the HEWRAT screening indicates a High Risk to groundwater, it is proposed that the EDB will be lined, thus preventing discharge to groundwater. On this basis the HgRA has been undertaken to further assess the risk from the un-lined EDBs. The conclusions of the HgRA are as follows:

- Acute risk from soluble contaminants present in the EDBs has been assessed as low. The contaminant concentrations in the EDBs, as derived from the HEWRAT assessment are below the UK DWS and thus pose no significant risk to groundwater.
- The models demonstrate that none of the EDBs are likely to result in an impact on groundwater from determinands present within the sediment lining the base of the EDBs (chronic risk).
- For the hazardous PAH compounds, the aqueous source term concentration leached from the EDB sediments is limited by the determinand pure phase solubility and the fact that these determinands are highly sorbed onto the sediment matrix. Thus, concentrations leaching from the sediment are modest. The HgRA model shows that there is likely to be a sufficient thickness of unsaturated zone, comprising material with sufficient organic carbon content to provide sufficient attenuation and ensure that there is no discharge of PAH compounds to the water table.
- Copper and cadmium also sorb highly to the EDB sediment such that aqueous concentrations in the EDBs are unlikely to reach concentrations that would cause pollution of groundwater. Predicted aqueous source term zinc concentrations are higher, but attenuation within the unsaturated zone, combined with dilution in the receiving groundwater is sufficient to ensure there is no pollution by this determinand.
- Once the following data from site-investigation works are available, the HgRA should be reviewed and updated based on the complete dataset.
    - Time series data on the depth of the water table, to provide more confidence on the unsaturated zone thickness at each of these structures.
    - Infiltration tests at the proposed EDB locations, which will inform the unsaturated zone hydraulic conductivity.
    - testing for organic carbon fraction, which will refine the DQRA model and inform predictions of the risk to groundwater from the Scheme's drainage design.

4.2. Microplastics (Research Overview)

Pollutant category 4 (Microplastics) is not yet considered in National Highways (HE) or other Statutory Authority assessment tools or legislation, but is currently recognised within research as a potential hazard for consideration in relation to highway schemes. An overview of relevant findings from research into MPs is given below.

Microplastics (MPs) is a category of pollutant within Total Suspended Solids and is defined as synthetic plastic particles of size < 5mm. These particles fall into two broad categories of synthetic fibres (various polymers) and tyre particles; wear or crumb. The sources of MPs and the range of MP sizes and mass in the environment is extremely diverse (Water 2019) and it is not considered practical to consider source as an area for assessment or mitigation in this Technical Note. However, it is being found in some research that there is a correlation between catchment land-use and MP loading in sediments. Industrial and commercial land uses, for instance, which abut the western M3J9 boundary, tend to produce pond sediments in which smaller and lighter MPs prevail. MPs in ponds serving residential catchments tend to be the heaviest and largest. Highway catchments tend to result in pond sediments in the mid-rage of size and mass. (TE 2019).

National Highways have undertaken the early stage of an ongoing research project into Microplastics from brake and tyre wear in road runoff (MPBTW 2020). A key outcome of this first stage is that HE conclude that current methods of assessment (LA113) and mitigation (CG 501) are not proposed to be changed at present (MPBTW 2020).

Figure 4.1 indicates the typical composition of MPs by polymer-type within sediments, water and fauna in stormwater ponds (Water 2019).

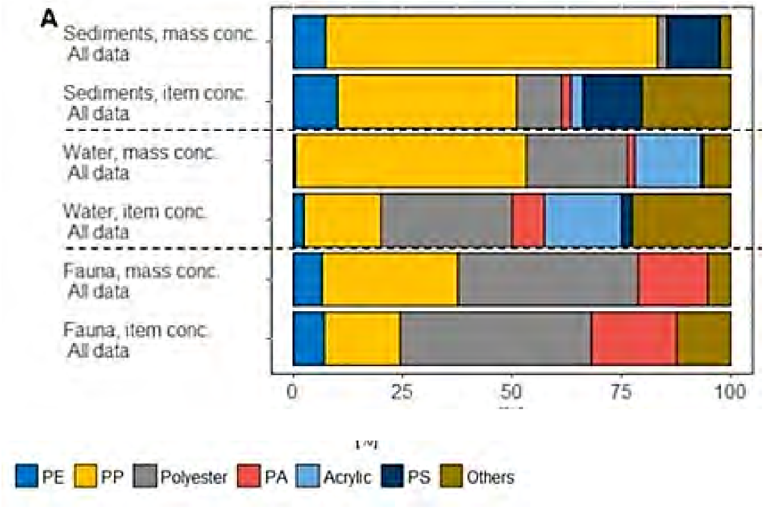


Figure 4.2 – Composition of Polymers in Ponds

Figure 4.2 indicates the distribution of MPs by mass and dimension in the sediments, water and fauna of stormwater ponds (Water 2019).

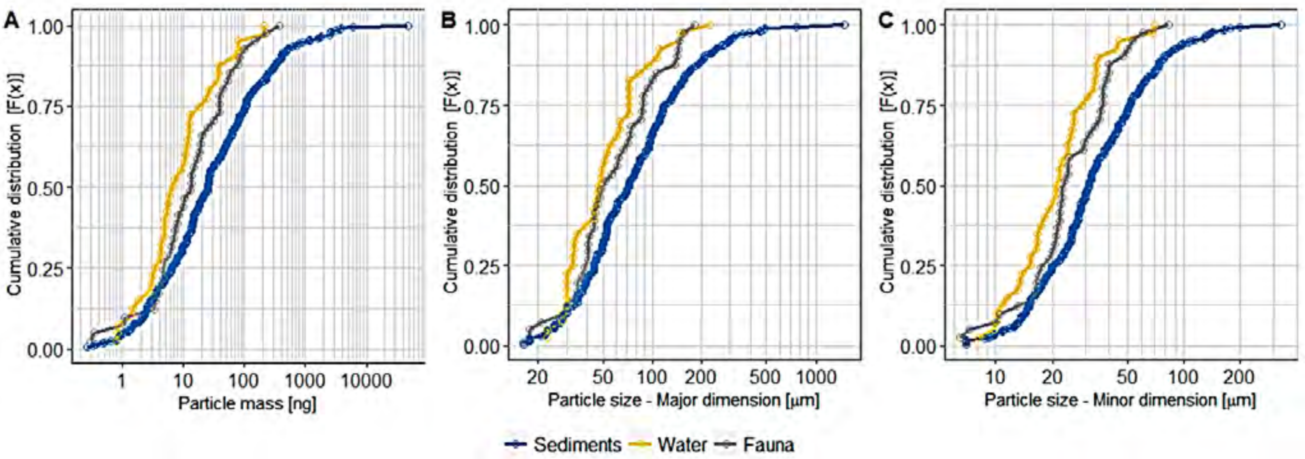


Figure 4.2a – Distribution of Polymers in Ponds

Generally, there is a close correlation between particle size and location in the water environment. Larger or heavier MP particles tend to be prevalent in sediments, at typical concentration of 0.4g/kg. The lightest and smallest MP particles tend to be prevalent in suspension (typically at concentrations of 4 mg/l). MP particles taken up by fauna, tend to be of mid-range mass and size and are typically present in fauna at concentrations similar to those in sediments (Water 2019).

Tyre particles, or crumb, typically exhibit a particle size distribution that is similar to coarse sand, but not as coarse as gravel.

Road runoff is identified as a significant pathway for tyre particles and ponds are shown to be sinks for MPs, by trapping MPs in sediments (EP 2019, Water 2019). Settlement rates for MPs have been shown to be similar to other particulates in settlement and detention ponds, with up to 85% of MPs removed from flows.

Sediments containing MPs need to be disposed of appropriately to avoid recirculation of settled MPs back into soil or water environments.

4.3. Microplastics Assessment Rationale

In light of the overview of current research findings, above, it is not currently possible to quantitatively assess the impact of MPs or design quantitative mitigation. It is therefore proposed to apply mitigation measures that research indicates are most effective at intercepting or ameliorating the source-pathway-receptor (S-P-R) linkages in the pollutant risk assessment of MPs as far as is practical within the M3J9 scheme,

MPs, which include tyre particles, are shown to be treatable as a fraction of the TSS load in stormwater flows. The mitigating mechanisms that are indicated as most effective are:

- Settlement and Filtration, followed by removal of MP-loaded sediments to a licenced waste facility

Separation of the tyre crumb component of MPs from the water flow is considered important, to minimise leaching of additives from tyre crumb into solution. It is not as important to separate other polymer MPs from the water environment, where leaching of volatile constituents is much reduced. Notably, tyre particles tend to be the larger particles in the particle size distribution within the MP load and so mechanical screening or vertical filtration within filter media will be an effective primary treatment that captures the coarser tyre crumb and removes it from the wet environment.

Further mitigation mechanisms proposed to capture smaller particle sizes in the MP load are:

- Detention and Biofiltration of flow that may be carrying finer MPs in suspension for extended periods, to maximise capture in sediments.

5. Baseline Drainage

The large majority of the existing M3/A33/A34/A272 interchange road surfaces (7.7ha out of 8.8ha) drains to existing soakage features, comprising linear soakaway trenches or ditches and single soakaway pits, which were constructed typically in the 1970s and 1980s.

There are no stand-alone pollution or attenuation mitigation measures built into the existing M3J9 highway drainage infrastructure in addition to the highway edge drainage, which is largely soakaway or edge-of-carriageway filter trenches leading to soakaway structures. There is one spillage containment structure (comprising a 25m long ditch, a penstock and an oil interceptor) that exists at the outfall from the A34 southbound carriageway drainage into the River Itchen.

The greatest concentration of drained area to a single soakage feature (4.1 ha), is the M3 mainline corridor, which drains to a single existing soakaway ditch running parallel to the M3, which lies to the north of the National Highways depot and west of the M3 (Figure 5). This is the most critical case location for the concentration of contaminated highway runoff within the existing scheme, in terms of traffic volume and drainage ratio (drained area/infiltration area).

It is apparent that the size and volume of the existing soakaway ditch (225m x 2.0m wide x 0.55m deep) could not by justified using current flood management design standards; it is undersized to contain the 100-year + 40% climate change within the highway boundary. It is likely that existing highway runoff to the soakaway ditch would overflow onto arable land downslope of the ditch, which lies outside the highway boundary (figure 5). The location of the existing soakaway trench coincides with chalk bedrock close to existing ground levels (ref. geotechnical logs DS114/TP11, Appendix A), and so it is likely that the existing soakaway trench is founded into fissured/fractured geology.

The A33/A34 carriageway north of the River Itchen (3.3ha) discharges runoff to the River Itchen via a series of existing drainage ditches.

The northernmost section of M3 mainline being upgraded within the M3J9 scheme, comprises 1.8ha of resurfaced carriageway that will continue to discharge to the River Itchen or local tributaries, via existing highway drainage.

5.1. Assessment of baseline risk to groundwater from existing drainage

In order to establish the baseline pollution risk to groundwater from runoff and HGV-load spillage, via the existing M3 drainage infiltration drainage, a HEWRAT screening assessment has been undertaken (Appendix B) for the existing critical-case soakage ditch in Figure 5.

The HEWRAT groundwater screening results (Appendix B) indicate that:

- the existing soakaway ditch risk to groundwater is in the high end of the Medium category, bordering the High category (scoring 245 out of 250).
- The existing return period probability for a spillage incident on the existing M3 corridor is 1 in 297 years, which would pass the 1 in 200 year return period risk expected by the Environment Agency in the context of the adjacent River Itchen SAC (Special Area of Conservation).

5.2. Assessment of run-off flow within geology from existing drainage

It is recognised that there is a possibility that karstic (solution) features may be present within the solid chalk geology, such as ‘pipes’ or swallow-holes, which may convey surface runoff to groundwater without major filtration or dissipation. The presence of Karstic features within the solid chalk geology at the infiltration surfaces of existing filter trenches and soakaways can not be ascertained without excavation and inspection. Until such inspection can be undertaken, the assessment of existing, baseline risk to groundwater assumes that no karstic features are present.

However, the assessment of proposed risk to groundwater does take account of the possible occurrence of karstic features beneath proposed infiltration surfaces by assuming that ponds are impermeably lined where solid geology underlies infiltration features, which serve traffic volumes that are sufficiently large to pose a significant source of pollution (refer to Appendix C – Proposed HEWRAT screening results).

5.3. Assessment of baseline risk to watercourse flow from existing drainage.

In order to establish the baseline pollution risk to the River Itchen from existing runoff, a HEWRAT assessment has been undertaken for the existing discharge point; an outfall adjacent to the A34/A33 road bridges.

The Existing HEWRAT screening results (Appendix B) indicate that:

- the existing discharge to the River Itchen does not result in an unacceptable risk of pollution due to the exceedance of thresholds set for soluble contaminants or sediments, as defined in HEWRAT.

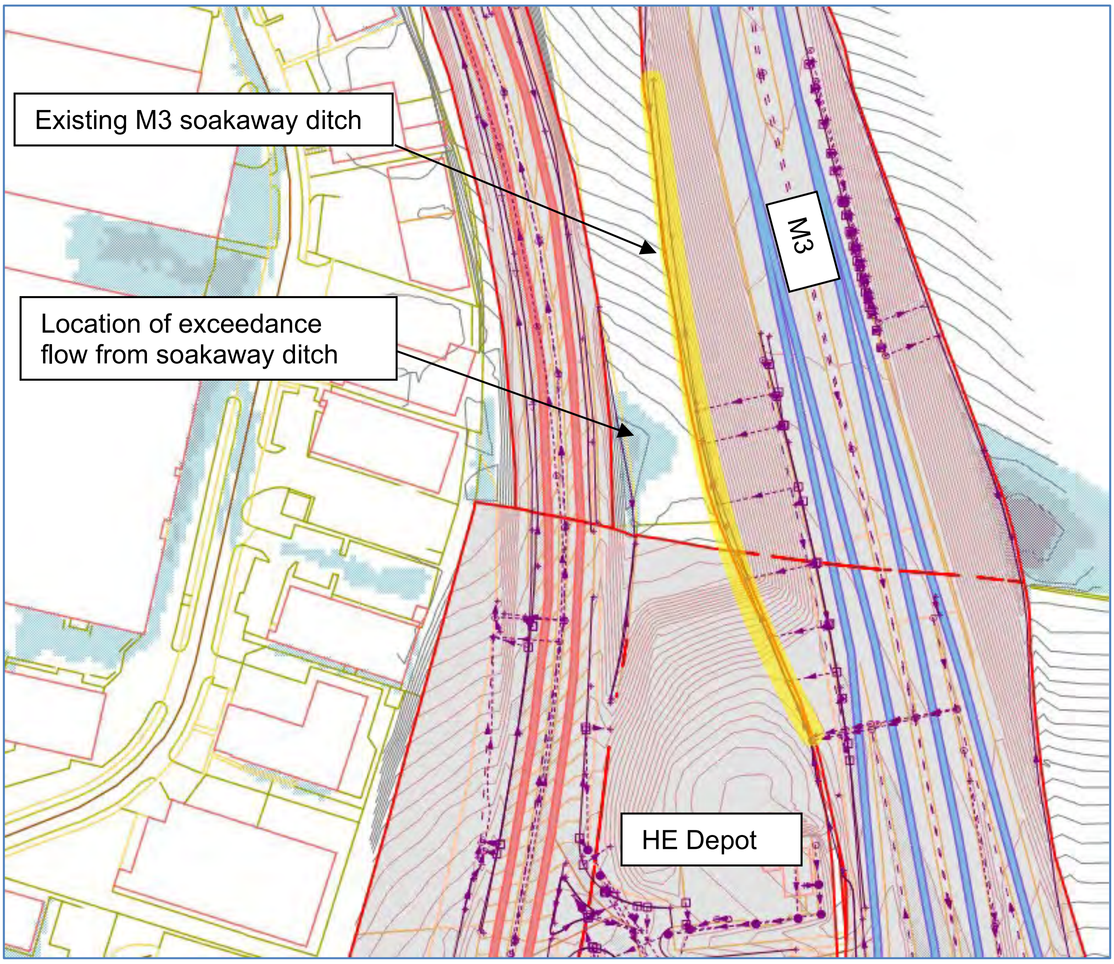


Figure 5 – Existing M3 soakage feature

5.4. Assessment of baseline risk to the water environment from Microplastics

As discussed in Section 4.2, a quantitative assessment of baseline risk from existing MPs is not possible given the current lack of research and policy guidance.

It should be noted however, that there are no specific existing mitigation measures for the settlement and filtration of MPs, or for the removal of MP-loaded sediments, within the existing drainage infrastructure. A source-pathway-receptor evaluation would find that the pathway taken by most of the existing MP load in highway runoff would terminate in sediments in filter trenches and soakaways.

6. Proposed Drainage

The proposed M3J9 scheme proposes to construct a new M3/A34NB off-slip embankment over the existing main M3 soakage ditch shown in Figure 5, rendering it obsolete. Also, M3 Junction 9 - 14 Safety Barrier Improvement Scheme changes to the M3 corridor will result in much of the existing M3 central reserve soakaway trenches and carriageway edge drainage being replaced. As such, all existing M3 carriageway runoff will be conveyed to the western side of the M3J9 scheme to be attenuated and treated in detention basins (EDBs) before being discharged to ground where possible, before a controlled discharge to the River Itchen.

The only areas where existing linear infiltration highway drainage, or sealed, piped highway drainage, is proposed to be retained and enhanced, where necessary to limit flooding, will be:

- A33/A34 carriageway to the north of the River Itchen (above latitude 131500 N)

- M3 carriageway to the north of latitude 131500 N.

Both these retained areas are proposed to discharge to the River Itchen via existing open ditches or filter trenches.

For full details of the proposed M3J9 drainage infrastructure, please refer to Stantec's *M3J9 Improvement Scheme Stage 3 – Drainage Strategy Report* and associated drawings and specifications.

In summary, the proposed drainage for new M3J9 carriageway areas comprises

- Over-the-edge drainage of run-off from carriageways on embankments to filter strips and to infiltration ditches

- Collection of run-off at carriageway edge in channel drains, gullies or filter drains, which is piped to:

- Primary Filtration treatment in filtration forebays followed by settlement in unplanted, lined detention basins.

- Attenuation, Secondary Settlement and Filtration treatment in vegetated, un-lined Extended Detention Basins containing both wet (marsh) and dry (grass) habitat zones.

- Tertiary treatment in a grassed swale prior to discharge to the River Itchen

- In areas where existing carriageway is being overlaid and existing highway drainage is being retained, run-off is either discharged over-the-edge to existing filter strips or infiltration ditches, or is captured in road gullies and channels, and conveyed to existing infiltration features such as existing soakaways or trenches.

7. Proposed Mitigation Measures

The mitigation effects of such Sustainable Drainage Systems (SuDS) features on suspended solids and soluble contaminants are well documented and quantifiable within National Highways and Environment Agency guidance (HEWRAT, EA 2003).

Current research findings conclude that insoluble Microplastics can be treated as part of the total suspended solids contaminant-load and managed in a similar way; that is, Settlement to remove larger MP particles from the flow and fix those particles in sediments; and Filtration to allow smaller particles to settle in lower flow velocities and be fixed by adsorption or absorption within the grassed surface or macrophyte zone in EDBs.

Peak concentrations of MPs in the 'first flush' of highway runoff are proposed to be treated through vertical filtration forebays to basins, which primarily separate floating debris and larger MPs from the water flow.

Thereafter, Basins 2, 3B and 3C (Refer to Drainage Schematic Plan, Appendix D) are the main, long-retention, secondary-treatment basins, prior to runoff out-falling to the River Itchen. Retention times of at least 20 hours have been calculated for in the 1-year, 60-minute storm volume, which represents 10.42 mm of rainfall in this location,

Typical removal rates in vertical filtration features are expected to be in the order of 100% for floating debris and 80% for larger MPs such as tyre crumb (figure 7.1).

A typical removal rate of 50% for sediments and heavy metals, has been assumed for EDBs 2, 3B and 3C. 50% has been taken to represent a conservative case for removal rates in dry basins. EDBs (i.e. basins which incorporate at least 25% of semi-permanent marsh or pools), are indicated to achieve typically at least 60% removal of sediments and metals (Figure 6). Basins 2 and 3C are proposed to be Extended Detention Basins.

It should be noted that both Basins 2 and 3C have at least one other settlement basin or detention basin upstream of them, which would achieve similar removal rates for suspended solids and heavy metals. Compounded removal rates have not been considered in this Technical Note, to allow for future bypassing of basins during maintenance or spill recovery.

7.1. Basin Sediment removal

Removal of sediments from detention basins is driven by both a need to maintain a minimum volume capacity within attenuation features and by the need to remove contaminated sediments from the environment.

With regard to removing contaminated material from the environment, a maximum fraction of 25% of basin area is assumed to be a reasonable estimate of basin area that can be removed and replanted every 4 years, without an overly detrimental effect to basin performance and habitat.

With regard to maintaining basin capacity, a minimum 90% capacity is targeted as the minimum basin capacity to be maintained at all times in the maintenance cycle.

Considering the two driving factors above, frequencies and volumes of sediment removal from basins (to a licensed facility) have been indicated in the summary table in Appendix C. These are based on the EA's Guidance Manual for Constructed Wetlands R&D Technical Report P2-159/TR2, an assumed sediment capture rate of 5m3/ha/yr from drained areas and an annual frequency of sediment removal operations.

Monitoring of the build-up of sediments within basins would be expected to be undertaken within the periodic maintenance inspections of basins, to assist in checking that sediment accumulation rates are as assumed, and that sediment removal frequencies are adjusted to accommodate the site-specific conditions.

7.2. Assessment of risk to groundwater from proposed M3J9 drainage

A HEWRAT screening assessment has been undertaken for all areas of infiltration within the proposed M3J9 works. The results are included in Appendix C and indicate that all but one basin are considered 'medium risk' to groundwater. This compares favourably to HEWRAT results for the existing M3 infiltration drainage for the M3. The proposed drainage discharges runoff via a far greater area of infiltration over granular soils, which provides a betterment in risk to groundwater from the M3J9 scheme.

Refer to the HgRA in Appendix E and summary in Section 4.1 for further quantitative groundwater risk assessment.

7.3. Assessment of run-off flow within geology from proposed M3J9 drainage

It is intended, in principle, to allow runoff to percolate into underlying solid or drift geology. It is recognised that there is a possibility that karstic (solution) features may be present, such as 'pipes' or swallow-holes, which may convey surface runoff to groundwater without major filtration or dissipation. The presence of Karstic features within the underlying solid chalk geology has been assessed from cavities survey data and the risk has been found to be low.

Nevertheless, infiltration features (basins) that are located in solid chalk geology have been sized as if lined with an impermeable liner, so that no infiltration is possible. Where basins overlie granular, drift geology, infiltration has been assumed within the design of basin volumes.

Proposed M3J9 basins serving high traffic volumes, and which are also founded on fissured/fractured chalk geology (Basins 3A and 4), have screening results close to, or within, the High risk category. Basins 3A and 4 are therefore proposed to be lined with an impermeable liner, to mitigate the risk to groundwater.

Refer to the HgRA in Appendix E and summary in Section 4.1 for further quantitative risk assessment of the risk to groundwater flows within geology.

Table 3.3 SuDS Pollutant Removal and Flow Attenuation Capacities

	Percentage Pollutant Removal Efficiency							Flow Attenuation Efficiency	
	Litter and Debris	Solids	BOD	P	N	Metals	Bacteria	Peak (allowable discharges)	Volume
Wetlands (Combined Ret/Det Basins)	NA	60-80%	20-40% – 40-60%	40-60% – 60-80%	20-40% – 40-60%	60-80%	40-60% – 80-100%	20-40% – 40-60%	0-20%
Wet Retention Basins (With marginal vegetation)	NA	60-80% – 80-100%	40-60%	40-60% – 60-80%	20-40%	40-60% – 60-80%	20-40% – 40-60%	40-60% – 60-80%	20-40%
ED Basins (<10 hour detention; with marsh)	80-100%	60-80%	20-40%	20-40%	20-40%	40-60%	?	60-80%	0-20%
ED Basins (10-24 hour detention; with marsh)	80-100%	80-100%	40-60%	20-40% – 60-80%	20-40%	60-80%	? – 0-20%	60-80%	20-40%
Dry Detention Basin (First flush infiltration)	80-100%	60-80%	60-80%	40-60%	20-40% – 40-60%	40-60%	20-40%	60-80%	20-40% – 40-60%
Dry Detention Basin (Total infiltration)	80-100%	80-100%	60-80%	60-80%	40-60% – 60-80%	80-100%	80-100%	60-80%	60-80% – 80-100%

KEY: ■ 80-100%; ▩ 60-80%; ⊞ 40-60%; ⁘ 20-40%; □ 0-20%

Figure 7.3 - Pollutant Removal Rates (Table 3.3 -EA Guidance Manual for Constructed Wetlands R&D Technical Report P2-159/2003)

7.4. Assessment of risk to watercourses from HGV-spillage.

The lowest return period for a spillage incident is 1 in 253 years, which meets the minimum 1 in 200 year return period expected for spillage probability, in the context of adjacent River Itchen SAC (Special Area of Conservation).

7.5. Assessment of risk to watercourse flow from proposed M3J9 drainage.

A HEWRAT risk assessment for acute and chronic pollution of watercourses has been undertaken for all attenuation basins and the only geocellular tank. The basins and tank have been assessed individually, as if these features each discharged directly into the River Itchen, without the ameliorating effects of basins upstream within their catchment. The cumulative effect of basins in series has therefore not been considered in this Technical Note in order to account for future bypassing of basins during maintenance or spill recovery.

The HEWRAT Runoff Risk Assessment results (Appendix C) indicate that:

- Each detention basin provides sufficient removal of sediments and pollutants to preclude exceedance of the thresholds for acute and chronic pollutant concentrations within the HEWRAT assessment tool.
- A Tier 2 assessment has been included in HEWRAT, which considers proposed pollutant removal efficiencies in light of the diluting effect of flows in the receiving watercourse. The Tier 2 assessment indicates no mitigation of runoff flows is required; mitigation is, however, proposed in detention basins.
- The lowest return period for a spillage incident is 1 in 253 years, which meets the minimum 1 in 200 year return period expected for spillage probability, in the context of adjacent River Itchen SAC (Special Area of Conservation).

7.6. Assessment of risk to the water environment from Microplastics (insoluble)

Table 7.6 below indicates the S-P-R assessment and the mitigation measures that are proposed within the M3J9 scheme, to ameliorate Microplastics contamination of groundwater and surface waters.

MP Source	Mitigation at Source	Pathway	Mitigation in pathway	Receptor	Outcome	Standard of Compliance
Wind	n/a	In suspension to River	Settlement, filtration, adsorption in vegetated detention basin	Direct- runoff flow (fluvial)	As TSS removal rates (min 50%) - To be monitored?	EA 2003, SuDS Manual
	n/a	In suspension to groundwater	Settlement, filtration, adsorption in vegetated detention basin, and filtration in sat/unsat. zone	Baseflow (fluvial)	100% retention in sat./unsat. zone	EA 2003, SuDS Manual
	n/a	In suspension to groundwater	Infiltration thro' granular blanket on basin base, then conveyance in Karstic features	Groundwater Abstraction	To be monitored?	EA Infiltration consent?
	n/a	Wind entrained to basins	Settlement, filtration, adsorption in vegetated detention basin, and filtration in sat/unsat. zone	Soils/sediments	As TSS removal rates (50%) - To be monitored?	EA 2003, SuDS Manual
Vehicles (incl. Tyre crumb)	HE road sweeping + disposal as hazardous waste	In suspension to river	Primary vertical filtration in forebays, then settlement and adsorption in vegetated detention basin (Minimum sequence of catchpits, sediment forebays, detention basins and swale).	Direct runoff flow (fluvial)	As TSS removal rates (min 50%)	EA 2003, SuDS Manual
		In suspension to groundwater		Baseflow (fluvial)	100% retention in sat/unsat. zone	EA 2003, SuDS Manual
				Groundwater Abstraction	To be monitored?	EA Infiltration consent
		Mechanical (scattering)	n/a	Soils (Verge, adj. landscape)	To be monitored?	n/a
MP Load Spillages	HE road sweeping/cleaning + disposal as hazardous waste (Spill captured in Pollution Control Device (lined ditch + penstock). <1hr response time by HE.	In suspension to River	Liquid (wash-down) flows to Pollution Control Device. HE Disposal as hazardous Waste.	Direct- runoff flow (fluvial)	Spill clean-up to HE/HCC standards	National Highways/HCC
		In suspension to groundwater	Liquid (wash-down) flows to Pollution Control Device. HE Disposal as hazardous Waste.	Baseflow (fluvial)	Spill clean-up to HE/HCC standards	National Highways/HCC
		Mechanical (scattering)	Mechanical or manual clean up and disposal to suitable waste facility	Soils (Verge, adj. landscape)	Spill clean-up to HE/HCC standards	National Highways/HCC
Litter from Traffic	HE road sweeping + disposal as hazardous waste	In suspension to River	Settlement and filtration in vegetated detention basin (incl trash screen on outlet)	Direct- runoff flow (fluvial)	100% retention in surface of basins	EA 2003, SuDS Manual
		In suspension to groundwater	Settlement and filtration in vegetated detention basin (incl trash screen on outlet).	Baseflow (fluvial)	100% retention in surface of basins	EA 2003, SuDS Manual
		Mechanical (scattering)	Mechanical or manual clean up and disposal to suitable waste facility	Soils (Verge, adj. landscape)	Litter removal to HE standards	National Highways/HCC
Basin Sediment	Flow velocity reduction/channelling to reduce re-suspension	In suspension to River	Primary vertical filtration in forebays, then settlement and adsorption in vegetated detention basin	Direct runoff flow (fluvial)	As TSS removal rates (min 80%)	EA 2003, SuDS Manual
		In suspension to groundwater	Primary vertical filtration in forebays, then settlement and adsorption in vegetated detention basin	Baseflow (fluvial)	100% retention in sat./unsat. zone	EA 2003, SuDS Manual
	Waste disposal practices to recognised DEFRA and EA standards (WAC testing, licenced transport, disposal etc)		Settlement, filtration in forebays, adsorption in vegetated detention basin downstream of accidental re-suspension during disposal	Direct runoff flow and baseflow(fluvial)	TSS removal rate of 50%	EA 2003, SuDS Manual

Table 7.6 – Microplastics: Risks and Mitigation

8. Maintenance Schedule

A Maintenance Schedule has been proposed to demonstrate that the performance of highway drainage and SuDS components can be maintained at a sufficient level to implement the removal rates for the pollutant types assessed, over the lifetime of the network.

Sediment removal in the primary vertical filtration areas (sediment forebays) is proposed to be the most frequent maintenance operation, as forebays are relatively small features, through which all runoff will flow and within which entrained, suspended solids will concentrate. It is envisaged that the frequency of replacement of the vertical filtration layer will be proportional to the filter media grading, rather than absolute MP or sediment load. Once the matrix voids become clogged with silt, MPs and tyre crumb, then it would be disposed of as hazardous waste. Once replacement frequencies are monitored, filter media grading can be reviewed to increase replacement frequencies if required. A lowest permeability limit of 500mm/min in filter media should be maintained to at least cater for the runoff flow from a 1-year return period, 60-min duration storm event, which is the standard of ‘first flush’ filtration treatment performance being targeted, and which represents 10.42mm of rainfall depth (EA 2003).

Sediment removal frequency in detention basins has been calculated on the basis of maintaining a minimum 90% volume capacity for attenuation, assuming 5 m3/ha/yr capture rate of sediments within detention basins from highway drainage catchments (EA 2003). This is a conservative figure when compared to the 3m3/ha/yr indicated in the EA guidance. It is proposed to remove sediment and macrophyte (root zone) layers, containing contaminated silts and MPs, at a rate of 25% of the basin footprint over 4 years. The sediment removal proposals are indicated in Table 8 below.

Basin	Attenuation m3/ha	m3/ha/yr silt accmulation rate	Est. time to 10% loss of capacity	Silt Storage Vol.	Forebay Area	Forebay Min. depth of freeboard	Comments
			yrs	m3	m2	mm	
1	1234	5	26	6	58	52	Check HEWRAT + MPs + cCLEA contaminant loadings in sediment 2 -yearly.
2	2084	5	44	13	36	333	Check HEWRAT + MPs + cCLEA contaminant loadings in sediment 2 -yearly.
3A	475	5	10	46	36	333	Check HEWRAT + MPs + cCLEA contaminant loadings in sediment 2 -yearly.
3B	286	5	6	53	36	333	Check HEWRAT + MPs + cCLEA contaminant loadings in sediment 2 -yearly.
3C	564	5	12	68	46	885	Check HEWRAT + MPs + cCLEA contaminant loadings in sediment 2 -yearly.
4	377	5	8	32	36	333	Check HEWRAT + MPs + cCLEA contaminant loadings in sediment 2 -yearly.
5	87	1	9	78			Not for highway
6	78	1	8	14			Swale to replace forebay for primary treatment
7	646	5	14	3	36	333	Check HEWRAT + MPs + CLEA contaminant loadings in sediment 2 -yearly.
	Notes	1. Forebay area to be adjusted where forebay depth of freeboard > 300mm, to achieve max. 300mm depth.					
	Ref: Fig. 4.1 - Guidance Manual for Constructed Wetlands R&D Technical Report P2-159/TR2						

Table 8 – Proposed Sediment Removal Regine

It is proposed to periodically test sediment forebay and detention basin sediments also for contaminant loadings against contaminated land quality standards. This ensures that the need for filter matrix replacement or sediment removal to meet contamination standards is also captured, rather than just for operational permeability and attenuation volume reasons.

All filter media removed for disposal should also be 'WAC tested' to identify compliance with the Waste Acceptance Criteria of the receiving disposal facility.

The regime for testing and replacement or removal of SUDS materials will be subject to a methodology agreed with the Environment Agency.

Ref.	Activity	Frequency	Organisation Responsible	Notes
1.0	**Litter Management**			
	Collect all litter in SuDS and Landscape areas, including wetlands and ponds or any debris lodged in planting.	Annually	National Highways	Frequency of litter removal at the extents of the highway boundary to be as required, in response to landowners' notifications, to avoid nuisance to public amenity.
2.0	**Grass Cutting**			
	All grass verges, paths and access to SuDS features. All cuts at 35-50mm with 75mm max. All cuttings collected at first and last cut annually removed to wildlife or compost piles otherwise left in-situ.	Monthly in the growing season	National Highways	
	All filter strips, swales and margins to low flow channels. All cut at 75-100mm with 150mm max. All cuttings collected at first and last cut annually removed to wildlife or compost piles otherwise left in-situ.	Monthly in growing season	National Highways	
	All basin/pond edges to be cut to 100mm during September-October annually or on a 3 year rotation and cuttings removed to wildlife or compost piles.	As required in growing season	National Highways	Avoid strimming where possible to minimise injury to fauna concealed in long grass.
	Any wildflower areas included within SuDS features to be cut to 100mm during September-October annually and all cuttings removed to wildlife or compost piles.	Annually	National Highways	Avoid strimming where possible to minimise injury to fauna concealed in long grass.
2.0	**Trash Screens and Forebays to all Basins**			
	Check Trash screens for blockages. Remove all accumulated solids and fibres to licenced waste facility	Monthly and as required.	National Highways	
	Check annually for free-flowing permeability of filtration blanket (minimum 500 mm/min). If filter matrix is clogged to an extent that hinders	Check annually, replace filter	National Highways	

Ref.	Activity	Frequency	Organisation Responsible	Notes
	permeability, replace full thickness of filter media.	media as required.		
	Inspect forebays to ensure min. 50% volume capacity is present above filter media.	6-monthly	National Highways	
	Remove all silt/sediment accumulation above filter media to restore full capacity of forebay	As required, when 50% full	National Highways	
3.0	**Settlement Basins**			
	Check sediment volume is less than 10% of basin volume.	Annually	National Highways	
	When sediment volume reaches 10% of basin volume, implement phased removal of all sediment to restore original basin volume. Replsnt with full plant assemblage	As required	National Highways	Expected 10-25 years depending on basin drainage ratio.
	All grass verges, paths and access to SuDS features. All cuts at 35-50mm with 75mm max. All cuttings collected at first and last cut annually removed to wildlife or compost piles otherwise left in-situ.	Monthly in the growing season	National Highways	
	All filter strips, swales and margins to low flow channels. All cut at 75-100mm with 150mm max. All cuttings collected at first and last cut annually removed to wildlife or compost piles otherwise left in-situ.	Monthly in growing season	National Highways	
	All pond edges to be cut to 100mm during September-October annually or on a 3 year rotation and cuttings removed to wildlife or compost piles.	As required in growing season	National Highways	Avoid strimming where possible to minimise injury to fauna concealed in long grass.
	Any wildflower areas within SuDS features to be cut to 100mm during September-October annually and all cuttings removed to wildlife or compost piles.	Annually	National Highways	Avoid strimming where possible to minimise injury to fauna concealed in long grass.
	Excavate and remove 25% of accumulated silt (full depth) using an agreed methodology retaining a fully representative plant assemblage in the SuDS feature by replanting.	4-yearly	National Highways	
	Stack silt within silt storage area and allow to dewater before disposal offsite (48 hours minimum to 1 month maximum). Undertake WAC testing to define suitable waste disposal facility.	4-yearly	National Highways	
	Remove plant remains to wildlife piles on site.	Annually	National Highways	
4.0	**Extended Detention Basin**			
	Check sediment volume is less than 10% of basin volume.	Annually	National Highways	

Ref.	Activity	Frequency	Organisation Responsible	Notes
	When sediment volume reaches 10% of basin volume, implement phased removal of all sediment to restore original basin volume. Replant with full plant assemblage	As required	National Highways	Expected 10-25 years depending on basin drainage ratio.
	An agreed area of wetland vegetation (25% max.) to be cut annually at 100mm above base. Avoid strimming, to reduce chance of injury to sheltering animals/insects).	Annually at end of growing season.	National Highways	
	All cuttings to be raked off and stacked in piles to allow dewatering for 48 hours. Remove cuttings to wildlife or compost piles on site. Work to be undertaken September – October or as this Schedule to avoid injury to protected wildlife.	Annually	National Highways	
	Erect temporary fence protection around sediment forebays only, to prevent access by children to potentially polluted silt if and where necessary during silt removal.	4-yearly	National Highways	
	Excavate and remove 25% of accumulated silt (full depth) to tally with area of removal of wetland vegetation, using an agreed methodology retaining a fully representative plant assemblage in the SuDS feature.	4-yearly	National Highways	
	Stack silt within silt storage area and allow to dewater before disposal offsite (48 hours minimum to 1 month maximum) Undertake WAC testing to define suitable waste disposal facility.	4-yearly	National Highways	
	Remove dead plants to wildlife piles on site.	Annually	National Highways	
5.0	**Planting**			
	Removal of overhanging branches or growth in SuDS features to be identified by arboriculturist and implemented by NH maintenance staff.	Annually	National Highways	
6.0	**Inlets, Outlets and Gratings**		National Highways	
	Inspect inlets and outlets and check for damage, blockages and silt accumulation.	Annually	National Highways	
	Remove all debris and silt from inlet/outlet aprons where present. Strim 1m area around structure where in grass or sweep to ensure unrestricted access.	Annually	National Highways	
	Inspect gratings monthly to check for damage, blockages and silt accumulation.	Annually	National Highways	
	Remove all debris and silt from apron below grating where present. Evaluate requirement to rod or jet pipe run at each inspection and annually after leaf fall. Strim 1m area around structure where in grass.	Annually	National Highways	

Ref.	Activity	Frequency	Organisation Responsible	Notes
7.0	**Inspection and Flow Control Chambers**			
	Inspect for damage and blockages after leaf fall. Remove accumulated debris and silt.	Annually	National Highways	
	Check Hydrobrake controls flow freely. Remove all debris and silt from flow control chamber.	Annually	National Highways	
8.0	**Silt Traps**			
	Inspect surface silt traps and forebays to basins and check for damage and blockages, removing silt at inlet, as required.	Annually	National Highways	
	Inspect below ground silt traps (catchpits) check for damage and blockages, removing silt as required.	Annually	National Highways	
10.0	**Flow Channels/Rills/Cascades (spillway)/Headwalls**			
	Inspect surface low flow channels and check for damage, blockages and silt accumulation removing all debris and silt as required.	Annually	National Highways	
	Inspect pipe routes/headwalls and evaluate requirement to rod any pipe.	Annually	National Highways	
	Rod or jet pipe runs after leaf fall. Remove silt and debris from site.	5 yearly	National Highways	
11.0	**Underground Storage Features**			
	Check inlets, outlets, control structures and overflows	Annually	National Highways	
	Rod or jet pipes through storage structures, including entries, exits, through-pipes, annually after leaf fall.	Annually	National Highways	
12.0	**Underground manholes & pipework**			
	Inspect manhole covers and interiors for damage, blockages and silt accumulation removing all debris and silt as required. Inspect/CCTV pipe routes and evaluate requirement to rod any pipe.	Prior to handover	National Highways	
	Inspect pipe routes and evaluate requirement to rod any pipe.	Annually	National Highways	
	Rod or jet pipe runs after leaf fall. Remove silt and debris from site.	5 yearly	National Highways	

Table 8.1 – Maintenance Schedule

9. References

A full list of cited documents is included in Table 9 below:

Document	Notes/web address	Citation Ref.
M3 Junction 9 Improvement Scheme: Drainage Strategy Report (2021), Stantec		DSR 2021
CIRIA C753, SUDS Manual		SUDS 2015
Factual Ground Investigation Report at M3 Junction 9 Improvement, for National Highways c/o Geoffrey Osborne Limited, Soils Ltd	HE551511-HEX-EGT-ZZ-RP-CE-0001_Factual Ground Investigation Report P03	GEO 2020
LA 113 - Road drainage and the water environment, DMRB.		LA113
CD 532 - Vegetated drainage systems for highway runoff		CD532
National River Flow Archive (NRFA) (2019). Gauging station No. 42016 – Itchen at Easton.	[redacted]	NRFA 2019
Guidance Manual for Constructed Wetlands R&D Technical Report P2-159/2003, Environment Agency		EA 2003
National Highways Water Risk Assessment Tool, v2.0.4		HEWRAT
DEFRA Report 14784 - Investigating the sources and pathways of synthetic fibre and vehicle tyre wear contamination into the marine environment		DEFRA
Microplastics in urban and highway stormwater retention ponds - Science of the Total Environment 671 (2019) 992–1000		TE 2019
Retention of microplastics in sediments of urban and highway stormwater retention ponds - Environmental Pollution 255 (2019) 113335		EP 2019
Microplastics in a Stormwater Pond - Water 2019, 11, 1466; doi:10.3390/w11071466 (Water 2019		Water 2019
Investigation of 'microplastics' from brake and tyre wear in road runoff – Task 1-902 Final project Report	[redacted]	MPBTW 2020

Table 9 – Full List of References and Citations

Appendix A Geotechnical Logs

Log for DS114

Soils Limited

Contract Name:	Client:	Hole ID:
M3 Junction 9	Geoffrey Osborne Limited	DS114

Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Hole Type:
17486	25/03/2019	JR		PRELIM	RC

Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
449574.9	130967.0	48.66mAOD	Comacchio 405	04/11/2019	1:50

Weather: Fine | Termination: | SPT Hammer: MC 405 Energy Ratio: 82% | Sheet 1 of 2

Samples & In Situ Testing

Depth	Tests/Samples	TCR	SCR	RQD	FI
0.25	1 ES				
0.50	2 ES, 3 D, 4 B				
1.00	5 ES, 6 D				
1.20	7 B, 8 UT				
1.60	9 D				
1.70	N=6 (1,1/2,1,1,2)(S), 10 D				
1.70 - 3.00		62	0	0	
2.60	23 ES				
3.00	N=10 (2,2/2,2,3,3)(S), 11 D				
3.00 - 4.50		67	34	0	
3.80	25 D				
4.00	24 ES				
4.50	N=9 (1,0/2,2,3,2)(S), 12 D				
5.20	26 ES				
4.50 - 6.00		80	80	80	
6.00	N=11 (1,1/1,2,4,4)(S), 13 D				
6.00 - 7.50		81	81	75	
6.58	27 ES				
7.08	28 D				
7.50	N=17 (2,4/4,4,5,4)(S), 14 D				
7.50 - 9.00		70	70	70	
8.30	30 D				
8.70	31 B				
8.90	29 ES				
9.00	N=12 (2,3/2,3,3,4)(S), 15 D				
9.00 - 10.50		68	68	68	

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
48.36	(0.30) 0.30	TOPSOIL: Grass over soft brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular and subrounded mainly fine and medium of chalk and rare flint. Frequent rootlets.
47.46	(0.90) 1.20	Structureless CHALK recovered as slightly sandy very gravelly SILT with low cobble content. Gravel and cobbles are of angular and subangular fine to coarse chalk and numerous rinded flints (<170x160mm). Locally orangish brown staining. (CIRIA Grade Dm) SEAFORD CHALK FORMATION
46.96	(0.50) 1.70	Core not inspected (UT). SEAFORD CHALK FORMATION
44.66	(2.30) 4.00	Structureless CHALK composed of silty subangular and subrounded fine to coarse GRAVEL and COBBLES. Clasts are very weak low density white with occasional black specks. Matrix is white rarely mottled orangish brown. (CIRIA Grade Dc) SEAFORD CHALK FORMATION
		Weak medium density white with rare black specks CHALK. (CIRIA Grade A4) SEAFORD CHALK FORMATION

Groundwater: Water Strike | Backfill/Installation

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
25-03-2019	07:50			Dry
25-03-2019	17:00			Dry

Borehole Diameter Depth (m)	Borehole Diameter Dia (mm)	Casing Diameter Depth (m)	Casing Diameter Dia (mm)

Remarks:
Inspection pit. Hand dug.

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour
1.70	3.00		100%-100%	white
3.00	4.50		100%-100%	white
4.50	6.00		100%-100%	white
6.00	7.50		100%-100%	white
7.50	9.00		100%-100%	white
9.00	10.50		100%-100%	white

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	16.50	PLAIN	50
16.50	19.50	SLOTTED	50

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	Groundwater not encountered

Fracture spacing reported in mm as Min, Average and Max values. TCR, SCR and RQD reported in %. Hand vane (HV) reported in kPa.

TECHNICAL NOTE

Log for TP11

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel. 01737 814221 Email: admin@soilslimited.co.uk	Trial Pit Log	Trial Pit No: TP11 Sheet 1 of 1
Project Name: M3 Junction 9 — Project No.: 17486	Method: Plant: 8t tracked excavator Support:	Hole Type: TP
Location:		Scale: 1:25
Client: Geoffrey Osborne Limited	Trial Pit Length: 3.00m — Trial Pit Width: 0.60m	Logged By: JT
Dates: 22/03/2019 — Level: 53.43m AOD	Co-ords: E449726.56 N130950.40	

Water Strike	Sample Depth	Type	Results	Depth (m)	Level (mAOD)	Stratum Description
						MADE GROUND: Dark brown gravelly fine to coarse slightly organic clayey SAND with occasional rootlets. Gravel is angular to subrounded fine to coarse of flint and chalk with rare gravel sized brick fragments.
	0.25	D ES		0.25	53.18	Structureless CHALK composed of silty subangular to subrounded GRAVEL. Clasts are very weak to weak medium to high density. Matrix is off white with heavy orange brown staining and brown silty sand. (CIRIA Grade Dc). SEAFORD CHALK FORMATION 0.25-0.45m: Periglacial striping locally with discontinuous infill of light brown fine to medium clayey sand (Head) approximately 300mm thick and 300mm apart. 0.60m: Cobble (100 x 150mm) of subrounded nodular flint.
	0.30	D ES				
	0.50	B D ES		0.65	52.78	Structureless CHALK composed of off white slightly sandy very gravelly SILT. Gravel is very weak to weak medium to high density subangular locally stained orange brown off white. Occasional cobbles (100mm x 120mm) of flint. (CIRIA Grade Dm). SEAFORD CHALK FORMATION 0.80-1.50m: Collapse on western and eastern edge of pit.
	1.00	B D D ES				
				1.40	52.03	Structureless CHALK composed of very silty subangular to subrounded GRAVEL. Clasts are very weak to weak medium to high density locally orange brown stained. Matrix is off white with occasional pockets (20mm x 100mm) of chalky clay. With rare cobbles (80mm x 100mm) of nodular flint. (CIRIA Grade Dc). SEAFORD CHALK FORMATION 1.40m: Tubular cobble (100 x 110mm) of flint. 1.50-2.90m: Collapse on western side.
	2.00	B D D ES				
				2.90	50.53	Structureless CHALK composed of off white slightly sandy very gravelly SILT. Gravel is very weak to weak medium to high density subangular. (CIRIA Grade Dm). SEAFORD CHALK FORMATION
	3.00	B D D ES				
	4.00	B B D ES		4.00	49.43	End of Pit at 4.000m

General Remarks:
No visible/olfactory evidence of contamination. Between 0.8-1.5m: Collapse on western and eastern edge of pit. Between 1.5-3.0m: Collapse on western face. Trial pit was backfilled with soil arisings and compacted by excavator every 300mm on completion.

Groundwater Remarks: Groundwater not encountered

Sample Type: D: Disturbed; B: Bulk; J: Jar; W: Water

Appendix B HEWRAT baseline results for existing M3 drainage

Existing A34 SB outfall @ North side of A34 bridge - HEWRAT Watercourse Assessment

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble					Sediment – Chronic Impact
EQS - Annual Average Concentration			Acute Impact		Alert. Protected Area.
	Copper	Zinc	Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00 ug/l	0.00 ug/l	Pass	Pass	Accumulating? No — 0.14 Low flow Vel m/s
Step 3	- ug/l	- ug/l			Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=50,000 and <100,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	1.1
Permeable area draining to outfall (ha)	0.8
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		0	No restriction	0

Stantec

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

In Runoff

Step 1 (Soluble)

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	79.10	77.10
No. of exceedances/worst year	98	95

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	32.10	37.10
No. of exceedances/worst year	44	43

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	33.20	106.50
	90%ile	64.34	217.34
	95%ile	83.57	320.76
	99%ile	138.39	560.94

Step 1 (Sediment)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	86.80	113.20	1.60	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	114	141	4	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	419	1651	1	11065	1914	1837	117	518
90%ile	924	3771	2	28184	4876	4679	299	1319
95%ile	1128	4754	3	56234	9729	9335	596	2632
99%ile	1722	7094	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	●	●
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	●	●
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	0.00	0.01
	90%ile	0.00	0.01
	95%ile	0.01	0.02
	99%ile	0.03	0.08

Step 2

Velocity: 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	-	-
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-

DI: -

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	-	-
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-
Annual average concentration (ug/l)	-	-

		Copper (ug/l)	Zinc (ug/l)
Thresholds resholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	-	-
	90%ile	-	-

Existing M3 Soakaway Ditch - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	245
RISK SCREENING LEVEL	Medium

Existing M3 Soakaway Ditch - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Groundwater							
D2	Length of road draining to outfall *(m)*	1,600							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Slip road							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00561	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00337	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00337	0.00000	0.00000	0.00000	0.00000	0.00000	0.0034	297
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00202	0.00000	0.00000	0.00000	0.00000	0.00000	0.0020	495
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00121	0.00000	0.00000	0.00000	0.00000	0.00000	0.0012	825

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Existing A34 SB Pollution Control Device - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

								Totals	Return Period (years)
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	No junction							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	87,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.29							
D9	Risk of accidental spillage	0.00069	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00041	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00041	0.00000	0.00000	0.00000	0.00000	0.00000	0.0004	2413
D14	Existing measures factor	0.5							
D15	Return period with existing pollution reduction	0.00021	0.00000	0.00000	0.00000	0.00000	0.00000	0.0002	4826
D16	Proposed measures factor	0.7							
D17	Residual with proposed Pollution reduction measures	0.00015	0.00000	0.00000	0.00000	0.00000	0.00000	0.0001	6895

Justification for choice of existing measures factors:

Justification for choice of proposed measures factors:

Spillage Factor

Location	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

TECHNICAL NOTE

Appendix C HEWRAT Proposed Drainage Results - Summary Table and Individual Basin results

<u>HEWRAT Inputs/Outputs Summary Table</u> (Proposed M3J9 basins)

M3J9 - Water Quality Assessment - Summary Table

2021 07 30

Basin/ Soakaway	SUDS type	Drained Highway Area	Drained Basin area	Total Drained area	Basin Base Area	Drainage Area Ratio	Hydraulic Loading Rate	Basin volume	300m3/ha indicative primary treatment vol.	200m3/ha indicative secondary treatment vol.
ref		ha (cum)	ha (cum)	ha (cum)	ha	ha	mm/day	m3	m3	m3
1	Infiltration Basin	0.612	0.170	0.822	0.018	19	30	1,290	61	
2	SDB	1.258	0.355	1.617	0.160	10	21	5,500		
3A	Detention Basin	7.633	0.433	8.129	0.056	146	293	4,365	763	
3B	Infiltration Basin	8.180	0.685	8.973	0.144	57	122	3,020	818	
3C	SDB	9.550	1.072	10.611	0.255	37	81	7,650		1,910
4	Detention Basin	5.784	0.128	6.213	0.035	165	356	2,000	578	
5	Infiltration Basin	1.681	76.000	77.7	0.100	6	12	5,500		
6	Infiltration Basin	0.000	14.000	14.0	0.146	0	0	29,900		
7	Geocell (blue bridges)	0.427	0.000	0.481	0.020	n/a		270		
Exig A33/A34 outfall to Itchen	Outfall	1.100	0.800	1.900	n/a	n/a		n/a		
Exig M3 Mainline Soakaway Ditch	*Infiltration Ditch*	1.630	0.000	1.670	0.10	20		67	503	3,326
Totals										

Notes

1 HEWRAT flags up 'Alert Protected Area' for all SW discharges to protected conservation sites - EA approval requried to satisfyHEWRAT alert.

2 HEWRAT detailed parameters and results are included in separate tabs for all storage/disposal features.

3 *Medium Risk* screening results for discharge to groundwater - Requirement for further quantitiative modelling to be confirmed with EA.

Individual Basin HEWRAT Results

Basin 1 – Watercourse Assessment

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.00	0.00	ug/l
Step 3	0.00	0.00	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >10,000 and <50,000 | Climatic region: Warm Wet | Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	0.445
Permeable area draining to outfall (ha)	0.179
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only – Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only – Ambient background concentration (μg/l): 0

For sediment impact only – Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- ○ Tier 1 – Estimated river width (m): 5
- ● Tier 2 – Bed width (m): 17 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Soluble – Acute Impact: Copper, Zinc

Sediment – Chronic Impact: Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene

Prediction of impact: Step1, Step2, Step3

In Runoff

Step 1 (Soluble)

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**67.90**	**62.20**
No. of exceedances/worst year	89	75

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**21.70**	**25.30**
No. of exceedances/worst year	28	29

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	27.32	84.71
	90%ile	52.94	172.88
	95%ile	68.76	255.14
	99%ile	113.86	446.19

Step 1 (Sediment) – Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**75.30**	**98.00**	**1.50**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	99	120	4	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	349	1168	1	11065	1914	1837	117	518
90%ile	786	2781	1	28184	4876	4679	299	1319
95%ile	968	3569	2	56234	9729	9335	596	2632
99%ile	1501	5477	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	0.00	0.00
	90%ile	0.00	0.00
	95%ile	0.00	0.01
	99%ile	0.01	0.02

Step 2

Velocity: 0.14 m/s

Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

DI: -

Basin 1 - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Basin 1 - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,000							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	16,731							
D8	% HGV	15							
D8	Spillage factor *(no/10⁹ HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.00283	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00170	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00170	0.00000	0.00000	0.00000	0.00000	0.00000	0.0017	589
D14	Existing measures factor	0.7							
D15	Return period with existing pollution reduction	0.00119	0.00000	0.00000	0.00000	0.00000	0.00000	0.0012	841
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00071	0.00000	0.00000	0.00000	0.00000	0.00000	0.0007	1402

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 2 – Watercourse Assessment

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.00	0.00	ug/l
Step 3	0.00	0.00	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >10,000 and <50,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	1.24
Permeable area draining to outfall (ha)	0.595
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only Ambient background concentration (μg/l): 0

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

DETAILED RESULTS

Back To Top | Go To Interface

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**67.90**	**62.20**
No. of exceedances/worst year	89	75

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**21.70**	**25.30**
No. of exceedances/worst year	28	29

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	27.32	84.71
	90%ile	52.94	172.88
	95%ile	68.76	255.14
	99%ile	113.86	446.19

Step 1

Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**75.30**	**98.00**	**1.50**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	99	120	4	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	349	1168	1	11065	1914	1837	117	518
90%ile	786	2781	1	28184	4876	4679	299	1319
95%ile	968	3569	2	56234	9729	9335	596	2632
99%ile	1501	5477	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	0.00	0.00
	90%ile	0.00	0.01
	95%ile	0.01	0.02
	99%ile	0.02	0.07

Step 2

Velocity 0.14 m/s

Tier 2 is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds resholds	RST24	21	92
Thresholds	RST6	42	184

DI -

Basin 2 - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	190
RISK SCREENING LEVEL	Medium

Basin 2 - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,000							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	> 1 hour							
D7	Traffic flow (AADT two way)	50,000							
D8	% HGV	15							
D8	Spillage factor *(no/10⁹ HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.00846	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.75							
D11	Risk of pollution incident	0.00634	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00634	0.00000	0.00000	0.00000	0.00000	0.00000	0.0063	158
D14	Existing measures factor	0.7							
D15	Return period with existing pollution reduction	0.00444	0.00000	0.00000	0.00000	0.00000	0.00000	0.0044	225
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00266	0.00000	0.00000	0.00000	0.00000	0.00000	0.0027	375

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 3A – Watercourse Assessment

highways england **Highways England Water Risk Assessment Tool** Version 2.0.4 June 2019

Soluble						Sediment – Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.02	ug/l	Pass	Pass	Accumulating? No — 0.14 Low flow Vel m/s
Step 3	0.00	0.01	ug/l			Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=100,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	5.856
Permeable area draining to outfall (ha)	0.435
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
		Estimated effectiveness		
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact	Soluble – Acute Impact: Copper	Zinc	Sediment – Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

In Runoff

Step 1

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	111.10	115.70
No. of exceedances/worst year	134	143
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	70.70	89.80
No. of exceedances/worst year	91	113
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	113.50	124.90	6.30	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	147	152	11	25	71	25	22	39
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.07
90%ile	0.04	0.17
95%ile	0.08	0.31
99%ile	0.23	0.99

Step 2

Velocity 0.14 m/s — Tier 2 is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI -

Basin 3A - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	260
RISK SCREENING LEVEL	High

Basin 3A - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	2,250							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	28,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.01066	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00639	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00639	0.00000	0.00000	0.00000	0.00000	0.00000	0.0064	156
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00384	0.00000	0.00000	0.00000	0.00000	0.00000	0.0038	261
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00153	0.00000	0.00000	0.00000	0.00000	0.00000	0.0015	652

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 3B – Watercourse Assessment

highways england

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.00	0.02	ug/l
Step 3	0.00	0.01	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=100,000 | Climatic region: Warm Wet | Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	6.147
Permeable area draining to outfall (ha)	0.685
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only Ambient background concentration (µg/l): 0

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

○ Tier 1 Estimated river width (m): 5

◉ Tier 2 Bed width (m): 17 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact	Soluble – Acute Impact: Copper	Zinc	Sediment – Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

In Runoff — Step 1

Soluble – RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**111.10**	**115.70**
No. of exceedances/worst year	134	143

Soluble – RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**70.70**	**89.80**
No. of exceedances/worst year	91	113

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Sediment – Toxicity Threshold	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**113.50**	**124.90**	**6.30**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.08
90%ile	0.04	0.18
95%ile	0.08	0.32
99%ile	0.25	1.04

Velocity 0.14 m/s — **Tier 2** is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation) — Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

DI -

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

Basin 3B - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Basin 3B - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	2,600							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	28,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.01232	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00739	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00739	0.00000	0.00000	0.00000	0.00000	0.00000	0.0074	135
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00443	0.00000	0.00000	0.00000	0.00000	0.00000	0.0044	226
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00177	0.00000	0.00000	0.00000	0.00000	0.00000	0.0018	564

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 3C – Watercourse Assessment

highways england

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.00	0.02	ug/l
Step 3	0.00	0.01	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=100,000 | Climatic region: Warm Wet | Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

- Annual Q_{95} river flow (m^3/s): 2.6
- Impermeable road area drained (ha): 7.107
- Permeable area draining to outfall (ha): 1.072
- Base Flow Index (BFI): 0.89

Freshwater EQS limits:

- Bioavailable dissolved copper (µg/l): 1
- Bioavailable dissolved zinc (µg/l): 10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

(Estimated effectiveness)

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

	Soluble – Acute Impact: Copper	Zinc	Sediment – Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact Step1										
Step2										
Step3										

In Runoff

Step 1 (Soluble)

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	**111.10**	**115.70**
No. of exceedances/worst year	134	143
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	**70.70**	**89.80**
No. of exceedances/worst year	91	113
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1 (Sediment)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**113.50**	**124.90**	**6.30**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	147	152	11	25	71	25	22	39
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.09
90%ile	0.04	0.21
95%ile	0.09	0.38
99%ile	0.28	1.20

Step 2

Velocity 0.14 m/s — Tier 2 is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

DI -

Basin 3C - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Basin 3C - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	3,250							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	11							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.83							
D9	Risk of accidental spillage	0.01624	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00974	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00974	0.00000	0.00000	0.00000	0.00000	0.00000	0.0097	103
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00585	0.00000	0.00000	0.00000	0.00000	0.00000	0.0058	171
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00234	0.00000	0.00000	0.00000	0.00000	0.00000	0.0023	428

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 4 – Watercourse Assessment

Highways England Water Risk Assessment Tool — Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.00	0.01	ug/l
Step 3	0.00	0.01	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=100,000 | Climatic region: Warm Wet | Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	4.389
Permeable area draining to outfall (ha)	0.128
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

In Runoff

Step 1 (Soluble)

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**111.10**	**115.70**
No. of exceedances/worst year	134	143

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**70.70**	**89.80**
No. of exceedances/worst year	91	113

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	57.52	264.56
	90%ile	111.45	539.93
	95%ile	144.76	796.85
	99%ile	239.71	1393.53

Step 1 (Sediment)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold: Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**113.50**	**124.90**	**6.30**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4676	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.01

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	0.01	0.05
	90%ile	0.03	0.13
	95%ile	0.06	0.23
	99%ile	0.18	0.75

Step 2

Velocity 0.14 m/s — Tier 2 is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI -

Basin 4 - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	240
RISK SCREENING LEVEL	Medium

Basin 4 - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,600							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	10							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00377	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00226	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00226	0.00000	0.00000	0.00000	0.00000	0.00000	0.0023	443
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00136	0.00000	0.00000	0.00000	0.00000	0.00000	0.0014	738
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00054	[illegible]	[illegible]	0.00000	0.00000	0.00000	0.0005	1844

Pollution reduction factor
Use the Indicative Pollution Risk Reduction Factor table below to estimate the factor.

Provide justification for the decision in the appropriate comments box below.

A default value of 1 is used if no measures are considered or if no value is entered.

Justification for choice of existing measures factors

[Justification for c]hoice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

TECHNICAL NOTE

Basin 5 – Watercourse Assessment

N/A

Basin 5 - HEWRAT Groundwater Assessment

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Mixed fracture and intergranular flow (e.g. consolidated deposits or unconsolidated deposits of medium – coarse sand)	2	40
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Basin 5 - HEWRAT Spillage Assessment

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	500							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Slip road							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	11							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00129	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000	0.0008	1287
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00047	0.00000	0.00000	0.00000	0.00000	0.00000	0.0005	2146
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00028	0.00000	0.00000	0.00000	0.00000	0.00000	0.0003	3576

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 6 – Watercourse Assessment

N/A

Basin 6 - HEWRAT Groundwater Assessment

N/A

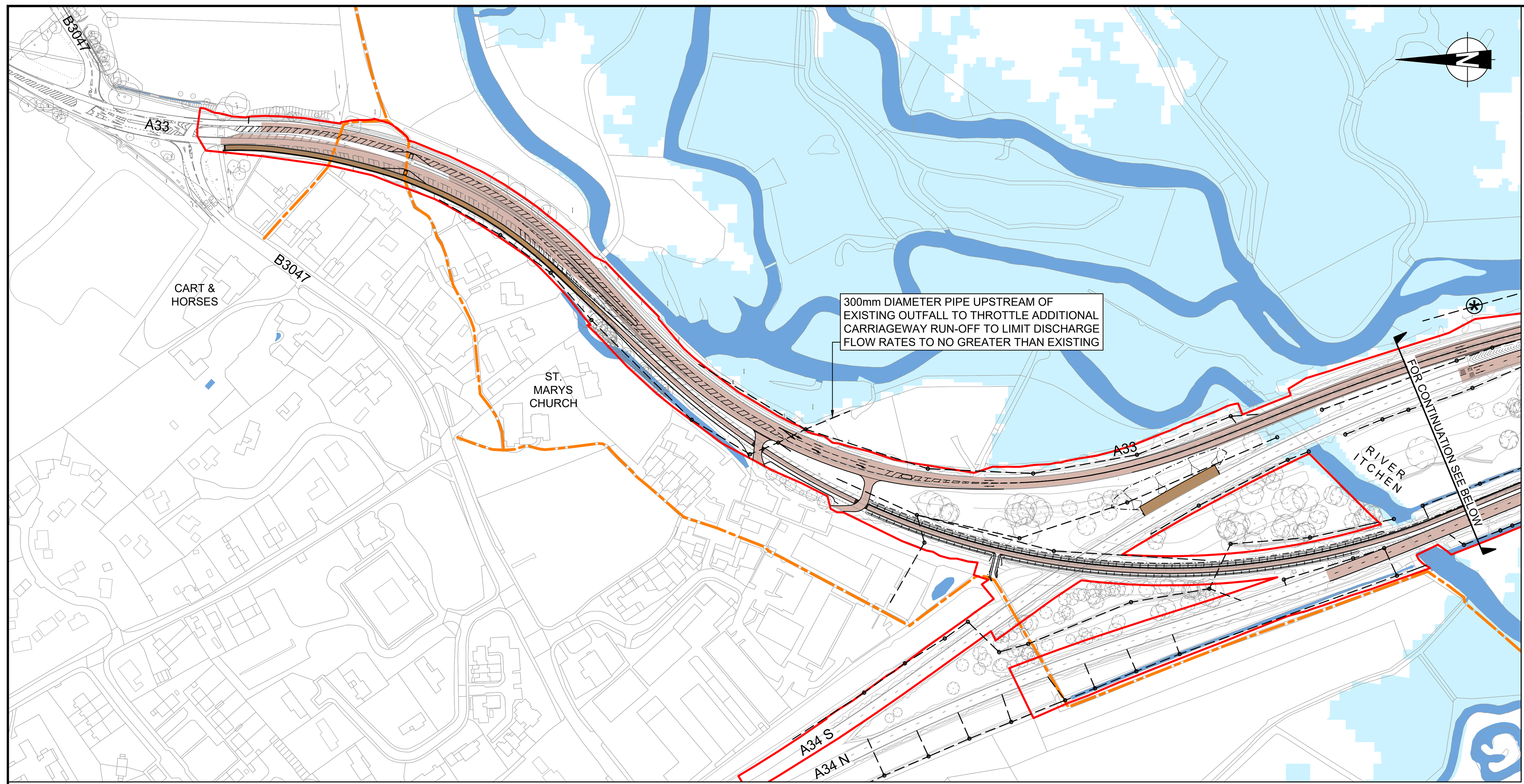
Basin 6 - HEWRAT Spillage Assessment

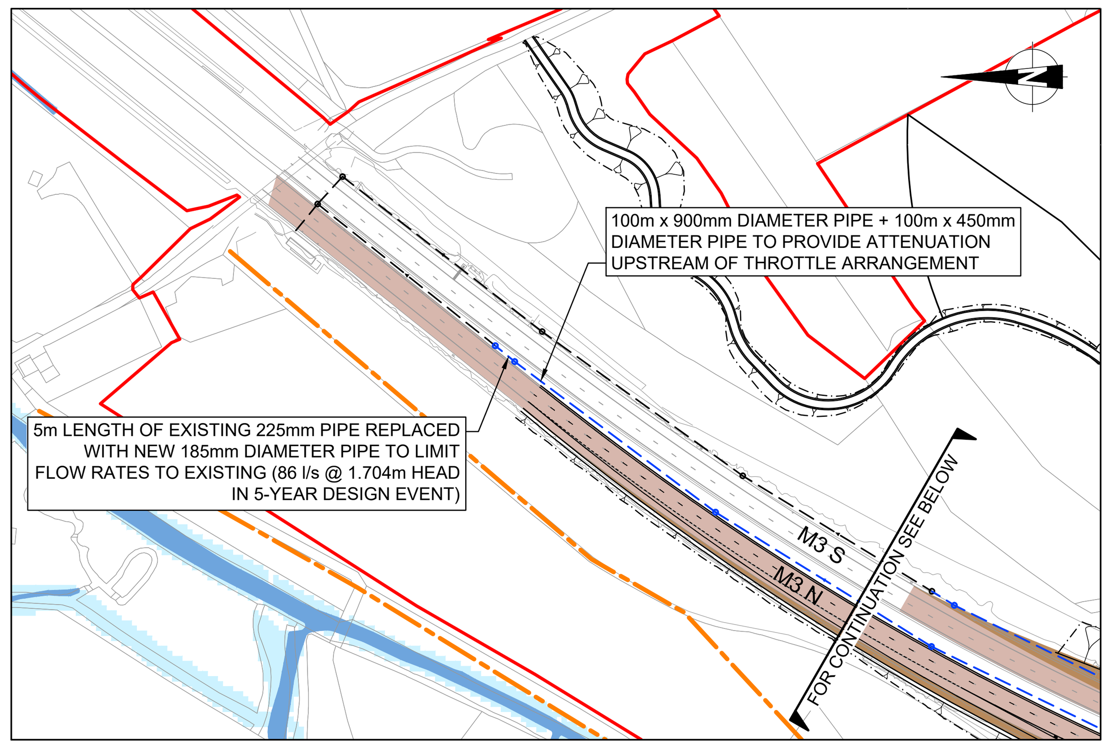
N/A

TECHNICAL NOTE

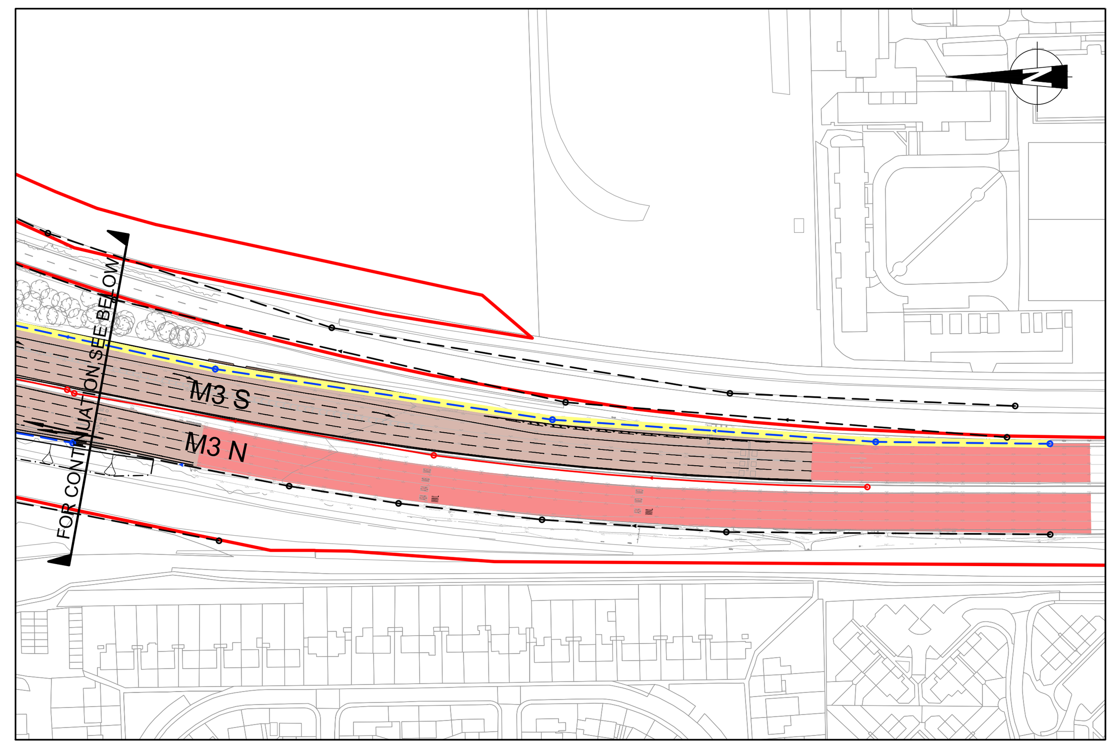
Appendix D Proposed M3J9 Drainage Schematic Plan

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 Drainage Schematic Plan





INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

KEY:

- DEVELOPMENT CONSENT ORDER BOUNDARY
- EXISTING FOOTPATH / PUBLIC RIGHT OF WAY
- PROPOSED HIGHWAY DRAINAGE NETWORK
- PROPOSED HIGHWAY DRAINAGE (INSTALLED AS PART OF M3 JUNCTION 9 TO 14 SAFETY BARRIER IMPROVEMENT SCHEME WORKS)
- PROPOSED ADDITIONAL DRAINAGE TO BE INSTALLED AS PART OF THE M3 JUNCTION 9 IMPROVEMENT SCHEME (FOLLOWING THE MANAGED MOTORWAY GOVERNMENT PAUSE)
- RETAINED EXISTING HIGHWAY DRAINAGE
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- PROPOSED GEOCELLULAR ATTENUATION
- PROPOSED INFILTRATION BASIN AND REFERENCE NUMBER
- PROPOSED LINED BASIN AND REFERENCE NUMBER
- PROPOSED GRASSED BASIN (ALL GRASSED EXCEPT BASIN 2 AND 3C)
- PROPOSED SWALE
- EXISTING CARRIAGEWAY AND DRAINAGE FEATURES TO BE RETAINED
- PROPOSED NEW CARRIAGEWAY / FOOTWAY / CYCLEWAY AREAS
- PROPOSED PENSTOCK
- PROPOSED SEDIMENT FOREBAY
- PROPOSED FLOW CONTROL MANHOLE
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED

CONFIDENTIAL
THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENTS REFER TO DRAWING NUMBERS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515 AND STANDARD NOTES.
6. FOR DETAIL OF M3 JUNCTION 9-14 MOTORWAY UPGRADE DRAINAGE DESIGN REFER TO MOTORWAY UPGRADE SCHEME DRAWING NUMBERS HE549338-JAC-HDG-S1-DN-MAINL-DR-CD-0002 TO 003.
7. PROPOSED DRAINAGE SCHEMATIC SHOWN IS SUBJECT TO REVIEW BY THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. PROPOSED RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
9. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING. THESE SHALL BE DETAILED DURING SGAR 5 (DETAILED DESIGN).
11. CONTROL OF RUN-OFF AND SEDIMENT DURING CONSTRUCTION IS TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING. THIS IS TO BE DEVELOPED DURING SGAR 5 (DETAILED DESIGN).
12. PROPOSED FORM OF DRAINAGE SYSTEM REQUIRED TO COLLECT THE SURFACE WATER RUN-OFF FROM THE CARRIAGEWAY SURFACE (eg. GULLIES, FILTER DRAINS ETC.) IS TO BE DETERMINED DURING SGAR 5 (DETAILED DESIGN).

SEDIMENT FOREBAY AREA SCHEDULE

BASIN	FOREBAY AREA (m²)	FOREBAY DEPTH OF FREEBOARD (mm)
1	10	150
2	40	300
3A	40	300
3B	40	300
3C	135	300
4	36	300
5	36	300

0 50 100 150 200 250m

SCALE 1:2500

Rev.	Date	Description	Drawn	Chk'd	App'd
P04	28.06.22	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	JH	LC	TRA
P03	24.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P02	15.10.21	UPDATES TO SUIT DESIGN DEVELOPMENT	RG	AC	TRA
P01	28.05.21	FIRST ISSUE	ME	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN PROPOSED SURFACE WATER DRAINAGE SCHEMATIC PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: Size	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21	Date: 28.05.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE551511 - VFK -HDG- X_XXXX_XX - DR - CD - 0512

Project Ref. No. 48176

Revision P04

TECHNICAL NOTE

Appendix E Hydrogeological Risk Assessment (HgRA)

Document ref: 330610074R1 M3 Junction 9 DQRA

M3 junction 9 improvement: Hydrogeological Risk Assessment

T1.02

M3 junction 9 improvement: Hydrogeological Risk Assessment

Prepared for

National Highways

Report reference:

330610074R1, October 2021

Report status:

Final

CONFIDENTIAL

New Zealand House, 160-162 Abbey Foregate,
Shrewsbury, Shropshire
SY2 6FD

Telephone: +44 (0)1743 276 100
Facsimile: +44 (01743 248 600

Registered Office:
Stantec UK Ltd
Buckingham Court
Kingsmead Business Park
Frederick Place, London Road
High Wycombe HP11 1JU
Registered in England No. 1188070

M3 junction 9 improvement: Hydrogeological Risk Assessment

	Name	Signature
Author	Richard Holtham Robert Sears	
Checked by	Robert Sears, Francis Crozier	
Reviewed by	Francis Crozier	

Revision record:

Issue	Date	Status	Comment	Author	Checker	Reviewer
1	21/09/21	Draft	Issued for comment	RAH, RCS	RCS, FKC	FKC
2	08/10/21	Final		RAH, RCS	RCS, FKC	FKC

Contents

1	INTRODUCTION	1
1.1	Background	1
1.2	Objectives	2
1.3	Scope of Work	2
1.4	Competent expert	2
2	DRAINAGE STRATEGY AND HEWRAT ASSESSMENT	4
3	BASELINE CONDITIONS	8
3.1	Site setting	8
3.2	Geology	8
3.2.1	Regional geology	8
3.2.2	Local Geology	13
3.2.3	Soil contamination	19
3.2.4	Infilled ground/landfilling and historical land use	19
3.3	Hydrology	21
3.3.1	Rainfall	21
3.3.2	Surface water features	22
3.3.3	Surface water quality	23
3.4	Hydrogeology	24
3.4.1	Groundwater classifications and systems	24
3.4.2	Groundwater Source Protection Zones (SPZs)	24
3.4.3	Aquifer properties	25
3.4.4	Groundwater levels and flow	26
3.4.5	Contaminated land and pollution events	36
3.4.6	Groundwater quality	37
3.5	Other potential receptors	40
3.5.1	Licenced water abstractions and discharges	40
3.5.2	Private water supplies	41

3.5.3 Designated environmental sites 42

4 CONCEPTUAL SITE MODEL 48

4.1 Sources 48

4.1.1 Carriageway drainage 48

4.1.2 Placement of potentially contaminated materials via cut and fill operations 48

4.1.3 Other sources of contamination 49

4.2 Pathways 49

4.2.1 Unsaturated zone 49

4.2.2 Saturated zone 49

4.3 Receptors 50

5 GROUNDWATER IMPACT ASSESSMENT 51

5.1 Road drainage 51

5.2 Filled areas 51

6 DETAILED QUANTITATIVE RISK ASSESSMENT FOR EDBS 54

6.1 Introduction 54

6.2 Model Parameterisation 54

6.3 Model Results 60

6.3.1 Level 1 Assessment 60

6.3.2 Level 2 Assessment – chronic pollution 60

6.3.3 Sensitivity analysis 62

7 CONCLUSIONS AND RECOMMENDATIONS 64

7.1 Conclusions 64

7.2 Recommendations 65

8 REFERENCES 66

FIGURES

Figure 1.1 Site location and points of interest 3
Figure 2.1 Application boundary and locations of EDBs 7
Figure 3.1 Bedrock geology 10
Figure 3.2 Superficial geology and artificial ground 12
Figure 3.3 Superficial geology - central area 13
Figure 3.4 Local superficial geology superimposed on proposed drainage 18
Figure 3.5 Historical landfill areas 21

Figure 3.6 Surface water features 23
Figure 3.7 Groundwater dip data from final day of installation works in mbgl 27
Figure 3.8 Groundwater levels data from final day of installation works in mAOD 28
Figure 3.9 Boreholes monitored for groundwater level 32
Figure 3.10 Groundwater level in Application Area SI boreholes in the Application Area (mAOD) 33
Figure 3.11 Groundwater level in Application Area SI boreholes in metres below ground level 34
Figure 3.12 Application Area overlaid on the Hydrogeological map (Institute of Hydrological Sciences, 1979) 36
Figure 3.13 Groundwater quality monitoring locations 38
Figure 3.14 Licenced and private abstractions and Source Protection Zones (SPZs) 42
Figure 3.15 Designated sites within 2 km 44

TABLES

Table 2.1 Summary of attenuation structures 5
Table 3.1 Stratigraphy of the bedrock geology in the Winchester (based on the BGS Sheet 299 (British Geological Survey, 2002) and BGS memoir (Booth et al., 2008) 9
Table 3.2 Summary of cavities hazard for each basin (from Appendix A of the Geotechnical Interpretation Report (Document Reference 7.11)) 14
Table 3.3 Summary of lithologies encountered from Geotechnical Interpretation Report (Document Reference 7.11) 16
Table 3.4 Historical landfill areas 19
Table 3.5 Outline definitions of Source Protection Zones 24
Table 3.6 Calculated soil infiltration rates (from Table 9.5 in Geotechnical Interpretation Report (Document Reference 7.11)) 26
Table 3.7 Groundwater level dip data during site investigation works in mAOD 29
Table 3.8 Groundwater monitoring locations 31
Table 3.9 Summary of groundwater levels (June 2019 to July 2020) 33
Table 3.10 Approximate depth to groundwater at unlined EDBs 34
Table 3.11 Pollution incidents within 2 km (from Envirocheck, 2016) 37
Table 3.12 Summary of groundwater quality data (based on data in Controlled Waters Risk Assessment in **ES Chapter 9: Geology and Soils** (Document Reference 6.1)) 39
Table 3.13 Private water abstractions (within 2 km of initial scheme boundary) 41
Table 3.14 Designated Sites within 2 km of the Application Area 43
Table 3.15 Licenced groundwater and surface water abstractions 45
Table 5.1 Summary of impacts 52
Table 6.1 Infiltration rates 55
Table 6.2 Source geometry 55
Table 6.3 Chronic Source terms (from HEWRAT) 56
Table 6.4 Acute source term concentrations (from HEWRAT – 95th percentile (mg/l)) 56
Table 6.5 Attenuation parameters 56
Table 6.6 Solubility parameters 57
Table 6.7 Target concentrations 58
Table 6.8 Hydrogeology parameters 59
Table 6.9 EDB2 Predicted concentrations (mg/l) 60
Table 6.10 EDB2 Predicted concentrations (mg/l) 60
Table 6.11 EDB2 Predicted concentrations (mg/l) 61
Table 6.12 EDB3B Predicted concentrations (mg/l) 61

Table 6.13 EDB3C Predicted concentrations (mg/l) 62
Table 6.14 Sensitivity run 1: fraction of organic carbon (mg/l) at 100 years 62
Table 6.15 Sensitivity run 2a: infiltration rate and unsaturated zone hydraulic conductivity (mg/l) at 100 years 63
Table 6.16 Sensitivity run 3: unsaturated zone thickness (mg/l) at 100 years 63

APPENDICES

Appendix A HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512_Drainage Schematic Plan
Appendix B HEWRAT screening assessments
Appendix C HE551551-VFK-HGT-X_XXXX_XX-DR-GE-004 Exploratory hole location plan
Appendix D HE551551-VFK-HGT-X_XXXX_XX-DR-GE-0020 Geological plan
Appendix E RAM model files (electronic appendix)

1 Introduction

1.1 Background

The M3 Junction 9 Improvement Scheme (the Scheme) is located at Junction 9 of the M3 to the east of Winchester, running north to south, centred in the Winnall area and extending north to Headbourne Worthy (Figure 1.1). The Scheme includes proposed motorway modifications including the introduction of a new on/off slip road to both northbound and southbound sides of the M3, new link roads between the A33, A34, A272 and M3 roads and a new overhead gyratory above the M3 corridor.

Parts of the Scheme are located in a low spot of the M3, towards which a total of approximately 1.6 km of the existing M3 corridor drains. A separate Motorway Upgrade is currently being constructed immediately to the south of the Scheme, which also drains towards the Land within the Scheme's Application Boundary (hereafter referred to as the "Application Area").

West of the Application Area are commercial and light industrial land uses associated with the Wykeham Trade Park and Winnall Industrial Estate. Most of the surrounding non-highway land is used for agricultural purposes, with arable grassland to the north, and a number of fisheries located to the west.

The Application Area is located in a sensitive hydrogeological environmental setting, located adjacent to the River Itchen, which underlies the M3 and A34 in the north. The River is a designated Main River, with the associated floodplain designated as a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). The Application Area is underlain by bedrock deposits of the White Chalk Subgroup, which are classified by the Environment Agency (EA) as a Principal Aquifer. Surrounding abstractions include thirty-one public abstractions, alongside nine abstractions for private water supplies within 2 km of the Scheme.

A ground investigation (GI) was previously undertaken, and additional works have been proposed by Stantec to provide supplementary information. Interpretation of the GI data is provided in the **Geotechnical Interpretation Report (Document Reference 7.11)**.

The Drainage Strategy Report which forms **Appendix 13.1: Chapter 13: Road Drainage and the Water Environment (Document Reference 6.1)** prepared for the planning application included a Highways England Water Risk Assessment Tool (HEWRAT) screening assessment. The results of the screening assessment are that all but one of the currently proposed Extended Detention Basins (EDT) present a 'medium risk' to groundwater and one has a high risk. LA113 (Road drainage and the water environment) (Highways England, 2020) states that where [HEWRAT] indicates a groundwater risk assessment is medium or high, a detailed assessment should be completed by a competent expert with the degree of detail being appropriate to the medium or high result.

A large area requires to be built up in the east of the Application Area (as shown in yellow on Drawing HE551511-VFK-HGN-X_XXXX_XX-SK-CH-0004_P03). It is expected that much of the material excavated from elsewhere in the Scheme will be used to fill this eastern area.

Piling will be undertaken as part of the works, and a piling risk assessment will be carried out prior to works commencing, in accordance with EA methodology. This risk assessment will consider impacts on the water environment.

1.2 Objectives

In its 'M3 Junction 9 Improvement – Environmental Impact Assessment (EIA) Scoping Notification and Consultation Reg 11' response to the Scoping Report the EA indicated concern, given the sensitivity of the groundwater environment beneath the Application Area.

Further comments were received from the EA in response to the Preliminary Environmental Information Report (PEIR). The EA states that its primary concern regarding the Scheme relates to the protection of groundwater, and protection / enhancement of the ecological balance and species within the River Itchen and surrounding areas.

This document has been prepared by Stantec UK Ltd (Stantec) on behalf of National Highways to provide the appropriate assessment for potential impacts to groundwater from the Scheme and, in particular, to address the concerns raised by the EA in its consultation responses.

1.3 Scope of Work

This report presents a Hydrogeological Risk Assessment (HgRA) to identify the significance of risks to the Chalk Aquifer and River Itchen. This HgRA is based on government guidelines appropriate to the geological and hydrogeological environment, which promote the protection of water bodies and related receptors from potential impact of development activities. Specific guidance referenced when undertaking the assessment include:

- Design Manual for Roads and Bridges (DMRB) LA 113 Road drainage and the water environment (Highways England, 2020).
- The EA's approach to groundwater protection (Environment Agency, 2018);
- Remedial Targets Methodology for contaminated land (Environment Agency, 2006);
- Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA, 2021); and
- Guidance on land contamination risk management (Environment Agency, 2021).

The scope of work undertaken for this HgRA includes the following:

- Review of the baseline geology and hydrogeology for the Application Area and surrounding area;
- Identification of receptors and assessment of potential impacts;
- Recommendations for appropriate monitoring and mitigation measures; and
- Preparation of a Detailed Quantitative Risk Assessment (DQRA) for risks that are qualitatively assessed as significant.

1.4 Competent expert

This report has been prepared by Stantec's Robert Sears, who is a hydrogeologist of over 30 years' experience. Robert is a Fellow of the Geological Society and is a Chartered Geologist.

Figure 1.1 Site location and points of interest

2 Drainage strategy and HEWRAT assessment

The Scheme's drainage strategy is described in the Drainage Strategy Report **Appendix 13.1: Drainage Strategy and Water Environment (Document Reference Appendix 6.1)**. The design approach is to install new gravity drainage for all new carriageway, or to replace existing highway drainage that is being built over by new impermeable highway, such as hardening of the central reserve and lane widenings.

In areas where existing carriageway is being overlaid only, then existing highway drainage is retained.

Areas of local, minor lane widenings proposed remote from the main works, are drained to existing highway drainage, which is modified, where required, to maintain existing discharge rates and no-flooding capacity.

All new drainage conveys run-off to extended detention basins (EDBs), which infiltrate to ground where the HEWRAT assessment of risk to groundwater, allows. These new EDBs are shown in Figure 2.1.

Runoff volumes are attenuated in the EDBs as far as space and acceptable draw-down times allow. Runoff volumes that are unable to drain to ground within a practical time period are discharged to the River Itchen.

Treatment of run-off before discharge is proposed as follows:

- Over-the-edge drainage of run-off from carriageways on embankments to filter strips and to infiltration ditches;
- Collection of run-off at carriageway edges in linear drains, gullies or filter drains, which is piped to the following:
  - Attenuation and Primary Settlement treatment in filtration forebays and unplanted, lined EDBs;
  - Attenuation, Secondary Settlement and Filtration treatment in vegetated EDBs, containing both wet and dry habitats; and
  - Tertiary treatment in a grassed swale prior to discharge to the River Itchen.

The only areas where existing linear infiltration drainage, or sealed drainage, is retained (and enhanced where necessary to limit flooding), will be the A33/A34 carriageway to the north of the River Itchen (above northing 131500) and M3 carriageway (above northing 131500). Both these retained areas are proposed to discharge to the River Itchen via existing open ditches or filter trenches.

The proposed drainage design is shown on Drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 which is included here as Appendix A. A summary of the EDBs is included in Table 2.1 and they are also labelled and shown on Figure 2.1.

Table 2.1 Summary of attenuation structures

Basin ref.	Type	Source	Inflows	Outfalls
1	EDB (lined)	Highway	From highway	To EDB 2
2	EDB (unlined)	Highway	From highway and EDB 1	To ground and river
3A	EDB (lined)	Highway	From highway	To EDB3B
3B	EDB (unlined)	Highway	From highway and EDB3A	To ground and EDB 3C
3C	EDB (unlined)	Highway	From highway and EDB3B	To ground and river via swale
4	EDB (lined)	Highway	From highway	To EDB 3A
5	EDB (unlined)	Rural overland flow and Highway runoff	From highway and rural land to east	To ground
6	EDB (unlined)	Rural overland flow	From rural land to east	To ground

Each EDB has been assessed using the HEWRAT. As detailed in the HEWRAT Help Guide (Highways England, 2015), the tool considers the following potential pollutants:

- acute pollution impacts associated with copper and zinc; and
- chronic pollution impacts associated with the following determinands in sediments: total copper, zinc, cadmium and total polycyclic aromatic hydrocarbons (PAH), including specific PAH's: pyrene, fluoranthene, anthracene, and phenanthrene.

For groundwater risk, HEWRAT uses an empirical approach taking into account the following factors:

- Traffic flow rate;
- Rainfall rate;
- Ratio of drainage area of road to active surface area of infiltration device;
- Infiltration method;
- Unsaturated zone thickness;
- Flow Type;

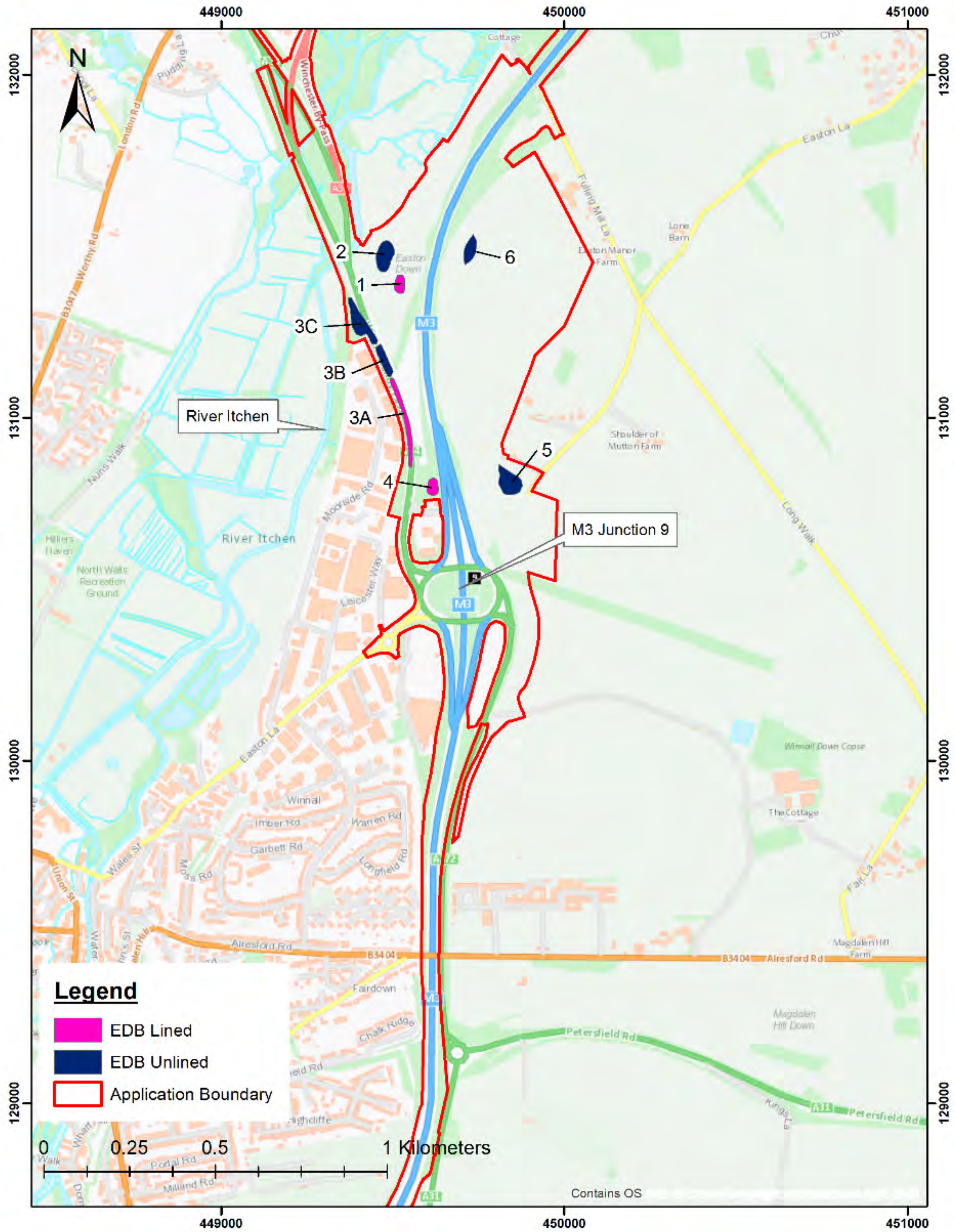
- Unsaturated zone clay content;
- Fraction of organic carbon; and
- Unsaturated zone soil pH.

For each of these parameters, a component score between 1 and 3 is assigned and this is then multiplied by a weighting factor for that parameter to provide a score. This process is repeated for all parameters and the scores are then summed to provide an overall risk score.

The HEWRAT screening assessments for each of the EDBs are presented in Appendix B. For the EDBs that discharge to ground, the highest scores (high risk) are derived where the unsaturated zone is thin (<5 m) and the flow type is dominated by fractures & fissures. The basins that get medium risk scores are those which either:

a) have a thicker unsaturated zone over fractures & fissures; or
b) have intergranular flow through superficial deposits & / or the unsaturated zone is thicker.

Figure 2.1 Application boundary and locations of EDBs



3 Baseline Conditions

3.1 Site setting

The Application Area is located in the River Itchen valley. The elevation in the west of the Applications Area is approximately 40 metres above ordnance datum (mAOD) and the land rises to the east up to a maximum of approximately 75 mAOD.

3.2 Geology

3.2.1 Regional geology

3.2.1.1 Bedrock

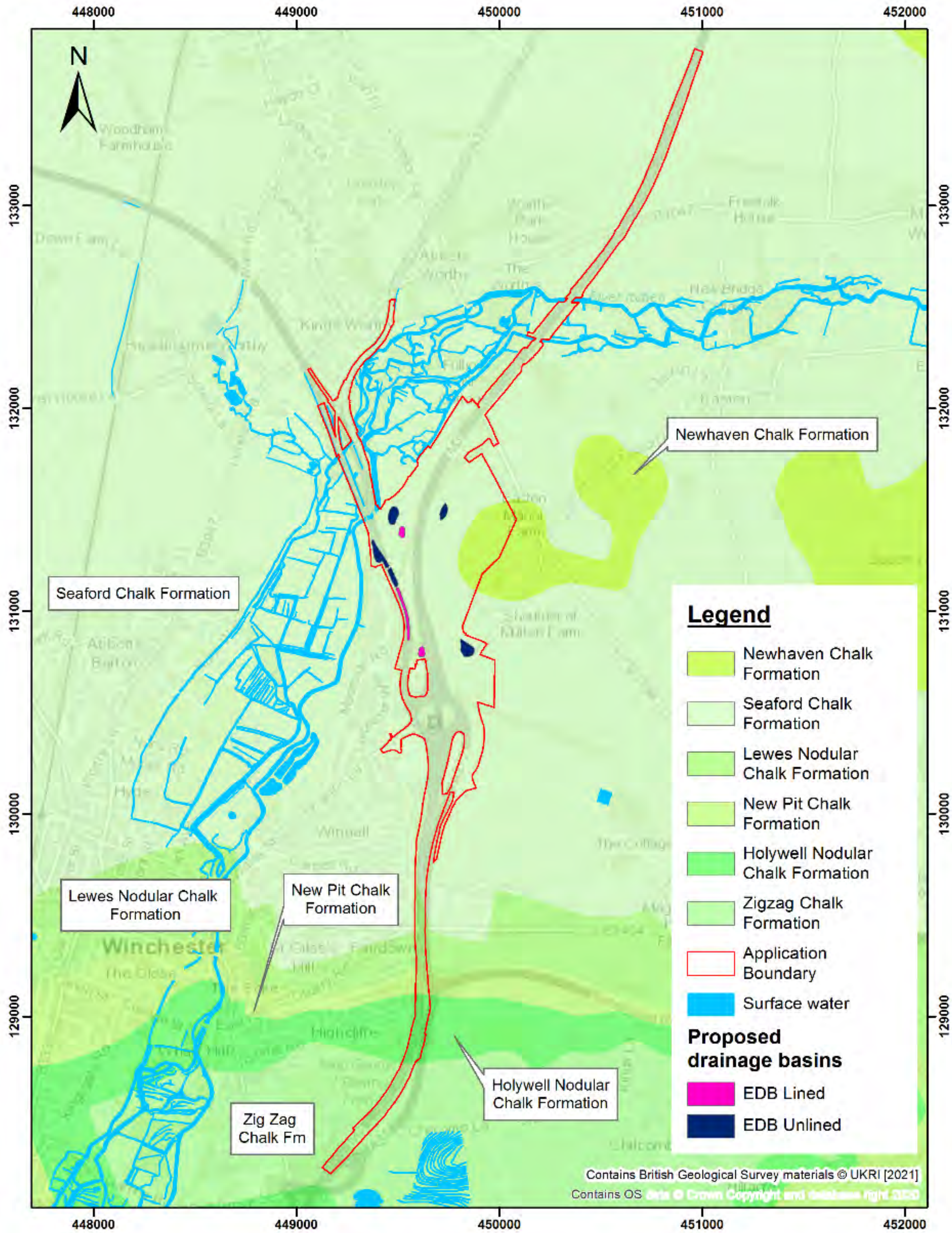
The British Geological Survey (BGS) indicates that the bedrock geology underlying the Application Area comprises the White Chalk Subgroup and the upper part of the Grey Chalk Formation of the Late Cretaceous era (Figure 3.1). The stratigraphy of the rock units in the Application Area and surrounding area are summarised in Table 3.1. In the Application Area, the five lower formations of the White Chalk outcrop, with the Seaford Chalk Formation outcropping across the majority of the Application Area, including the central area around Junction 9 itself and the River Itchen. The Seaford Chalk Formation typically consists of firm white chalk, with nodular and tabular flint seams. Underlying the Seaford Chalk are the Lewes Nodular Chalk Formation, New Pit Chalk Formation, Holywell Nodular Chalk Formation (all of the White Chalk) and Zig Zag Chalk Formation (Grey Chalk Subgroup). These units crop out to the south of the Spitfire Roundabout (A31 and A272). Above the Seaford Chalk Formation is the Newhaven Chalk Formation, which outcrops in small areas in the north of the Application Area.

The Application Area lies on the Winchester-East Meon Anticline, an east to west trending fold. In the main central area of the Application Area, the strata dip 5-10 degrees to the north. In the south of the Application Area, south of the Spitfire Roundabout, the strata dip 4 degrees to the south.

Table 3.1 Stratigraphy of the bedrock geology in the Winchester (based on the BGS Sheet 299 (British Geological Survey, 2002) and BGS memoir (Booth et al., 2008)

	Name	Thickness	Description	Present at surface at Application Area?
White Chalk Sub-group	Portsdown Chalk Formation	5	White chalk with marl beds and a few flint bands	No
	Culver Chalk Formation	50-70	White chalk with flints and many thin marl beds. Comprises the Tarrant Chalk Member and the Spetisbury Chalk Member.	No
	Newhaven Chalk Formation	40-70	Soft to medium hard, white chalk with flints and many thin marl beds (20-70 mm thick).	Yes – small areas in the north
	Seaford Chalk Formation	40-65	Soft white chalk with seams of large nodular and semi-tabular flint. Commonly blocky.	Yes – majority of central area
	Lewes Nodular Chalk Formation	55-65	White, interbedded hard, nodular chalks with soft-medium chalks and marls. Contains persistent seams of flints near the base. Conjugate fractures. Contains karstic features in the Twyford Down Cutting (approx. 500 m south of Application area – See Figure 1.1) including a partially sediment-filled paleaocave system and calcreted karst.	Yes
	New Pit Chalk Formation	40-45	White chalk with many regularly spaced marl beds. Massive and medium hard. Flint beds in the upper half of the succession. Conjugate fractures.	Yes
	Holywell Nodular Chalk Formation	25-30	Hard, nodular chalk with some shelly beds. Characterised by shell debris. Includes Melbourn Rock (c. 5 m) and Plenus Marls (1-3 m) at base.	Yes
Grey Chalk Sub-group	Zig Zag Chalk Formation			Yes

Figure 3.1 Bedrock geology



3.2.1.2 Superficial deposits

Superficial deposits are shown on Figure 3.2 and Figure 3.3. The majority of the Application Area is not underlain by superficial deposits; however, in the north of the Application Area, the M3 and A34 is underlain by alluvium and head deposits. Alluvium deposits of the River Itchen form a band that is crossed by the M3 and A34, within the Application Area, and also is located to the west of the Application Area. Alluvium is typically formed of unconsolidated detrital material deposited by a river or stream and comprises sorted or semi-sorted sediment within the riverbed or floodplain. This can have a variable lithology depending on the river environment and may comprise clay, silt, sand, peat or gravel. Borehole data available from the British Geological Survey (BGS) indicate that the Alluvium comprises 1 to 1.5 m of peaty silts and clays above 4.5 to 5.5 m of dense gravels (Booth, et al., 2008).

Head deposits are located beneath the north-eastern part of the Application Area beneath the M3 and in smaller lateral bands located north and south of the of the M3 Junction 9 roundabout (see Figure 3.2). To the northeast an area of the M3 crosses through superficial deposits of Head 1; this comprises clay, silt, sand and gravel, often poorly sorted and poorly stratified, formed mostly by solifluction and / or hillwash and soil creep. The smaller bands of Head are composed of clay, silt, sand and gravel that is poorly sorted and poorly stratified containing angular rock debris and clayey hillwash and soil creep that is mantling a hillslope and deposited by solifluction and gelifluction processes.

Except for a small area of Basin 3A (lined) and approximately half of Basin 5 (unlined), none of the other drainage features are shown by the BGS mapping to be underlain by superficial deposits (see Figure 3.3).

Figure 3.2 Superficial geology and artificial ground

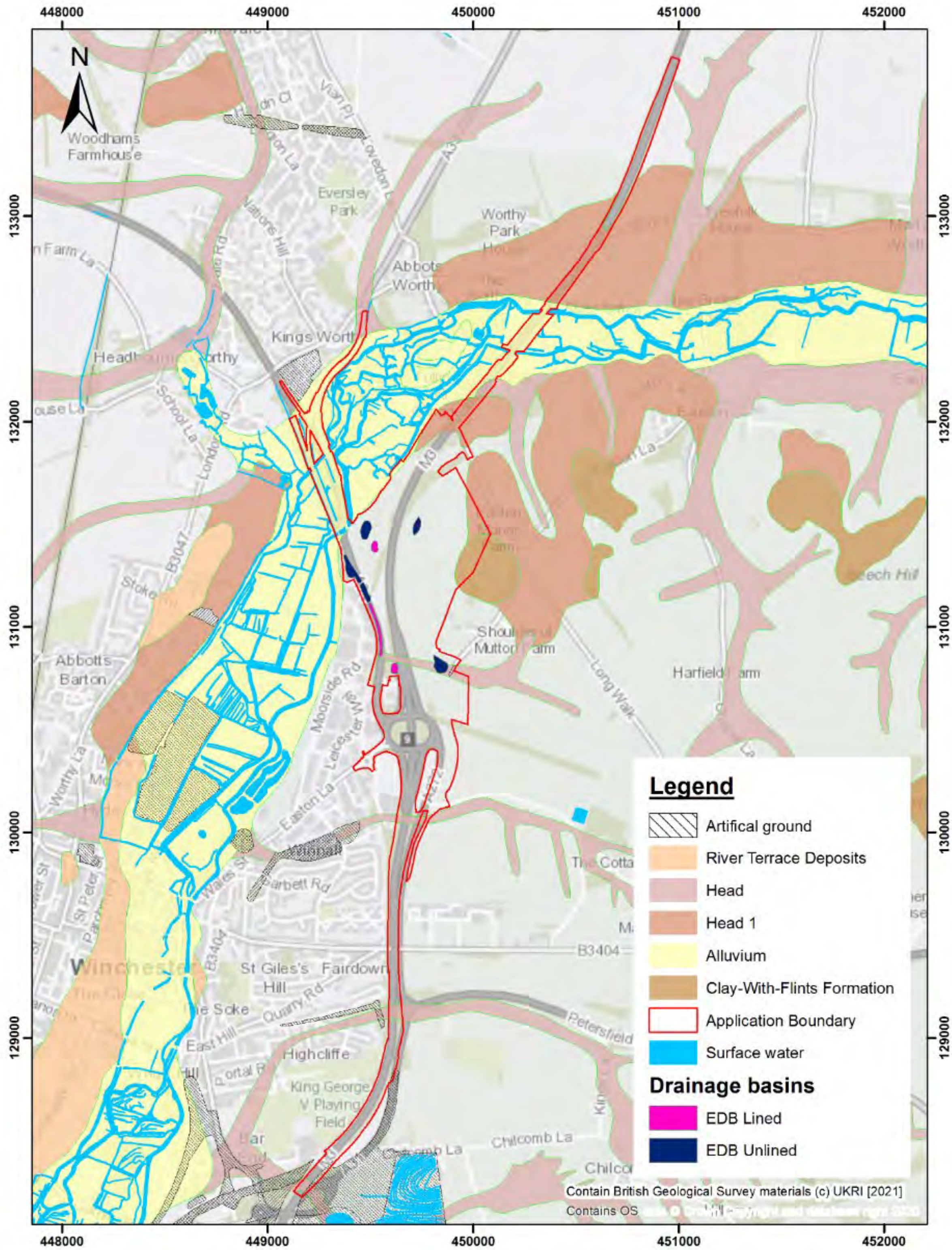
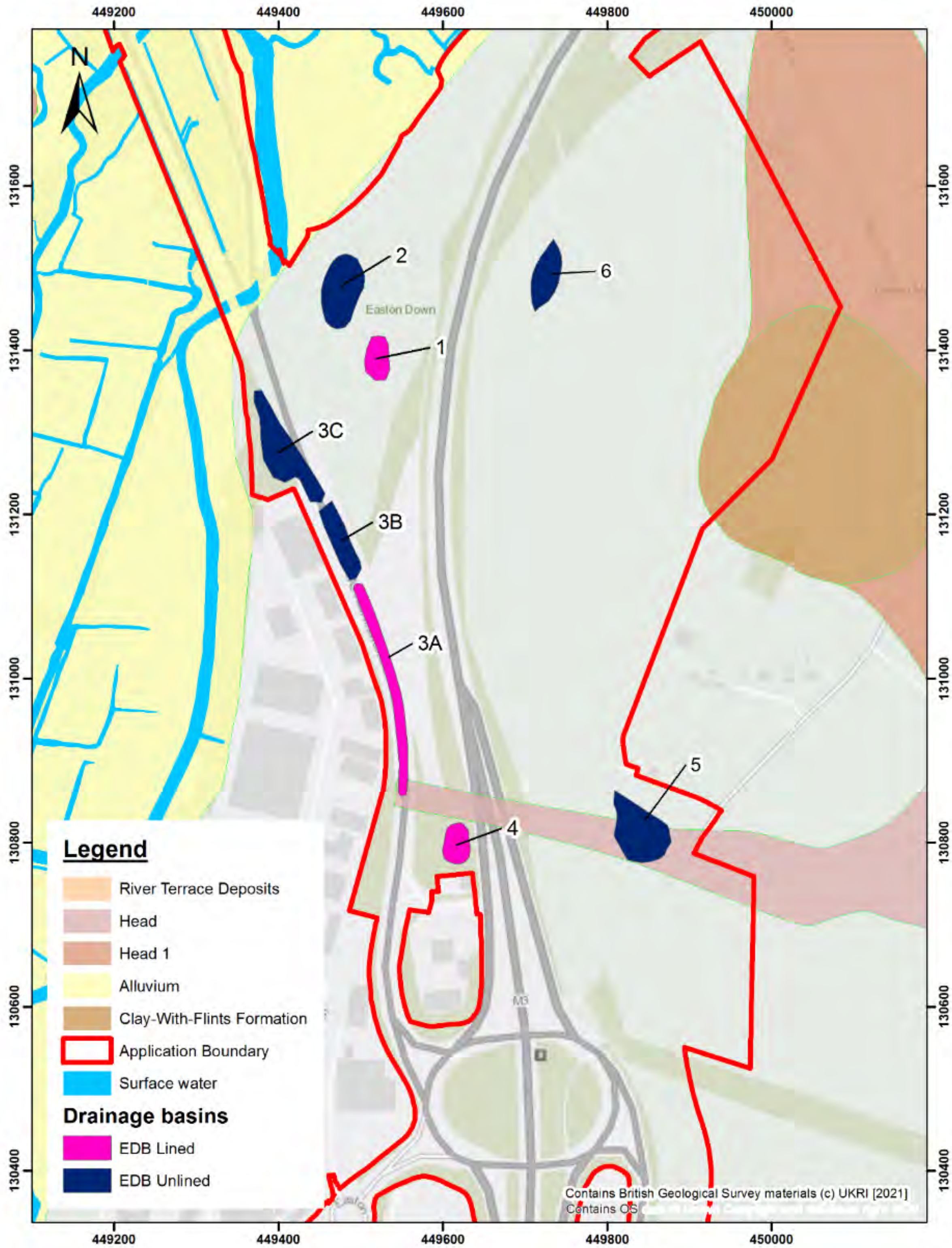


Figure 3.3 Superficial geology - central area



3.2.2 Local Geology

Soils

Soilscapes classifies the majority of the soils within the Application Area as being freely draining, shallow lime-rich soils over chalk limestone. The agricultural land classification and soil resources report prepared for the Scheme by Reading Agricultural Consultants identifies these as being soils of the Andover 1 association (Reading Agricultural Consultants, 2021). Towards the northeast of the Application Area the soils become fen peat soils, classified as being Charity 2 association, which drain to local groundwater.

Underground cavities

A Cavities Risk Assessment has been undertaken as part of the **Geotechnical Interpretation Report (Document Reference 7.11)**. There was one natural cavity record within 500 m of the Application Area, which was 10 solution pipes on the course of the River Itchen.

A summary of the Hazard ratings for each basin is given in Table 3.2 below. The Hazard rating represents the likelihood for cavities to be present. Most basins are located in an area of Moderate-Low hazard for both natural and mining cavities which means they may occur but are unlikely. A Moderate hazard rating means that they may occur, but probably at a single location.

Table 3.2 Summary of cavities hazard for each basin (from Appendix A of the Geotechnical Interpretation Report (Document Reference 7.11))

Basin	Natural cavity hazard	Mining cavity hazard
1	Moderate-Low	Moderate-Low
2	Moderate-Low	Moderate-Low
3A	Moderate-Low and Moderate	Moderate-Low
3B	Moderate-Low	Moderate-Low
3C	Moderate-Low	Low and Moderate-Low
4	Moderate-Low and Moderate (small area)	Moderate-Low
5	Moderate and Moderate-Low (small area)	Moderate-Low
6	Moderate-Low	Moderate-Low

Encountered geology

The GI information is presented and reviewed in the **Geotechnical Interpretation Report (Document Reference 7.11)**. A summary of the factual report of this investigation is given in Table 3.3. The borehole locations are shown on Drawing HE551551-VFK-HGT-X_XXXX_XX-DR-GE-004 which is included here as Appendix C.

The local superficial geology is shown on Drawing HE551551-VFK-HGT-X_XXXX_XX-DR-GE-0020 which is included here as Appendix D and overlain onto Figure 3.4.

In the central area around the drainage features, the Application Area is typically underlain by topsoil, Made Ground / Engineered Fill and Seaford Chalk Formation. This is in broad agreement with the publicly available BGS data.

In the central area of the Application Area where the EDBs are proposed, the superficial deposits extend further eastwards than indicated by BGS mapping. A summary is given below of the likely superficial geology at each of the EDBs, although it is noted that there is insufficient borehole coverage to make a detailed assessment.

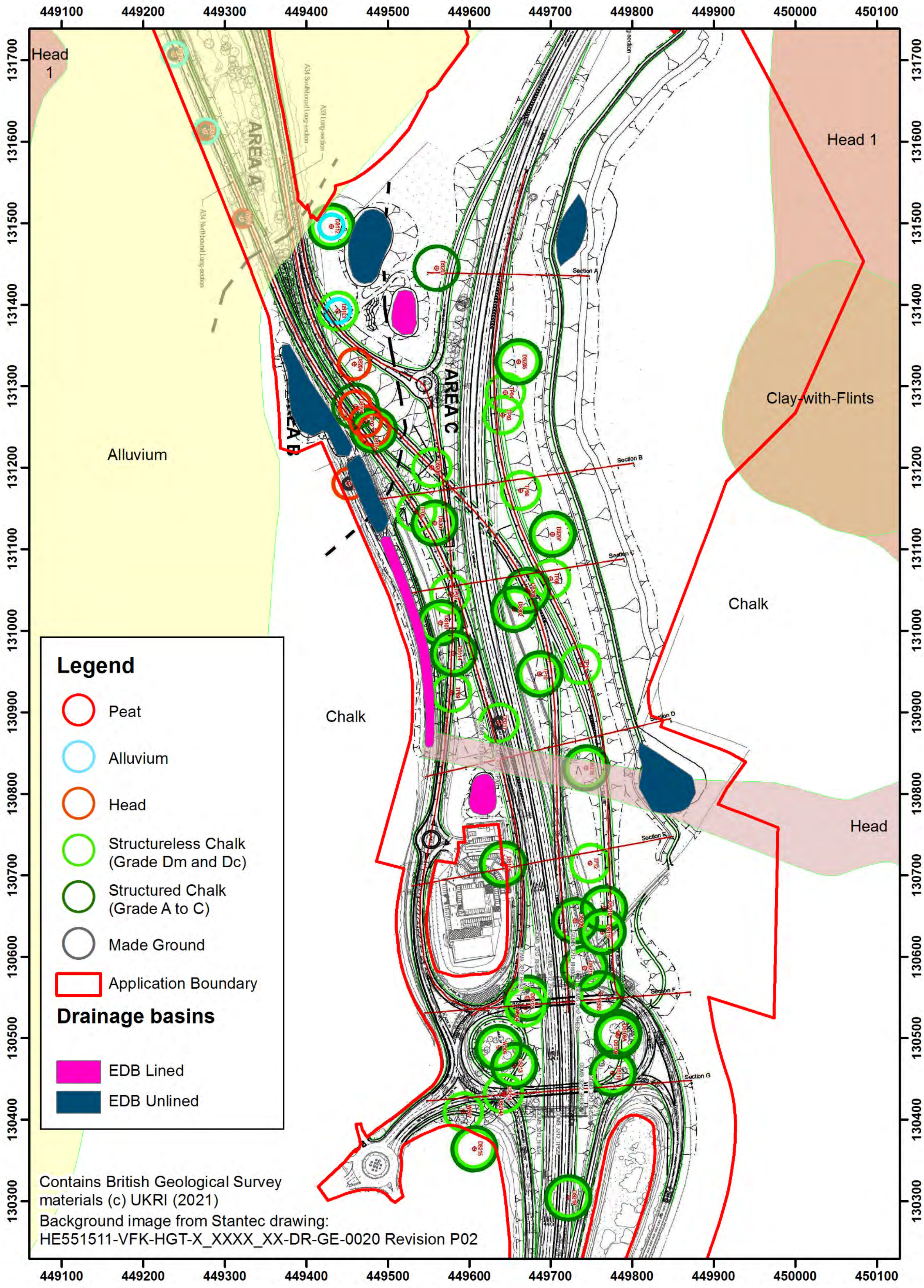
- EDB1. Borehole DS203 shows that there is no superficial geology present close to this location. The EDB drains directly onto structured chalk.
- EDB2. Borehole DS112 suggests that alluvial deposits may be present under this EDB to a depth of 5 m, which is in turn underlain by structureless chalk to a depth of 6.23 m followed by structured chalk.
- EDB3A. Boreholes DS107 and DS114 and trial pits TP07 and TP09 are located to the east of this EDB. The trial pits show structureless chalk whilst the boreholes show structureless chalk to a depth of 1.2 m underlain by structured chalk.
- EDB3B. Borehole WS08 is located immediately west of the northern end of this EDB. This borehole recorded Made Ground to a depth of 5.11 m comprising predominantly white chalk recovered as silty clay with fractured flint. This is underlain by 1.89 m of head comprising a sandy, gravelly, silty clay. The base of the head deposits was not penetrated.
- EDB3C. Boreholes DS104 and DS105 and trial pit TP02 are located east of the southern end of this EDB. TP02 recorded 0.3 m of made ground comprising clayey sand. This is underlain by 3.7 m of alluvium to the base of the pit. The alluvium predominantly comprised a silty or sandy, gravelly clay. Borehole DS104 encountered made ground to 0.3 m, comprising clayey sand. This is underlain by 8.2 m of alluvium to the base of the borehole. The alluvium comprised a sandy gravelly clay with interbedded gravel. Borehole DS105 encountered made ground to 0.35 m, comprising clayey gravelly sand. This is underlain by 5.65 m of head which comprised a gravelly, silty clay. This is underlain by 2 m of structureless chalk followed by structured chalk.
- EDB4. There are no GI boreholes adjacent to this EDB. The nearest boreholes are DS217 and DS108. Both of these record structureless chalk overlying structured chalk. Given this EDBs location further to the east, it is likely that it is underlain by chalk.
- EDB5 and EDB6. No GI data in the vicinity of these EDBs, but underlying geology is likely to be chalk.

Table 3.3 Summary of lithologies encountered from Geotechnical Interpretation Report (Document Reference 7.11)

Layer	Range of depths encountered (m)	Location and brief description
Topsoil	0.0 - 0.45	Encountered in 16 out of 53 boreholes. Grass over light- to dark- brown slightly gravelly clayey sand or sandy gravelly clay.
Made ground / Engineered fill	0.0 - 11.35	Varied across the Application Area, but typically comprised tarmac, sub-base, reworked chalk, gravelly sandy clay with flint cobbles, varying concrete and brick gravel content. It is noted in the **Geotechnical Interpretation Report (Document Reference 7.11)** that in some areas the strata identified by Soils Limited as Made Ground may also be Engineered Fill. Engineered Fill is typically structureless chalk recovered as slightly clayey silty sandy gravel. The Engineered Fill is likely to originate from the construction of the M3, A33 and A34.
Alluvium / Head	0.0m – 9.15,	Located in the north of the investigation area along the A34. Comprising clayey, sandy gravel with low flint cobble content, clayey gravelly sand or silty, sandy, gravelly clay. In places deposits comprised solely sands, gravels and cobbles, with the fines assumed to have been washed away. Peat was encountered as part of the alluvial deposits; this comprised firm brown mottled grey silty slightly sandy gravelly fibrous peat, with fragments of black organic material or plastic dark brown pseudofibrous peat. The **Geotechnical Interpretation Report (Document Reference 7.11)** has reclassified the Alluvium identified by Soils Limited as Head at some locations.

Layer	Range of depths encountered (m)	Location and brief description
Head	0.0 and 7.0	Located in the north of the Scheme and comprising dark brown slightly clayey gravelly sand and firm to stiff silty sandy gravelly clay. Often interbedded cohesive and granular horizons.
Seaford Chalk	0.0 and 30.45 (base of borehole)	Consists primarily of very weak, low density white chalk recovered as gravelly silty clay; structureless silty gravel and cobbles (CIRIA Grade Dm or Dc); structureless chalk composed of slightly sandy silty gravel or clay; weak low density white chalk (CIRIA Grade A3 to C5) or very weak to weak low to medium density speckled chalk (CIRIA Grades A to C). Rare cobbles and gravel comprised of angular flints were also present. It is noted in the **Geotechnical Interpretation Report (Document Reference 7.11)** that the classification of these chalks as structured or unstructured may not be consistent.

Figure 3.4 Local superficial geology superimposed on proposed drainage



3.2.3 Soil contamination

Geoenvironmental testing was carried out during the GI as detailed in the **Geotechnical Interpretation Report (Document Reference 7.11)** to determine the concentrations of contaminants of selected soil and groundwater samples. The testing suite comprised a range of heavy metals, inorganic and organic compounds, and for soils an asbestos screen.

The Geotechnical Interpretation Report states that the vast majority of the soil results are below the selected assessment criteria. The exception to this is one sample out of the 126 samples tested which indicated a marginal exceedance of the Public Open Space assessment criteria for Beryllium (2.3mg/kg compared to an assessment criteria of 2.2 mg/kg). The **Geotechnical Interpretation Report (Document Reference 7.11)** does not consider this significant when compared to the Generic Assessment Criteria.

In addition, waste acceptance criteria (WAC) testing of 10 samples of near surface material was undertaken to allow a preliminary determination of the waste characterisation of any material to be disposed of to landfill. The results of the WAC tests analysis classify the near surface material tested as appropriate for disposal at an Inert Waste Landfill.

3.2.4 Infilled ground/landfilling and historical land use

Infilled ground, landfilling and other historical land uses may be sources of contamination to the water environment.

There are 13 historical landfill areas shown on EA mapping data in the vicinity of the Application Area. The information is summarised in Table 3.4 and the locations are shown on Figure 3.5. These data show there are four historical landfills within or directly adjacent to the Application Area:

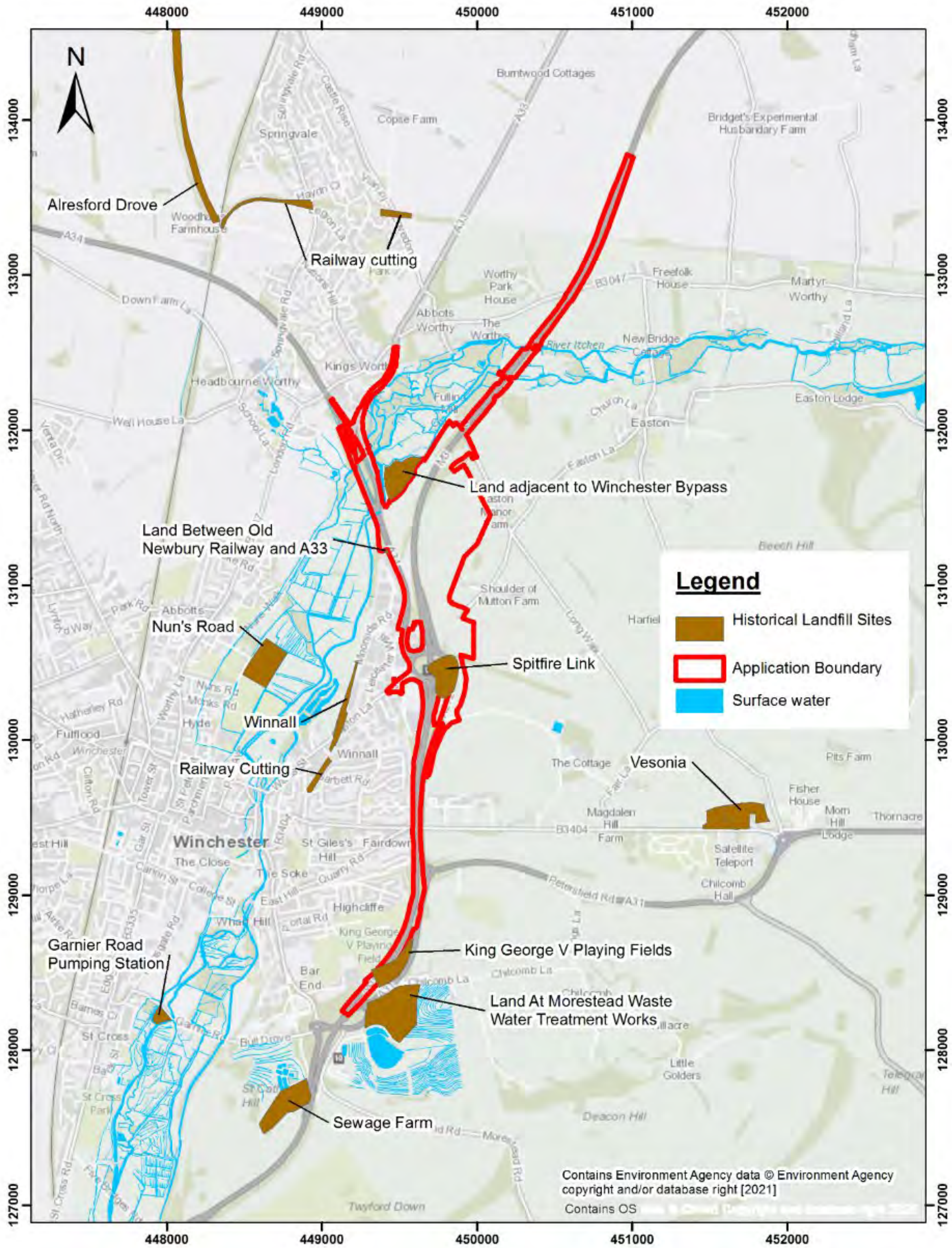
Table 3.4 Historical landfill areas

Name	Waste type	Dates active	Distance from site	Comments
Spitfire Link	No further information		On site	Soil Limited (2020) drilled six exploratory boreholes within or adjacent to the mapped boundary. No records of waste are indicated on borehole logs.
King George V Playing Fields	No further information		On site and adjacent to east	
Land adjacent to Winchester Bypass	Inert	1967-1968	Adjacent to north	Timings suggest related to Winchester Bypass widening. Controlled Waters Risk Assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)**

Name	Waste type	Dates active	Distance from site	Comments
Land Between Old Newbury Railway and A33	No further information		Adjacent to west	Very small so likely to have been a commercial operation. Controlled Waters Risk Assessment **Chapter 9: Geology and Soils (Document Reference 6.1)**
Land At Morestead Wastewater Treatment Works	Inert	1993-2001	30 m southeast	-
Winnall	Commercial and household	1969-	220 m to west	-
Sewage Farm	Commercial and household	Not provided	490 m to south	-
Railway Cutting (near to Winnall landfill)	Inert and commercial	1978-	530 m west	-
Nun's Road	Inert and Industrial	1963-	730 m to west	-
Railway cutting (two parts)	No further information		850 m to north	-
Alresford Drove	Commercial and household	Not provided	1 km northwest	-
Vesonia	Inert and commercial	1979-	1 km east	-
Garnier Road Pumping Station	Commercial and household	1910-	1.1 km west	-

A Controlled Waters risk assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)** has identified a number of other potential sources of contamination that are relevant to this study. These comprise a former gas works and iron works, railways, and land of mixed industrial use within or close to the Application Area that may also be a source of contaminants in soils.

Figure 3.5 Historical landfill areas



3.3 Hydrology

3.3.1 Rainfall

The Standard Average Annual Rainfall (SAAR) for the area around the Itchen at Easton river monitoring point (42016) is 848 mm (NRFA, 2021).

3.3.2 Surface water features

Surface water features in the vicinity of the Application Area are shown on Figure 3.6.

Watercourses

The River Itchen flows east to west across the northern part of the Application Area and then flows south to the west of the Application Area approximately parallel with the M3. The River Itchen is a chalk stream comprising a number of anabranches in the area around Winchester and the Application Area. There is also a network of ditches that are connected with the Itchen that follow the boundaries of the former water meadows within the Itchen floodplain. The Itchen is a designated Main River, with the associated floodplain designated as a SAC and SSSI. Much of the floodplain to the west of the central part of the Application Area is managed as the Winnall Moors Local Nature Reserve.

According to the National River Flow Archive the mean flow data of the River Itchen upstream of the Application Area (location 42016 - Itchen at Easton) is 4.239 m^3/s. Downstream of the Application Area (location 42010 - Itchen at Highbridge & Allbrook Total) mean flow is 5.539 m^3/s, implying that the River gains within the Application Area. Both locations show evidence of substantial surface and groundwater abstraction and the presence of cress beds and fish farms. The baseflow index (BFIHOST) at the River Itchen at Easton is 0.95, indicating that it almost entirely groundwater fed.

To the west of the River Itchen is Nun's Walk Stream, which flows parallel to the track/road of the same name and the Itchen. This is also a designated Main River. Ordnance Survey mapping indicates that Nun's Walk Stream starts around springs at Headbourne Worthy in the north and flows southwest parallel with the Itchen on a straight course and joins with an Itchen anabranch at the north end of Park Road, Winchester, south of the River Park Leisure Centre, approximately 2.5 km to the south.

In the surrounding area, there are very few water courses or water features other than the River Itchen that lie on the Chalk, and this is generally due to the high secondary porosity and permeability of the Chalk allowing rainfall to infiltrate and recharge the aquifer directly.

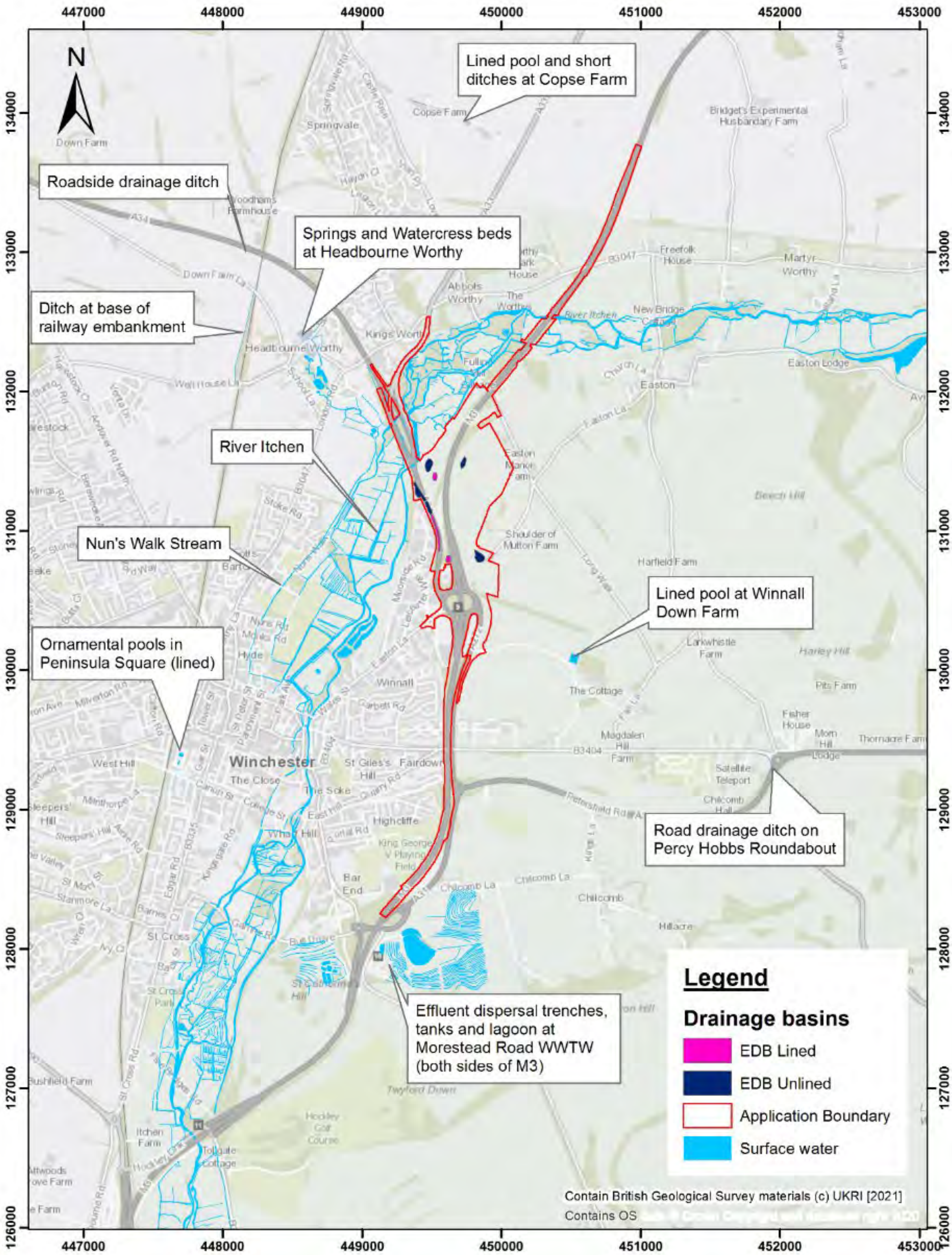
Waterbodies

There are a number of water bodies that fall within the course of the River Itchen. There are three waterbodies located on the eastern side of the Itchen south of the Junction 9 roundabout. There is also a square pond at Winnall Down Farm (125 m from the Application Area, that given its shape is very likely to be manmade, and it appears from satellite imagery that it is lined.

To the south around St Catherine's Hill and Chilcomb there are many effluent dispersal trenches, tanks and a lagoon forming part of the Morestead Road Wastewaster Treatment Works. These features are both to the west and east of the M3.

There are number of fisheries and water cress ponds in the surrounding area that rely on chalk-fed water features, such as those in Headbourne Worthy, 480 m to the west of the Application Area. These ponds are fed by springs from the chalk. There are also watercress ponds around New Alresford, 8 km to the east of the Application Area and upstream on the River Itchen.

Figure 3.6 Surface water features



3.3.3 Surface water quality

No surface water samples were taken as part of the site investigation undertaken by Soils Limited in 2019.

3.4 Hydrogeology

3.4.1 Groundwater classifications and systems

The Alluvium underlying the north of the Application Area is classified by the EA as a Secondary A aquifer, meaning it is a formed of permeable layers capable of supporting water supplies at a local rather than strategic scale, and can provide an important source of base flow to rivers.

The Head deposits are classified as Secondary Undifferentiated aquifer. These are layers for which it has not been possible to determine a permeability due to the variable characteristics of the rock type.

The Chalk Subgroup is classified by the EA as a Principal Aquifer, due to its high fracture permeability, and as such it supports water supply and river base flow on a strategic scale. The Chalk is a dual porosity aquifer with rapid flow occurring through fracture networks and slower flow through the porous matrix.

The top of the Chalk is logged as structureless chalk. Structureless chalk tends to have fewer fissures and fractures and the clayey matrix is often a barrier to groundwater flow.

The Groundwater Vulnerability maps from the EA indicates that the groundwater is of High vulnerability to pollutant discharge at the surface in areas without superficial cover and Moderate-High vulnerability in areas with superficial cover.

3.4.2 Groundwater Source Protection Zones (SPZs)

The Application Area lies within two overlapping groundwater Source Protection Zones (SPZ); which relate to groundwater sources that are used for public drinking water supply. The definitions of each zone are described in Table 3.5 below. There is also another SPZ to the northwest and one to the south. The SPZs are shown on Figure 3.14.

Table 3.5 Outline definitions of Source Protection Zones

Zone	Outline definition (from Environment Agency website – (Environment Agency, 2019)
Zone 1 (Inner Zone)	Defined by a 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.
Zone 2 (Outer Zone)	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. Older SPZs may have used a different methodology.
Zone 3 (Total Catchment)	Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

The SPZ in the northeast of the Application Area is for two Southern Water public water supply boreholes near Easton and lies mostly along the M3 north of the Application Area[1]. Where the Application area is within the SPZ it is mostly in Zone 1, with the northernmost area in Zone 2 (c. 860 m of M3).

[1] Note that co-ordinates are not available for the Itchen Valley PWS's near Easton.

There is also an SPZ approximately 450 m to the northwest of the Application Area associated with the Headbourne Worthy Watercress Beds. These beds are fed by springs. The area closest to the Application Area is in Zone 1 with the 'tail' of Zone 2 and 3 spreading to the northwest away from the Application Area.

There is another SPZ 1 km southeast of the Application Area which is related to further Southern Water public water supply boreholes.

The Drinking Water Groundwater Safeguard Zone (DWGSZ) for the River Itchen Chalk covers Zone 1 and 2 of the SPZ.

3.4.3 Aquifer properties

The Chalk exhibits both matrix flow and fracture flow and the Seaford Chalk Formation has regular orthogonal joint sets (Allen, et al., 1997). The Seaford Chalk usually has high storage although not always high permeability due to the narrow apertures of the fractures (Allen, et al., 1997). Numerous fractures are identified in the chalk in borehole logs.

It is common for there to be higher permeability in chalk river valleys. Palaeogene sediments in river valleys tend to be quite acidic, enhancing dissolution (Allen, et al., 1997). Transmissivities in the Hampshire Basin area are reported in Allen *et al.,* (1997) from 0.55 to 29,000 m^2/d with a geometric mean of 1,600 m^2/d. Allen *et al.* (1997) note that these values are high due to higher number of tests near to rivers. Transmissivity values of 1,000 m^2/d are common in the valley areas. The Candover valley, a tributary of the Itchen to the east, has transmissivities of 1,000 - 3,000 m^2/d and a storage coefficient of 0.01-0.03. Folding tends to enhance fracturing of rocks. However, it also notes that in the axes of anticlines, such as is found here, aquifer properties are thought to be less well developed, with groundwater mounds and lower transmissivities of 100 m^2/d. (Entec, 2002) within (WPK, 2007) suggest transmissivities in the Winchester Anticline are 100-600 m^2/d.

At the Itchen Valley (Easton) Public Water Supply (PWS) to the north of the Application Area, transmissivities of 2,400 and 4,700 m^2/d have been calculated from pumping tests (Environment Agency, 1997 within WPK, 2007).

If we assume that the transmissivity is concentrated in the top 50 m of the Chalk, then a transmissivity of 1,000 m^2/d equates to a hydraulic conductivity of 20 m/d. Below 50 m, chalk fissures tend to be closed due to the mass of rock above them and yields decrease.

Variable head permeability tests were undertaken during the site investigation by Soils Limited. However, it is understood that these tests were undertaken above the watertable and thus may not reflect the hydraulic conductivity of the strata tested. In the **Geotechnical Interpretation Report (Document Reference 7.11)** calculated soil infiltration rates to use as an indication for preliminary designs. Table 9.5 from the **Geotechnical Interpretation Report (Document Reference 7.11)** is reproduced here as Table 3.6. Based on these calculations a soil infiltration rate of 1×10^{-6} m/s was adopted for Alluvium, Head and Structured Chalk within 2 mbgl (metres below ground level), and 1×10^{-5} m/s for Structured Chalk below 2 mbgl.

Table 3.6 Calculated soil infiltration rates (from Table 9.5 in Geotechnical Interpretation Report (Document Reference 7.11))

Location	Test depth range (mbgl)	Geology as per borehole record logs (mbgl)	Soil infiltration – calculated (m/s)	Soil infiltration(m/hr)
DS104	0 - 4	0.3 - 3.0 Sandy gravelly clay [Alluvium] 3.0 - 4.0 No description [Alluvium]	9.5×10^{-6}	3.4×10^{-2}
DS107	0 - 4	0.4 - 1.2 Structureless chalk 1.7 - 4.0 Chalk Grade B2	1.4×10^{-5}	5.2×10^{-2}
DS109	0 - 3	0.5 - 1.2 Structureless chalk 1.2 - 3.0 Chalk Grade B2	2.8×10^{-5}	1.0×10^{-1}
DS210	0 - 4	0 - 1.7 Structureless chalk (Grade Dc) 1.7 - 4.0 Chalk Grade B2	4.2×10^{-6}	1.5×10^{-2}
DS301	5.7 - 10.15	5.7 - 7.0 Chalk Grade A3-A4 7.0 - 10.15Chalk Grade A3	1.1×10^{-4}	4.1×10^{-1}

Yields in the Lewes to Portsdown Formations are typically 10.5 l/s in boreholes in the Winchester District (Booth, et al., 2008). Booth *et al.* also note that "*rapid groundwater flows are sometimes found in the unconfined chalk aquifer where karstic-type development has taken place. This is commonly associated with the proximity of thin cover, such as the Palaeogene deposits or clay-with-flints".*

3.4.4 Groundwater levels and flow

Available data

Limited groundwater monitoring data are available. Monitoring wells were installed by Soils Limited during March and April 2019 at 23 locations and dips were taken at 13 from the installation until 15th April 2019. Four locations (DS104, DS114, DS301, DS302) were then monitored hourly using pressure transmitters and loggers for the period June 2019 to July 2020.

Groundwater levels

Dip data

Fourteen boreholes were dipped once installed and typically each day during the site investigation works by Soils Limited. The dips and levels on the final day (15th April 2019) are plotted on Figure 3.7 and Figure 3.8 respectively, which also shows the locations. The dip data is provided in Table 3.7 for the whole GI period (where available). These data are taken from the Soils Limited (2020) Factual Report and converted to metres above ordnance datum based on the groundwater elevations provided in the report. A number of boreholes were dry throughout the works period. These data indicate that the groundwater level across the central part of the Application Area is approximately 37.5 mAOD. Groundwater levels at DS208 are noticeably higher at 52.04 mAOD, which is because this borehole is screened in the Seaford Chalk at a higher elevation of 51.91-54.91 mAOD, whereas the other boreholes are screened below 30 mAOD. There is therefore a locally perched groundwater table at DS208.

Groundwater seepage was encountered during the Jacobs Application Area investigation at a depth of 3.10 mbgl in WS02 and 4.50 mbgl in WS03, and 7 mbgl in WS08.

Figure 3.7 Groundwater dip data from final day of installation works in mbgl

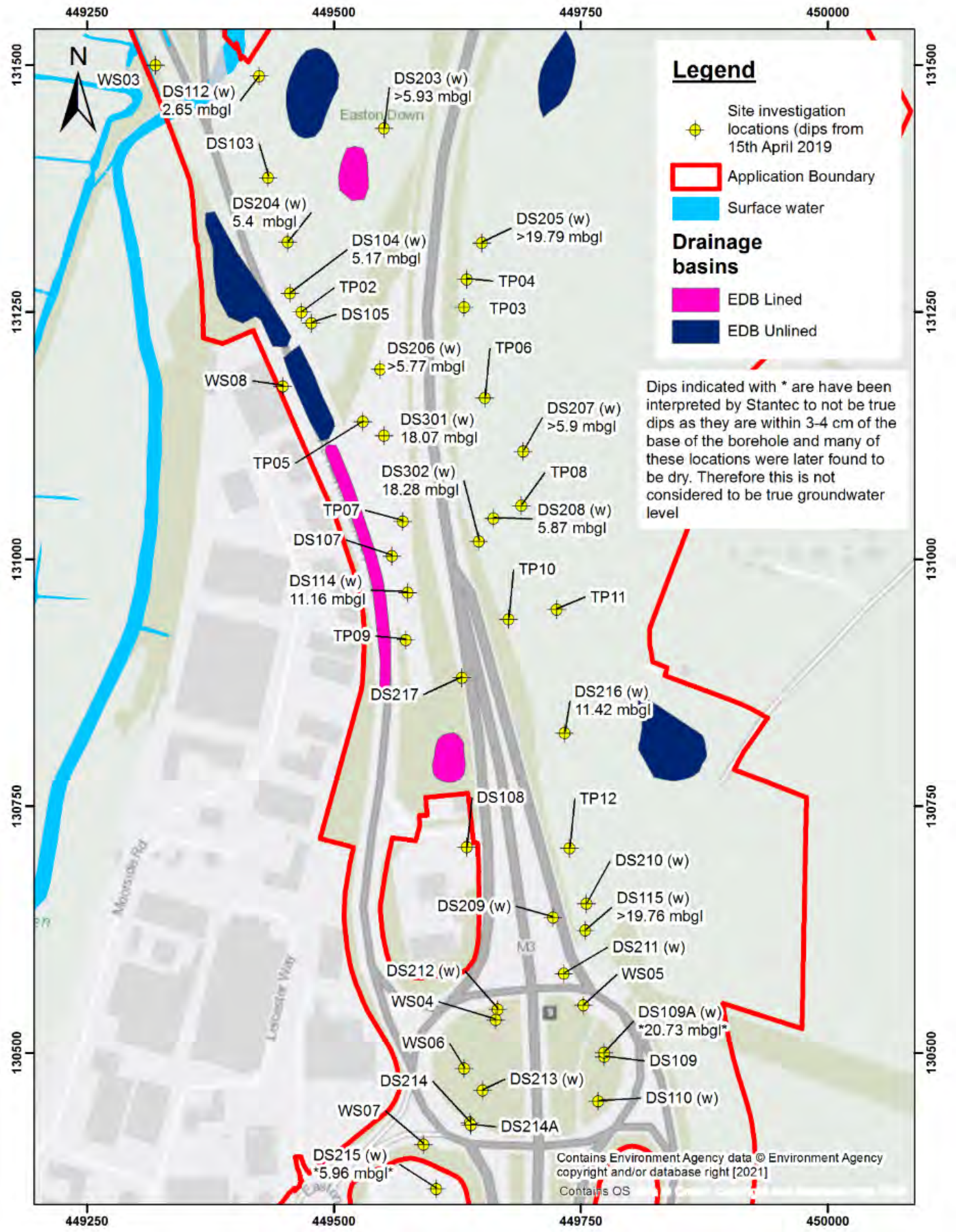


Figure 3.8 Groundwater levels data from final day of installation works in mAOD

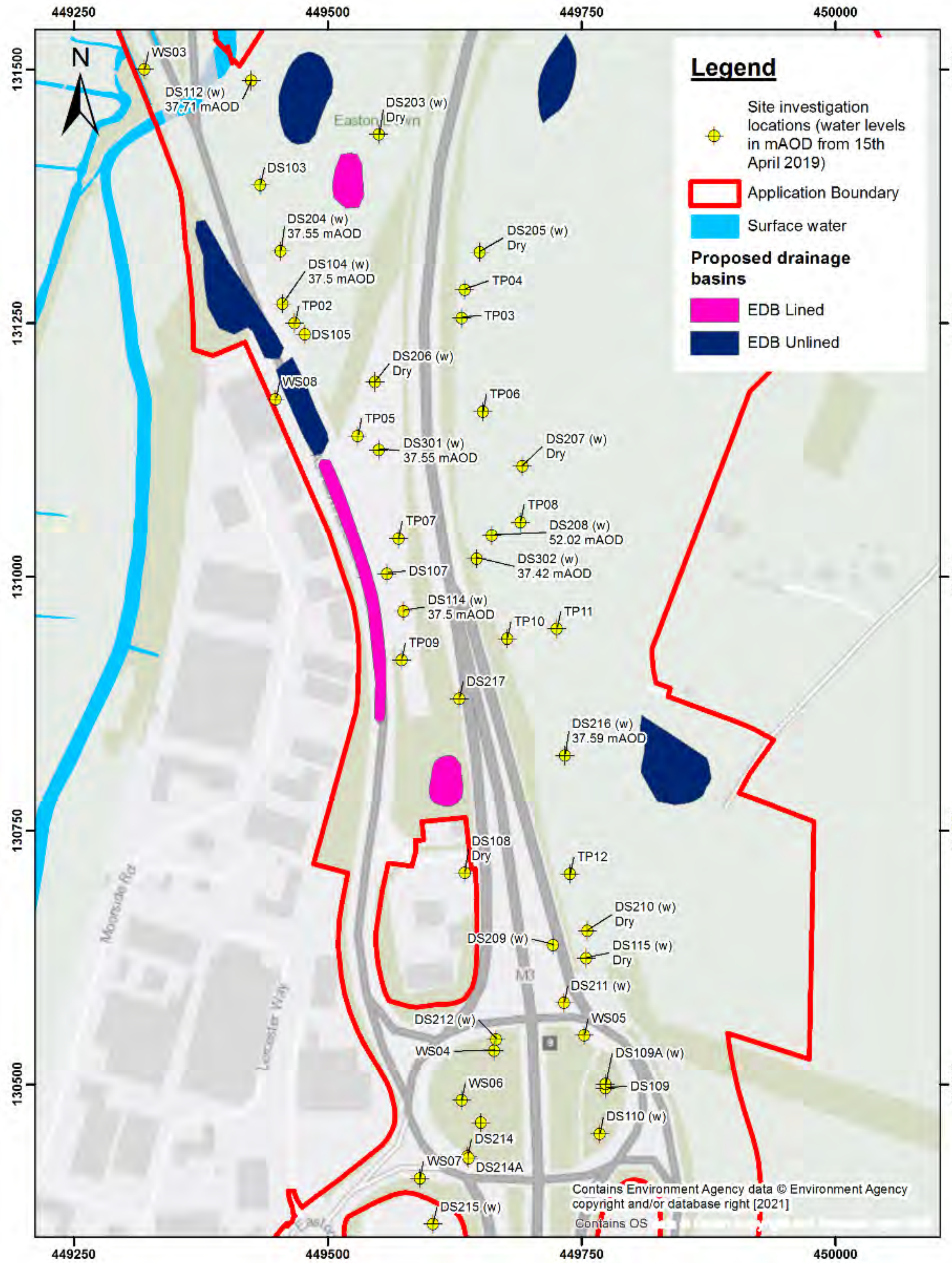


Table 3.7 Groundwater level dip data during site investigation works in mAOD

	Date	18/03/2019		19/03/2019		20/03/2019		22/03/2019		25/03/2019		26/03/2019		27/03/2019		28/03/2019		01/04/2019	
Trial Hole	**Ground level (mAOD)**	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base
DS104	42.67																		
DS112	40.36																	37.72	20.93
DS114	48.66													37.56	29.10	37.55	29.10	37.56	29.10
DS115	62.23					Installed		42.82	42.43			Dry	42.47	Dry	42.47	Dry	42.47	Dry	42.46
DS203	57.43																		
DS204	42.95																	37.59	36.85
DS205	69.16	Dry	49.39	Dry	49.39	Dry	49.39	Dry	49.39	Dry	49.44	Dry	49.39	Dry	49.44	Dry	49.39	Dry	49.44
DS206	56.88															Installed		Dry	51.11
DS207	64.65	Dry	58.45	Dry	58.77	Dry	58.71	Dry	58.77	Dry	58.78	Dry	58.75	Dry	58.73	Dry	58.78	Dry	58.78
DS208	57.91	Dry	51.74	Dry	51.92	52.02	51.98	Dry	51.89	52.01	51.97	52.05	52.01	52.00	51.98	52.05	52.01	52.04	52.02
DS210	61.41							Dry	55.63	Dry	55.63	Dry	55.62	Dry	55.62	Dry	55.62	Dry	55.63
DS216	49.01							Installed				37.64	34.28	37.47	33.96	37.65	34.29	37.48	33.98
DS301	55.62													Installed				37.60	<25.62
DS302	55.7			Installed		37.66	<25.7	37.65	<25.7	37.76	<25.7	37.67	<25.7	37.61	<25.7	37.62	<25.7	37.63	<25.7

(Continued on next page)

	Date	02/04/2019		03/04/2019		05/04/2019		09/04/2019		10/04/2019		11/04/2019		12/04/2019		15/04/2019	
Trial Hole	Ground level	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base
DS104	42.67	Installed		37.54	27.96	37.75	28.04	37.55	27.94	37.53	27.95	37.66	28.05	37.54	27.95	37.50	27.95
DS112	40.36	37.70	20.95	37.74	21.08	37.87	20.95	37.80	20.95	37.73	21.00	37.71	21.00	37.70	20.89	37.71	21.02
DS114	48.66	37.56	29.10	37.54	29.38	37.64	29.22	37.56	29.10	48.66	48.66	37.61	29.09	37.52	29.51	37.50	29.42
DS115	62.23	Dry	42.68	Dry	42.68	Dry	42.82	Dry	42.68	Dry	42.82	Dry	42.46	Dry	42.46	Dry	42.47
DS203	57.43			Installed				Dry	51.48	Dry	51.48	Dry	51.48	Dry	51.53	Dry	51.50
DS204	42.95	37.58	36.87	37.58	36.87	37.77	36.91	37.78	36.87	37.60	36.89	37.69	36.89	37.56	36.90	37.55	36.89
DS205	69.16	Dry	49.44	Dry	49.44	Dry	49.44	Dry	49.44	Dry	49.44	Dry	49.67	Dry	49.69	Dry	49.37
DS206	56.88	Dry	51.11	Dry	51.10	Dry	51.10	Dry	51.01	56.88	56.88	Dry	51.01	Dry	51.10	Dry	51.11
DS207	64.65	Dry	58.78	Dry	58.78	Dry	58.78	Dry	58.76	Dry	58.74	Dry	58.73	Dry	58.74	Dry	58.75
DS208	57.91	52.04	52.03	52.03	52.01	Dry	52.03	Dry	63.79	52.04	52.03	Dry	52.02	Dry	52.02	52.04	52.02
DS210	61.41	Dry	55.62	Dry	55.63	Dry	55.63	Dry	55.63	Dry	55.52	Dry	55.51	Dry	55.51	Dry	55.52
DS216	49.01	37.48	34.14	37.47	34.23	37.74	34.14	37.19	34.14	37.45	34.16	37.61	34.26	37.60	34.26	37.59	34.26
DS301	55.62	37.59	<25.62	44.54	<25.62	37.59	<25.62	37.60	<25.62			37.69	<25.62	37.61	<25.62	37.55	<25.62
DS302	55.7	37.78	<25.7	37.62	<25.7	37.28	<25.7	37.49	<25.7	37.64	<25.7	37.46	<25.7	37.44	<25.7	37.42	<25.7

Red text indicates that the base of the borehole extended beyond the reach of the 30 m dip tape used.
Yellow highlighting indicates water levels that may be errors.

<u>Logger data</u>

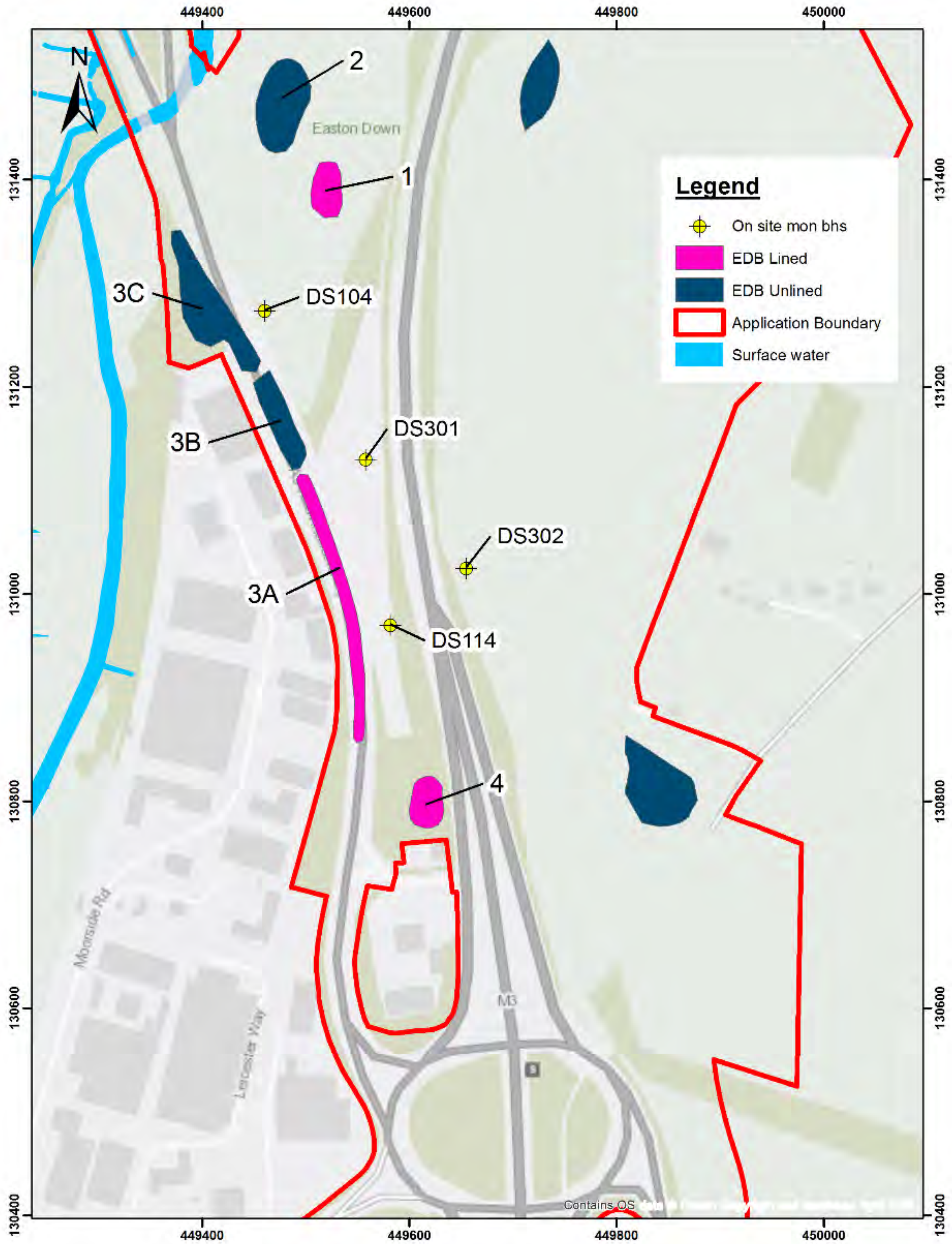
Groundwater monitoring points DS104, DS114, DS301 and DS302 are located close to the proposed drainage basins 2, 3A, 3B and 3C, as shown on Figure 3.9, and monitor the Seaford Chalk Formation. These boreholes are between 15 and 30.5 m in depth and are screened at their base within the Seaford Chalk Formation. A summary of the depths and horizons at the boreholes is given in Table 3.8.

These boreholes were monitored using loggers for one year from June 2019 to July 2020. The water level (in mbgl) is plotted in Figure 3.11. The barometrically adjusted groundwater level (in mAOD)) is plotted in Figure 3.10. A summary of the groundwater level is given in Table 3.9.

Table 3.8 Groundwater monitoring locations

Borehole	Ground level (mAOD)	Depth (mbgl)	Elevation of base (mAOD)	Screened interval (mAOD)	Geology summary
DS104	42.67	15.00	27.67	27.67-32.60 (Seaford Chalk)	Topsoil/Made Ground 0 to 0.3 mbgl Head 0.3 to 8.5 mbgl (some core not recovered). Typically sandy gravelly clay down to 3 mbgl and variable sand, gravels, and sandy gravelly clays at depth. No recovery 8.5 to 10.00 mbgl Seaford Chalk Formation 10.00-15.00 mbgl
DS114	48.66	19.95	28.71	29.16-32.16 (Seaford Chalk Formation)	Topsoil 0 to 0.3 mbgl Seaford Chalk Formation from 0.3 to 19.95
DS301	55.62	30.25	25.27	25.62-30.62 (Seaford Chalk Formation)	Topsoil to 0.4 mbgl. Seaford Chalk from 0.4 to 30.25 mbgl
DS302	55.70	30.45	25.25	25.70-30.70 (Seaford Chalk Formation)	Head from 0 to 0.27 mbgl. Head is composed of light brown slightly gravelly sandy clay. Seaford Chalk from 0.27 to 30.45 mbgl

Figure 3.9 Boreholes monitored for groundwater level



During the monitoring period the groundwater levels vary by approximately 2 m, with all locations showing almost identical trends. Groundwater level generally increase gradually from June 2019 to December 2019, then rise more quickly from mid-December to February 2020 and decline from February to June 2020. Groundwater levels in DS301 and DS302 are approximately 0.3 m higher than those at DS104 and DS114. The groundwater levels range between 37.19 to 39.38 mAOD. This is the same elevation as the River Itchen and surrounding area to the west. We note that the Chalk groundwater level flow direction is likely to be towards the River Itchen (i.e. from east to west). These wells are located along an approximate north to south line (perpendicular to groundwater flow), making it difficult to assess flow directions or hydraulic gradients directly from these data.

Table 3.9 Summary of groundwater levels (June 2019 to July 2020)

Borehole	Groundwater level (mbgl)			Groundwater level (mAOD)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
DS104	3.83	4.97	5.43	37.24	37.70	38.84
DS114	9.67	10.98	11.49	37.17	37.68	38.99
DS301	16.41	17.68	29.21	37.43	37.94	39.21
DS302	16.32	17.73	28.90	37.42	37.98	39.38

Figure 3.10 Groundwater level in Application Area SI boreholes in the Application Area (mAOD)

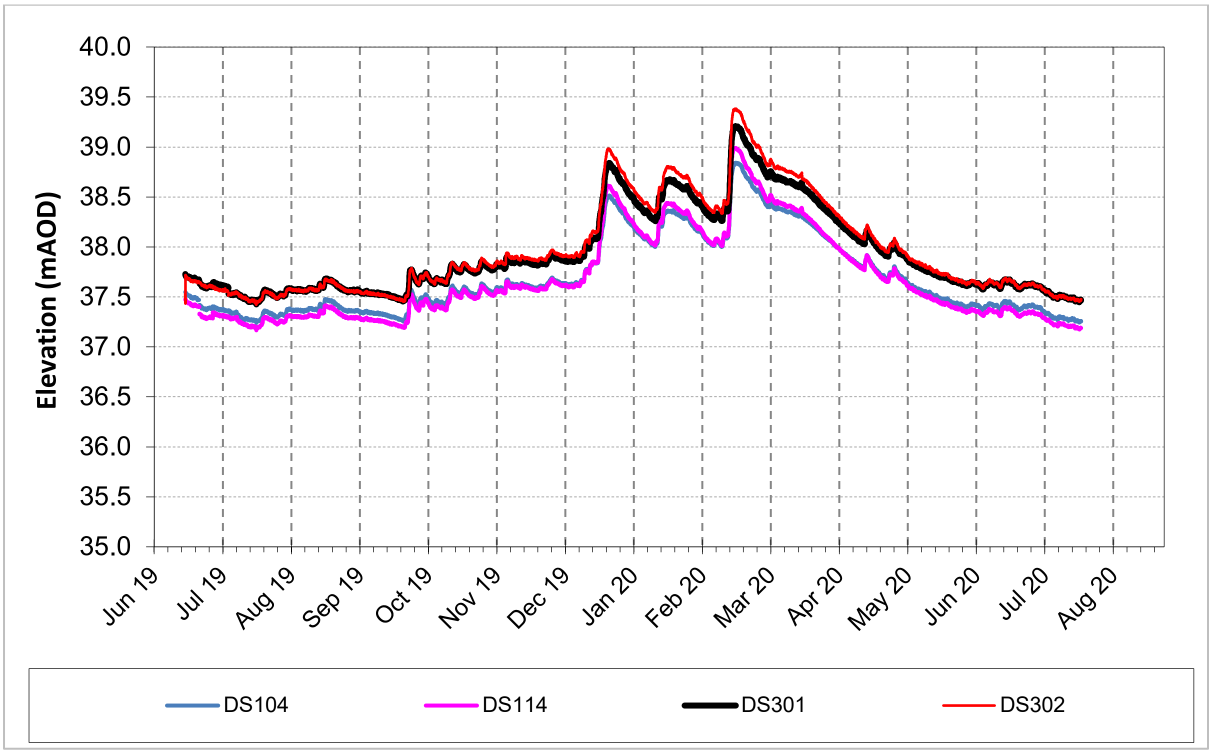
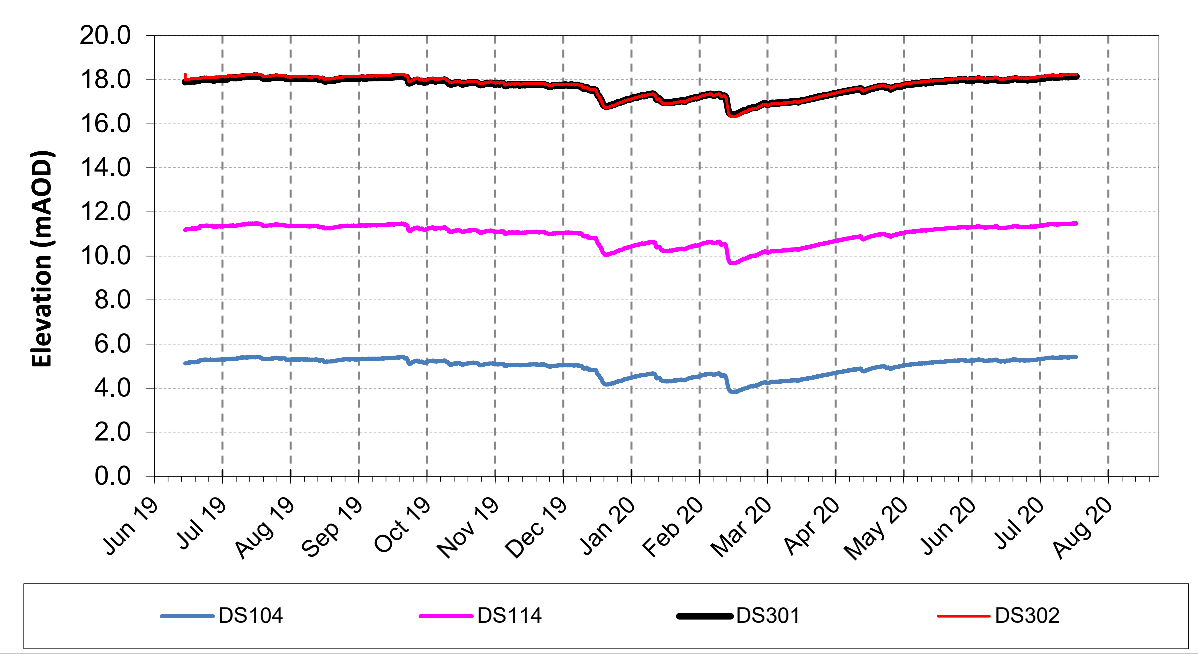


Figure 3.11 Groundwater level in Application Area SI boreholes in metres below ground level



<u>Unsaturated zone thickness</u>

Based on the available groundwater level data, the groundwater depth (unsaturated zone thickness) at each of the proposed EDBs can be estimated. These estimates are summarised in Table 3.10. Unsaturated zone thickness is based on the average groundwater level in the closest borehole to where the EDB is proposed. The logger data at four boreholes indicates that the average groundwater level over the year was 0.2 m higher than the water level recorded in April 2019 during the installation. Therefore, it has been assumed that variability is the same across all boreholes and so the average unsaturated thickness is taken to be 0.2 m smaller than was measured in April 2019.

Table 3.10 Approximate depth to groundwater at unlined EDBs

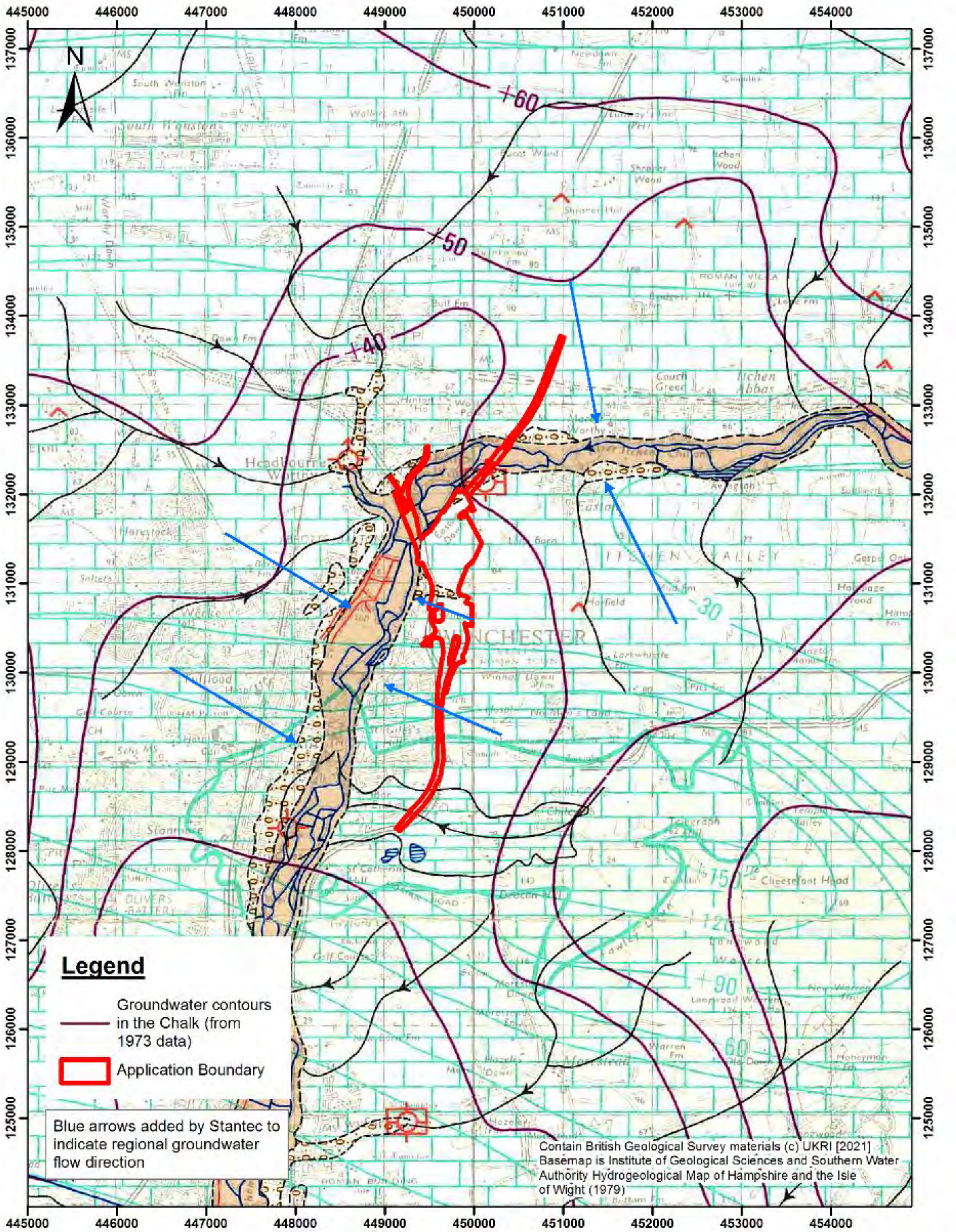
EDB	Approximate average elevation of EDB (mAOD)	Approximate average unsaturated thickness to nearest 0.1 m	Nearest borehole
1	45	7.1	DS112
2	51	13.1	DS203 DS112
3B	43.5	5.8	DS104
3C	41.5	3.8	DS104

Groundwater flow

The Hydrogeology map of Hampshire and the Isle of Wight (Institute of Geological Sciences and Southern Water Authority, 1979) shows the groundwater contours in the Upper Chalk around the Application Area to be generally mirroring the topography and indicates groundwater flow towards the River Itchen (Figure 3.12). In the area of the drainage features within the Application Area, groundwater flows to the southwest are indicated, towards the River. These contours suggest that groundwater discharges to the River.

The shape of the SPZs indicate a southeasterly flow at Headbourne Worthy which lies on the western side of the River Itchen. The Itchen Valley abstractions near Easton draw in water from the north of the River and also from the southeast.

Figure 3.12 Application Area overlaid on the Hydrogeological map (Institute of Hydrological Sciences, 1979)



3.4.5 Contaminated land and pollution events

An Envirocheck report was obtained to inform the Preliminary Sources Study Report (WSP, 2017). Envirocheck notes there are two petrol filling stations on Easton Lane, one 7 m (Shell) from the Application Area and one 66 m (Tesco) away. Stantec has also been made aware by Winchester City Council that there also is a former petrol station located within the Application Area along the A33 (letter reference 21/01483/NSIP, dated 7th July 2021).

Pollution incidents up to 2 km away from the Application area are summarised in Table 3.11 (Envirocheck, 2016). These pollution incidents occurred between 1992 and 1999.

Table 3.11 Pollution incidents within 2 km (from Envirocheck, 2016)

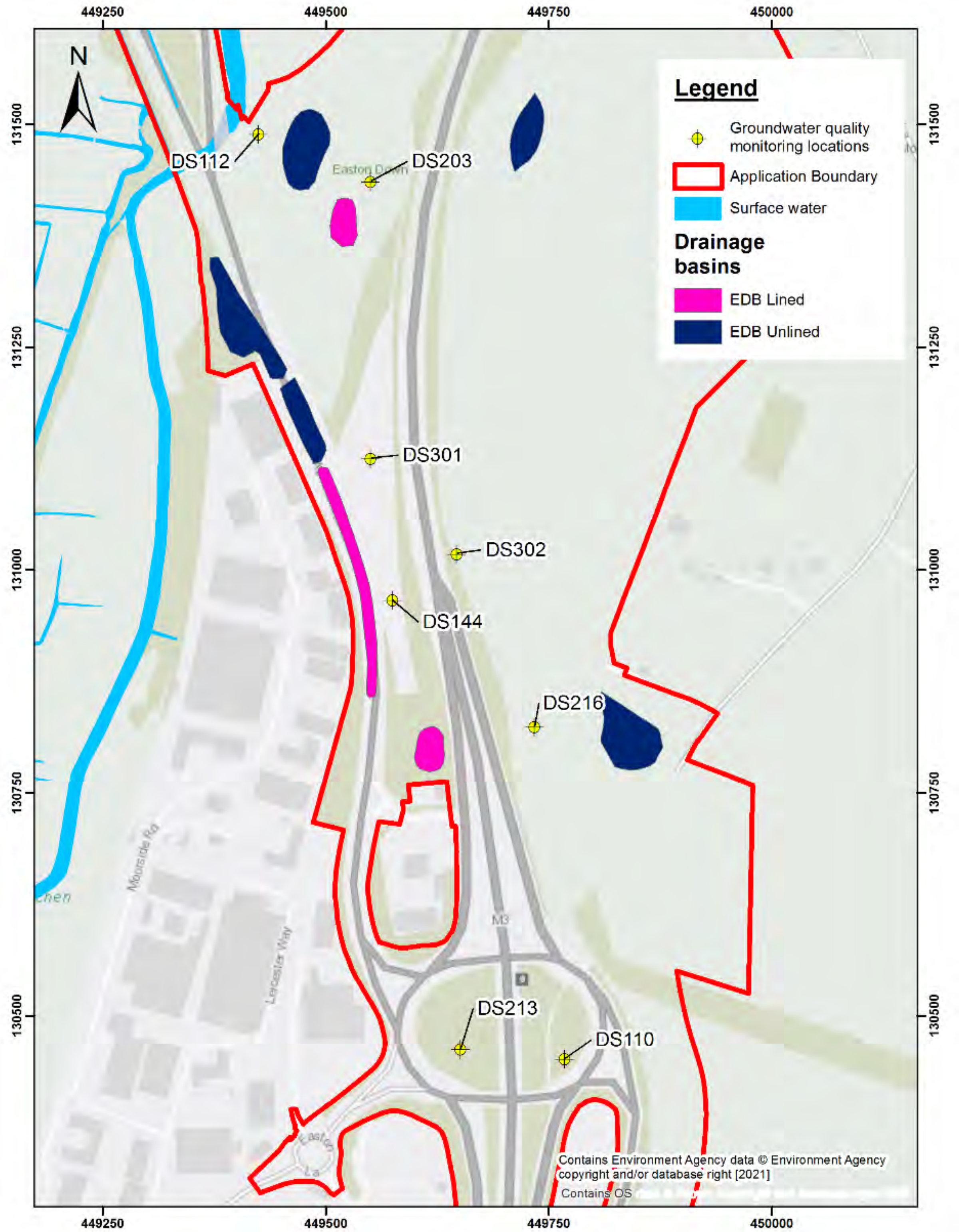
<table>
<tr><th>Distance</th><th>Number of recorded incidents</th><th>Summary of incidents</th></tr>
<tr><td>On site</td><td>1</td><td>Poultry manure</td></tr>
<tr><td rowspan="4">0-250 m</td><td rowspan="4">4</td><td>Petrol poured onto ground</td></tr>
<tr><td>LPG tanker overturned</td></tr>
<tr><td>Mineral and synthetic oil</td></tr>
<tr><td>Inert suspended solids from cress beds</td></tr>
<tr><td rowspan="2">251-500 m</td><td rowspan="2">2</td><td>Slurry discharge</td></tr>
<tr><td>Inert suspended solids from farm</td></tr>
<tr><td rowspan="6">501-2000 m</td><td rowspan="6">12</td><td>Slurry discharge</td></tr>
<tr><td>Milky white discharge from construction</td></tr>
<tr><td>Suspended solids from construction</td></tr>
<tr><td>Industrial chemicals</td></tr>
<tr><td>Waste oil</td></tr>
<tr><td>River has turned black – inert solids</td></tr>
</table>

3.4.6 Groundwater quality

Groundwater samples were taken from eight boreholes on two occasions during the GI in 2019. The locations tested were DS110, DS112, DS114, DS203, DS213, DS216, DS301 and DS302, which are shown on Figure 3.13

On each monitoring occasion, two samples were taken from DS110 at 12 mbgl and 29.5 mbgl, and one sample was taken at the other seven boreholes. Only results from one occasion are available for review by Stantec.

Figure 3.13 Groundwater quality monitoring locations



The Tier 2 Controlled Waters Risk Assessment in **ES Chapter 9: Geology and Soils (Document Reference 6.1)** identified one exceedance of copper, two exceedances of mercury, one exceedance of nickel and one exceedance of zinc against the Environmental Quality Standards (EQS). Furthermore, the limit of detections (LOD) for cadmium, hexavalent chromium, copper, lead and cyanide are above the EQS. It also identified one exceedance of mercury, one exceedance of nickel and two exceedances of nitrate compared to the UK DWS (Drinking Water Standards). The nitrate exceedances were from wells sampling from the rural catchment to the east of the Scheme and the metal exceedances were from wells sampling close to historical landfills.

Table 3.12 Summary of groundwater quality data (based on data in Controlled Waters Risk Assessment in ES Chapter 9: Geology and Soils (Document Reference 6.1))

Analyte	Units	LOD	Fresh Water (EQS)	No. of Tests	Min	Max	No. > Limit	Locations with exceedances
Arsenic	µg/l	5	50	9	5	5		
Boron	µg/l	5	-	9	14	28		
Cadmium	µg/l	0.4	0.08	9	0.4	0.4	**9**	All
Chromuim (Total)	µg/l	5	-	9	5	10		
Chromium Hexavalant	µg/l	20	3.4	9	20	20	**9**	All
Copper	µg/l	5	1	9	5	9	**9**	All. Detected at DS103 only
Lead	µg/l	5	1.2	9	5	5	**9**	All
Mercury	µg/l	0.05	0.07	9	0.05	18.3	**2**	DS110 (0.24) and DS203 (18.3)
Nickel	µg/l	5	4	9	5	68	**9**	All. Detected at DS203 only
Selenium	µg/l	5	-	9	5	5		
Zinc	µg/l	2	10.9	9	2	27	**1**	DS203
Ammoniacal Nitrogen as NH4	µg/l	50	260	9	50	107		
Cyanide	µg/l	5	1	9	5	5	**9**	All
Nitrate as NO3	µg/l	500	-	9	14300	56000		
Sulphate	µg/l	1000	-	9	6000	31000		
pH	pH Units	1	-	9	7.7	7.8		
>C5 to C6 Aliphatic	µg/l	10	-	9	10	10		
>C6 to C8 Aliphatic	µg/l	10	-	9	10	10		
>C8 to C10 Aliphatic	µg/l	10	-	9	10	10		
>C10 to C12 Aliphatic	µg/l	10	-	9	10	10		
>C12 to C16 Aliphatic	µg/l	10	-	9	10	10		
>C16 to C21 Aliphatic	µg/l	10	-	9	10	10		
>C21 to C35 Aliphatic	µg/l	10	-	9	10	18		
Total Aliphatic C5-35	µg/l	70	-	9	70	70		
>C7 to C8 Aromatic	µg/l	10	-	9	10	10		
>C8 to C10 Aromatic	µg/l	10	-	9	10	10		
>C10 to C12 Aromatic	µg/l	10	-	9	10	10		

Analyte	Units	LOD	Fresh Water (EQS)	No. of Tests	Min	Max	No. > Limit	Locations with exceedances
>C12 to C16 Aromatic	µg/l	10	-	9	10	10		
>C16 to C21 Aromatic	µg/l	10	-	9	10	10		
>C21 to C35 Aromatic	µg/l	10	-	9	10	10		
Benzene	µg/l	1	10	9	1	1		
Ethylbenzene	µg/l	5	-	9	5	5		
Toluene	µg/l	5	74	9	5	5		
M- & P-Xylene	µg/l	10	-	9	10	10		
O-Xylene	µg/l	5	-	9	5	5		
Total Xylene (M, P & O)	µg/l	15	-	9	15	15		
MTBE	µg/l	10	-	9	10	10		
naphthalene	µg/l	0.01	2	9	0.01	0.04		
Acenaphthylene	µg/l	0.01	-	9	0.01	0.01		
Acenaphthene	µg/l	0.01	-	9	0.01	0.01		
Fluorene	µg/l	0.01	-	9	0.01	0.01		
Phenanthrene	µg/l	0.01	-	9	0.01	0.01		
Anthracene	µg/l	0.01	0.1	9	0.01	0.01		
Fluoranthene	µg/l	0.01	0.0063	9	0.01	0.01	**9**	All
Pyrene	µg/l	0.01	-	9	0.01	0.01		
Benzo(a)anthracene	µg/l	0.01	-	9	0.01	0.01		
Chrysene	µg/l	0.01	-	9	0.01	0.01		
Benzo(b)fluoranthene	µg/l	0.01	0.017	9	0.01	0.01		
Benzo(k)fluoranthene	µg/l	0.01	0.017	9	0.01	0.01		
Benzo(a)pyrene	µg/l	0.01	0.00017	9	0.01	0.01	**9**	All
Benzo(g,h,i)perylene	µg/l	0.01	0.0082	9	0.01	0.01	**9**	All
Dibenzo(ah)anthracene	µg/l	0.01	-	9	0.01	0.01		
Indeno(1,2,3-c,d)pyrene	µg/l	0.01	-	9	0.008	0.008		
Sum (benzo b, k, ghi & indeno123cd)	µg/l	0.04	-	9	0.038	0.038		

Orange highlight means LOD > EQS
Red highlight means result > EQS

3.5 Other potential receptors

3.5.1 Licenced water abstractions and discharges

There are multiple public groundwater abstractions to the north and south of the Application Boundary. The majority of groundwater abstractions to the north are for potable water supply, with the abstractions to the south and west primarily used for water cress production and other agricultural purposes, see Table 3.15 and Figure 3.14.

Given the groundwater divide at the River Itchen, the impact from the EDBs on the boreholes to the west and north of the Itchen will be negligible and are not considered further here.

3.5.2 Private water supplies

Winchester City Council have previously provided information on private water supply abstractions and discharges, located within a 2 km radius of the Application Boundary. It is understood that the current Application Boundary has been revised and as a result some of these supplies now fall more than 2 km from the Application Boundary.

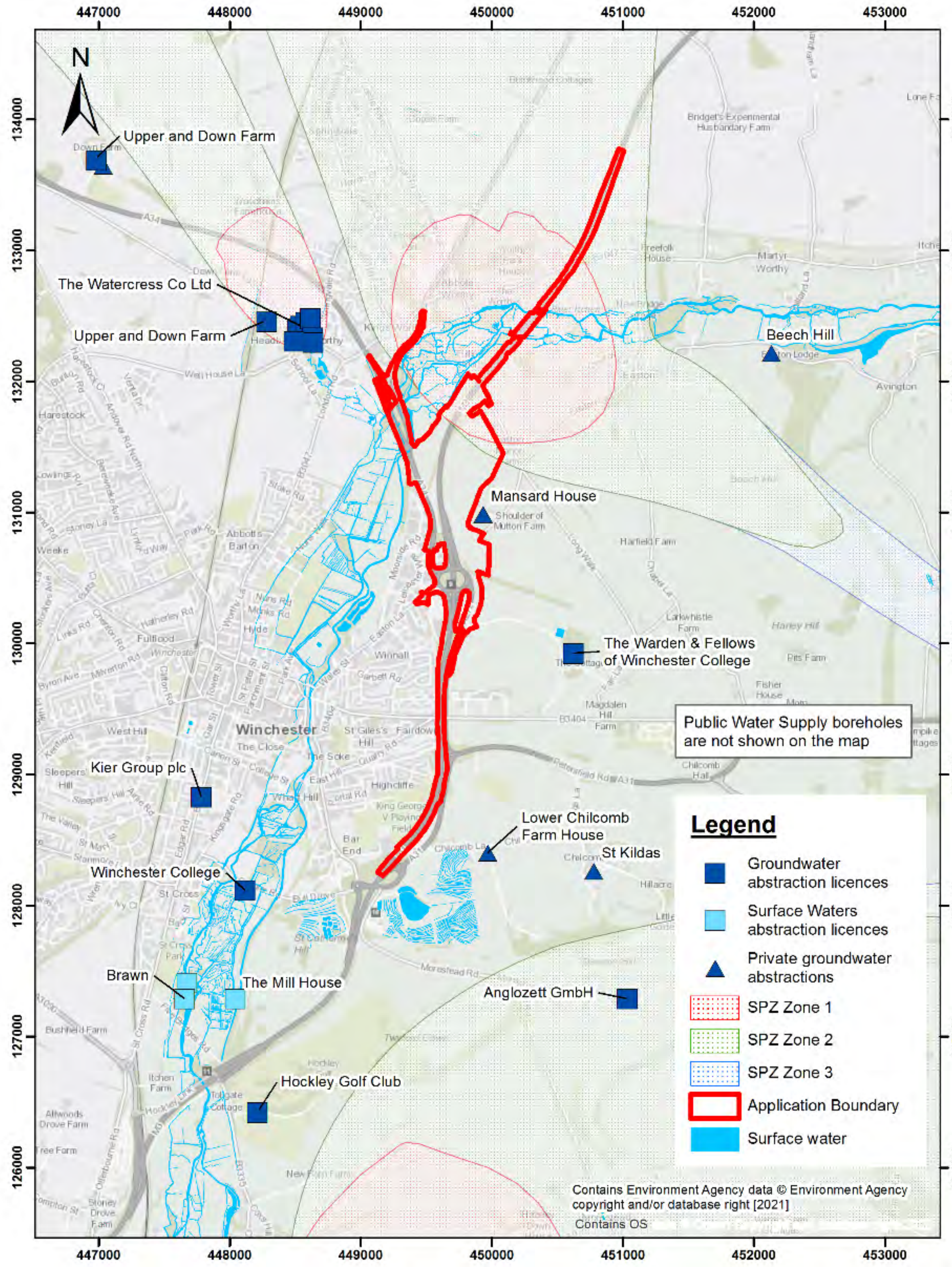
There are nine boreholes used for private water supplies, all of which are currently active and abstract from the underlying chalk aquifer; details of these can be seen in Table 3.13. The locations of private water supply boreholes are shown on Figure 3.14. Some abstractions to the north are beyond the extent of the map and are therefore not shown.

Since all of the private water supplies are on the western and northern side of the River Itchen, up hydraulic gradient, or across hydraulic gradient at a sufficient distance of the EDBs, the Scheme will have a negligible impact upon them, and they are not considered further here.

Table 3.13 Private water abstractions (within 2 km of initial scheme boundary)

FID	Supply Name	Supply Number	Source Type	Source Eastings	Source Northings	Distance from Application Area
Within Application Boundary						
	None					-
Identified outside of the Application Boundary						
19	Shroner Wood	PW000123	Borehole	451582	135626	2 km north
32	Burntwood Farm	PW000118	Borehole	450500	134760	1 km to north
35	Downs Farm Cottages	PW000195	Borehole	447032	133651	2.5 km to north west
51	Mansard House	PW000120	Well	449931	130990	90 m to east
58	Shroner Hill Farmhouse	PW000122	Borehole	450989	135290	1.5 km north
77	Beech Hill	PW000117	Borehole	452132	132220	1.6 km to east
112	Lower Chilcomb FarmHouse	PW000186	Borehole	449967	128403	500 m to east
133	St Kildas	PW000107	Borehole	450776	128265	560 m to south east
136	The Beacon	PW000066	Borehole	450992	135448	1.65 km north

Figure 3.14 Licenced and private abstractions and Source Protection Zones (SPZs)



3.5.3 Designated environmental sites

There are three designated sites within 2 km of the Application Boundary, two of which are within the Application Area itself.

The River Itchen is a SSSI and a SAC along all of its length. The SSSI extends to the surrounding water dependent habitats and environments. Part of the River Itchen SSSI is managed as the Winnall Moors Nature Reserve to the west of the Application Area. The River Itchen flows south to the Solent and Dorset Coast Special Protection Area (SPA) and the Solent and Southampton Water SPA / Ramsar Site.

The South Downs National Park forms part of the eastern side of the Application Area and extends to the east.

Only the River Itchen SSSI is groundwater dependent.

Table 3.14 Designated Sites within 2 km of the Application Area

Name	Designation	Description	Groundwater dependent?	Closest distance from Application Area
River Itchen (multiple parts)	SSSI SAC	River Itchen and surrounding land. Multiple habitats and environments. Close to site: - Fen, marsh swamp, lowland - Broadleaved mixed and yew woodland - Neutral grassland - Rivers and streams	Yes	On site
South Downs	National Park	Chalk Hills and wooded sandstone and clay hills and vales.	Not generally. None within 5 km other than River Itchen (see above).	On site
St Catherine's Hill	SSSI (Biological)	Chalk grassland scrub	No	1.4 km south
Cheesefoot Head	SSSI (Biological)	Chalk downland with horseshoe shaped dry valley, with species rich grasslands.	No	1.8 km east

Figure 3.15 Designated sites within 2 km

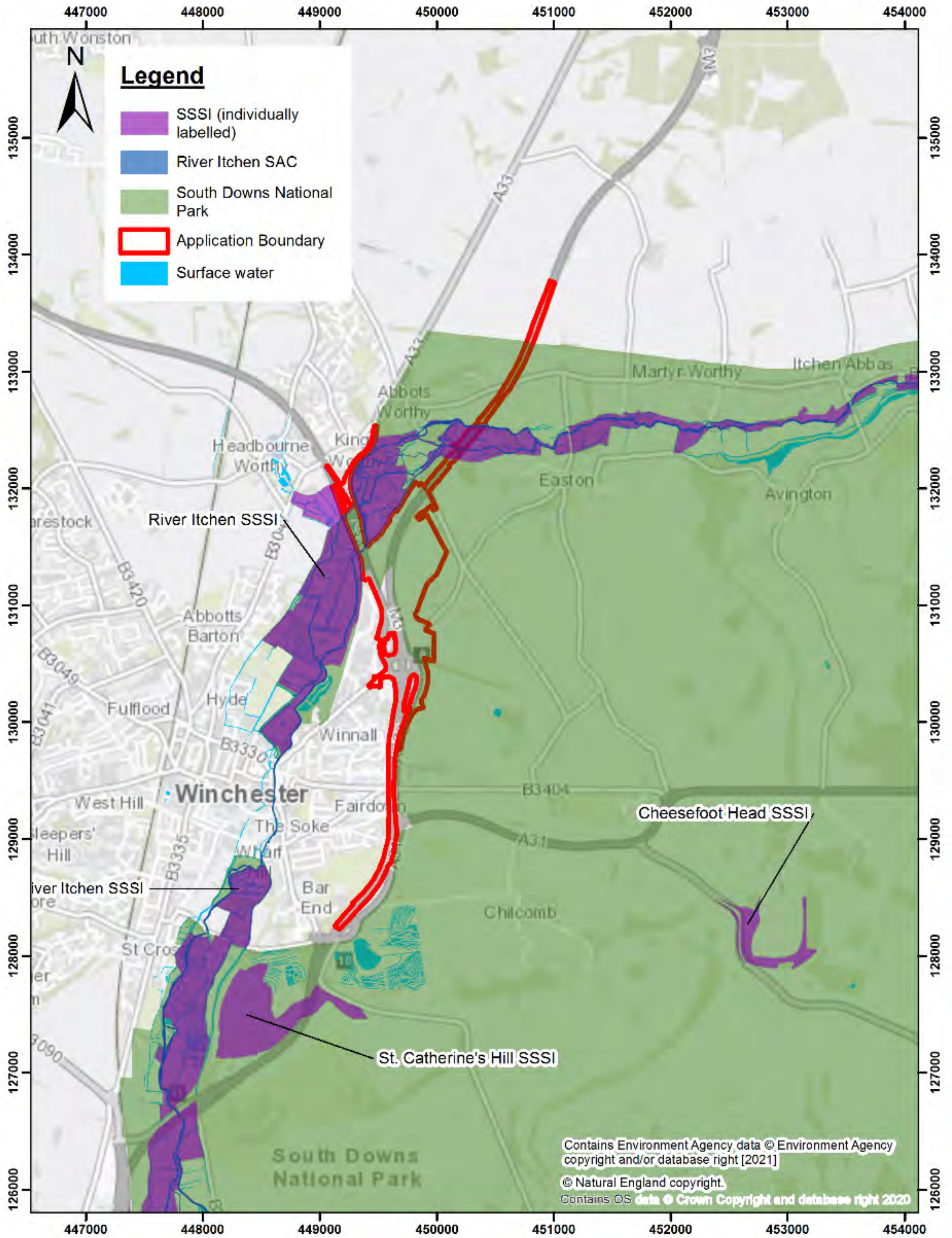


Table 3.15 Licenced groundwater and surface water abstractions

Supply Name	Licence number	Effective date	Purpose	Use	Source	Aquifer type	National Grid Reference
St Cross (Itchen)	31/086	23/04/1992	Aquaculture Fish	Fish Farm/Cress Pond Throughflow	Southern Region Surface Waters	-	SU47672741
Point A, Borehole At Garnier Road	SO/042/00 31/019	17/02/2012	Aquaculture Fish	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4811328115
Burntwood Farm, Martyr Worthy	11/42/22.5/ 76	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU50333501
Hazeley Estate, Twyford	11/42/22.6/ 89	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU51032729
Watercress Beds At Headbourne Worthy Point A	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4851732410
Watercress Beds At Headbourne Worthy Point B	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4853832428
Watercress Beds At Headbourne Worthy Point C	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4857832456
Watercress Beds At Headbourne Worthy Point D	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4861432487
Watercress Beds At Headbourne Worthy Point E	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4862732339
Watercress Beds At Headbourne Worthy Point F	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4863532303

Supply Name	Licence number	Effective date	Purpose	Use	Source	Aquifer type	National Grid Reference
Upper & Down Farms Point A, Headbourne Worthy	11/42/22.5/73	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU46983369
Upper & Down Farms Point B, Headbourne Worthy	11/42/22.5/73	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48283246
Upper & Down Farms Point C, Headbourne Worthy	11/42/22.5/73	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48493231
Point A Down Farm Hursley	31/108	22/07/2008	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5 Chalk	SU44402660
St Cross, Winchester (Itchen)	SO/042/0031/035	02/05/2014	Private Water Supply	Heat Pump	Southern Region Surface Waters	-	SU4765327288
Shawford Mill Headrace (Itchen Navigation)	SO/042/0031/018/R01	21/07/2020	Electricity	Hydroelectric Power Generation	Southern Region Surface Waters	-	SU4739724981
Carrier Channel (Itchen)	SO/042/0031/002	29/01/2010	Electricity	Hydroelectric Power Generation	Southern Region Surface Waters	-	SU5365232564
Twyford Ps Point D	11/42/22.6/92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4824
Twyford Ps Point A	11/42/22.6/92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4825
Twyford Ps Point C	11/42/22.6/92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4924
Twyford Ps Point B	11/42/22.6/92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4924
Itchen Valley Point D	11/42/22.4/80	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4932
Itchen Valley Point A	11/42/22.4/80	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU5032

Supply Name	Licence number	Effective date	Purpose	Use	Source	Aquifer type	National Grid Reference
Itchen Valley Point C	11/42/22.4/80	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU5032
Winnall Down Farm, Winchester	11/42/22.4/146	20/06/1977	General Agriculture	Spray Irrigation - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU5061929927
Hockley Golf Club	11/42/22.6/95	23/12/1965	Golf Courses	Spray Irrigation - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48212642
Hockley Golf Club	11/42/22.6/95	23/12/1965	Golf Courses	Spray Irrigation - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48212642
River Itchen At Shawford Park	SO/042/0031/003	09/10/2009	Remedial River/Wetland Support	Transfer Between Sources (Post Water Act 2003)	Southern Region Surface Waters	-	SU4740724753
Water Meadow Channel Off R Itchen	SO/042/0031/010	18/10/2010	Remedial River/Wetland Support	Transfer Between Sources (Post Water Act 2003)	Southern Region Surface Waters	-	SU4804127290
Lower Itchen Navigation At Shawford	SO/042/0031/020	27/03/2012	Non-Remedial River/Wetland Support	Transfer Between Sources (Pre Water Act 2003)	Southern Region Surface Waters	-	SU4711323809
Wellpoints At Winchester College	SO/042/0032/012	22/07/2020	Construction	Dewatering	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4777928830

4 Conceptual site model

4.1 Sources

4.1.1 Carriageway drainage

Rainwater on the carriageway will wash any contaminants present into the drainage system. Contaminants may be in solution which are considered to provide an acute risk or sorbed onto solids which may present a chronic risk. The following pollutants have been identified by the HEWRAT (Highways England, 2015) as potential contaminants to receptors from road drainage schemes:

- Microplastics and other particulate matter (from brake and tyre wear);
- Soluble metals (copper and zinc) and;
- Sediment related pollutants associated with chronic pollution impacts (total copper, zinc, cadmium, PAH - including species pyrene, fluoranthene, anthracene and phenanthrene).

The drainage system discharges into the EDBs. Prior to entry into the EDBs large items are screened out within the lined Pollution Control Device (PCD) ditches and vertical separation forebays. Within the EDBs, finer suspended sediment will settle out as flow velocities diminish. EDBs 1, 3A and 4 are sealed and will not discharge to ground. There will also be an element of attenuation as soluble heavy metals and hydrocarbons will sorb onto sediment present within the EDBs.

Discharge from the lined EDBs is to the unlined EDBs 2, 3B, 3C, 5 and 6. Within these EDBs there will be secondary attenuation, settlement and filtration within vegetated EDBs which will contain both wet and dry habitats.

We note that un-lined EDB2 and EDB3C receive direct runoff from the carriageway via lined PCD ditches and forebays.

Sediment will not infiltrate through the superficial deposits or structureless chalk. Unless, the EDBs are constructed directly over transmissive fissures, we can expect there will be no infiltration of solids, even to structured chalk. Sediment (and any entrained contaminants) will remain trapped within the forebays or EDBs and be subject to periodic removal during maintenance events. Thus, it is contaminants that are directly soluble or that leach from the sediments within the EDBs that form the potential source of contamination for groundwater.

4.1.2 Placement of potentially contaminated materials via cut and fill operations

It is expected that much of the material excavated under the Scheme will be re-used as fill material to bring areas up to required levels. It is noted that a significant volume of material is required to raise levels in the eastern part of the Scheme.

As detailed in Section 3.2.2 this material may contain a proportion of Made Ground from previous road schemes.

4.1.3 Other sources of contamination

There are a number of potential sources of contamination within and adjacent to the Application Boundary. These include landfills, a former gasworks and ironworks, petrol stations, railways and land with mixed industrial use. Rainwater passing through these sources has the potential to leach contaminants into the groundwater.

4.2 Pathways

4.2.1 Unsaturated zone

Where the EDBs and retained highway soakaways are un-lined, they have the potential to discharge to ground. Site specific soil infiltration rates are presented in Section 3.4.3. On the basis of these limited data a maximum soil infiltration rate of 1×10^{-6} m/s was adopted for Alluvium, Head and Structured Chalk within 2 mbgl, and 1×10^{-5} m/s for Structured Chalk below 2 mbgl.

The other sources of contamination, including re-used material, may be located on superficial deposits or directly on the Chalk. Either way, contaminants will have to pass through the unsaturated zone to the watertable.

Rainfall is estimated as 806 mm/a which represents a long-term average infiltration rate to the EDBs. So long as the unsaturated zone hydraulic conductivity is higher than this, recharge to the watertable will occur. During storm events, when the EDBs become saturated, the infiltration rate could rise to a maximum rate that will be limited by the hydraulic conductivity of the underlying strata. However, such high infiltration rates will be relatively short lived as excess water within the EDBs will drain to surface water and it is expected that the EDBs will be dry for most of the time.

Within the unsaturated zone contaminant attenuation may occur. Attenuation comprises retardation and degradation processes. Heavy metals may be retarded via sorption. There are a number of mechanisms that control metal sorption which is often influenced by soil pH and redox conditions. Where sorption occurs due to cation exchange, the degree of sorption is influenced by the concentration gradient between the soluble contaminant and the solid matrix. If a more dilute flux subsequently passes through the unsaturated zone, contaminants may de-sorb back into solution. Organic compounds, such as PAHs, adsorb onto clay particles and the sorption rate is largely controlled by the fraction of organic carbon present. Whilst this may be significant in alluvial material, chalk tends to have very low organic carbon contents and as such retardation may be limited. Organic compounds may also bio-degrade within the unsaturated zone.

4.2.2 Saturated zone

Once the contaminants reach the watertable, they will migrate within the receiving groundwater, down the hydraulic gradient. Whilst the superficial deposits and structureless chalk may be saturated and act as contaminant transport pathways, contaminant transport will be greatest within fissures and fractures within the structured chalk.

Whilst it is possible that attenuation processes may occur during transport within fissured chalk, they tend to be relatively insignificant. The most likely process is diffusion from the fissure into the chalk matrix, which effectively retards contaminant migration within the Chalk. Given the difficulties in parameterising this process, it has conservatively been ignored for this assessment.

Estimating the volumetric flux in fissured chalk is difficult. Transmissivity data provides a weighted average of hydraulic conductivity in fissures and matrix and applying this across the entire chalk body provides a reasonable dilution estimate. However, in order to determine realistic travel times, it is often necessary to utilise very low effective porosity values. This latter parameter effectively determines the proportion of the chalk that is present as fissures where travel times can be very fast.

Based on the published chalk groundwater contours, the flow direction within the chalk is assessed as follows.

- Areas occupied by the EDBs and retained highway soakaways is to the southwest, towards the River Itchen; and
- Areas within the Itchen Valley (near Easton) PWS SPZ is to the northwest towards the PWS.

4.3 Receptors

For the purposes of this assessment, the following receptors have been assessed.

- The watertable is the receptor for Hazardous substances and
- A distance of 50 m from the Application Boundary is taken to be the receptor for non-hazardous pollutants.

5 Groundwater Impact Assessment

The impact to groundwater from the developments in the Application Area has been assessed using the methodology outlined in Section 9.4 of the Preliminary Environmental Information Report (PEIR) (Stantec, 2021) and is detailed in Table 5.1. The receptor for all potential sources of contamination is groundwater.

5.1 Road drainage

The impact assessment has determined that, without mitigation, the road drainage has the potential to cause a significant impact (Moderate, Large or Very Large) on the groundwater receptor. To mitigate against the potential impacts, a DQRA will be undertaken to investigate the impact of the EBDs on the groundwater quality. This involves modelling of the EDBs following the EA Remedial Targets Methodology (RTM) approach. The findings of this modelling are provided in Section 6.3.

5.2 Filled areas

Soil samples from the Application Area were subject to geoenvironmental testing as detailed in the **Geotechnical Interpretation Report** **(Document Reference 7.11)**. A comparison was made of the results to Generic Assessment Criteria which showed that the soils would not pose a hazard to human health. Water samples were also subject to testing. The water samples would contain any contaminants that have leached from the soils and are detailed in Section 3.4.6. These results were compared to EQS and DWS limits as part of a controlled waters risk assessment in **Chapter 9: Geology and Soils** **(Document Reference 6.1)** which concluded that the risk to controlled waters was low.

Table 5.1 Summary of impacts

Source of Impact	Receptor	Pathways	Magnitude of impact	Value (sensitivity) of receptor/ resource	Potential degree of impact	Potential degree of impact following further assessment
Unlined EDBs 2, 3B & 3C	Groundwater	Unsaturated zone / saturated zone	Moderate (HEWRAT assessment is medium / high)	High	Moderate or Large	Yes – EBDs (the embedded mitigation) will prevent infiltration of solids and will sorb some contaminants. Further sorption and attenuation will occur in the unsaturated zone. It is demonstrated in the DQRA detailed in the next section that impacts are minor.
Unlined EDBs 5 & 6	Groundwater	Unsaturated zone / saturated zone	Predominantly receive runoff from rural catchments to east of Application Area. – Negligible	High	Slight	N/A
Fill areas	Groundwater	Unsaturated zone / saturated zone	Soil and water testing on samples has shown no risk to human health or controlled waters. Negligible	High	Slight	N/A
Old petrol station	Groundwater	Unsaturated zone / saturated zone	Negligible	High	Slight	Investigation to determine if any tanks or residual contaminants in the ground
Operational petrol stations	Groundwater	Unsaturated zone / saturated zone	Negligible as any issues would be rapidly identified and remediated by petrol station operator	High	Slight	N/A

Source of Impact	Receptor	Pathways	Magnitude of impact	Value (sensitivity) of receptor/ resource	Potential degree of impact	Potential degree of impact following further assessment
Historical land contamination	Groundwater	Unsaturated zone / saturated zone	Negligible as assessed by Controlled Waters Risk Assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)**	High	Slight	N/A
Historical pollution events	Groundwater	Unsaturated zone / saturated zone	Negligible as short-lived events unlikely to cause gross contamination of groundwater	High	Slight	N/A

6 Detailed Quantitative Risk Assessment for EDBs

6.1 Introduction

Section 5 has identified a potential impact from the un-lined EDBs No's 2, 3B and 3C. The EDBs have been subject to a HEWRAT screening assessment. The results of the screening assessment are that all but one of the currently proposed EDBs have a 'medium risk' to groundwater and one has a high risk.

In accordance with the National Highways methodology these have been taken forward to a DQRA in order to provide a more robust assessment of the risk to the Chalk groundwater from these potential sources of contamination.

The DQRA follows the Remedial Targets Methodology (RTM) (Environment Agency, 2006). A Level 1 and Level 2 Assessment has been undertaken.

A Level 1 Assessment considers processes within the source term. For the acute source term, there is no process operating within the source term and the predicted concentrations will equal the source term concentrations. For the chronic source term, partitioning of the contaminants between soil and aqueous phase within the source term is taken into account and the estimated aqueous concentration is limited by the contaminants pure phase solubility.

A Level 2 Assessment considers attenuation processes within the unsaturated zone and dilution within the saturated zone. The input to the RTM is source concentrations for acute and chronic risk based on HEWRAT Step 2 output (i.e. representative concentrations within the EDBs). The output from the model is predicted concentrations at the identified groundwater receptors. These predicted concentrations are compared to receptor Target Concentrations. If the predicted concentration is lower than the Target Concentration, we conclude that the EDBs do not pose a risk to groundwater. Conversely, if they are higher, we conclude that they may pose a risk.

Modelling is undertaken using Stantec's (formally ESI) Risk Assessment Model (RAM) software (ESI, 2008). Electronic copies of the models are given in Appendix E.

The RAM software package, together with a number of groundwater risk assessment tools, has been benchmarked by ESI for the EA (ESI, 2001). Additionally, the equations used in RAM have been verified by comparison between direct evaluation of an analytical solution and the semi-analytic transform approach applied for more complex pathways, and by comparison with published solutions used for verification as part of the nuclear waste industry code comparison exercise INTRACOIN (Robinson & Hodgkinson, 1996).

6.2 Model Parameterisation

In the model, it is conservatively assumed that the EDBs are saturated for 50% of the year i.e. that the EDBs contain water for 6 months in each year and are dry of 6 months. During periods when the EDBs are saturated, the infiltration rate is limited to the maximum infiltration rate of the receiving strata. For the remaining 6 months of the year, it is assumed that there is no infiltration. The maximum infiltration rates are presented in Table 6.1 and these rates are multiplied by 0.5 in the model to derive a conservatively appropriate annual average infiltration rate.

Table 6.1 Infiltration rates

Basin	Underlying geology	Infiltration rate into top of unsaturated zone (m/s)	Justification for infiltration rate
2	Alluvium, structured chalk,	1 x 10^{-6}	Calculated infiltration rate from **Geotechnical Interpretation Report (Document Reference 7.11)** for sediments
3B	Made Ground and head (base not penetrated)	1 x 10^{-6}	
3C	Made Ground, alluvium, structureless chalk and structured chalk.	1 x 10^{-6}	

The source geometry for each of the EDBs is given in Table 6.2. The area and width perpendicular to groundwater flow has been measured from GIS. The length is then obtained by dividing the width into the area. A sediment thickness of 1 m is assigned in order to estimate a volume.

Table 6.2 Source geometry

EDB	Parameter	Values	Units	Justification
All	Thickness	1	m	Parameter not used in model as a constant source (rather than declining source) assumed
2	Area	1351	m^2	Measured from GIS
	Width	55	m	Indicative measured width perpendicular to groundwater flow from plans (assumed to be rectangular in model)
	Length	24.6	m	Calculated from area divided by the width
3B	Area	2,046	m^2	Measured from GIS
	Width	93	m	Indicative measured width perpendicular to groundwater flow from plans (assumed to be rectangular in model)
	Length	22	m	Calculated from area divided by the width
3C	Area	4,205	m^2	Measured from GIS

EDB	Parameter	Values	Units	Justification
	Width	150	m	Indicative measured width perpendicular to groundwater flow from plans (assumed to be rectangular in model)
	Length	28	m	Calculated from area divided by the width

Chronic source term concentrations are taken from the HEWRAT Step 2 output (i.e. representative concentrations within the EDBs) (Table 6.3). These represent soil concentrations within the sediments at the base of the EDBs. Following the RTM methodology, these are converted into aqueous concentrations on the basis of partitioning coefficients for solid and aqueous phases (Table 6.5) and the resulting aqueous concentration is limited by the contaminant solubility (Table 6.6). Acute source term concentrations are taken directly from HEWRAT Step 2 output (Table 6.4).

The attenuation parameters (Table 6.5) are also assigned for sorption within the unsaturated zone.

Table 6.3 Chronic Source terms (from HEWRAT)

	Sediment concentrations from HEWRAT assessment – 95th percentile (mg/kg)						
EDB	Copper	Zinc	Cadmium	Pyrene	Fluoranthene	Anthracene	Phenanthrene
2	968	3569	2	9.729	9.335	0.596	2.632
3B	1875	7101	3	9.729	9.335	0.596	2.632
3C	1875	7101	3	9.729	9.335	0.596	2.632

Table 6.4 Acute source term concentrations (from HEWRAT – 95th percentile (mg/l))

EDB	Copper	Zinc
2	0.069	0.255
3B	0.145	0.797
3C	0.145	0.797

Table 6.5 Attenuation parameters

Determinand	Parameter	Value	Units	Justification
Copper	Partition coefficient (Kd)	13,770	l/Kg	Mid-point of LandSim help
	Half life	No decay		-
Zinc	Partition coefficient (Kd)	301	l/Kg	Mid-point of LandSim help
	Half life	No decay		-
Cadmium	Partition coefficient (Kd)	751	l/Kg	Mid-point of LandSim help

Determinand	Parameter	Value	Units	Justification
	Half life	No decay		-
Pyrene	Partition coefficient (Koc)	6.8×10^4	l/Kg	USEPA (1999)
	Half life	1,925	days	Longest half life in Dallas et al (1999)
Fluoranthene	Partition coefficient (Koc)	4.91×10^4	l/Kg	USEPA (1999)
	Half life	462	days	Longest half life in Dallas et al (1999)
Anthracene	Partition coefficient (Koc)	2.35×10^4	l/Kg	USEPA (1999)
	Half life	365	days	Abiotic degradation rate Verschueren (2001)
Phenanthrene	Partition coefficient (Koc)	2.09×10^4	l/Kg	USEPA (1999)
	Half life	730	days	Abiotic degradation rate Verschueren (2001)

Table 6.6 Solubility parameters

Determinand	Solubility (mg/l)	Unit	Justification
Copper	2.93×10^5	mg/l	ConSim
Zinc	6.06×10^5	mg/l	ConSim
Cadmium	6.51×10^5	mg/l	ConSim
Pyrene	0.137	mg/l	USEPA (1999)
Fluoranthene	0.232	mg/l	USEPA (1999)
Anthracene	0.0537	mg/l	USEPA (1999)
Phenanthrene	1.28	mg/l	USEPA (1999)

The Target Concentrations are defined as follows (Table 6.7):

- Hazardous substances: UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided (UKTAG, 2016).
- Non-hazardous pollutants: UK DWS taken from the 2016 Regulations, or 1989 Regulations as detailed in Table 6.7.

Table 6.7 Target concentrations

Parameter	Value	Units	Justification
Copper	2	mg/l	Non-hazardous pollutant. The Water Supply (Water Quality) Regulations 2016
Zinc	5	mg/l	Non-hazardous pollutant. Water Supply (Water Quality Regulations) 1989
Cadmium	5×10^{-3}	mg/l	Non-hazardous pollutant. The Water Supply (Water Quality) Regulations 2016
Pyrene	5×10^{-6}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided for benzo(a)pyrene.
Fluoranthene	5×10^{-5}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided for benzo(a)pyrene.
Anthracene	5×10^{-5}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided.
Phenanthrene	5×10^{-8}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided for benzo(a)pyrene.

Hydrogeological parameters are presented in Table 6.8. The Structured Chalk hydraulic conductivity and hydraulic gradient are used, along with the cross-sectional area, to calculate the groundwater flux. The groundwater flux is used to dilute non-hazardous pollutants.

The hydraulic conductivity of the fissured Chalk is likely to be significantly higher than the value of 1×10^{-5} m/s assigned in Table 6.8 and, based on the data presented in Section 3.4.3, a value of between 1×10^{-5} m/s and 1×10^{-3} m/s may be more plausible. However, by using the value at the lower end of the plausible range, a conservative estimate for dilution is derived.

The effective porosity of the saturated zone is used to estimate travel times. For a Level 2 assessment only dilution is considered in the saturated zone, not attenuation, and so the travel time is for information only.

Table 6.8 Hydrogeology parameters

Parameter		Value	Unit	Justification
Hydraulic conductivity of Structured Chalk (saturated zone)		1×10^{-5}	m/s	Calculated infiltration rate from **Geotechnical Interpretation Report** **(Document Reference 7.11)**.
Hydraulic gradient		0.0076	-	Based on topography in the area around the EDBs. From Lidar data
Effective porosity of aquifer	Unsaturated zone	0.1		Conservative assumption
	Saturated zone	0.01		Conservative assumption to ensure rapid travel time within fissured strata.
Unsaturated zone thickness	EDB 1	7.1	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
	EDB 2	13.1	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
	EDB 3B	5.8	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
	EDB 3C	3.8	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
Fraction of organic carbon – alluvial deposits		0.01	-	Assumption of 1%
Fraction of organic carbon – structureless Chalk deposits		0.001	-	Chalk has little organic carbon, so assigned 0.1%.
Unsaturated zone bulk density		2,385	kg/m^3	Estimated based on particle density of 2,650 and porosity of 0.1 (Freeze & Cherry, 1979)
Mixing depth		5	m	10 % of the travel distance (50 m)

6.3 Model Results

6.3.1 Level 1 Assessment

As detailed in Section 6.1, a Level 1 assessment considers processes operating within the source term.

6.3.1.1 Acute pollution from soluble contaminants

There are no processes operating in the source term for the acute source term. In this case an aqueous source term is considered, and these concentrations are compared directly with the Target Concentrations. The model has been run for EDBs 3B and 3C which have the highest source term concentrations. The predicted concentrations given in Table 6.9 are the same as the source term concentrations given in Table 6.4. These concentrations are lower than the target concentrations given in Table 6.7. Thus, we conclude that the risk to groundwater from acute pollution within the EDBs is not significant.

Table 6.9 EDB2 Predicted concentrations (mg/l)

Copper	Zinc
1.450E-01	7.970E-01

Note blue cells below Target concentration, red cells above target concentration

6.3.1.2 Chronic pollution from sediments

For the chronic source term, following partitioning between the solid and aqueous phases within the EDB sediment, and limited by the pure phase solubility, Table 6.10 shows that there is a predicted impact from zinc and all four PAH compounds. These determinands are therefore taken forward to the Level 2 assessment.

Table 6.10 EDB2 Predicted concentrations (mg/l)

Copper	Zinc	Cadmium	Pyrene	Fluoranthene	Anthracene	Phenanthrene
1.362E-01	2.359E+01	3.994E-03	1.431E-02	1.901E-02	2.536E-03	1.259E-02

Note blue cells below Target concentration, red cells above target concentration

6.3.2 Level 2 Assessment – chronic pollution

6.3.2.1 EDB 2

EDB 2 is located on alluvium overlying structured Chalk and it is estimated that the unsaturated zone thickness at this location is 13.1 m. The model predicts that no hazardous substances would be predicted to reach the watertable at concentrations in excess of the Target Concentration and that there is no pollution by non-hazardous pollutants within 100 years (Table 6.11).

Table 6.11 EDB2 Predicted concentrations (mg/l)

Time(years)	Zinc	Pyrene	Fluoranthene	Anthracene	Phenanthrene
0.1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
100	2.134E-03	1.202E-21	4.616E-32	6.259E-26	4.661E-17

Note blue cells below Target concentration, red cells above target concentration

6.3.2.2 EDB 3B

EDB 3B is located on Made Ground and Head deposits and it is estimated that the unsaturated zone thickness at this location is 5.8 m. The model predicts that no hazardous substances would be predicted to reach the watertable at concentrations in excess of the Target Concentration and that there is no pollution by non-hazardous pollutants within 100 years (Table 6.12).

Table 6.12 EDB3B Predicted concentrations (mg/l)

Time(years)	Zinc	Pyrene	Fluoranthene	Anthracene	Phenanthrene
0.1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10	4.616E-27	0.000E+00	0.000E+00	1.187E-27	5.555E-23
100	4.206E-01	4.070E-13	1.730E-21	1.019E-17	1.276E-11

Note blue cells below Target concentration, red cells above target concentration

6.3.2.3 EDB 3C

EDB 3C is located on Made Ground, Alluvium and Structureless Chalk deposits and it is estimated that the unsaturated zone thickness at this location is 3.8 m. The model predicts that no hazardous substances would be predicted to reach the watertable at concentrations in excess of the Target Concentration and that there is no pollution by non-hazardous pollutants within 100 years (Table 6.13).

Table 6.13 EDB3C Predicted concentrations (mg/l)

Time(years)	Zinc	Pyrene	Fluoranthene	Anthracene	Phenanthrene
0.1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10	4.103E-17	0.000E+00	1.766E-34	7.760E-20	4.866E-16
100	3.338E+00	1.448E-10	1.711E-17	1.274E-14	1.393E-09

Note blue cells below Target concentration, red cells above target concentration

6.3.3 Sensitivity analysis

In order to demonstrate model sensitivity to key parameters, the EDB 3B base case model has been selected. We note that similar relative changes in predicted concentrations would be found for all the models and thus it is only necessary to run sensitivity analysis on one of the EDB models.

6.3.3.1 Fraction of organic carbon

The fraction of organic carbon is decreased by an order of magnitude from 0.01 to 0.001. The effect of this is to decrease retardation of organic compounds in the unsaturated zone by an order of magnitude, which allows less time for degradation to occur. Model results (Table 6.14) show that decreasing the fraction of organic carbon results in predicted concentrations rising by many orders of magnitude which demonstrates that the model is sensitive to this parameter. Pyrene and phenanthrene concentrations are predicted to be higher than the Target Concentration. Note that metals are not assessed as the model does not use fraction of organic carbon to estimate metal retardation rates.

Table 6.14 Sensitivity run 1: fraction of organic carbon (mg/l) at 100 years

	Target concentration	0.01 (base case)	0.001 (sens run 1)
Pyrene	5.000E-06	4.070E-13	**8.102E-05**
Fluoranthene	5.000E-05	1.730E-21	2.697E-07
Anthracene	5.000E-05	1.019E-17	8.754E-07
Phenanthrene	5.000E-06	1.276E-11	**1.517E-04**

Concentrations given in bold exceed the Target Concentration

6.3.3.2 Infiltration rate

In the base case model, the superficial strata hydraulic conductivity is assumed to be limiting the infiltration rate when the EDBs are full of water, and it is further considered that the EDBs are full of water for 50% of each year. For this sensitivity run, it is assumed that the EDBs are full of water for 100% of the year i.e. the infiltration rate is solely limited by the unsaturated zone hydraulic conductivity.

Model results (Table 6.15) shows that increasing the infiltration rate increases predicted concentrations. The reason for this is twofold. Firstly, for hazardous substances, the contaminants spend a shorter period within the unsaturated zone where they degrade. The retarded travel time non-hazardous pollutants through the unsaturated zone is decreased.

Secondly, for non-hazardous pollutants, the greater flux through the unsaturated zone results in a decrease in dilution applied at the watertable.

The results show that the PAH compounds remain well below the Target Concentrations, but zinc is predicted to slightly exceed it.

Table 6.15 Sensitivity run 2a: infiltration rate and unsaturated zone hydraulic conductivity (mg/l) at 100 years

	Target concentration	50% (base case)	100% (sens run 2a)
Zinc	5.000E+00	4.206E-01	**7.894E+00**
Pyrene	5.000E-06	4.070E-13	2.678E-09
Fluoranthene	5.000E-05	1.730E-21	2.359E-15
Anthracene	5.000E-05	1.019E-17	5.761E-13
Phenanthrene	5.000E-06	1.276E-11	1.691E-08

Concentrations given in bold exceed the Target Concentration

6.3.3.3 Unsaturated zone thickness

For EDB 3B, the unsaturated zone has been estimated at 5.8 m thick. For this sensitivity run, the unsaturated zone thickness has been increased by 5 m to 10.8 m.

Model results (Table 6.16) show a decrease in concentrations for all contaminants. This is due to the longer travel time within the unsaturated zone pathway segment resulting in longer breakthrough times. We note that the maximum concentration (at any time) for the PAH compounds is reduced as the longer time spent in the unsaturated zone provides more time for degradation. For zinc, however, which does not degrade, breakthrough would eventually occur to the same concentrations as in the base case model.

Table 6.16 Sensitivity run 3: unsaturated zone thickness (mg/l) at 100 years

	Target concentration	5.8 m (base case)	10.8 m (sens run 3)
Zinc	5.000E+00	4.206E-01	1.535E-03
Pyrene	5.000E-06	4.070E-13	5.244E-19
Fluoranthene	5.000E-05	1.730E-21	3.758E-29
Anthracene	5.000E-05	1.019E-17	1.144E-23
Phenanthrene	5.000E-06	1.276E-11	1.475E-15

7 Conclusions and recommendations

7.1 Conclusions

There are a number of potential sources of contamination within and adjacent to the Application Area. These include landfills, a former gasworks and ironworks, petrol stations, railways and land with mixed industrial uses. On the basis of the soil and water quality data obtained to date by the Scheme, these potential sources have been assessed as detailed in a Controlled Waters Risk Assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)** and it was concluded that the potential for significant contamination to groundwater from these sources is low.

Some material will need to be excavated as part of the Scheme. It is envisaged that all this material will be used to raise levels along the eastern side of the Application Area and that there will be no surplus material from the Scheme.

GI has shown that there is a significant quantity of Made Ground within the Application Area, which is probably associated with previous road scheme construction.

On the basis of the soil and water quality data obtained to date by the Scheme, it is considered unlikely that placement of excavated material to raise levels will result in significant mobilisation of contamination. Thus, whilst no significant risk to human health or controlled waters is currently assessed for the in-situ materials, it is also considered that there will be no significant risk following excavation and placement.

The most significant risk to groundwater from the Scheme is considered to be the road drainage. Considerable thought has been put into designing an upgraded road drainage system, with as much drainage as possible captured and discharged to the EDBs. Where levels permit, discharge is routed first to a lined EDB for initial settlement and attenuation of contaminants, followed by discharge to un-lined and vegetated EDBs for further attenuation. Whilst the un-lined EDBs are designed to drain to ground, it is expected that a significant proportion of the discharge following storm events will be routed to the River Itchen.

A HEWRAT assessment has been undertaken for each of the EDBs. The results of the screening assessment show that all but one of the currently proposed Extended Detention Basins (EDT) have a 'medium risk' to groundwater and one has a high risk. In order to mitigate against the high risk EDB, it is proposed that this EDB will be lined, thus preventing discharge to groundwater. On this basis a DQRA has been undertaken to further assess the risk from the un-lined EDBs.

Acute risk from soluble contaminants present in the EDBs has been assessed as low. The contaminant concentrations in the EDBs, as derived from the HEWRAT assessment are below the UK DWS and thus pose no significant risk to groundwater.

The models demonstrate that none of the EDBs are likely to result in an impact on groundwater from determinands present within the sediment lining the base of the EDBs (chronic risk).

For the hazardous PAH compounds, the aqueous source term concentration leached from the EDB sediments is limited by the determinand pure phase solubility and the fact that these determinands are highly sorbed onto the sediment matrix. Thus, concentrations leaching from the sediment are modest. The model shows that there is likely to be a sufficient thickness of unsaturated zone, comprising material containing sufficient organic carbon, to provide sufficient attenuation and ensure that there is no discharge to the watertable.

Copper and cadmium also sorb highly to the EDB sediment such that aqueous concentrations in the EDBs are unlikely to reach concentrations that would cause pollution of groundwater. Predicted aqueous source term zinc concentrations are higher, but attenuation within the unsaturated zone, combined with dilution in the receiving groundwater is sufficient to ensure there is no pollution by this determinand.

Sensitivity analysis has been undertaken of the DQRA models. These show that the models are sensitive to the faction of organic carbon (for organic compounds), infiltration rate and unsaturated zone thickness. Further data on these parameters should be collected as detailed in the next section.

7.2 Recommendations

Stantec has proposed additional GI at each of the EDBs. Geological data obtained from this GI will provide a better understanding of the superficial strata likely to underlie each of these structures. Once these data are available, the HgRA should be reviewed and updated based on the complete dataset.

A number of the boreholes will be completed as groundwater monitoring wells. Timeseries monitoring data will provide more confidence on the unsaturated zone thickness at each of these structures.

It is proposed to undertake soakaway tests at the proposed EDB locations. This will inform the understanding of the unsaturated zone hydraulic conductivity.

It is recommended that soil samples are taken from each of the strata encountered and subject to laboratory testing for fraction of organic carbon. These data can then be used to refine the DQRA model and inform predictions of the risk to groundwater from the Scheme’s drainage design.

8 References

Allen, D. J., Brewerton, L. J., Coleby, L. M., Gibbs, B. R., Lewis, M. A., MacDonald, A. M., & Williams, A. T. (1997). *The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34.*

Booth, K., Farrant, A. R., Hopson, P. M., Woods, M. A., Evans, D. J., & Wilskinson, I. (2008). *Geology of the Winchester district. Sheet description of the British Geological Survey, 1:50 000 Series Sheet 299 (England and Wales).*

British Geological Survey. (2002). *Winchester. England and Wales Sheet 299. Solid and Drift Geology. 1:50 000. (Keyworth, Nottingham: British Geology Survey).*

CIRIA. (2021). *Contaminated Land Risk Assessment. A Guide to Good Practice.*

Entec. (2002). *River Itchen Catchment Groundwater Modelling Study Phase 2.*

Envirocheck. (2016). *Envirocheck Report, Site at Winnall Down Farm HampshireOrder Number 85178192_1_1 fo WSP.*

Environment Agency. (2006). *Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.*

Environment Agency. (2018). *The Environment Agency's approach to groundwater protection V1.2.*

Environment Agency. (2019). *Guidance Groundwater source protection zones (SPZs)*. Retrieved August 2021, from https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs

Environment Agency. (2021). *https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm*.

ESI. (2001). *Benchmarking RAM: ESI'S Groundwater Risk Assessment Tool. Report Reference 5303R1D1.*

ESI. (2008). *RAM 3 User Guide.*

Freeze, R. A., & Cherry, J. A. (1979). *Groundwater.* Prentice-Hall.

Highways England. (2015). *HEWRAT V2.0 Help guide.*

Institute of Geological Sciences and Southern Water Authority. (1979). *Hydrogeological map of Hampshire and the Isle of Wight, Scale 1:100 000.*

NRFA. (2021). *42016 - Itchen at Easton*. Retrieved August 2021, from https://nrfa.ceh.ac.uk/data/station/spatial/42016

Reading Agricultural Consultants. (2021). *Agricultural Land Classification and Soil Resources at M3 Junction 9 Winchester.* For Stantec UK Limited.

Robinson, P. C., & Hodgkinson, D. P. (1996). *Exact solutions for radionuclide transport in the presence of parameter uncertainty.* Technical Report AERE R 12125. Harwell Laboratory, Oxfordshire.

Stantec. (2021). *M3 Junction 9 improvement scheme - Preliminary Environmental Information Report (PEIR).*

UKTAG. (2016). *UK Technical Advisory Group on the Water Framework Directive: Technical report on Groundwater Hazardous Substances.*

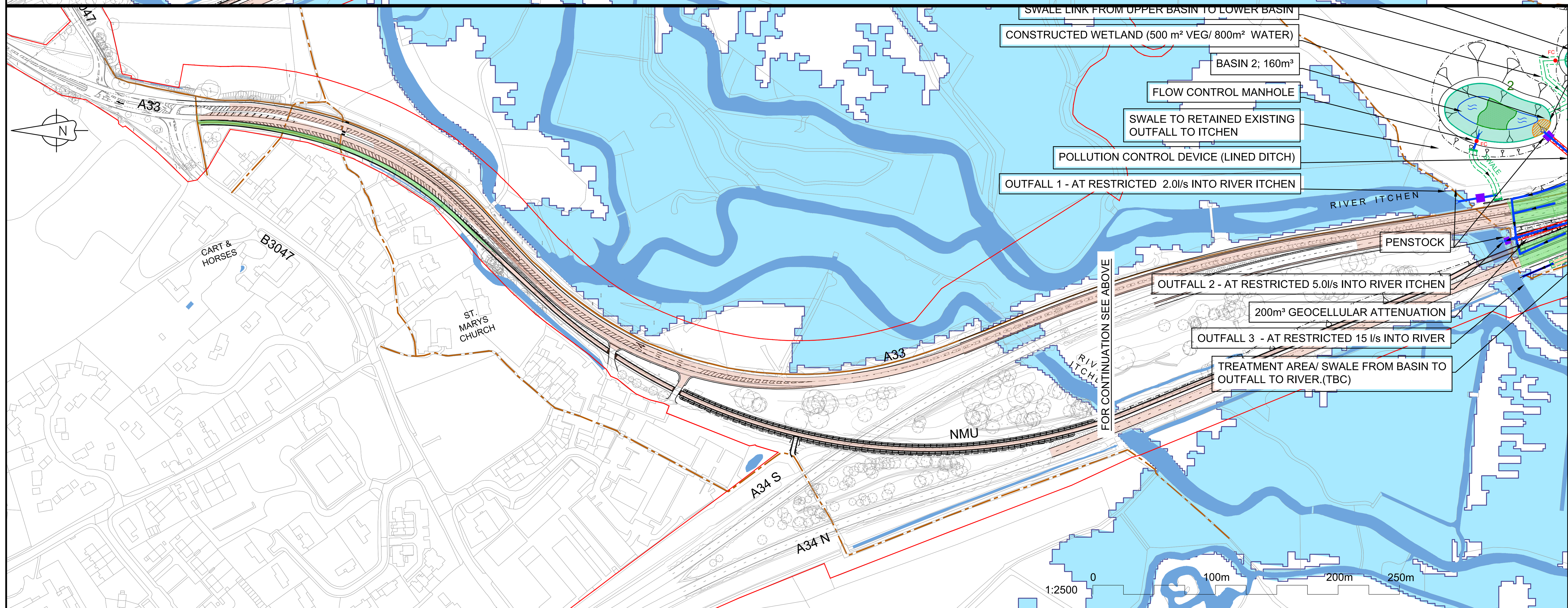
WPK. (2007). *Wastewater discharges to ground Morestead Road Wastewater Treatment Works Groundwater Investigations - Interpretative Report prepared for Southern Water.*

WSP. (2017). *Preliminary Sources Study Report.*

APPENDICES

Appendix A

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512_Drainage Schematic Plan



KEY:

- INDICATIVE APPLICATION BOUNDARY
- EXISTING FOOTPATH
- PROPOSED HIGHWAY DRAINAGE NETWORK
- RETAINED EXISTING DRAINAGE
- RIVER ITCHEN
- EA FLOOD ZONE 3 EXTENT
- GEOCELLULAR ATTENUATION
- SA1 - GEOCELLULAR SOAKAWAY
- 1 INFILTRATION BASIN AND REFERENCE
- NEW CARRIAGEWAY
- RETAINED EXISTING CARRIAGEWAY AND DRAINAGE FEATURES
- PROPOSED SMART MOTORWAYS SCHEME TO BE CONSTRUCTED PRIOR TO JUNCTION 9 IMPROVEMENTS SCHEME
- PROPOSED PENSTOCK
- PROPOSED SEDIMENT FOREBAY
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED
- TSC TRASH SCREEN CHAMBER
- FC FLOW CONTROL MANHOLE
- GRASSED BASINS (ALL GRASSED EXCEPT BASIN 2 AND 3C)

Notes:

1. Scheme is subject to Preliminary Design at stage 3 and subject to change pending design development.
2. For existing drainage network refer to drawings HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0507 to 0511
3. For detail of Smart Motorway drainage design refer to SMP drawings HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007
4. Proposed scheme shown is subject to reviews with the respective Highway Authorities, Lead Local Flood Authority and the Environment Agency.
5. Suitability of re-use of existing drainage assets is subject to review of survey, asset records and site verification.
6. Drawing to be read in conjunction with Pollution Prevention Technical Note ref: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003.

Rev.	Date	Description	Drawn	Chk'd	App'd
P01		FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE SCHEMATIC PLAN

DRAFT

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: A1	Date: 05.02.21	Date: 05.02.21	Date: 05.02.21	Date: 05.02.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE551511 - VFK -HDG- X-XXXX-XX - DR - CD - 0512

Project Ref. No.: 48176

Revision: P01

Appendix B
HEWRAT screening assessments

Runoff to Watercourses

Basin 1 HEWRAT

EQS - Annual Average Concentration	Copper	Zinc	
Step 2	0.00	0.00	ug/l
Step 3	0.00	0.00	ug/l

Acute Impact	Copper	Zinc
	Pass	Pass

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality AADT: >10,000 and <50,000 Climatic region: Warm Wet Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	0.445
Permeable area draining to outfall (ha)	0.179
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 — Bed width (m): 17 Manning's n: 0.07 Side slope (m/m): 0.5 Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Basin 1 HEWRAT Infiltration to Groundwater

highways england — Reset GW Assessment — Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Basin 1 HEWRAT

Runoff to Watercourses

DETAILED RESULTS

Back To Top — Go To Interface

Summary of predictions — Soluble - Acute Impact (Copper, Zinc); Sediment - Chronic Impact (Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene)

Prediction of impact: Step1, Step2, Step3

In Runoff — Step 1

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	67.90	62.20
No. of exceedances/worst year	89	75
RST6 Allowable Exceedances/year	1	1
No. of exceedances/year	21.70	25.30
No. of exceedances/worst year	28	29
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	27.32	84.71
90%ile	52.94	172.88
95%ile	68.76	255.14
99%ile	113.86	446.19

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable	1	1	1	1	1	1	1	1
No. of exceedances/year	75.30	98.00	1.50	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	99	120	4	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	349	1168	1	11065	1914	1837	117	518
90%ile	786	2781	1	28184	4876	4679	299	1319
95%ile	968	3569	2	56234	9729	9335	596	2632
99%ile	1501	5477	4	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	0.00	0.00
90%ile	0.00	0.00
95%ile	0.00	0.01
99%ile	0.01	0.02

Step 2: Velocity 0.14 m/s — Tier 2 is used for the calculation. DI: -. Minimum % settlement needed: - %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI: -

Basin 1 HEWRAT Spillage Risks

highways england — View Parameters — Reset Spillage Risk — Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,000							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	16,731							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.00283	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00170	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00170	0.00000	0.00000	0.00000	0.00000	0.00000	0.0017	589
D14	Existing measures factor	0.7							
D15	Return period with existing pollution reduction	0.00119	0.00000	0.00000	0.00000	0.00000	0.00000	0.0012	841
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00071	0.00000	0.00000	0.00000	0.00000	0.00000	0.0007	1402

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Basin 1 HEWRAT

Runoff to Watercourses Basin 2 HEWRAT

Highways England Water Risk Assessment Tool

highways england — Version 2.0.4 June 2019

Soluble						Sediment - Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.00	ug/l	Pass	Pass	Accumulating? No — 0.14 Low flow Vel m/s
Step 3	0.00	0.00	ug/l			Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality — AADT: >10,000 and <50,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	1.24
Permeable area draining to outfall (ha)	0.595
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Infiltration to Groundwater Basin 2 HEWRAT

highways england — Reset GW Assessment — Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	190
RISK SCREENING LEVEL	Medium

Runoff to Watercourses Basin 2 HEWRAT

DETAILED RESULTS

Back To Top — Go To Interface

In Runoff

Step 1

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	67.90	62.20
No. of exceedances/worst year	89	75
RST6 Allowable Exceedances/year	1	1
No. of exceedances/year	21.70	25.30
No. of exceedances/worst year	28	29
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	27.32	84.71
90%ile	52.94	172.88
95%ile	68.76	255.14
99%ile	113.86	446.19

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	75.30	98.00	1.50	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	99	120	4	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	349	1168	1	11065	1914	1837	117	518
90%ile	786	2781	1	28184	4876	4679	299	1319
95%ile	968	3569	2	56234	9729	9335	596	2632
99%ile	1501	5477	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	0.00	0.00
90%ile	0.00	0.01
95%ile	0.01	0.02
99%ile	0.02	0.07

Step 2

Velocity 0.14 m/s — Tier 2 is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00
Thresholds resholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184

DI -

Spillage Risks Basin 2 HEWRAT

highways england — View Parameters — Reset Spillage Risk — Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,000							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	> 1 hour							
D7	Traffic flow (AADT two way)	50,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.00846	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.75							
D11	Risk of pollution incident	0.00634	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00634	0.00000	0.00000	0.00000	0.00000	0.00000	0.0063	158
D14	Existing measures factor	0.7							
D15	Return period with existing pollution reduction	0.00444	0.00000	0.00000	0.00000	0.00000	0.00000	0.0044	225
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00266	0.00000	0.00000	0.00000	0.00000	0.00000	0.0027	375

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Runoff to Watercourses — Basin 3A HEWRAT

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

Soluble						Sediment – Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.02	ug/l	Pass	Pass	Accumulating? No — 0.14 Low flow Vel m/s
Step 3	0.00	0.01	ug/l			Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=100,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	5.856
Permeable area draining to outfall (ha)	0.435
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Basin 3A HEWRAT Infiltration to Groundwater — Basin 3A HEWRAT

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <=5 m	3	60
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	260
RISK SCREENING LEVEL	High

Runoff to Watercourses — Basin 3A HEWRAT

DETALED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact: Step1, Step2, Step3 (Soluble – Acute Impact: Copper, Zinc; Sediment – Chronic Impact: Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene)

In Runoff — Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	111.10	115.70
No. of exceedances/worst year	134	143

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	70.70	89.80
No. of exceedances/worst year	91	113

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Sediment – Step 1 (Toxicity Threshold)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable	1	1	1	1	1	1	1	1
No. of exceedances/year	113.50	124.90	6.30	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	766	2676	1	11065	1314	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.07
90%ile	0.04	0.17
95%ile	0.08	0.31
99%ile	0.23	0.99

Step 2 (sediment): Velocity 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation) — Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

DI: -

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

Basin 3A HEWRAT Spillage Risks — Basin 3A HEWRAT

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	2,250							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	28,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.01066	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00639	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00639	0.00000	0.00000	0.00000	0.00000	0.00000	0.0064	156
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00384	0.00000	0.00000	0.00000	0.00000	0.00000	0.0038	261
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00153	0.00000	0.00000	0.00000	0.00000	0.00000	0.0015	652

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Runoff to Watercourses

Basin 3B HEWRAT

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

Soluble					Sediment – Chronic Impact
EQS - Annual Average Concentration				Acute Impact	Alert. Protected Area.
	Copper	Zinc		Copper: Pass	Sediment deposition for this site is judged as:
Step 2	0.00	0.02	ug/l	Zinc: Pass	Accumulating? No — 0.14 Low flow Vel m/s
Step 3	0.00	0.01	ug/l		Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality AADT >=100,000 Climatic region Warm Wet Rainfall site Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

- Annual Q_{95} river flow (m^3/s): 2.6
- Impermeable road area drained (ha): 6.147
- Permeable area draining to outfall (ha): 0.685
- Base Flow Index (BFI): 0.89

Freshwater EQS limits:
- Bioavailable dissolved copper (µg/l): 1
- Bioavailable dissolved zinc (µg/l): 10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
		Estimated effectiveness		
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Basin 3B HEWRAT Infiltration to Groundwater

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <=5 m	3	60
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Runoff to Watercourses

Basin 3B HEWRAT

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Soluble – Acute Impact: Copper, Zinc — Prediction of impact Step1, Step2, Step3

Sediment – Chronic Impact: Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene

In Runoff

Step 1 — Soluble

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	111.10	115.70
No. of exceedances/worst year	134	143
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	70.70	89.80
No. of exceedances/worst year	91	113
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1 — Sediment (Toxicity Threshold)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	113.50	124.90	6.30	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	147	152	11	25	71	25	22	39
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.08
90%ile	0.04	0.18
95%ile	0.08	0.32
99%ile	0.25	1.04

Step 2 — Velocity 0.14 m/s; Tier 2 is used for the calculation; DI -; Minimum % settlement needed - %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI -

Basin 3B HEWRAT Spillage Risks

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	2,600							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	28,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.01232	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00739	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00739	0.00000	0.00000	0.00000	0.00000	0.00000	0.0074	135
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00443	0.00000	0.00000	0.00000	0.00000	0.00000	0.0044	226
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00177	0.00000	0.00000	0.00000	0.00000	0.00000	0.0018	564

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

highways england

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	0.00	0.02	ug/l
Step 3	0.00	0.01	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality AADT >=100,000 Climatic region Warm Wet Rainfall site Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	7.107
Permeable area draining to outfall (ha)	1.072
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 — Bed width (m): 17; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

highways england — Reset GW Assessment — Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <=5 m	3	60
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

DETAILED RESULTS

Back To Top — Go To Interface

Summary of predictions — Soluble - Acute Impact — Sediment - Chronic Impact

Prediction of impact	Copper	Zinc	Copper (sed.)	Zinc (sed.)	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

In Runoff — Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**111.10**	**115.70**
No. of exceedances/worst year	134	143

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**70.70**	**89.80**
No. of exceedances/worst year	91	113

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1 — Sediment (Toxicity Threshold)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**113.50**	**124.90**	**6.30**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.09
90%ile	0.04	0.21
95%ile	0.09	0.38
99%ile	0.28	1.20

Step 2 — Velocity 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation) — Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

DI: -

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

highways england — View Parameters — Reset Spillage Risk — Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	3,250							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	11							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.83							
D9	Risk of accidental spillage	0.01624	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00974	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00974	0.00000	0.00000	0.00000	0.00000	0.00000	0.0097	103
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00585	0.00000	0.00000	0.00000	0.00000	0.00000	0.0058	171
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00234	0.00000	0.00000	0.00000	0.00000	0.00000	0.0023	428

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Runoff to Watercourses — **Basin 4 HEWRAT**

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

Soluble					Sediment – Chronic Impact
EQS - Annual Average Concentration			Acute Impact		Alert. Protected Area.
	Copper	Zinc	Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.01 ug/l	Pass	Pass	Accumulating? No 0.14 Low flow Vel m/s
Step 3	0.00	0.01 ug/l			Extensive? No - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality — AADT: >=100,000; Climatic region: Warm Wet; Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

- Annual Q_{95} river flow (m^3/s): 2.6
- Impermeable road area drained (ha): 4.389
- Permeable area draining to outfall (ha): 0.128
- Base Flow Index (BFI): 0.89
- Freshwater EQS limits: Bioavailable dissolved copper (µg/l): 1; Bioavailable dissolved zinc (µg/l): 10.9
- Is the discharge in or within 1 km upstream of a protected site for conservation? Yes
- For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l
- For dissolved copper only — Ambient background concentration (µg/l): 0
- For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No
  - Tier 1 — Estimated river width (m): 5
  - Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Basin 4 HEWRAT Infiltration to Groundwater — **Basin 4 HEWRAT**

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	240
RISK SCREENING LEVEL	Medium

Runoff to Watercourses — **Basin 4 HEWRAT**

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact: Step1 / Step2 / Step3 — Soluble – Acute Impact (Copper, Zinc); Sediment – Chronic Impact (Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene)

In Runoff — Step 1

Soluble (RST24):

	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**111.10**	**115.70**
No. of exceedances/worst year	134	143

Soluble (RST6):

	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**70.70**	**89.80**
No. of exceedances/worst year	91	113

	Copper	Zinc
	(ug/l)	(ug/l)
Thresholds RST24	21	32
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Sediment (Toxicity Threshold):

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**113.50**	**124.90**	**6.30**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	147	152	11	25	71	25	22	39
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.01
	(ug/l)	(ug/l)
Thresholds RST24	21	32
Thresholds RST6	42	184
Event Statistics Mean	0.01	0.05
90%ile	0.03	0.13
95%ile	0.06	0.23
99%ile	0.18	0.75

Velocity: 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI: -

Basin 4 HEWRAT Spillage Risks — **Basin 4 HEWRAT**

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,600							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	10							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00377	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00226	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00226	0.00000	0.00000	0.00000	0.00000	0.00000	0.0023	443
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00136	0.00000	0.00000	0.00000	0.00000	0.00000	0.0014	738
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00054	[illegible]	[illegible]	0.00000	0.00000	0.00000	0.0005	1844

Pollution reduction factor
Use the Indicative Pollution Risk Reduction Factor table below to estimate the factor.

Provide justification for the decision in the appropriate comments box below.

A default value of 1 is used if no measures are considered or if no value is entered.

Justification for choice of existing measures factors | [Justification for c]hoice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Mixed fracture and intergranular flow (e.g. consolidated deposits or unconsolidated deposits of medium – coarse sand)	2	40
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	500							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Slip road							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	11							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00129	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000	0.0008	1287
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00047	0.00000	0.00000	0.00000	0.00000	0.00000	0.0005	2146
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00028	0.00000	0.00000	0.00000	0.00000	0.00000	0.0003	3576

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

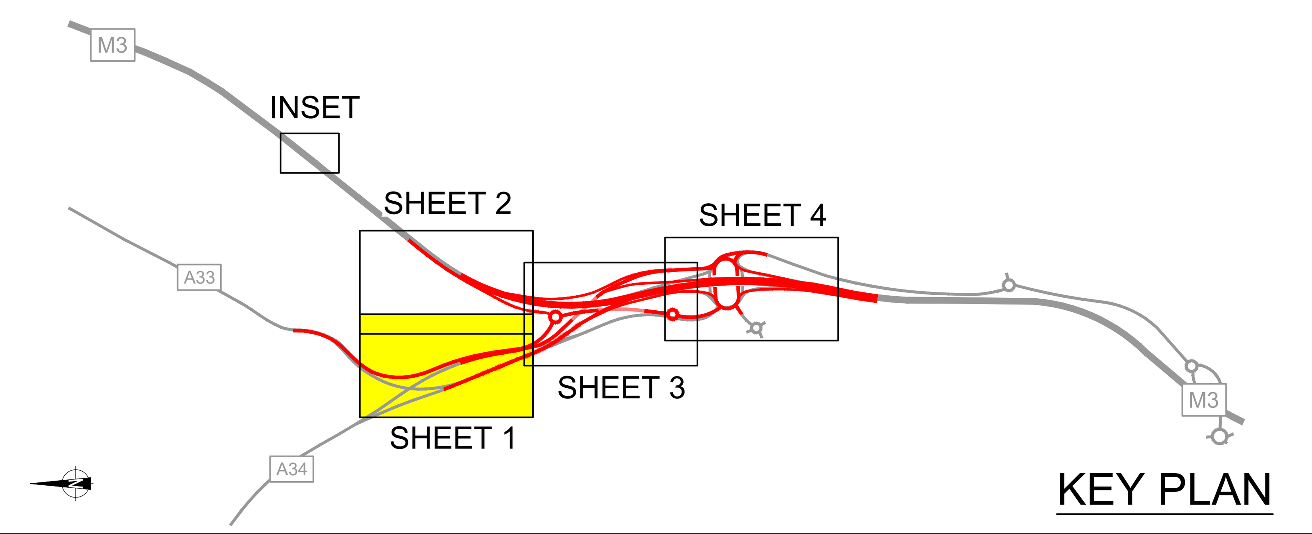
System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Appendix C

HE551551-VFK-HGT-X_XXXX_XX-DR-GE-004 Exploratory hole location plan

Report Reference: 330610074R1
Report Status: Final



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 1 OF 4

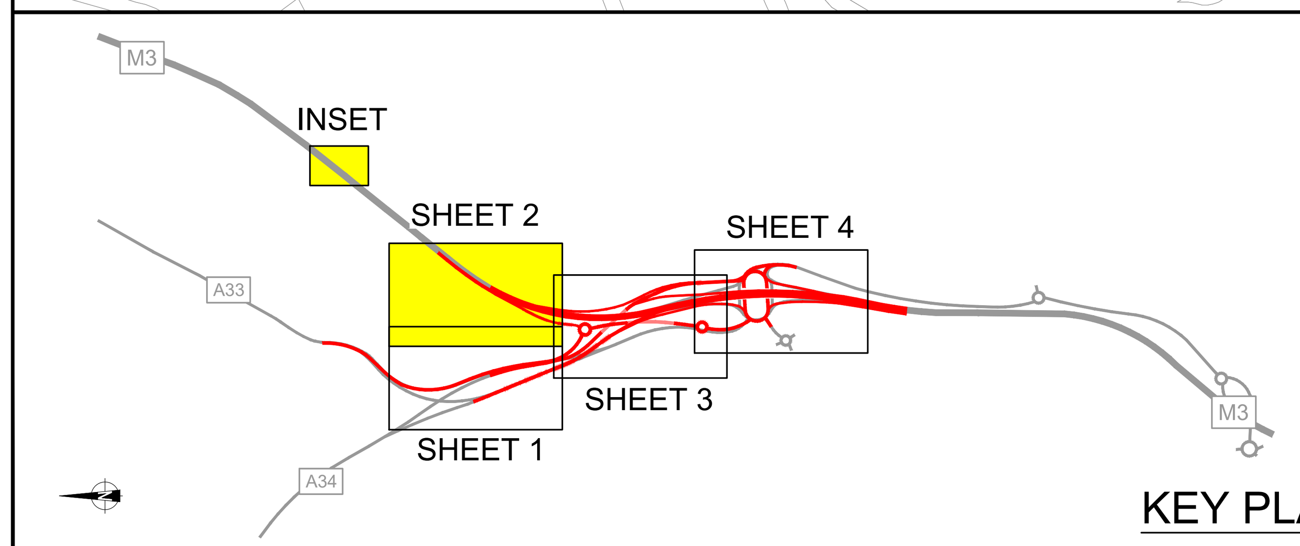
Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size: A1	Date: 05.05.21	Date: 05.05.21	Date: 05.05.21	Date: 06.05.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0001

Project Ref. No. 48176

Revision P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

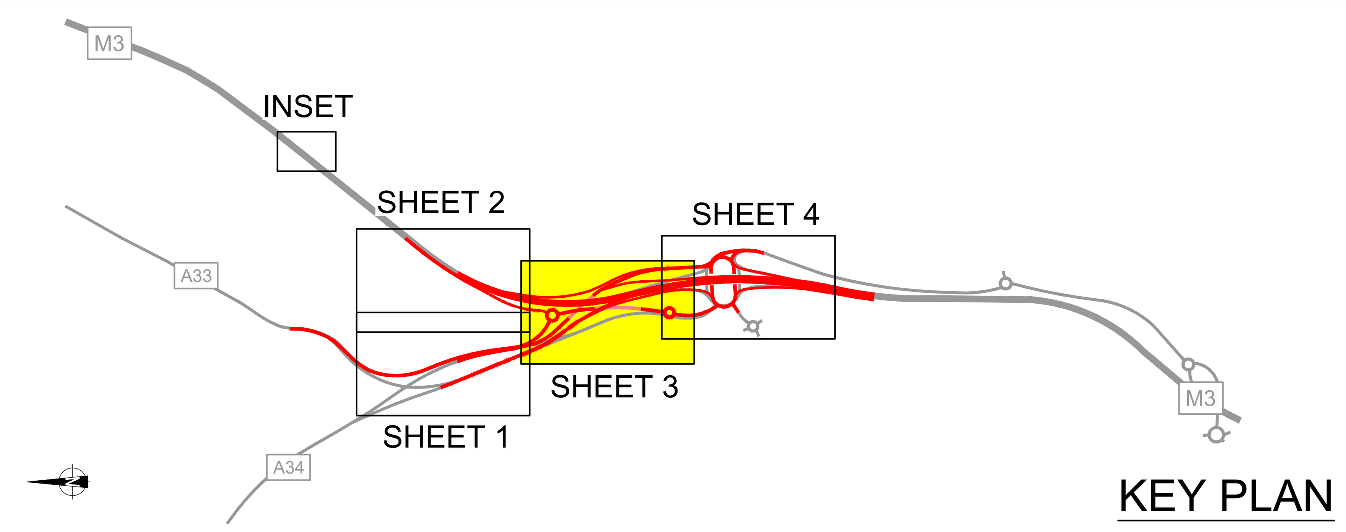
SHEET 2 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size: A1	Date: 05.05.21	Date: 05.05.21	Date: 05.05.21	Date: 06.05.21

Drawing Number: HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0002 (HE PIN / Originator / Volume / Location / Type / Role / Number)

Project Ref. No.: 48176

Revision: P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

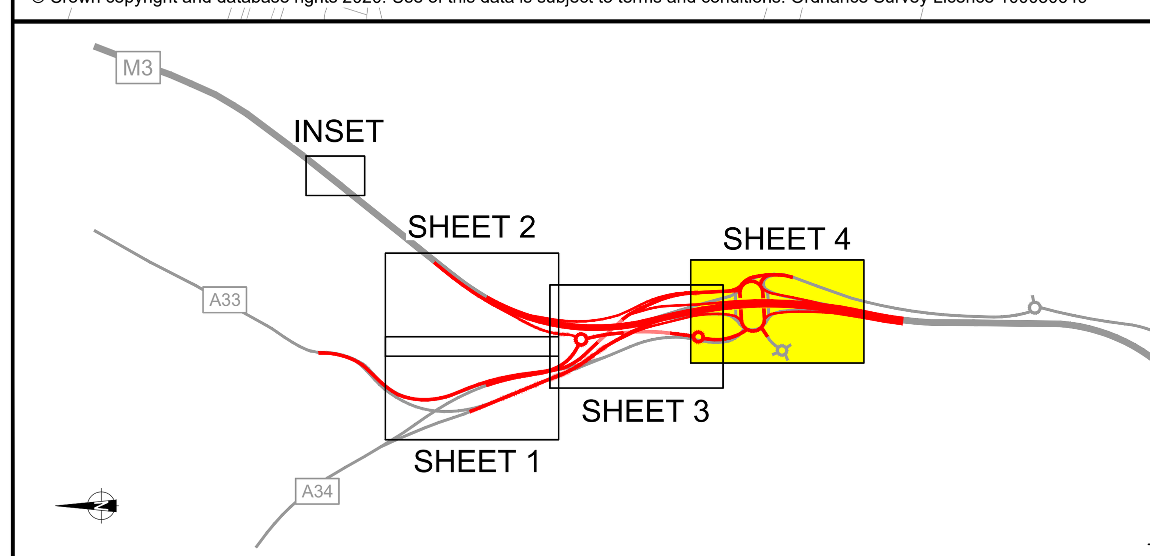
SHEET 3 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size: A1	Date: 05.05.21	Date: 05.05.21	Date: 05.05.21	Date: 06.05.21

Drawing Number: HE PIN | Originator | Volume
HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0003
Location | Type | Role | Number

Project Ref. No.: 48176

Revision: P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 4 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size A1	Date 05.05.21	Date 05.05.21	Date 05.05.21	Date 06.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX - Location DR - Type GE - Role 0004 Number

Project Ref. No. 48176

Revision P01

Appendix D

HE551551-VFK-HGT-X_XXXX_XX-DR-GE-0020 Geological plan

Key

- Made Ground
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 04.12.20	Date: 08.12.20

Drawing Number: HE PIN | Originator | Volume
HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0020
Location | Type | Role | Number

Project Ref. No.: 48176

Revision: P02

Appendix E

RAM model files (electronic appendix)

Appendix J – Hydrogeological Risk Assessment:

330610074R1 - M3 Junction 9 DQRA M3 junction 9 improvement: Hydrogeological Risk Assessment

M3 junction 9 improvement: Hydrogeological Risk Assessment

T1.02

M3 junction 9 improvement: Hydrogeological Risk Assessment

Prepared for
National Highways

Report reference:

330610074R1, October 2021

Report status:

Final

CONFIDENTIAL

New Zealand House, 160-162 Abbey Foregate,
Shrewsbury, Shropshire
SY2 6FD

Telephone: +44 (0)1743 276 100
Facsimile: +44 (01743 248 600

Registered Office:
Stantec UK Ltd
Buckingham Court
Kingsmead Business Park
Frederick Place, London Road
High Wycombe HP11 1JU
Registered in England No. 1188070

M3 junction 9 improvement: Hydrogeological Risk Assessment

	Name	Signature
Author	Richard Holtham Robert Sears	[redacted]
Checked by	Robert Sears, Francis Crozier	[redacted]
Reviewed by	Francis Crozier	[redacted]

Revision record:

Issue	Date	Status	Comment	Author	Checker	Reviewer
1	21/09/21	Draft	Issued for comment	RAH, RCS	RCS, FKC	FKC
2	08/10/21	Final		RAH, RCS	RCS, FKC	FKC

Contents

1	INTRODUCTION	1
1.1	Background	1
1.2	Objectives	2
1.3	Scope of Work	2
1.4	Competent expert	2
2	DRAINAGE STRATEGY AND HEWRAT ASSESSMENT	4
3	BASELINE CONDITIONS	8
3.1	Site setting	8
3.2	Geology	8
3.2.1	Regional geology	8
3.2.2	Local Geology	13
3.2.3	Soil contamination	19
3.2.4	Infilled ground/landfilling and historical land use	19
3.3	Hydrology	21
3.3.1	Rainfall	21
3.3.2	Surface water features	22
3.3.3	Surface water quality	23
3.4	Hydrogeology	24
3.4.1	Groundwater classifications and systems	24
3.4.2	Groundwater Source Protection Zones (SPZs)	24
3.4.3	Aquifer properties	25
3.4.4	Groundwater levels and flow	26
3.4.5	Contaminated land and pollution events	36
3.4.6	Groundwater quality	37
3.5	Other potential receptors	40
3.5.1	Licenced water abstractions and discharges	40
3.5.2	Private water supplies	41

3.5.3 Designated environmental sites 42

4 CONCEPTUAL SITE MODEL 48

4.1 Sources 48

4.1.1 Carriageway drainage 48

4.1.2 Placement of potentially contaminated materials via cut and fill operations 48

4.1.3 Other sources of contamination 49

4.2 Pathways 49

4.2.1 Unsaturated zone 49

4.2.2 Saturated zone 49

4.3 Receptors 50

5 GROUNDWATER IMPACT ASSESSMENT 51

5.1 Road drainage 51

5.2 Filled areas 51

6 DETAILED QUANTITATIVE RISK ASSESSMENT FOR EDBS 54

6.1 Introduction 54

6.2 Model Parameterisation 54

6.3 Model Results 60

6.3.1 Level 1 Assessment 60

6.3.2 Level 2 Assessment – chronic pollution 60

6.3.3 Sensitivity analysis 62

7 CONCLUSIONS AND RECOMMENDATIONS 64

7.1 Conclusions 64

7.2 Recommendations 65

8 REFERENCES 66

FIGURES

Figure 1.1 Site location and points of interest 3
Figure 2.1 Application boundary and locations of EDBs 7
Figure 3.1 Bedrock geology 10
Figure 3.2 Superficial geology and artificial ground 12
Figure 3.3 Superficial geology - central area 13
Figure 3.4 Local superficial geology superimposed on proposed drainage 18
Figure 3.5 Historical landfill areas 21

Figure 3.6 Surface water features 23
Figure 3.7 Groundwater dip data from final day of installation works in mbgl 27
Figure 3.8 Groundwater levels data from final day of installation works in mAOD 28
Figure 3.9 Boreholes monitored for groundwater level 32
Figure 3.10 Groundwater level in Application Area SI boreholes in the Application Area (mAOD) 33
Figure 3.11 Groundwater level in Application Area SI boreholes in metres below ground level 34
Figure 3.12 Application Area overlaid on the Hydrogeological map (Institute of Hydrological Sciences, 1979) 36
Figure 3.13 Groundwater quality monitoring locations 38
Figure 3.14 Licenced and private abstractions and Source Protection Zones (SPZs) 42
Figure 3.15 Designated sites within 2 km 44

TABLES

Table 2.1 Summary of attenuation structures 5
Table 3.1 Stratigraphy of the bedrock geology in the Winchester (based on the BGS Sheet 299 (British Geological Survey, 2002) and BGS memoir (Booth et al., 2008) 9
Table 3.2 Summary of cavities hazard for each basin (from Appendix A of the Geotechnical Interpretation Report (Document Reference 7.11)) 14
Table 3.3 Summary of lithologies encountered from Geotechnical Interpretation Report (Document Reference 7.11) 16
Table 3.4 Historical landfill areas 19
Table 3.5 Outline definitions of Source Protection Zones 24
Table 3.6 Calculated soil infiltration rates (from Table 9.5 in Geotechnical Interpretation Report (Document Reference 7.11)) 26
Table 3.7 Groundwater level dip data during site investigation works in mAOD 29
Table 3.8 Groundwater monitoring locations 31
Table 3.9 Summary of groundwater levels (June 2019 to July 2020) 33
Table 3.10 Approximate depth to groundwater at unlined EDBs 34
Table 3.11 Pollution incidents within 2 km (from Envirocheck, 2016) 37
Table 3.12 Summary of groundwater quality data (based on data in Controlled Waters Risk Assessment in **ES Chapter 9: Geology and Soils** (Document Reference 6.1)) 39
Table 3.13 Private water abstractions (within 2 km of initial scheme boundary) 41
Table 3.14 Designated Sites within 2 km of the Application Area 43
Table 3.15 Licenced groundwater and surface water abstractions 45
Table 5.1 Summary of impacts 52
Table 6.1 Infiltration rates 55
Table 6.2 Source geometry 55
Table 6.3 Chronic Source terms (from HEWRAT) 56
Table 6.4 Acute source term concentrations (from HEWRAT – 95th percentile (mg/l)) 56
Table 6.5 Attenuation parameters 56
Table 6.6 Solubility parameters 57
Table 6.7 Target concentrations 58
Table 6.8 Hydrogeology parameters 59
Table 6.9 EDB2 Predicted concentrations (mg/l) 60
Table 6.10 EDB2 Predicted concentrations (mg/l) 60
Table 6.11 EDB2 Predicted concentrations (mg/l) 61
Table 6.12 EDB3B Predicted concentrations (mg/l) 61

Table 6.13 EDB3C Predicted concentrations (mg/l) 62
Table 6.14 Sensitivity run 1: fraction of organic carbon (mg/l) at 100 years 62
Table 6.15 Sensitivity run 2a: infiltration rate and unsaturated zone hydraulic conductivity (mg/l) at 100 years 63
Table 6.16 Sensitivity run 3: unsaturated zone thickness (mg/l) at 100 years 63

APPENDICES

Appendix A HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512_Drainage Schematic Plan
Appendix B HEWRAT screening assessments
Appendix C HE551551-VFK-HGT-X_XXXX_XX-DR-GE-004 Exploratory hole location plan
Appendix D HE551551-VFK-HGT-X_XXXX_XX-DR-GE-0020 Geological plan
Appendix E RAM model files (electronic appendix)

1 Introduction

1.1 Background

The M3 Junction 9 Improvement Scheme (the Scheme) is located at Junction 9 of the M3 to the east of Winchester, running north to south, centred in the Winnall area and extending north to Headbourne Worthy (Figure 1.1). The Scheme includes proposed motorway modifications including the introduction of a new on/off slip road to both northbound and southbound sides of the M3, new link roads between the A33, A34, A272 and M3 roads and a new overhead gyratory above the M3 corridor.

Parts of the Scheme are located in a low spot of the M3, towards which a total of approximately 1.6 km of the existing M3 corridor drains. A separate Motorway Upgrade is currently being constructed immediately to the south of the Scheme, which also drains towards the Land within the Scheme's Application Boundary (hereafter referred to as the "Application Area").

West of the Application Area are commercial and light industrial land uses associated with the Wykeham Trade Park and Winnall Industrial Estate. Most of the surrounding non-highway land is used for agricultural purposes, with arable grassland to the north, and a number of fisheries located to the west.

The Application Area is located in a sensitive hydrogeological environmental setting, located adjacent to the River Itchen, which underlies the M3 and A34 in the north. The River is a designated Main River, with the associated floodplain designated as a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). The Application Area is underlain by bedrock deposits of the White Chalk Subgroup, which are classified by the Environment Agency (EA) as a Principal Aquifer. Surrounding abstractions include thirty-one public abstractions, alongside nine abstractions for private water supplies within 2 km of the Scheme.

A ground investigation (GI) was previously undertaken, and additional works have been proposed by Stantec to provide supplementary information. Interpretation of the GI data is provided in the **Geotechnical Interpretation Report (Document Reference 7.11)**.

The Drainage Strategy Report which forms **Appendix 13.1: Chapter 13: Road Drainage and the Water Environment (Document Reference 6.1)** prepared for the planning application included a Highways England Water Risk Assessment Tool (HEWRAT) screening assessment. The results of the screening assessment are that all but one of the currently proposed Extended Detention Basins (EDT) present a 'medium risk' to groundwater and one has a high risk. LA113 (Road drainage and the water environment) (Highways England, 2020) states that where [HEWRAT] indicates a groundwater risk assessment is medium or high, a detailed assessment should be completed by a competent expert with the degree of detail being appropriate to the medium or high result.

A large area requires to be built up in the east of the Application Area (as shown in yellow on Drawing HE551511-VFK-HGN-X_XXXX_XX-SK-CH-0004_P03). It is expected that much of the material excavated from elsewhere in the Scheme will be used to fill this eastern area.

Piling will be undertaken as part of the works, and a piling risk assessment will be carried out prior to works commencing, in accordance with EA methodology. This risk assessment will consider impacts on the water environment.

1.2 Objectives

In its ‘M3 Junction 9 Improvement – Environmental Impact Assessment (EIA) Scoping Notification and Consultation Reg 11’ response to the Scoping Report the EA indicated concern, given the sensitivity of the groundwater environment beneath the Application Area.

Further comments were received from the EA in response to the Preliminary Environmental Information Report (PEIR). The EA states that its primary concern regarding the Scheme relates to the protection of groundwater, and protection / enhancement of the ecological balance and species within the River Itchen and surrounding areas.

This document has been prepared by Stantec UK Ltd (Stantec) on behalf of National Highways to provide the appropriate assessment for potential impacts to groundwater from the Scheme and, in particular, to address the concerns raised by the EA in its consultation responses.

1.3 Scope of Work

This report presents a Hydrogeological Risk Assessment (HgRA) to identify the significance of risks to the Chalk Aquifer and River Itchen. This HgRA is based on government guidelines appropriate to the geological and hydrogeological environment, which promote the protection of water bodies and related receptors from potential impact of development activities. Specific guidance referenced when undertaking the assessment include:

- Design Manual for Roads and Bridges (DMRB) LA 113 Road drainage and the water environment (Highways England, 2020).
- The EA’s approach to groundwater protection (Environment Agency, 2018);
- Remedial Targets Methodology for contaminated land (Environment Agency, 2006);
- Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA, 2021); and
- Guidance on land contamination risk management (Environment Agency, 2021).

The scope of work undertaken for this HgRA includes the following:

- Review of the baseline geology and hydrogeology for the Application Area and surrounding area;
- Identification of receptors and assessment of potential impacts;
- Recommendations for appropriate monitoring and mitigation measures; and
- Preparation of a Detailed Quantitative Risk Assessment (DQRA) for risks that are qualitatively assessed as significant.

1.4 Competent expert

This report has been prepared by Stantec’s Robert Sears, who is a hydrogeologist of over 30 years’ experience. Robert is a Fellow of the Geological Society and is a Chartered Geologist.

Figure 1.1 Site location and points of interest

2 Drainage strategy and HEWRAT assessment

The Scheme's drainage strategy is described in the Drainage Strategy Report **Appendix 13.1: Drainage Strategy and Water Environment (Document Reference Appendix 6.1)**. The design approach is to install new gravity drainage for all new carriageway, or to replace existing highway drainage that is being built over by new impermeable highway, such as hardening of the central reserve and lane widenings.

In areas where existing carriageway is being overlaid only, then existing highway drainage is retained.

Areas of local, minor lane widenings proposed remote from the main works, are drained to existing highway drainage, which is modified, where required, to maintain existing discharge rates and no-flooding capacity.

All new drainage conveys run-off to extended detention basins (EDBs), which infiltrate to ground where the HEWRAT assessment of risk to groundwater, allows. These new EDBs are shown in Figure 2.1.

Runoff volumes are attenuated in the EDBs as far as space and acceptable draw-down times allow. Runoff volumes that are unable to drain to ground within a practical time period are discharged to the River Itchen.

Treatment of run-off before discharge is proposed as follows:

- Over-the-edge drainage of run-off from carriageways on embankments to filter strips and to infiltration ditches;
- Collection of run-off at carriageway edges in linear drains, gullies or filter drains, which is piped to the following:
    - Attenuation and Primary Settlement treatment in filtration forebays and unplanted, lined EDBs;
    - Attenuation, Secondary Settlement and Filtration treatment in vegetated EDBs, containing both wet and dry habitats; and
    - Tertiary treatment in a grassed swale prior to discharge to the River Itchen.

The only areas where existing linear infiltration drainage, or sealed drainage, is retained (and enhanced where necessary to limit flooding), will be the A33/A34 carriageway to the north of the River Itchen (above northing 131500) and M3 carriageway (above northing 131500). Both these retained areas are proposed to discharge to the River Itchen via existing open ditches or filter trenches.

The proposed drainage design is shown on Drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512 which is included here as Appendix A. A summary of the EDBs is included in Table 2.1 and they are also labelled and shown on Figure 2.1.

Table 2.1 Summary of attenuation structures

Basin ref.	Type	Source	Inflows	Outfalls
1	EDB (lined)	Highway	From highway	To EDB 2
2	EDB (unlined)	Highway	From highway and EDB 1	To ground and river
3A	EDB (lined)	Highway	From highway	To EDB3B
3B	EDB (unlined)	Highway	From highway and EDB3A	To ground and EDB 3C
3C	EDB (unlined)	Highway	From highway and EDB3B	To ground and river via swale
4	EDB (lined)	Highway	From highway	To EDB 3A
5	EDB (unlined)	Rural overland flow and Highway runoff	From highway and rural land to east	To ground
6	EDB (unlined)	Rural overland flow	From rural land to east	To ground

Each EDB has been assessed using the HEWRAT. As detailed in the HEWRAT Help Guide (Highways England, 2015), the tool considers the following potential pollutants:

- acute pollution impacts associated with copper and zinc; and
- chronic pollution impacts associated with the following determinands in sediments: total copper, zinc, cadmium and total polycyclic aromatic hydrocarbons (PAH), including specific PAH's: pyrene, fluoranthene, anthracene, and phenanthrene.

For groundwater risk, HEWRAT uses an empirical approach taking into account the following factors:

- Traffic flow rate;
- Rainfall rate;
- Ratio of drainage area of road to active surface area of infiltration device;
- Infiltration method;
- Unsaturated zone thickness;
- Flow Type;

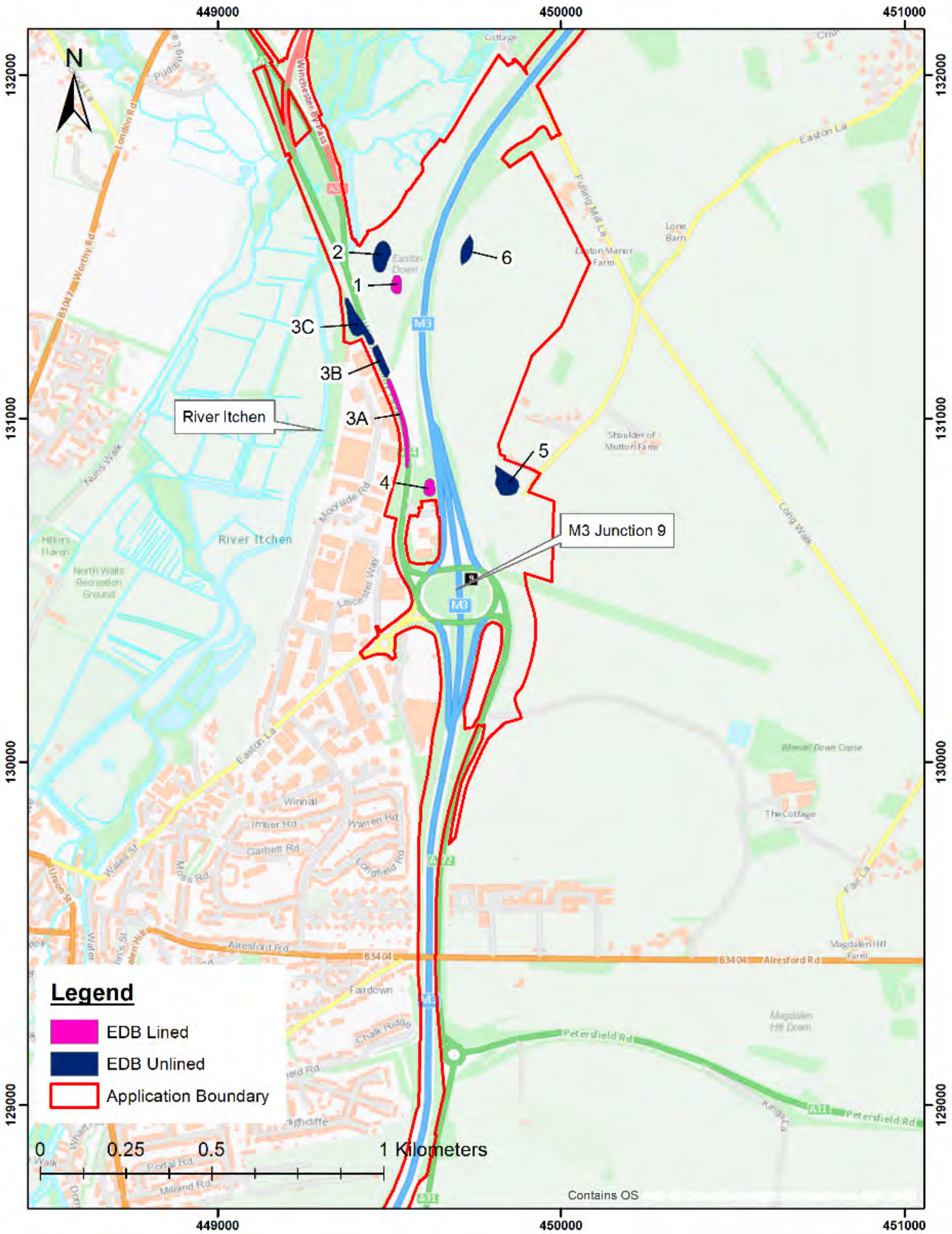
- Unsaturated zone clay content;
- Fraction of organic carbon; and
- Unsaturated zone soil pH.

For each of these parameters, a component score between 1 and 3 is assigned and this is then multiplied by a weighting factor for that parameter to provide a score. This process is repeated for all parameters and the scores are then summed to provide an overall risk score.

The HEWRAT screening assessments for each of the EDBs are presented in Appendix B. For the EDBs that discharge to ground, the highest scores (high risk) are derived where the unsaturated zone is thin (<5 m) and the flow type is dominated by fractures & fissures. The basins that get medium risk scores are those which either:

a) have a thicker unsaturated zone over fractures & fissures; or
b) have intergranular flow through superficial deposits & / or the unsaturated zone is thicker.

Figure 2.1 Application boundary and locations of EDBs



3 Baseline Conditions

3.1 Site setting

The Application Area is located in the River Itchen valley. The elevation in the west of the Applications Area is approximately 40 metres above ordnance datum (mAOD) and the land rises to the east up to a maximum of approximately 75 mAOD.

3.2 Geology

3.2.1 Regional geology

3.2.1.1 Bedrock

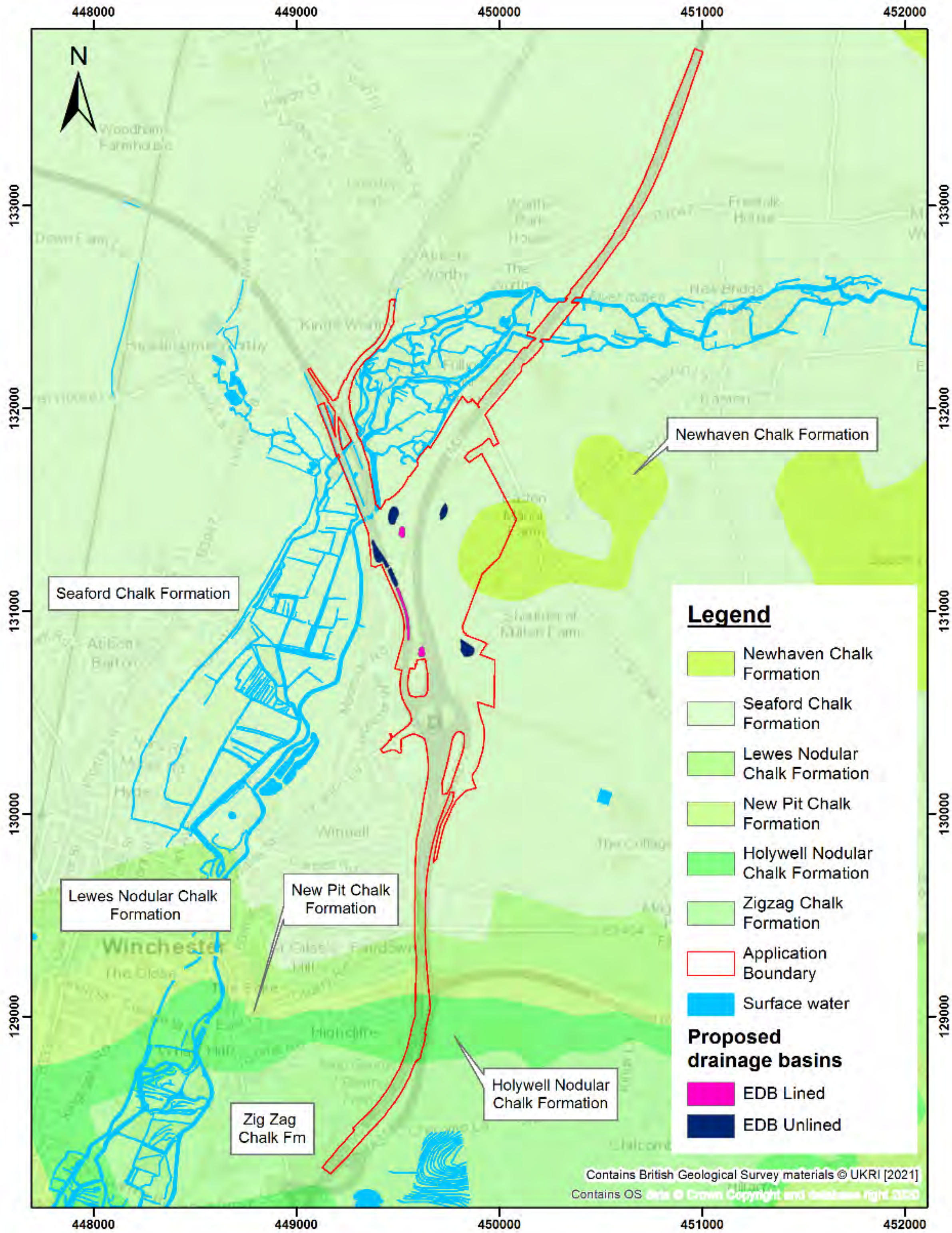
The British Geological Survey (BGS) indicates that the bedrock geology underlying the Application Area comprises the White Chalk Subgroup and the upper part of the Grey Chalk Formation of the Late Cretaceous era (Figure 3.1). The stratigraphy of the rock units in the Application Area and surrounding area are summarised in Table 3.1. In the Application Area, the five lower formations of the White Chalk outcrop, with the Seaford Chalk Formation outcropping across the majority of the Application Area, including the central area around Junction 9 itself and the River Itchen. The Seaford Chalk Formation typically consists of firm white chalk, with nodular and tabular flint seams. Underlying the Seaford Chalk are the Lewes Nodular Chalk Formation, New Pit Chalk Formation, Holywell Nodular Chalk Formation (all of the White Chalk) and Zig Zag Chalk Formation (Grey Chalk Subgroup). These units crop out to the south of the Spitfire Roundabout (A31 and A272). Above the Seaford Chalk Formation is the Newhaven Chalk Formation, which outcrops in small areas in the north of the Application Area.

The Application Area lies on the Winchester-East Meon Anticline, an east to west trending fold. In the main central area of the Application Area, the strata dip 5-10 degrees to the north. In the south of the Application Area, south of the Spitfire Roundabout, the strata dip 4 degrees to the south.

Table 3.1 Stratigraphy of the bedrock geology in the Winchester (based on the BGS Sheet 299 (British Geological Survey, 2002) and BGS memoir (Booth et al., 2008)

	Name	Thickness	Description	Present at surface at Application Area?
White Chalk Sub-group	Portsdown Chalk Formation	5	White chalk with marl beds and a few flint bands	No
	Culver Chalk Formation	50-70	White chalk with flints and many thin marl beds. Comprises the Tarrant Chalk Member and the Spetisbury Chalk Member.	No
	Newhaven Chalk Formation	40-70	Soft to medium hard, white chalk with flints and many thin marl beds (20-70 mm thick).	Yes – small areas in the north
	Seaford Chalk Formation	40-65	Soft white chalk with seams of large nodular and semi-tabular flint. Commonly blocky.	Yes – majority of central area
	Lewes Nodular Chalk Formation	55-65	White, interbedded hard, nodular chalks with soft-medium chalks and marls. Contains persistent seams of flints near the base. Conjugate fractures. Contains karstic features in the Twyford Down Cutting (approx. 500 m south of Application area – See Figure 1.1) including a partially sediment-filled paleaocave system and calcreted karst.	Yes
	New Pit Chalk Formation	40-45	White chalk with many regularly spaced marl beds. Massive and medium hard. Flint beds in the upper half of the succession. Conjugate fractures.	Yes
	Holywell Nodular Chalk Formation	25-30	Hard, nodular chalk with some shelly beds. Characterised by shell debris. Includes Melbourn Rock (c. 5 m) and Plenus Marls (1-3 m) at base.	Yes
Grey Chalk Sub-group	Zig Zag Chalk Formation			Yes

Figure 3.1 Bedrock geology



3.2.1.2 Superficial deposits

Superficial deposits are shown on Figure 3.2 and Figure 3.3. The majority of the Application Area is not underlain by superficial deposits; however, in the north of the Application Area, the M3 and A34 is underlain by alluvium and head deposits. Alluvium deposits of the River Itchen form a band that is crossed by the M3 and A34, within the Application Area, and also is located to the west of the Application Area. Alluvium is typically formed of unconsolidated detrital material deposited by a river or stream and comprises sorted or semi-sorted sediment within the riverbed or floodplain. This can have a variable lithology depending on the river environment and may comprise clay, silt, sand, peat or gravel. Borehole data available from the British Geological Survey (BGS) indicate that the Alluvium comprises 1 to 1.5 m of peaty silts and clays above 4.5 to 5.5 m of dense gravels (Booth, et al., 2008).

Head deposits are located beneath the north-eastern part of the Application Area beneath the M3 and in smaller lateral bands located north and south of the of the M3 Junction 9 roundabout (see Figure 3.2). To the northeast an area of the M3 crosses through superficial deposits of Head 1; this comprises clay, silt, sand and gravel, often poorly sorted and poorly stratified, formed mostly by solifluction and / or hillwash and soil creep. The smaller bands of Head are composed of clay, silt, sand and gravel that is poorly sorted and poorly stratified containing angular rock debris and clayey hillwash and soil creep that is mantling a hillslope and deposited by solifluction and gelifluction processes.

Except for a small area of Basin 3A (lined) and approximately half of Basin 5 (unlined), none of the other drainage features are shown by the BGS mapping to be underlain by superficial deposits (see Figure 3.3).

Figure 3.2 Superficial geology and artificial ground

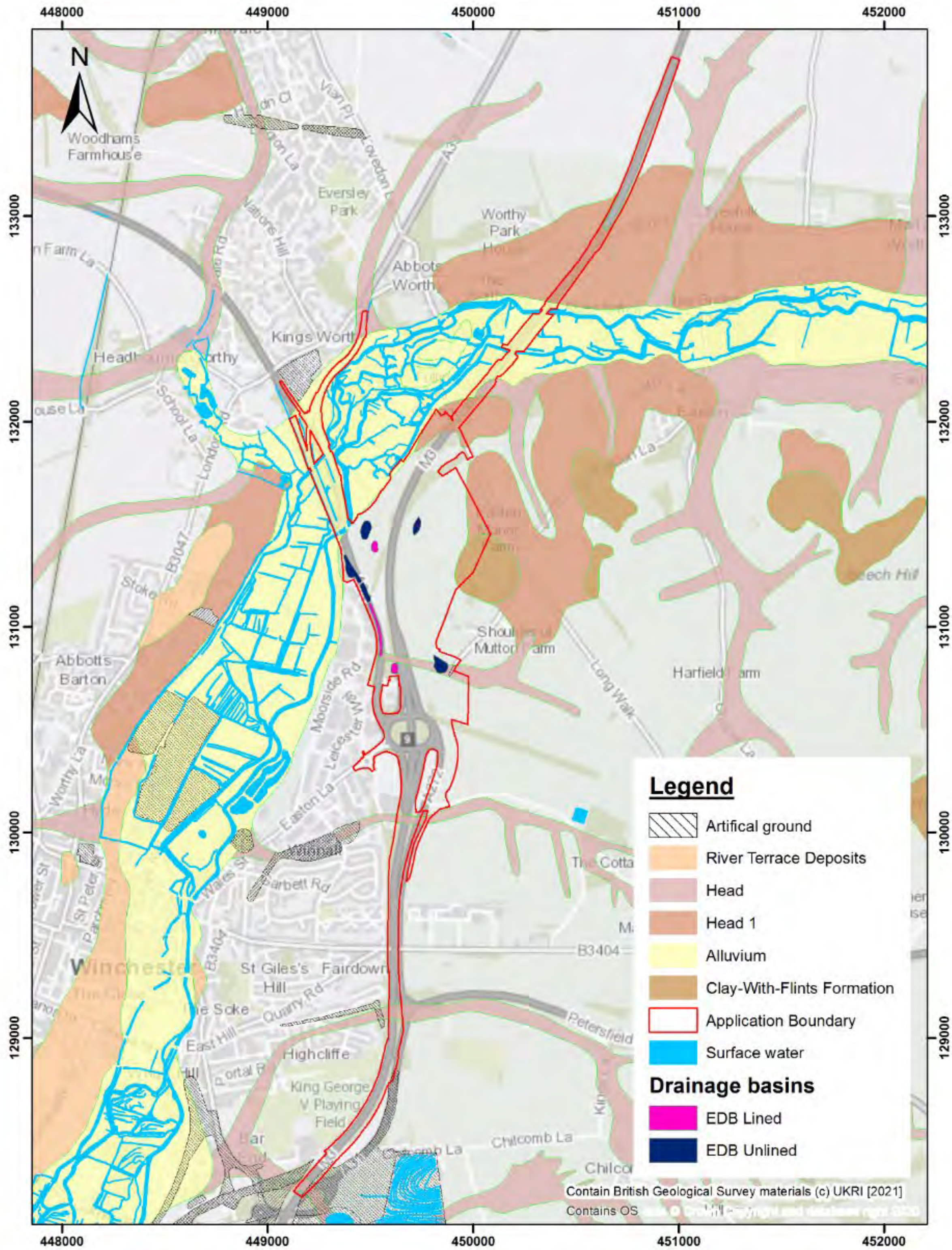
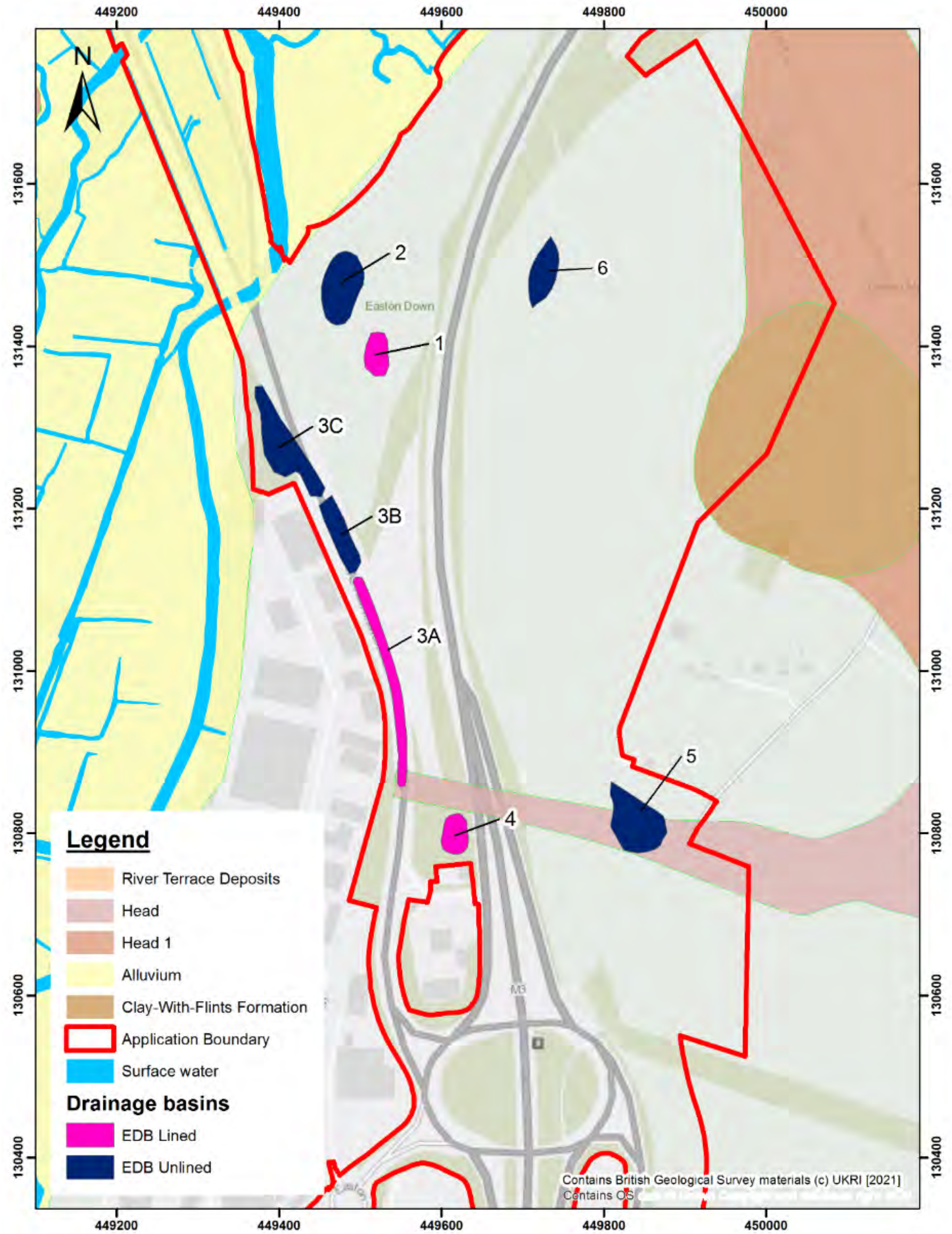


Figure 3.3 Superficial geology - central area



3.2.2 Local Geology

Soils

Soilscapes classifies the majority of the soils within the Application Area as being freely draining, shallow lime-rich soils over chalk limestone. The agricultural land classification and soil resources report prepared for the Scheme by Reading Agricultural Consultants identifies these as being soils of the Andover 1 association (Reading Agricultural Consultants, 2021). Towards the northeast of the Application Area the soils become fen peat soils, classified as being Charity 2 association, which drain to local groundwater.

Underground cavities

A Cavities Risk Assessment has been undertaken as part of the **Geotechnical Interpretation Report (Document Reference 7.11)**. There was one natural cavity record within 500 m of the Application Area, which was 10 solution pipes on the course of the River Itchen.

A summary of the Hazard ratings for each basin is given in Table 3.2 below. The Hazard rating represents the likelihood for cavities to be present. Most basins are located in an area of Moderate-Low hazard for both natural and mining cavities which means they may occur but are unlikely. A Moderate hazard rating means that they may occur, but probably at a single location.

Table 3.2 Summary of cavities hazard for each basin (from Appendix A of the Geotechnical Interpretation Report (Document Reference 7.11))

Basin	Natural cavity hazard	Mining cavity hazard
1	Moderate-Low	Moderate-Low
2	Moderate-Low	Moderate-Low
3A	Moderate-Low and Moderate	Moderate-Low
3B	Moderate-Low	Moderate-Low
3C	Moderate-Low	Low and Moderate-Low
4	Moderate-Low and Moderate (small area)	Moderate-Low
5	Moderate and Moderate-Low (small area)	Moderate-Low
6	Moderate-Low	Moderate-Low

Encountered geology

The GI information is presented and reviewed in the **Geotechnical Interpretation Report (Document Reference 7.11)**. A summary of the factual report of this investigation is given in Table 3.3. The borehole locations are shown on Drawing HE551551-VFK-HGT-X_XXXX_XX-DR-GE-004 which is included here as Appendix C.

The local superficial geology is shown on Drawing HE551551-VFK-HGT-X_XXXX_XX-DR-GE-0020 which is included here as Appendix D and overlain onto Figure 3.4.

In the central area around the drainage features, the Application Area is typically underlain by topsoil, Made Ground / Engineered Fill and Seaford Chalk Formation. This is in broad agreement with the publicly available BGS data.

In the central area of the Application Area where the EDBs are proposed, the superficial deposits extend further eastwards than indicated by BGS mapping. A summary is given below of the likely superficial geology at each of the EDBs, although it is noted that there is insufficient borehole coverage to make a detailed assessment.

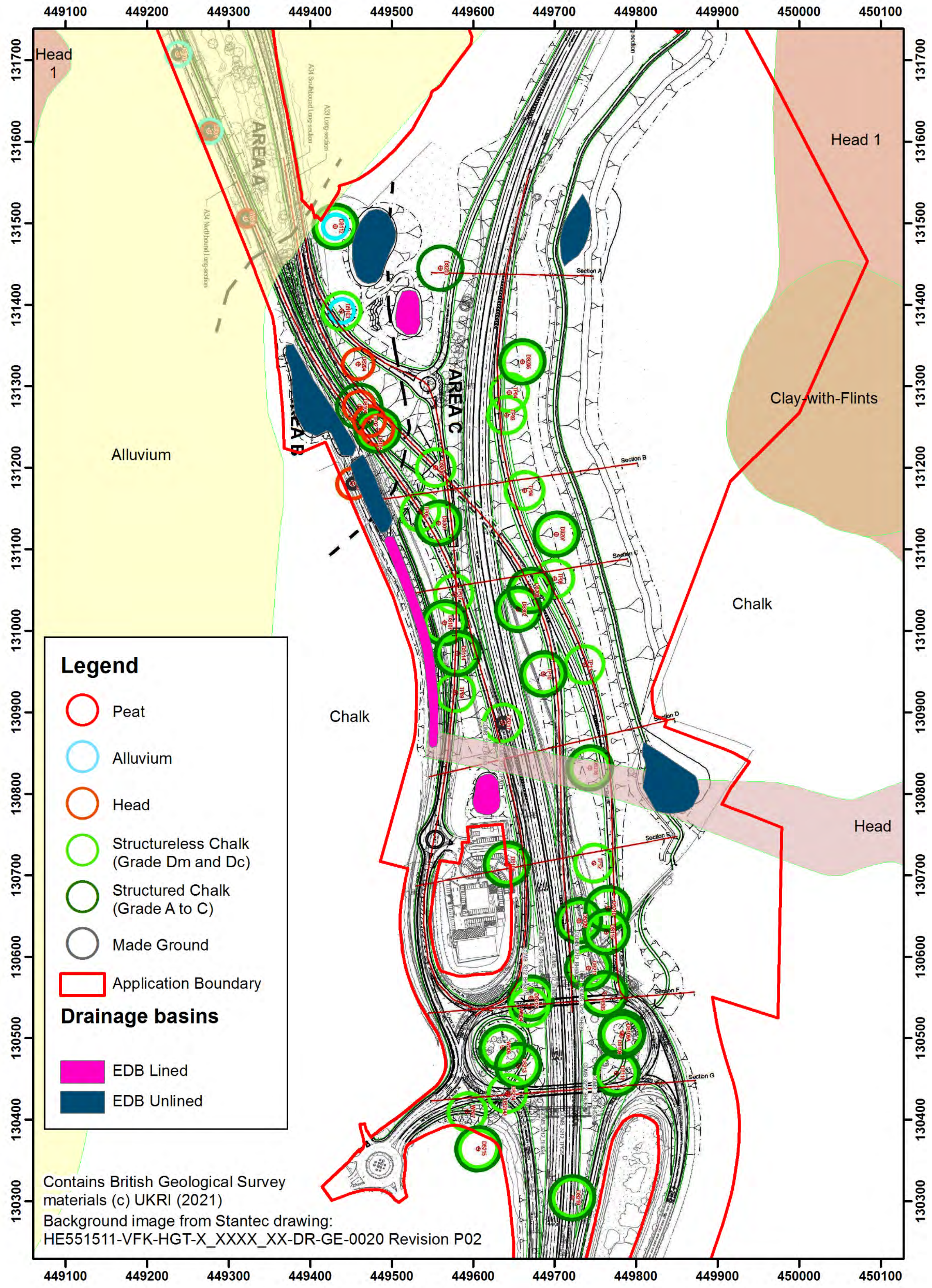
- EDB1. Borehole DS203 shows that there is no superficial geology present close to this location. The EDB drains directly onto structured chalk.
- EDB2. Borehole DS112 suggests that alluvial deposits may be present under this EDB to a depth of 5 m, which is in turn underlain by structureless chalk to a depth of 6.23 m followed by structured chalk.
- EDB3A. Boreholes DS107 and DS114 and trial pits TP07 and TP09 are located to the east of this EDB. The trial pits show structureless chalk whilst the boreholes show structureless chalk to a depth of 1.2 m underlain by structured chalk.
- EDB3B. Borehole WS08 is located immediately west of the northern end of this EDB. This borehole recorded Made Ground to a depth of 5.11 m comprising predominantly white chalk recovered as silty clay with fractured flint. This is underlain by 1.89 m of head comprising a sandy, gravelly, silty clay. The base of the head deposits was not penetrated.
- EDB3C. Boreholes DS104 and DS105 and trial pit TP02 are located east of the southern end of this EDB. TP02 recorded 0.3 m of made ground comprising clayey sand. This is underlain by 3.7 m of alluvium to the base of the pit. The alluvium predominantly comprised a silty or sandy, gravelly clay. Borehole DS104 encountered made ground to 0.3 m, comprising clayey sand. This is underlain by 8.2 m of alluvium to the base of the borehole. The alluvium comprised a sandy gravelly clay with interbedded gravel. Borehole DS105 encountered made ground to 0.35 m, comprising clayey gravelly sand. This is underlain by 5.65 m of head which comprised a gravelly, silty clay. This is underlain by 2 m of structureless chalk followed by structured chalk.
- EDB4. There are no GI boreholes adjacent to this EDB. The nearest boreholes are DS217 and DS108. Both of these record structureless chalk overlying structured chalk. Given this EDBs location further to the east, it is likely that it is underlain by chalk.
- EDB5 and EDB6. No GI data in the vicinity of these EDBs, but underlying geology is likely to be chalk.

Table 3.3 Summary of lithologies encountered from Geotechnical Interpretation Report (Document Reference 7.11)

Layer	Range of depths encountered (m)	Location and brief description
Topsoil	0.0 - 0.45	Encountered in 16 out of 53 boreholes. Grass over light- to dark- brown slightly gravelly clayey sand or sandy gravelly clay.
Made ground / Engineered fill	0.0 - 11.35	Varied across the Application Area, but typically comprised tarmac, sub-base, reworked chalk, gravelly sandy clay with flint cobbles, varying concrete and brick gravel content. It is noted in the **Geotechnical Interpretation Report (Document Reference 7.11)** that in some areas the strata identified by Soils Limited as Made Ground may also be Engineered Fill. Engineered Fill is typically structureless chalk recovered as slightly clayey silty sandy gravel. The Engineered Fill is likely to originate from the construction of the M3, A33 and A34.
Alluvium / Head	0.0m – 9.15,	Located in the north of the investigation area along the A34. Comprising clayey, sandy gravel with low flint cobble content, clayey gravelly sand or silty, sandy, gravelly clay. In places deposits comprised solely sands, gravels and cobbles, with the fines assumed to have been washed away. Peat was encountered as part of the alluvial deposits; this comprised firm brown mottled grey silty slightly sandy gravelly fibrous peat, with fragments of black organic material or plastic dark brown pseudofibrous peat. The **Geotechnical Interpretation Report (Document Reference 7.11)** has reclassified the Alluvium identified by Soils Limited as Head at some locations.

Layer	Range of depths encountered (m)	Location and brief description
Head	0.0 and 7.0	Located in the north of the Scheme and comprising dark brown slightly clayey gravelly sand and firm to stiff silty sandy gravelly clay. Often interbedded cohesive and granular horizons.
Seaford Chalk	0.0 and 30.45 (base of borehole)	Consists primarily of very weak, low density white chalk recovered as gravelly silty clay; structureless silty gravel and cobbles (CIRIA Grade Dm or Dc); structureless chalk composed of slightly sandy silty gravel or clay; weak low density white chalk (CIRIA Grade A3 to C5) or very weak to weak low to medium density speckled chalk (CIRIA Grades A to C). Rare cobbles and gravel comprised of angular flints were also present. It is noted in the **Geotechnical Interpretation Report (Document Reference 7.11)** that the classification of these chalks as structured or unstructured may not be consistent.

Figure 3.4 Local superficial geology superimposed on proposed drainage



3.2.3 Soil contamination

Geoenvironmental testing was carried out during the GI as detailed in the **Geotechnical Interpretation Report (Document Reference 7.11)** to determine the concentrations of contaminants of selected soil and groundwater samples. The testing suite comprised a range of heavy metals, inorganic and organic compounds, and for soils an asbestos screen.

The Geotechnical Interpretation Report states that the vast majority of the soil results are below the selected assessment criteria. The exception to this is one sample out of the 126 samples tested which indicated a marginal exceedance of the Public Open Space assessment criteria for Beryllium (2.3mg/kg compared to an assessment criteria of 2.2 mg/kg). The **Geotechnical Interpretation Report (Document Reference 7.11)** does not consider this significant when compared to the Generic Assessment Criteria.

In addition, waste acceptance criteria (WAC) testing of 10 samples of near surface material was undertaken to allow a preliminary determination of the waste characterisation of any material to be disposed of to landfill. The results of the WAC tests analysis classify the near surface material tested as appropriate for disposal at an Inert Waste Landfill.

3.2.4 Infilled ground/landfilling and historical land use

Infilled ground, landfilling and other historical land uses may be sources of contamination to the water environment.

There are 13 historical landfill areas shown on EA mapping data in the vicinity of the Application Area. The information is summarised in Table 3.4 and the locations are shown on Figure 3.5. These data show there are four historical landfills within or directly adjacent to the Application Area:

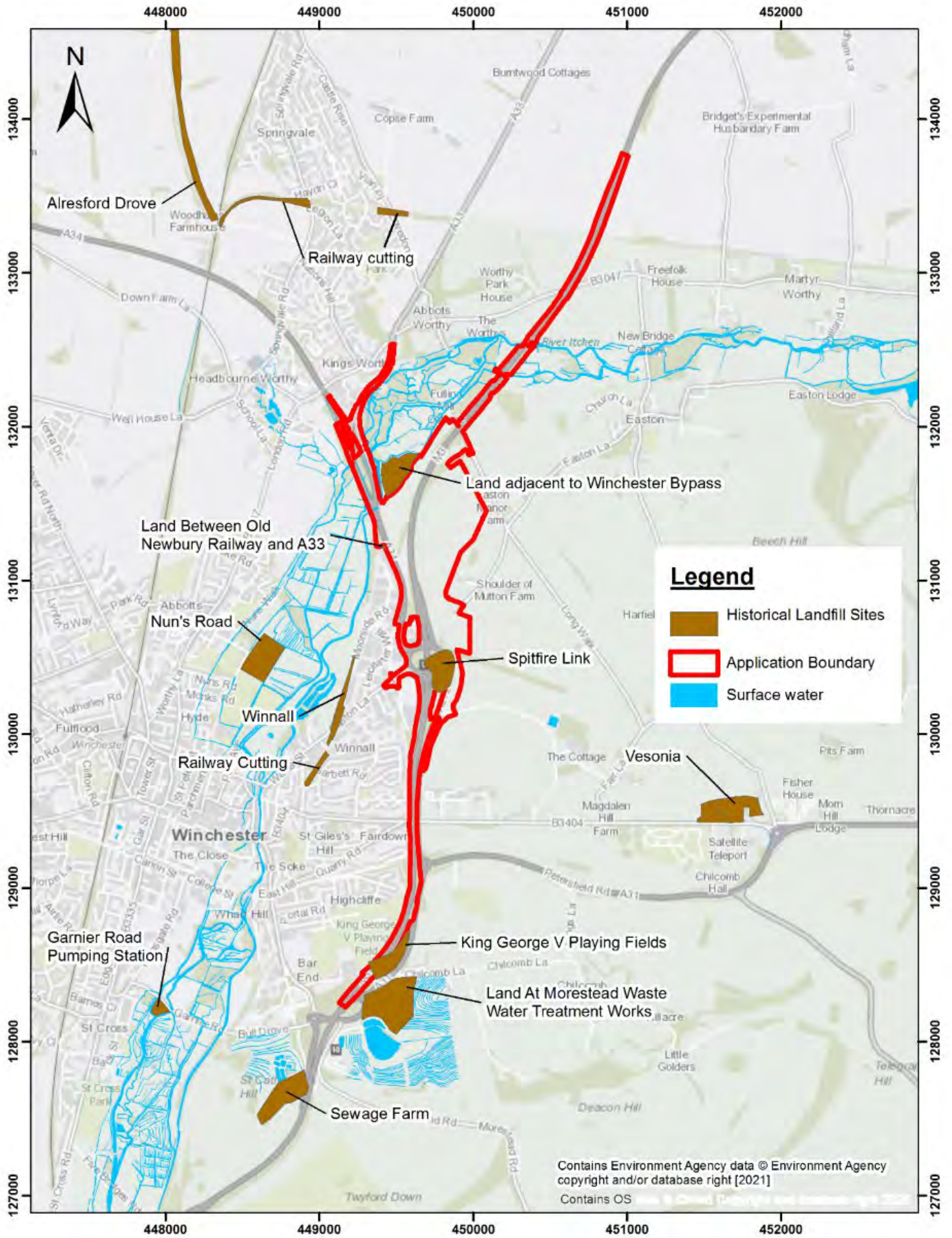
Table 3.4 Historical landfill areas

Name	Waste type	Dates active	Distance from site	Comments
Spitfire Link	No further information		On site	Soil Limited (2020) drilled six exploratory boreholes within or adjacent to the mapped boundary. No records of waste are indicated on borehole logs.
King George V Playing Fields	No further information		On site and adjacent to east	
Land adjacent to Winchester Bypass	Inert	1967-1968	Adjacent to north	Timings suggest related to Winchester Bypass widening. Controlled Waters Risk Assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)**

Name	Waste type	Dates active	Distance from site	Comments
Land Between Old Newbury Railway and A33	No further information		Adjacent to west	Very small so likely to have been a commercial operation. Controlled Waters Risk Assessment **Chapter 9: Geology and Soils (Document Reference 6.1)**
Land At Morestead Wastewater Treatment Works	Inert	1993-2001	30 m southeast	-
Winnall	Commercial and household	1969-	220 m to west	-
Sewage Farm	Commercial and household	Not provided	490 m to south	-
Railway Cutting (near to Winnall landfill)	Inert and commercial	1978-	530 m west	-
Nun's Road	Inert and Industrial	1963-	730 m to west	-
Railway cutting (two parts)	No further information		850 m to north	-
Alresford Drove	Commercial and household	Not provided	1 km northwest	-
Vesonia	Inert and commercial	1979-	1 km east	-
Garnier Road Pumping Station	Commercial and household	1910-	1.1 km west	-

A Controlled Waters risk assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)** has identified a number of other potential sources of contamination that are relevant to this study. These comprise a former gas works and iron works, railways, and land of mixed industrial use within or close to the Application Area that may also be a source of contaminants in soils.

Figure 3.5 Historical landfill areas



3.3 Hydrology

3.3.1 Rainfall

The Standard Average Annual Rainfall (SAAR) for the area around the Itchen at Easton river monitoring point (42016) is 848 mm (NRFA, 2021).

3.3.2 Surface water features

Surface water features in the vicinity of the Application Area are shown on Figure 3.6**.**

Watercourses

The River Itchen flows east to west across the northern part of the Application Area and then flows south to the west of the Application Area approximately parallel with the M3. The River Itchen is a chalk stream comprising a number of anabranches in the area around Winchester and the Application Area. There is also a network of ditches that are connected with the Itchen that follow the boundaries of the former water meadows within the Itchen floodplain. The Itchen is a designated Main River, with the associated floodplain designated as a SAC and SSSI. Much of the floodplain to the west of the central part of the Application Area is managed as the Winnall Moors Local Nature Reserve.

According to the National River Flow Archive the mean flow data of the River Itchen upstream of the Application Area (location 42016 - Itchen at Easton) is 4.239 m^3/s. Downstream of the Application Area (location 42010 - Itchen at Highbridge & Allbrook Total) mean flow is 5.539 m^3/s, implying that the River gains within the Application Area. Both locations show evidence of substantial surface and groundwater abstraction and the presence of cress beds and fish farms. The baseflow index (BFIHOST) at the River Itchen at Easton is 0.95, indicating that it almost entirely groundwater fed.

To the west of the River Itchen is Nun's Walk Stream, which flows parallel to the track/road of the same name and the Itchen. This is also a designated Main River. Ordnance Survey mapping indicates that Nun's Walk Stream starts around springs at Headbourne Worthy in the north and flows southwest parallel with the Itchen on a straight course and joins with an Itchen anabranch at the north end of Park Road, Winchester, south of the River Park Leisure Centre, approximately 2.5 km to the south.

In the surrounding area, there are very few water courses or water features other than the River Itchen that lie on the Chalk, and this is generally due to the high secondary porosity and permeability of the Chalk allowing rainfall to infiltrate and recharge the aquifer directly.

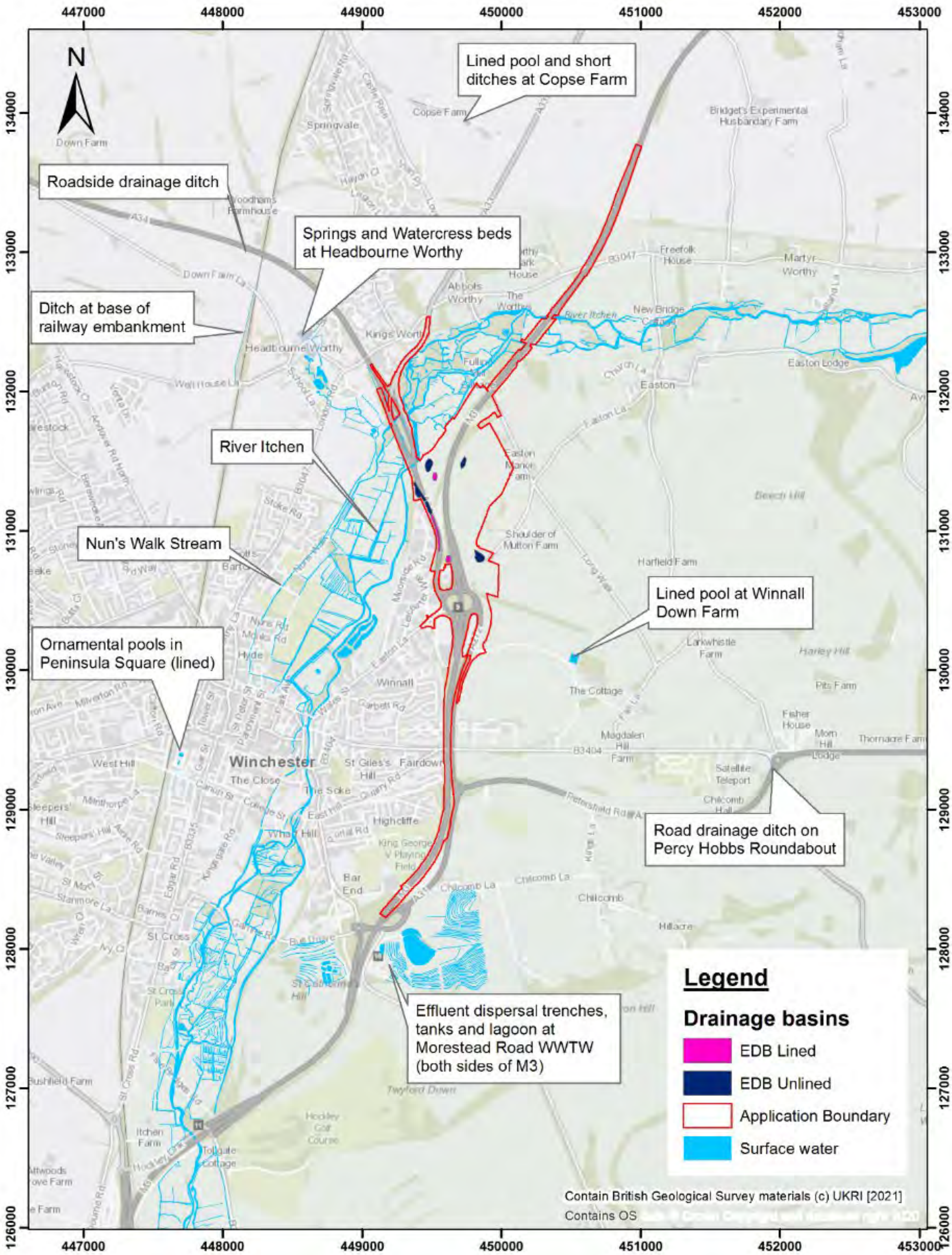
Waterbodies

There are a number of water bodies that fall within the course of the River Itchen. There are three waterbodies located on the eastern side of the Itchen south of the Junction 9 roundabout. There is also a square pond at Winnall Down Farm (125 m from the Application Area, that given its shape is very likely to be manmade, and it appears from satellite imagery that it is lined.

To the south around St Catherine's Hill and Chilcomb there are many effluent dispersal trenches, tanks and a lagoon forming part of the Morestead Road Wastewaster Treatment Works. These features are both to the west and east of the M3.

There are number of fisheries and water cress ponds in the surrounding area that rely on chalk-fed water features, such as those in Headbourne Worthy, 480 m to the west of the Application Area. These ponds are fed by springs from the chalk. There are also watercress ponds around New Alresford, 8 km to the east of the Application Area and upstream on the River Itchen.

Figure 3.6 Surface water features



3.3.3 Surface water quality

No surface water samples were taken as part of the site investigation undertaken by Soils Limited in 2019.

3.4 Hydrogeology

3.4.1 Groundwater classifications and systems

The Alluvium underlying the north of the Application Area is classified by the EA as a Secondary A aquifer, meaning it is a formed of permeable layers capable of supporting water supplies at a local rather than strategic scale, and can provide an important source of base flow to rivers.

The Head deposits are classified as Secondary Undifferentiated aquifer. These are layers for which it has not been possible to determine a permeability due to the variable characteristics of the rock type.

The Chalk Subgroup is classified by the EA as a Principal Aquifer, due to its high fracture permeability, and as such it supports water supply and river base flow on a strategic scale. The Chalk is a dual porosity aquifer with rapid flow occurring through fracture networks and slower flow through the porous matrix.

The top of the Chalk is logged as structureless chalk. Structureless chalk tends to have fewer fissures and fractures and the clayey matrix is often a barrier to groundwater flow.

The Groundwater Vulnerability maps from the EA indicates that the groundwater is of High vulnerability to pollutant discharge at the surface in areas without superficial cover and Moderate-High vulnerability in areas with superficial cover.

3.4.2 Groundwater Source Protection Zones (SPZs)

The Application Area lies within two overlapping groundwater Source Protection Zones (SPZ); which relate to groundwater sources that are used for public drinking water supply. The definitions of each zone are described in Table 3.5 below. There is also another SPZ to the northwest and one to the south. The SPZs are shown on Figure 3.14.

Table 3.5 Outline definitions of Source Protection Zones

Zone	Outline definition (from Environment Agency website – (Environment Agency, 2019)
Zone 1 (Inner Zone)	Defined by a 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.
Zone 2 (Outer Zone)	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. Older SPZs may have used a different methodology.
Zone 3 (Total Catchment)	Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

The SPZ in the northeast of the Application Area is for two Southern Water public water supply boreholes near Easton and lies mostly along the M3 north of the Application Area[1]. Where the Application area is within the SPZ it is mostly in Zone 1, with the northernmost area in Zone 2 (c. 860 m of M3).

[1] Note that co-ordinates are not available for the Itchen Valley PWS's near Easton.

There is also an SPZ approximately 450 m to the northwest of the Application Area associated with the Headbourne Worthy Watercress Beds. These beds are fed by springs. The area closest to the Application Area is in Zone 1 with the 'tail' of Zone 2 and 3 spreading to the northwest away from the Application Area.

There is another SPZ 1 km southeast of the Application Area which is related to further Southern Water public water supply boreholes.

The Drinking Water Groundwater Safeguard Zone (DWGSZ) for the River Itchen Chalk covers Zone 1 and 2 of the SPZ.

3.4.3 Aquifer properties

The Chalk exhibits both matrix flow and fracture flow and the Seaford Chalk Formation has regular orthogonal joint sets (Allen, et al., 1997). The Seaford Chalk usually has high storage although not always high permeability due to the narrow apertures of the fractures (Allen, et al., 1997). Numerous fractures are identified in the chalk in borehole logs.

It is common for there to be higher permeability in chalk river valleys. Palaeogene sediments in river valleys tend to be quite acidic, enhancing dissolution (Allen, et al., 1997). Transmissivities in the Hampshire Basin area are reported in Allen *et al.,* (1997) from 0.55 to 29,000 m^2/d with a geometric mean of 1,600 m^2/d. Allen *et al.* (1997) note that these values are high due to higher number of tests near to rivers. Transmissivity values of 1,000 m^2/d are common in the valley areas. The Candover valley, a tributary of the Itchen to the east, has transmissivities of 1,000 - 3,000 m^2/d and a storage coefficient of 0.01-0.03. Folding tends to enhance fracturing of rocks. However, it also notes that in the axes of anticlines, such as is found here, aquifer properties are thought to be less well developed, with groundwater mounds and lower transmissivities of 100 m^2/d. (Entec, 2002) within (WPK, 2007) suggest transmissivities in the Winchester Anticline are 100-600 m^2/d.

At the Itchen Valley (Easton) Public Water Supply (PWS) to the north of the Application Area, transmissivities of 2,400 and 4,700 m^2/d have been calculated from pumping tests (Environment Agency, 1997 within WPK, 2007).

If we assume that the transmissivity is concentrated in the top 50 m of the Chalk, then a transmissivity of 1,000 m^2/d equates to a hydraulic conductivity of 20 m/d. Below 50 m, chalk fissures tend to be closed due to the mass of rock above them and yields decrease.

Variable head permeability tests were undertaken during the site investigation by Soils Limited. However, it is understood that these tests were undertaken above the watertable and thus may not reflect the hydraulic conductivity of the strata tested. In the **Geotechnical Interpretation Report (Document Reference 7.11)** calculated soil infiltration rates to use as an indication for preliminary designs. Table 9.5 from the **Geotechnical Interpretation Report (Document Reference 7.11)** is reproduced here as Table 3.6. Based on these calculations a soil infiltration rate of 1 x 10^{-6} m/s was adopted for Alluvium, Head and Structured Chalk within 2 mbgl (metres below ground level), and 1 x 10^{-5} m/s for Structured Chalk below 2 mbgl.

Table 3.6 Calculated soil infiltration rates (from Table 9.5 in Geotechnical Interpretation Report (Document Reference 7.11))

Location	Test depth range (mbgl)	Geology as per borehole record logs (mbgl)	Soil infiltration – calculated (m/s)	Soil infiltration(m/hr)
DS104	0 - 4	0.3 - 3.0 Sandy gravelly clay [Alluvium] 3.0 - 4.0 No description [Alluvium]	9.5×10^{-6}	3.4×10^{-2}
DS107	0 - 4	0.4 - 1.2 Structureless chalk 1.7 - 4.0 Chalk Grade B2	1.4×10^{-5}	5.2×10^{-2}
DS109	0 - 3	0.5 - 1.2 Structureless chalk 1.2 - 3.0 Chalk Grade B2	2.8×10^{-5}	1.0×10^{-1}
DS210	0 - 4	0 - 1.7 Structureless chalk (Grade Dc) 1.7 - 4.0 Chalk Grade B2	4.2×10^{-6}	1.5×10^{-2}
DS301	5.7 - 10.15	5.7 - 7.0 Chalk Grade A3-A4 7.0 - 10.15Chalk Grade A3	1.1×10^{-4}	4.1×10^{-1}

Yields in the Lewes to Portsdown Formations are typically 10.5 l/s in boreholes in the Winchester District (Booth, et al., 2008). Booth *et al.* also note that "*rapid groundwater flows are sometimes found in the unconfined chalk aquifer where karstic-type development has taken place. This is commonly associated with the proximity of thin cover, such as the Palaeogene deposits or clay-with-flints".*

3.4.4 Groundwater levels and flow

Available data

Limited groundwater monitoring data are available. Monitoring wells were installed by Soils Limited during March and April 2019 at 23 locations and dips were taken at 13 from the installation until 15th April 2019. Four locations (DS104, DS114, DS301, DS302) were then monitored hourly using pressure transmitters and loggers for the period June 2019 to July 2020.

Groundwater levels

Dip data

Fourteen boreholes were dipped once installed and typically each day during the site investigation works by Soils Limited. The dips and levels on the final day (15th April 2019) are plotted on Figure 3.7 and Figure 3.8 respectively, which also shows the locations. The dip data is provided in Table 3.7 for the whole GI period (where available). These data are taken from the Soils Limited (2020) Factual Report and converted to metres above ordnance datum based on the groundwater elevations provided in the report. A number of boreholes were dry throughout the works period. These data indicate that the groundwater level across the central part of the Application Area is approximately 37.5 mAOD. Groundwater levels at DS208 are noticeably higher at 52.04 mAOD, which is because this borehole is screened in the Seaford Chalk at a higher elevation of 51.91-54.91 mAOD, whereas the other boreholes are screened below 30 mAOD. There is therefore a locally perched groundwater table at DS208.

Groundwater seepage was encountered during the Jacobs Application Area investigation at a depth of 3.10 mbgl in WS02 and 4.50 mbgl in WS03, and 7 mbgl in WS08.

Figure 3.7 Groundwater dip data from final day of installation works in mbgl

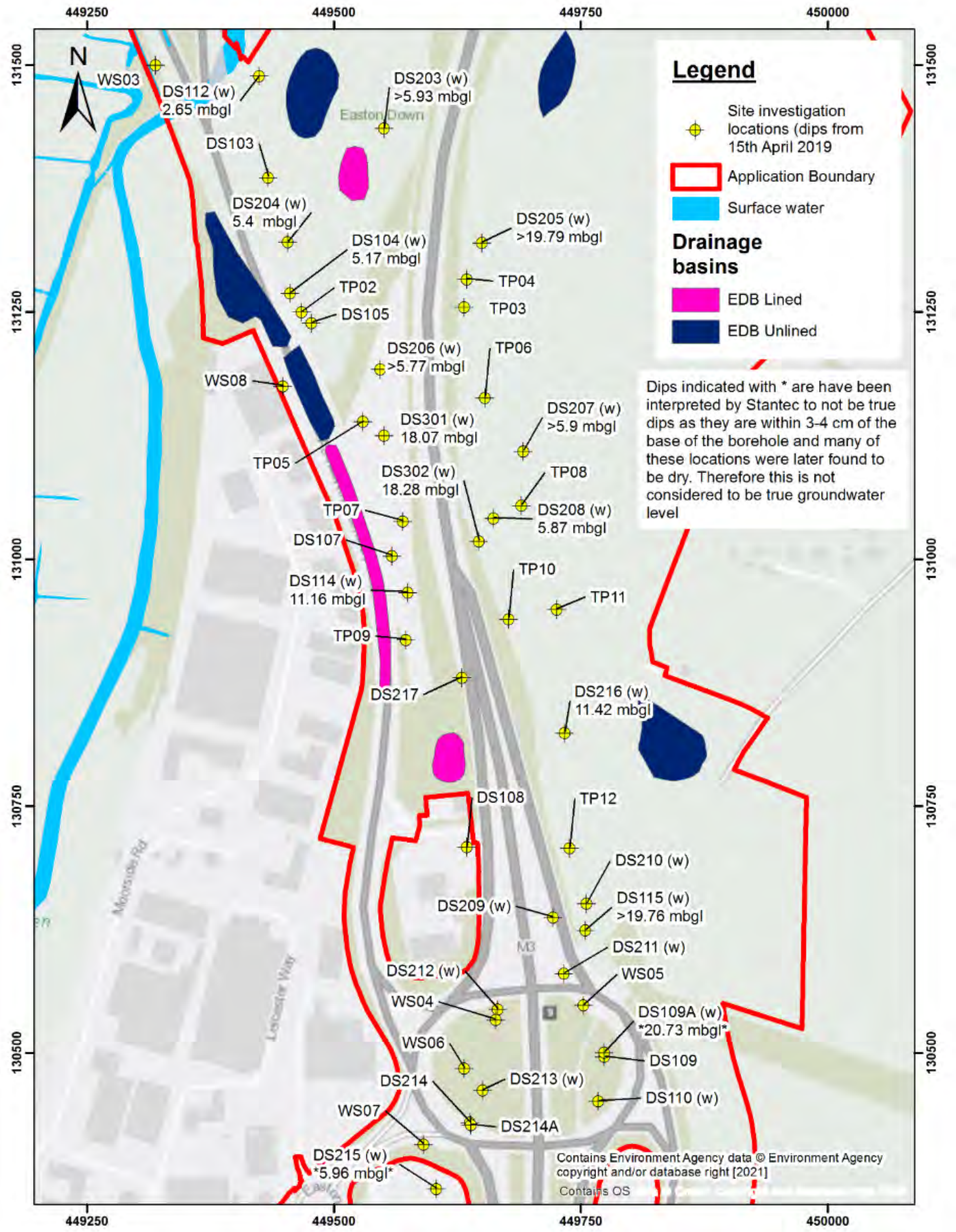


Figure 3.8 Groundwater levels data from final day of installation works in mAOD

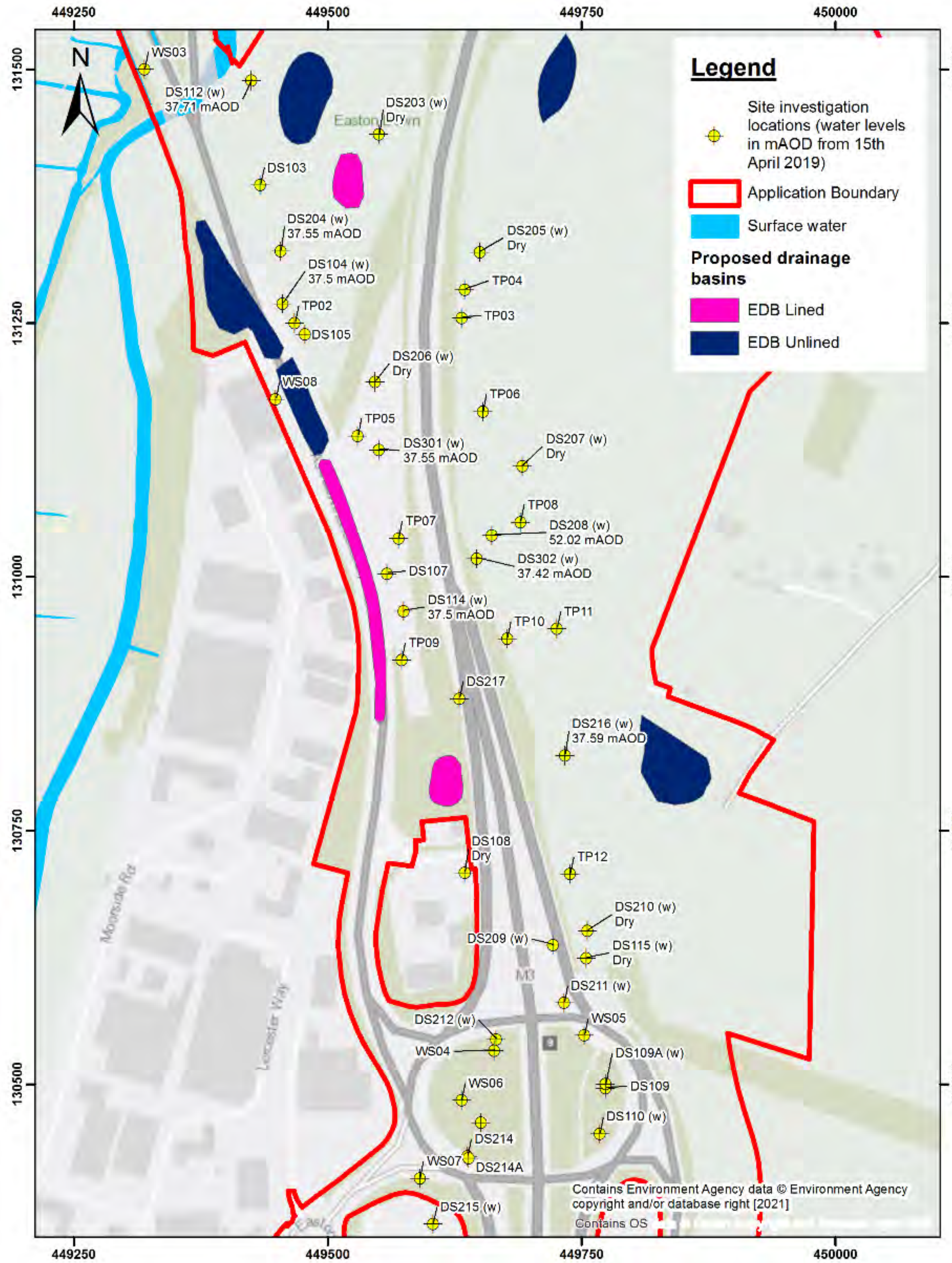


Table 3.7 Groundwater level dip data during site investigation works in mAOD

	Date	18/03/2019		19/03/2019		20/03/2019		22/03/2019		25/03/2019		26/03/2019		27/03/2019		28/03/2019		01/04/2019	
Trial Hole	**Ground level (mAOD)**	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base
DS104	42.67																		
DS112	40.36																	37.72	20.93
DS114	48.66													37.56	29.10	37.55	29.10	37.56	29.10
DS115	62.23					Installed		42.82	42.43			Dry	42.47	Dry	42.47	Dry	42.47	Dry	42.46
DS203	57.43																		
DS204	42.95																	37.59	36.85
DS205	69.16	Dry	49.39	Dry	49.39	Dry	49.39	Dry	49.39	Dry	49.44	Dry	49.39	Dry	49.44	Dry	49.39	Dry	49.44
DS206	56.88															Installed		Dry	51.11
DS207	64.65	Dry	58.45	Dry	58.77	Dry	58.71	Dry	58.77	Dry	58.78	Dry	58.75	Dry	58.73	Dry	58.78	Dry	58.78
DS208	57.91	Dry	51.74	Dry	51.92	52.02	51.98	Dry	51.89	52.01	51.97	52.05	52.01	52.00	51.98	52.05	52.01	52.04	52.02
DS210	61.41							Dry	55.63	Dry	55.63	Dry	55.62	Dry	55.62	Dry	55.62	Dry	55.63
DS216	49.01							Installed				37.64	34.28	37.47	33.96	37.65	34.29	37.48	33.98
DS301	55.62													Installed				37.60	<25.62
DS302	55.7			Installed		37.66	<25.7	37.65	<25.7	37.76	<25.7	37.67	<25.7	37.61	<25.7	37.62	<25.7	37.63	<25.7

(Continued on next page)

	Date	02/04/2019		03/04/2019		05/04/2019		09/04/2019		10/04/2019		11/04/2019		12/04/2019		15/04/2019	
Trial Hole	Ground level	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base	Water level	Base
DS104	42.67	Installed		37.54	27.96	37.75	28.04	37.55	27.94	37.53	27.95	37.66	28.05	37.54	27.95	37.50	27.95
DS112	40.36	37.70	20.95	37.74	21.08	37.87	20.95	37.80	20.95	37.73	21.00	37.71	21.00	37.70	20.89	37.71	21.02
DS114	48.66	37.56	29.10	37.54	29.38	37.64	29.22	37.56	29.10	48.66	48.66	37.61	29.09	37.52	29.51	37.50	29.42
DS115	62.23	Dry	42.68	Dry	42.68	Dry	42.82	Dry	42.68	Dry	42.82	Dry	42.46	Dry	42.46	Dry	42.47
DS203	57.43			Installed				Dry	51.48	Dry	51.48	Dry	51.48	Dry	51.53	Dry	51.50
DS204	42.95	37.58	36.87	37.58	36.87	37.77	36.91	37.78	36.87	37.60	36.89	37.69	36.89	37.56	36.90	37.55	36.89
DS205	69.16	Dry	49.44	Dry	49.44	Dry	49.44	Dry	49.44	Dry	49.44	Dry	49.67	Dry	49.69	Dry	49.37
DS206	56.88	Dry	51.11	Dry	51.10	Dry	51.10	Dry	51.01	56.88	56.88	Dry	51.01	Dry	51.10	Dry	51.11
DS207	64.65	Dry	58.78	Dry	58.78	Dry	58.78	Dry	58.76	Dry	58.74	Dry	58.73	Dry	58.74	Dry	58.75
DS208	57.91	52.04	52.03	52.03	52.01	Dry	52.03	Dry	63.79	52.04	52.03	Dry	52.02	Dry	52.02	52.04	52.02
DS210	61.41	Dry	55.62	Dry	55.63	Dry	55.63	Dry	55.63	Dry	55.52	Dry	55.51	Dry	55.51	Dry	55.52
DS216	49.01	37.48	34.14	37.47	34.23	37.74	34.14	37.19	34.14	37.45	34.16	37.61	34.26	37.60	34.26	37.59	34.26
DS301	55.62	37.59	<25.62	44.54	<25.62	37.59	<25.62	37.60	<25.62			37.69	<25.62	37.61	<25.62	37.55	<25.62
DS302	55.7	37.78	<25.7	37.62	<25.7	37.28	<25.7	37.49	<25.7	37.64	<25.7	37.46	<25.7	37.44	<25.7	37.42	<25.7

Red text indicates that the base of the borehole extended beyond the reach of the 30 m dip tape used.
Yellow highlighting indicates water levels that may be errors.

<u>Logger data</u>

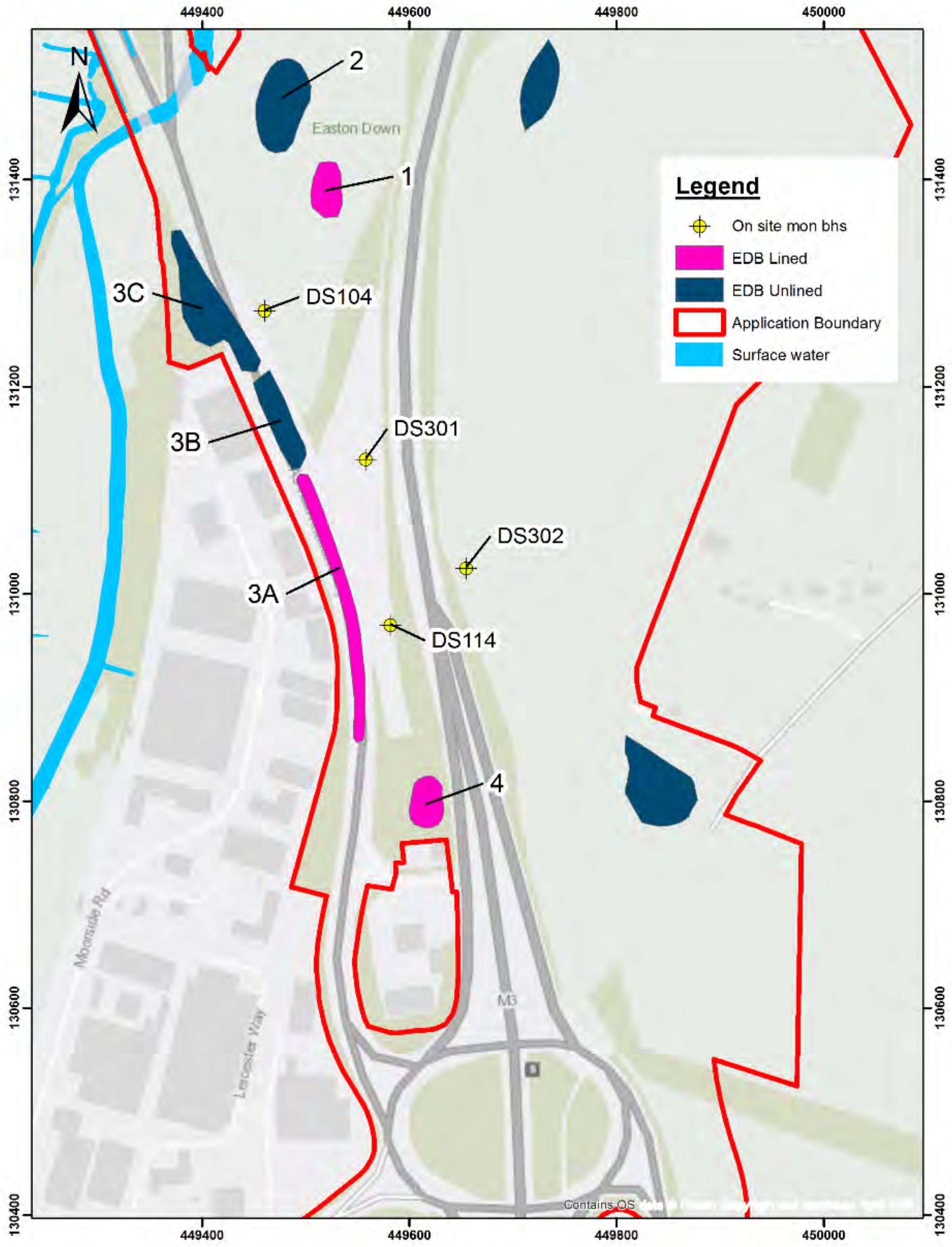
Groundwater monitoring points DS104, DS114, DS301 and DS302 are located close to the proposed drainage basins 2, 3A, 3B and 3C, as shown on Figure 3.9, and monitor the Seaford Chalk Formation. These boreholes are between 15 and 30.5 m in depth and are screened at their base within the Seaford Chalk Formation. A summary of the depths and horizons at the boreholes is given in Table 3.8.

These boreholes were monitored using loggers for one year from June 2019 to July 2020. The water level (in mbgl) is plotted in Figure 3.11. The barometrically adjusted groundwater level (in mAOD)) is plotted in Figure 3.10. A summary of the groundwater level is given in Table 3.9.

Table 3.8 Groundwater monitoring locations

Borehole	Ground level (mAOD)	Depth (mbgl)	Elevation of base (mAOD)	Screened interval (mAOD)	Geology summary
DS104	42.67	15.00	27.67	27.67-32.60 (Seaford Chalk)	Topsoil/Made Ground 0 to 0.3 mbgl Head 0.3 to 8.5 mbgl (some core not recovered). Typically sandy gravelly clay down to 3 mbgl and variable sand, gravels, and sandy gravelly clays at depth. No recovery 8.5 to 10.00 mbgl Seaford Chalk Formation 10.00-15.00 mbgl
DS114	48.66	19.95	28.71	29.16-32.16 (Seaford Chalk Formation)	Topsoil 0 to 0.3 mbgl Seaford Chalk Formation from 0.3 to 19.95
DS301	55.62	30.25	25.27	25.62-30.62 (Seaford Chalk Formation)	Topsoil to 0.4 mbgl. Seaford Chalk from 0.4 to 30.25 mbgl
DS302	55.70	30.45	25.25	25.70-30.70 (Seaford Chalk Formation)	Head from 0 to 0.27 mbgl. Head is composed of light brown slightly gravelly sandy clay. Seaford Chalk from 0.27 to 30.45 mbgl

Figure 3.9 Boreholes monitored for groundwater level



During the monitoring period the groundwater levels vary by approximately 2 m, with all locations showing almost identical trends. Groundwater level generally increase gradually from June 2019 to December 2019, then rise more quickly from mid-December to February 2020 and decline from February to June 2020. Groundwater levels in DS301 and DS302 are approximately 0.3 m higher than those at DS104 and DS114. The groundwater levels range between 37.19 to 39.38 mAOD. This is the same elevation as the River Itchen and surrounding area to the west. We note that the Chalk groundwater level flow direction is likely to be towards the River Itchen (i.e. from east to west). These wells are located along an approximate north to south line (perpendicular to groundwater flow), making it difficult to assess flow directions or hydraulic gradients directly from these data.

Table 3.9 Summary of groundwater levels (June 2019 to July 2020)

Borehole	Groundwater level (mbgl)			Groundwater level (mAOD)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
DS104	3.83	4.97	5.43	37.24	37.70	38.84
DS114	9.67	10.98	11.49	37.17	37.68	38.99
DS301	16.41	17.68	29.21	37.43	37.94	39.21
DS302	16.32	17.73	28.90	37.42	37.98	39.38

Figure 3.10 Groundwater level in Application Area SI boreholes in the Application Area (mAOD)

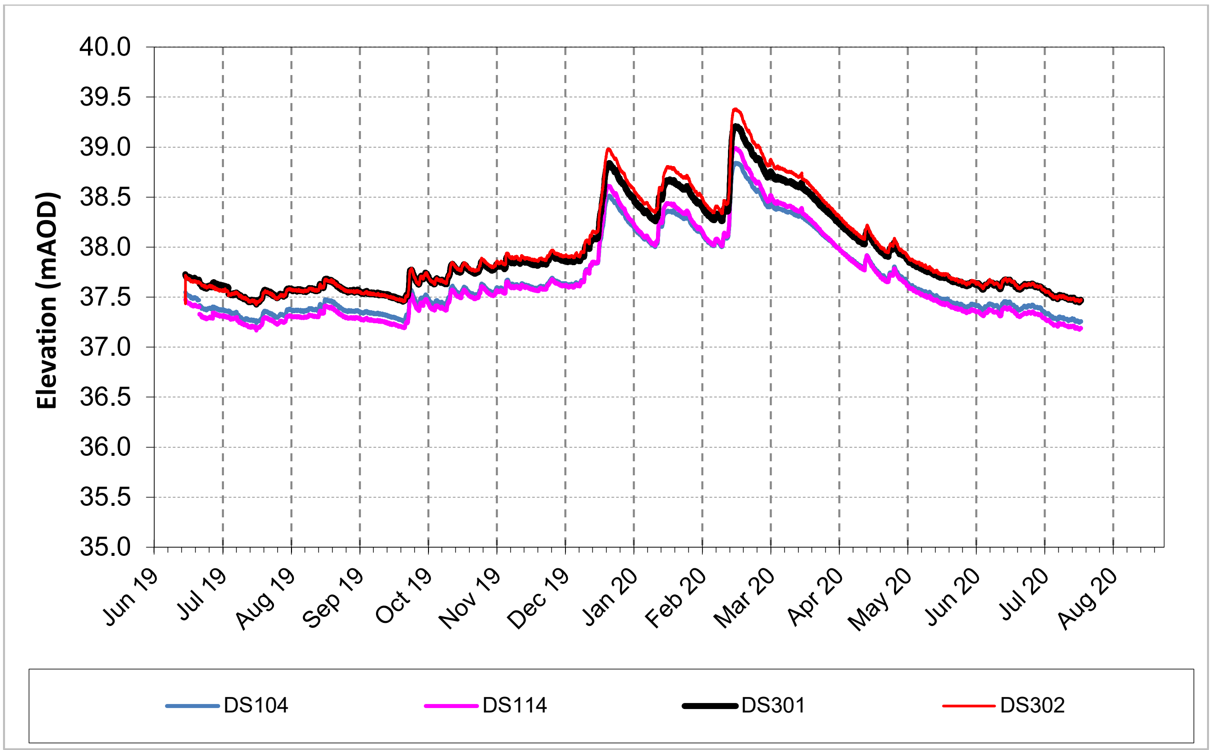
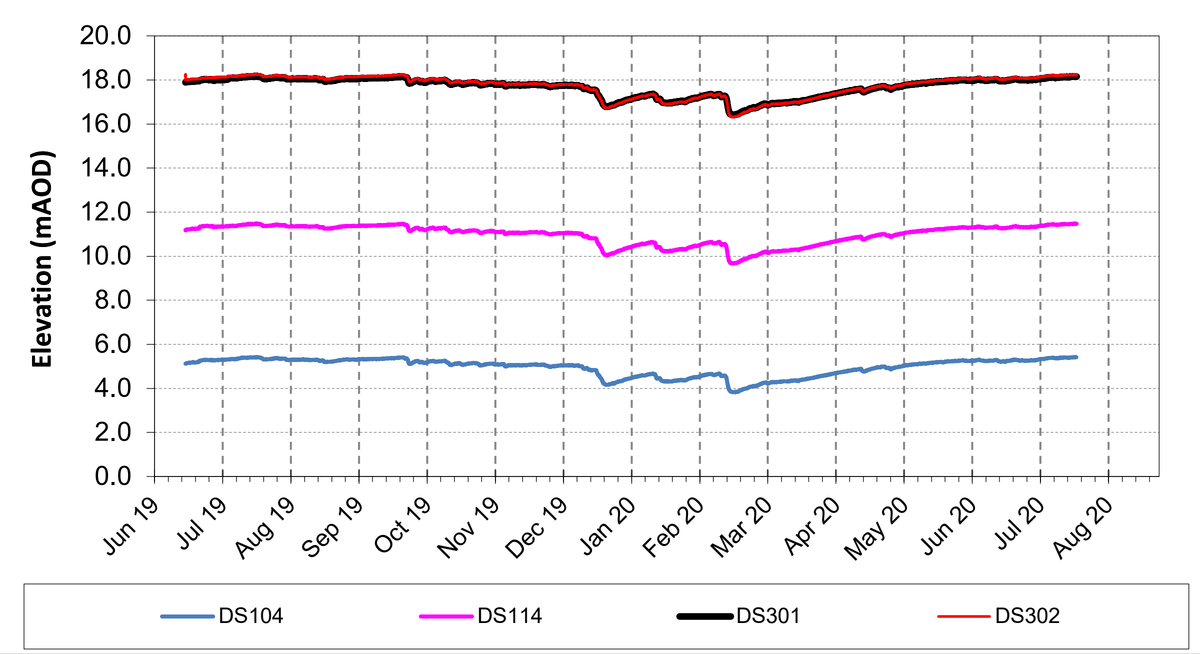


Figure 3.11 Groundwater level in Application Area SI boreholes in metres below ground level



<u>Unsaturated zone thickness</u>

Based on the available groundwater level data, the groundwater depth (unsaturated zone thickness) at each of the proposed EDBs can be estimated. These estimates are summarised in Table 3.10. Unsaturated zone thickness is based on the average groundwater level in the closest borehole to where the EDB is proposed. The logger data at four boreholes indicates that the average groundwater level over the year was 0.2 m higher than the water level recorded in April 2019 during the installation. Therefore, it has been assumed that variability is the same across all boreholes and so the average unsaturated thickness is taken to be 0.2 m smaller than was measured in April 2019.

Table 3.10 Approximate depth to groundwater at unlined EDBs

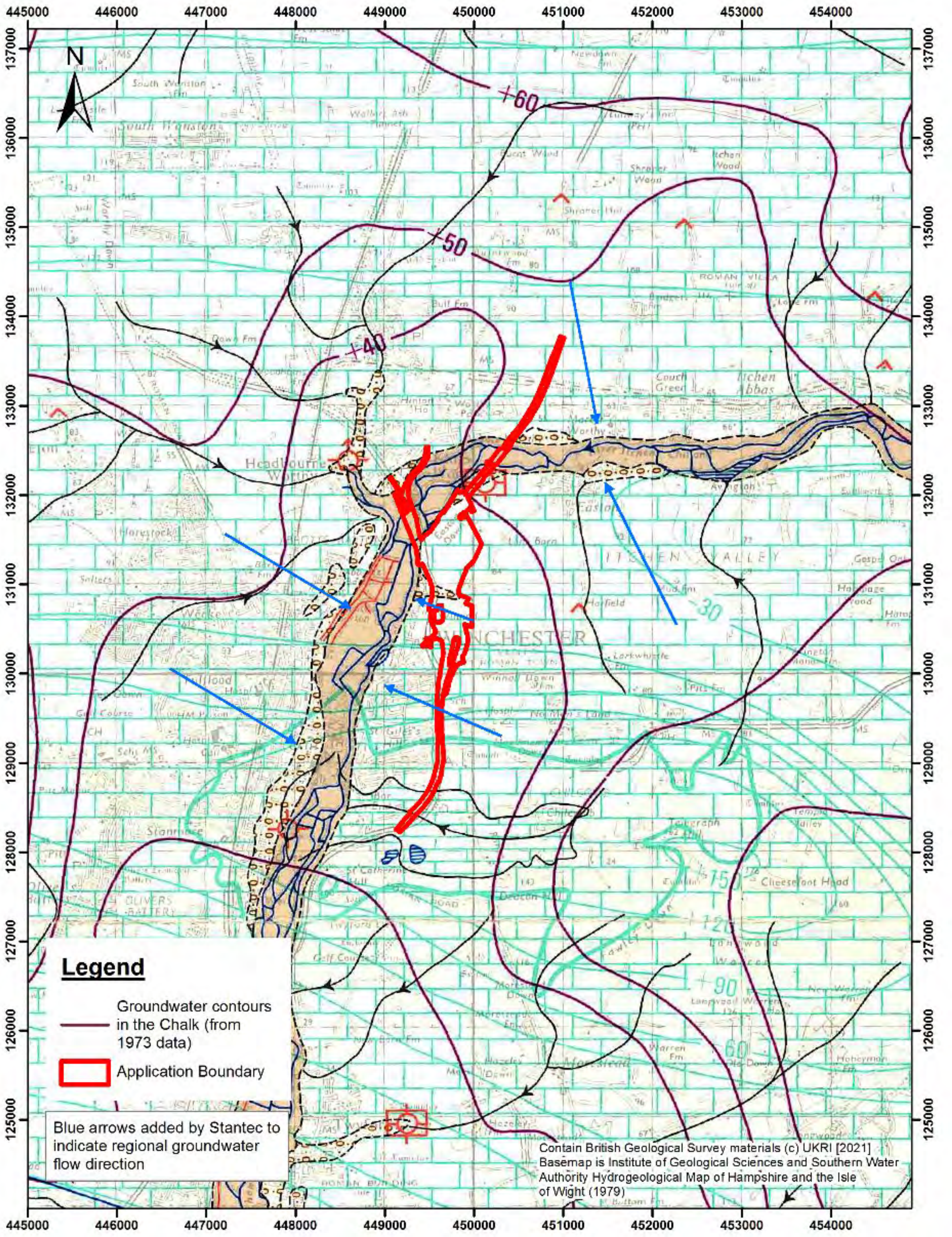
EDB	Approximate average elevation of EDB (mAOD)	Approximate average unsaturated thickness to nearest 0.1 m	Nearest borehole
1	45	7.1	DS112
2	51	13.1	DS203 DS112
3B	43.5	5.8	DS104
3C	41.5	3.8	DS104

Groundwater flow

The Hydrogeology map of Hampshire and the Isle of Wight (Institute of Geological Sciences and Southern Water Authority, 1979) shows the groundwater contours in the Upper Chalk around the Application Area to be generally mirroring the topography and indicates groundwater flow towards the River Itchen (Figure 3.12). In the area of the drainage features within the Application Area, groundwater flows to the southwest are indicated, towards the River. These contours suggest that groundwater discharges to the River.

The shape of the SPZs indicate a southeasterly flow at Headbourne Worthy which lies on the western side of the River Itchen. The Itchen Valley abstractions near Easton draw in water from the north of the River and also from the southeast.

Figure 3.12 Application Area overlaid on the Hydrogeological map (Institute of Hydrological Sciences, 1979)



3.4.5 Contaminated land and pollution events

An Envirocheck report was obtained to inform the Preliminary Sources Study Report (WSP, 2017). Envirocheck notes there are two petrol filling stations on Easton Lane, one 7 m (Shell) from the Application Area and one 66 m (Tesco) away. Stantec has also been made aware by Winchester City Council that there also is a former petrol station located within the Application Area along the A33 (letter reference 21/01483/NSIP, dated 7th July 2021).

Pollution incidents up to 2 km away from the Application area are summarised in Table 3.11 (Envirocheck, 2016). These pollution incidents occurred between 1992 and 1999.

Table 3.11 Pollution incidents within 2 km (from Envirocheck, 2016)

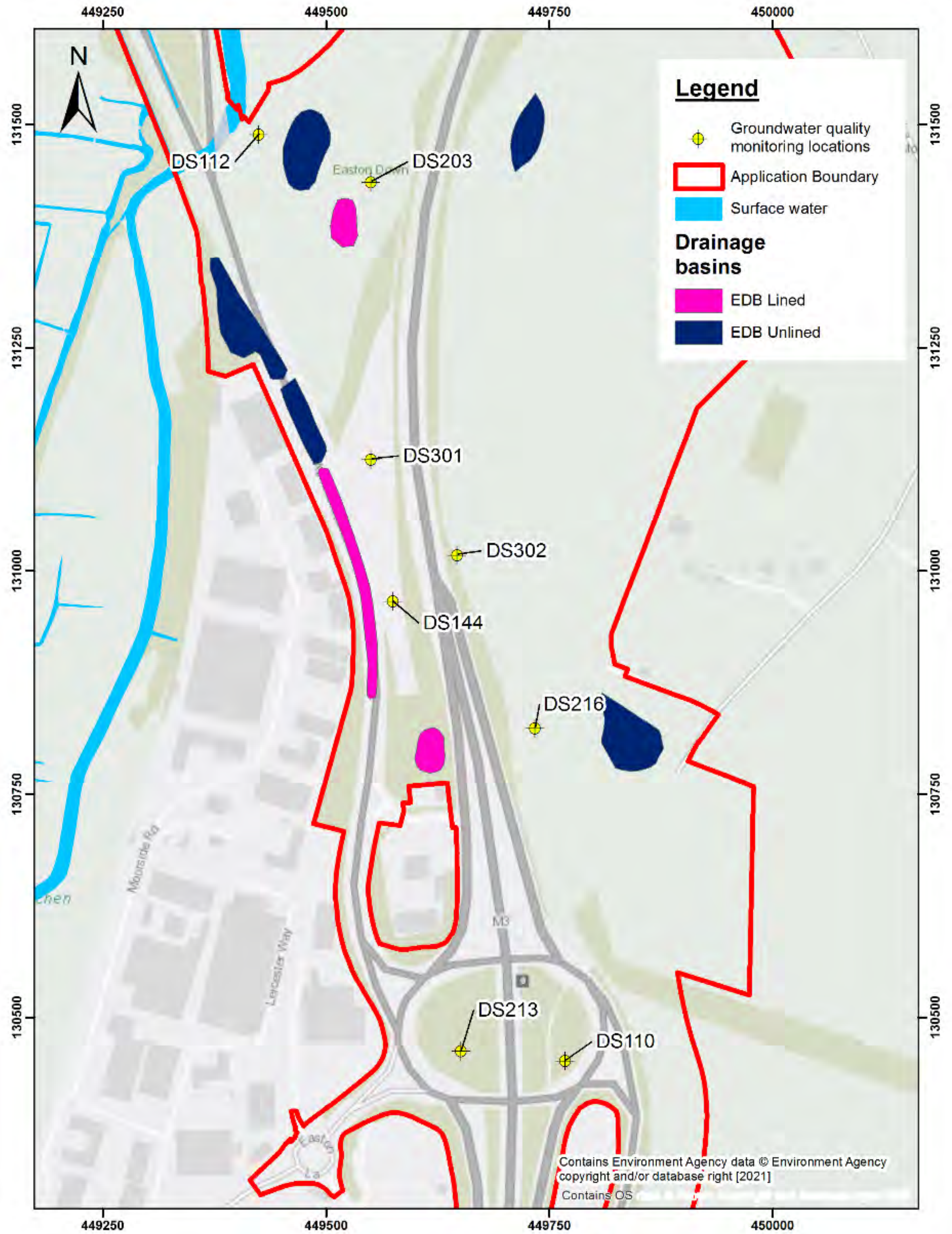
Distance	Number of recorded incidents	Summary of incidents
On site	1	Poultry manure
0-250 m	4	Petrol poured onto ground
		LPG tanker overturned
		Mineral and synthetic oil
		Inert suspended solids from cress beds
251-500 m	2	Slurry discharge
		Inert suspended solids from farm
501-2000 m	12	Slurry discharge
		Milky white discharge from construction
		Suspended solids from construction
		Industrial chemicals
		Waste oil
		River has turned black – inert solids

3.4.6 Groundwater quality

Groundwater samples were taken from eight boreholes on two occasions during the GI in 2019. The locations tested were DS110, DS112, DS114, DS203, DS213, DS216, DS301 and DS302, which are shown on Figure 3.13

On each monitoring occasion, two samples were taken from DS110 at 12 mbgl and 29.5 mbgl, and one sample was taken at the other seven boreholes. Only results from one occasion are available for review by Stantec.

Figure 3.13 Groundwater quality monitoring locations



The Tier 2 Controlled Waters Risk Assessment in **ES Chapter 9: Geology and Soils (Document Reference 6.1)** identified one exceedance of copper, two exceedances of mercury, one exceedance of nickel and one exceedance of zinc against the Environmental Quality Standards (EQS). Furthermore, the limit of detections (LOD) for cadmium, hexavalent chromium, copper, lead and cyanide are above the EQS. It also identified one exceedance of mercury, one exceedance of nickel and two exceedances of nitrate compared to the UK DWS (Drinking Water Standards). The nitrate exceedances were from wells sampling from the rural catchment to the east of the Scheme and the metal exceedances were from wells sampling close to historical landfills.

Table 3.12 Summary of groundwater quality data (based on data in Controlled Waters Risk Assessment in ES Chapter 9: Geology and Soils (Document Reference 6.1))

Analyte	Units	LOD	Fresh Water (EQS)	No. of Tests	Min	Max	No. > Limit	Locations with exceedances
Arsenic	µg/l	5	50	9	5	5		
Boron	µg/l	5	-	9	14	28		
Cadmium	µg/l	0.4	0.08	9	0.4	0.4	**9**	All
Chromuim (Total)	µg/l	5	-	9	5	10		
Chromium Hexavalant	µg/l	20	3.4	9	20	20	**9**	All
Copper	µg/l	5	1	9	5	9	**9**	All. Detected at DS103 only
Lead	µg/l	5	1.2	9	5	5	**9**	All
Mercury	µg/l	0.05	0.07	9	0.05	18.3	**2**	DS110 (0.24) and DS203 (18.3)
Nickel	µg/l	5	4	9	5	68	**9**	All. Detected at DS203 only
Selenium	µg/l	5	-	9	5	5		
Zinc	µg/l	2	10.9	9	2	27	**1**	DS203
Ammoniacal Nitrogen as NH4	µg/l	50	260	9	50	107		
Cyanide	µg/l	5	1	9	5	5	**9**	All
Nitrate as NO3	µg/l	500	-	9	14300	56000		
Sulphate	µg/l	1000	-	9	6000	31000		
pH	pH Units	1	-	9	7.7	7.8		
>C5 to C6 Aliphatic	µg/l	10	-	9	10	10		
>C6 to C8 Aliphatic	µg/l	10	-	9	10	10		
>C8 to C10 Aliphatic	µg/l	10	-	9	10	10		
>C10 to C12 Aliphatic	µg/l	10	-	9	10	10		
>C12 to C16 Aliphatic	µg/l	10	-	9	10	10		
>C16 to C21 Aliphatic	µg/l	10	-	9	10	10		
>C21 to C35 Aliphatic	µg/l	10	-	9	10	18		
Total Aliphatic C5-35	µg/l	70	-	9	70	70		
>C7 to C8 Aromatic	µg/l	10	-	9	10	10		
>C8 to C10 Aromatic	µg/l	10	-	9	10	10		
>C10 to C12 Aromatic	µg/l	10	-	9	10	10		

Analyte	Units	LOD	Fresh Water (EQS)	No. of Tests	Min	Max	No. > Limit	Locations with exceedances
>C12 to C16 Aromatic	µg/l	10	-	9	10	10		
>C16 to C21 Aromatic	µg/l	10	-	9	10	10		
>C21 to C35 Aromatic	µg/l	10	-	9	10	10		
Benzene	µg/l	1	10	9	1	1		
Ethylbenzene	µg/l	5	-	9	5	5		
Toluene	µg/l	5	74	9	5	5		
M- & P-Xylene	µg/l	10	-	9	10	10		
O-Xylene	µg/l	5	-	9	5	5		
Total Xylene (M, P & O)	µg/l	15	-	9	15	15		
MTBE	µg/l	10	-	9	10	10		
naphthalene	µg/l	0.01	2	9	0.01	0.04		
Acenaphthylene	µg/l	0.01	-	9	0.01	0.01		
Acenaphthene	µg/l	0.01	-	9	0.01	0.01		
Fluorene	µg/l	0.01	-	9	0.01	0.01		
Phenanthrene	µg/l	0.01	-	9	0.01	0.01		
Anthracene	µg/l	0.01	0.1	9	0.01	0.01		
Fluoranthene	µg/l	0.01	0.0063	9	0.01	0.01	**9**	All
Pyrene	µg/l	0.01	-	9	0.01	0.01		
Benzo(a)anthracene	µg/l	0.01	-	9	0.01	0.01		
Chrysene	µg/l	0.01	-	9	0.01	0.01		
Benzo(b)fluoranthene	µg/l	0.01	0.017	9	0.01	0.01		
Benzo(k)fluoranthene	µg/l	0.01	0.017	9	0.01	0.01		
Benzo(a)pyrene	µg/l	0.01	0.00017	9	0.01	0.01	**9**	All
Benzo(g,h,i)perylene	µg/l	0.01	0.0082	9	0.01	0.01	**9**	All
Dibenzo(ah)anthracene	µg/l	0.01	-	9	0.01	0.01		
Indeno(1,2,3-c,d)pyrene	µg/l	0.01	-	9	0.008	0.008		
Sum (benzo b, k, ghi & indeno123cd)	µg/l	0.04	-	9	0.038	0.038		

Orange highlight means LOD > EQS
Red highlight means result > EQS

3.5 Other potential receptors

3.5.1 Licenced water abstractions and discharges

There are multiple public groundwater abstractions to the north and south of the Application Boundary. The majority of groundwater abstractions to the north are for potable water supply, with the abstractions to the south and west primarily used for water cress production and other agricultural purposes, see Table 3.15 and Figure 3.14.

Given the groundwater divide at the River Itchen, the impact from the EDBs on the boreholes to the west and north of the Itchen will be negligible and are not considered further here.

3.5.2 Private water supplies

Winchester City Council have previously provided information on private water supply abstractions and discharges, located within a 2 km radius of the Application Boundary. It is understood that the current Application Boundary has been revised and as a result some of these supplies now fall more than 2 km from the Application Boundary.

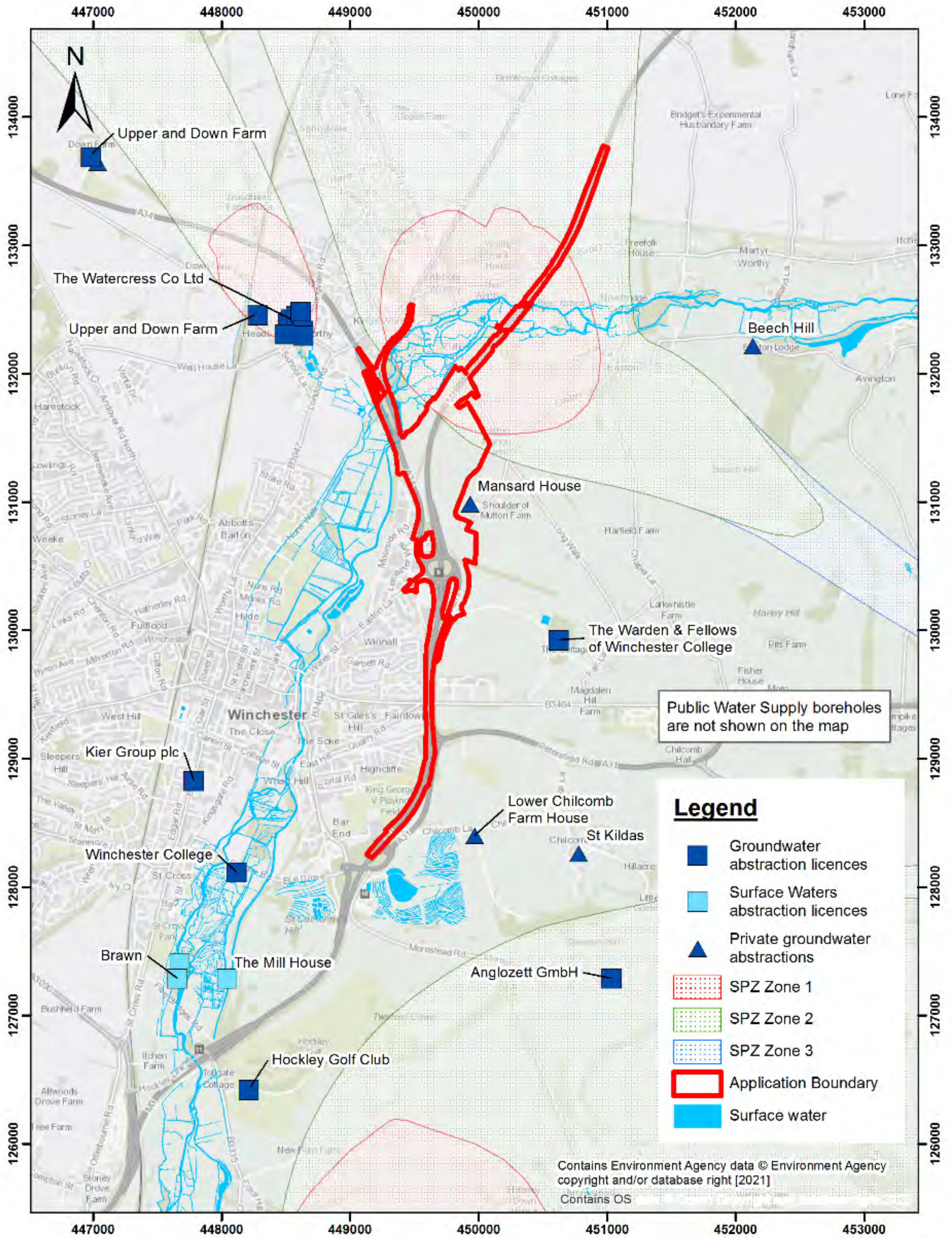
There are nine boreholes used for private water supplies, all of which are currently active and abstract from the underlying chalk aquifer; details of these can be seen in Table 3.13. The locations of private water supply boreholes are shown on Figure 3.14. Some abstractions to the north are beyond the extent of the map and are therefore not shown.

Since all of the private water supplies are on the western and northern side of the River Itchen, up hydraulic gradient, or across hydraulic gradient at a sufficient distance of the EDBs, the Scheme will have a negligible impact upon them, and they are not considered further here.

Table 3.13 Private water abstractions (within 2 km of initial scheme boundary)

FID	Supply Name	Supply Number	Source Type	Source Eastings	Source Northings	Distance from Application Area
Within Application Boundary						
	None					-
Identified outside of the Application Boundary						
19	Shroner Wood	PW000123	Borehole	451582	135626	2 km north
32	Burntwood Farm	PW000118	Borehole	450500	134760	1 km to north
35	Downs Farm Cottages	PW000195	Borehole	447032	133651	2.5 km to north west
51	Mansard House	PW000120	Well	449931	130990	90 m to east
58	Shroner Hill Farmhouse	PW000122	Borehole	450989	135290	1.5 km north
77	Beech Hill	PW000117	Borehole	452132	132220	1.6 km to east
112	Lower Chilcomb FarmHouse	PW000186	Borehole	449967	128403	500 m to east
133	St Kildas	PW000107	Borehole	450776	128265	560 m to south east
136	The Beacon	PW000066	Borehole	450992	135448	1.65 km north

Figure 3.14 Licenced and private abstractions and Source Protection Zones (SPZs)



3.5.3 Designated environmental sites

There are three designated sites within 2 km of the Application Boundary, two of which are within the Application Area itself.

The River Itchen is a SSSI and a SAC along all of its length. The SSSI extends to the surrounding water dependent habitats and environments. Part of the River Itchen SSSI is managed as the Winnall Moors Nature Reserve to the west of the Application Area. The River Itchen flows south to the Solent and Dorset Coast Special Protection Area (SPA) and the Solent and Southampton Water SPA / Ramsar Site.

The South Downs National Park forms part of the eastern side of the Application Area and extends to the east.

Only the River Itchen SSSI is groundwater dependent.

Table 3.14 Designated Sites within 2 km of the Application Area

Name	Designation	Description	Groundwater dependent?	Closest distance from Application Area
River Itchen (multiple parts)	SSSI SAC	River Itchen and surrounding land. Multiple habitats and environments. Close to site: - Fen, marsh swamp, lowland - Broadleaved mixed and yew woodland - Neutral grassland - Rivers and streams	Yes	On site
South Downs	National Park	Chalk Hills and wooded sandstone and clay hills and vales.	Not generally. None within 5 km other than River Itchen (see above).	On site
St Catherine's Hill	SSSI (Biological)	Chalk grassland scrub	No	1.4 km south
Cheesefoot Head	SSSI (Biological)	Chalk downland with horseshoe shaped dry valley, with species rich grasslands.	No	1.8 km east

Figure 3.15 Designated sites within 2 km

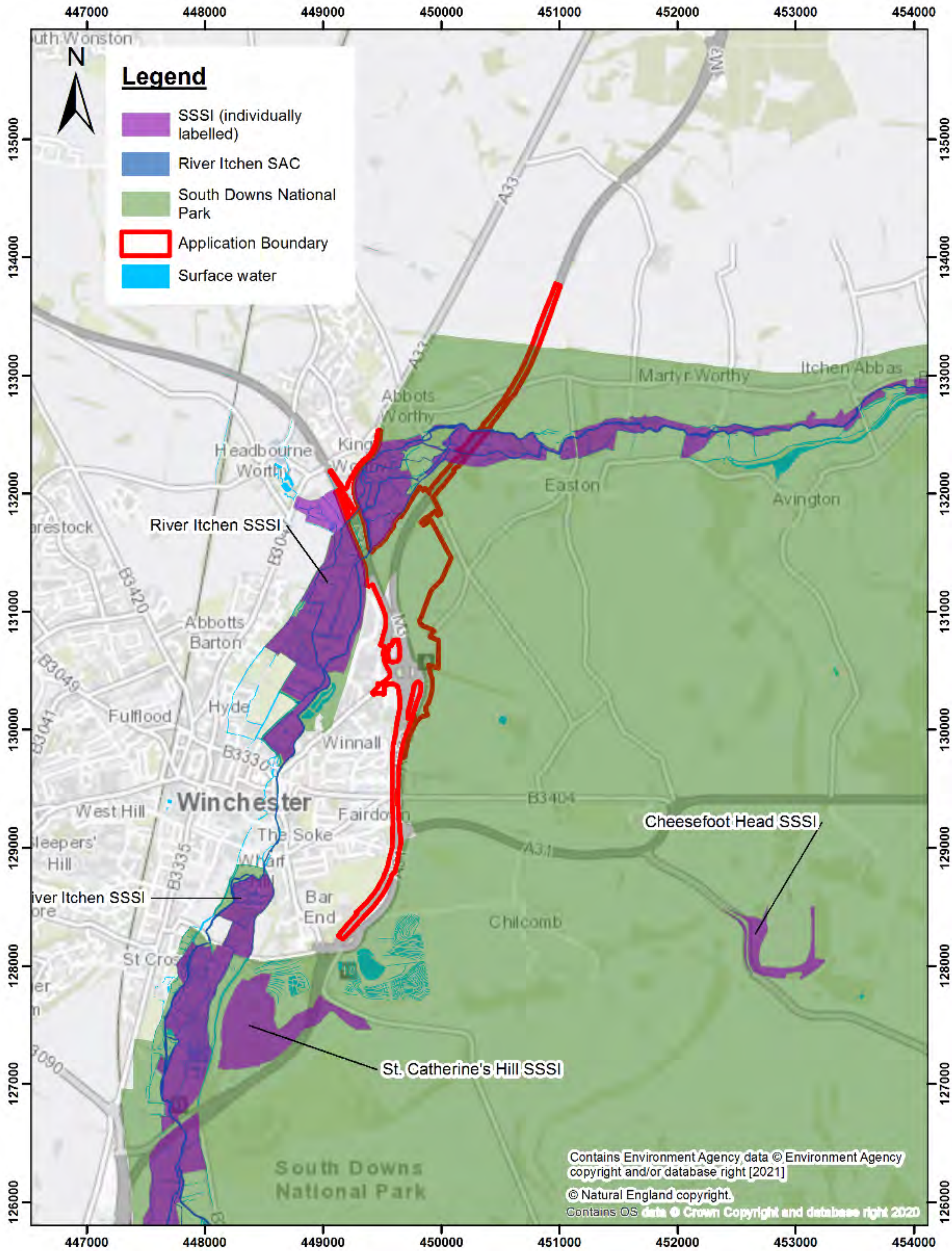


Table 3.15 Licenced groundwater and surface water abstractions

Supply Name	Licence number	Effective date	Purpose	Use	Source	Aquifer type	National Grid Reference
St Cross (Itchen)	31/086	23/04/1992	Aquaculture Fish	Fish Farm/Cress Pond Throughflow	Southern Region Surface Waters	-	SU47672741
Point A, Borehole At Garnier Road	SO/042/00 31/019	17/02/2012	Aquaculture Fish	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4811328115
Burntwood Farm, Martyr Worthy	11/42/22.5/ 76	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU50333501
Hazeley Estate, Twyford	11/42/22.6/ 89	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU51032729
Watercress Beds At Headbourne Worthy Point A	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4851732410
Watercress Beds At Headbourne Worthy Point B	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4853832428
Watercress Beds At Headbourne Worthy Point C	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4857832456
Watercress Beds At Headbourne Worthy Point D	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4861432487
Watercress Beds At Headbourne Worthy Point E	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4862732339
Watercress Beds At Headbourne Worthy Point F	11/42/22.5/ 1	22/02/1966	Aquaculture Plant	Fish Farm/Cress Pond Throughflow	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4863532303

Supply Name	Licence number	Effective date	Purpose	Use	Source	Aquifer type	National Grid Reference
Upper & Down Farms Point A, Headbourne Worthy	11/42/22.5/ 73	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU46983369
Upper & Down Farms Point B, Headbourne Worthy	11/42/22.5/ 73	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48283246
Upper & Down Farms Point C, Headbourne Worthy	11/42/22.5/ 73	23/12/1965	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48493231
Point A Down Farm Hursley	31/108	22/07/2008	General Agriculture	General Farming & Domestic	Southern Region Groundwater	H5 Chalk	SU44402660
St Cross, Winchester (Itchen)	SO/042/00 31/035	02/05/2014	Private Water Supply	Heat Pump	Southern Region Surface Waters	-	SU4765327288
Shawford Mill Headrace (Itchen Navigation)	SO/042/00 31/018/R01	21/07/2020	Electricity	Hydroelectric Power Generation	Southern Region Surface Waters	-	SU4739724981
Carrier Channel (Itchen)	SO/042/00 31/002	29/01/2010	Electricity	Hydroelectric Power Generation	Southern Region Surface Waters	-	SU5365232564
Twyford Ps Point D	11/42/22.6/ 92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4824
Twyford Ps Point A	11/42/22.6/ 92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4825
Twyford Ps Point C	11/42/22.6/ 92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4924
Twyford Ps Point B	11/42/22.6/ 92	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4924
Itchen Valley Point D	11/42/22.4/ 80	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4932
Itchen Valley Point A	11/42/22.4/ 80	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU5032

Supply Name	Licence number	Effective date	Purpose	Use	Source	Aquifer type	National Grid Reference
Itchen Valley Point C	11/42/22.4/ 80	26/11/1965	Public Water Supply	Potable Water Supply - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU5032
Winnall Down Farm, Winchester	11/42/22.4/ 146	20/06/1977	General Agriculture	Spray Irrigation - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU5061929927
Hockley Golf Club	11/42/22.6/ 95	23/12/1965	Golf Courses	Spray Irrigation - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48212642
Hockley Golf Club	11/42/22.6/ 95	23/12/1965	Golf Courses	Spray Irrigation - Direct	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU48212642
River Itchen At Shawford Park	SO/042/00 31/003	09/10/2009	Remedial River/Wetland Support	Transfer Between Sources (Post Water Act 2003)	Southern Region Surface Waters	-	SU4740724753
Water Meadow Channel Off R Itchen	SO/042/00 31/010	18/10/2010	Remedial River/Wetland Support	Transfer Between Sources (Post Water Act 2003)	Southern Region Surface Waters	-	SU4804127290
Lower Itchen Navigation At Shawford	SO/042/00 31/020	27/03/2012	Non-Remedial River/Wetland Support	Transfer Between Sources (Pre Water Act 2003)	Southern Region Surface Waters	-	SU4711323809
Wellpoints At Winchester College	SO/042/00 32/012	22/07/2020	Construction	Dewatering	Southern Region Groundwater	H5IT Itchen Chalk / UGS	SU4777928830

4 Conceptual site model

4.1 Sources

4.1.1 Carriageway drainage

Rainwater on the carriageway will wash any contaminants present into the drainage system. Contaminants may be in solution which are considered to provide an acute risk or sorbed onto solids which may present a chronic risk. The following pollutants have been identified by the HEWRAT (Highways England, 2015) as potential contaminants to receptors from road drainage schemes:

- Microplastics and other particulate matter (from brake and tyre wear);
- Soluble metals (copper and zinc) and;
- Sediment related pollutants associated with chronic pollution impacts (total copper, zinc, cadmium, PAH - including species pyrene, fluoranthene, anthracene and phenanthrene).

The drainage system discharges into the EDBs. Prior to entry into the EDBs large items are screened out within the lined Pollution Control Device (PCD) ditches and vertical separation forebays. Within the EDBs, finer suspended sediment will settle out as flow velocities diminish. EDBs 1, 3A and 4 are sealed and will not discharge to ground. There will also be an element of attenuation as soluble heavy metals and hydrocarbons will sorb onto sediment present within the EDBs.

Discharge from the lined EDBs is to the unlined EDBs 2, 3B, 3C, 5 and 6. Within these EDBs there will be secondary attenuation, settlement and filtration within vegetated EDBs which will contain both wet and dry habitats.

We note that un-lined EDB2 and EDB3C receive direct runoff from the carriageway via lined PCD ditches and forebays.

Sediment will not infiltrate through the superficial deposits or structureless chalk. Unless, the EDBs are constructed directly over transmissive fissures, we can expect there will be no infiltration of solids, even to structured chalk. Sediment (and any entrained contaminants) will remain trapped within the forebays or EDBs and be subject to periodic removal during maintenance events. Thus, it is contaminants that are directly soluble or that leach from the sediments within the EDBs that form the potential source of contamination for groundwater.

4.1.2 Placement of potentially contaminated materials via cut and fill operations

It is expected that much of the material excavated under the Scheme will be re-used as fill material to bring areas up to required levels. It is noted that a significant volume of material is required to raise levels in the eastern part of the Scheme.

As detailed in Section 3.2.2 this material may contain a proportion of Made Ground from previous road schemes.

4.1.3 Other sources of contamination

There are a number of potential sources of contamination within and adjacent to the Application Boundary. These include landfills, a former gasworks and ironworks, petrol stations, railways and land with mixed industrial use. Rainwater passing through these sources has the potential to leach contaminants into the groundwater.

4.2 Pathways

4.2.1 Unsaturated zone

Where the EDBs and retained highway soakaways are un-lined, they have the potential to discharge to ground. Site specific soil infiltration rates are presented in Section 3.4.3. On the basis of these limited data a maximum soil infiltration rate of 1 x 10^{-6} m/s was adopted for Alluvium, Head and Structured Chalk within 2 mbgl, and 1 x 10^{-5} m/s for Structured Chalk below 2 mbgl.

The other sources of contamination, including re-used material, may be located on superficial deposits or directly on the Chalk. Either way, contaminants will have to pass through the unsaturated zone to the watertable.

Rainfall is estimated as 806 mm/a which represents a long-term average infiltration rate to the EDBs. So long as the unsaturated zone hydraulic conductivity is higher than this, recharge to the watertable will occur. During storm events, when the EDBs become saturated, the infiltration rate could rise to a maximum rate that will be limited by the hydraulic conductivity of the underlying strata. However, such high infiltration rates will be relatively short lived as excess water within the EDBs will drain to surface water and it is expected that the EDBs will be dry for most of the time.

Within the unsaturated zone contaminant attenuation may occur. Attenuation comprises retardation and degradation processes. Heavy metals may be retarded via sorption. There are a number of mechanisms that control metal sorption which is often influenced by soil pH and redox conditions. Where sorption occurs due to cation exchange, the degree of sorption is influenced by the concentration gradient between the soluble contaminant and the solid matrix. If a more dilute flux subsequently passes through the unsaturated zone, contaminants may de-sorb back into solution. Organic compounds, such as PAHs, adsorb onto clay particles and the sorption rate is largely controlled by the fraction of organic carbon present. Whilst this may be significant in alluvial material, chalk tends to have very low organic carbon contents and as such retardation may be limited. Organic compounds may also bio-degrade within the unsaturated zone.

4.2.2 Saturated zone

Once the contaminants reach the watertable, they will migrate within the receiving groundwater, down the hydraulic gradient. Whilst the superficial deposits and structureless chalk may be saturated and act as contaminant transport pathways, contaminant transport will be greatest within fissures and fractures within the structured chalk.

Whilst it is possible that attenuation processes may occur during transport within fissured chalk, they tend to be relatively insignificant. The most likely process is diffusion from the fissure into the chalk matrix, which effectively retards contaminant migration within the Chalk. Given the difficulties in parameterising this process, it has conservatively been ignored for this assessment.

Estimating the volumetric flux in fissured chalk is difficult. Transmissivity data provides a weighted average of hydraulic conductivity in fissures and matrix and applying this across the entire chalk body provides a reasonable dilution estimate. However, in order to determine realistic travel times, it is often necessary to utilise very low effective porosity values. This latter parameter effectively determines the proportion of the chalk that is present as fissures where travel times can be very fast.

Based on the published chalk groundwater contours, the flow direction within the chalk is assessed as follows.

- Areas occupied by the EDBs and retained highway soakaways is to the southwest, towards the River Itchen; and
- Areas within the Itchen Valley (near Easton) PWS SPZ is to the northwest towards the PWS.

4.3 Receptors

For the purposes of this assessment, the following receptors have been assessed.

- The watertable is the receptor for Hazardous substances and
- A distance of 50 m from the Application Boundary is taken to be the receptor for non-hazardous pollutants.

5 Groundwater Impact Assessment

The impact to groundwater from the developments in the Application Area has been assessed using the methodology outlined in Section 9.4 of the Preliminary Environmental Information Report (PEIR) (Stantec, 2021) and is detailed in Table 5.1. The receptor for all potential sources of contamination is groundwater.

5.1 Road drainage

The impact assessment has determined that, without mitigation, the road drainage has the potential to cause a significant impact (Moderate, Large or Very Large) on the groundwater receptor. To mitigate against the potential impacts, a DQRA will be undertaken to investigate the impact of the EBDs on the groundwater quality. This involves modelling of the EDBs following the EA Remedial Targets Methodology (RTM) approach. The findings of this modelling are provided in Section 6.3.

5.2 Filled areas

Soil samples from the Application Area were subject to geoenvironmental testing as detailed in the **Geotechnical Interpretation Report** **(Document Reference 7.11)**. A comparison was made of the results to Generic Assessment Criteria which showed that the soils would not pose a hazard to human health. Water samples were also subject to testing. The water samples would contain any contaminants that have leached from the soils and are detailed in Section 3.4.6. These results were compared to EQS and DWS limits as part of a controlled waters risk assessment in **Chapter 9: Geology and Soils** **(Document Reference 6.1)** which concluded that the risk to controlled waters was low.

Table 5.1 Summary of impacts

Source of Impact	Receptor	Pathways	Magnitude of impact	Value (sensitivity) of receptor/ resource	Potential degree of impact	Potential degree of impact following further assessment
Unlined EDBs 2, 3B & 3C	Groundwater	Unsaturated zone / saturated zone	Moderate (HEWRAT assessment is medium / high)	High	Moderate or Large	Yes – EBDs (the embedded mitigation) will prevent infiltration of solids and will sorb some contaminants. Further sorption and attenuation will occur in the unsaturated zone. It is demonstrated in the DQRA detailed in the next section that impacts are minor.
Unlined EDBs 5 & 6	Groundwater	Unsaturated zone / saturated zone	Predominantly receive runoff from rural catchments to east of Application Area. – Negligible	High	Slight	N/A
Fill areas	Groundwater	Unsaturated zone / saturated zone	Soil and water testing on samples has shown no risk to human health or controlled waters. Negligible	High	Slight	N/A
Old petrol station	Groundwater	Unsaturated zone / saturated zone	Negligible	High	Slight	Investigation to determine if any tanks or residual contaminants in the ground
Operational petrol stations	Groundwater	Unsaturated zone / saturated zone	Negligible as any issues would be rapidly identified and remediated by petrol station operator	High	Slight	N/A

Source of Impact	Receptor	Pathways	Magnitude of impact	Value (sensitivity) of receptor/ resource	Potential degree of impact	Potential degree of impact following further assessment
Historical land contamination	Groundwater	Unsaturated zone / saturated zone	Negligible as assessed by Controlled Waters Risk Assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)**	High	Slight	N/A
Historical pollution events	Groundwater	Unsaturated zone / saturated zone	Negligible as short-lived events unlikely to cause gross contamination of groundwater	High	Slight	N/A

6 Detailed Quantitative Risk Assessment for EDBs

6.1 Introduction

Section 5 has identified a potential impact from the un-lined EDBs No's 2, 3B and 3C. The EDBs have been subject to a HEWRAT screening assessment. The results of the screening assessment are that all but one of the currently proposed EDBs have a 'medium risk' to groundwater and one has a high risk.

In accordance with the National Highways methodology these have been taken forward to a DQRA in order to provide a more robust assessment of the risk to the Chalk groundwater from these potential sources of contamination.

The DQRA follows the Remedial Targets Methodology (RTM) (Environment Agency, 2006). A Level 1 and Level 2 Assessment has been undertaken.

A Level 1 Assessment considers processes within the source term. For the acute source term, there is no process operating within the source term and the predicted concentrations will equal the source term concentrations. For the chronic source term, partitioning of the contaminants between soil and aqueous phase within the source term is taken into account and the estimated aqueous concentration is limited by the contaminants pure phase solubility.

A Level 2 Assessment considers attenuation processes within the unsaturated zone and dilution within the saturated zone. The input to the RTM is source concentrations for acute and chronic risk based on HEWRAT Step 2 output (i.e. representative concentrations within the EDBs). The output from the model is predicted concentrations at the identified groundwater receptors. These predicted concentrations are compared to receptor Target Concentrations. If the predicted concentration is lower than the Target Concentration, we conclude that the EDBs do not pose a risk to groundwater. Conversely, if they are higher, we conclude that they may pose a risk.

Modelling is undertaken using Stantec's (formally ESI) Risk Assessment Model (RAM) software (ESI, 2008). Electronic copies of the models are given in Appendix E.

The RAM software package, together with a number of groundwater risk assessment tools, has been benchmarked by ESI for the EA (ESI, 2001). Additionally, the equations used in RAM have been verified by comparison between direct evaluation of an analytical solution and the semi-analytic transform approach applied for more complex pathways, and by comparison with published solutions used for verification as part of the nuclear waste industry code comparison exercise INTRACOIN (Robinson & Hodgkinson, 1996).

6.2 Model Parameterisation

In the model, it is conservatively assumed that the EDBs are saturated for 50% of the year i.e. that the EDBs contain water for 6 months in each year and are dry of 6 months. During periods when the EDBs are saturated, the infiltration rate is limited to the maximum infiltration rate of the receiving strata. For the remaining 6 months of the year, it is assumed that there is no infiltration. The maximum infiltration rates are presented in Table 6.1 and these rates are multiplied by 0.5 in the model to derive a conservatively appropriate annual average infiltration rate.

Table 6.1 Infiltration rates

Basin	Underlying geology	Infiltration rate into top of unsaturated zone (m/s)	Justification for infiltration rate
2	Alluvium, structured chalk,	1 x 10^{-6}	Calculated infiltration rate from Geotechnical Interpretation Report **(Document Reference 7.11)** for sediments
3B	Made Ground and head (base not penetrated)	1 x 10^{-6}	
3C	Made Ground, alluvium, structureless chalk and structured chalk.	1 x 10^{-6}	

The source geometry for each of the EDBs is given in Table 6.2. The area and width perpendicular to groundwater flow has been measured from GIS. The length is then obtained by dividing the width into the area. A sediment thickness of 1 m is assigned in order to estimate a volume.

Table 6.2 Source geometry

EDB	Parameter	Values	Units	Justification
All	Thickness	1	m	Parameter not used in model as a constant source (rather than declining source) assumed
2	Area	1351	m^2	Measured from GIS
	Width	55	m	Indicative measured width perpendicular to groundwater flow from plans (assumed to be rectangular in model)
	Length	24.6	m	Calculated from area divided by the width
3B	Area	2,046	m^2	Measured from GIS
	Width	93	m	Indicative measured width perpendicular to groundwater flow from plans (assumed to be rectangular in model)
	Length	22	m	Calculated from area divided by the width
3C	Area	4,205	m^2	Measured from GIS

EDB	Parameter	Values	Units	Justification
	Width	150	m	Indicative measured width perpendicular to groundwater flow from plans (assumed to be rectangular in model)
	Length	28	m	Calculated from area divided by the width

Chronic source term concentrations are taken from the HEWRAT Step 2 output (i.e. representative concentrations within the EDBs) (Table 6.3). These represent soil concentrations within the sediments at the base of the EDBs. Following the RTM methodology, these are converted into aqueous concentrations on the basis of partitioning coefficients for solid and aqueous phases (Table 6.5) and the resulting aqueous concentration is limited by the contaminant solubility (Table 6.6). Acute source term concentrations are taken directly from HEWRAT Step 2 output (Table 6.4).

The attenuation parameters (Table 6.5) are also assigned for sorption within the unsaturated zone.

Table 6.3 Chronic Source terms (from HEWRAT)

	Sediment concentrations from HEWRAT assessment – 95th percentile (mg/kg)						
EDB	Copper	Zinc	Cadmium	Pyrene	Fluoranthene	Anthracene	Phenanthrene
2	968	3569	2	9.729	9.335	0.596	2.632
3B	1875	7101	3	9.729	9.335	0.596	2.632
3C	1875	7101	3	9.729	9.335	0.596	2.632

Table 6.4 Acute source term concentrations (from HEWRAT – 95th percentile (mg/l))

EDB	Copper	Zinc
2	0.069	0.255
3B	0.145	0.797
3C	0.145	0.797

Table 6.5 Attenuation parameters

Determinand	Parameter	Value	Units	Justification
Copper	Partition coefficient (Kd)	13,770	l/Kg	Mid-point of LandSim help
	Half life	No decay		-
Zinc	Partition coefficient (Kd)	301	l/Kg	Mid-point of LandSim help
	Half life	No decay		-
Cadmium	Partition coefficient (Kd)	751	l/Kg	Mid-point of LandSim help

Determinand	Parameter	Value	Units	Justification
	Half life	No decay		-
Pyrene	Partition coefficient (Koc)	6.8×10^4	l/Kg	USEPA (1999)
	Half life	1,925	days	Longest half life in Dallas et al (1999)
Fluoranthene	Partition coefficient (Koc)	4.91×10^4	l/Kg	USEPA (1999)
	Half life	462	days	Longest half life in Dallas et al (1999)
Anthracene	Partition coefficient (Koc)	2.35×10^4	l/Kg	USEPA (1999)
	Half life	365	days	Abiotic degradation rate Verschueren (2001)
Phenanthrene	Partition coefficient (Koc)	2.09×10^4	l/Kg	USEPA (1999)
	Half life	730	days	Abiotic degradation rate Verschueren (2001)

Table 6.6 Solubility parameters

Determinand	Solubility (mg/l)	Unit	Justification
Copper	2.93×10^5	mg/l	ConSim
Zinc	6.06×10^5	mg/l	ConSim
Cadmium	6.51×10^5	mg/l	ConSim
Pyrene	0.137	mg/l	USEPA (1999)
Fluoranthene	0.232	mg/l	USEPA (1999)
Anthracene	0.0537	mg/l	USEPA (1999)
Phenanthrene	1.28	mg/l	USEPA (1999)

The Target Concentrations are defined as follows (Table 6.7):

- Hazardous substances: UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided (UKTAG, 2016).
- Non-hazardous pollutants: UK DWS taken from the 2016 Regulations, or 1989 Regulations as detailed in Table 6.7.

Table 6.7 Target concentrations

Parameter	Value	Units	Justification
Copper	2	mg/l	Non-hazardous pollutant. The Water Supply (Water Quality) Regulations 2016
Zinc	5	mg/l	Non-hazardous pollutant. Water Supply (Water Quality Regulations) 1989
Cadmium	5×10^{-3}	mg/l	Non-hazardous pollutant. The Water Supply (Water Quality) Regulations 2016
Pyrene	5×10^{-6}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided for benzo(a)pyrene.
Fluoranthene	5×10^{-5}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided for benzo(a)pyrene.
Anthracene	5×10^{-5}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided.
Phenanthrene	5×10^{-8}	mg/l	Hazardous substance. UKTAG Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided for benzo(a)pyrene.

Hydrogeological parameters are presented in Table 6.8. The Structured Chalk hydraulic conductivity and hydraulic gradient are used, along with the cross-sectional area, to calculate the groundwater flux. The groundwater flux is used to dilute non-hazardous pollutants.

The hydraulic conductivity of the fissured Chalk is likely to be significantly higher than the value of 1×10^{-5} m/s assigned in Table 6.8 and, based on the data presented in Section 3.4.3, a value of between 1×10^{-5} m/s and 1×10^{-3} m/s may be more plausible. However, by using the value at the lower end of the plausible range, a conservative estimate for dilution is derived.

The effective porosity of the saturated zone is used to estimate travel times. For a Level 2 assessment only dilution is considered in the saturated zone, not attenuation, and so the travel time is for information only.

Table 6.8 Hydrogeology parameters

Parameter		Value	Unit	Justification
Hydraulic conductivity of Structured Chalk (saturated zone)		1 x 10^{-5}	m/s	Calculated infiltration rate from Geotechnical Interpretation Report **(Document Reference 7.11)**.
Hydraulic gradient		0.0076	-	Based on topography in the area around the EDBs. From Lidar data
Effective porosity of aquifer	Unsaturated zone	0.1		Conservative assumption
	Saturated zone	0.01		Conservative assumption to ensure rapid travel time within fissured strata.
Unsaturated zone thickness	EDB 1	7.1	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
	EDB 2	13.1	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
	EDB 3B	5.8	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
	EDB 3C	3.8	m	Based on average groundwater levels (see Table 3.10) and average elevation of EDB location
Fraction of organic carbon – alluvial deposits		0.01	-	Assumption of 1%
Fraction of organic carbon – structureless Chalk deposits		0.001	-	Chalk has little organic carbon, so assigned 0.1%.
Unsaturated zone bulk density		2,385	kg/m^3	Estimated based on particle density of 2,650 and porosity of 0.1 (Freeze & Cherry, 1979)
Mixing depth		5	m	10 % of the travel distance (50 m)

6.3 Model Results

6.3.1 Level 1 Assessment

As detailed in Section 6.1, a Level 1 assessment considers processes operating within the source term.

6.3.1.1 Acute pollution from soluble contaminants

There are no processes operating in the source term for the acute source term. In this case an aqueous source term is considered, and these concentrations are compared directly with the Target Concentrations. The model has been run for EDBs 3B and 3C which have the highest source term concentrations. The predicted concentrations given in Table 6.9 are the same as the source term concentrations given in Table 6.4. These concentrations are lower than the target concentrations given in Table 6.7. Thus, we conclude that the risk to groundwater from acute pollution within the EDBs is not significant.

Table 6.9 EDB2 Predicted concentrations (mg/l)

Copper	Zinc
1.450E-01	7.970E-01

Note blue cells below Target concentration, red cells above target concentration

6.3.1.2 Chronic pollution from sediments

For the chronic source term, following partitioning between the solid and aqueous phases within the EDB sediment, and limited by the pure phase solubility, Table 6.10 shows that there is a predicted impact from zinc and all four PAH compounds. These determinands are therefore taken forward to the Level 2 assessment.

Table 6.10 EDB2 Predicted concentrations (mg/l)

Copper	Zinc	Cadmium	Pyrene	Fluoranthene	Anthracene	Phenanthrene
1.362E-01	2.359E+01	3.994E-03	1.431E-02	1.901E-02	2.536E-03	1.259E-02

Note blue cells below Target concentration, red cells above target concentration

6.3.2 Level 2 Assessment – chronic pollution

6.3.2.1 EDB 2

EDB 2 is located on alluvium overlying structured Chalk and it is estimated that the unsaturated zone thickness at this location is 13.1 m. The model predicts that no hazardous substances would be predicted to reach the watertable at concentrations in excess of the Target Concentration and that there is no pollution by non-hazardous pollutants within 100 years (Table 6.11).

Table 6.11 EDB2 Predicted concentrations (mg/l)

Time(years)	Zinc	Pyrene	Fluoranthene	Anthracene	Phenanthrene
0.1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
100	2.134E-03	1.202E-21	4.616E-32	6.259E-26	4.661E-17

Note blue cells below Target concentration, red cells above target concentration

6.3.2.2 EDB 3B

EDB 3B is located on Made Ground and Head deposits and it is estimated that the unsaturated zone thickness at this location is 5.8 m. The model predicts that no hazardous substances would be predicted to reach the watertable at concentrations in excess of the Target Concentration and that there is no pollution by non-hazardous pollutants within 100 years (Table 6.12).

Table 6.12 EDB3B Predicted concentrations (mg/l)

Time(years)	Zinc	Pyrene	Fluoranthene	Anthracene	Phenanthrene
0.1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10	4.616E-27	0.000E+00	0.000E+00	1.187E-27	5.555E-23
100	4.206E-01	4.070E-13	1.730E-21	1.019E-17	1.276E-11

Note blue cells below Target concentration, red cells above target concentration

6.3.2.3 EDB 3C

EDB 3C is located on Made Ground, Alluvium and Structureless Chalk deposits and it is estimated that the unsaturated zone thickness at this location is 3.8 m. The model predicts that no hazardous substances would be predicted to reach the watertable at concentrations in excess of the Target Concentration and that there is no pollution by non-hazardous pollutants within 100 years (Table 6.13).

Table 6.13 EDB3C Predicted concentrations (mg/l)

Time(years)	Zinc	Pyrene	Fluoranthene	Anthracene	Phenanthrene
0.1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10	4.103E-17	0.000E+00	1.766E-34	7.760E-20	4.866E-16
100	3.338E+00	1.448E-10	1.711E-17	1.274E-14	1.393E-09

Note blue cells below Target concentration, red cells above target concentration

6.3.3 Sensitivity analysis

In order to demonstrate model sensitivity to key parameters, the EDB 3B base case model has been selected. We note that similar relative changes in predicted concentrations would be found for all the models and thus it is only necessary to run sensitivity analysis on one of the EDB models.

6.3.3.1 Fraction of organic carbon

The fraction of organic carbon is decreased by an order of magnitude from 0.01 to 0.001. The effect of this is to decrease retardation of organic compounds in the unsaturated zone by an order of magnitude, which allows less time for degradation to occur. Model results (Table 6.14) show that decreasing the fraction of organic carbon results in predicted concentrations rising by many orders of magnitude which demonstrates that the model is sensitive to this parameter. Pyrene and phenanthrene concentrations are predicted to be higher than the Target Concentration. Note that metals are not assessed as the model does not use fraction of organic carbon to estimate metal retardation rates.

Table 6.14 Sensitivity run 1: fraction of organic carbon (mg/l) at 100 years

	Target concentration	0.01 (base case)	0.001 (sens run 1)
Pyrene	5.000E-06	4.070E-13	**8.102E-05**
Fluoranthene	5.000E-05	1.730E-21	2.697E-07
Anthracene	5.000E-05	1.019E-17	8.754E-07
Phenanthrene	5.000E-06	1.276E-11	**1.517E-04**

Concentrations given in bold exceed the Target Concentration

6.3.3.2 Infiltration rate

In the base case model, the superficial strata hydraulic conductivity is assumed to be limiting the infiltration rate when the EDBs are full of water, and it is further considered that the EDBs are full of water for 50% of each year. For this sensitivity run, it is assumed that the EDBs are full of water for 100% of the year i.e. the infiltration rate is solely limited by the unsaturated zone hydraulic conductivity.

Model results (Table 6.15) shows that increasing the infiltration rate increases predicted concentrations. The reason for this is twofold. Firstly, for hazardous substances, the contaminants spend a shorter period within the unsaturated zone where they degrade. The retarded travel time non-hazardous pollutants through the unsaturated zone is decreased.

Secondly, for non-hazardous pollutants, the greater flux through the unsaturated zone results in a decrease in dilution applied at the watertable.

The results show that the PAH compounds remain well below the Target Concentrations, but zinc is predicted to slightly exceed it.

Table 6.15 Sensitivity run 2a: infiltration rate and unsaturated zone hydraulic conductivity (mg/l) at 100 years

	Target concentration	50% (base case)	100% (sens run 2a)
Zinc	5.000E+00	4.206E-01	**7.894E+00**
Pyrene	5.000E-06	4.070E-13	2.678E-09
Fluoranthene	5.000E-05	1.730E-21	2.359E-15
Anthracene	5.000E-05	1.019E-17	5.761E-13
Phenanthrene	5.000E-06	1.276E-11	1.691E-08

Concentrations given in bold exceed the Target Concentration

6.3.3.3 Unsaturated zone thickness

For EDB 3B, the unsaturated zone has been estimated at 5.8 m thick. For this sensitivity run, the unsaturated zone thickness has been increased by 5 m to 10.8 m.

Model results (Table 6.16) show a decrease in concentrations for all contaminants. This is due to the longer travel time within the unsaturated zone pathway segment resulting in longer breakthrough times. We note that the maximum concentration (at any time) for the PAH compounds is reduced as the longer time spent in the unsaturated zone provides more time for degradation. For zinc, however, which does not degrade, breakthrough would eventually occur to the same concentrations as in the base case model.

Table 6.16 Sensitivity run 3: unsaturated zone thickness (mg/l) at 100 years

	Target concentration	5.8 m (base case)	10.8 m (sens run 3)
Zinc	5.000E+00	4.206E-01	1.535E-03
Pyrene	5.000E-06	4.070E-13	5.244E-19
Fluoranthene	5.000E-05	1.730E-21	3.758E-29
Anthracene	5.000E-05	1.019E-17	1.144E-23
Phenanthrene	5.000E-06	1.276E-11	1.475E-15

7 Conclusions and recommendations

7.1 Conclusions

There are a number of potential sources of contamination within and adjacent to the Application Area. These include landfills, a former gasworks and ironworks, petrol stations, railways and land with mixed industrial uses. On the basis of the soil and water quality data obtained to date by the Scheme, these potential sources have been assessed as detailed in a Controlled Waters Risk Assessment in **Chapter 9: Geology and Soils (Document Reference 6.1)** and it was concluded that the potential for significant contamination to groundwater from these sources is low.

Some material will need to be excavated as part of the Scheme. It is envisaged that all this material will be used to raise levels along the eastern side of the Application Area and that there will be no surplus material from the Scheme.

GI has shown that there is a significant quantity of Made Ground within the Application Area, which is probably associated with previous road scheme construction.

On the basis of the soil and water quality data obtained to date by the Scheme, it is considered unlikely that placement of excavated material to raise levels will result in significant mobilisation of contamination. Thus, whilst no significant risk to human health or controlled waters is currently assessed for the in-situ materials, it is also considered that there will be no significant risk following excavation and placement.

The most significant risk to groundwater from the Scheme is considered to be the road drainage. Considerable thought has been put into designing an upgraded road drainage system, with as much drainage as possible captured and discharged to the EDBs. Where levels permit, discharge is routed first to a lined EDB for initial settlement and attenuation of contaminants, followed by discharge to un-lined and vegetated EDBs for further attenuation. Whilst the un-lined EDBs are designed to drain to ground, it is expected that a significant proportion of the discharge following storm events will be routed to the River Itchen.

A HEWRAT assessment has been undertaken for each of the EDBs. The results of the screening assessment show that all but one of the currently proposed Extended Detention Basins (EDT) have a ‘medium risk’ to groundwater and one has a high risk. In order to mitigate against the high risk EDB, it is proposed that this EDB will be lined, thus preventing discharge to groundwater. On this basis a DQRA has been undertaken to further assess the risk from the un-lined EDBs.

Acute risk from soluble contaminants present in the EDBs has been assessed as low. The contaminant concentrations in the EDBs, as derived from the HEWRAT assessment are below the UK DWS and thus pose no significant risk to groundwater.

The models demonstrate that none of the EDBs are likely to result in an impact on groundwater from determinands present within the sediment lining the base of the EDBs (chronic risk).

For the hazardous PAH compounds, the aqueous source term concentration leached from the EDB sediments is limited by the determinand pure phase solubility and the fact that these determinands are highly sorbed onto the sediment matrix. Thus, concentrations leaching from the sediment are modest. The model shows that there is likely to be a sufficient thickness of unsaturated zone, comprising material containing sufficient organic carbon, to provide sufficient attenuation and ensure that there is no discharge to the watertable.

Copper and cadmium also sorb highly to the EDB sediment such that aqueous concentrations in the EDBs are unlikely to reach concentrations that would cause pollution of groundwater. Predicted aqueous source term zinc concentrations are higher, but attenuation within the unsaturated zone, combined with dilution in the receiving groundwater is sufficient to ensure there is no pollution by this determinand.

Sensitivity analysis has been undertaken of the DQRA models. These show that the models are sensitive to the faction of organic carbon (for organic compounds), infiltration rate and unsaturated zone thickness. Further data on these parameters should be collected as detailed in the next section.

7.2 Recommendations

Stantec has proposed additional GI at each of the EDBs. Geological data obtained from this GI will provide a better understanding of the superficial strata likely to underlie each of these structures. Once these data are available, the HgRA should be reviewed and updated based on the complete dataset.

A number of the boreholes will be completed as groundwater monitoring wells. Timeseries monitoring data will provide more confidence on the unsaturated zone thickness at each of these structures.

It is proposed to undertake soakaway tests at the proposed EDB locations. This will inform the understanding of the unsaturated zone hydraulic conductivity.

It is recommended that soil samples are taken from each of the strata encountered and subject to laboratory testing for fraction of organic carbon. These data can then be used to refine the DQRA model and inform predictions of the risk to groundwater from the Scheme’s drainage design.

8 References

Allen, D. J., Brewerton, L. J., Coleby, L. M., Gibbs, B. R., Lewis, M. A., MacDonald, A. M., & Williams, A. T. (1997). *The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34.*

Booth, K., Farrant, A. R., Hopson, P. M., Woods, M. A., Evans, D. J., & Wilskinson, I. (2008). *Geology of the Winchester district. Sheet description of the British Geological Survey, 1:50 000 Series Sheet 299 (England and Wales).*

British Geological Survey. (2002). *Winchester. England and Wales Sheet 299. Solid and Drift Geology. 1:50 000. (Keyworth, Nottingham: British Geology Survey).*

CIRIA. (2021). *Contaminated Land Risk Assessment. A Guide to Good Practice.*

Entec. (2002). *River Itchen Catchment Groundwater Modelling Study Phase 2.*

Envirocheck. (2016). *Envirocheck Report, Site at Winnall Down Farm HampshireOrder Number 85178192_1_1 fo WSP.*

Environment Agency. (2006). *Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.*

Environment Agency. (2018). *The Environment Agency's approach to groundwater protection V1.2.*

Environment Agency. (2019). *Guidance Groundwater source protection zones (SPZs)*. Retrieved August 2021, from https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs

Environment Agency. (2021). *https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm*.

ESI. (2001). *Benchmarking RAM: ESI'S Groundwater Risk Assessment Tool. Report Reference 5303R1D1.*

ESI. (2008). *RAM 3 User Guide.*

Freeze, R. A., & Cherry, J. A. (1979). *Groundwater.* Prentice-Hall.

Highways England. (2015). *HEWRAT V2.0 Help guide.*

Institute of Geological Sciences and Southern Water Authority. (1979). *Hydrogeological map of Hampshire and the Isle of Wight, Scale 1:100 000.*

NRFA. (2021). *42016 - Itchen at Easton*. Retrieved August 2021, from https://nrfa.ceh.ac.uk/data/station/spatial/42016

Reading Agricultural Consultants. (2021). *Agricultural Land Classification and Soil Resources at M3 Junction 9 Winchester.* For Stantec UK Limited.

Robinson, P. C., & Hodgkinson, D. P. (1996). *Exact solutions for radionuclide transport in the presence of parameter uncertainty.* Technical Report AERE R 12125. Harwell Laboratory, Oxfordshire.

Stantec. (2021). *M3 Junction 9 improvement scheme - Preliminary Environmental Information Report (PEIR).*

UKTAG. (2016). *UK Technical Advisory Group on the Water Framework Directive: Technical report on Groundwater Hazardous Substances.*

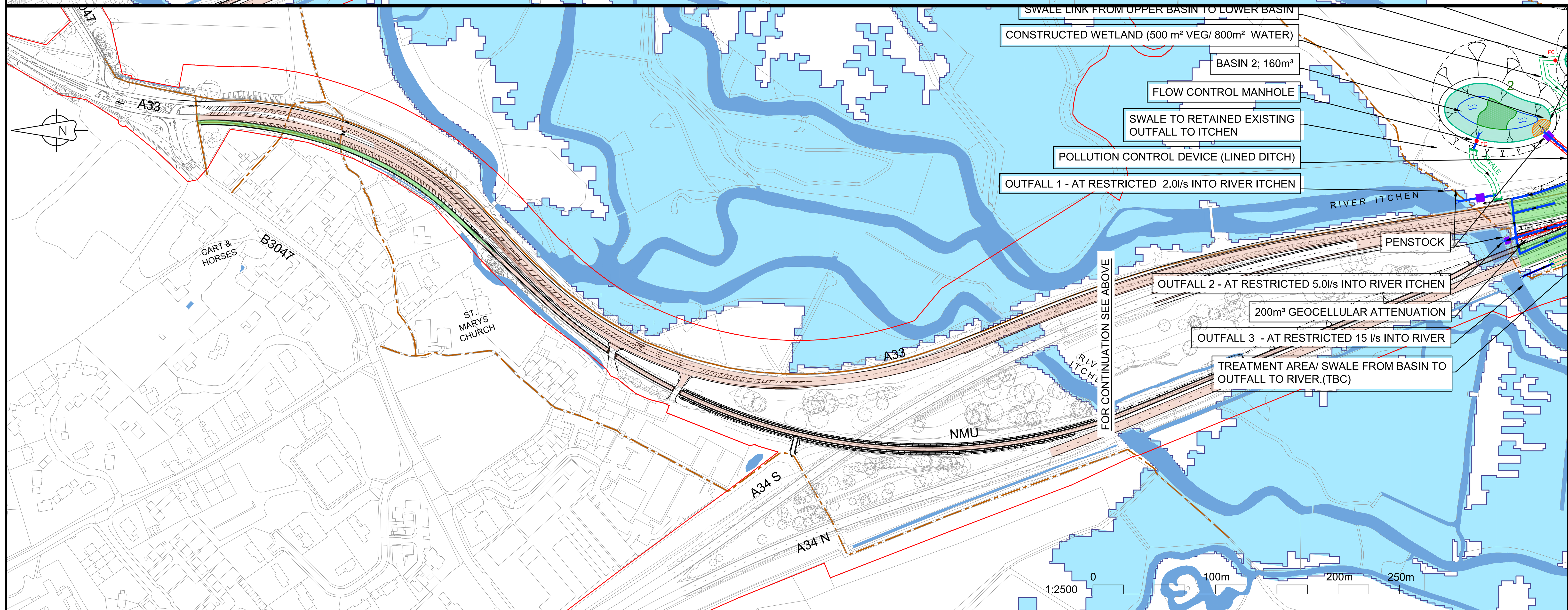
WPK. (2007). *Wastewater discharges to ground Morestead Road Wastewater Treatment Works Groundwater Investigations - Interpretative Report prepared for Southern Water.*

WSP. (2017). *Preliminary Sources Study Report.*

APPENDICES

Appendix A

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512_Drainage Schematic Plan



KEY:

- INDICATIVE APPLICATION BOUNDARY
- EXISTING FOOTPATH
- PROPOSED HIGHWAY DRAINAGE NETWORK
- RETAINED EXISTING DRAINAGE
- RIVER ITCHEN
- EA FLOOD ZONE 3 EXTENT
- GEOCELLULAR ATTENUATION
- SA1 - GEOCELLULAR SOAKAWAY
- 1 INFILTRATION BASIN AND REFERENCE
- NEW CARRIAGEWAY
- RETAINED EXISTING CARRIAGEWAY AND DRAINAGE FEATURES
- PROPOSED SMART MOTORWAYS SCHEME TO BE CONSTRUCTED PRIOR TO JUNCTION 9 IMPROVEMENTS SCHEME
- PROPOSED PENSTOCK
- PROPOSED SEDIMENT FOREBAY
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED
- TSC TRASH SCREEN CHAMBER
- FC FLOW CONTROL MANHOLE
- GRASSED BASINS (ALL GRASSED EXCEPT BASIN 2 AND 3C)

Notes:

1. Scheme is subject to Preliminary Design at stage 3 and subject to change pending design development.
2. For existing drainage network refer to drawings HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0507 to 0511
3. For detail of Smart Motorway drainage design refer to SMP drawings HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007
4. Proposed scheme shown is subject to reviews with the respective Highway Authorities, Lead Local Flood Authority and the Environment Agency.
5. Suitability of re-use of existing drainage assets is subject to review of survey, asset records and site verification.
6. Drawing to be read in conjunction with Pollution Prevention Technical Note ref: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003.

Rev.	Date	Description	Drawn	Chk'd	App'd
P01		FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE SCHEMATIC PLAN

DRAFT

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: A1	Date: 05.02.21	Date: 05.02.21	Date: 05.02.21	Date: 05.02.21

Drawing Number: HE PIN / Originator / Volume / Location / Type / Role / Number
HE551511 - VFK -HDG- X-XXXX-XX - DR - CD - 0512

Project Ref. No.: 48176

Revision: P01

Appendix B

HEWRAT screening assessments

Runoff to Watercourses — **Basin 1 HEWRAT**

EQS - Annual Average Concentration	Copper	Zinc	
Step 2	0.00	0.00	ug/l
Step 3	0.00	0.00	ug/l

Acute Impact	Copper	Zinc
	Pass	Pass

Alert. Protected Area.

Sediment deposition for this site is judged as:

Accumulating?	No	0.14	Low flow Vel m/s
Extensive?	No	-	Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality AADT >10,000 and <50,000 Climatic region Warm Wet Rainfall site Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	0.445
Permeable area draining to outfall (ha)	0.179
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1	D
Bioavailable dissolved zinc (μg/l)	10.9	D

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0 D

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07 D; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)		Attenuation for solubles - restricted discharge rate (l/s)		Settlement of sediments (%)	
Existing measures		0	D	No restriction	D	0	D
Proposed measures		50		No restriction	D	50	

(Estimated effectiveness)

Basin 1 HEWRAT Infiltration to Groundwater — **Basin 1 HEWRAT**

highways england — Reset GW Assessment — Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Runoff to Watercourses — **Basin 1 HEWRAT**

DETALED RESULTS

Back To Top — Go To Interface

Summary of predictions

Soluble – Acute Impact / Sediment – Chronic Impact

Prediction of impact: Step1, Step2, Step3 (Copper, Zinc; Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene)

In Runoff — Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	67.90	62.20
No. of exceedances/worst year	89	75

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	21.70	25.30
No. of exceedances/worst year	28	29

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	27.32	84.71
	90%ile	52.94	172.88
	95%ile	68.76	255.14
	99%ile	113.86	446.19

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	75.30	98.00	1.50	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	99	120	4	25	71	25	22	39
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	349	1168	1	11065	1914	1837	117	518
90%ile	786	2781	1	28184	4876	4679	299	1319
95%ile	968	3569	2	56234	9729	9335	596	2632
99%ile	1501	5477	4	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	0.00	0.00
	90%ile	0.00	0.00
	95%ile	0.00	0.01
	99%ile	0.01	0.02

Velocity 0.14 m/s — Tier 2 is used for the calculation

DI -

Minimum % settlement needed - %

In River (with mitigation) — Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI -

Basin 1 HEWRAT Spillage Risks — **Basin 1 HEWRAT**

highways england — View Parameters — Reset Spillage Risk — Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,000							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	16,731							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.00283	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00170	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00170	0.00000	0.00000	0.00000	0.00000	0.00000	0.0017	589
D14	Existing measures factor	0.7							
D15	Return period with existing pollution reduction	0.00119	0.00000	0.00000	0.00000	0.00000	0.00000	0.0012	841
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00071	0.00000	0.00000	0.00000	0.00000	0.00000	0.0007	1402

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

highways england

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

Soluble						Sediment – Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.00	ug/l	Pass	Pass	Accumulating? No 0.14 Low flow Vel m/s
Step 3	0.00	0.00	ug/l			Extensive? No - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >10,000 and <50,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6	Freshwater EQS limits:		
Impermeable road area drained (ha)	1.24	Bioavailable dissolved copper (µg/l)	1	D
Permeable area draining to outfall (ha)	0.595	Bioavailable dissolved zinc (µg/l)	10.9	D
Base Flow Index (BFI)	0.89	Is the discharge in or within 1 km upstream of a protected site for conservation?	Yes	

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0 D

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 — Manning's n: 0.07 D — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)		Attenuation for solubles - restricted discharge rate (l/s)		Settlement of sediments (%)	
Existing measures		0	D	No restriction	D	0	D
Proposed measures		50		No restriction	D	50	

highways england — Reset GW Assessment — Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <=5 m	3	60
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	190
RISK SCREENING LEVEL	Medium

DETAILED RESULTS

Back To Top — Go To Interface

In Runoff

Step 1 (RST24)

	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	67.90	62.20
No. of exceedances/worst year	89	75

Step 1 (RST6)

	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	21.70	25.30
No. of exceedances/worst year	28	23

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	27.32	84.71
	90%ile	52.94	172.88
	95%ile	68.76	255.14
	99%ile	113.86	446.19

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	75.30	98.00	1.50	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	99	120	4	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	349	1168	1	11065	1914	1837	117	518
90%ile	786	2781	1	28184	4876	4679	299	1319
95%ile	968	3569	2	56234	9729	9335	596	2632
99%ile	1501	5477	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2 (RST24)

	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

Step 2 (RST6)

	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	0.00	0.00
	90%ile	0.00	0.01
	95%ile	0.01	0.02
	99%ile	0.02	0.07

Step 2: Velocity 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation)

Step 3 (RST24)

	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

Step 3 (RST6)

	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds resholds	RST24	21	92
Thresholds	RST6	42	184

DI: -

highways england — View Parameters — Reset Spillage Risk — Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,000							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	> 1 hour							
D7	Traffic flow (AADT two way)	50,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.00846	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.75							
D11	Risk of pollution incident	0.00634	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00634	0.00000	0.00000	0.00000	0.00000	0.00000	0.0063	158
D14	Existing measures factor	0.7							
D15	Return period with existing pollution reduction	0.00444	0.00000	0.00000	0.00000	0.00000	0.00000	0.0044	225
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00266	0.00000	0.00000	0.00000	0.00000	0.00000	0.0027	375

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Runoff to Watercourses — Basin 3A HEWRAT

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

Soluble						Sediment – Chronic Impact
EQS - Annual Average Concentration	Copper	Zinc		Acute Impact: Copper	Acute Impact: Zinc	Alert. Protected Area.
Step 2	0.00	0.02	ug/l	Pass	Pass	Sediment deposition for this site is judged as:
Step 3	0.00	0.01	ug/l			Accumulating? No — 0.14 Low flow Vel m/s
						Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality — AADT: >=100,000; Climatic region: Warm Wet; Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

- Annual Q_{95} river flow (m^3/s): 2.6
- Impermeable road area drained (ha): 5.856
- Permeable area draining to outfall (ha): 0.435
- Base Flow Index (BFI): 0.89
- Freshwater EQS limits: Bioavailable dissolved copper (μg/l): 1 D; Bioavailable dissolved zinc (μg/l): 10.9 D
- Is the discharge in or within 1 km upstream of a protected site for conservation? Yes
- For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l
- For dissolved copper only — Ambient background concentration (μg/l): 0 D
- For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D
- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07 D; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Basin 3A HEWRAT Infiltration to Groundwater — Basin 3A HEWRAT

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <=5 m	3	60
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	260
RISK SCREENING LEVEL	High

Runoff to Watercourses — Basin 3A HEWRAT

DETALED RESULTS

Back To Top | Go To Interface

Summary of predictions

Prediction of impact (Step1, Step2, Step3): Soluble – Acute Impact (Copper, Zinc); Sediment – Chronic Impact (Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene)

In Runoff — Step 1

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	111.10	115.70
No. of exceedances/worst year	134	143
RST6 Allowable Exceedances/year	1	1
No. of exceedances/year	70.70	89.80
No. of exceedances/worst year	91	113
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	113.50	124.90	6.30	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Toxicity	197 (mg/kg)	315 (mg/kg)	3.5 (mg/kg)	16770 (ug/kg)	875 (ug/kg)	2355 (ug/kg)	245 (ug/kg)	515 (ug/kg)
Mean	766	2676	1	11065	1314	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	0.02	0.07
90%ile	0.04	0.17
95%ile	0.08	0.31
99%ile	0.23	0.99

Step 2: Velocity 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI: -

Basin 3A HEWRAT Spillage Risks — Basin 3A HEWRAT

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	2,250							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	28,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.01066	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00639	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00639	0.00000	0.00000	0.00000	0.00000	0.00000	0.0064	156
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00384	0.00000	0.00000	0.00000	0.00000	0.00000	0.0038	261
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00153	0.00000	0.00000	0.00000	0.00000	0.00000	0.0015	652

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

highways england

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble						Sediment - Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.02	ug/l	Pass	Pass	Accumulating? No 0.14 Low flow Vel m/s
Step 3	0.00	0.01	ug/l			Extensive? No - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality

AADT: >=100,000 | Climatic region: Warm Wet | Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	6.147
Permeable area draining to outfall (ha)	0.685
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

- Bioavailable dissolved copper (μg/l): 1
- Bioavailable dissolved zinc (μg/l): 10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17 | Manning's n: 0.07 | Side slope (m/m): 0.5 | Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions — Soluble - Acute Impact | Sediment - Chronic Impact

Prediction of impact: Step1, Step2, Step3

In Runoff

Step 1

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	111.10	115.70
No. of exceedances/worst year	134	143
RST6 Allowable Exceedances/year	1	1
No. of exceedances/year	70.70	89.80
No. of exceedances/worst year	91	113
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1

Toxicity Threshold	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	113.50	124.90	6.30	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02
Thresholds RST24 (ug/l)	21	92
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	0.02	0.08
90%ile	0.04	0.18
95%ile	0.08	0.32
99%ile	0.25	1.04

Step 2 — Velocity: 0.14 m/s | Tier 2 is used for the calculation | DI: - | Minimum % settlement needed: - %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI: -

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	2,600							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	28,000							
D8	% HGV	15							
D8	Spillage factor *(no/10^9 HGVkm/year)*	3.09							
D9	Risk of accidental spillage	0.01232	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00739	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00739	0.00000	0.00000	0.00000	0.00000	0.00000	0.0074	135
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00443	0.00000	0.00000	0.00000	0.00000	0.00000	0.0044	226
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00177	0.00000	0.00000	0.00000	0.00000	0.00000	0.0018	564

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Runoff to Watercourses — **Basin 3C HEWRAT**

highways england — **Highways England Water Risk Assessment Tool** — Version 2.0.4 June 2019

Soluble					Sediment - Chronic Impact
EQS - Annual Average Concentration				Acute Impact	Alert. Protected Area.
	Copper	Zinc		Copper / Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.02	ug/l	Pass / Pass	Accumulating? No — 0.14 Low flow Vel m/s
Step 3	0.00	0.01	ug/l		Extensive? No — - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality — AADT: >=100,000 — Climatic region: Warm Wet — Rainfall site: Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	2.6
Impermeable road area drained (ha)	7.107
Permeable area draining to outfall (ha)	1.072
Base Flow Index (BFI)	0.89

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (μg/l): 0

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 5

Tier 2 — Bed width (m): 17 — Manning's n: 0.07 — Side slope (m/m): 0.5 — Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		0	No restriction	0
Proposed measures		50	No restriction	50

Basin 3C HEWRAT Infiltration to Groundwater

highways england — Reset GW Assessment — Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

Runoff to Watercourses — **Basin 3C HEWRAT Spillage Risks**

DETAILED RESULTS

Back To Top — Go To Interface

Summary of predictions — Soluble - Acute Impact (Copper, Zinc); Sediment - Chronic Impact (Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene)

Prediction of impact: Step1, Step2, Step3

In Runoff — Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	111.10	115.70
No. of exceedances/worst year	134	143

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	70.70	89.80
No. of exceedances/worst year	91	113

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	113.50	124.90	6.30	17.00	56.00	17.00	14.80	31.10
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Units	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity	197	315	3.5	16770	875	2355	245	515
Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.02

	Copper (ug/l)	Zinc (ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.02	0.09
90%ile	0.04	0.21
95%ile	0.09	0.38
99%ile	0.28	1.20

Step 2 — Velocity: 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation) — Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

DI: -

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

Basin 3C HEWRAT

highways england — View Parameters — Reset Spillage Risk — Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	3,250							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	11							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.83							
D9	Risk of accidental spillage	0.01624	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00974	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00974	0.00000	0.00000	0.00000	0.00000	0.00000	0.0097	103
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00585	0.00000	0.00000	0.00000	0.00000	0.00000	0.0058	171
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00234	0.00000	0.00000	0.00000	0.00000	0.00000	0.0023	428

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages (Billion HGV km/ year)	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

highways england

Highways England Water Risk Assessment Tool

Version 2.0.4 June 2019

	Soluble					Sediment - Chronic Impact
	EQS - Annual Average Concentration			Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.00	0.01	ug/l	Pass	Pass	Accumulating? No 0.14 Low flow Vel m/s
Step 3	0.00	0.01	ug/l			Extensive? No - Deposition Index

Road number		HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting	Northing	
OS grid reference of outfall structure (m)	Easting	Northing	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse			
EA receiving water Detailed River Network ID		Assessor and affiliation	
Date of assessment		Version of assessment	
Notes			

Step 1 Runoff Quality AADT >=100,000 Climatic region Warm Wet Rainfall site Southampton (SAAR 820mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

- Annual Q_{95} river flow (m^3/s): 2.6
- Impermeable road area drained (ha): 4.389
- Permeable area draining to outfall (ha): 0.128
- Base Flow Index (BFI): 0.89

Freshwater EQS limits:
- Bioavailable dissolved copper (µg/l): 1 D
- Bioavailable dissolved zinc (µg/l): 10.9 D

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

For dissolved zinc only — Water hardness: Medium = 50-200 CaCO3/l

For dissolved copper only — Ambient background concentration (µg/l): 0 D

For sediment impact only — Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

- Tier 1 — Estimated river width (m): 5
- Tier 2 (selected) — Bed width (m): 17; Manning's n: 0.07 D; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)		Attenuation for solubles - restricted discharge rate (l/s)		Settlement of sediments (%)	
Existing measures		0	D	No restriction	D	0	D
Proposed measures		50		No restriction	D	50	

DETAILED RESULTS

Back To Top | Go To Interface

Summary of predictions

Soluble - Acute Impact: Copper, Zinc — Sediment - Chronic Impact: Copper, Zinc, Cadmium, Total PAH, Pyrene, Fluoranthene, Anthracene, Phenanthrene

Prediction of impact: Step1, Step2, Step3

In Runoff — Step 1

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	**111.10**	**115.70**
No. of exceedances/worst year	134	143
RST6 Allowable Exceedances/year	1	1
No. of exceedances/year	**70.70**	**89.80**
No. of exceedances/worst year	31	113
Thresholds RST24 (ug/l)	21	32
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	57.52	264.56
90%ile	111.45	539.93
95%ile	144.76	796.85
99%ile	239.71	1393.53

Step 1 — Toxicity Threshold

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	**113.50**	**124.90**	**6.30**	**17.00**	**56.00**	**17.00**	**14.80**	**31.10**
No. of exceedances/worst year	147	152	11	25	71	25	22	39
Toxicity	197 (mg/kg)	315 (mg/kg)	3.5 (mg/kg)	16770 (ug/kg)	875 (ug/kg)	2355 (ug/kg)	245 (ug/kg)	515 (ug/kg)
Event Statistics Mean	766	2676	1	11065	1914	1837	117	518
90%ile	1573	5762	3	28184	4876	4679	299	1319
95%ile	1875	7101	3	56234	9729	9335	596	2632
99%ile	2727	10215	5	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.01
Thresholds RST24 (ug/l)	21	32
Thresholds RST6 (ug/l)	42	184
Event Statistics Mean	0.01	0.05
90%ile	0.03	0.13
95%ile	0.06	0.23
99%ile	0.18	0.75

Step 2: Velocity 0.14 m/s — Tier 2 is used for the calculation

DI: -

Minimum % settlement needed: - %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24 Allowable Exceedances/year	1	1
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6 Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0

DI: -

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	>50 to <150	2	20
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Flow dominated by fractures/ fissures (e.g. well consolidated sedimentary deposits, igneous and metamorphic rocks or unconsolidated deposits of very coarse sand and coarser)	3	60
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	240
RISK SCREENING LEVEL	Medium

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	1,600							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Roundabout							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	10							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00377	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00226	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	No							
D13	Return period without pollution reduction measures	0.00226	0.00000	0.00000	0.00000	0.00000	0.00000	0.0023	443
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00136	0.00000	0.00000	0.00000	0.00000	0.00000	0.0014	738
D16	Proposed measures factor	0.4							
D17	Residual with proposed Pollution reduction measures	0.00054	[illegible]	[illegible]	0.00000	0.00000	0.00000	0.0005	1844

Pollution reduction factor
Use the Indicative Pollution Risk Reduction Factor table below to estimate the factor.

Provide justification for the decision in the appropriate comments box below.

A default value of 1 is used if no measures are considered or if no value is entered.

Justification for choice of existing measures factors

[Justification for c]hoice of proposed measures factors

Spillage Factor

Location	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

highways england

Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>=100,000 AADT	3	30
2	SOURCE	10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3	SOURCE	10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5	PATHWAY	20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6	PATHWAY	20	Flow type (Incorporates flow type an effective grain size)	Mixed fracture and intergranular flow (e.g. consolidated deposits or unconsolidated deposits of medium – coarse sand)	2	40
7	PATHWAY	5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8	PATHWAY	5	Organic Carbon	<=1% SOM	3	15
9	PATHWAY	5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	210
RISK SCREENING LEVEL	Medium

highways england

View Parameters | Reset Spillage Risk | Go To Interface

		A (main road)	B	C	D	E	F	Totals	Return Period
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	500							
D3	Road Type *(A-road or Motorway)*	M							
D4	If A road, is site urban or rural?	Rural							
D5	Junction type	Slip road							
D6	Location (response time for emergency services)	< 1 hour							
D7	Traffic flow (AADT two way)	149,961							
D8	% HGV	11							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.43							
D9	Risk of accidental spillage	0.00129	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.60							
D11	Risk of pollution incident	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000	0.0008	1287
D14	Existing measures factor	0.6							
D15	Return period with existing pollution reduction	0.00047	0.00000	0.00000	0.00000	0.00000	0.00000	0.0005	2146
D16	Proposed measures factor	0.6							
D17	Residual with proposed Pollution reduction measures	0.00028	0.00000	0.00000	0.00000	0.00000	0.00000	0.0003	3576

Justification for choice of existing measures factors

Justification for choice of proposed measures factors

Spillage Factor

	Serious Accidental Spillages *(Billion HGV km/ year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	3.09	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

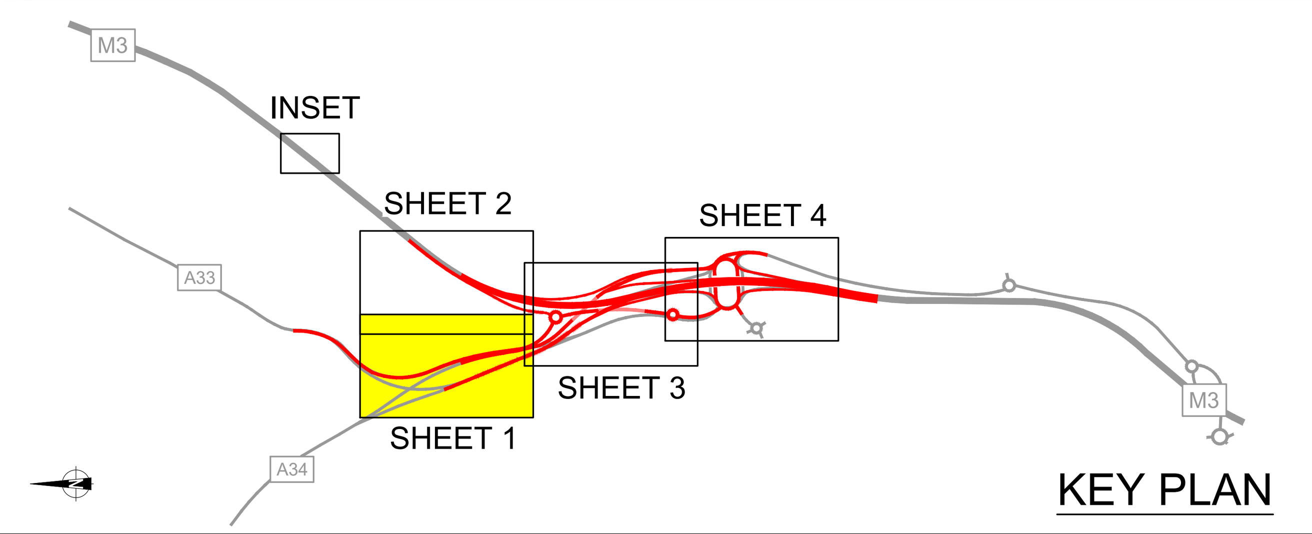
Indicative Pollution Risk Reduction Factors for Spillages

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

The worksheet should be read in conjunction with DMRB 11.3.10.

Appendix C

HE551551-VFK-HGT-X_XXXX_XX-DR-GE-004 Exploratory hole location plan



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

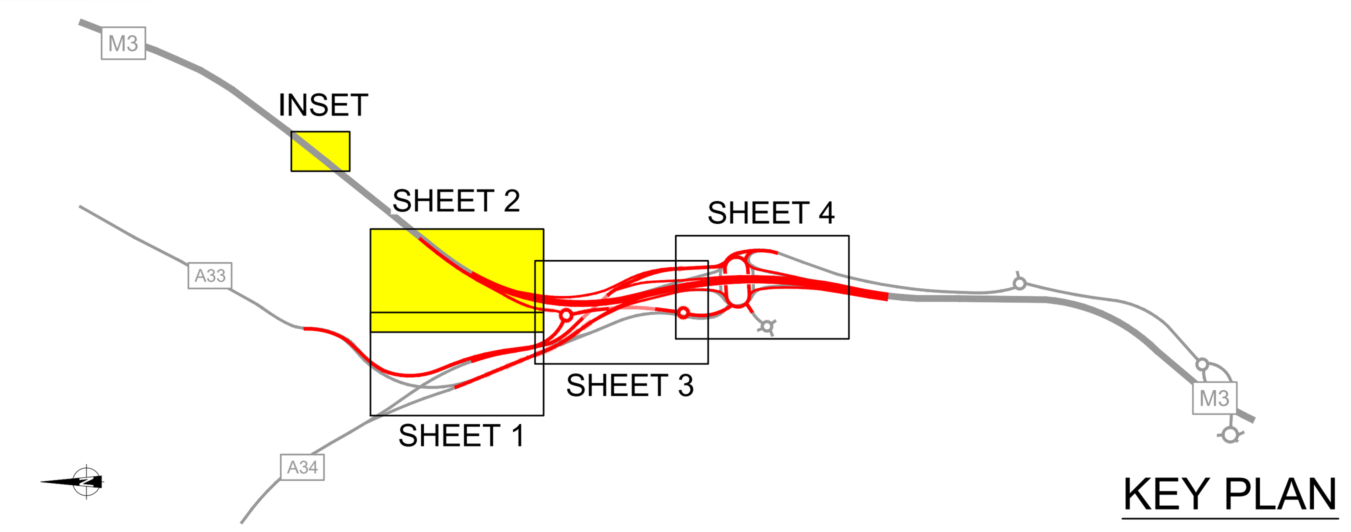
SHEET 1 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size A1	Date 05.05.21	Date 05.05.21	Date 05.05.21	Date 06.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - Location X_XXXX_XX - Type DR - Role GE - Number 0001

Project Ref. No. 48176

Revision P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 2 OF 4

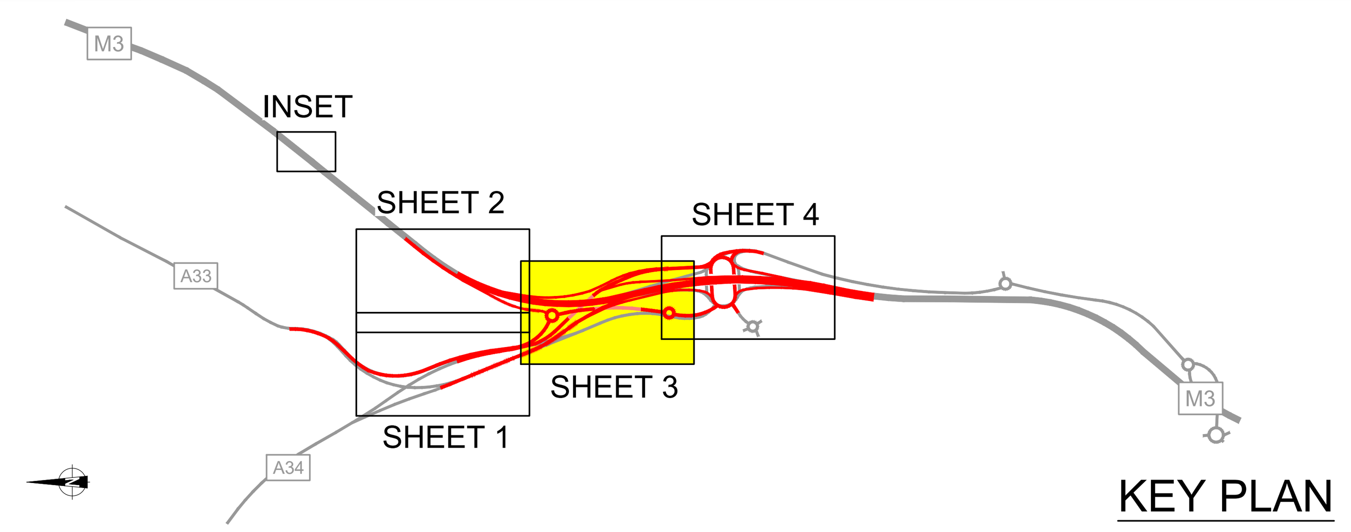
Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size: A1	Date: 05.05.21	Date: 05.05.21	Date: 05.05.21	Date: 06.05.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0002

Project Ref. No.: 48176

Revision: P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

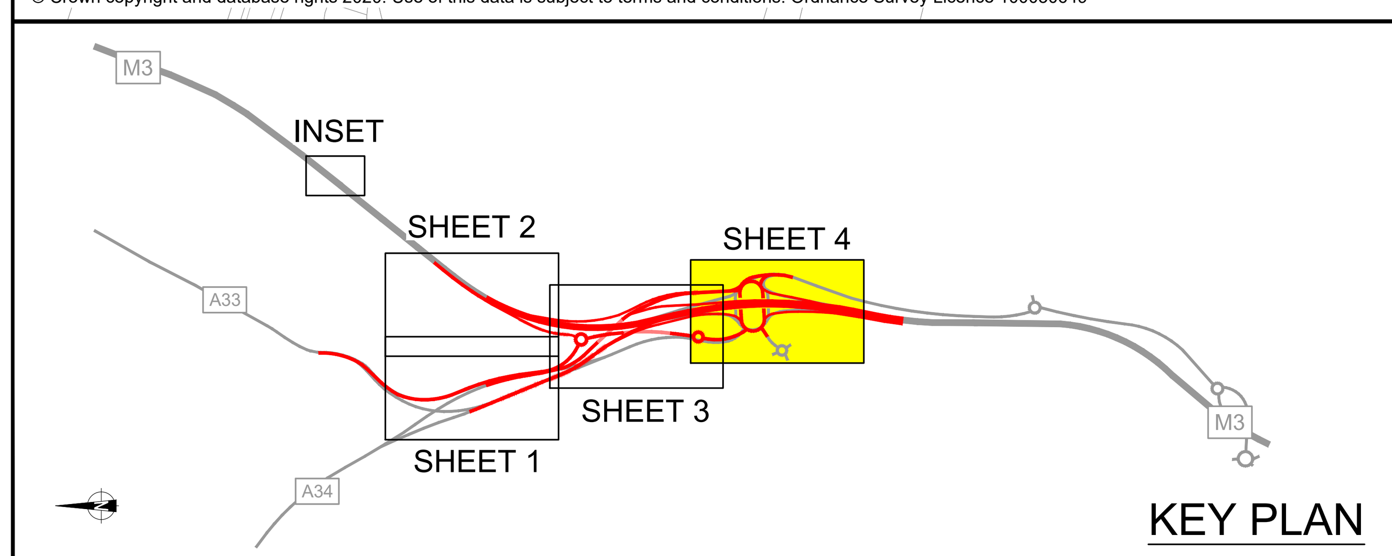
SHEET 3 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size A1	Date 05.05.21	Date 05.05.21	Date 05.05.21	Date 06.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX (Location) - DR (Type) - GE (Role) - 0003 (Number)

Project Ref. No. 48176

Revision P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 4 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT

Original Size	Date	Date	Date	Date
A1	05.05.21	05.05.21	05.05.21	06.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX - DR - GE - 0004 (Location, Type, Role, Number)

Project Ref. No.: 48176

Revision: P01

Appendix D

HE551551-VFK-HGT-X_XXXX_XX-DR-GE-0020 Geological plan

Key

- Made Ground
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size A1	Date 01.12.20	Date 01.12.20	Date 04.12.20	Date 08.12.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX - DR - GE - 0020 (Location, Type, Role, Number)

Project Ref. No. 48176

Revision P02

Appendix E

RAM model files (electronic appendix)

Appendix K – Technical Note: *Decommissioning and Renovation of Existing Highway Soakaways*

HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0003 Soakaway Renovation Technical Note

TECHNICAL NOTE

Job Name: M3 Junction 9 Improvement Scheme

Job No: 48176/2000

Note No: HE551511-VFK-HDG-X_XXXX_XX-TN-CH-0003

Date: October 2021 (Updated July 2022)

Revision: P02

Prepared By: P. Rogers / A. Champion (P02 by J.Harvey)

Checked by: T. Allen

Subject: **Decommissioning and Renovation of Existing Highway Soakaways**

Contents

1. Executive Summary 2
2. Introduction 2
3. Project Overview 3
4. Stage of Design 3
5. Regulatory Context 4
6. CDM 4
7. Risk Assessment & Method Statement (RAMS) 4
8. Permitting 5
9. Asset Types 5
10. Testing Outcomes 6
11. Refurbishment Methodology 6
12. Decommissioning Methodology 7

Appendices

Appendix A Drainage Infiltration Testing Requirements

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0003	P01	Oct'21	PR	AC	TRA	MF
	P02	July	JH	LC	LC	MF

T: E:

TECHNICAL NOTE

1. Executive Summary

The separate Stantec document '*M3 Junction 9 Improvements, Drainage Infiltration Testing Requirements',* details the methodology for infiltration testing for the design of new M3J9 soakaways and for the verification of existing, retained soakaways. The Infiltration testing will use clean water and does not require disposal of contaminated waters to controlled groundwater or watercourses, nor does it require environmental permitting.

This Technical Note relates to the following activities during the renovation or removal of existing soakaways, which will trigger the need for an environmental permit:

- Excavation and disposal of soakaway silts/sludge and filter material
- Excavation and disposal of contaminated natural ground surrounding an abandoned soakaway
- De-watering and disposal of contaminated waters from within an existing soakaway

This document identifies the relevant regulatory guidance and statutory obligations expected to be fulfilled during the above activities.

In addition, this document identifies the hazards, risks and mitigation measures to be considered in the retention or removal of existing soakage highway assets, either soakaway chambers or soakaway trenches.

2. Introduction

A number of existing National Highways and Hampshire Highways' infiltration (soakage) drainage assets, which serve the M3 at Junction 9, are proposed to be retained within the new M3J9 Improvement works. Some of the existing soakage assets are proposed to be abandoned and removed. Subject to testing and inspection, some existing soakage assets may be retained.

This Technical Note identifies the methodology for renovating soakaways that are to be retained, and for decommissioning and removing soakaways that are to be abandoned.

Testing for new soakaways is detailed in the Stantec document HE551511-VFK-HDG-X_XXXX_XX-RQ-CD-0002 Drainage Infiltration Testing Requirements and in Drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0506_Drainage Infiltration Testing Requirements, which are included in Appendix A of this document, for reference.

This Technical Note does not consider soakage assets serving the adjacent M3 Junction 9 – 14 Safety Barrier Improvement Scheme immediately to the south. However, near the interface with Safety Barrier Improvement Scheme, there are soakaways considered in this Technical Note whose catchment partly comprises the Safety Barrier Improvement Schemes highway area and partly M3J9 highway area.

This document should be read in conjunction with the following documents:

- Drainage Strategy Report (DSR) ref. HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001.
- Technical Note - Climate Change allowances applied to the Drainage Design & Exceedance ref. HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001.
- Drainage Infiltration Testing Requirements ref. HE551511-VFK-HDG-X_XXXX_XX-RQ-CD-0002.

- Drainage Schematic Plan ref. HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.
- Water Resources Land Drainage and Groundwater Consenting Layout ref. HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0517.
- Water Resources Land Drainage and Groundwater Consenting Table ref. HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0522.

3. Project Overview

The M3J9 scheme runs north-south, and lies immediately to the east of Winchester, centred in the Winnall area and extending north to Headbourne Worthy.

Abutting the west of the scheme are commercial and light industrial land uses associated with the Wykeham Trade Park and Winnall Industrial Estate, which fall away from the M3J9 towards the River Itchen.

Land rises to the east of the M3J9 and comprises entirely arable land or woodland, with a low density of minor agricultural settlements. 206 hectares (ha) of arable land drain overland from the east towards M3J9. The 206 ha overland catchment is intercepted by M3J9 before it would otherwise reach the River Itchen. Overland flow from 192 ha drains to ground on the eastern side of the M3J9 scheme in existing soakage features maintained by National Highways. Overland flow from 14 ha of the 206 ha passes under the M3J9 in an existing 300mm dia culvert and then flows overland towards the River Itchen.

Proposed modifications to M3J9 comprise the introduction of new on/off slip-roads to both northbound and southbound sides of the M3, new link roads between A33/A34/A272 and M3 roads and a new overhead roundabout above the M3 corridor. Junction 9 is located in a low spot of the M3, towards which a total of approximately 1.6km of the existing M3 corridor drains.

A separate M3 Junction 9 – 14 Safety Barrier Improvement Scheme is to be provided immediately to the south of M3J9. The extent of the mainline M3 associated with the Safety Barrier Scheme will extend into the M3J9 Improvement scheme works boundary.

Safety Barrier Improvements to the M3 are to be provided south of M3J9 between Junctions 9 to 14, these are to comprise of hardening the central reserve, installation of a new concrete safety barrier and improvements to the existing highway drainage to account for the increased hard paved surfaces. Approximately 2ha of the M3 Junction 9 to 14 Safety Barrier Improvement Scheme drains into the 15.5ha M3J9 project area, resulting in an overall approximate drained area of 17.5ha passing through M3J9 drainage.

4. Stage of Design

At the time of writing, the project is at a Stage 3 (Preliminary Design) level of design. Calculations identifying the sizing and spacing of Carriageway Drainage (surface) components such as road gullies, concrete, grassed or grated channels to CD 521, are a Detailed Design item as such are not yet undertaken. However, below-ground Highway Drainage (collector drains and chambers in carriageway and verge, which serve the surface drainage components) has been included in a Stage 3 M3J9 hydraulic design model using Microdrainage software (v 2020.1.3). Return-period design criteria is in accordance with CD 521 - Hydraulic design of road edge surface water channels and outlets. Hydraulic calculations are advanced enough to demonstrate conveyance capacity and levels of surcharging in the below ground Highway Drainage Network.

Retained soakage features are only proposed for draining retained, unmodified existing carriageway areas, or existing carriageway areas with minor widenings, such as central reserve hardening. No retained soakage features are proposed for the disposal of runoff from primarily new areas of drained carriageway.

Refer to the Drainage Strategy Report (DSR) for full details of Stage 3 (Preliminary Design) Drainage calculations.

5. Regulatory Context

The following documents relate to the regulation of waste waters and solids arising from the testing and renovation of highway soakaways:

- Environment Agency: Environmental Permitting rules: water discharge activity and groundwater (point source) activity.
- A Guide to the Special Waste Regulations 1996: Environment Agency
- Waste management, the Duty of Care, A code of practice (revised 1996)
- CIRIA Report 183: Management of gully pots for improved runoff quality:
- British Water, Code of Practice: Guide to the Desludging of Sewage Treatment Systems
- PPG10: Pollution Prevention Guidelines, Highway Depots (withdrawn, but relevant)
- PPG5: Pollution Prevention Guidelines Works and maintenance in or near water (withdrawn, but relevant)
- DMRB CD 530: Design of soakaways
- BRE Digest 365: Soakaway Design (Appendix A)

6. CDM

Organisations undertaking testing and renovation of highway assets will be expected to comply with CDM (2015) legislation. In addition, the contractor will be required to submit F10 notification to HSE if the work is applicable, as follows:

- last longer than 30 working days and have more than 20 workers working at the same time at any point on the project or
- exceed 500 person days

7. Risk Assessment & Method Statement (RAMS)

The owner of the highway asset is the relevant highway authority (HA); either National Highways (NH); or Hampshire County Council (HCC). Organisations undertaking testing and renovation will be required to comply with the HA's requirements for the assessment of risk and pre-approval of activities affecting safety of highway users and operatives.

Any access for inspection, testing or construction works to HCC assets requires liaison with HCC under existing Section Agreements in place between NH and HCC.

7.1. Risk Assessment

Organisations undertaking testing and renovation will be required to undertake a risk assessment of proposed activities in accordance with document:

- GG 104 Requirements for safety risk assessment.

7.2. Method Statements

Prior to undertaking soakaway renovation or removal works, the principal contractor must prepare and submit a Method Statement for the works for HA approval, in accordance with the HA's requirements. The NH project engineer should be contacted for confirmation of the required procedure for approval of method statements.

8. Permitting

Activities involving the discharge of wastewater from dewatering to surface waters or to groundwater, will be required to comply with the environmental permit rules set by the Environment Agency.

A bespoke environmental permit for a '**Water Discharge Activity and Groundwater (point source) Activity**' is likely to be required for the discharge of contaminated waters during renovation or decommissioning of soakage assets.

Discharging potable water (or roof runoff) to ground during testing will not require an environmental permit.

9. Asset Types

9.1. Soakaway Trenches

Soakaway trenches are trenches that are lined with filter fabric and filled with a granular filter media, with or without an incoming perforated distribution pipe within the filter media. There is no exit pipe from a soakaway trench. Water that enters the soakaway trench filter media, via the distribution pipe, is intended to drain to ground by infiltration.

9.2. Soakaway Chambers

Soakaway chambers are pre-cast, or brick, manhole chambers that are perforated to allow water entering the chamber to percolate out to a surrounding filter media layer or to a larger, surrounding pit filled with granular filter media. A soakaway chamber may sometimes be present within a soakaway trench, which forms the surrounding pit, and which may be widened to accommodate the diameter of the soakaway chamber.

10. Testing Outcomes

Refer to Stantec document '*M3 Junction 9 Improvements, Drainage Infiltration Testing Requirements'* in Appendix A, for full details of the methodology for infiltration testing for the design of new M3J9 soakaways and for the verification of existing soakaways.

10.1. Infiltration Rate

Infiltration rates lower than 1×10^{-6} m/s will not normally be considered adequate. In such instances, the existing soakaway will be decommissioned and abandoned in accordance with this Technical Note. Retention of such existing, low-performing assets will require the strict approval of NH, following an assessment of storage capacity and exceedance performance limits.

10.2. Storage Capacity

The free volume in infiltration assets will be expected to accommodate runoff volumes from drained areas, without surface flooding, up the critical duration event with a 10-year return period, including 40% for climate change.

10.3. Drained Areas

The following runoff coefficients should be assumed for calculating runoff volumes:

- Hard surfaces - 100%
- Permeable surfaces (cuttings) - 20%

11. Refurbishment Methodology

Where testing of any existing soakage asset's infiltration rate and storage capacity prove it to be adequate for future retention within the M3J9 works, then it shall be renovated, as necessary, to meet the following minimum parameters.

11.1. Minimum performance criteria of retained soakage asset

- Void ratio of filter media to be 30% min.
- Minimum 1no.catchpit on all pipe entries.
- Minimum volume capacity to accommodate the 10-year + 40% CC runoff volume
- Flow routes for exceedance flows arising from events greater than the 10-year + 40% CC design event, to be directed to soft landscaping away from, and without surcharge onto, live carriageways.

Refurbishment of soakage assets shall be undertaken in accordance with the principles of the documents listed within this Technical Note under Section 5; Regulatory Context and Section 8; Permitting, specifically with regard to the disposal of contaminated silts and filter media and the discharge of contaminated waters to watercourses or to ground.

11.2. Silt Removal & Disposal

As much as possible of the accumulated silts, grit and debris within the free volume of an infiltration assets, will be removed prior to re-use.

Arisings from silt removal will be disposed of in accordance with the requirements of current Waste Regulations applicable to the transport and disposal of hazardous waste. Silt removal and desludging shall be undertaken in accordance with the documents listed in Section 5 - Regulatory Context, of this Technical Note.

For soakaway chambers this will require specialist contractor activities, using gully-pot suction and silt-storage equipment and licenced processes.

For soakaway trenches, this will require an assessment of how much of the free volume can be practically accessed (inspection wells, soakaway chambers etc), and then specialist contractor activities as above, to remove as much silt and debris as possible.

11.3. Inspection for Asset Integrity

Prior to re-use, an infiltration feature will be inspected visually to assess the following:

- Structural Stability.

  A visual inspection shall be made of each infiltration asset for signs of vertical settlement, slope instability or loss of structural integrity (cracks >3mm in width, missing masonry/concrete/ironwork). Any significant instability (fresh earth movement for instance) is to be notified to the HA before proceeding.

- Hydraulic Performance

  If an infiltration asset is found to be holding water to above 25% capacity after a preceding dry 24hrs, notify the HA before proceeding.

12. Decommissioning Methodology

Decommissioning and removal of soakage assets shall be undertaken in accordance with the principles of the documents listed within this Technical Note under Section 5; Regulatory Context and Section 8; Permitting, specifically with regard to the disposal of contaminated silts and filter media, and the discharge of contaminated waters to watercourses or to ground.

In the event that testing of an existing soakage asset's infiltration rate and storage capacity prove it to be inadequate for future retention for M3J9, then it shall be removed. Removal of former soakage assets will be undertaken in a way that minimises the risks presented by the following hazards, to an acceptable level.

12.1. Hazardous waste

All filter media surrounding soakaway chambers, or within soakaway trenches, should be treated as hazardous waste, and carried and disposed of in accordance with current Waste Regulations testing and licencing.

Natural ground immediately surrounding a soakage asset is likely to be contaminated with hydrocarbons and other contaminants carried by inflows from the drained area of carriageway. The extant of removal of such contaminated natural ground will be confirmed on site by inspection, but it is expected that all excavations will be taken back to uncontaminated natural ground beyond the extents of the existing asset. Arisings from the excavation of contaminated natural ground shall be treated as Hazardous Waste, as if filter media.

12.2. Dewatering

Any pumped dewatering during removal of soakage assets, which is discharged to watercourses or to groundwaters, shall be treated to remove suspended solids and contaminants in solution or in suspension, in accordance with the environmental permit for that activity (Refer to Section 8).

12.3. Reinstatement

Following removal of all contaminated material to NH approval, the remaining asset void shall be reinstated as follows

In landscaped areas

Reinstate void in clean general fill material, placed and compacted in accordance with the Highways Specification for M3J9. Finish with a minimum depth of 150mm clean topsoil as the M3J9 Highways Specification. Each location shall be reviewed individually with reference to the scheme's proposed Landscape and Ecology (SHW series 3000) Layouts and Specification and appropriately reinstated to permanent or existing construction details depending on which is present at time of backfill.

In hard standings or trafficked areas

Reinstate void in clean, well-graded granular material suitable for use in road foundations, placed and compacted in accordance with the Highways Specification for M3J9. Each location shall be reviewed individually with reference to the scheme's proposed Pavement Construction (SHW series 0700) Layouts and Highways Specification and appropriately reinstated to permanent or existing construction details depending on which is present at time of backfill.

Appendix A Drainage Infiltration Testing Requirements

ref: HE551511-VFK-HDG-X_XXXX_XX-RQ-CD-0002
(Includes drawing HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0506_Drainage Infiltration Testing Requirements-0506)

M3 Junction 9 Improvements

Drainage Infiltration Testing Requirements

On behalf of **Highways England**

Project Ref: 48176 | Rev: P04 | Date: September 2021

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address:
T: E:

Document Control Sheet

Project Name: **M3 J9 Improvements**

Project Ref: **48176**

Report Title: **Drainage Infiltration Testing Requirements**

Doc Ref: **HE551511-VFK-HDG-X_XXXX_XX-RQ-CD-0002**

Date: **December 2020**

	Name	Position	Signature	Date
Prepared by:	P. Rogers	Drainage Engineer		21.12.2020
Reviewed by:	A. Champion	Principal Engineer		21.12.2020
Approved by:	T. Allen	Associate		21.12.2020
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
P01	21.12.2020	First Issue	PR	AC	TRA
P02	19.07.2021	2nd Issue	PR	AC	TRA
P03	01.09.2021	Feature type INF 24, 25 & 28 amended to manholes	AC	AC	TRA
P04	08.09.2021	INF 5, 6, 14 & 15 amended to suit Basin revision	AC	AC	TRA

This page is intentionally blank

1 Infiltration Testing

1.1 Overview

1.1.1 The Drainage Strategy seeks to infiltrate surface water run-off to ground where possible. Minimal data is currently available regarding infiltration rates on which to form a basis for detailed drainage design.

1.1.2 The aim of the infiltration testing is to identify infiltration rates from new soakage features such as swales and detention basins, which will influence surface attenuation volumes and subsequent basin sizes and earthworks. The assumed values for infiltration so far, are at the lower design limit of 1 x 10^{-6} m/s. Infiltration rates are likely to be variable, and higher infiltration rates may be identified with the proposed range of testing locations.

1.1.3 At each location, 3 No. tests to BRE 365 will be required, at the same level of the permanent infiltration surface, which is typically 1.5m – 2.5m below finished road or landscaping levels.

1.1.4 Test locations and depths will be informed as the geology at formation level is exposed and identified, and as attenuation or infiltration areas are better defined at the detail design stage.

1.1.5 The schedule provides the purpose of each test, which is either required for use at detailed design stage for existing infiltration areas or is required for construction/validation of proposed infiltration areas.

1.2 Scope and Specification

1.2.1 This document covers the testing of natural strata at new soakaway locations (new-design testing), and the method of testing existing soakaways to verify capacity (verification-testing).

1.2.2 New-Design Testing

For design-testing, guidance on the method for undertaking soil infiltration testing is given in BRE Digest DG 365 (2016).

Each new-design test needs to comprise the following:

- Machine excavate (e.g. JCB 3CX) a trial pit between 1m and 3m long and 0.3m and 1m wide.
- The trial pits are expected to be generally between 1.0m and 2.0m deep, but this is dependent on the geology encountered.
- The trial pit sides need to trimmed.
- If there is a risk of collapse of the sides of the trial pits, then they need to be backfilled with gravel and a vertical observation tube installed.
- The trial pits are then filled with water and allowed to drain fully whilst recording the time and water level at close intervals.
- This needs to be done 3 times at each location on the same or consecutive days.
- Infiltration testing uses a lot of water, so a water bowser or tanker will likely be required.
- The water used must meet the requirements of the Water Supply (Water Quality) Regulations 2018 to avoid introducing potential contamination into the underlying aquifers.

1.2.3 Verification-Testing

For existing soakaway verification-testing, the method for undertaking infiltration testing is proposed below, and is subject to agreement with the asset owner, either Highways England or Hampshire County Council.

Any testing works to Hampshire County Council Assets are to be undertaken within existing Section Agreements between Highways England and Hampshire County Council.

Each verification-test needs to comprise the following:

- For soakaway chamber assets, take 3no. 1kg samples of silt from within the base of the chamber.
- For soakaway trenches, take 3no. 1kg silt samples at the centre of 1/3 sections, at ¾ depth of the soakaway feature. This will require local excavation and reinstatement of the soakaway trench.
- For soakaway trenches, also take a 5kg sample of the aggregate matrix to determine void ratio.
- Test all silt samples for Waste Acceptance Criteria.
- For Soakaway chambers, remove all silt from within the chamber. Inspect and clean infiltration surfaces, replacing any clogged, accessible geotextiles. Dispose of all removed silt to a suitably licensed facility.
- Assess the available volume of each existing soakage feature to be tested. Make available enough clean water (bowser) to fill each soakage feature.
- Fill the soakage feature to full capacity and record draw-down times from 100%, through 75%, 50% to 25% capacity. This may require an inspection well being installed to soakage trenches to enable water levels to be monitored, if no inspection well already exists.

1.2.4 An Infiltration Testing Requirements layout and a Testing Schedule drawing are provided within Appendix A, showing the testing locations, reference numbers, Eastings, Northings and testing levels.

1.2.5 Infiltration testing needs to be coordinated with proposed ground levels and timed when grading and phasing allows testing to be undertaken at the permanent infiltration level.

1.2.6 Infiltration areas are subject to final highway alignment detail design.

1.2.7 Connections between infiltration areas subject to final Drainage design.

1.2.8 Soil Testing:

- To get best value out of the *new-design testing* trial pits, the soils encountered need to be described in accordance with BS5930:2015 and chalk described in accordance with CIRIA C574 and then engineering logs produced.
- Soil samples should be taken at 1m depth intervals comprising 2 large bulk bags in each of the pits for future laboratory testing.

- A set of 3 hand shear vane tests should be undertaken at 0.5m depth intervals in any cohesive strata encountered.

- All soil, descriptions, sampling and testing in a trial pit is to be undertaken to full depth, before water is introduced for BRE 365 testing.

1.2.9 The Geotechnical Contractor is to submit Risk Assessment, Method Statements and Programme of Works for review, prior to the Works.

1.2.10 Key H&S hazards:

- Excavation depths > 1m.

- Working close to live carriageway.

1.2.11 Key Design hazards:

- Creating soft spots at formation within future carriageway (Geo. Contractor to keep *new-design testing* out of carriageway)

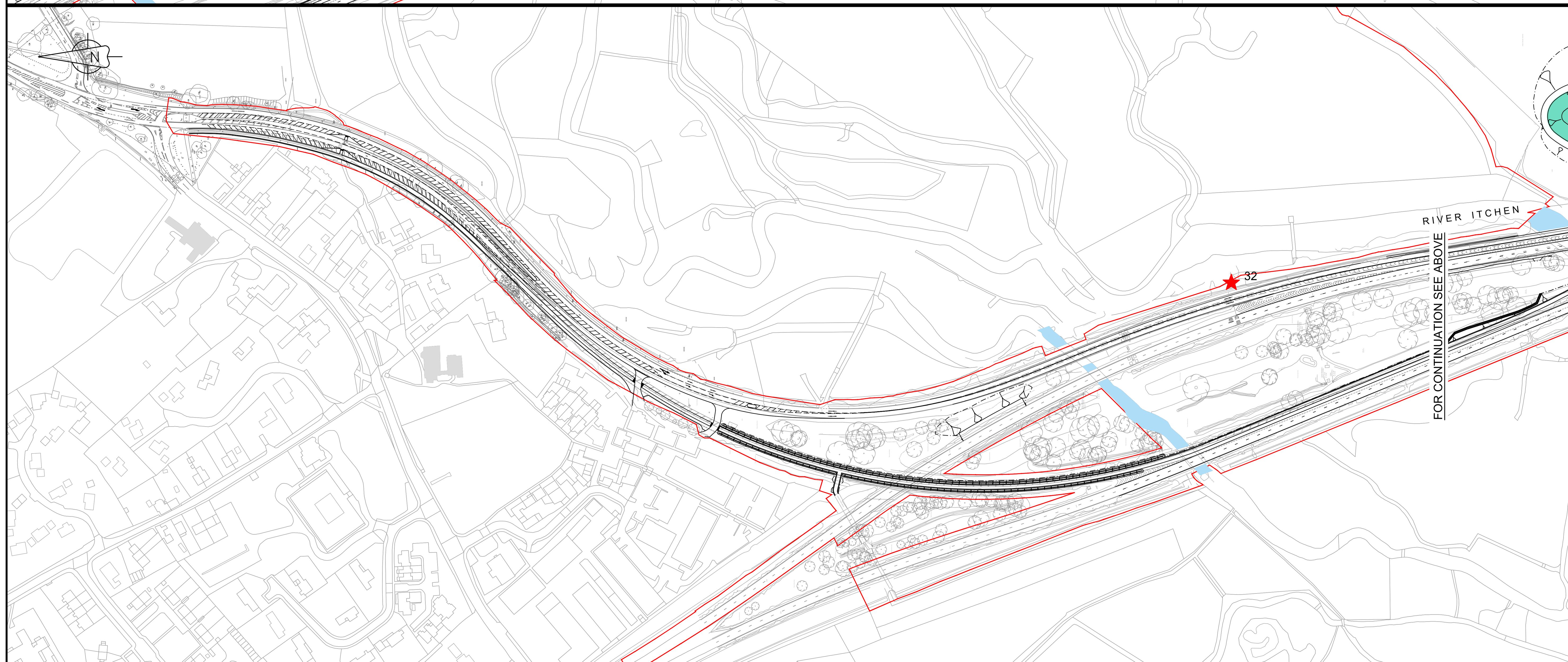
2 Deliverables

2.1 Results Schedule

2.1.1 Infiltration Testing Results to be submitted in tabulated format including:

- Test Reference (as per Testing Requirements and Schedule), including test reference location plan.
- Date of Test (DD/MM/YYYY)
- Easting (OS grid m)
- Northing (OS grid m)
- Ground level (mAOD)
- Trial Pit (or existing soakaway chamber/trench) base level (mAOD)
- Trial Pit (or existing soakaway chamber/trench) dimensions (mm)
- Infiltration Test Result 01,
- Infiltration Test Result 02,
- Infiltration Test Result 03,
- Void ratio result for stone matrix samples taken from soakaway trenches.
- Average infiltration rate from Tests 01, 02 and 03, at each location.
- Record any water strikes.
- Record soil descriptions, sampling and testing as the specification above, at each *new-design testing* location.
- Record any damage or required maintenance to existing soakaway structures at each *verification-testing* location.

Appendix A - Drawings



KEY:

- ★ # INFILTRATION TEST WITHIN EXISTING SOAKAWAY TRENCH
- ⊛ # INFILTRATION TEST WITHIN EXISTING SOAKAWAY MANHOLE
- (green fill) INDICATIVE AREAS OF NEW OUT-OF-CARRIAGEWAY INFILTRATION FEATURES
- ⌖ # INFILTRATION TEST AT LOCATION OF PROPOSED SOAKAGE FEATURE. (REFER TO SCHEDULE FOR TYPE AND BASE LEVEL)

NOTES:

1. INFILTRATION TESTS FOR NEW SOAKAGE FEATURES NEED TO TO BE COORDINATED WITH PROPOSED LEVELS AND TIMED DURING GRADING AND PHASING TO ALLOW TESTING TO BE UNDERTAKEN AT THE PERMANENT INFILTRATION LEVEL.
2. INFILTRATION AREAS SUBJECT TO FINAL HIGHWAY DESIGN ALIGNMENT DESIGN.
3. CONNECTIONS BETWEEN INFILTRATION AREAS SUBJECT TO FINAL DRAINAGE DESIGN.
4. REFER TO DRAWING NO.HE551511-VFK-HDG-X_XXXX_XX-SH-CD-0001 DRAINAGE INFILTRATION TESTING SCHEDULE FOR COORDINATES, DEPTHS FOR TESTING AND NOTES OF CONSTRAINTS
5. INFILTRATION TESTS FOR NEW SOAKAGE FEATURES TO BE UNDERTAKEN IN ACCORDANCE WITH BRE DG 365 (2016).
6. INFILTRATION TESTS FOR GEO. CONTRACTOR TO SUBMIT RAMS FOR APPROVAL PRIOR TO THE WORKS. KEY HAZARDS - EXCAVATION DEPTHS > 1M AND WORKING CLOSE TO LIVE CARRIAGEWAY, AND DISPOSE OF CONTAMINATED SILTS.
7. SEPARATE RISK ASSESSMENTS AND METHOD STATEMENTS TO BE PREPARED BY CONTRACTOR AND AGREED WITH HE OR HCC (DEPENDANT ON OWNERSHIP) PRIOR TO WORKS BEING UNDERTAKEN. EXISTING HIGHWAYS ENGLAND SECTION AGREEMENTS AND PROCESSES TO BE FOLLOWED.
8. TESTING RAMS TO BE APPROVED BY EA, PARTICULARLY WITH REGARD TO DISPOSAL OF CONTAMINATED SILTS FROM EXISTING SOAKAWAY CHAMBERS & TRENCHES, WHICH WILL REQUIRE WAC TESTING BEFORE SUITABLE DISPOSAL.
9. LOCATIONS INF1-6 AND 8-16 ARE IN UNDISTURBED AREAS AND COULD CONTAIN ARCHAEOLOGICAL REMAINS. PRIOR TO UNDERTAKING ANY EXCAVATION FOR INFILTRATION TESTING REFERENCE MUST BE MADE TO THE ARCHAEOLOGICAL MITIGATION STRATEGY.

Rev.	Date	Description	Drawn	Chk'd	App'd
P05	08.09.21	INF 5, 6, 14, 15 COORDINATES UPDATED	MP	AC	TRA
P04	01.09.21	INF 24, 25 & 28 TRENCHES AMENDED AS MANHOLES	AC	AC	TRA
P03	29.06.21	TESTING ON EXISTING SOAKAWAYS CLARIFIED	GP	AC	TRA
P02	25.05.21	INFILTRATION BASIN LAYOUT UPDATED	NK	AC	TRA
P01	04.12.20	FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE INFILTRATION AREAS AND INFILTRATION TESTING REQUIREMENTS

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	ME	AC	TRA
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20	Date: 02.12.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HDG - Location X_XXXX_XX - Type DR - Role CD - Number 0506

Project Ref. No. 48176

Revision P05

Infiltration Test Ref:	Type of Test	Road Ref	E	N	EGL (mAOD)	FRL/FGL (mAOD)	Test formation level (mAOD)	Depth (m) to Test formation, from EGL	test result 01 (m/s)	test result 02 (m/s)	test result 03 (m/s)	Average Test result (m/s)	Purpose of Test	Notes
INF 1	BRE 365	A33 (infiltr area)	449,465.384	131,481.663	43.539	39.369	39.069	4.470					New Soakaway Design	Basin 1 base infiltration (See note 11)
INF 2	BRE 365	A33 (infiltr area)	449,458.873	131,440.137	43.607	39.369	39.069	4.538					New Soakaway Design	Basin 1 base infiltration (See note 11)
INF 3	BRE 365	A33 (infiltr area)	449,514.153	131,400.760	50.567	48.604	48.304	2.263					New Soakaway Design	Basin 2 base infiltration (See note 11)
INF 4	BRE 365	A33 (infiltr area)	449,513.523	131,371.840	50.061	48.604	48.304	1.757					New Soakaway Design	Basin 2 base infiltration (See note 11)
INF 5	BRE 365	Overland infiltration basin	449,822.088	130,842.662	51.096	EGL	50.096	1.000					New Soakaway Design	Infilt'n basin in extg valley (Test min. 1m deep from EGL) (See notes 8 and 11)
INF 6	BRE 365	Overland infiltration basin	449,830.280	130,788.393	51.328	EGL	50.328	1.000					New Soakaway Design	Infilt'n basin in extg valley (Test min. 1m deep from EGL) (See note 9 and 11)
INF 10	BRE 365	A34 NB	449,380.737	131,317.575	42.278	40.850	40.550	1.728					New Soakaway Design	Proposed Infiltration Basin 3C (See note 12)
INF 11	BRE 365	A34 NB	449,421.998	131,237.905	43.114	40.850	40.550	2.564					New Soakaway Design	Proposed Infiltration Basin 3C (See note 12)
INF 12	BRE 365	A34 NB	449,457.757	131,194.028	43.534	42.075	41.775	1.759					New Soakaway Design	Proposed Infiltration Basin 3B (See note 12)
INF 13	BRE 365	A34 NB	449,484.143	131,132.407	44.170	42.075	41.775	2.395					New Soakaway Design	Proposed Infiltration Basin 3B (See note 12)
INF 14	BRE 365	M3 SB Diverge	449,718.618	131,505.362	63.463	EGL	62.463	1.000					New Soakaway Design	Proposed Infiltration Basin 6 (See note 11)
INF 15	BRE 365	M3 SB Diverge	449,713.805	131,455.112	63.519	EGL	62.519	1.000					New Soakaway Design	Proposed Infiltration Basin 6 (See note 11)
INF 16	BRE 365	A34 NB bottom of embankment	449,571.801	130,834.084	46.956	EGL	45.956	1.000					New Soakaway Design	Existing Soakaway Trench (See note 12)
INF 18	BRE 365	Easton Lane	449,578.531	130,408.111	60.432			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 19	BRE 365	Easton Lane	449,542.390	130,392.786	60.284			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 20	BRE 365	Easton Lane	449,521.846	130,375.194	60.210			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 21	BRE 365	Easton Lane	449,513.415	130,356.853	59.909			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 22	BRE 365	Easton Lane	449,493.414	130,382.689	60.235			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 23	BRE 365	Easton Lane	449,482.976	130,382.644	59.814			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Manhole (See note 7)
INF 24	BRE 365	M3 Northbound	449,642.902	130,156.307	58.155			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 25	BRE 365	M3 Northbound	449,654.958	130,127.124	63.188			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 26	BRE 365	M3 Northbound	449,647.572	130,058.669	64.420			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 27	BRE 365	M3 Northbound	449,641.026	130,023.992	65.292			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 28	BRE 365	M3 Northbound	449,618.767	129,972.025	60.101			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench
INF 29	BRE 365	A272	449,730.444	130,086.410	56.950			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench (See note 7)
INF 30	BRE 365	A272	449,760.615	130,066.778	55.678			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench (See note 7)
INF 31	BRE 365	A272	449,750.173	130,038.562	55.806			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench (See note 7)
INF 32	BRE 365	A33	449,348.849	131,743.575	40.544			Existing Soakaway					Validation of retained soakaway	Existing Soakaway Trench

NOTES:

1. INFILTRATION TESTS NEED TO TO BE COORDINATED WITH PROPOSED LEVELS AND TIMED DURING GRADING AND PHASING TO ALLOW TESTING TO BE UNDERTAKEN AT THE PERMANENT INFILTRATION LEVEL.
2. INFILTRATION AREAS SUBJECT TO FINAL HIGHWAY DESIGN ALIGNMENT DESIGN.
3. CONNECTIONS BETWEEN INFILTRATION AREAS SUBJECT TO FINAL DRAINAGE DESIGN.
4. REFER TO DRAWING NO.HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0506 DRAINAGE INFILTRATION AREAS AND INFILTRATION TESTING REQUIREMENTS.
5. ALL INFILTRATION TESTS TO BE UNDERTAKEN IN ACCORDANCE WITH BRE DG 365 (2016).
6. GEO. CONTRACTOR TO SUBMIT RAMS FOR APPROVAL PRIOR TO THE WORKS. KEY HAZARDS - EXCAVATION DEPTHS > 1M AND WORKING CLOSE TO LIVE CARRIAGEWAY.
7. HAMPSHIRE COUNTY COUNCIL ASSET. WORKS TO BE UNDERTAKEN UNDER EXISTING HIGHWAYS ENGLAND SECTION AGREEMENTS WITH HAMPSHIRE COUNTY COUNCIL.
8. OVERHEAD POWER CABLE IN LOCAL VICINITY. THE CONTRACTOR SHOULD CONSULT HSE GUIDANCE NOTE GS6 AVOIDING DANGER FROM OVERHEAD POWER LINES AND LIAISE WITH SCOTTISH AND SOUTHERN ELECTRICITY NETWORKS.
9. BELOW GROUND GAS MAIN IN LOCAL VICINITY. THE GAS MAIN IS SPUN IRON AND SHOULD BE IDENTIFIABLE BY CAT SCANNING OR SIMILAR OTHER NON-INTRUSIVE METHODS.
10. CONTRACTOR TO REFER TO ALL EXISTING AND PROPOSED UTILITY RECORDS PRIOR TO UNDERTAKING SITE INVESTIGATIONS.
11. TESTING PROVIDED AS PART OF GROUND INVESTIGATION SCOPE REPORT (GISR) (REF. HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0002).
12. LOCATIONS ARE OBSTRUCTED BY EXISTING HIGHWAY OR ECOLOGY. THESE REQUIRE SITE OCCUPATION AND/OR ADDITIONAL VEGETATION CLEARANCE. CONTRACTOR'S METHOD STATEMENT TO INCLUDE MEASURES TO ADDRESS THE ECOLOGICAL CONSIDERATIONS. MINIMISE VEGETATION CLEARANCE. DORMOUSE METHOD STATEMENT AND ECOLOGICAL SITE SUPERVISION LIKELY TO BE REQUIRED.
13. LOCATIONS INF1-6 AND 8-16 ARE IN UNDISTURBED AREAS AND COULD CONTAIN ARCHAEOLOGICAL REMAINS. PRIOR TO UNDERTAKING ANY EXCAVATION FOR INFILTRATION TESTING REFERENCE MUST BE MADE TO THE ARCHAEOLOGICAL MITIGATION STRATEGY.

Rev.	Date	Description	Drawn	Chk'd	App'd
P05	08.09.21	INF 5, 6, 14, 15 COORDINATES UPDATED	MP	AC	TRA
P04	31.08.21	INF 24, 25, 28 TRENCHES AMENDED TO MANHOLES	MP	AC	TRA
P03	29.06.21	ALL EXISTING INFILTRATION SYSTEMS ADDED	GP	AC	TRA
P02	25.05.21	EXISTING SOAKAWAYS ADDED	NK	AC	TRA
P01	04.12.20	FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE INFILTRATION TESTING SCHEDULE

Scale	Designed	Drawn	Checked	Approved
N/A	N/A	ME	AC	TRA
Original Size: A1	Date: 02.12.20	Date: 02.12.20	Date: 02.12.20	Date: 02.12.20

Drawing Number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE551511 - VFK -HDG- X_XXXX_XX - SH - CD - 0001

Project Ref. No.: 48176

Revision: P05

Appendix L – Technical Note: *Drainage Network Resilience to Critical-Location Blockages*

HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0002 Resilience in Highway Drainage Design

TECHNICAL NOTE

Stantec

Job Name: M3 Junction 9 Improvement Scheme

Job No: 48176/2000

Note No: HE551511-VFK-HDG-X_XXXX_XX-TN-CH-0002

Date: October 2021 (Updated July 2022)

Revision: P02

Prepared By: P. Rogers / A. Champion (P02 by J. Harvey)

Checked by: T. Allen

Subject: **Drainage Network Resilience to Critical-Location Blockages**

Contents

1. Executive Summary 2
2. Introduction 2
3. Project Overview 3
4. Stage of Design 3
5. Proposed type and locations of assessed network blockages or failures 4
6. Summary of network performance during resilience scenarios 6
7. Mitigation Measures 9

Figures

No table of figures entries found.

Tables

Table 6.1 Summary of network performance during resilience scenarios 8
Table 6.2 Summary of network performance during resilience scenarios 10

Appendices

Appendix A Drainage Network Resilience to Critical-Location Blockages
Appendix B Resilience Drainage Calculations

TECHNICAL NOTE

1. Executive Summary

Please refer to this Technical Note for an assessment of drainage network performance during blockages or loss of infiltration (resilience scenarios).

The blockages and loss of infiltration are simulated at critical locations in the network, such as at low spots in cuttings, where surface flooding would otherwise cause highway operation to be disrupted.

The impact of blockages on network performance has been assessed in the critical-duration, 5-year + 20% Climate Change (CC) event, and sensitivity-tested in the 10-year + 40% climate change event.

The impact of loss of infiltration on network performance has been assessed in the critical-duration, 100-year + 40% Climate Change (CC) event.

Mitigation measures to maintain network performance during resilience scenarios are proposed.

Please refer to the separate Technical Note *HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001 Climate Change Criteria in Highway Drainage Design,* for clarification of the application of design criteria to the normal network design and of network sensitivity to exceedances in return period and climate change allowances. The coincidence of blockages during exceedance events has not been included in this technical Note.

2. Introduction

This Technical Note identifies the resilience measures in the M3J9 works area only. It does not consider resilience measures for the adjacent M3 Junction 9 to 14 Safety Barrier Improvement Scheme immediately to the south, from which attenuated flows pass into the M3J9 drainage network

Any surcharging of surface water above cover level (flood volume) identified within this resilience assessment is assumed to be held at the surface where it floods, until water levels in the below-ground network subside enough to allow surface flood volumes to be drained back into the network. In this way, all runoff volumes are routed through attenuation structures and outfalls.

This document should be read in conjunction with the following documents:

- HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001 - Drainage Strategy Report (DSR)
- Technical Note HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001 - Climate Change allowances applied to the Drainage Design & Exceedance.
- Stage 3 Preliminary Design Highway Drainage Layouts.

2.1. Adjacent M3 Junction 9 to 14 Safety Barrier Improvement Scheme

The modelling presented in this Technical Note includes the flow volumes that are generated from hard drained surfaces within the adjacent Safety Barrier Improvement Scheme, to the south of M3J9, and which flow into the M3J9 highway drainage network. Surface flooding that may or may not arise within the schemes area are not identified in this Technical Note. However, all runoff volume from the Safety Barrier Improvement Scheme is accounted for, even if it has surcharged to surface outside the M3J9 area at some point in during storm event analysis.

3. Project Overview

The M3J9 scheme runs north-south, and lies immediately to the east of Winchester, centred in the Winnall area and extending north to Headbourne Worthy.

Abutting the west of the scheme are commercial and light industrial land uses associated with the Wykeham Trade Park and Winnall Industrial Estate, which fall away from the M3J9 towards the River Itchen.

Land rises to the east of the M3J9 and comprises entirely arable land or woodland, with a low density of minor agricultural settlements. 206 hectares (ha) of arable land drain overland from the east towards M3J9. The 206 ha overland catchment is intercepted by M3J9 before it would otherwise reach the River Itchen. Overland flow from 192 ha drains to ground on the eastern side of the M3J9 scheme in existing soakage features maintained by National Highways. Overland flow from 14 ha of the 206 ha passes under the M3J9 in an existing 300mm dia. culvert and then flows overland towards the River Itchen.

Proposed modifications to M3J9 comprise the introduction of new on/off slip-roads to both northbound and southbound sides of the M3, new link roads between A33/A34/A272 and M3 roads and a new overhead roundabout above the M3 corridor. Junction 9 is located in a low spot of the M3, towards which a total of approximately 1.6km of the existing M3 corridor drains.

A separate Safety Barrier Improvement Scheme is currently being constructed immediately to the south of M3J9 between Junctions 9 to 14. The M3 Junction 9 to 14 Safety Barrier Improvement Scheme to the mainline M3 will extend into the M3J9 Improvement scheme works boundary.

Safety Barrier Improvements to the M3 are under construction to the south of M3J9, which comprise hardening of the central reserve and conversion of the hard shoulder to a running lane, or addition of a running lane where no hard shoulder exists. Approximately 2ha of the Safety Barrier Improvement Scheme drains into the 15.5ha M3J9 project area, resulting in an overall approximate drained area of 17.5ha passing through M3J9 drainage.

4. Stage of Design

At the time of writing, the project is at Stage 3 (Preliminary) level of design. Calculations identifying the sizing and spacing of CD surface components such as road gullies, concrete, grassed or grated channels to CD 521, which would be a Detailed Design level, are not yet complete. However, below-ground collector drains and chambers in carriageway and verge, which serve the surface drainage components, have been included in a Stage 3 M3J9 hydraulic design model using Microdrainage software (v 2020.1.3). Return-period design criteria is in accordance with CD 521 - Hydraulic design of road edge surface water channels and outlets. Hydraulic calculations are advanced enough to demonstrate conveyance capacity and levels of surcharging in the below ground Highway Drainage Network.

The resilience scenarios below have been simulated within the M3J9 Microdrainage hydraulic model.

Refer to the Drainage Strategy Report (DSR) for full details of Stage 3 (Preliminary) Drainage calculations.

Appendix B of this Technical Note contains calculations relating to the resilience assessment.

5. Proposed type and locations of assessed network blockages or failures

In order to identify the sensitivity, or resilience, of the proposed network to occurrences of operational failure, two types of scenario have been assessed, namely;

1. Blockages of 50% in pipelines at critical locations. Blockages have been simulated by introducing an orifice plate with an opening size equal to 50% the pipe cross-sectional area. For instance, a 50% blockage of a 300mm diameter pipe is simulated by introducing a 212mm dia. orifice.

2. Total loss (blockage) of infiltration rates within SuDS infiltration features. The normal design parameter for infiltration rate is 1 x 10^{-6} m/s with a Factor of Safety of 2.0. In the resilience scenario, the infiltration rate in basin surfaces has been assumed to be 0.00 m/s.

Resilience in the piped drainage network has been assessed under the normal highway drainage design conditions set out in DMRB design document CG 501 - Design of highway drainage systems, which is the 5-year + 20% Climate Change (CC) critical-duration rain event. Sensitivity-testing has been provided for further context, which is the network performance (when blocked) under the critical-duration 10-year + 40% CC rain event.

Resilience of open, infiltration features have been assessed under the normal SuDS design conditions set out in the SuDS Manual, CD 532 - Vegetated drainage systems for highway runoff and planning policy, which is the 100-year + 40% CC critical-duration rain event.

A separate assessment of network sensitivity to climate change, under normal operation, is covered in the separate Technical Note *HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001 - Climate Change allowances applied to the Drainage Design & Exceedance.*

The locations and descriptions of the resilience scenarios assessed are listed below and indicated on drawing *HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0520 Drainage Network Resilience - Resilience Scenarios and Mitigation Measures*, which is included in Appendix A.

5.1. Blockages in Pipelines & Flow Controls

Pipe blockages of 50% have been assessed in the following critical locations (refer to drawing *HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0520*):

A. Low point in the A34 Southbound approach (near-side kerb) to the A34 underpass (western portal)

B. Low points at the A33 northbound approach (both kerbs, cambered) to the A33 underpass (southern portal)

C. Drainage exit to Basin 4 at low point from M3 Mainline to West A34 northbound (nearside kerb).

D. Basin 4 outlet

E. Low point of WCH (east of M3 gyratory)

F. Low point of WCH (within western half of M3 gyratory)

G. Drainage exit from low point of M3 southbound diverge in cutting (near-side kerb)

H. Drainage exit of geocellular storage in footway/cycleway route between A34 northbound and A34 southbound

I. Drainage exit from low point at West M3 northbound diverge (near-side)

J. M3 northbound low point (near-side kerb)

K. Basin 3A outlet

L. Basin 3B outlet

M. East M3 southbound low point (Central Reservation)

N. Low point in western gyratory roundabout (off-side kerb)

O. Low point in western gyratory roundabout (near-side kerb)

5.2. Loss of infiltration in SuDS Infiltration features

The loss of soil permeability in SuDS infiltration features has been assessed at the following locations. The normal design parameter for infiltration rate is 1×10^{-6} m/s with a Factor of Safety of 2.0. In the resilience scenario, the infiltration rate in basin surfaces has been assumed to be 0.00 m/s.

P. Basin 1 base & sides

Q. Basin 2 base & sides

R. Basin 3B base & sides

S. Basin 3C base & sides

T. Overland Basin 5 base & sides

U. Overland Basin 6 base & sides

5.3. Non-critical areas.

In areas of the M3J9 scheme where existing carriageway is being retained and overlaid, with minor localised widenings (i.e. A33 and A34 on embankment over River Itchen floodplain, and the M3 mainline north of Basin 1), the existing highway drainage is being retained. 3no. pipeline constructions are added to limit runoff from overlaid carriageway to existing flow rates. The consequence of surface flooding during blockages in these areas would be to overspill off embankment to floodplain, or to run in verge to a valley bottom offsite. It is not proposed to incorporate mitigation measures for resilience in these non-critical areas. Locations are shown within the Drainage Schematic Plan included within the Drainage Strategy Report.

6. Summary of network performance during resilience scenarios

Table 6.1 summarises the volume and duration of surface flooding, or the volume of flow bypassed below-ground without surface flooding, during all resilience scenarios.

Hydraulic calculations for the flooding occurrences below are included in Appendix B.

Resilience Scenario Location Ref.	Location Description	Resilience Scenario	Duration of critical 5-yr + 20%CC rainfall event	Volume of Flooding (m^3)	Duration of surface flooding (mins)	Duration of critical 10-year +40% rainfall event	volume of Flooding (m^3)	Duration of flooding (mins)	Notes
A	Low point in the A34 Southbound approach (near-side kerb) to the A34 underpass (western portal)	50% blockage in 600mm dia. pipe	15 mins	No surface flooding. 7.0m^3 bypassed around blockage via sub-surface overflow pipe	n/a	15 mins	No surface flooding. 26.5m^3 bypassed around blockage via sub-surface overflow pipe	n/a	Surcharging flow from blockage in tunnel cutting utilises each of 3 x sub-surface overflows to bypass blockage
B	Low points at the A33 NB approach (both kerbs, cambered) to the A33 underpass (southern portal)	50% blockage in 450mm dia. pipe	15 mins	No surface flooding. 2.3m^3 bypassed around blockage via sub-surface overflow pipe	n/a	15 mins	No surface flooding. 8.7m^3 bypassed around blockage via sub-surface overflow pipe	n/a	Surcharging flow from blockage in tunnel cutting utilises 1 x sub-surface overflow to bypass blockage
C	Drainage exit to Basin 4 at low point from M3 Mainline to West A34 NB (nearside kerb).	50% blockage in 750mm dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
D	Basin 4 outlet	50% reduction in flow control capacity	n/a	n/a	n/a	n/a	n/a	n/a	
E	Low point of WCH (east of gyratory roundabout)	50% blockage in 225mm dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
F	Low point of WCH (within western half of gyratory roundabout)	50% blockage in 150mm dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
G	Drainage exit from low point of M3SB diverge in cutting (near-side kerb)	50% blockage in 600mm dia. pipe	n/a	n/a	n/a	15 mins	15 m^3 temporary surcharge to surface.	12 mins	Cutting-toe trench drain alongside low spot has approx. 14m^3 void capacity below ground, which reduces surface flooding at low spot to 15m^3, which will drain down via

									overspill out of carriageway at downstream blockage point
H	Drainage exit of geocellular storage in footway/cycleway between A34 NB and A34 SB	50% blockage in flow control capacity	n/a	n/a	n/a	n/a	n/a	n/a	
I	Drainage exit from low point at West M3NB diverge (near-side)	50% blockage in 450mm dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
J	M3 NB low point (near-side kerb)	50% blockage in 750m dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
K	Basin 3A outlet	50% blockage in 200mm dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
L	Basin 3B outlet	50% blockage in 600mm dia. pipe	n/a	n/a	n/a	n/a	n/a	n/a	
M	East M3 SB low point (against Central Reservation)	50% blockage in 750mm dia. pipe (blockage as J)	n/a	n/a	n/a	n/a	n/a	n/a	
N	Low point in western roundabout (off-side kerb)	50% blockage in 375mm dia. pipe	n/a	n/a	n/a	15 mins	13 m^3 temporary surcharge to surface.	8 mins	Overspill out of carriageway to soft landscaping, west of A33N exit from gyratory
O	Low point in western roundabout (near-side kerb)	50% blockage in 375mm dia. pipe (blockage as N)	n/a	n/a	n/a	15 mis	5 m^3 temporary surcharge to surface.	10 mins	Overspill out of carriageway to soft landscaping, west of A33N exit from gyratory
Resilience Scenario Location Ref.	**Location Description**	**Resilience Scenario**				**Duration of critical 100-year +40% rainfall event**	**volume of Flooding (m^3)**	**Duration of flooding (mins)**	**Notes**
P	Basin 1	(Lined)						n/a	Lining proposed to protect groundwater Refer to DSR for half-drain times.
Q	Basin 2 base & sides	Zero infiltration				7 days	n/a	n/a	Flow contained. No overspill

	Basin 3A	(Lined)						n/a	Lining proposed to protect groundwater Refer to DSR for half-drain times.
R	Basin 3B base & sides	Zero infiltration				1.5 days	n/a	n/a	Flow contained. No overspill
S	Basin 3C base & sides	Zero infiltration				4 days	n/a	n/a	Flow contained. No overspill
	Basin 4 base & sides	(Lined)						n/a	Lining proposed to protect groundwater Refer to DSR for half-drain times.
T	Overland Basin 5 base & sides	Zero infiltration				6 hrs		n/a	Flow contained. No overspill
U	Overland Basin 6 base & sides	Zero infiltration				4 hrs		n/a	Flow contained. No overspill
	Geocell 7	(Lined)						n/a	Lining proposed to protect groundwater Refer to DSR for half-drain times.

Table 6.1 Summary of network performance during resilience scenarios

7. Mitigation Measures

The following Mitigation Measures have been proposed within the drainage network to achieve the performance identified in Table 6.1:

Resilience Scenario Location Ref.	Location Description	Resilience Scenario	Mitigation Measures
A	Low point in the A34 Southbound approach (near-side kerb) to the A34 underpass (western portal)	50% blockage in 600mm dia. pipe	3no. 300mm dia. cross-pipes to bypass primary drainage route at low spot
B	Low points at the A33 NB approach (both kerbs, cambered) to the A33 underpass (southern portal)	50% blockage in 450mm dia. pipe	1no. 300mm dia. cross-pipes to bypass primary drainage route at low spot
C	Drainage exit to Basin 4 at low point from M3 Mainline to West A34 NB (nearside kerb).	50% blockage in 750mm dia. pipe	None required. A precautionary measure will be an overspill route in the WM3NB nearside kerb, to allow exceedance flows to landscaping north of Basin 4.
D	Basin 4 outlet	50% reduction in flow control capacity	300 dia. overflow above flow control @ 100-year + 40%CC design level.
E	Low point of WCH (east of M3 roundabout)	50% blockage in 225mm dia. pipe	None required
F	Low point of WCH (within western half of M3 roundabout)	50% blockage in 150mm dia. pipe	None required. A precautionary measure will be an overspill route in the WCH east verge, to allow exceedance flows to flow over the WM3NB cutting slope.
G	Drainage exit from low point of EM3SB diverge in cutting (near-side kerb)	50% blockage in 600mm dia. pipe	None required. A natural overspill route to out-of-carriageway landscaping exists at the blockage point in the proposed verge.
H	Drainage exit of geocellular storage in Footway/Cycleway Route between A34 NB and A34 SB	50% blockage in flow control capacity	150mm dia. overflow above flow control @ 100-year + 40%CC design level.
I	Drainage exit from low point at West M3NB diverge (near-side)	50% blockage in 450mm dia. pipe	None required. A natural overspill route to out-of-carriageway landscaping exists at the blockage point in the proposed verge.
J	M3 NB low point (near-side kerb)	50% blockage in 750mm dia. pipe	None required. A precautionary measure will be double grated entries to cater for exceedance flows into verge carriageway-drainage.
K	Basin 3A outlet	50% blockage in 200mm dia. pipe	None required. An overspill route from Basin 3A to 3B is proposed via a low point in the service access route passing above and behind the Basin 3A outlet flow control.
L	Basin 3B outlet	50% blockage in 600mm dia. pipe	None required. An overspill route from Basin 3A to 3B is proposed via a low point in the service access route passing above and behind the Basin 3A outlet flow control.
M	East M3 SB low point (against Central Reservation)	50% blockage in 750mm dia. pipe (blockage as J)	None required. Surface flooding from the blockage scenario can be drained via the separate carriageway drainage on the eastern side of the M3 central reserve.
N	Low point in western roundabout (off-side kerb)	50% blockage in 375mm dia. pipe	None required. Overflow connection from kerb-drain outlet into roundabout landscaping.
O	Low point in western roundabout (near-side kerb)	50% blockage in 375mm dia. pipe (blockage as N)	None required. Increase gully spacings reduced and pipework diameter increased for additional capacity for exceedance surface flows.

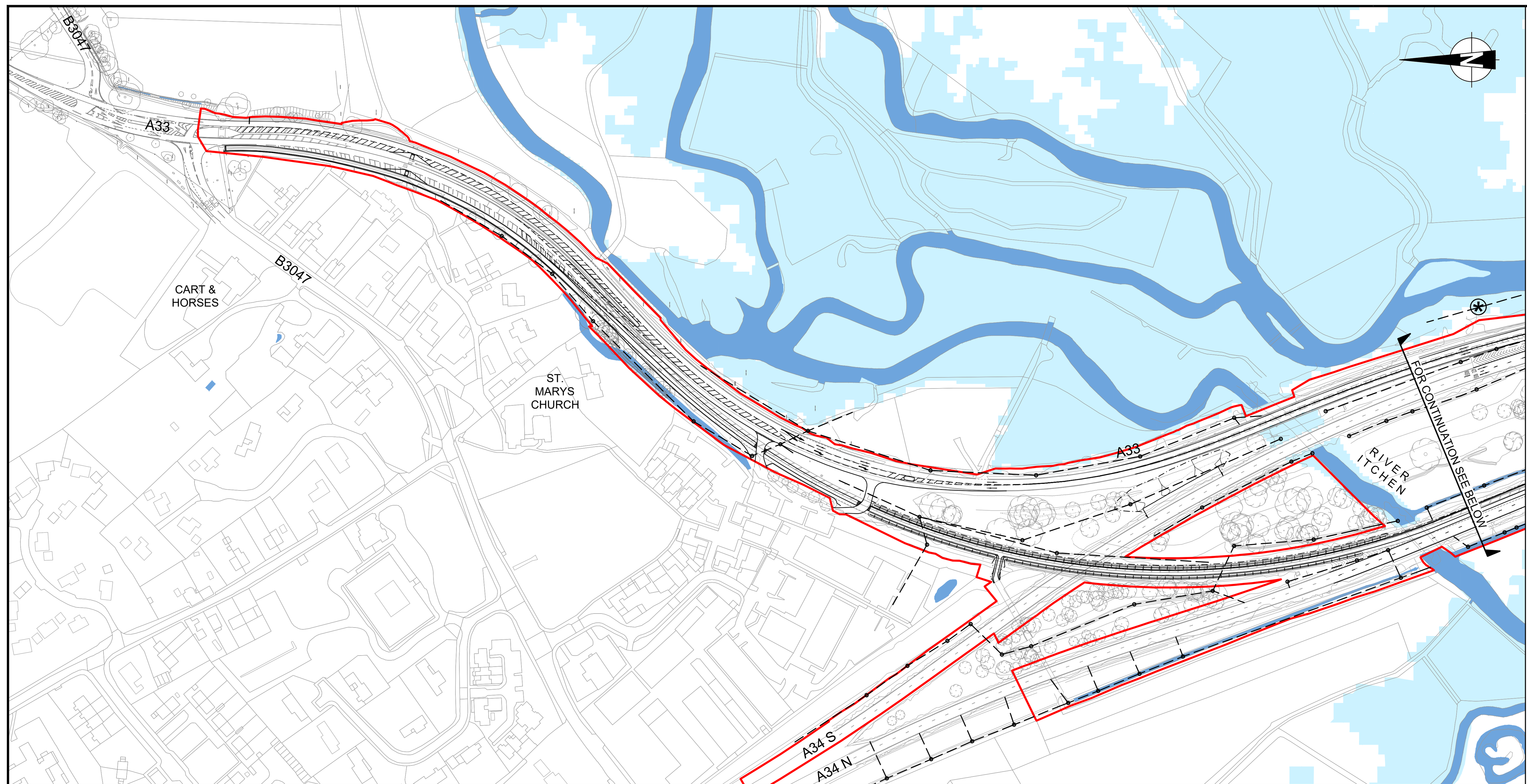
Resilience Scenario Location Ref.	Location Description	Resilience Scenario	None required
P	Basin 1 base & sides	(Lined)	None required. Overspill flows routed overland on floodplain to River Itchen.
Q	Basin 2 base & sides	Zero infiltration	None required. Overspill flows routed overland on floodplain to River Itchen.
	Basin 3A	(Lined)	None required
R	Basin 3B base & sides	Zero infiltration	None required. An overspill route from Basin 3B to 3C is proposed via a low point in the service access route passing above and behind the Basin 3B outlet flow control.
S	Basin 3C base & sides	Zero infiltration	None required. Overspill flows routed overland on floodplain to River Itchen.
	Basin 4 base & sides	(Lined)	None required
T	Overland Basin 5 base & sides	Zero infiltration	None required. Highway + Overland flow contained
U	Overland Basin 6 base & sides	Zero infiltration	None required. Overland flow contained
	Geocell 7	(Lined)	None required

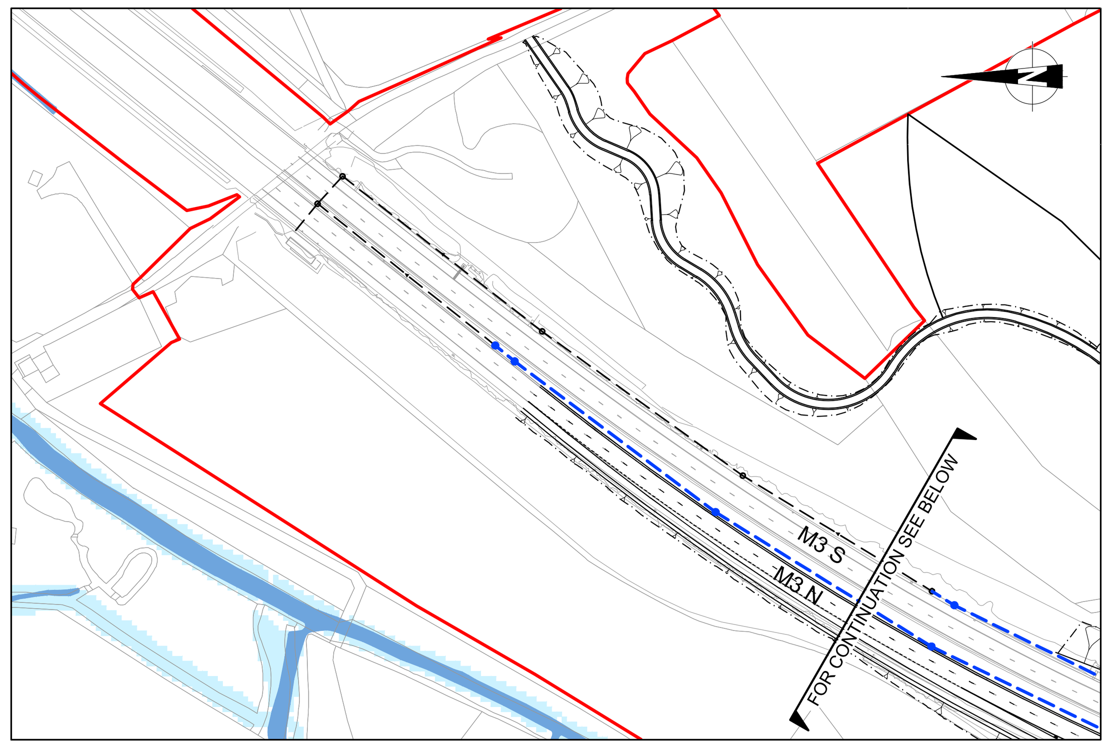
Table 6.2 Summary of network performance during resilience scenarios

Appendix A Drainage Network Resilience to Critical-Location Blockages

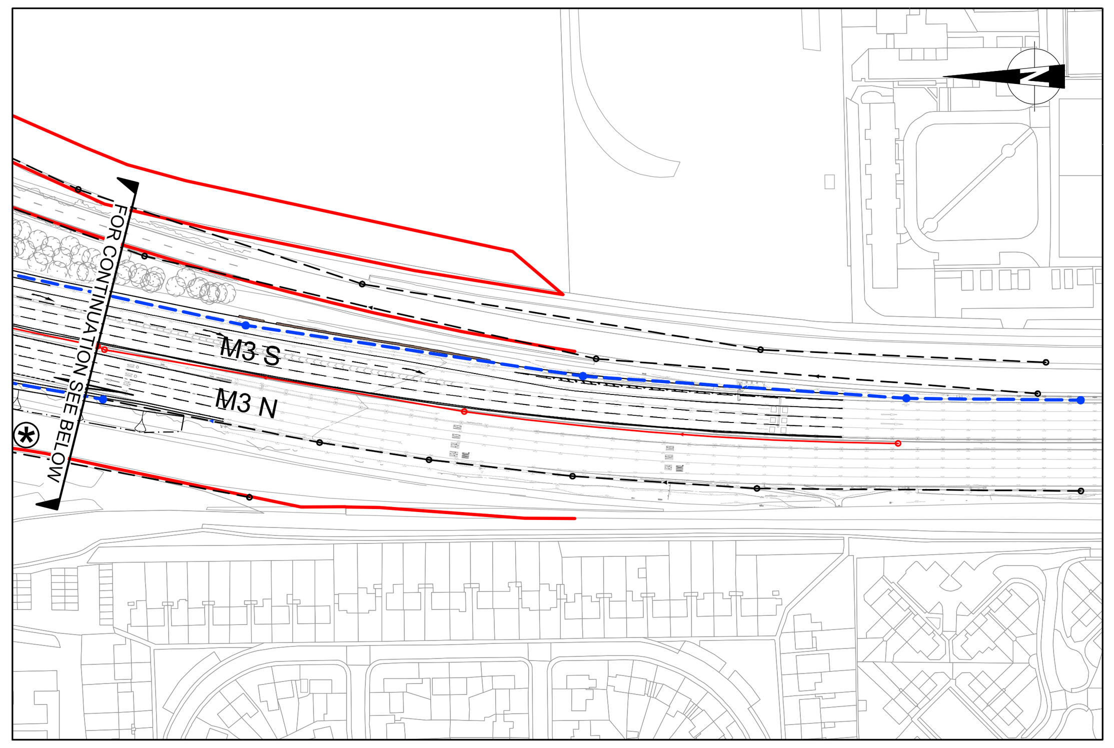
HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0520 Drainage Resilience Performance

HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0521 Drainage Network Resilience Table





INSET 1: M3 NORTHBOUND CONTINUATION EXTRACT



INSET 2: M3 SOUTHBOUND CONTINUATION EXTRACT

KEY

- DEVELOPMENT CONSENT ORDER BOUNDARY
- PROPOSED HIGHWAY SURFACE WATER DRAINAGE NETWORK
- RETAINED EXISTING HIGHWAY SURFACE WATER DRAINAGE
- RIVER ITCHEN
- ENVIRONMENT AGENCY FLOOD ZONE 3 EXTENT
- EXISTING SOAKAWAY FEATURE REFURBISHED AND REUSED
- EXISTING INFILTRATION FEATURE TO BE ABANDONED
- PROPOSED POLLUTION CONTROL DEVICE
- PROPOSED UNDERPASS / SUBWAY
- EXISTING / PROPOSED CARRIAGEWAY LOW SPOT / VULNERABLE FEATURE
- ADDITIONAL OVERFLOW PIPEWORK CONNECTION PROVIDED FOR MITIGATION
- UPSIZED OVERFLOW PIPEWORK CONNECTION PROVIDED FOR MITIGATION

CONFIDENTIAL
THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. DO NOT SCALE FROM THIS DRAWING.
3. THE LAYOUT SHOWN IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN.
4. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER SGAR 3 SUBMISSION DRAWINGS AND DOCUMENTS.
5. FOR PROPOSED AND EXISTING HIGHWAY CATCHMENTS REFER TO DRAWING NUMBERS HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0513 AND 0515.
6. FOR DETAIL OF M3 JUNCTION 9-14 MOTORWAY UPGRADE SCHEME DRAINAGE DESIGN REFER TO DRAWING NUMBERS HE549338-MMSJV-HDG-000-DR-CD-31001 TO 31007.
7. PROPOSED SCHEME SHOWN IS SUBJECT TO REVIEW BY THE RESPECTIVE HIGHWAY AUTHORITIES, LEAD LOCAL FLOOD AUTHORITY AND THE ENVIRONMENT AGENCY.
8. RE-USE OF EXISTING DRAINAGE ASSETS IS SUBJECT TO REVIEW OF SURVEY DATA, ASSET RECORDS AND SITE VERIFICATION. THIS IS TO BE UNDERTAKEN DURING SGAR 5 (DETAILED DESIGN).
9. DRAWING TO BE READ IN CONJUNCTION WITH:
   - DRAINAGE STRATEGY REPORT REF: HE551511-VFK-HDG-X_XXXX_XX-RP-CD-0001
   - POLLUTION PREVENTION TECHNICAL NOTE REF: HE551511-VFK-HGN-X_XXXX_XX-TN-CH-0003
   - CLIMATE CHANGE CRITERIA TECHNICAL NOTE REF: HE551511-VFK-HDG-X_XXXX_XX-TN-CD-0001
10. FIN DRAINS ARE NOT SHOWN ON THIS DRAWING. THESE SHALL BE DETAILED DURING SGAR 5 (DETAILED DESIGN).
11. CONTROL OF RUNOFF AND SEDIMENT DURING CONSTRUCTION TO BE STRICTLY IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN, WHICH MAY INCLUDE PIPES, SWALES AND BASINS NOT SHOWN ON THIS DRAWING.THIS IS TO BE DEVELOPED DURING SGAR 5 (DETAILED DESIGN).
12. FOR DRAINAGE STRATEGY LAYOUT INCLUDING DETAIL OF PROPOSED DRAINAGE FEATURES REFER TO DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0512.
13. FOR DRAINAGE NETWORK RESILIENCE (VULNERABLE AREA) PERFORMANCE INFORMATION, REFER TO TABLE ON DRAWING NUMBER HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0521.

0 50 100 150 200 250m

SCALE 1:2500

Rev.	Date	Description	Drawn	Chk'd	App'd
P03	06.07.21	UPDATED TO SUIT OMISSION OF MANAGED MOTORWAY SCHEME	JH	LC	MF
P02	23.11.21	ISSUED FOR S3 SUBMISSION	ljj	AC	TRA
P01	15.10.21	FIRST ISSUE	NK	AC	TRA

Drawing Status: S3 - FOR REVIEW & COMMENT

VolkerFitzpatrick

Client: national highways

Project Title: M3 JUNCTION 9 IMPROVEMENT

Drawing Title: SGAR 3 PRELIMINARY DESIGN DRAINAGE NETWORK RESILIENCE RESILIENCE SCENARIOS AND MITIGATION MEASURES

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	NK	AC	TRA
Original Size: Size	Date: 15.10.21	Date: 15.10.21	Date: 15.10.21	Date: 15.10.21

Drawing Number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE551511 - VFK -HDG- X_XXXX_XX - DR - CD - 0520

Project Ref. No.: 48176

Revision: P03

Resilience Scenario Location Ref.	Location Description	Resilience Scenario	Duration of critical 5-year + 20% rainfall event	Volume of Flooding (m3)	Duration of surface flooding (mins)	Duration of critical 10-year +40% rainfall event	volume of Flooding (m3)	Duration of flooding (mins)	Notes
A	Low point in the A34 Southbound approach (near-side kerb) to the A34 underpass (western portal)	50% blockage in 600 dia pipe	15 mins	No surface flooding. 7.0m3 bypassed around blockage via sub-surface overflow pipe	n/a	15 mins	No surface flooding. 26.5m3 bypassed around blockage via sub-surface overflow pipe	n/a	Surcharging flow from blockage in tunnel cutting utilises each of 3 x sub-surface overflows to bypass blockage
B	Low points at the A33 NB approach (both kerbs, cambered) to the A33 underpass (southern portal)	50% blockage in 450 dia pipe	15 mins	No surface flooding. 2.3m3 bypassed around blockage via sub-surface overflow pipe	n/a	15 mins	No surface flooding. 8.7m3 bypassed around blockage via sub-surface overflow pipe	n/a	Surcharging flow from blockage in tunnel cutting utilises 1 x sub-surface overflow to bypass blockage
C	Drainage exit to Basin 4 at low point from M3 Mainline to West A34 NB (nearside kerb).	50% blockage in 750 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
D	Basin 4 outlet	50% reduction in flow control capacity	n/a	n/a	n/a	n/a	n/a	n/a	
E	Low point of NMU (east of M3 roundabout)	50% blockage in 225 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
F	Low point of NMU (within western half of M3 roundabout)	50% blockage in 150 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
G	Drainage exit from low point of M3SB diverge in cutting (near-side kerb)	50% blockage in 600 dia pipe	n/a	n/a	n/a	15 mins	15m3 temporary surcharge to surface.	12 mins	Cutting-toe trench drain alongside lowspot has approx. 14m3 void capcity below ground, which reduces surface flooding at low spot to 15m3, which will drain down via overspill out of carriageway at downstream blockge point
H	Drainage exit of geocellular storage in NMU between A34 NB and A34 SB	50% blockage in flow control capacity	n/a	n/a	n/a	n/a	n/a	n/a	
I	Drainage exit from low point at West M3NB diverge (near-side)	50% blockage in 450 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
J	M3 NB low point (near-side kerb)	50% blockage in 600 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
K	Basin 3A outlet	50% blockage in 200 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
L	Basin 3B outlet	50% blockage in 600 dia pipe	n/a	n/a	n/a	n/a	n/a	n/a	
M	East M3 SB low point (against Central Reservation)	50% blockage in 750 dia pipe (blockage as J)	n/a	n/a	n/a	n/a	n/a	n/a	
N	Low point in western roundabout (off-side kerb)	50% blockage in 375 dia pipe	n/a	n/a	n/a	15 mins	13m3 temporary surcharge to surface.	8 mins	Overspill out of carriageway to soft landscaping, west of A33N exit from gyratory
O	Low point in western roundabout (near-side kerb)	50% blockage in 375 dia pipe (blockage as N)	n/a	n/a	n/a	15 mis	5m3 temporary surcharge to surface.	10 mins	Overspill out of carriageway to soft landscaping, west of A33N exit from gyratory
Resilience Scenario Location Ref.	**Location Description**	**Resilience Scenario**				**Duration of critical 100-year +40% rainfall event**	**volume of Flooding (m3)**	**Duration of flooding (mins)**	**Notes**
P	Basin 1	(Lined)						Refer to DSR	Lining proposed to protect groundwater
Q	Basin 2 base & sides	Zero infiltration				7 days	n/a	n/a	Flow contained. No overspill
	Basin 3A	(Lined)						Refer to DSR	Lining proposed to protect groundwater
R	Basin 3B base & sides	Zero infiltration				1.5 days	n/a	n/a	Flow contained. No overspill
S	Basin 3C base & sides	Zero infiltration				4 days	n/a	n/a	Flow contained. No overspill
	Basin 4 base & sides	(Lined)						Refer to DSR	Lining proposed to protect groundwater

NOTES:

1. THIS DRAWING PROVIDES THE TABULATED INFORMATION TO SUPPORT THE DRAINAGE NETWORK RESILIENCE SCENARIOS AND MITIGATION MEASURES LAYOUT, AS SHOWN ON DRAWING REF: HE551511-VFK-HDG-X_XXXX_XX-DR-CD-0520

Rev.	Date	Description	Drawn	Chk'd	App'd
P01	11.10.21	FIRST ISSUE	RG	AC	TRA

Drawing Status: S2 - FOR INFORMATION

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: DRAINAGE NETWORK RESILIENCE - PERFORMANCE SUMMARY TABLE

Client

Scale	Designed	Drawn	Checked	Approved
1:2500	PR	RG	AC	TRA
Original Size: A3	Date: 11.10.21	Date: 11.10.21	Date: 11.10.21	Date: 11.10.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE551511 - VFK -HDG- X-XXXX-XX - DR - CD - 0521

Project Ref. No. 48176

Revision P01

Appendix B Resilience Drainage Calculations

5yr + 20%CC + 50% blockages

1. Highway Drainage to Outfalls A & 8 (Ex): Basins 2 + 3C M5-20% - 50% blockages.
2. Highway Drainage to Outfall B: Geocell M5-20% - 50% blockages.
3. Highway Drainage to Basin 5: Basins 5 M5-20% - 50% blockages.
4. Retained & Modified Highway Drainage to A33, A34 & M3 North of M3J9. **(N/A)**

10yr + 40%CC + 50% blockages (Sensitivity)

5. Highway Drainage to Outfalls A & 8 (Ex): Basins 2 + 3C M10-40% - 50% blockages (sensitivity).
6. Highway Drainage to Outfall B: Geocell M10-40% - 50% blockages (sensitivity).
7. Highway Drainage to Basin 5: Basins 5 M10-40% - 50% blockages (sensitivity).
8. Retained & Modified Highway Drainage to A33, A34 & M3 North of M3J9 - **(N/A)**

100yr + 40%CC (zero infiltration)

9. Highway Drainage to Outfalls A & 8 (Ex): Basins 2 + 3C M100-40% - zero infiltration.
10. Highway Drainage to Outfall B: - **(N/A)**
11. Highway Drainage to Basin 5: 2021 10 25 Basin 5 M100+40CC zero infiltr.
12. Basin 6: 2021 10 25 Basin 6 M100+40CC zero infiltr.
13. Retained & Modified Highway Drainage to A33, A34 & M3) North of M3J9. - **(N/A)**

Online Controls for New works to Basins 2 & 3C

Orifice Manhole: S36, DS/PN: S316.010, Volume (m^3): 4.7

Diameter (m) 0.265 Discharge Coefficient 0.600 Invert Level (m) 58.499

Orifice Manhole: S47, DS/PN: S321.002, Volume (m^3): 28.2

Diameter (m) 0.240 Discharge Coefficient 0.600 Invert Level (m) 56.653

Orifice Manhole: S61, DS/PN: S323.007, Volume (m^3): 67.7

Diameter (m) 0.160 Discharge Coefficient 0.600 Invert Level (m) 55.488

Orifice Manhole: S78, DS/PN: S325.003, Volume (m^3): 1.6

Diameter (m) 0.106 Discharge Coefficient 0.600 Invert Level (m) 57.000

Orifice Manhole: S243, DS/PN: S321.010, Volume (m^3): 28.9

Diameter (m) 0.530 Discharge Coefficient 0.600 Invert Level (m) 52.126

Hydro-Brake® Optimum Manhole: S71, DS/PN: S320.006, Volume (m^3): 19.2

Unit Reference	MD-SHE-0414-1250-2500-1250
Design Head (m)	2.500
Design Flow (l/s)	125.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	414
Invert Level (m)	51.393
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.500	124.9	Kick-Flo®	1.707	103.8
Flush-Flo™	0.790	124.3	Mean Flow over Head Range	-	106.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	11.2	0.800	124.3	2.000	112.0	4.000	157.0	7.000	206.5
0.200	40.4	1.000	123.2	2.200	117.4	4.500	166.3	7.500	213.6
0.300	78.8	1.200	121.0	2.400	122.4	5.000	175.1	8.000	220.4
0.400	113.5	1.400	117.4	2.600	127.3	5.500	183.5	8.500	227.1
0.500	120.0	1.600	110.4	3.000	136.5	6.000	191.5	9.000	233.5
0.600	122.7	1.800	106.5	3.500	147.1	6.500	199.1	9.500	239.8

Orifice Manhole: S98, DS/PN: S314.004, Volume (m^3): 1.2

Diameter (m) 0.141 Discharge Coefficient 0.600 Invert Level (m) 42.850

Orifice Manhole: S54, DS/PN: S331.006, Volume (m^3): 3.5

Diameter (m) 0.318 Discharge Coefficient 0.600 Invert Level (m) 43.083

Orifice Manhole: S114, DS/PN: S314.006, Volume (m³): 1.2

Diameter (m) 0.141 Discharge Coefficient 0.600 Invert Level (m) 42.050

Orifice Manhole: S100, DS/PN: S334.012, Volume (m³): 10.9

Diameter (m) 0.424 Discharge Coefficient 0.600 Invert Level (m) 42.176

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Unit Reference	MD-SHE-0214-2930-2400-2930
Design Head (m)	2.400
Design Flow (l/s)	29.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	40.850
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.400	29.3	Kick-Flo®	1.466	23.1
Flush-Flo™	0.693	29.2	Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	0.800	29.1	2.000	26.8	4.000	37.4	7.000	49.1
0.200	20.9	1.000	28.5	2.200	28.1	4.500	39.6	7.500	50.7
0.300	26.1	1.200	27.2	2.400	29.3	5.000	41.7	8.000	52.3
0.400	27.8	1.400	24.6	2.600	30.4	5.500	43.7	8.500	53.9
0.500	28.7	1.600	24.1	3.000	32.6	6.000	45.5	9.000	55.4
0.600	29.1	1.800	25.5	3.500	35.1	6.500	47.3	9.500	56.9

Orifice Manhole: S261, DS/PN: S336.009, Volume (m³): 14.7

Diameter (m) 0.318 Discharge Coefficient 0.600 Invert Level (m) 55.282

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m³): 5.8

Unit Reference	MD-SHE-0082-4000-2000-4000
Design Head (m)	2.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	48.604
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	4.0	Kick-Flo®	0.729	2.5
Flush-Flo™	0.356	3.1	Mean Flow over Head Range	-	3.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m³): 5.8

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	3.0	1.000	2.9	2.200	4.2	4.500	5.8	7.500	7.4
0.300	3.1	1.200	3.2	2.400	4.3	5.000	6.1	8.000	7.7
0.400	3.1	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	3.1	1.600	3.6	3.000	4.8	6.000	6.7	9.000	8.1
0.600	2.9	1.800	3.8	3.500	5.2	6.500	6.9	9.500	8.3

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m³): 10.9

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	41.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.8	7.000	4.9
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	1.9	1.200	2.2	2.400	3.0	5.000	4.2	8.000	5.2
0.400	1.9	1.400	2.3	2.600	3.1	5.500	4.4	8.500	5.4
0.500	1.8	1.600	2.5	3.000	3.3	6.000	4.6	9.000	5.5
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.7

Orifice Manhole: S261, DS/PN: S352.004, Volume (m³): 38.1

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 60.425

Depth/Flow Relationship Manhole: S256, DS/PN: S355.001, Volume (m³): 50.4

Invert Level (m) 64.300

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.700	0.0000	1.300	0.0000	1.900	0.0000	2.500	0.0000
0.200	0.0000	0.800	0.0000	1.400	0.0000	2.000	0.0000	2.600	0.0000
0.300	0.0000	0.900	0.0000	1.500	0.0000	2.100	0.0000	2.700	0.0000
0.400	0.0000	1.000	0.0000	1.600	0.0000	2.200	0.0000	2.800	0.0000
0.500	0.0000	1.100	0.0000	1.700	0.0000	2.300	0.0000	2.900	0.0000
0.600	0.0000	1.200	0.0000	1.800	0.0000	2.400	0.0000	3.000	0.0000

Offline Controls for New works to Basins 2 & 3C

Pipe Manhole: SSMP CR010, DS/PN: S323.004, Loop to PN: S337.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	60.041

Pipe Manhole: S61, DS/PN: S323.007, Loop to PN: S339.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	55.488

Pipe Manhole: S71, DS/PN: S320.006, Loop to PN: S315.009

Diameter (m)	0.450	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	40.000	Upstream Invert Level (m)	54.650

Weir Manhole: S98, DS/PN: S314.004, Loop to PN: S314.005

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 45.200

Pipe Manhole: S106, DS/PN: S331.005, Loop to PN: S331.007

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	200.0	Coefficient of Contraction	0.600
Length (m)	16.500	Upstream Invert Level (m)	43.514

Weir Manhole: S114, DS/PN: S314.006, Loop to PN: S314.007

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.900

Pipe Manhole: S98, DS/PN: S335.002, Loop to PN: S334.015

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	27.5	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	43.032

Pipe Manhole: S99, DS/PN: S335.003, Loop to PN: S334.014

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	57.0	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	42.850

Weir Manhole: S154, DS/PN: S314.008, Loop to PN: S314.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.150

Pipe Manhole: S262, DS/PN: S336.006, Loop to PN: S350.000

Diameter (m)	0.225	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	59.809

Weir Manhole: S261, DS/PN: S352.004, Loop to PN: S321.000

Discharge Coef 0.544 Width (m) 1.800 Invert Level (m) 61.255

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Offline Controls	11	Number of Time/Area Diagrams	0
Number of Online Controls	16	Number of Storage Structures	7	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.411
FEH Rainfall Version	1999	E (1km)	0.294
Site Location	GB 449350 131500 SU 49350 31500	F (1km)	2.313
C (1km)	-0.025	Cv (Summer)	1.000
D1 (1km)	0.429	Cv (Winter)	1.000
D2 (1km)	0.273		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S314.000	S32	15 Summer	5	+20%					49.876	-0.068	0.000	0.58
S314.001	S33	15 Summer	5	+20%					48.808	-0.043	0.000	0.83
S315.000	S31	15 Summer	5	+20%					59.356	-0.094	0.000	0.29
S315.001	S32	15 Summer	5	+20%					58.258	-0.076	0.000	0.47
S316.000	S26	15 Summer	5	+20%					63.391	-0.102	0.000	0.22
S316.001	S27	15 Summer	5	+20%					63.153	-0.090	0.000	0.33
S316.002	S28	15 Summer	5	+20%					62.773	-0.060	0.000	0.66
S316.003	S29	15 Summer	5	+20%					62.464	-0.108	0.000	0.51
S316.004	S30	30 Summer	5	+20%	5/15 Summer				59.949	0.168	0.000	0.72
S316.005	S31	30 Summer	5	+20%	5/15 Summer				59.864	0.181	0.000	0.45
S316.006	S32	30 Summer	5	+20%	5/15 Summer				59.714	0.272	0.000	0.79
S316.007	S33	30 Summer	5	+20%	5/15 Summer				59.630	0.272	0.000	0.73
S316.008	S9	30 Summer	5	+20%	5/15 Summer				59.536	0.274	0.000	0.39
S317.000	S33	15 Summer	5	+20%					63.237	-0.135	0.000	0.34
S317.001	S34	15 Summer	5	+20%					62.682	-0.149	0.000	0.49
S317.002	S35	15 Summer	5	+20%					62.587	-0.174	0.000	0.36
S317.003	S36	15 Summer	5	+20%					62.413	-0.176	0.000	0.33
S317.004	S38	15 Summer	5	+20%					60.270	-0.175	0.000	0.36
S317.005	S39	30 Summer	5	+20%					59.703	-0.047	0.000	0.52
S317.006	S40	30 Summer	5	+20%	5/15 Summer				59.629	0.165	0.000	0.48
S317.007	S41	30 Summer	5	+20%	5/15 Summer				59.509	0.258	0.000	0.68
S318.000	S12	15 Summer	5	+20%					60.951	-0.111	0.000	0.16
S318.001	S13	15 Summer	5	+20%					60.677	-0.101	0.000	0.24
S318.002	S14	15 Summer	5	+20%					60.170	-0.084	0.000	0.40
S318.003	S15	15 Summer	5	+20%					59.697	-0.080	0.000	0.44
S319.000	S30	15 Summer	5	+20%					59.643	-0.107	0.000	0.18
S319.001	S31	30 Summer	5	+20%	5/15 Summer				59.444	0.028	0.000	0.20
S318.004	S176	30 Summer	5	+20%	5/15 Summer				59.438	0.293	0.000	0.84
S316.009	S18	30 Summer	5	+20%	5/15 Summer				59.416	0.336	0.000	0.73
S316.010	S36	30 Summer	5	+20%	5/15 Summer				59.290	0.416	0.000	0.71

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S314.000	S32			21.3	OK	
S314.001	S33			30.8	OK	
S315.000	S31			9.0	OK	
S315.001	S32			17.1	OK	
S316.000	S26			4.8	OK	
S316.001	S27			7.7	OK	
S316.002	S28			11.2	OK	
S316.003	S29			41.2	OK	
S316.004	S30			45.6	SURCHARGED	
S316.005	S31			51.2	SURCHARGED	
S316.006	S32			50.0	SURCHARGED	
S316.007	S33			51.6	SURCHARGED	
S316.008	S9			53.7	SURCHARGED	
S317.000	S33			26.6	OK	
S317.001	S34			30.1	OK	
S317.002	S35			33.6	OK	
S317.003	S36			50.1	OK	
S317.004	S38			56.3	OK	
S317.005	S39			54.2	OK	
S317.006	S40			51.8	SURCHARGED	
S317.007	S41			47.7	SURCHARGED	
S318.000	S12			4.2	OK	
S318.001	S13			6.1	OK	
S318.002	S14			9.7	OK	
S318.003	S15			11.1	OK	
S319.000	S30			4.0	OK	
S319.001	S31			4.3	SURCHARGED	
S318.004	S176			11.9	SURCHARGED	
S316.009	S18			106.0	SURCHARGED	
S316.010	S36			118.1	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S316.011	S37	30 Summer	5	+20%					58.337	-0.080
S316.012	S36	30 Summer	5	+20%					58.109	-0.213
S316.013	S37	30 Summer	5	+20%					57.133	-0.238
S315.002	S34	30 Summer	5	+20%					56.011	-0.186
S315.003	S28	30 Summer	5	+20%					53.776	-0.209
S315.004	S29	30 Summer	5	+20%					52.066	-0.208
S315.005	S30	30 Summer	5	+20%	5/15 Summer				50.531	0.011
S315.006	S72	30 Summer	5	+20%					50.155	-0.161
S315.007	S73	30 Summer	5	+20%					49.515	-0.181
S315.008	S8	30 Summer	5	+20%					48.864	-0.181
S320.000	S1	15 Summer	5	+20%					59.676	-0.043
S320.001	S2	15 Summer	5	+20%					58.066	-0.044
S320.002	S3	15 Summer	5	+20%					55.183	-0.094
S320.003	S4	15 Summer	5	+20%					54.199	-0.064
S321.000	S45	15 Summer	5	+20%					59.047	-0.449
S321.001	S46	15 Summer	5	+20%					57.989	-0.444
S321.002	S47	30 Summer	5	+20%	5/15 Summer				57.347	0.394
S321.003	S48	30 Summer	5	+20%					56.623	-0.191
S321.004	S74	30 Summer	5	+20%					55.688	-0.183
S321.005	S75	30 Summer	5	+20%					55.059	-0.200
S321.006	S76	30 Summer	5	+20%					54.527	-0.182
S321.007	S77	30 Summer	5	+20%					53.685	-0.182
S322.000	S94	15 Summer	5	+20%					54.483	-0.032
S322.001	S95	15 Summer	5	+20%					54.065	-0.072
S322.002	S96	15 Summer	5	+20%					53.784	-0.151
S322.003	S97	15 Summer	5	+20%					53.557	-0.083
S322.004	S98	15 Summer	5	+20%					53.366	-0.157
S321.008	S58	30 Summer	5	+20%	5/15 Summer				53.294	0.219
S323.000	S54	15 Summer	5	+20%					67.398	-0.020
S323.001	SSMP CR012	15 Summer	5	+20%					66.601	-0.062
S323.002	SSMP CR011	60 Summer	5	+20%					64.108	-0.445
S323.003	SSMP CRS4	60 Summer	5	+20%	5/15 Summer	5/15 Summer			64.047	1.518
S323.004	SSMP CR010	15 Summer	5	+20%			5/15 Summer	24	60.156	-0.335
S323.005	SSMP CR009	15 Summer	5	+20%					58.522	-0.799
S323.006	SSMP 1106	15 Summer	5	+20%					57.325	-0.771
S323.007	S61	30 Summer	5	+20%	5/15 Summer		5/15 Summer	24	56.600	0.737
S323.008	S79	30 Summer	5	+20%					54.512	-0.272
S323.009	S63	30 Summer	5	+20%					54.145	-0.285
S323.010	S80	30 Summer	5	+20%					53.810	-0.266
S323.011	S81	30 Summer	5	+20%					53.378	-0.241
S323.012	S66	30 Summer	5	+20%					53.223	-0.206
S321.009	SSMP CR004	30 Summer	5	+20%	5/15 Summer				53.171	0.195
S324.000	S67	15 Summer	5	+20%					54.683	-0.091
S324.001	S68	15 Summer	5	+20%					53.877	-0.079
S324.002	S69	15 Summer	5	+20%					53.480	-0.013
S325.000	S12	15 Summer	5	+20%					59.892	-0.102
S325.001	S13	15 Summer	5	+20%					59.180	-0.100
S325.002	S19	15 Summer	5	+20%					58.308	-0.098
S325.003	S78	15 Summer	5	+20%	5/15 Summer				57.243	0.093
S324.003	S78	30 Summer	5	+20%	5/30 Summer				53.242	0.015
S324.004	S70	30 Summer	5	+20%	5/15 Summer				53.119	0.125
S321.010	S243	30 Summer	5	+20%	5/15 Summer				53.083	0.207
S321.011	S72	180 Summer	5	+20%	5/180 Summer				52.783	0.020
S321.012	S244	180 Summer	5	+20%	5/120 Summer				52.769	0.120
S321.013	S63	180 Summer	5	+20%	5/30 Summer				52.755	0.319
S320.004	S5	180 Summer	5	+20%	5/30 Summer				52.745	0.335
S326.000	S249	15 Summer	5	+20%					59.359	-0.062
S326.001	S251	15 Summer	5	+20%					58.638	-0.131
S326.002	S251	15 Summer	5	+20%					56.575	-0.066
S326.003	S78	15 Summer	5	+20%	5/15 Summer				55.964	0.148

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S316.011	S37	0.000	0.98			118.1	OK	
S316.012	S36	0.000	0.39			122.9	OK	
S316.013	S37	0.000	0.29			122.8	OK	
S315.002	S34	0.000	0.50			137.1	OK	
S315.003	S28	0.000	0.41			146.7	OK	
S315.004	S29	0.000	0.41			155.5	OK	
S315.005	S30	0.000	1.07			162.2	SURCHARGED	
S315.006	S72	0.000	0.62			166.9	OK	
S315.007	S73	0.000	0.53			166.7	OK	
S315.008	S8	0.000	0.52			169.5	OK	
S320.000	S1	0.000	0.85			29.2	OK	
S320.001	S2	0.000	0.81			34.5	OK	
S320.002	S3	0.000	0.62			44.2	OK	
S320.003	S4	0.000	0.87			70.3	OK	
S321.000	S45	0.000	0.14			117.2	OK*	
S321.001	S46	0.000	0.15			114.1	OK	
S321.002	S47	0.000	0.97			90.9	SURCHARGED	
S321.003	S48	0.000	0.48			89.6	OK	
S321.004	S74	0.000	0.52			90.2	OK	
S321.005	S75	0.000	0.44			90.8	OK	
S321.006	S76	0.000	0.51			90.6	OK	
S321.007	S77	0.000	0.52			93.8	OK	
S322.000	S94	0.000	0.92			15.9	OK	
S322.001	S95	0.000	0.76			28.7	OK	
S322.002	S96	0.000	0.47			37.2	OK	
S322.003	S97	0.000	0.84			45.6	OK	
S322.004	S98	0.000	0.46			48.8	OK	
S321.008	S58	0.000	0.56			114.8	SURCHARGED	
S323.000	S54	0.000	0.89			49.1	OK	
S323.001	SSMP CR012	0.000	0.88			111.9	OK	
S323.002	SSMP CR011	0.000	0.11			113.1	OK	
S323.003	SSMP CRS4	47.035	1.29			33.3	FLOOD	14
S323.004	SSMP CR010	0.000	0.15	12.4		71.0	OK	
S323.005	SSMP CR009	0.000	0.03			71.3	OK	
S323.006	SSMP 1106	0.000	0.05			114.9	OK	
S323.007	S61	0.000	0.26	53.9		53.9	SURCHARGED	
S323.008	S79	0.000	0.32			69.1	OK	
S323.009	S63	0.000	0.29			69.0	OK	
S323.010	S80	0.000	0.35			99.6	OK	
S323.011	S81	0.000	0.56			140.6	OK	
S323.012	S66	0.000	0.53			133.5	OK	
S321.009	SSMP CR004	0.000	0.91			226.9	SURCHARGED	
S324.000	S67	0.000	0.73			77.2	OK	
S324.001	S68	0.000	0.90			127.1	OK	
S324.002	S69	0.000	1.00			137.7	OK	
S325.000	S12	0.000	0.23			6.3	OK	
S325.001	S13	0.000	0.24			8.0	OK	
S325.002	S19	0.000	0.26			9.0	OK	
S325.003	S78	0.000	0.18			10.2	SURCHARGED	
S324.003	S78	0.000	0.59			130.3	SURCHARGED	
S324.004	S70	0.000	0.44			134.2	SURCHARGED	
S321.010	S243	0.000	0.73			337.9	SURCHARGED	
S321.011	S72	0.000	0.55			256.3	SURCHARGED	
S321.012	S244	0.000	0.53			256.9	SURCHARGED	
S321.013	S63	0.000	0.85			252.2	SURCHARGED	
S320.004	S5	0.000	0.60			265.1	SURCHARGED	
S326.000	S249	0.000	0.75			35.6	OK	
S326.001	S251	0.000	0.55			72.9	OK	
S326.002	S251	0.000	0.90			107.1	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.003	S78	0.000	1.14			100.7	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S326.004	S77	15 Summer	5	+20%	5/15 Summer				55.369	0.045	0.000
S326.005	S80	15 Summer	5	+20%					54.762	-0.119	0.000
S327.000	S60	15 Summer	5	+20%					54.703	-0.150	0.000
S326.006	S243	15 Summer	5	+20%					52.905	-0.093	0.000
S328.000	S81	15 Summer	5	+20%					58.996	-0.150	0.000
S328.001	S251	15 Summer	5	+20%					58.773	-0.168	0.000
S328.002	S82	15 Summer	5	+20%					57.801	-0.177	0.000
S328.003	S253	15 Summer	5	+20%					56.755	-0.058	0.000
S328.004	S86	15 Summer	5	+20%					55.630	-0.267	0.000
S328.005	S82	15 Summer	5	+20%					54.598	-0.269	0.000
S328.006	S89	15 Summer	5	+20%					53.567	-0.269	0.000
S329.000	S66	15 Summer	5	+20%	5/15 Summer				53.887	0.133	0.000
S329.001	S67	15 Summer	5	+20%	5/15 Summer				53.384	0.099	0.000
S329.002	S68	15 Summer	5	+20%	5/15 Summer				53.331	0.366	0.000
S326.007	S244	180 Summer	5	+20%	5/60 Summer				52.842	0.212	0.000
S326.008	S246	180 Summer	5	+20%	5/15 Summer				52.738	0.354	0.000
S330.000	S6	15 Summer	5	+20%	5/15 Summer				55.571	0.021	0.000
S330.001	S7	15 Summer	5	+20%					54.013	-0.106	0.000
S330.002	S121	15 Summer	5	+20%					53.205	-0.090	0.000
S320.005	S71	180 Summer	5	+20%	5/30 Summer				52.733	0.401	0.000
S320.006	S71	180 Summer	5	+20%	5/15 Summer			0	52.718	0.936	0.000
S315.009	S42	30 Summer	5	+20%					47.613	-0.214	0.000
S315.010	S48	30 Summer	5	+20%	5/15 Summer				46.188	0.218	0.000
S314.002	S41	30 Summer	5	+20%	5/15 Summer				45.338	0.088	0.000
S314.003	S34	30 Summer	5	+20%					44.742	-0.221	0.000
S314.004	S98	720 Summer	5	+20%	5/15 Summer			0	44.633	1.583	0.000
S331.000	S50	15 Summer	5	+20%	5/15 Summer				53.086	0.278	0.000
S331.001	S51	15 Summer	5	+20%					52.001	-0.037	0.000
S331.002	S52	15 Summer	5	+20%					48.140	-0.127	0.000
S331.003	S100	15 Summer	5	+20%					45.434	-0.109	0.000
S331.004	S53	15 Summer	5	+20%					43.729	-0.026	0.000
S331.005	S106	15 Summer	5	+20%	5/15 Summer		5/15 Summer	7	43.580	0.066	0.000
S332.000	S50	15 Summer	5	+20%					45.674	-0.103	0.000
S332.001	S165	15 Summer	5	+20%					44.079	-0.128	0.000
S332.002	S166	15 Summer	5	+20%					43.703	-0.185	0.000
S331.006	S54	15 Winter	5	+20%					43.533	0.000	0.000
S331.007	S106	15 Summer	5	+20%					43.199	-0.231	0.000
S331.008	S109	15 Summer	5	+20%					43.064	-0.215	0.000
S331.009	S110	960 Winter	5	+20%					43.000	-0.094	0.000
S331.010	S111	960 Winter	5	+20%	5/720 Summer				43.000	0.065	0.000
S314.005	S37	960 Winter	5	+20%	5/480 Summer				42.999	0.182	0.000
S314.006	S114	1440 Summer	5	+20%	5/60 Summer			0	42.949	0.699	0.000
S333.000	S69	15 Summer	5	+20%	5/15 Summer				54.186	0.183	0.000
S333.001	S70	15 Summer	5	+20%					53.398	-0.078	0.000
S333.002	S71	15 Summer	5	+20%					52.087	-0.106	0.000
S333.003	S72	15 Summer	5	+20%					47.159	-0.092	0.000
S334.000	S60	15 Summer	5	+20%					54.449	-0.148	0.000
S334.001	S61	15 Summer	5	+20%					53.847	-0.150	0.000
S334.002	S62	15 Summer	5	+20%					53.777	-0.142	0.000
S334.003	S63	15 Summer	5	+20%					53.536	-0.172	0.000
S334.004	S64	15 Summer	5	+20%					52.872	-0.171	0.000
S334.005	S65	15 Summer	5	+20%					51.782	-0.148	0.000
S334.006	S58	15 Summer	5	+20%					50.519	-0.242	0.000
S334.007	S54	15 Summer	5	+20%					49.197	-0.240	0.000
S334.008	S55	15 Summer	5	+20%					45.763	-0.227	0.000
S334.009	S100	15 Summer	5	+20%					45.031	-0.231	0.000
S334.010	S101	15 Summer	5	+20%					43.833	-0.208	0.000
S334.011	S102	15 Summer	5	+20%					42.914	-0.346	0.000
S335.000	S96	15 Summer	5	+20%					44.426	-0.052	0.000
S335.001	S97	15 Summer	5	+20%					44.039	-0.065	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.004	S77	1.05			94.9	SURCHARGED	
S326.005	S80	0.80			94.6	OK	
S327.000	S60	0.00			0.0	OK	
S326.006	S243	0.81			94.3	OK	
S328.000	S81	0.00			0.0	OK	
S328.001	S251	0.39			45.9	OK	
S328.002	S82	0.34			44.6	OK	
S328.003	S253	0.97			123.1	OK	
S328.004	S86	0.34			122.8	OK	
S328.005	S82	0.34			121.0	OK	
S328.006	S89	0.34			120.7	OK	
S329.000	S66	1.00			38.7	SURCHARGED	
S329.001	S67	0.71			48.4	SURCHARGED	
S329.002	S68	1.34			48.2	SURCHARGED	
S326.007	S244	0.38			144.6	SURCHARGED	
S326.008	S246	1.00			142.6	SURCHARGED	
S330.000	S6	0.90			54.8	SURCHARGED	
S330.001	S7	0.75			107.0	OK	
S330.002	S121	0.81			124.8	OK	
S320.005	S71	0.62			419.3	SURCHARGED	
S320.006	S71	0.15	0.0	87	124.3	SURCHARGED	
S315.009	S42	0.54			289.0	OK	
S315.010	S48	3.49			290.5	SURCHARGED	
S314.002	S41	1.25			306.3	SURCHARGED	
S314.003	S34	0.59			305.9	OK	
S314.004	S98	1.36	0.0	564	47.0	SURCHARGED*	
S331.000	S50	1.07			18.9	SURCHARGED	
S331.001	S51	0.91			37.2	OK	
S331.002	S52	0.39			49.9	OK	
S331.003	S100	0.52			50.0	OK	
S331.004	S53	0.77			57.4	OK	
S331.005	S106	0.89	7.5		49.8	SURCHARGED	
S332.000	S50	0.21			8.4	OK	
S332.001	S165	0.37			19.8	OK	
S332.002	S166	0.31			26.7	OK	
S331.006	S54	0.39			70.9	OK	
S331.007	S106	0.46			81.5	OK	
S331.008	S109	0.51			79.9	OK	
S331.009	S110	0.07			10.7	OK	
S331.010	S111	0.17			13.7	SURCHARGED	
S314.005	S37	0.12			59.1	SURCHARGED*	
S314.006	S114	0.66	0.0	899	37.8	SURCHARGED*	
S333.000	S69	1.06			45.9	SURCHARGED	
S333.001	S70	0.74			58.2	OK	
S333.002	S71	0.54			72.8	OK	
S333.003	S72	0.65			85.1	OK	
S334.000	S60	0.41			34.4	OK	
S334.001	S61	0.50			35.0	OK	
S334.002	S62	0.52			41.4	OK	
S334.003	S63	0.37			49.8	OK	
S334.004	S64	0.38			63.1	OK	
S334.005	S65	0.49			82.5	OK	
S334.006	S58	0.27			87.8	OK	
S334.007	S54	0.27			103.3	OK	
S334.008	S55	0.33			109.1	OK	
S334.009	S100	0.31			108.9	OK	
S334.010	S101	0.41			108.3	OK	
S334.011	S102	0.22			107.6	OK	
S335.000	S96	0.74			13.8	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.001	S97	0.58			18.5	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S335.002	S98	15 Summer	5	+20%				0	42.944	-0.088	0.000
S335.003	S99	15 Summer	5	+20%	5/15 Summer		5/15 Summer	3	42.862	0.018	0.000
S334.012	S100	15 Summer	5	+20%	5/15 Summer				42.833	0.057	0.000
S334.013	S69	15 Summer	5	+20%					42.498	-0.226	0.000
S334.014	S137	15 Summer	5	+20%					42.434	-0.244	0.000
S334.015	S72	15 Summer	5	+20%					42.358	-0.274	0.000
S334.016	S74	15 Summer	5	+20%					42.291	-0.274	0.000
S333.004	S73	30 Summer	5	+20%					42.030	-0.388	0.000
S333.005	S114	30 Summer	5	+20%					41.574	-0.271	0.000
S314.007	S154	1440 Summer	5	+20%	5/1440 Summer				41.506	0.000	0.000
S314.008	S154	1440 Summer	5	+20%	5/360 Summer			0	41.485	0.273	0.000
S314.009	S163	1440 Summer	5	+20%					40.736	-0.305	0.000
S336.000	S163	15 Summer	5	+20%	5/15 Summer				67.761	0.099	0.000
S336.001	S219	15 Summer	5	+20%					66.735	-0.070	0.000
S336.002	S220	15 Summer	5	+20%					65.736	-0.068	0.000
S336.003	S221	15 Summer	5	+20%					64.748	-0.080	0.000
S336.004	S64	15 Summer	5	+20%					63.537	-0.061	0.000
S336.005	S223	30 Summer	5	+20%					61.192	-0.018	0.000
S337.000	S218	15 Summer	5	+20%					60.091	-0.146	0.000
S336.006	S262	15 Summer	5	+20%			5/15 Summer	24	59.937	-0.097	0.000
S336.007	S266	30 Summer	5	+20%	5/15 Summer	5/15 Summer			59.371	0.933	2.096
S336.008	S267	30 Summer	5	+20%	5/15 Summer	5/15 Summer			58.530	0.878	3.584
S338.000	S143	15 Summer	5	+20%					61.068	-0.082	0.000
S338.001	S144	15 Summer	5	+20%					60.674	-0.053	0.000
S338.002	S145	15 Summer	5	+20%					58.774	-0.035	0.000
S338.003	S146	30 Summer	5	+20%	5/15 Summer				56.404	0.324	0.000
S339.000	S173	15 Summer	5	+20%	5/15 Summer				56.898	1.025	0.000
S336.009	S261	30 Summer	5	+20%	5/15 Summer				56.288	0.481	0.000
S340.000	S82	15 Summer	5	+20%					59.501	-1.207	0.000
S340.001	S183	15 Summer	5	+20%					56.927	-1.207	0.000
S336.010	S262	30 Summer	5	+20%					55.628	-0.118	0.000
S341.000	S113	15 Summer	5	+20%					58.429	-0.271	0.000
S341.001	S114	15 Summer	5	+20%					54.479	-0.264	0.000
S342.000	S299	15 Summer	5	+20%					39.086	-1.207	0.000
S342.001	S300	15 Summer	5	+20%					38.550	-0.300	0.000
S343.000	S247	15 Summer	5	+20%	5/15 Summer				51.563	0.088	0.000
S343.001	S80	15 Summer	5	+20%	5/15 Summer				51.354	0.035	0.000
S343.002	S81	15 Summer	5	+20%					51.095	-0.097	0.000
S343.003	S82	15 Summer	5	+20%					50.959	-0.118	0.000
S344.000	S88	15 Summer	5	+20%					60.063	-0.107	0.000
S344.001	S89	15 Summer	5	+20%					58.292	-0.121	0.000
S344.002	S90	15 Summer	5	+20%					55.109	-0.063	0.000
S344.003	S264	15 Summer	5	+20%					54.794	-0.071	0.000
S344.004	S59	15 Summer	5	+20%					53.612	-0.157	0.000
S344.005	S60	15 Summer	5	+20%					52.335	-0.114	0.000
S344.006	S61	15 Summer	5	+20%					51.797	-0.107	0.000
S344.007	S62	15 Summer	5	+20%	5/15 Summer				50.808	0.040	0.000
S343.004	S83	15 Summer	5	+20%	5/15 Summer				50.256	0.131	0.000
S343.005	S64	15 Summer	5	+20%	5/15 Summer				49.886	0.655	0.000
S343.006	S84	1440 Summer	5	+20%	5/30 Summer				49.148	0.465	0.000
S343.007	S85	15 Summer	5	+20%					43.823	-0.339	0.000
S345.000	S87	15 Summer	5	+20%					49.094	-0.067	0.000
S345.001	S88	15 Summer	5	+20%					46.850	-0.058	0.000
S345.002	S89	15 Summer	5	+20%					44.828	-0.046	0.000
S345.003	S270	15 Summer	5	+20%					43.668	-0.042	0.000
S343.008	S87	15 Summer	5	+20%					41.864	-0.270	0.000
S346.000	S78	15 Summer	5	+20%					44.345	-0.063	0.000
S346.001	S79	15 Summer	5	+20%					43.719	-0.064	0.000
S346.002	S80	15 Summer	5	+20%					42.947	-0.032	0.000
S346.003	S81	15 Summer	5	+20%					42.008	-0.111	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.002	S98	0.66	0.0		24.0	OK	
S335.003	S99	0.60	1.1		18.8	SURCHARGED	
S334.012	S100	0.49			151.0	SURCHARGED	
S334.013	S69	0.66			149.0	OK	
S334.014	S137	0.65			148.4	OK	
S334.015	S72	0.57			150.6	OK	
S334.016	S74	0.57			156.0	OK	
S333.004	S73	0.27			201.2	OK	
S333.005	S114	0.58			201.7	OK	
S314.007	S154	0.15			59.1	SURCHARGED	
S314.008	S154	0.12	0.0		29.2	SURCHARGED*	
S314.009	S163	0.04			29.2	OK	
S336.000	S163	0.77			11.0	SURCHARGED	
S336.001	S219	0.50			10.3	OK	
S336.002	S220	0.55			12.6	OK	
S336.003	S221	0.44			12.3	OK	
S336.004	S64	0.64			18.4	OK	
S336.005	S223	1.00			27.3	OK	
S337.000	S218	0.26			12.3	OK	
S336.006	S262	0.60	13.7		47.0	OK	
S336.007	S266	1.04			69.4	FLOOD	3
S336.008	S267	1.17			78.9	FLOOD	5
S338.000	S143	0.42			9.2	OK	
S338.001	S144	0.72			21.1	OK	
S338.002	S145	0.93			34.5	OK	
S338.003	S146	0.39			51.8	SURCHARGED	
S339.000	S173	0.62			42.9	SURCHARGED	
S336.009	S261	0.85			155.5	SURCHARGED	
S340.000	S82	0.00			0.0	OK	
S340.001	S183	0.00			0.0	OK	
S336.010	S262	0.97			154.9	OK*	
S341.000	S113	0.02			5.0	OK	
S341.001	S114	0.03			7.8	OK	
S342.000	S299	0.00			0.0	OK	
S342.001	S300	0.00			0.0	OK*	
S343.000	S247	1.15			18.6	SURCHARGED	
S343.001	S80	1.14			17.8	SURCHARGED	
S343.002	S81	0.61			24.5	OK	
S343.003	S82	0.45			34.3	OK	
S344.000	S88	0.50			37.0	OK	
S344.001	S89	0.42			47.5	OK	
S344.002	S90	0.87			66.1	OK	
S344.003	S264	0.82			67.9	OK	
S344.004	S59	0.44			77.3	OK	
S344.005	S60	0.68			104.1	OK	
S344.006	S61	0.73			111.0	OK	
S344.007	S62	1.16			111.1	SURCHARGED	
S343.004	S83	1.30			144.9	SURCHARGED	
S343.005	S64	1.92			141.4	SURCHARGED	
S343.006	S84	0.01		1184	3.1	SURCHARGED	
S343.007	S85	0.02			5.6	OK	
S345.000	S87	0.59			31.0	OK	
S345.001	S88	0.69			35.5	OK	
S345.002	S89	0.80			35.5	OK	
S345.003	S270	0.83			35.1	OK	
S343.008	S87	0.18			40.9	OK	
S346.000	S78	0.63			15.0	OK	
S346.001	S79	0.61			19.3	OK	
S346.002	S80	0.96			28.6	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S346.003	S81	0.51			28.7	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S343.009	S106	1440 Winter	5	+20%	5/360 Summer				41.342	0.129
S343.010	S79	1440 Winter	5	+20%					40.416	-0.201
S343.011	S300	1440 Winter	5	+20%					38.826	-0.415
S342.002	S245	1440 Winter	5	+20%					37.975	-0.514
S347.000	S251	15 Summer	5	+20%					63.486	-0.058
S347.001	S252	15 Summer	5	+20%					63.200	-0.035
S347.002	S253	15 Summer	5	+20%					62.957	-0.031
S347.003	S251	15 Summer	5	+20%					62.454	-0.082
S347.004	S71	15 Summer	5	+20%					61.451	-0.081
S347.005	S252	15 Summer	5	+20%					59.997	-0.070
S347.006	S73	15 Summer	5	+20%					58.414	-0.143
S347.007	S200	15 Summer	5	+20%					57.333	-0.115
S347.008	S254	15 Summer	5	+20%					56.521	-0.123
S347.009	S202	15 Summer	5	+20%					55.883	-0.176
S347.010	S198	15 Summer	5	+20%					55.053	-0.162
S347.011	S306	15 Summer	5	+20%	5/15 Summer				54.624	0.116
S348.000	S277	15 Summer	5	+20%					63.803	-0.097
S348.001	S278	15 Summer	5	+20%					63.436	-0.066
S348.002	S279	15 Summer	5	+20%					63.124	-0.066
S349.000	S280	15 Summer	5	+20%					63.394	-0.077
S348.003	S280	15 Summer	5	+20%					62.966	-0.095
S348.004	S281	15 Summer	5	+20%					62.866	-0.079
S348.005	S282	15 Summer	5	+20%					62.733	-0.096
S348.006	S283	15 Summer	5	+20%					62.476	-0.103
S348.007	S284	15 Summer	5	+20%					62.122	-0.098
S348.008	S285	15 Summer	5	+20%					61.727	-0.112
S348.009	S286	15 Summer	5	+20%					61.081	-0.116
S348.010	S216	15 Summer	5	+20%					60.943	-0.157
S348.011	S103	15 Summer	5	+20%					57.893	-0.169
S348.012	S218	15 Summer	5	+20%					54.851	-0.166
S347.012	S305	15 Summer	5	+20%	5/15 Summer				54.469	0.094
S350.000	S220	15 Summer	5	+20%					59.728	-0.187
S351.000	SSU4931_9196a	15 Summer	5	+20%					51.243	-0.375
S351.001	S226	15 Summer	5	+20%					51.124	-0.450
S352.000	SSMP East Start	15 Summer	5	+20%					67.632	-0.093
S352.001	S187	15 Summer	5	+20%					66.420	-0.128
S352.002	S188	15 Summer	5	+20%					64.582	-0.078
S352.003	SSMP SBK3	15 Summer	5	+20%					62.295	-0.419
S352.004	S261	15 Summer	5	+20%	5/15 Summer		5/15 Summer	17	61.369	0.794
S353.000	S261	15 Summer	5	+20%					67.200	-0.150
S353.001	S262	15 Summer	5	+20%					64.208	-0.150
S353.002	S262	15 Summer	5	+20%					60.988	-0.150
S352.005	S303	15 Summer	5	+20%					57.496	-0.079
S354.000	S265	15 Summer	5	+20%					67.557	-0.068
S354.001	S266	15 Summer	5	+20%	5/15 Summer				66.313	0.026
S354.002	S267	15 Summer	5	+20%					63.350	-0.059
S354.003	S309	15 Summer	5	+20%					58.487	-1.186
S352.006	S304	15 Summer	5	+20%					54.462	-1.122
S355.000	S255	15 Summer	5	+20%					73.500	-0.543
S355.001	S256	15 Summer	5	+20%					64.300	-0.300

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S343.009	S106	0.000	0.02			1.9	SURCHARGED	
S343.010	S79	0.000	0.03			1.9	OK	
S343.011	S300	0.000	0.02			1.9	OK	
S342.002	S245	0.000	0.00			1.9	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S347.000	S251	0.000	0.36			3.2	OK	
S347.001	S252	0.000	0.74			5.6	OK	
S347.002	S253	0.000	0.80			6.4	OK	
S347.003	S251	0.000	0.42			13.3	OK	
S347.004	S71	0.000	0.42			16.2	OK	
S347.005	S252	0.000	0.54			20.9	OK	
S347.006	S73	0.000	0.28			26.6	OK	
S347.007	S200	0.000	0.47			32.2	OK	
S347.008	S254	0.000	0.61			52.7	OK	
S347.009	S202	0.000	0.36			52.8	OK	
S347.010	S198	0.000	0.43			51.9	OK	
S347.011	S306	0.000	0.46			52.0	SURCHARGED	
S348.000	S277	0.000	0.27			6.1	OK	
S348.001	S278	0.000	0.57			10.1	OK	
S348.002	S279	0.000	0.60			10.3	OK	
S349.000	S280	0.000	0.48			12.1	OK	
S348.003	S280	0.000	0.59			20.6	OK	
S348.004	S281	0.000	0.75			27.3	OK	
S348.005	S282	0.000	0.60			31.9	OK	
S348.006	S283	0.000	0.56			36.2	OK	
S348.007	S284	0.000	0.61			39.7	OK	
S348.008	S285	0.000	0.50			43.0	OK	
S348.009	S286	0.000	0.67			48.7	OK	
S348.010	S216	0.000	0.43			71.0	OK	
S348.011	S103	0.000	0.39			83.1	OK	
S348.012	S218	0.000	0.41			82.7	OK	
S347.012	S305	0.000	1.82			142.1	SURCHARGED	
S350.000	S220	0.000	0.07			13.6	OK	
S351.000	SSU4931_9196a	0.000	0.00			0.0	OK	
S351.001	S226	0.000	0.00			0.0	OK	
S352.000	SSMP East Start	0.000	0.60			39.7	OK	
S352.001	S187	0.000	0.55			72.3	OK	
S352.002	S188	0.000	0.82			115.1	OK	
S352.003	SSMP SBK3	0.000	0.19			147.3	OK	
S352.004	S261	0.000	0.66	117.4		28.3	FLOOD RISK	
S353.000	S261	0.000	0.00			0.0	OK	
S353.001	S262	0.000	0.00			0.0	OK	
S353.002	S262	0.000	0.00			0.0	OK	
S352.005	S303	0.000	0.46			28.3	OK	
S354.000	S265	0.000	0.68			37.9	OK	
S354.001	S266	0.000	0.94			64.8	SURCHARGED	
S354.002	S267	0.000	0.88			86.7	OK	
S354.003	S309	0.000	0.01			100.8	OK	
S352.006	S304	0.000	0.02			128.8	OK	
S355.000	S255	0.000	0.00			0.0	OK	
S355.001	S256	0.000	0.00			0.0	OK*	

Online Controls for Between A33_34 to Itchen

Hydro-Brake® Optimum Manhole: S79, DS/PN: S213.005, Volume (m³): 4.0

Unit Reference	MD-SHE-0070-3000-2000-3000
Design Head (m)	2.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	38.563
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	3.0	Kick-Flo®	0.630	1.8
Flush-Flo™	0.310	2.2	Mean Flow over Head Range	-	2.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.4	3.000	3.6	7.000	5.4
0.200	2.1	1.400	2.5	3.500	3.9	7.500	5.6
0.300	2.2	1.600	2.7	4.000	4.1	8.000	5.7
0.400	2.2	1.800	2.9	4.500	4.4	8.500	5.9
0.500	2.1	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.9	2.200	3.1	5.500	4.8	9.500	6.2
0.800	2.0	2.400	3.3	6.000	5.0		
1.000	2.2	2.600	3.4	6.500	5.2		

Offline Controls for Between A33_34 to Itchen

Pipe Manhole: S79, DS/PN: S213.005, Loop to PN: S213.006

Diameter (m)	0.150	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	41.000

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	5
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S213.000	S152	15 Summer	5	+20%					43.440
S213.001	S153	15 Summer	5	+20%					41.735
S213.002	S154	720 Winter	5	+20%					39.778
S213.003	S77	720 Winter	5	+20%					39.778
S213.004	S78	720 Winter	5	+20%	5/15 Summer				39.778
S214.000	S96	15 Summer	5	+20%					41.312
S215.000	S94	15 Summer	5	+20%					41.615
S215.001	S95	15 Summer	5	+20%					40.741
S215.002	S96	15 Summer	5	+20%					40.379

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S213.000	S152	-0.120	0.000	0.44			35.6	OK	
S213.001	S153	-0.165	0.000	0.41			54.8	OK	
S213.002	S154	-1.218	0.000	0.00			6.1	OK*	
S213.003	S77	-1.047	0.000	0.00			3.0	OK*	
S213.004	S78	0.799	0.000	0.06			3.9	SURCHARGED	
S214.000	S96	-0.136	0.000	0.33			27.6	OK	
S215.000	S94	-0.084	0.000	0.40			13.2	OK	
S215.001	S95	-0.045	0.000	0.83			15.4	OK	
S215.002	S96	-0.112	0.000	0.49			18.5	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S214.001	S97	15 Summer	5	+20%					40.267
S213.005	S79	720 Winter	5	+20%	5/15 Summer			0	39.808
S213.006	S12	720 Winter	5	+20%					38.459

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S214.001	S97	-0.132	0.000	0.35			47.1	OK	
S213.005	S79	0.945	0.000	0.03	0.0		2.4	SURCHARGED	
S213.006	S12	-0.268	0.000	0.03			2.4	OK	

Online Controls for M3 SB to Basin 5

Orifice Manhole: S5, DS/PN: S101.004, Volume (m³): 2.0

Diameter (m) 0.159 Discharge Coefficient 0.600 Invert Level (m) 59.398

Orifice Manhole: S10, DS/PN: S102.007, Volume (m³): 24.3

Diameter (m) 0.424 Discharge Coefficient 0.600 Invert Level (m) 51.379

Depth/Flow Relationship Manhole: S103, DS/PN: S100.002, Volume (m³): 222.3

Invert Level (m) 49.000

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 3 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	5
Climate Change (%)	20

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S100.000	S2	15 Summer	5	+20%					54.310
S101.000	S5	15 Summer	5	+20%					62.146
S101.001	S7	15 Summer	5	+20%					60.801
S101.002	S8	15 Summer	5	+20%					59.804
S101.003	S9	15 Summer	5	+20%	5/15 Summer				59.778
S101.004	S5	15 Summer	5	+20%	5/15 Summer				59.754
S101.005	S7	15 Summer	5	+20%					59.444

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S100.000	S2	0.000	0.000	1.00			187.6	SURCHARGED*	
S101.000	S5	-0.071	0.000	0.54			19.8	OK	
S101.001	S7	-0.069	0.000	0.57			21.9	OK	
S101.002	S8	-0.103	0.000	0.53			20.4	OK	
S101.003	S9	0.102	0.000	0.53			14.0	SURCHARGED	
S101.004	S5	0.131	0.000	0.81			22.1	SURCHARGED	
S101.005	S7	-0.129	0.000	0.57			29.7	OK	

QVA Consulting		Page 4
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 15:13 File 2021 10 25 FEH M5+20CC	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S101.006	S28	15 Summer	5	+20%					59.282
S101.007	S30	15 Summer	5	+20%					59.139
S101.008	S10	15 Summer	5	+20%					58.844
S101.009	S11	15 Summer	5	+20%					53.970
S102.000	S47	15 Summer	5	+20%	5/15 Summer				60.134
S102.001	S48	15 Summer	5	+20%					59.451
S103.000	S249	15 Summer	5	+20%	5/15 Summer				60.870
S103.001	S6	15 Summer	5	+20%	5/15 Summer				60.238
S103.002	S250	15 Summer	5	+20%					59.663
S103.003	S80	15 Summer	5	+20%					59.306
S102.002	S49	15 Summer	5	+20%					58.669
S102.003	S50	15 Summer	5	+20%					56.588
S102.004	S51	15 Summer	5	+20%					53.973
S102.005	S12	30 Summer	5	+20%	5/15 Summer				52.920
S104.000	S54	15 Summer	5	+20%					54.291
S104.001	S55	15 Summer	5	+20%					53.885
S104.002	S56	15 Summer	5	+20%					53.223
S104.003	S53	30 Summer	5	+20%	5/15 Summer				52.808
S102.006	S52	30 Summer	5	+20%	5/15 Summer				52.786
S105.000	S56	15 Summer	5	+20%					63.596
S105.001	S57	15 Summer	5	+20%					63.175
S105.002	S58	15 Summer	5	+20%					62.719
S105.003	S59	15 Summer	5	+20%					62.426
S105.004	S60	15 Summer	5	+20%					62.238
S105.005	S61	15 Summer	5	+20%					59.132
S105.006	S62	15 Summer	5	+20%					58.228
S106.000	S76	15 Summer	5	+20%					60.785
S105.007	S63	15 Summer	5	+20%					57.994
S105.008	S64	15 Summer	5	+20%					55.491
S105.009	S56	15 Summer	5	+20%					54.194
S105.010	S57	15 Summer	5	+20%					53.788
S105.011	S58	15 Summer	5	+20%					53.329
S105.012	S59	30 Summer	5	+20%					52.913
S102.007	S10	30 Summer	5	+20%	5/15 Summer				52.659
S100.002	S103	960 Winter	5	+20%	5/480 Summer				49.389

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S101.006	S28	-0.139	0.000	0.55			28.3	OK	
S101.007	S30	-0.170	0.000	0.39			28.0	OK*	
S101.008	S10	-0.325	0.000	0.02			28.0	OK	
S101.009	S11	-0.319	0.000	0.03			28.0	OK	
S102.000	S47	0.121	0.000	1.02			42.8	SURCHARGED	
S102.001	S48	-0.091	0.000	0.81			79.6	OK	
S103.000	S249	0.280	0.000	1.20			51.5	SURCHARGED	

QVA Consulting		Page 5
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 15:13 File 2021 10 25 FEH M5+20CC	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S103.001	S6	0.061	0.000	1.06			45.7	SURCHARGED	
S103.002	S250	-0.100	0.000	0.76			71.8	OK	
S103.003	S80	-0.146	0.000	0.52			72.3	OK	
S102.002	S49	-0.260	0.000	0.37			180.7	OK	
S102.003	S50	-0.264	0.000	0.35			208.4	OK	
S102.004	S51	-0.218	0.000	0.51			250.6	OK	
S102.005	S12	0.535	0.000	0.93			208.3	SURCHARGED	
S104.000	S54	-0.058	0.000	0.64			10.9	OK	
S104.001	S55	-0.032	0.000	0.95			19.4	OK	
S104.002	S56	-0.113	0.000	0.48			32.7	OK	
S104.003	S53	0.383	0.000	0.57			29.2	SURCHARGED	
S102.006	S52	0.581	0.000	0.59			224.1	SURCHARGED	
S105.000	S56	-0.083	0.000	0.41			8.8	OK	
S105.001	S57	-0.086	0.000	0.36			8.5	OK	
S105.002	S58	-0.051	0.000	0.76			12.2	OK	
S105.003	S59	-0.123	0.000	0.40			15.3	OK	
S105.004	S60	-0.135	0.000	0.33			22.6	OK	
S105.005	S61	-0.180	0.000	0.32			37.7	OK	
S105.006	S62	-0.169	0.000	0.39			38.1	OK	
S106.000	S76	-0.100	0.000	0.25			10.3	OK	
S105.007	S63	-0.203	0.000	0.23			49.3	OK	
S105.008	S64	-0.181	0.000	0.33			61.6	OK	
S105.009	S56	-0.112	0.000	0.70			72.6	OK	
S105.010	S57	-0.070	0.000	0.93			88.4	OK	
S105.011	S58	-0.073	0.000	0.92			97.7	OK	
S105.012	S59	-0.037	0.000	0.92			106.9	OK	
S102.007	S10	0.680	0.000	1.16			319.2	SURCHARGED	
S100.002	S103	0.089	0.000	0.00			0.0	SURCHARGED*	

Online Controls for New works to Basins 2 & 3C

Orifice Manhole: S36, DS/PN: S316.010, Volume (m^3): 4.7

Diameter (m) 0.265 Discharge Coefficient 0.600 Invert Level (m) 58.499

Orifice Manhole: S47, DS/PN: S321.002, Volume (m^3): 28.2

Diameter (m) 0.240 Discharge Coefficient 0.600 Invert Level (m) 56.653

Orifice Manhole: S61, DS/PN: S323.007, Volume (m^3): 67.7

Diameter (m) 0.160 Discharge Coefficient 0.600 Invert Level (m) 55.488

Orifice Manhole: S78, DS/PN: S325.003, Volume (m^3): 1.6

Diameter (m) 0.106 Discharge Coefficient 0.600 Invert Level (m) 57.000

Orifice Manhole: S243, DS/PN: S321.010, Volume (m^3): 28.9

Diameter (m) 0.530 Discharge Coefficient 0.600 Invert Level (m) 52.126

Hydro-Brake® Optimum Manhole: S71, DS/PN: S320.006, Volume (m^3): 19.2

Unit Reference	MD-SHE-0414-1250-2500-1250
Design Head (m)	2.500
Design Flow (l/s)	125.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	414
Invert Level (m)	51.393
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.500	124.9	Kick-Flo®	1.707	103.8
Flush-Flo™	0.790	124.3	Mean Flow over Head Range	-	106.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	11.2	0.800	124.3	2.000	112.0	4.000	157.0	7.000	206.5
0.200	40.4	1.000	123.2	2.200	117.4	4.500	166.3	7.500	213.6
0.300	78.8	1.200	121.0	2.400	122.4	5.000	175.1	8.000	220.4
0.400	113.5	1.400	117.4	2.600	127.3	5.500	183.5	8.500	227.1
0.500	120.0	1.600	110.4	3.000	136.5	6.000	191.5	9.000	233.5
0.600	122.7	1.800	106.5	3.500	147.1	6.500	199.1	9.500	239.8

Orifice Manhole: S98, DS/PN: S314.004, Volume (m^3): 1.2

Diameter (m) 0.141 Discharge Coefficient 0.600 Invert Level (m) 42.850

Orifice Manhole: S54, DS/PN: S331.006, Volume (m^3): 3.5

Diameter (m) 0.318 Discharge Coefficient 0.600 Invert Level (m) 43.083

Orifice Manhole: S114, DS/PN: S314.006, Volume (m³): 1.2

Diameter (m) 0.141 Discharge Coefficient 0.600 Invert Level (m) 42.050

Orifice Manhole: S100, DS/PN: S334.012, Volume (m³): 10.9

Diameter (m) 0.424 Discharge Coefficient 0.600 Invert Level (m) 42.176

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m³): 1.1

Unit Reference	MD-SHE-0214-2930-2400-2930
Design Head (m)	2.400
Design Flow (l/s)	29.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	40.850
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.400	29.3	Kick-Flo®	1.466	23.1
Flush-Flo™	0.693	29.2	Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	0.800	29.1	2.000	26.8	4.000	37.4	7.000	49.1
0.200	20.9	1.000	28.5	2.200	28.1	4.500	39.6	7.500	50.7
0.300	26.1	1.200	27.2	2.400	29.3	5.000	41.7	8.000	52.3
0.400	27.8	1.400	24.6	2.600	30.4	5.500	43.7	8.500	53.9
0.500	28.7	1.600	24.1	3.000	32.6	6.000	45.5	9.000	55.4
0.600	29.1	1.800	25.5	3.500	35.1	6.500	47.3	9.500	56.9

Orifice Manhole: S261, DS/PN: S336.009, Volume (m³): 14.7

Diameter (m) 0.318 Discharge Coefficient 0.600 Invert Level (m) 55.282

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m³): 5.8

Unit Reference	MD-SHE-0082-4000-2000-4000
Design Head (m)	2.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	48.604
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	4.0	Kick-Flo®	0.729	2.5
Flush-Flo™	0.356	3.1	Mean Flow over Head Range	-	3.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S84, DS/PN: S343.006, Volume (m³): 5.8

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	3.0	1.000	2.9	2.200	4.2	4.500	5.8	7.500	7.4
0.300	3.1	1.200	3.2	2.400	4.3	5.000	6.1	8.000	7.7
0.400	3.1	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	3.1	1.600	3.6	3.000	4.8	6.000	6.7	9.000	8.1
0.600	2.9	1.800	3.8	3.500	5.2	6.500	6.9	9.500	8.3

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m³): 10.9

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	41.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.8	7.000	4.9
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	1.9	1.200	2.2	2.400	3.0	5.000	4.2	8.000	5.2
0.400	1.9	1.400	2.3	2.600	3.1	5.500	4.4	8.500	5.4
0.500	1.8	1.600	2.5	3.000	3.3	6.000	4.6	9.000	5.5
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.7

Orifice Manhole: S261, DS/PN: S352.004, Volume (m³): 38.1

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 60.425

Depth/Flow Relationship Manhole: S256, DS/PN: S355.001, Volume (m³): 50.4

Invert Level (m) 64.300

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.700	0.0000	1.300	0.0000	1.900	0.0000	2.500	0.0000
0.200	0.0000	0.800	0.0000	1.400	0.0000	2.000	0.0000	2.600	0.0000
0.300	0.0000	0.900	0.0000	1.500	0.0000	2.100	0.0000	2.700	0.0000
0.400	0.0000	1.000	0.0000	1.600	0.0000	2.200	0.0000	2.800	0.0000
0.500	0.0000	1.100	0.0000	1.700	0.0000	2.300	0.0000	2.900	0.0000
0.600	0.0000	1.200	0.0000	1.800	0.0000	2.400	0.0000	3.000	0.0000

Offline Controls for New works to Basins 2 & 3C

Pipe Manhole: SSMP CR010, DS/PN: S323.004, Loop to PN: S337.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	60.041

Pipe Manhole: S61, DS/PN: S323.007, Loop to PN: S339.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	55.488

Pipe Manhole: S71, DS/PN: S320.006, Loop to PN: S315.009

Diameter (m)	0.450	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	40.000	Upstream Invert Level (m)	54.650

Weir Manhole: S98, DS/PN: S314.004, Loop to PN: S314.005

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 45.200

Pipe Manhole: S106, DS/PN: S331.005, Loop to PN: S331.007

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	200.0	Coefficient of Contraction	0.600
Length (m)	16.500	Upstream Invert Level (m)	43.514

Weir Manhole: S114, DS/PN: S314.006, Loop to PN: S314.007

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.900

Pipe Manhole: S98, DS/PN: S335.002, Loop to PN: S334.015

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	27.5	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	43.032

Pipe Manhole: S99, DS/PN: S335.003, Loop to PN: S334.014

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	57.0	Coefficient of Contraction	0.600
Length (m)	12.000	Upstream Invert Level (m)	42.850

Weir Manhole: S154, DS/PN: S314.008, Loop to PN: S314.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.150

Pipe Manhole: S262, DS/PN: S336.006, Loop to PN: S350.000

Diameter (m)	0.225	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	40.0	Coefficient of Contraction	0.600
Length (m)	1.000	Upstream Invert Level (m)	59.809

Weir Manhole: S261, DS/PN: S352.004, Loop to PN: S321.000

Discharge Coef 0.544 Width (m) 1.800 Invert Level (m) 61.255

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Offline Controls	11	Number of Time/Area Diagrams	0
Number of Online Controls	16	Number of Storage Structures	7	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.411
FEH Rainfall Version	1999	E (1km)	0.294
Site Location	GB 449350 131500 SU 49350 31500	F (1km)	2.313
C (1km)	-0.025	Cv (Summer)	1.000
D1 (1km)	0.429	Cv (Winter)	1.000
D2 (1km)	0.273		

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	5
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S314.000	S32	15 Summer	5	+40%					49.885	-0.059	0.000	0.68
S314.001	S33	15 Summer	5	+40%					48.820	-0.030	0.000	0.97
S315.000	S31	15 Summer	5	+40%					59.361	-0.089	0.000	0.34
S315.001	S32	15 Summer	5	+40%					58.265	-0.069	0.000	0.55
S316.000	S26	15 Summer	5	+40%					63.395	-0.098	0.000	0.26
S316.001	S27	15 Summer	5	+40%					63.158	-0.085	0.000	0.39
S316.002	S28	15 Summer	5	+40%					62.783	-0.050	0.000	0.77
S316.003	S29	15 Summer	5	+40%					62.476	-0.096	0.000	0.59
S316.004	S30	30 Summer	5	+40%	5/15 Summer				60.175	0.394	0.000	0.80
S316.005	S31	30 Summer	5	+40%	5/15 Summer				60.090	0.407	0.000	0.46
S316.006	S32	30 Summer	5	+40%	5/15 Summer				59.935	0.493	0.000	0.90
S316.007	S33	30 Summer	5	+40%	5/15 Summer				59.849	0.490	0.000	0.88
S316.008	S9	30 Summer	5	+40%	5/15 Summer				59.758	0.496	0.000	0.46
S317.000	S33	15 Summer	5	+40%					63.245	-0.127	0.000	0.40
S317.001	S34	15 Summer	5	+40%					62.697	-0.135	0.000	0.58
S317.002	S35	15 Summer	5	+40%					62.598	-0.162	0.000	0.42
S317.003	S36	15 Summer	5	+40%					62.424	-0.165	0.000	0.39
S317.004	S38	15 Summer	5	+40%					60.281	-0.163	0.000	0.41
S317.005	S39	30 Summer	5	+40%	5/15 Summer				59.996	0.246	0.000	0.60
S317.006	S40	30 Summer	5	+40%	5/15 Summer				59.861	0.397	0.000	0.50
S317.007	S41	30 Summer	5	+40%	5/15 Summer				59.725	0.474	0.000	0.72
S318.000	S12	15 Summer	5	+40%					60.955	-0.107	0.000	0.18
S318.001	S13	15 Summer	5	+40%					60.682	-0.096	0.000	0.28
S318.002	S14	15 Summer	5	+40%					60.177	-0.077	0.000	0.47
S318.003	S15	15 Summer	5	+40%					59.704	-0.073	0.000	0.52
S319.000	S30	30 Summer	5	+40%					59.676	-0.074	0.000	0.16
S319.001	S31	30 Summer	5	+40%	5/15 Summer				59.669	0.253	0.000	0.23
S318.004	S176	30 Summer	5	+40%	5/15 Summer				59.659	0.514	0.000	0.90
S316.009	S18	30 Summer	5	+40%	5/15 Summer				59.642	0.562	0.000	0.84
S316.010	S36	30 Summer	5	+40%	5/15 Summer				59.518	0.644	0.000	0.81

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S314.000	S32			24.9	OK	
S314.001	S33			36.0	OK	
S315.000	S31			10.5	OK	
S315.001	S32			20.0	OK	
S316.000	S26			5.6	OK	
S316.001	S27			9.0	OK	
S316.002	S28			13.0	OK	
S316.003	S29			48.1	OK	
S316.004	S30			50.8	SURCHARGED	
S316.005	S31			51.8	SURCHARGED	
S316.006	S32			56.5	SURCHARGED	
S316.007	S33			61.5	SURCHARGED	
S316.008	S9			63.2	FLOOD RISK	
S317.000	S33			31.1	OK	
S317.001	S34			35.1	OK	
S317.002	S35			39.1	OK	
S317.003	S36			58.4	OK	
S317.004	S38			65.6	OK	
S317.005	S39			62.5	SURCHARGED	
S317.006	S40			53.9	FLOOD RISK	
S317.007	S41			50.7	FLOOD RISK	
S318.000	S12			4.9	OK	
S318.001	S13			7.1	OK	
S318.002	S14			11.3	OK	
S318.003	S15			13.0	OK	
S319.000	S30			3.6	OK	
S319.001	S31			5.0	SURCHARGED	
S318.004	S176			12.7	SURCHARGED	
S316.009	S18			121.4	FLOOD RISK	
S316.010	S36			136.4	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S316.011	S37	30 Summer	5	+40%	5/15 Summer				58.433	0.016
S316.012	S36	30 Summer	5	+40%					58.124	-0.198
S316.013	S37	30 Summer	5	+40%					57.146	-0.225
S315.002	S34	15 Summer	5	+40%					56.027	-0.170
S315.003	S28	30 Summer	5	+40%					53.787	-0.197
S315.004	S29	30 Summer	5	+40%					52.078	-0.196
S315.005	S30	30 Summer	5	+40%	5/15 Summer				50.594	0.074
S315.006	S72	30 Summer	5	+40%					50.173	-0.143
S315.007	S73	30 Summer	5	+40%					49.530	-0.166
S315.008	S8	30 Summer	5	+40%					48.878	-0.167
S320.000	S1	15 Summer	5	+40%					59.689	-0.031
S320.001	S2	15 Summer	5	+40%					58.079	-0.031
S320.002	S3	15 Summer	5	+40%					55.197	-0.080
S320.003	S4	15 Summer	5	+40%					54.242	-0.021
S321.000	S45	15 Summer	5	+40%					59.063	-0.433
S321.001	S46	15 Summer	5	+40%					58.007	-0.426
S321.002	S47	30 Summer	5	+40%	5/15 Summer				57.594	0.641
S321.003	S48	30 Summer	5	+40%					56.636	-0.178
S321.004	S74	30 Summer	5	+40%					55.702	-0.169
S321.005	S75	30 Summer	5	+40%					55.070	-0.189
S321.006	S76	30 Summer	5	+40%					54.540	-0.169
S321.007	S77	30 Summer	5	+40%					53.699	-0.168
S322.000	S94	15 Summer	5	+40%	5/15 Summer				54.567	0.052
S322.001	S95	15 Summer	5	+40%					54.078	-0.059
S322.002	S96	15 Summer	5	+40%					53.798	-0.137
S322.003	S97	15 Summer	5	+40%					53.581	-0.058
S322.004	S98	60 Summer	5	+40%					53.458	-0.065
S321.008	S58	60 Summer	5	+40%	5/15 Summer				53.428	0.354
S323.000	S54	15 Summer	5	+40%	5/15 Summer				67.583	0.165
S323.001	SSMP CR012	15 Summer	5	+40%	5/15 Summer				66.786	0.123
S323.002	SSMP CR011	60 Summer	5	+40%					64.135	-0.418
S323.003	SSMP CRS4	120 Summer	5	+40%	5/15 Summer	5/15 Summer			64.069	1.540
S323.004	SSMP CR010	15 Summer	5	+40%			5/15 Summer	24	60.164	-0.327
S323.005	SSMP CR009	15 Summer	5	+40%					58.526	-0.795
S323.006	SSMP 1106	15 Summer	5	+40%					57.334	-0.762
S323.007	S61	30 Summer	5	+40%	5/15 Summer		5/15 Summer	24	56.756	0.893
S323.008	S79	30 Summer	5	+40%					54.521	-0.263
S323.009	S63	30 Summer	5	+40%					54.154	-0.276
S323.010	S80	30 Summer	5	+40%					53.822	-0.254
S323.011	S81	60 Summer	5	+40%					53.474	-0.145
S323.012	S66	60 Summer	5	+40%					53.409	-0.019
S321.009	SSMP CR004	60 Summer	5	+40%	5/15 Summer				53.302	0.325
S324.000	S67	15 Summer	5	+40%					54.713	-0.061
S324.001	S68	15 Summer	5	+40%	5/15 Summer				54.002	0.046
S324.002	S69	15 Summer	5	+40%	5/15 Summer				53.557	0.063
S325.000	S12	15 Summer	5	+40%					59.896	-0.098
S325.001	S13	15 Summer	5	+40%					59.184	-0.096
S325.002	S19	15 Summer	5	+40%					58.312	-0.094
S325.003	S78	15 Summer	5	+40%	5/15 Summer				57.304	0.154
S324.003	S78	30 Summer	5	+40%	5/15 Summer				53.357	0.130
S324.004	S70	30 Summer	5	+40%	5/15 Summer				53.234	0.240
S321.010	S243	60 Summer	5	+40%	5/15 Summer				53.203	0.327
S321.011	S72	240 Summer	5	+40%	5/60 Summer				53.031	0.268
S321.012	S244	240 Summer	5	+40%	5/30 Summer				53.020	0.371
S321.013	S63	240 Summer	5	+40%	5/15 Summer				53.008	0.572
S320.004	S5	240 Summer	5	+40%	5/30 Summer				52.999	0.589
S326.000	S249	15 Summer	5	+40%					59.405	-0.016
S326.001	S251	15 Summer	5	+40%					58.655	-0.115
S326.002	S251	15 Summer	5	+40%	5/15 Summer				56.768	0.127
S326.003	S78	15 Summer	5	+40%	5/15 Summer				56.076	0.260

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S316.011	S37	0.000	1.14			138.1	SURCHARGED	
S316.012	S36	0.000	0.45			143.3	OK	
S316.013	S37	0.000	0.34			142.3	OK	
S315.002	S34	0.000	0.56			152.9	OK	
S315.003	S28	0.000	0.45			162.6	OK	
S315.004	S29	0.000	0.46			173.6	OK	
S315.005	S30	0.000	1.20			182.6	SURCHARGED	
S315.006	S72	0.000	0.70			188.3	OK	
S315.007	S73	0.000	0.60			188.0	OK	
S315.008	S8	0.000	0.59			191.0	OK	
S320.000	S1	0.000	0.99			34.1	OK	
S320.001	S2	0.000	0.95			40.2	OK	
S320.002	S3	0.000	0.73			51.5	OK	
S320.003	S4	0.000	0.99			80.4	OK	
S321.000	S45	0.000	0.17			140.8	OK*	
S321.001	S46	0.000	0.18			138.0	OK	
S321.002	S47	0.000	1.08			100.8	SURCHARGED	
S321.003	S48	0.000	0.53			99.7	OK	
S321.004	S74	0.000	0.58			100.8	OK	
S321.005	S75	0.000	0.49			101.2	OK	
S321.006	S76	0.000	0.58			101.5	OK	
S321.007	S77	0.000	0.58			105.4	OK	
S322.000	S94	0.000	1.01			17.4	SURCHARGED	
S322.001	S95	0.000	0.86			32.6	OK	
S322.002	S96	0.000	0.55			43.1	OK	
S322.003	S97	0.000	0.96			52.3	OK	
S322.004	S98	0.000	0.42			45.0	OK	
S321.008	S58	0.000	0.61			125.9	SURCHARGED	
S323.000	S54	0.000	1.00			54.7	SURCHARGED	
S323.001	SSMP CR012	0.000	0.98			124.5	SURCHARGED	
S323.002	SSMP CR011	0.000	0.12			131.8	OK	
S323.003	SSMP CRS4	69.167	1.29			33.3	FLOOD	17
S323.004	SSMP CR010	0.000	0.16	13.8		79.4	OK	
S323.005	SSMP CR009	0.000	0.03			79.7	OK	
S323.006	SSMP 1106	0.000	0.06			130.6	OK	
S323.007	S61	0.000	0.28	62.7		57.8	SURCHARGED	
S323.008	S79	0.000	0.36			75.8	OK	
S323.009	S63	0.000	0.32			75.7	OK	
S323.010	S80	0.000	0.39			112.2	OK	
S323.011	S81	0.000	0.58			146.5	OK	
S323.012	S66	0.000	0.53			132.4	OK	
S321.009	SSMP CR004	0.000	0.97			241.1	SURCHARGED	
S324.000	S67	0.000	0.85			90.0	OK	
S324.001	S68	0.000	1.01			143.5	SURCHARGED	
S324.002	S69	0.000	1.12			155.2	SURCHARGED	
S325.000	S12	0.000	0.26			7.4	OK	
S325.001	S13	0.000	0.28			9.4	OK	
S325.002	S19	0.000	0.30			10.5	OK	
S325.003	S78	0.000	0.21			11.6	SURCHARGED	
S324.003	S78	0.000	0.61			133.3	SURCHARGED	
S324.004	S70	0.000	0.49			149.7	SURCHARGED	
S321.010	S243	0.000	0.81			376.6	SURCHARGED	
S321.011	S72	0.000	0.54			252.5	SURCHARGED	
S321.012	S244	0.000	0.52			252.5	SURCHARGED	
S321.013	S63	0.000	0.84			249.0	SURCHARGED	
S320.004	S5	0.000	0.60			266.2	SURCHARGED	
S326.000	S249	0.000	0.87			41.3	OK	
S326.001	S251	0.000	0.64			85.1	OK	
S326.002	S251	0.000	0.96			113.8	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.003	S78	0.000	1.22			107.5	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S326.004	S77	15 Summer	5	+40%	5/15 Summer				55.454	0.129	0.000
S326.005	S80	15 Summer	5	+40%					54.777	-0.104	0.000
S327.000	S60	15 Summer	5	+40%					54.703	-0.150	0.000
S326.006	S243	240 Summer	5	+40%	5/120 Summer				53.125	0.127	0.000
S328.000	S81	15 Summer	5	+40%					58.996	-0.150	0.000
S328.001	S251	15 Summer	5	+40%					58.786	-0.155	0.000
S328.002	S82	15 Summer	5	+40%					57.812	-0.166	0.000
S328.003	S253	15 Summer	5	+40%	5/15 Summer				56.959	0.146	0.000
S328.004	S86	15 Summer	5	+40%					55.638	-0.259	0.000
S328.005	S82	15 Summer	5	+40%					54.608	-0.259	0.000
S328.006	S89	15 Summer	5	+40%					53.576	-0.260	0.000
S329.000	S66	15 Summer	5	+40%	5/15 Summer				54.035	0.280	0.000
S329.001	S67	15 Summer	5	+40%	5/15 Summer				53.595	0.310	0.000
S329.002	S68	15 Summer	5	+40%	5/15 Summer				53.469	0.504	0.000
S326.007	S244	240 Summer	5	+40%	5/30 Summer				53.111	0.480	0.000
S326.008	S246	240 Summer	5	+40%	5/15 Summer				52.994	0.610	0.000
S330.000	S6	15 Summer	5	+40%	5/15 Summer				55.768	0.219	0.000
S330.001	S7	15 Summer	5	+40%					54.036	-0.084	0.000
S330.002	S121	15 Summer	5	+40%					53.226	-0.069	0.000
S320.005	S71	240 Summer	5	+40%	5/15 Summer				52.988	0.657	0.000
S320.006	S71	240 Summer	5	+40%	5/15 Summer			0	52.975	1.193	0.000
S315.009	S42	30 Summer	5	+40%					47.625	-0.202	0.000
S315.010	S48	30 Summer	5	+40%	5/15 Summer				46.233	0.262	0.000
S314.002	S41	30 Summer	5	+40%	5/15 Summer				45.391	0.141	0.000
S314.003	S34	720 Summer	5	+40%	5/600 Summer				45.050	0.087	0.000
S314.004	S98	720 Summer	5	+40%	5/15 Summer			0	44.846	1.796	0.000
S331.000	S50	15 Summer	5	+40%	5/15 Summer				53.254	0.447	0.000
S331.001	S51	15 Summer	5	+40%					52.029	-0.009	0.000
S331.002	S52	15 Summer	5	+40%					48.146	-0.120	0.000
S331.003	S100	15 Summer	5	+40%					45.442	-0.101	0.000
S331.004	S53	15 Summer	5	+40%	5/15 Summer				43.781	0.026	0.000
S331.005	S106	15 Summer	5	+40%	5/15 Summer		5/15 Summer	8	43.595	0.081	0.000
S332.000	S50	15 Summer	5	+40%					45.678	-0.099	0.000
S332.001	S165	15 Summer	5	+40%					44.088	-0.119	0.000
S332.002	S166	15 Summer	5	+40%					43.714	-0.175	0.000
S331.006	S54	15 Summer	5	+40%	5/15 Summer				43.544	0.011	0.000
S331.007	S106	15 Summer	5	+40%					43.217	-0.213	0.000
S331.008	S109	1440 Winter	5	+40%					43.131	-0.148	0.000
S331.009	S110	1440 Winter	5	+40%	5/1440 Summer				43.130	0.036	0.000
S331.010	S111	1440 Winter	5	+40%	5/600 Summer				43.130	0.195	0.000
S314.005	S37	1440 Winter	5	+40%	5/360 Summer				43.130	0.313	0.000
S314.006	S114	1440 Winter	5	+40%	5/60 Summer			0	43.029	0.779	0.000
S333.000	S69	15 Summer	5	+40%	5/15 Summer				54.355	0.352	0.000
S333.001	S70	15 Summer	5	+40%					53.411	-0.065	0.000
S333.002	S71	15 Summer	5	+40%					52.096	-0.097	0.000
S333.003	S72	15 Summer	5	+40%					47.171	-0.080	0.000
S334.000	S60	15 Summer	5	+40%					54.464	-0.133	0.000
S334.001	S61	15 Summer	5	+40%					53.862	-0.134	0.000
S334.002	S62	15 Summer	5	+40%					53.793	-0.126	0.000
S334.003	S63	15 Summer	5	+40%					53.548	-0.160	0.000
S334.004	S64	15 Summer	5	+40%					52.884	-0.159	0.000
S334.005	S65	15 Summer	5	+40%					51.797	-0.133	0.000
S334.006	S58	15 Summer	5	+40%					50.531	-0.230	0.000
S334.007	S54	15 Summer	5	+40%					49.209	-0.228	0.000
S334.008	S55	15 Summer	5	+40%					45.776	-0.214	0.000
S334.009	S100	15 Summer	5	+40%					45.044	-0.218	0.000
S334.010	S101	15 Summer	5	+40%					43.849	-0.193	0.000
S334.011	S102	15 Summer	5	+40%					42.942	-0.318	0.000
S335.000	S96	15 Summer	5	+40%					44.438	-0.041	0.000
S335.001	S97	15 Summer	5	+40%					44.048	-0.056	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S326.004	S77	1.13			102.7	SURCHARGED	
S326.005	S80	0.87			102.4	OK	
S327.000	S60	0.00			0.0	OK	
S326.006	S243	0.44			50.9	SURCHARGED	
S328.000	S81	0.00			0.0	OK	
S328.001	S251	0.45			53.5	OK	
S328.002	S82	0.40			52.1	OK	
S328.003	S253	1.06			134.6	SURCHARGED	
S328.004	S86	0.38			134.5	OK	
S328.005	S82	0.37			134.4	OK	
S328.006	S89	0.37			134.0	OK	
S329.000	S66	1.10			42.8	SURCHARGED	
S329.001	S67	0.72			49.2	SURCHARGED	
S329.002	S68	1.51			54.1	SURCHARGED	
S326.007	S244	0.38			144.1	SURCHARGED	
S326.008	S246	1.00			142.9	SURCHARGED	
S330.000	S6	1.00			60.8	SURCHARGED	
S330.001	S7	0.84			119.4	OK	
S330.002	S121	0.94			144.3	OK	
S320.005	S71	0.65			441.8	SURCHARGED	
S320.006	S71	0.15	0.0	118	124.3	SURCHARGED	
S315.009	S42	0.59			312.2	OK	
S315.010	S48	3.78			314.5	SURCHARGED	
S314.002	S41	1.36			333.4	SURCHARGED	
S314.003	S34	0.39			200.6	SURCHARGED*	
S314.004	S98	1.40	0.0	608	48.5	SURCHARGED*	
S331.000	S50	1.17			20.5	SURCHARGED	
S331.001	S51	1.00			40.9	OK	
S331.002	S52	0.44			55.6	OK	
S331.003	S100	0.59			55.7	OK	
S331.004	S53	0.86			64.7	SURCHARGED	
S331.005	S106	0.98	10.6		55.2	SURCHARGED	
S332.000	S50	0.25			9.9	OK	
S332.001	S165	0.43			23.1	OK	
S332.002	S166	0.36			31.2	OK	
S331.006	S54	0.45			80.7	SURCHARGED*	
S331.007	S106	0.53			93.9	OK	
S331.008	S109	0.06			8.9	OK	
S331.009	S110	0.06			9.1	SURCHARGED	
S331.010	S111	0.14			11.4	SURCHARGED	
S314.005	S37	0.12			57.7	SURCHARGED*	
S314.006	S114	0.69	0.0	1052	39.5	SURCHARGED*	
S333.000	S69	1.17			50.7	SURCHARGED	
S333.001	S70	0.84			66.3	OK	
S333.002	S71	0.61			82.4	OK	
S333.003	S72	0.74			96.4	OK	
S334.000	S60	0.48			40.1	OK	
S334.001	S61	0.59			40.9	OK	
S334.002	S62	0.61			48.2	OK	
S334.003	S63	0.44			58.2	OK	
S334.004	S64	0.44			73.8	OK	
S334.005	S65	0.58			96.1	OK	
S334.006	S58	0.31			102.2	OK	
S334.007	S54	0.32			120.3	OK	
S334.008	S55	0.38			127.1	OK	
S334.009	S100	0.37			127.0	OK	
S334.010	S101	0.48			126.5	OK	
S334.011	S102	0.25			125.4	OK	
S335.000	S96	0.86			16.1	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.001	S97	0.67			21.6	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S335.002	S98	15 Summer	5	+40%				0	42.959	-0.073	0.000
S335.003	S99	15 Summer	5	+40%	5/15 Summer		5/15 Summer	5	42.898	0.054	0.000
S334.012	S100	15 Summer	5	+40%	5/15 Summer				42.877	0.101	0.000
S334.013	S69	15 Summer	5	+40%					42.536	-0.188	0.000
S334.014	S137	15 Summer	5	+40%					42.474	-0.204	0.000
S334.015	S72	15 Summer	5	+40%					42.391	-0.241	0.000
S334.016	S74	15 Summer	5	+40%					42.325	-0.240	0.000
S333.004	S73	15 Summer	5	+40%					42.051	-0.367	0.000
S333.005	S114	1440 Summer	5	+40%					41.622	-0.223	0.000
S314.007	S154	1440 Summer	5	+40%	5/960 Summer				41.622	0.116	0.000
S314.008	S154	1440 Summer	5	+40%	5/360 Summer			0	41.619	0.407	0.000
S314.009	S163	960 Summer	5	+40%					40.736	-0.305	0.000
S336.000	S163	15 Summer	5	+40%	5/15 Summer				67.905	0.243	0.000
S336.001	S219	15 Summer	5	+40%					66.741	-0.064	0.000
S336.002	S220	15 Summer	5	+40%					65.743	-0.061	0.000
S336.003	S221	15 Summer	5	+40%					64.754	-0.074	0.000
S336.004	S64	30 Summer	5	+40%					63.546	-0.052	0.000
S336.005	S223	30 Summer	5	+40%	5/15 Summer				61.428	0.218	0.000
S337.000	S218	15 Summer	5	+40%					60.096	-0.141	0.000
S336.006	S262	30 Summer	5	+40%			5/15 Summer	24	59.967	-0.067	0.000
S336.007	S266	30 Summer	5	+40%	5/15 Summer	5/15 Summer			59.376	0.938	7.645
S336.008	S267	30 Summer	5	+40%	5/15 Summer	5/15 Summer			58.534	0.882	7.702
S338.000	S143	15 Summer	5	+40%					61.074	-0.076	0.000
S338.001	S144	15 Summer	5	+40%					60.686	-0.042	0.000
S338.002	S145	15 Summer	5	+40%	5/15 Summer				58.957	0.148	0.000
S338.003	S146	15 Summer	5	+40%	5/15 Summer				56.492	0.412	0.000
S339.000	S173	60 Summer	5	+40%	5/15 Summer				57.018	1.145	0.000
S336.009	S261	30 Summer	5	+40%	5/15 Summer				56.400	0.593	0.000
S340.000	S82	15 Summer	5	+40%					59.501	-1.207	0.000
S340.001	S183	15 Summer	5	+40%					56.927	-1.207	0.000
S336.010	S262	30 Summer	5	+40%					55.649	-0.097	0.000
S341.000	S113	15 Summer	5	+40%					58.429	-0.271	0.000
S341.001	S114	15 Summer	5	+40%					54.480	-0.264	0.000
S342.000	S299	15 Summer	5	+40%					39.086	-1.207	0.000
S342.001	S300	15 Summer	5	+40%					38.550	-0.300	0.000
S343.000	S247	15 Summer	5	+40%	5/15 Summer				51.666	0.191	0.000
S343.001	S80	15 Summer	5	+40%	5/15 Summer				51.400	0.081	0.000
S343.002	S81	15 Summer	5	+40%					51.107	-0.086	0.000
S343.003	S82	15 Summer	5	+40%					50.968	-0.108	0.000
S344.000	S88	15 Summer	5	+40%					60.075	-0.095	0.000
S344.001	S89	15 Summer	5	+40%					58.302	-0.110	0.000
S344.002	S90	15 Summer	5	+40%					55.152	-0.020	0.000
S344.003	S264	15 Summer	5	+40%					54.813	-0.052	0.000
S344.004	S59	15 Summer	5	+40%					53.623	-0.146	0.000
S344.005	S60	15 Summer	5	+40%					52.354	-0.095	0.000
S344.006	S61	15 Summer	5	+40%					51.818	-0.087	0.000
S344.007	S62	15 Summer	5	+40%	5/15 Summer				50.875	0.108	0.000
S343.004	S83	15 Summer	5	+40%	5/15 Summer				50.518	0.393	0.000
S343.005	S64	15 Summer	5	+40%	5/15 Summer				50.099	0.867	0.000
S343.006	S84	1440 Summer	5	+40%	5/30 Summer				49.270	0.587	0.000
S343.007	S85	15 Summer	5	+40%					43.826	-0.336	0.000
S345.000	S87	15 Summer	5	+40%					49.102	-0.058	0.000
S345.001	S88	15 Summer	5	+40%					46.860	-0.048	0.000
S345.002	S89	15 Summer	5	+40%					44.840	-0.034	0.000
S345.003	S270	15 Summer	5	+40%					43.684	-0.026	0.000
S343.008	S87	15 Summer	5	+40%					41.874	-0.259	0.000
S346.000	S78	15 Summer	5	+40%					44.354	-0.054	0.000
S346.001	S79	15 Summer	5	+40%					43.729	-0.055	0.000
S346.002	S80	15 Summer	5	+40%	5/15 Summer				43.061	0.083	0.000
S346.003	S81	15 Summer	5	+40%					42.014	-0.105	0.000

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S335.002	S98	0.77	0.0		27.9	OK	
S335.003	S99	0.63	7.4		19.8	SURCHARGED	
S334.012	S100	0.55			170.3	SURCHARGED	
S334.013	S69	0.74			168.6	OK	
S334.014	S137	0.76			172.9	OK	
S334.015	S72	0.66			175.2	OK	
S334.016	S74	0.67			181.8	OK	
S333.004	S73	0.32			238.5	OK	
S333.005	S114	0.11			37.7	OK	
S314.007	S154	0.17			66.2	SURCHARGED	
S314.008	S154	0.12	0.0		29.2	SURCHARGED*	
S314.009	S163	0.04			29.2	OK	
S336.000	S163	0.89			12.8	SURCHARGED	
S336.001	S219	0.59			12.0	OK	
S336.002	S220	0.62			14.2	OK	
S336.003	S221	0.50			14.2	OK	
S336.004	S64	0.72			21.0	OK	
S336.005	S223	1.09			29.8	SURCHARGED	
S337.000	S218	0.29			13.7	OK	
S336.006	S262	0.65	17.9		50.6	OK	
S336.007	S266	1.04			69.5	FLOOD	5
S336.008	S267	1.18			80.1	FLOOD	7
S338.000	S143	0.49			10.8	OK	
S338.001	S144	0.84			24.5	OK	
S338.002	S145	0.98			36.3	SURCHARGED	
S338.003	S146	0.45			59.4	SURCHARGED	
S339.000	S173	0.75			52.6	SURCHARGED	
S336.009	S261	0.91			166.7	SURCHARGED	
S340.000	S82	0.00			0.0	OK	
S340.001	S183	0.00			0.0	OK	
S336.010	S262	1.04			166.1	OK*	
S341.000	S113	0.02			5.0	OK	
S341.001	S114	0.04			8.3	OK	
S342.000	S299	0.00			0.0	OK	
S342.001	S300	0.00			0.0	OK*	
S343.000	S247	1.28			20.7	SURCHARGED	
S343.001	S80	1.29			20.0	SURCHARGED	
S343.002	S81	0.69			27.8	OK	
S343.003	S82	0.51			39.3	OK	
S344.000	S88	0.59			43.1	OK	
S344.001	S89	0.49			55.5	OK	
S344.002	S90	1.00			75.6	OK	
S344.003	S264	0.94			77.7	OK	
S344.004	S59	0.51			90.0	OK	
S344.005	S60	0.79			120.4	OK	
S344.006	S61	0.84			128.1	OK	
S344.007	S62	1.34			128.2	SURCHARGED	
S343.004	S83	1.44			160.4	SURCHARGED	
S343.005	S64	2.16			159.5	SURCHARGED	
S343.006	S84	0.01		1333	3.1	SURCHARGED	
S343.007	S85	0.02			6.6	OK	
S345.000	S87	0.69			36.2	OK	
S345.001	S88	0.80			41.4	OK	
S345.002	S89	0.93			41.4	OK	
S345.003	S270	0.97			40.9	OK	
S343.008	S87	0.21			48.0	OK	
S346.000	S78	0.73			17.5	OK	
S346.001	S79	0.71			22.5	OK	
S346.002	S80	1.04			30.9	SURCHARGED	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S346.003	S81	0.55			31.1	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S343.009	S106	1440 Winter	5	+40%	5/240 Summer				41.390	0.177
S343.010	S79	1440 Winter	5	+40%					40.416	-0.201
S343.011	S300	1440 Summer	5	+40%					38.826	-0.415
S342.002	S245	1440 Winter	5	+40%					37.975	-0.514
S347.000	S251	15 Summer	5	+40%					63.490	-0.055
S347.001	S252	15 Summer	5	+40%					63.208	-0.027
S347.002	S253	15 Summer	5	+40%					62.965	-0.023
S347.003	S251	15 Summer	5	+40%					62.461	-0.076
S347.004	S71	15 Summer	5	+40%					61.458	-0.074
S347.005	S252	15 Summer	5	+40%					60.005	-0.062
S347.006	S73	15 Summer	5	+40%					58.422	-0.135
S347.007	S200	15 Summer	5	+40%					57.343	-0.105
S347.008	S254	15 Summer	5	+40%					56.541	-0.103
S347.009	S202	15 Summer	5	+40%					55.893	-0.166
S347.010	S198	15 Summer	5	+40%					55.066	-0.149
S347.011	S306	15 Summer	5	+40%	5/15 Summer				54.671	0.163
S348.000	S277	15 Summer	5	+40%					63.807	-0.093
S348.001	S278	15 Summer	5	+40%					63.445	-0.057
S348.002	S279	15 Summer	5	+40%					63.133	-0.057
S349.000	S280	15 Summer	5	+40%					63.401	-0.070
S348.003	S280	15 Summer	5	+40%					62.980	-0.081
S348.004	S281	15 Summer	5	+40%					62.883	-0.062
S348.005	S282	15 Summer	5	+40%					62.747	-0.082
S348.006	S283	15 Summer	5	+40%					62.489	-0.090
S348.007	S284	15 Summer	5	+40%					62.135	-0.085
S348.008	S285	15 Summer	5	+40%					61.738	-0.101
S348.009	S286	15 Summer	5	+40%					61.103	-0.094
S348.010	S216	15 Summer	5	+40%					60.956	-0.144
S348.011	S103	15 Summer	5	+40%					57.905	-0.157
S348.012	S218	15 Summer	5	+40%					54.863	-0.154
S347.012	S305	15 Summer	5	+40%	5/15 Summer				54.517	0.142
S350.000	S220	15 Summer	5	+40%					59.736	-0.179
S351.000	SSU4931_9196a	15 Summer	5	+40%					51.243	-0.375
S351.001	S226	15 Summer	5	+40%					51.124	-0.450
S352.000	SSMP East Start	15 Summer	5	+40%					67.646	-0.079
S352.001	S187	15 Summer	5	+40%					66.438	-0.110
S352.002	S188	15 Summer	5	+40%					64.642	-0.018
S352.003	SSMP SBK3	15 Summer	5	+40%					62.308	-0.406
S352.004	S261	15 Summer	5	+40%	5/15 Summer		5/15 Summer	20	61.384	0.809
S353.000	S261	15 Summer	5	+40%					67.200	-0.150
S353.001	S262	15 Summer	5	+40%					64.208	-0.150
S353.002	S262	15 Summer	5	+40%					60.988	-0.150
S352.005	S303	15 Summer	5	+40%					57.496	-0.079
S354.000	S265	15 Summer	5	+40%					67.576	-0.049
S354.001	S266	15 Summer	5	+40%	5/15 Summer				66.532	0.245
S354.002	S267	15 Summer	5	+40%					63.360	-0.049
S354.003	S309	15 Summer	5	+40%					58.489	-1.184
S352.006	S304	15 Summer	5	+40%					54.463	-1.121
S355.000	S255	15 Summer	5	+40%					73.500	-0.543
S355.001	S256	15 Summer	5	+40%					64.300	-0.300

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S343.009	S106	0.000	0.02			1.9	SURCHARGED	
S343.010	S79	0.000	0.03			1.9	OK	
S343.011	S300	0.000	0.02			1.9	OK	
S342.002	S245	0.000	0.00			1.9	OK	

5 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S347.000	S251	0.000	0.42			3.7	OK	
S347.001	S252	0.000	0.86			6.5	OK	
S347.002	S253	0.000	0.94			7.5	OK	
S347.003	S251	0.000	0.49			15.4	OK	
S347.004	S71	0.000	0.49			18.9	OK	
S347.005	S252	0.000	0.63			24.4	OK	
S347.006	S73	0.000	0.33			31.0	OK	
S347.007	S200	0.000	0.55			37.6	OK	
S347.008	S254	0.000	0.71			61.3	OK	
S347.009	S202	0.000	0.41			61.4	OK	
S347.010	S198	0.000	0.50			60.3	OK	
S347.011	S306	0.000	0.54			60.6	SURCHARGED	
S348.000	S277	0.000	0.31			7.1	OK	
S348.001	S278	0.000	0.66			11.7	OK	
S348.002	S279	0.000	0.70			12.0	OK	
S349.000	S280	0.000	0.56			14.1	OK	
S348.003	S280	0.000	0.68			24.0	OK	
S348.004	S281	0.000	0.88			31.8	OK	
S348.005	S282	0.000	0.70			37.2	OK	
S348.006	S283	0.000	0.66			42.2	OK	
S348.007	S284	0.000	0.71			46.3	OK	
S348.008	S285	0.000	0.58			50.1	OK	
S348.009	S286	0.000	0.78			56.8	OK	
S348.010	S216	0.000	0.50			82.6	OK	
S348.011	S103	0.000	0.45			96.7	OK	
S348.012	S218	0.000	0.47			96.1	OK	
S347.012	S305	0.000	2.13			165.7	SURCHARGED	
S350.000	S220	0.000	0.09			18.1	OK	
S351.000	SSU4931_9196a	0.000	0.00			0.0	OK	
S351.001	S226	0.000	0.00			0.0	OK	
S352.000	SSMP East Start	0.000	0.70			46.3	OK	
S352.001	S187	0.000	0.64			84.3	OK	
S352.002	S188	0.000	0.96			135.4	OK	
S352.003	SSMP SBK3	0.000	0.22			170.3	OK	
S352.004	S261	0.000	0.67	140.2		28.5	FLOOD RISK	
S353.000	S261	0.000	0.00			0.0	OK	
S353.001	S262	0.000	0.00			0.0	OK	
S353.002	S262	0.000	0.00			0.0	OK	
S352.005	S303	0.000	0.46			28.5	OK	
S354.000	S265	0.000	0.80			44.2	OK	
S354.001	S266	0.000	1.01			69.7	SURCHARGED	
S354.002	S267	0.000	0.95			93.4	OK	
S354.003	S309	0.000	0.01			109.9	OK	
S352.006	S304	0.000	0.02			138.4	OK	
S355.000	S255	0.000	0.00			0.0	OK	
S355.001	S256	0.000	0.00			0.0	OK*	

Online Controls for M3 SB to Basin 5

Orifice Manhole: S5, DS/PN: S101.004, Volume (m³): 2.0

Diameter (m) 0.159 Discharge Coefficient 0.600 Invert Level (m) 59.398

Orifice Manhole: S10, DS/PN: S102.007, Volume (m³): 24.3

Diameter (m) 0.424 Discharge Coefficient 0.600 Invert Level (m) 51.379

Depth/Flow Relationship Manhole: S103, DS/PN: S100.002, Volume (m³): 222.3

Invert Level (m) 49.000

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

QVA Consulting		Page 2
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:51 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	10
Climate Change (%)	40

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S100.000	S2	15 Summer	10	+40%					54.310
S101.000	S5	15 Summer	10	+40%					62.170
S101.001	S7	15 Summer	10	+40%					60.829
S101.002	S8	15 Summer	10	+40%	10/15 Summer				60.227
S101.003	S9	15 Summer	10	+40%	10/15 Summer				60.188
S101.004	S5	15 Summer	10	+40%	10/15 Summer				60.151
S101.005	S7	15 Summer	10	+40%					59.543

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S100.000	S2	0.000	0.000	1.17			218.2	SURCHARGED*	
S101.000	S5	-0.047	0.000	0.81			29.5	OK	
S101.001	S7	-0.041	0.000	0.88			33.8	OK	
S101.002	S8	0.320	0.000	0.71			27.1	SURCHARGED	
S101.003	S9	0.512	0.000	0.86			22.9	FLOOD RISK	
S101.004	S5	0.528	0.000	1.33			36.2	SURCHARGED	
S101.005	S7	-0.030	0.000	0.93			48.7	OK	

QVA Consulting		Page 4
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:51 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S101.006	S28	15 Summer	10	+40%				
S101.007	S30	15 Summer	10	+40%				
S101.008	S10	15 Summer	10	+40%				
S101.009	S11	15 Summer	10	+40%				
S102.000	S47	15 Summer	10	+40%	10/15 Summer			
S102.001	S48	15 Summer	10	+40%	10/15 Summer			
S103.000	S249	15 Summer	10	+40%	10/15 Summer			
S103.001	S6	15 Summer	10	+40%	10/15 Summer			
S103.002	S250	15 Summer	10	+40%	10/15 Summer			
S103.003	S80	15 Summer	10	+40%				
S102.002	S49	15 Summer	10	+40%				
S102.003	S50	15 Summer	10	+40%				
S102.004	S51	15 Summer	10	+40%	10/15 Summer			
S102.005	S12	30 Summer	10	+40%	10/15 Summer	10/15 Summer		
S104.000	S54	15 Summer	10	+40%	10/15 Summer			
S104.001	S55	15 Summer	10	+40%	10/15 Summer			
S104.002	S56	30 Summer	10	+40%	10/15 Summer			
S104.003	S53	30 Summer	10	+40%	10/15 Summer			
S102.006	S52	15 Summer	10	+40%	10/15 Summer			
S105.000	S56	15 Summer	10	+40%				
S105.001	S57	15 Summer	10	+40%				
S105.002	S58	15 Summer	10	+40%	10/15 Summer			
S105.003	S59	15 Summer	10	+40%				
S105.004	S60	15 Summer	10	+40%				
S105.005	S61	15 Summer	10	+40%				
S105.006	S62	15 Summer	10	+40%				
S106.000	S76	15 Summer	10	+40%				
S105.007	S63	15 Summer	10	+40%				
S105.008	S64	15 Summer	10	+40%				
S105.009	S56	15 Summer	10	+40%	10/15 Summer			
S105.010	S57	15 Summer	10	+40%	10/15 Summer			
S105.011	S58	15 Summer	10	+40%	10/15 Summer			
S105.012	S59	15 Summer	10	+40%	10/15 Summer			
S102.007	S10	15 Summer	10	+40%	10/15 Summer			
S100.002	S103	960 Winter	10	+40%	10/180 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S101.006	S28	59.345	-0.076	0.000	0.88			45.4	OK
S101.007	S30	59.182	-0.127	0.000	0.63			44.9	OK*
S101.008	S10	58.854	-0.314	0.000	0.03			44.8	OK
S101.009	S11	53.983	-0.306	0.000	0.04			44.6	OK
S102.000	S47	60.608	0.596	0.000	1.30			54.5	FLOOD RISK
S102.001	S48	59.748	0.205	0.000	1.14			112.7	SURCHARGED
S103.000	S249	61.428	0.837	0.000	1.54			66.2	FLOOD RISK

QVA Consulting		Page 5
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:51 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S103.001	S6	60.541	0.364	0.000	1.30			56.1	SURCHARGED
S103.002	S250	59.796	0.033	0.000	1.06			100.1	SURCHARGED
S103.003	S80	59.341	-0.111	0.000	0.71			99.8	OK
S102.002	S49	58.718	-0.210	0.000	0.55			266.1	OK
S102.003	S50	56.641	-0.210	0.000	0.54			321.1	OK
S102.004	S51	54.388	0.197	0.000	0.78			381.5	SURCHARGED
S102.005	S12	53.340	0.955	27.885	1.21			270.5	FLOOD
S104.000	S54	54.415	0.066	0.000	0.86			14.8	SURCHARGED
S104.001	S55	54.222	0.304	0.000	1.22			25.0	SURCHARGED
S104.002	S56	53.536	0.200	0.000	0.65			43.7	SURCHARGED
S104.003	S53	53.333	0.909	0.000	0.71			36.2	FLOOD RISK
S102.006	S52	53.230	1.026	0.000	0.77			290.2	SURCHARGED
S105.000	S56	63.614	-0.065	0.000	0.61			13.1	OK
S105.001	S57	63.192	-0.069	0.000	0.55			12.7	OK
S105.002	S58	62.844	0.075	0.000	1.15			18.4	SURCHARGED
S105.003	S59	62.464	-0.085	0.000	0.68			25.7	OK
S105.004	S60	62.270	-0.102	0.000	0.56			38.3	OK
S105.005	S61	59.182	-0.130	0.000	0.58			67.5	OK
S105.006	S62	58.281	-0.116	0.000	0.69			67.1	OK
S106.000	S76	60.798	-0.087	0.000	0.37			15.3	OK
S105.007	S63	58.033	-0.164	0.000	0.41			89.9	OK
S105.008	S64	55.544	-0.129	0.000	0.60			113.4	OK
S105.009	S56	55.170	0.864	0.000	1.09			113.3	SURCHARGED
S105.010	S57	54.789	0.932	0.000	1.31			125.2	FLOOD RISK
S105.011	S58	54.169	0.767	0.000	1.16			123.4	SURCHARGED
S105.012	S59	53.570	0.620	0.000	1.15			134.0	SURCHARGED
S102.007	S10	53.129	1.150	0.000	1.41			388.1	SURCHARGED
S100.002	S103	49.522	0.222	0.000	0.00			0.0	SURCHARGED*

PN	US/MH Name	Level Exceeded
S101.006	S28	
S101.007	S30	
S101.008	S10	
S101.009	S11	
S102.000	S47	
S102.001	S48	
S103.000	S249	
S103.001	S6	
S103.002	S250	
S103.003	S80	
S102.002	S49	
S102.003	S50	
S102.004	S51	
S102.005	S12	5

Summary of Critical Results by Maximum Level (Rank 1) for M3 SB to Basin 5

PN	US/MH Name	Level Exceeded
S104.000	S54	
S104.001	S55	
S104.002	S56	
S104.003	S53	
S102.006	S52	
S105.000	S56	
S105.001	S57	
S105.002	S58	
S105.003	S59	
S105.004	S60	
S105.005	S61	
S105.006	S62	
S106.000	S76	
S105.007	S63	
S105.008	S64	
S105.009	S56	
S105.010	S57	
S105.011	S58	
S105.012	S59	
S102.007	S10	
S100.002	S103	

QVA Consulting		Page 1
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:18 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Online Controls for Between A33_34 to Itchen

Hydro-Brake® Optimum Manhole: S79, DS/PN: S213.005, Volume (m³): 4.0

Unit Reference	MD-SHE-0070-3000-2000-3000
Design Head (m)	2.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	38.563
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	3.0	Kick-Flo®	0.630	1.8
Flush-Flo™	0.310	2.2	Mean Flow over Head Range	-	2.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.4	3.000	3.6	7.000	5.4
0.200	2.1	1.400	2.5	3.500	3.9	7.500	5.6
0.300	2.2	1.600	2.7	4.000	4.1	8.000	5.7
0.400	2.2	1.800	2.9	4.500	4.4	8.500	5.9
0.500	2.1	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.9	2.200	3.1	5.500	4.8	9.500	6.2
0.800	2.0	2.400	3.3	6.000	5.0		
1.000	2.2	2.600	3.4	6.500	5.2		

Offline Controls for Between A33_34 to Itchen

Pipe Manhole: S79, DS/PN: S213.005, Loop to PN: S213.006

Diameter (m)	0.150	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	20.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	41.000

QVA Consulting		Page 3
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:18 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	10
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S213.000	S152	15 Summer	10	+40%					43.470
S213.001	S153	15 Summer	10	+40%					41.787
S213.002	S154	720 Winter	10	+40%					40.231
S213.003	S77	720 Winter	10	+40%					40.231
S213.004	S78	720 Winter	10	+40%	10/15 Summer				40.231
S214.000	S96	15 Summer	10	+40%					41.335
S215.000	S94	15 Summer	10	+40%					41.633
S215.001	S95	15 Summer	10	+40%	10/15 Summer				40.916
S215.002	S96	15 Summer	10	+40%					40.419

QVA Consulting		Page 4
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:18 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S213.000	S152	-0.091	0.000	0.65			53.2	OK	
S213.001	S153	-0.113	0.000	0.69			91.9	OK	
S213.002	S154	-0.765	0.000	0.00			8.4	OK*	
S213.003	S77	-0.594	0.000	0.00			3.3	OK*	
S213.004	S78	1.252	0.000	0.07			4.3	SURCHARGED	
S214.000	S96	-0.114	0.000	0.49			41.2	OK	
S215.000	S94	-0.067	0.000	0.60			19.7	OK	
S215.001	S95	0.130	0.000	1.21			22.5	SURCHARGED	
S215.002	S96	-0.072	0.000	0.80			30.0	OK	

QVA Consulting		Page 5
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 14:18 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for Between A33_34 to Itchen

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S214.001	S97	15 Summer	10	+40%					40.294
S213.005	S79	720 Winter	10	+40%	10/15 Summer			0	40.229
S213.006	S12	720 Winter	10	+40%					38.461

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S214.001	S97	-0.106	0.000	0.53			71.0	OK	
S213.005	S79	1.365	0.000	0.03	0.0		2.8	SURCHARGED	
S213.006	S12	-0.266	0.000	0.03			2.8	OK	

QVA Consulting		Page 1
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 18:14 File 2021 10 25 FEH M100 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Online Controls for New works to Basins 2 & 3C

Hydro-Brake® Optimum Manhole: S154, DS/PN: S314.008, Volume (m^3): 1.1

Unit Reference	MD-SHE-0214-2930-2400-2930
Design Head (m)	2.400
Design Flow (l/s)	29.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	40.850
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.400	29.3	Kick-Flo®	1.466	23.1
Flush-Flo™	0.693	29.2	Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	7.3	1.200	27.2	3.000	32.6	7.000	49.1
0.200	20.9	1.400	24.6	3.500	35.1	7.500	50.7
0.300	26.1	1.600	24.1	4.000	37.4	8.000	52.3
0.400	27.8	1.800	25.5	4.500	39.6	8.500	53.9
0.500	28.7	2.000	26.8	5.000	41.7	9.000	55.4
0.600	29.1	2.200	28.1	5.500	43.7	9.500	56.9
0.800	29.1	2.400	29.3	6.000	45.5		
1.000	28.5	2.600	30.4	6.500	47.3		

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m^3): 10.9

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	41.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: S106, DS/PN: S343.009, Volume (m³): 10.9

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		

Offline Controls for New works to Basins 2 & 3C

Weir Manhole: S114, DS/PN: S314.006, Loop to PN: S314.007

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.900

Weir Manhole: S154, DS/PN: S314.008, Loop to PN: S314.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.250

Storage Structures for New works to Basins 2 & 3C

Infiltration Basin Manhole: S114, DS/PN: S314.006

Invert Level (m) 42.075 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1171.8	0.601	1414.1	1.201	1665.5	1.801	1925.8
0.101	1211.6	0.701	1455.4	1.301	1708.2	1.901	1970.1
0.201	1251.6	0.801	1496.9	1.401	1751.3	1.925	1980.8
0.301	1291.9	0.901	1538.7	1.501	1794.5		
0.401	1332.4	1.001	1580.7	1.601	1838.0		
0.501	1373.1	1.101	1623.0	1.701	1881.8		

Infiltration Basin Manhole: S154, DS/PN: S314.008

Invert Level (m) 40.850 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2392.3	0.701	2848.2	1.401	3316.3	2.101	3796.8
0.101	2456.7	0.801	2914.3	1.501	3384.2	2.201	3866.4
0.201	2521.3	0.901	2980.7	1.601	3452.3	2.301	3936.3
0.301	2586.2	1.001	3047.3	1.701	3520.7	2.400	4005.7
0.401	2651.3	1.101	3114.2	1.801	3589.4		
0.501	2716.7	1.201	3181.3	1.901	3658.2		
0.601	2782.3	1.301	3248.7	2.001	3727.4		

Infiltration Basin Manhole: S106, DS/PN: S343.009

Invert Level (m) 40.988 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1300.0	0.700	1682.5	1.400	2114.3	2.100	2595.3
0.100	1351.6	0.800	1741.2	1.500	2180.0	2.200	2668.0
0.200	1404.3	0.900	1800.8	1.600	2246.7	2.300	2741.8
0.300	1457.9	1.000	1861.5	1.700	2314.4	2.400	2816.5
0.400	1512.5	1.100	1923.2	1.800	2383.1	2.500	2892.3
0.500	1568.2	1.200	1985.9	1.900	2452.8		
0.600	1624.8	1.300	2049.6	2.000	2523.6		

QVA Consulting		Page 5
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 18:14 File 2021 10 25 FEH M100 +	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	6
Number of Online Controls	6	Number of Time/Area Diagrams	0
Number of Offline Controls	10	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Cv (Summer)	1.000
Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	US Label	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S314.006	S114	Basin 3B	2160 minute 100 year Winter I+40%	44.000	43.791	1.541	0.000
S314.008	S154	Basin 3C	5760 minute 100 year Winter I+40%	43.250	43.243	2.031	0.000
S343.009	S106	Basin 2	10080 minute 100 year Winter I+40%	43.650	42.278	1.065	0.000

Summary of Critical Results by Maximum Level (Rank 1) for New works to Basins 2 & 3C

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Overflow Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S314.006	S114	1.07	0.0	0.000	10584.329	61.2	FLOOD RISK*
S314.008	S154	0.12	0.0	0.000	17619.984	29.2	FLOOD RISK*
S343.009	S106	0.02			2220.529	2.2	SURCHARGED

QVA Consulting		Page 1
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 19:26 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Simulation Criteria for M3 SB to Basin 5

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	40.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	1440
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	1	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Summer Storms	No
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Storm Duration (mins)	360

QVA Consulting		Page 2
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 19:26 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Online Controls for M3 SB to Basin 5

Depth/Flow Relationship Manhole: S103, DS/PN: S100.002, Volume (m^3): 222.3

Invert Level (m) 49.800

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

QVA Consulting		Page 3
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 19:26 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Storage Structures for M3 SB to Basin 5

Infiltration Basin Manhole: S103, DS/PN: S100.002

Invert Level (m) 49.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.900	791.0	1.800	2320.0	2.700	4062.0
0.100	3.0	1.000	994.0	1.900	2507.0	2.800	4270.0
0.200	32.0	1.100	1104.0	2.000	2692.0	2.900	4481.0
0.300	90.0	1.200	1270.0	2.100	2878.0	3.000	4695.0
0.400	176.0	1.300	1439.0	2.200	3067.0	3.100	4910.0
0.500	281.0	1.400	1609.0	2.300	3258.0	3.200	5130.0
0.600	392.0	1.500	1781.0	2.400	3452.0	3.300	5354.0
0.700	515.0	1.600	1954.0	2.500	3652.0	3.400	5583.0
0.800	647.0	1.700	2130.0	2.600	3856.0		

QVA Consulting		Page 4
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 19:26 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Summary of Results for 360 minute 100 year Winter (M3 SB to Basin 5)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S100.002	S103	52.958	2.858	0.000	0.00			0.0	FLOOD RISK*

QVA Consulting		Page 1
43 Denmark Road Carshalton Surrey SM5 2JE		
Date 25/10/2021 19:28 File 2021 10 25 FEH	Designed by phill Checked by	
XP Solutions	Network 2020.1.3	

Simulation Criteria for New works to Basins 2 & 3C

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	40.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	1440
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	1	Number of Storage Structures	7
Number of Online Controls	7	Number of Time/Area Diagrams	0
Number of Offline Controls	10	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 449350 131500 SU 49350 31500
C (1km)	-0.025
D1 (1km)	0.429
D2 (1km)	0.273
D3 (1km)	0.411
E (1km)	0.294
F (1km)	2.313
Summer Storms	No
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Storm Duration (mins)	360

Online Controls for New works to Basins 2 & 3C

Depth/Flow Relationship Manhole: S256, DS/PN: S355.001, Volume (m³): 50.4

Invert Level (m) 64.300

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.900	0.0000	1.700	0.0000	2.500	0.0000
0.200	0.0000	1.000	0.0000	1.800	0.0000	2.600	0.0000
0.300	0.0000	1.100	0.0000	1.900	0.0000	2.700	0.0000
0.400	0.0000	1.200	0.0000	2.000	0.0000	2.800	0.0000
0.500	0.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000
0.600	0.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000
0.700	0.0000	1.500	0.0000	2.300	0.0000		
0.800	0.0000	1.600	0.0000	2.400	0.0000		

Storage Structures for New works to Basins 2 & 3C

Infiltration Basin Manhole: S256, DS/PN: S355.001

Invert Level (m) 64.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	0.0	0.700	417.0	1.400	1200.0	2.100	1600.0
0.100	32.0	0.800	501.0	1.500	1400.0	2.200	1600.0
0.200	78.0	0.900	588.0	1.600	1600.0	2.300	1600.0
0.300	133.0	1.000	676.0	1.700	1600.0	2.400	1600.0
0.400	195.0	1.100	766.0	1.800	1600.0	2.500	1600.0
0.500	264.0	1.200	891.0	1.900	1600.0		
0.600	338.0	1.300	1006.0	2.000	1600.0		

Summary of Results for 360 minute 100 year Winter (New works to Basins 2 & 3C)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S355.001	S256	65.903	1.303	0.000	0.00			0.0	FLOOD RISK*

Appendix M – M3J9 Improvements, PCF Stage 3B – Ground Investigation Report

HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0001

Regional Investment Programme

M3 Junction 9 Improvements

PCF Stage 3B – Ground Investigation Report

June 2021

HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0001
Revision: C03

GDMS Report Number: 32161

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

Notice

This document and its contents have been prepared and are intended solely for Highway England's information and use in relation to the M3 Junction 9 Improvements PCF Stage 3B, one of the schemes of the Regional Investment Programme. Stantec assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

Document Control

The Project Manager is responsible for production of this document, based on the contributions made by his/her team existing at each Stage.

Document Title	PCF Stage 3B: M3 Junction 9 Improvements – Ground Investigation Report
Author	Richard Thomas
Owner	Jon Roose, Highways England
Distribution	Highways England Consultees, Volker Fitzpatrick, Stantec Team
Document Status	**S4 For SGAR3B**

Revision History

This document is updated at least every stage.

Version	Date	Description	Author
P01	06/01/21	S3 Review and Comment	Richard Thomas
C01	14/05/21	S4 For SGAR 3B	Richard Thomas
C02	11/06/21	Incorporating HE Comments 2	Richard Thomas
C03	23//06/21	Incorporating HE Comments 3	Richard Thomas

Reviewer List

Name	Role
Asmi Desai	Stantec Project Team
Richard Thomas	Designer's Geotechnical Advisor
Jon Roose	Highways England, Project Manager
Robert Benson	Highways England, Geotechnical Advisor
Alan Feist	Highways England, Programme Delivery Director

Approvals

The Project SRO is accountable for the content of this document

Name	Signature	Title	Date of Issue	Version
Alan Feist		Highways England Project SRO		

M3 Junction 9 Improvements

PCF Stage 3B – Ground Investigation Report

GDMS REF: 32161

On behalf of **Highways England**

Project Ref: 48176/3500| Rev: C03| Date: June 2021

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: Caversham Bridge House, Waterman Place, Reading, Berkshire RG1 8DN
T: +44 (0)118 950 0761 E: PBA.Reading@stantec.com

Document Control Sheet

Project Name: **M3 Junction 9 Improvements**

Project Ref: **48176/3500**

Report Title: **PCF Stage 3B – Ground Investigation Report**

Doc Ref: **HE551511-VFK-HGT-X_XXXX_XX-RP-GE-0001**

Date: **June 2021**

	Name	Position	Signature	Date
Prepared by:	Tom Taplin	Assistant Geotechnical Engineer	T Taplin	23/06/21
Reviewed by:	Asmi Desai	Senior Associate	A Desai	23/06/21
Approved by:	Richard Thomas	Designer's Geotechnical Adviser	R Thomas	23/06/21
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
P01	06/01/21	S3 Review and Comment	TT	AD	RHT
C01	14/05/21	S4 For SGAR 3B	TT	AD	RHT
C02	11/06/21	Incorporating HE comments 2	AD	AD	RHT
C03	23/06/21	Incorporating HE comments 2	AD	AD	RHT

Contents

1 Introduction 10
1.1 Background 10
1.2 Scope and Objective of the Report 10
1.3 Description of Project 10
1.4 Geotechnical Category of Project 11
1.5 Other Relevant Information 11
1.6 Limitations 11
1.7 Guidance of the Context of the Report 11
2 Existing Information 13
2.1 Introduction 13
2.2 Topography 13
2.3 Geological Maps and Memoirs 13
2.4 Site History 15
2.5 Aerial Photography 15
2.6 Natural and Mining Cavities 16
2.7 Land Use and Soil Survey Information 16
2.8 Archaeological and Historical Investigations 16
2.9 Previous Ground Investigations 16
2.10 Soils and Agricultural Land Use 17
2.11 Designated Sites 17
2.12 Hydrology and Flooding 17
2.13 Hydrogeology 17
2.14 Landfill Sites and Contaminated Land 17
2.15 Unexploded Ordnance (UXO) Risk 18
3 Field and Laboratory Studies 19
3.1 Walkover Survey 19
3.2 Geomorphological / Geological Mapping 19
3.3 Ground Investigation 19
3.4 Drainage Studies 21
3.5 Geophysical Surveys 21
3.6 Pile Tests 21
3.7 Other Fieldwork 21
3.8 Laboratory Investigations 21
3.9 Review of the 2019 Ground Investigation Factual Report 22
4 Ground Summary 26
4.1 Geology 26
4.2 Hydrogeology 28
4.3 Visual and Olfactory Evidence of Contamination 29
4.4 Site Specific Ground Models 29

5 Ground Conditions and Material Properties 33
5.1 General 33
5.2 Derivation Methods 33
5.3 Made Ground 34
5.4 Engineered Fill 35
5.5 Alluvium (Peat) 35
5.6 Alluvium 35
5.7 Head Deposits 36
5.8 Structureless Chalk 37
5.9 Structured Chalk 38
5.10 Groundwater 39
5.11 Geotechnical Parameters Summary Table 40
6 Geoenvironmental Assessment 42
6.1 Introduction 42
6.2 Generic Assessment Criteria 42
6.3 Waste Assessment 43
6.4 Assessment of Soil Results 43
6.5 Assessment of Groundwater Results 44
6.6 Assessment of Ground Gas Results 44
7 Tier 2 Geoenvironmental Summary and Risk Estimation 45
7.1 Hazard Identification 45
7.2 Receptor Identification 46
7.3 Risk Estimation 47
7.4 Risk Evaluation 48
7.5 Recommendations 48
8 Geotechnical Risk Register 49
9 Engineering Assessment 50
9.1 Introduction 50
9.2 Natural and Mining Cavities 50
9.3 Earthworks 51
9.4 Site Preparation 53
9.5 Highways Structures 54
9.6 Pavement Design 57
9.7 Mix Design of Buried Concrete 58
9.8 Drainage 58
10 Additional Ground Investigation 61
References 63

Tables

Table 3.1 Summary of Geotechnical Testing 21
Table 3.2 Summary of Geoenvironmental Testing 22
Table 4.1 Summary of Post Fieldwork Groundwater Level Monitoring 28
Table 4.2 Summary of the Ground Conditions to the North and West of the River Itchen (Area A)..... 30
Table 4.3 Summary of the Ground Conditions between A34 and M3 (Area B) 31
Table 4.4 Summary of the Ground Conditions across the remainder of the site (Area C) 31
Table 5.1 Summary of Characteristic Groundwater Levels (for preliminary design only) 40
Table 5.2 Summary of Geotechnical Parameters 41
Table 7.1 Potential Sources of Contamination 45
Table 7.2 Summary of the Potential Receptors and their Sensitivity 46
Table 9.1 Summary of Initial Material Properties for Reuse in Earthworks 52
Table 9.2 Preliminary Design CBR Values 58
Table 9.3 Summary of pH and Sulphate Results 58
Table 9.4 Summary of the Variable Head Permeability Tests 59
Table 9.5 Summary of calculated Soil Infiltration Rates 59
Table 9.6 Adopted Infiltration Rates 60
Table 10.1 Summary of Provisional Additional Exploratory Holes 61

Figures

Figure 1a Barometrically Compensated Water Level m AOD
Figure 1b Barometrically Compensated Water Level m bgl
Figure 2 Atterberg Limits
Figure 3a Particle Size Distribution – Class 2A/2B
Figure 3b Particle Size Distribution – Class 2C
Figure 4a Corrected SPT N_{60} vs Depth – Engineered Fill
Figure 4b Corrected SPT N_{60} vs Depth – Alluvium
Figure 4c Corrected SPT N_{60} vs Depth – Head Deposits
Figure 4d Corrected SPT N_{60} vs Depth – Structureless Chalk
Figure 4e Corrected SPT N_{60} vs Depth – Structured Chalk
Figure 5a Maximum Dry Density vs Optimum Moisture Content Relationship – Head Deposits
Figure 5b Maximum Dry Density vs Optimum Moisture Content Relationship – Structureless Chalk
Figure 5c Maximum Dry Density vs Optimum Moisture Content Relationship – Structured Chalk
Figure 6 Preliminary Earthworks Chalk Classification
Figure 7 Effective Stress Plot

Drawings

HE551511-VFK-HGT-X_XXXX-XX-DR-GE-0001-04 – Exploratory Hole Plans
HE551511-VFK-HGT-X_XXXX-XX-DR-GE-0020 – Geological Plan
HE551511-VFK-HGT-X_XXXX-XX-DR-GE-0021-23 – Geological Cross-sections
HE551511-VFK-HGT-X_XXXX-XX-DR-GE-0031-34 – Geological Long-sections
HE551511-VFK-HGN-X_XXXX-XX-DR-CH-0051-55 – Proposed Contours
HE551511-VFK-HML-X_XXXX-XX-DR-CH-0101 – General Overview Layout
HE551511-VFK-SGN-X_XXXX-XX-DR-CB-0100 – Structures General Arrangement

Appendices

Appendix A	Cavity Occurrence Assessment
Appendix B	Stantec Methodology for the Assessment of Contaminated Land
Appendix C	Geoenvironmental Soils Assessment
Appendix D	Controlled Water Risk Assessment
Appendix E	Ground Gas Risk Assessment
Appendix F	Geotechnical Risk Register

This page is intentionally blank

1 Introduction

1.1 Background

1.1.1 Stantec UK Ltd are working as the design consultants to VolkerFitzpatrick Ltd who have been awarded the proposed M3 Junction 9 Improvements Scheme as part of the Highways England Regional Delivery Partnership. Jacobs UK Ltd were previously appointed by Highways England to manage a ground investigation for the proposed M3 Junction 9 Improvements Scheme and write a Ground Investigation Report (GIR). Jacobs did not complete the Ground Investigation Report, and this GIR has been produced by Stantec based on the available ground investigation information as instructed by Highways England.

1.1.2 It should be noted that the ground investigation was specified based on a previous iteration of the scheme (Stage 3A). Stantec are currently revising the Stage 3 preliminary design of the scheme (Stage 3B).

1.2 Scope and Objective of the Report

1.2.1 This report has been prepared following a ground investigation carried out to provide information on the ground conditions. The fieldwork and laboratory testing were undertaken by Principal Contractor Geoffrey Osborne Limited (GOL) employing ground investigation contractors Soils Limited and SM Associates under the instruction of Jacobs. A factual ground investigation report was produced by Soils Ltd (Soils, 2020) and is presented in **Appendix A**.

1.2.2 This Ground Investigation Report has been prepared in general accordance with BS EN 1997-1:2004+A1:2013, BS EN 1997-2:2007 and CD622 Managing Geotechnical Risk. The report presents an assessment of the ground conditions, together with recommended characteristic values of geotechnical parameters for use in the design of the geotechnical elements of the proposed Stage 3B scheme. In addition, this report presents an assessment of the risks associated with existing contamination in the ground to human health, the environment and proposed development.

1.2.3 The comments and opinions in this report are based on engineering and scientific appraisal of information on the ground conditions encountered within the exploratory holes and the results of field and laboratory testing carried out for this investigation. There may be conditions pertaining to the site which were not disclosed by the investigation and which therefore could not be taken into account.

1.3 Description of Project

1.3.1 M3 Junction 9 is a key transport interchange that connects South Hampshire (facilitating an intensive freight generating industry) and the wider sub-region, with London via the M3 and the Midlands/North via the A34 (which also links to the principal east-west A303 corridor).

1.3.2 The M3 Junction 9 Improvement Scheme involves widening of the M3 to four lanes, a smaller gyratory roundabout, improved walking, cycling and horse-riding facilities, connector roads to the new gyratory roundabout and improved motorway slip roads. This will create direct links from the M3 to the A34 northbound and A34 southbound to the M3. Additionally, this feeds into the M3 J9 smart motorways programme including new gantries.

1.3.3 A general overview of the Stage 3B scheme is shown on Drawing HE551511-VFK-HML-X_XXXX-XX-DR-CH-0101.

1.4 Geotechnical Category of Project

1.4.1 The project was previously categorised in the Preliminary Sources Study Report (PSSR) (WSP, 2017) as a Geotechnical Category 2. This categorisation was based on a previous design for the scheme at Stage 3A.

1.4.2 Stantec have undertaken a review of the revised proposed scheme (Stage 3B) and associated project risks to assess the expected geotechnical classification of the project and thus the requirement for geotechnical certification. On this basis of this review, it is anticipated that the scheme may be classified as a Geotechnical Category 2 project with potential structures and earthwork solutions of low/medium complexity.

1.4.3 Geotechnical Category 2 is defined in BS EN 1997-1 (2004+A1:2013) as a project including conventional types of earthworks, structures and foundations with no exceptional risk or difficult ground or loading conditions.

1.5 Other Relevant Information

1.5.1 The 2019 ground investigation was undertaken in accordance with a ground investigation specification that was produced to aid in the design of the Stage 3A scheme design which is no longer being taken forward to detailed design. Therefore, the information obtained during the 2019 ground investigation does not satisfy the needs for the design of all the geotechnical elements of the current Stage 3B scheme because some structures have been moved and additional major structures incorporated such that adequate ground investigation data is not available at all locations. Therefore, further ground investigation data will need to be obtained in line with the current Stage 3B scheme design.

1.6 Limitations

1.6.1 The opinions and recommendations in this report are based on the information obtained from the PSSR and the ground investigation specified and carried out by others. Stantec can, therefore, only base any recommendations included in this report from the information provided within the Factual Ground Investigation Report (Soils, 2019).

1.7 Guidance of the Context of the Report

1.7.1 This report has been prepared within an agreed timeframe and to an agreed budget that will necessarily apply some constraints on its content and usage. The remarks below are presented to assist the reader in understanding the context of this report and any general limitations or constraints. If there are any specific limitations and constraints, they are described in the report text or relevant design appendix.

i. The recommendations presented in this report are based on statute, guidance, and best practice current at the time of its preparation. Stantec UK does not accept any liability whatsoever for the consequences of any future legislative changes or the release of subsequent guidance documentation, etc. Such changes may render some of the opinions and advice in this report inappropriate or incorrect and we will be pleased to advise if any report requires revision due to changing circumstances, especially those over one year old. Following delivery of any report PBA has no obligation to advise the Client or any other party of such changes or their repercussions.

ii. Some of the ground models and geotechnical parameters presented in this report are based on third party data or third-party interpretation. No guarantee can be given for the accuracy or completeness of any of the third-party data or interpretation used. Some of the data used in this report may be historical or for other reasons not fully compliant with the requirements of current standards and good practice guidance.

iii. The recommendations presented in this report are based on the information reviewed and/or the ground conditions encountered in exploratory holes and the results of any field or laboratory testing undertaken. There may be ground conditions at the site that have not been disclosed by the information reviewed or by the investigative work undertaken. Such undiscovered conditions cannot be taken into account in any analysis and design.

iv. It should be noted that groundwater levels and surface water levels can vary due to seasonal, climatic, tidal and man-made effects and that where necessary cautious estimates of the water level parameters have been used in design.

2 Existing Information

2.1 Introduction

2.1.1 A review of existing information on the scheme area is contained in the PSSR (WSP, 2017). We are not aware of any significant changes to the site area since the issue of the PSSR, that may affect the ground conditions for the proposed Stage 3B scheme. A summary of salient points from the PSSR, relevant to the ground conditions at the site, are briefly described below.

2.2 Topography

2.2.1 The Site is partly situated on the west facing side of the River Itchen valley. The ground generally slopes towards the river to the west. The River Itchen flows from north to south through Winchester to the west of the scheme. Part of the scheme crosses the River Itchen towards the northern extent of the A34 within the scheme order limits.

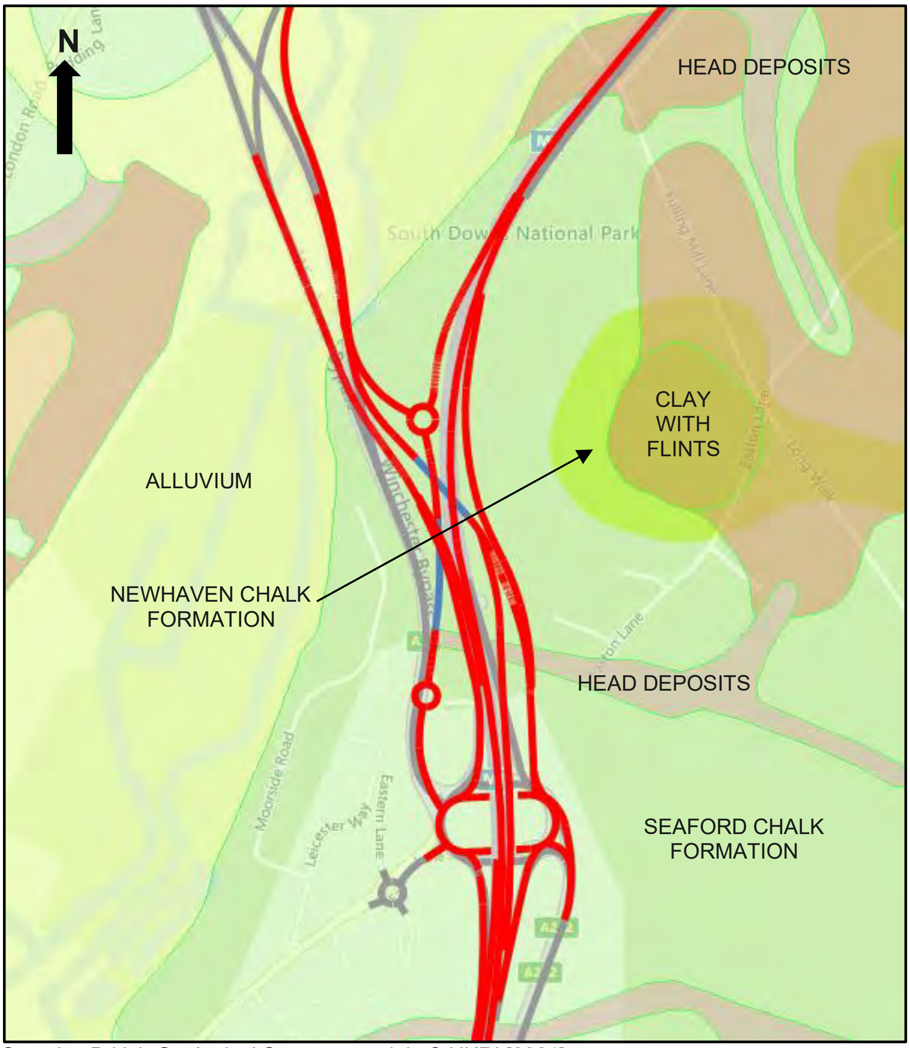
2.2.2 The topography across the scheme varies significantly. The centre of the M3 Junction 9 roundabout varies between approximately 59.0m AOD at M3 carriageway level and up to 66.0m AOD at roundabout level. The elevation of Easton Lane on the east side of the scheme is approximately 65.0m. The elevation of the A272 at the M3 junction is approximately 67m AOD and descends to a low point at approximately 60m AOD, 300m south-west of the junction. Elevation of the A34 falls from 67m AOD at the junction with the M3 to approximately 40m AOD at marker post MP1/5 by the Kingsworthy Flyover.

2.3 Geological Maps and Memoirs

2.3.1 The 1:50,000 Series Geological Map Sheet 299 Winchester (BGS, 1975) and memoir (BGS, 2003) indicate that solid geology of the Site is the Seaford Chalk Formation. The geological maps indicate that the site is underlain partly by superficial deposits at the northern end of A34, where the River Itchen crosses the carriageway and in the vicinity the roundabout of Junction 9. The superficial deposits recorded around the A34 comprises Alluvium associated with the River Itchen. The superficial deposits within the vicinity of Junction 9 are recorded as Head Deposits approximately 300m north and 450m south of the junction.

2.3.2 An extract of the BGS geological online mapping is presented below.

Extract of BGS Geological Map with Scheme Overlay



Contains British Geological Survey materials © UKRI [2021]

Made Ground

2.3.3 Made Ground is anticipated to be present within the scheme extents comprising both Made Ground and Engineered Fill. The Made Ground is anticipated to be present locally across the scheme comprising a combination of reworked Alluvium, Head Deposits, Clay-with-Flints and Chalk.

Engineered Fill

2.3.4 The Engineered Fill is anticipated to be encountered within the current road alignments and adjacent verges. The Engineered Fill along the scheme is likely to comprise mainly of chalk fill associated with the construction of the M3 and A34.

Superficial Deposits

2.3.5 The geological maps indicate that there are no recorded areas of superficial deposits within the immediate vicinity of the existing M3 Junction 9 roundabout. However, where the A34 carriageway crosses the River Itchen, a layer of Alluvium has been recorded, overlying Head Deposits. Two small areas of Head Deposits are recorded approximately 500m north and south of the Junction 9 roundabout within two linear dry valley features. Clay-with-Flints are also recorded within the northern eastern part of the proposed Stage 3B scheme.

2.3.6 The Alluvium in the area typically comprises clays, silts and sands with various proportions of gravel and pockets of organic material. The materials are overlapping sheets but frequently merging into one another (BGS, 2008).

2.3.7 The Head Deposits comprise sands and gravels. Locally with lenses of silt, clay or peat and organic material. The British Geological Survey (BGS 2008) describe these soils as being formed from material accumulated by down slope movements including landslide, debris flow, solifluction, soil creep and hill wash. They typically composed of very gravelly silty, sandy clay or diamiction, ranging to clayey sandy gravel, all with variable proportions of coarser material. The Head is typically derived by erosion of the Chalk and Palaeogene strata but may well include material reworked from older Quaternary Deposits.

2.3.8 The Clay-with-Flints typically comprises orange brown or reddish-brown clays and sandy clays with abundant nodules and pebbles of flint. BGS 2008 notes the formation is a residual deposit formed from the dissolution, decalcification and cryoturbation of bed rock strata of the Seaford Chalk Formation. Within the area of the proposed Stage 3B scheme, the formation lies upon the Seaford Chalk Formation with the interface being flat or uneven where it may result in dissolution features upon the Chalk. If the material is solifluncted and comes to rest on an inclined surface on a hillside, the material is classified as Head Deposits rather than Clay-with-Flints (BGS 2008).

Bedrock Deposits

2.3.9 The Seaford Chalk Formation is a sedimentary bedrock formed approximately 84 to 89 million years ago in the Cretaceous Period. The stratum comprises a firm white chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardground and thin marls are known to be present in the lowest beds of the formation. The Seaford Chalk Formation is typically between 40 to 65m thick in the area of the proposed scheme, with a generalised dip of between 5 and 10 degrees to the north (BGS, 2002).

Geological Faults

2.3.10 No geological faults have been identified on the geological map of the area.

2.4 Site History

2.4.1 The earliest available OS mapping published in the 1870s shows the scheme to comprises agricultural land, woods and coppices present in a rural setting east of Winchester. The first development that occurred within the order limits of the Stage 3B scheme was the Didcot, Newbury and Southampton GWR railway line in the northern extent of the A34, just to the south of Kingsworthy. A number of roman roads had existed through the early 20th Century within the boundaries of the proposed scheme, specifically in the area now occupied by the M3 carriageway. It is unknown how these old transport links were decommissioned; therefore, the remnants may still be present beneath the current ground surface. The Winchester Bypass was constructed in the early 1960s followed by the construction of the M3 motorway in the 1980s. Since the construction of the two major roads, no significant development has occurred with the order limits of the scheme.

2.5 Aerial Photography

2.5.1 Publicly available aerial photography has been reviewed as part of this report, using Google Earth imagery from as early as 1999. The aerial photography typically aligns with the information from the historical maps obtained as part of the PSSR carried out by WSP (WSP, 2017). The aerial photographs show that the area of the scheme has undergone very little change with the exception of the R&W Traffic Management Yard between the J9 M3 southbound on slip and the A272 between 2008 and 2017.

2.6 Natural and Mining Cavities

2.6.1 The Natural and Mining Cavities Databases, as maintained and updated by Stantec, have been searched for relevant natural and mining cavity records. A search was carried out at a 500m buffer around the proposed route alignment along with a review of the information presented in the PSSR. A technical note highlighting the potential for any mining cavity locations within the scheme boundary is presented in **Appendix A**.

2.6.2 A review of the PSSR highlighted one natural cavity location 500m west of the scheme. From a search of a database held by Stantec, this record pertained to a polygon of ten solution pipes up to 500m west of the site. The technical note presented in **Appendix A** summarises the details of the recorded natural cavities within the vicinity of the proposed Stage 3B scheme.

2.6.3 The PSSR highlighted the present of five chalk quarries located within 500m of the site, two of which are within 250m of the site and one which is located within 100m of the site. All five records have been recorded as Chalk pits on the historical maps.

2.7 Land Use and Soil Survey Information

2.7.1 The land use on site is dominated by carriageways and associated verges of the A33 and A34. The land immediately surrounding site comprises mostly agricultural land to north and east within the South Downs National Park. Winnall Industrial Estate is immediate to the west of the A34 whilst the city of Winchester is approximately 18.8km to the south-west of the existing M3 Junction 9.

2.8 Archaeological and Historical Investigations

2.8.1 A geophysical survey was carried out by SUMO in 2018 as part of Stage 2 for the M3 Junction 9 improvements. This was followed by a targeted trial trench evaluation carried out by Wessex Archaeology in 2019. The findings of these investigations are presented in the Geophysical Survey Report (WSP, 2018) and the Archaeological Evaluation Report prepared by Wessex Archaeology Ltd (2019).

2.8.2 The investigations identified the remains of a Neolithic or Bronze Age ring ditch which had been partially excavated prior to the construction of the M3. The ring ditch which is centred on SU 495313 is of regional importance as a well-preserved example of its type, which was recorded by Wessex Archaeology to be of particular note due to the indications of comparatively early activity associated with it. It was noted that there were few other archaeological features encountered during the investigation other than several discrete pit-like features, former field boundaries and a parish boundary but these were noted to be of lesser significance.

2.8.3 The trial trench evaluation identified some areas of disturbance from agricultural activity, previous archaeological investigations and construction work associated with the building of the M3, but it was noted by Wessex Archaeology that this has not diminished the potential for significant archaeological remains to survive.

2.9 Previous Ground Investigations

2.9.1 The ground conditions along the current M3 alignment were previously investigated in 1973 by an intrusive ground investigation to provide specific information for the construction of the M3, referenced as M3 Popham to Compton Investigation (GDMS Reference 3212). The scope of the investigation comprised 5 boreholes using rotary coring techniques, 26 boreholes using cable percussion techniques and 10 trial pits.

2.9.2 The ground conditions in the vicinity of the Kingsworthy junction with the A34 were previously investigated in 2020 (GDMS Reference 25799) by an intrusive ground investigation to provide specific information for the proposed upgrade to the road restraint system on the A33 offside verge to protect the piers supporting the A34 over bridge.. The scope of the investigation comprised 2 window sample borehole and 2 machine excavated trial pits.

2.10 Soils and Agricultural Land Use

2.10.1 An Agricultural Land Classification (ALC) survey was undertaken in 2017 to identify the ALC baseline of the M3 J9 Improvement site. The survey identified that the site was a mix of Grade 3a (one of the categories of best and most versatile agricultural land (BMV)) and Grade 3b as well as land not classed as agricultural.

2.10.2 In accordance with DMRB guidance LA 109 Geology and Soils (Highways England, 2019), as the proposed Stage 3B scheme is likely to affect land classified as BMV, further consideration will be given within the Environment Statement Report (ES).

2.11 Designated Sites

2.11.1 The River Itchen is designated a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC) due to its ecological status. The proposed scheme only intersects these boundaries where the River Itchen flows underneath the A34. The north eastern part of the proposed Stage 3B scheme lies within the South Downs National Park (SDNP) and the eastern and south parts of the proposed Stage 3B scheme border the SDNP.

2.12 Hydrology and Flooding

2.12.1 The PSSR (WSP, 2017) indicates that the River Itchen Flood Plain is located on both sides of the A34 carriageway at the northern end of the study area. The Flood Risk Maps highlight that the areas on either side of the A34 is in a Flood Zone 2 (Extreme Flooding from rivers without flood defences). The Flood Risk Maps presented in the PSSR show that the River Itchen typically floods to the north on a much wider floodplain away from the M3/A34 junction interchange.

2.12.2 There are no known flood defences within the scheme extents.

2.13 Hydrogeology

2.13.1 The Seaford Chalk Formation is classified as a Principal Bedrock Aquifer, which is defined as an aquifer where layers of rock or drift deposits have a high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage. They may support water supply and or river base flow on a strategic scale. The Head Deposits and the Alluvium are designated as Secondary Aquifer with the Alluvium classified as a Secondary A Aquifer and the Head Deposits a Secondary (undifferentiated) Aquifer. A Secondary A aquifer is defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. A Secondary (undifferentiated) Aquifer is defined where it has been assigned cases where it has not been possible to attribute either category A or B to the strata. In most cases, this means that the layer in question has been previously designated as both minor and non-aquifer in different locations due to the variable characteristics of the strata.

2.13.2 The M3 and A34 corridors both pass through Source Protection Zones (SPZ) One and Two towards the northern extent of the proposed Stage 3B scheme north of the River Itchen. The SPZs are related to groundwater abstraction boreholes operated by Southern Water Services Limited located approximately 75m and 170m to the east of the M3.

2.14 Landfill Sites and Contaminated Land

2.14.1 From review of the PSSR (WSP, 2017), there are four historical landfill sites recorded in the vicinity of the Stage 3B scheme. One of the historical landfills is recorded on site, on the east side of the current roundabout at Junction 9. This record is named the Spitfire Link landfill; however, there are no details in the PSSR as to when the landfill was operational or the waste that was received. The western part of the Spitfire Link landfill, which is located within the proposed scheme, was investigated by Soils Limited (Soils, 2020) with six exploratory holes undertaken within or immediately adjacent to the mapped extents of the landfill. No evidence of waste was indicated on those exploratory hole records.

2.14.2 The closest off-site record pertains to a landfill recorded adjacent to the Winchester Bypass located immediate to the east of the bypass. This historical landfill was recorded operation between July 1967 and July 1968 and received inert waste. Another smaller historical landfill is recorded just to the west of the A34, just north of the Winnall Industrial Estate, however, has no records when it was operational, or the waste received.

2.15 Unexploded Ordnance (UXO) Risk

2.15.1 A detailed UXO Assessment for the scheme was undertaken by Zetica UXO in June 2018 prior to the ground investigation (Zetica, 2018) and is included in Appendix D of the Factual Report. The study concluded that the residual risk posed by UXO was low and that no further risk mitigation was required. The report states no military activity was identified on or affecting the scheme area Pre-WWI nor during WWI. The WWI strategic targets identified within 5km of the site comprised the following:

- Winnal Down Camp established in close proximity of the site. This was one of several camps in the vicinity of the Site, including those at Magdalen Hill and Avington

- The former GWR line, running across the western part of the Site, was used for transporting troops from regional military camps to the southern coast embarkation ports during WWI.

2.15.2 Within the proposed scheme extents neither Pre-WWII nor WWII military activity on or affecting the site was identified. There were a number of air raid incidents detailed in the vicinity of the site as detailed in maps within in the Zetica report.

3 Field and Laboratory Studies

3.1 Walkover Survey

3.1.1 A walkover survey was carried out before commencement of the 2019 ground investigation to confirm the access arrangement for the ground investigation. The walkover was attended by a representative of the Jacobs, the ground investigation contractor and a representative of the Highways England. At the time of writing this report, Stantec are unaware of any additional walkover surveys and have not conducted any walkover surveys themselves.

3.2 Geomorphological / Geological Mapping

3.2.1 No geomorphological or geological mapping has been undertaken as part of this scheme.

3.3 Ground Investigation

3.3.1 Further details on the scope of the ground investigation are presented in the Ground Investigation Specification prepared by Jacobs (Jacobs, 2018). The objective of the ground investigation was to investigate the locations of the principal geotechnical elements of the Stage 3A scheme in order to provide information on the ground conditions required to develop and inform the design.

3.3.2 Since the completion of the ground investigation in 2019, the design of the scheme has changed and therefore, the ground investigation carried out does not provide adequate spatial or depth of investigation coverage for the design of all the geotechnical elements of the proposed Stage 3B scheme.

3.3.3 The factual results of the investigation are presented in a report prepared by Soils Ltd (GDMS Ref, 32506) which should be read in conjunction with this report.

3.3.4 The aims of the ground investigation as set out in the Jacobs Ground Investigation Specification were to establish the ground conditions, suitability of the natural geological strata as a founding stratum and confirm the presence of and quantify the natural and likely extent of potential contaminants identified in a desk study.

3.3.5 The works carried out as part of the ground investigation comprised the following:

- Utility service clearance at all exploratory hole locations using a cable Avoidance tool (CAT) at inspection pit locations and at the base of the inspection pits.
- Provide unexploded ordnance awareness briefing to site staff at commencement of the works, prior to undertaking excavations:
- Thirty-two boreholes using a combination of dynamic sampling and rotary coring techniques to a maximum depth of 30m below existing ground level with standard penetration testing and the recovery of soil samples
- Seven windowless sampling boreholes to a maximum depth of 7m below existing ground level with standard penetration testing and the recovery of soil samples
- Eleven machine excavated trial pits with the recovery of soil samples.
- Variable head permeability testing in six selected boreholes at selected depths.
- Installation of standpipes and standpipe piezometers in selected boreholes and return site visits to monitor groundwater levels.

- A suite of geoenvironmental and geotechnical testing on selected soil samples.

3.3.6 Exploratory hole plans including locations from previous ground investigations have been produced as Drawings HE551511-VFK-HGT-X_XXXX_XX-DR-GE-0001 to 0004

Description of Fieldwork

3.3.7 The ground investigation was carried out in site between 11th March 2019 and the 5th June 2019 by Principal Contractor Geoffrey Osborne Limited employing ground investigation contractors Soils Limited and SM Associates under the technical instruction of Jacobs

3.3.8 The boreholes were sunk using a tracked multi-purpose rig to a maximum depth of 30m below existing ground level using varying combinations of dynamic sampling and rotary coring techniques. The ground conditions were investigated by the recovery of open drive UT100 samples, disturbed small and bulk samples and standard penetration tests carried out using either a split spoon sampler or solid cone. On completion, standpipes were installed in twenty-four boreholes with response zones varying in depth between 3.0m and 30.0m below ground level. Other boreholes were backfilled with bentonite pellets and the surface reinstated.

3.3.9 Dynamic sampling boreholes were sunk using a small tracked rig to maximum depth of 7.0m bgl. The ground conditions were investigated by recovery of disturbed small and bulk samples and standard penetration tests carried out using either a split spoon sampler or solid cone. On completion, all exploratory holes were backfilled with bentonite pellets and the surface reinstated.

3.3.10 The trial pits were excavated using a hydraulic excavator to depth of 4.0m below existing ground level to obtain detailed information on the near-surface ground conditions. On completion, the trial pits were backfilled with the arisings and compacted by the excavator every 300mm.

3.3.11 Five post fieldwork groundwater level and gas monitoring visits were carried out on twenty-one of the twenty-four boreholes with monitoring installations by Soils Limited between 13 June 2019 and 12 July 2019. Installations have been recorded in boreholes DS101, DS111 and DS209, however, have not been monitored as part of the post fieldwork monitoring. At the time of writing this report, it is unclear as to why the remaining three boreholes were not monitored during the post fieldwork monitoring. A summary of the groundwater levels monitored over this period are summarised in Section 4 and presented in the **Table 4.1**.

3.3.12 Data loggers for groundwater monitoring were installed in 5 boreholes (DS301, DS302, DS114, DS104 and DS109A) on completion of the boreholes. In addition, baro loggers were also installed in boreholes DS301 and DS109A to measure the changes in atmospheric pressure in the boreholes during the monitoring period. Data was collected on the loggers between 15th June 2019 to 24 August 2020 at hourly intervals. The data is summarised in the **Table 4.1** below and presented on plots on **Figure 1a** and **Figure 1b**.

Ground Investigation Factual Report

3.3.13 All details of the ground investigation can be found in the Factual Report produced by Soils Limited (GDMS Ref. 32506).

In-Situ Testing

3.3.14 Standard Penetration Tests (SPTs) were carried out in all boreholes at scheduled 1.5m intervals to determine the penetration resistance to correlated with geotechnical parameters. The SPTs were carried out in accordance with BS, EN ISO 22476-3: 2005 *'Geotechnical investigation and testing – Field testing Part 3: Standard penetration test'*. SPT results have been discussed in Section 5, Ground Conditions. Four SPT hammers were used in the ground investigation with energy ratios ranging between 68 and 82 per cent.

3.4 Drainage Studies

3.4.1 A total of 5 falling head tests were undertaken in boreholes DS104, DS107, DS109, DS210 and DS301. The falling head tests were undertaken in accordance with BS EN 22282-1:2012 '*Geotechnical investigation and Testing- geohydraulic testing. General Rules*'. The results of the tests are discussed in Section 9.8 of this report and presented in the Factual Report prepared by Soil Ltd.

3.5 Geophysical Surveys

3.5.1 No geophysical surveys were undertaken a part of the ground investigation

3.6 Pile Tests

3.6.1 No pile tests were undertaken as part of the ground investigation

3.7 Other Fieldwork

3.7.1 No other fieldwork undertaken.

3.8 Laboratory Investigations

Geotechnical Laboratory Testing

3.8.1 Geotechnical laboratory soils testing was carried out to verify the visual identification and classification, and to determine the physical properties of selected samples of the materials encountered. The testing was scheduled by Investigation Supervisor (Jacobs) and carried by Geo Site & Testing Services Limited out in accordance with BS 1377 (1990) or, where superseded, by BS EN ISO 17892. Geo Site and Testing Services Limited hold UKAS accreditation for the geotechnical soil testing carried out (certificate reviewed online). The results of the geotechnical testing are presented in the factual report. The geotechnical tests have been summarised in **Table 3.1**.

Table 3.1 Summary of Geotechnical Testing

Property	Test Method	Number of Tests
Moisture Content	BS 1377:1990 Part 2	220
Liquid and Plastic Limit	BS 1377:1990 Part 2	51
Intact Dry Density	ASTM	43
Particle Size Distribution (PSD)	BS 1377:1990 Part 2	10
Dry Density / Optimum Moisture Content Relationship	BS 1377:1990 Part 4	34
Moisture Condition Value / Moisture Content Relationship	BS 1377:1990 Part 4	28
One Dimensional Consolidation	BS 1377:1990 Part 5	6
Consolidated Undrained Triaxial Compression	BS 1377:1990 Part 8	15
Uniaxial Compressive Strength	ISRM	5

Property	Test Method	Number of Tests
Chalk Crushing Value	ISRM	1
Sulphate and pH	BRE Suite C	57
	Within Geoenvironmental testing suite	126

Geoenvironmental Laboratory Testing

3.8.2 Geoenvironmental testing was also carried out to determine the concentrations of contaminants of selected samples of soil and samples of groundwater. The testing suite comprised a range of heavy metals, inorganic and organic compounds, and for soils an asbestos screen. The testing was scheduled by the Investigation Supervisor (Jacobs) and carried out by DETS who hold UKAS and MCERTS accreditation for the geoenvironmental testing carried out. The results of the geoenvironmental testing are presented in the factual report. A summary of the testing carried out is in **Table 3.2** below:

Table 3.2 Summary of Geoenvironmental Testing

Samples	Testing	Number
Soil	Soil Suite	126
	WAC Testing	73
Groundwater	Water Suite	9

3.8.3 It should be noted that a second round of groundwater sampling is referred to in the Factual Report, however the results of the testing were not included. Stantec requested the missing data, however Highways England and Osbornes have confirmed that the testing results of the second round of groundwater sampling are not available. Therefore, the information on the groundwater testing in this report pertains to the first round of groundwater laboratory results only.

3.9 Review of the 2019 Ground Investigation Factual Report

3.9.1 Current good practice for the investigation and assessment of chalk, and for geotechnical design in chalk for foundations, retaining structures and earthworks is predicated on the recommendations given in CIRIA Report C574 “Engineering in Chalk” (CIRIA 2002). The report draws on and brings together previous research and guidance including that from the then named Transport Research Laboratory and Department of Transport.

3.9.2 Chalk as an engineering material in nature in the ground exhibits a wide range of mechanical and physical properties varying from a putty like clay and silt size matrix (that has properties akin to a soil and is called structureless chalk) to a relatively intact calcareous rock (structured chalk) such as that forming much of our coastal scenery. There are a whole range of gradations between these two types. Good practice in the selection of appropriate geotechnical parameters for engineering design in Chalk depends on the “recommended engineering classification of chalk” as set out in Section 3.3.6 of CIRIA 2002. The classification is based on a structured scheme of engineering geological description of the chalk and for structured chalk its intact dry density (see below for Figure 9.1 and Table 9.2 from CIRIA C574).

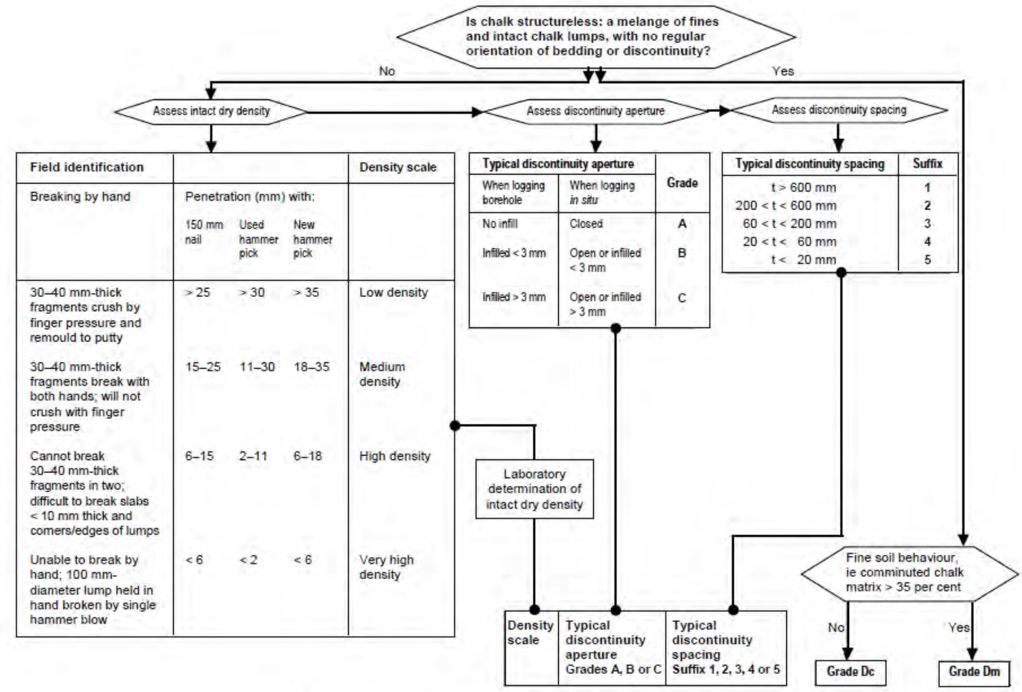


Figure 9.1 *Engineering classification of chalk (also Figure 3.1)*

Table 9.2 *Methods of identifying chalk density in the field, to be backed up by laboratory measurements of intact dry density (based on Bowden* et al, *2002 and Matthews* et al, *1993, also Table 3.7)*

	CIRIA density class			
Identification method	**Low-density**	**Medium-density**	**High-density**	**Very-high-density**
Intact dry density[2]	< 1.55 Mg/m³	1.55 – 1.70 Mg/m³	1.70–1.95 Mg/m³	> 1.95 Mg/m³
Porosity[12]	> 0.43	0.43–0.37	0.37–0.28	< 0.28
Saturation moisture content[12]	> 27.5 per cent	27.5–21.8 per cent	21.8–14.3 per cent	< 14.3 per cent
Approximate UCS[3]	< 3 MN/m²	3–5 MN/m²	5–12.5 MN/m²	> 12.5 MN/m²
BS5930 strength term	Very weak and lower end of weak	Upper end of weak	Moderately weak	Moderately strong
Ease of breaking fragments [9]	30–40 mm-thick fragments can be crushed between finger and thumb, and remould to putty[4]	30–40 mm-thick fragments can be broken in two using both hands, but cannot be crushed between finger and thumb[4]	30–40 mm thick fragments cannot be broken in two[4]. Only thin slabs < 10 mm thick, and corners and edges of lumps can be broken with difficulty using both hands	Cannot be broken by hand. 100 mm-diameter lump can be broken by a single hammer blow when held in the palm of the hand[5]
150 mm nail penetration [6] [7] [10]	> 25 mm putty, formed around nail	15–25 mm	6–15 mm	< 6 mm
Used hammer pick penetration[7] [8] [11]	> 30 mm, chalk splashes	11–30 mm	2–11 mm	< 2 mm
New hammer pick penetration[7] [8] [11]	> 35 mm, chalk splashes	18–35 mm	6–18 mm	< 6 mm

3.9.3 It is important to note however, that many methods of ground investigation involve relatively small diameter borehole drilling methods to recover samples of the ground. Chalk being often a very weak broken and fractured rock is very susceptible to disturbance caused by the drilling and sampling process such that the samples recovered do not reliably reflect the actual characteristics and properties of the chalk as it is present in the ground in its undisturbed state.

Structured chalk of a high classification grade can be broken up by the investigation process to provide a lower grade or a structured chalk could be recovered as a structureless chalk by some drilling processes. Some methods of investigation may not recover the weaker grades of chalk at all, leaving just a few of the stronger intact lumps in the sample.

3.9.4 Consequently investigative methods such as trial pitting or large diameter bored shafts are preferred for reliable visual description of the Chalk in-situ or if such techniques are impractical or not available then large diameter high quality rotary core drilling with an appropriate core barrel and suitable flushing medium should be used to recover a sample that is as little disturbed as possible. The Factual Report does not provide any information on the rotary coring method or the core diameters adopted.

3.9.5 We have reviewed the ground investigation methods adopted in the 2019 investigation and assessed the descriptions of chalk and its classification given on the exploratory hole records under the CIRIA scheme.

3.9.6 The descriptions of the chalk grades across the scheme are inconsistent, often providing a range of grades or the grade classification is missing altogether from the description. For example, from review of the total core recovery (TCR) with the description, some of the descriptions do not match up with the TCR. In areas where Grade A chalk has been recorded you would expect to see TCR between 80-100 per cent, in some areas TCR is down between 0 and 25 per cent. Therefore, it is difficult to contemplate that a Grade A chalk in the ground would have such a low core recovery. Without commentary in the report text it is often unclear whether the description on the exploratory hole record reflects the characteristics of the chalk material as recovered at the surface, or whether that is an interpretation of the in-situ chalk and its grade. There are examples where the chalk descriptions on the exploratory hole records do not comply with the descriptive and classification scheme set out in CIRIA C574. There are no trial pit photographs in the Factual Report to aid interpretation.

3.9.7 Also it was noted that there is a fundamental inconsistency in the description of the chalk matrix, the material sampled from boreholes has been described as being recovered as a clay, whereas the material described from the trial pits has been described as recovered as a silt. Based on CIRIA C574 chalk matrix is described as silt.

3.9.8 In addition, there are concerns with the reported results of the intact dry density testing where the measured natural moisture contents in some of the samples have been reported as being greater than their saturation moisture content. This would indicate that the moisture content of the chalk in the ground is greater than its theoretical moisture content if all the voids were filled with water.

3.9.9 Therefore, for the purposes of this report, the engineering assessment of Seaford Chalk Formation has been simplified, with Chalk classified as either structureless or structured.

3.9.10 Six exploratory holes (DS103, DS104, DS105, DS112, TP02 and DS204) were completed to the south-east of the River Itchen, all with very similar descriptions for the superficial deposits. However, some of the descriptions on the borehole records have identified the material encountered (essentially similar throughout) as Alluvium and others as Head Deposits. The descriptions of the materials encountered are more typical of a Head Deposit rather than Alluvium.

3.9.11 From review of the descriptions of the Alluvium in exploratory holes to the north of the River Itchen (WS02 and WS03), the material differs greatly compared to the soils interpreted as Alluvium to the south east of the river.

3.9.12 Therefore for the purposes of this Ground Investigation Report based on the review of the descriptions in conjunction with the topographical setting, Stantec has reassessed the geological strata names for the superficial deposits south east of the river, as Head Deposits with the exception of the materials encountered in DS103 and DS112 which could plausibly be Alluvium due to their proximity to the River Itchen and ground elevation.

3.9.13 Stantec has also identified a discrepancy in the description of the Made Ground across the scheme. Stantec has identified that typically the Made Ground located along the M3 and A34 which is greater than 1.0m in thickness is likely to be Engineered Fill. For the purposes of this report anthropogenic Made Ground is defined as soils containing anthropogenic material, whereas Engineered Fill is defined as soils from existing earthworks comprising primarily of chalk. Engineered Fill has been identified in two boreholes along the M3 (DS217 and DS218) typically comprising structureless Chalk recovered as Gravel with lenses of sand and clays. Engineered Fill has been located along the A34 in five boreholes (DS101, DS111, WS02, WS03, WS08) and typically comprises structureless chalk again with lenses of sand and clay and occasional Peat.

3.9.14 An exploratory hole (WS03) located along the A34 did not fully penetrate the encountered Peat. In addition, laboratory testing was not carried out on the Peat for classification.

3.9.15 Within the laboratory testing, consolidated undrained triaxial compression tests were carried out on 7 samples of remoulded structureless chalk and 5 samples of undisturbed structured chalk to provide an angle shearing resistance and the effective cohesion. However, the tests that were carried out were single stage triaxial tests rather than multistage tests, meaning a value for angle of shearing resistance or effective cohesion could not be provided directly from the testing. Additional analysis is required to derive the angle of shearing resistance and cohesion from these test results.

3.9.16 Consolidated undrained triaxial tests on the undisturbed structured chalk were only undertaken on samples obtained from thin walled push or UT100 samples. The sampling techniques adopted are biased towards obtaining sample from the weaker chalk and will have been disturbed during the sampling process. In addition, no core subsamples were tested. Therefore, it is unlikely that the test results are characteristic of the mass properties of the structured chalk.

3.9.17 Stantec has identified that a number of groundwater records provided in the Factual Report are incorrect. The record for DS212 on the 13/06/19 is recorded at 21.51m below ground level, however, the groundwater monitoring standpipe was only installed to 10.50mbgl. This record may pertain to DS213 (which had an installation to 30m bgl) rather than DS212. The result on the 19/06/19 for DS212 is recorded at 11.38m also is below the installation depth and again may be a mistaking in the reporting.

4 Ground Summary

4.1 Geology

4.1.1 The ground conditions in the area of the scheme as revealed by the ground investigations indicate that the proposed Stage 3B scheme typically lies on areas of Made Ground/Engineered Fill overlying Seaford Chalk Formation. However, locally around the River Itchen the scheme lies on Alluvium and Head Deposits are present also over the Seaford Chalk Formation near the river. These ground conditions generally agree with the published geological information for the area.

4.1.2 In the text below descriptions of the strata encountered are based on the soil descriptions provided on the exploratory hole records in the Factual Report, and it is noted that some of the descriptions do not always comply with the descriptive schemes set out in BS EN ISO 14688-1, BS EN ISO 14688-2 and CIRIA C574.

4.1.3 Drawings indicating the geological strata encountered in each borehole, as well as cross-sections and long-sections are presented in Drawings section of this report.

- HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0001 – Geological Plan.
- HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0021 to 023 – Geological Cross-sections
- HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0031 to 034 – Geological Long-sections.

Topsoil

4.1.4 Topsoil was encountered in 16 of the 53 boreholes completed during the 2019 ground investigation (DS103, DS107, DS114, DS203, DS206, DS208, DS209, DS210, DS211, DS212, DS213, DS216, DS301, TP03, TP04 and WS04). Topsoil was encountered between ground level and 0.45m below ground level, typically comprising a dark brown slightly clayey gravelly SAND or a dark brown sandy gravelly CLAY. The average thickness of Topsoil encountered in the exploratory holes is approximately 0.3m.

Made Ground

4.1.5 Made Ground was encountered in 31 of the 53 boreholes completed during the 2019 ground investigation (DS101, DS104, DS108, DS109, DS109A, DS110, DS111, DS115, DS204, DS214, DS214A, DS215, DS217, DS218, DS219, DS220, TP02, TP05, TP06, TP07, TP08, TP09, TP10, TP11, TP12, WS01, WS02, WS03, WS06, WS07, WS08). The Made Ground was encountered between ground level and 4.20m below ground level. The Made Ground varies greatly along the scheme, with varying amounts of fine and granular material along with horizons of organic material and structureless chalk.

Engineered Fill

4.1.6 Made Ground, which has been identified as Engineered Fill, was encountered in 7 of the 31 boreholes (DS111, DS217, DS218 along the M3 and WS01, WS02, WS03 and WS04 along the A34). The Engineered Fill was encountered between ground level and 11.35m below ground level. The material typically comprised structureless chalk recovered as clayey GRAVEL with occasional fine to coarse angular flint. However, along the A34 lenses of organic soil described as Peat were recorded within the fill material.

Alluvium

4.1.7 Alluvium was encountered in 7 of the 53 boreholes completed during the 2019 investigation (DS101, DS103, DS111, DS112, DS218, WS02 and WS03). Alluvium was encountered within the vicinity of the River Itchen described as containing horizons of both granular and cohesive material as well as organic material. The material was typically interbedded and encountered between ground level and 9.15m bgl. The cohesive material typically described as comprising variably soft and firm slightly sandy gravelly silty CLAY with occasional silty organic material. Gravel is fine to coarse angular to rounded of flint and chalk. The granular material was described as comprising slightly clayey sandy GRAVEL with a low cobble content. Gravel is fine to coarse angular to rounded of flint and chalk.

4.1.8 The Peat was typically encountered to the north of the River Itchen (WS02, WS03, DS111 and DS218). The thickness of the Peat was proved to range from 0.25m to 1.55m and was encountered at depths between 2.9m and 5.95m below existing ground level. The base of the Peat was not proven in WS03. The organic material was typically found beneath a layer of Engineered Fill that likely forms part of the road embankment. The material generally comprises either a spongy plastic brown pseudo fibrous PEAT or a firm slightly sandy slightly gravelly fibrous PEAT.

Head Deposits

4.1.9 Head Deposits were encountered in 14 of the 53 exploratory holes completed as part of the 2019 investigation (DS104, DS105, DS204, DS205, DS206, DS207, DS211, DS216, DS302, TP02, TP08, TP10, WS05 and WS08). The Head Deposits were encountered locally across the scheme but typically encountered to the south and east of the River Itchen. The Head Deposits have been described as comprising both cohesive horizons and granular horizons, all typically interbedded. The Head Deposits were encountered between ground level and 10.00m bgl. Where encountered, the Head Deposits were generally less than 1m in thickness except in the exploratory holes (DS104, DS105, DS204, TP02 and WS08) which are located near to the A34 on the western extent of the scheme, In this area the Head Deposits were proved to be between 6m (DS105) and 10m (DS104) thick. The full extent of the Head Deposits was not fully penetrated in all of these boreholes near to the A34.

4.1.10 The cohesive strata were typically described as a soft to firm brown sandy gravelly CLAY. Sand and gravelly portions vary from slightly to very sandy/gravelly and typically comprises fine to coarse, angular to subrounded flint and chalk. The granular strata were typically described as a brown clayey gravelly SAND. Gravel is fine to coarse, angular to subrounded of flint and chalk.

Seaford Chalk Formation

4.1.11 As discussed in Section 3.9 (above), there are inconsistencies in the fieldwork descriptions and the assigned CIRIA grades of chalk, along with the reservations about the laboratory testing information provided. For the purposes of this report, chalk has been categorised as either Structureless Chalk or Structured Chalk. Structureless Chalk is that which has been described by the ground investigation contractor as Grade Dc or Dm. Structured Chalk is that where the ground investigation contractor has assigned grades, Grades A-C. Where no grading is assigned then the soil descriptions have been used to determine whether the Chalk is likely to be structured or structureless.

4.1.12 The Seaford Chalk Formation was encountered in all boreholes below the Topsoil or Made Ground or where the superficial deposits were fully penetrated. The chalk was investigated to between 0.25m and 30.45m depth below ground level.

4.1.13 The ground investigation contractor described Grade Dc chalk as recovered as an off white sandy silty fine to coarse subangular to subrounded chalk clast GRAVEL. Clasts are very weak to weak medium to high density with rare angular fine to coarse flints.

4.1.14 The ground investigation contractor described the Grade Dm chalk as recovered as off white or light brown sandy gravelly SILT/CLAY. Gravels are fine to coarse angular to subrounded very weak to weak low to high density chalk clast with rare angular flint.

4.1.15 The Structured Chalk typically comprises very weak to weak low to medium density white very lightly speckled black CHALK (assigned as Grades A2-C3) in the Factual Report. It should be noted that some of the descriptions are likely to have been based on heavily disturbed samples caused by the drilling techniques adopted during the ground investigation.

4.2 Hydrogeology

4.2.1 **Groundwater Entries** During the ground investigation, groundwater was only encountered in three of the boreholes during drilling (WS02, WS03, WS08). Groundwater was encountered between 3.1m and 7.0m below ground level, recorded as seepage in all three boreholes. All three window sample boreholes are located along the A34 within the flood plain of the River Itchen.

4.2.2 **Groundwater Levels** Throughout the fieldwork groundwater monitoring was carried out on completion of the boreholes daily between the 18 March 2019 and 15 April 2019. The groundwater from during the fieldwork are presented in Appendix A.2 of the Factual Report (SOIL 2020). On completion of the fieldwork, groundwater monitoring was undertaken between 12 June 2019 and 12 July 2019 on five occasions. Groundwater was recorded in 4 of the 5 boreholes installed with data loggers, DS109A was recorded as dry. Groundwater measured between 2.60m and 28.80m bgl across the scheme. A summary of the groundwater monitoring is presented in **Table 4.1** below.

Table 4.1 Summary of Post Fieldwork Groundwater Level Monitoring

Borehole	Ground Level, m OD	Base of Installation Level, m OD	Water level, m OD (m bgl)	
			Min	Max
DS104*	42.67	27.67	37.20 (5.43)	38.84 (3.83)
DS108	54.42	39.42	DRY	DRY
DS109A	65.18	44.68	Dry	44.55 (20.63) #
DS110	65.87	35.87	37.07 (28.80)	37.35 (28.52)
DS112	40.36	20.86	37.52 (2.84)	37.71 (2.65)
DS114*	48.66	29.16	37.17 (11.49)	38.99 (9.67)
DS115	62.23	42.73	DRY	DRY
DS203	57.43	51.43	DRY	51.39 (6.04) #
DS204	42.95	36.75	36.77 (6.18) #	37.54 (5.41)
DS205	69.19	49.89	DRY	DRY
DS206	56.88	50.88	DRY	DRY
DS207	64.65	58.65	DRY	58.76 (5.89) #
DS208	57.91	51.91	DRY	52.04 (5.87) #
DS210	61.41	55.41	DRY	55.41 (6.00) #
DS211	63.53	57.53	DRY	DRY

Borehole	Ground Level, m OD	Base of Installation Level, m OD	Water level, m OD (m bgl)	
			Min	Max
DS212	61.78	51.28	DRY	51.28 (10.50) #
DS213	58.82	28.82	37.03 (21.79)	37.34 (21.48)
DS215	61.10	55.10	DRY	DRY
DS216	49.01	34.01	37.28 (11.73)	37.45 (11.56)
DS301*	55.62	25.62	37.42 (18.19)	39.21 (16.41)
DS302*	55.70	25.70	37.32 (18.38)	39.38 (16.32)

Note:
* denotes monitoring point installed with data loggers.
# indicate groundwater in base of borehole and unlikely to be true reflection of groundwater levels

4.2.3 The data in the above plots is summarised on **Figure 1a** and **Figure 1b**.

4.2.4 Groundwater was encountered within both the superficial deposits and the chalk at varying depths across the scheme. The groundwater was recorded closest to existing ground level around the River Itchen within the superficial deposits. The groundwater was also recorded at varying depths within the Seaford Chalk Formation between 5.90m bgl and 28.80m bgl. The groundwater in the chalk was recorded at its highest elevation in DS203 along the M3 at northern end of the scheme.

4.3 Visual and Olfactory Evidence of Contamination

4.3.1 Made Ground was encountered across the scheme in a number of exploratory hole locations down to a maximum depth of 4.50m below ground level. This was generally found to be related to the existing road construction and any embankments constructed for the current infrastructure. It was recorded in the logs that no other visual or olfactory evidence of contamination was found.

4.4 Site Specific Ground Models

4.4.1 Based on the information from the recent and historical ground investigations, the ground conditions along the scheme have been split between three areas of the scheme in accordance with the differing geology, see Drawing HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0020 (Areas A, B and C). Geological cross-sections and long-sections are presented on Drawings HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0021 to 23 and HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0031 to34, respectively.

North and West of the River Itchen (Area A)

4.4.2 Based on the information obtained from the ground investigation the area to the north and west of the River Itchen is likely to comprise a layer of Engineered Fill over Alluvium over the Seaford Chalk Formation. The details of the geological strata are summarised in **Table 4.2** below:

Table 4.2 Summary of the Ground Conditions to the North and West of the River Itchen (Area A).

Strata	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)	Typical GI Contractor Description
Engineered Fill	0.00	1.20 – >7.00	1.20 – >7.00	Off white mottled grey and brown structureless CHALK recovered as slightly clayey silty sandy GRAVEL. Gravel is fine to coarse subangular to subrounded chalk and flint. Locally recovered as a gravelly sandy silty CLAY.
Alluvium	0.30 - 4.65	5.00 – 9.00	2.70 - 7.80	Interbedded layers of: Soft to firm light brown and greyish brown slightly sandy gravelly silt CLAY. Gravel is fine to coarse angular to rounded of flint. Multicoloured slightly silty clayey sandy GRAVEL. Gravel is fine to coarse angular to subrounded of flint with low cobble content Plastic dark brown pseudo fibrous PEAT with fine gravel of chalk and flint.
Structureless Seaford Chalk Formation	5.34 - 7.10	6.23 – >15.00	0.89 – >7.00	Off white to yellowish brown structureless CHALK recovered as slightly gravelly silty clay. Gravel is fine to coarse subrounded to rounded Off white to orangish brown structureless CHALK recovered as slightly sandy silty GRAVEL and COBBLES. Clasts are very weak to weak medium to high density subrounded chalk.
Structured Seaford Chalk Formation	6.23 – 8.55	>19.95	>13.72	Very weak and weak low and medium density white unstained CHALK

4.4.3 However, boreholes completed in this area did not reach sufficient depth to be able to provide appropriate information for the foundation design of the proposed footbridge across the River Itchen. The deeper boreholes are located too far north of the proposed footbridge and therefore, the quality of the Chalk has not been assessed in the vicinity of the proposed footbridge. In addition, the boreholes along the A34 also do not fully penetrate the Peat, therefore, the extent of the Peat around the River Itchen is also unknown.

Area between A34 and M3 (Area B)

4.4.4 Based on the information from the ground investigation, the area to the south of the River Itchen between A34 and M3 and directly north of the Highways England Depot, is likely to be underlain by Alluvium, close to the river, over Head Deposits over the Seaford Chalk Formation. The details of the geological strata are summarised in **Table 4.3** below:

Table 4.3 Summary of the Ground Conditions between A34 and M3 (Area B)

Strata	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)	Typical Gi Contractor Description
Topsoil / Made Ground	0.00	0.30 - 0.35	0.30 -0.35	Grass over dark brown soft to firm slightly gravelly clayey SAND. Gravel is fine to coarse subangular to sub round of flint and brick
Alluvium	0.30	6.00	5.70	Light brown clayey gravelly SAND. Gravel is fine to coarse and angular of flint and chalk Soft light brown slightly sandy to very sandy gravelly to very gravelly silty CLAY. Gravel is angular to subrounded fine to coarse flint and chalk.
Head Deposits	0.00 – 0.30	4.00 – 10.00	3.70 – 9.70	Interbedded: Soft to firm light brown slightly sandy slightly gravelly to very gravelly silty CLAY. Gravel is fine to coarse angular to subrounded of chalk and flint. Light brown clayey SANDS and GRAVELS. Gravel is fine to coarse angular to subrounded of chalk and flint
Structureless Seaford Chalk Formation	0.35 - 6.00	1.20 - 8.00	0.95 -2.00	Structureless CHALK recovered as silty subangular and subrounded fine to coarse GRAVEL. Gravel is very weak low-density white chalk. Matrix is greyish brown
Structured Seaford Chalk Formation	1.20 – 10.00	>15.45	>9.55	Very weak and weak low and medium density white locally stained orangish brown and lightly speckled CHALK.

Remainder of the Site (Area C)

4.4.5 Based on the information within the ground investigation, the geology across the majority of the scheme typically comprised a layer of Made Ground or Topsoil over the Seaford Chalk Formation. The only exception is to the north of Junction 9 where the exploratory hole has been positioned within the road embankment. Across the scheme where within the road embankments, the ground conditions will typically comprise a thickness of Engineered Fill over the Seaford Chalk Formation. The details of the geological strata are summarised in **Table 4.4** below:

Table 4.4 Summary of the Ground Conditions across the remainder of the site (Area C)

Strata	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)	Typical GI Contractor Description
Made Ground (Hard Standing)	0.00	0.45 – 0.50	0.45 – 0.50	Tarmac over Concrete over subbase comprising of light orangish greyish brown sandy GRAVEL.

Strata	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)	Typical GI Contractor Description
Made Ground (Grassed)	0.00	0.25 – 0.50	0.25 – 0.50	Grass over dark brown slightly gravelly organic clayey SAND. Gravel fine to coarse angular to subrounded of flint and brick.
Engineered Fill (DS217)	0.45	11.35	10.90	Weak low density white lightly speckled black CHALK recovered as silty angular to subrounded fine to coarse gravel.
Head Deposits	0.00 – 0.5	0.3 – 0.8	0.10 – 0.50	Soft to firm light brown gravely sandy CLAY or clayey SAND. Gravel is fine to coarse angular to subrounded of flint and chalk.
Structureless Seaford Chalk Formation	0.25 – 11.35	0.50 – 13.24	0.20 – 5.45	Interbedded: Structureless CHALK recovered as off white to white of slightly sandy silty GRAVELS and COBBLES. Clasts are very weak to weak low to high density. Rare to occasional fine o coarse subangular to subrounded flint. Structureless CHALK recovered as off white to light brown sandy gravelly SILT / CLAY. Gravel is fine to coarse angular to subrounded chalk and flint. Chalk is very weak to weak medium density subangular fine to coarse with rare cobbles.
Structured Seaford Chalk Formation	0.35 – 4.00	>30.45	>29.25	Extremely weak to weak low to medium density white speckled black CHALK.

4.4.6 The boreholes in the vicinity of the proposed M3 underpass in the revised Stage 3B scheme terminated at 6.5m below ground level and therefore did not penetrate the underlying ground sufficiently deep enough to provide information for the design of the underpass and associated retaining walls. Therefore, additional boreholes will be required to understand the quality of the founding materials and to assign parameters for detailed design.

5 Ground Conditions and Material Properties

5.1 General

5.1.1 Comments on the nature and extent of each stratum are presented in the following sections of this report. Where characteristic values of parameters for geotechnical design are suggested in the discussion on ground conditions below, reference should be made to the terminology and definitions given in BS EN 1997-1 (2004) and BS EN 1997-2 (2007) as appropriate. Characteristic values of geotechnical parameters for use in design should be reviewed and selected by the Geotechnical Designers taking in consideration the limit states and design methods being used, and the process should be documented in the Geotechnical Design Report.

5.1.2 The geotechnical parameters recommended in this section have been based on the available ground investigation testing information (measured or derived) and where there is insufficient or questionable information, published data has been used and a cautious approach to the selection of geotechnical parameters has been adopted. A further ground investigation will be required to confirm the assumed geotechnical parameters as well as to provide appropriate information on the ground conditions for the proposed structures.

5.1.3 Where available and considered representative, the results from the 1973 ground investigation have been included in the figures and drawings generated. It should be noted that a hammer efficiency of 60% has been assumed for the 1973 data used on the SPT N_{60} versus depth plots.

5.2 Derivation Methods

5.2.1 Derivation methods of assessing geotechnical parameters of the underlying geology of the scheme have only been used where no direct testing has been undertaken on the strata.

Unit Weight

5.2.2 Where there is no suitable testing to determine the unit weight of a material, the material characteristics have been cross referenced against Figures 1 and 2 in BS 8004.

Undrained Shear Strength

5.2.3 Derived values of undrained shear strength (c_u) for the cohesive strata have been determined using the empirical correlation with SPT N values (Stroud, 1989) corrected for hammer efficiency (N_{60}). The resulting c_u values have been calculated using the equation $c_u=f_1/N_{60}$ presented in Stroud, where f_1 is determined using the plasticity index of the material.

Angle of Shearing Resistance (Granular Horizons)

5.2.4 Angle of shearing resistance has been calculated using the equations presented in BS 8004.

5.2.5 For the granular material, the critical angle of shearing resistance has been derived using the equation 4, $\varphi'_{cv,k} = 30° + \varphi'_{ang} + \varphi'_{PSD}$, and Table 1 from BS 8004 which takes into the account the angularity of the granular material in the sample and the uniformity coefficient of the sample.

5.2.6 Where the material has a <15% fines content, the peak angle of shearing resistance can be calculated using the critical angle of shearing resistance and adding the density index provided from SPT N values as presented in equation 5, $\varphi'_{pk,k} = \varphi'_{cv,k} + \varphi'_{dil}$.

5.2.7 Table 1 from BS 8004 is presented below:

Table 1 **Values of φ'_{ang}, φ'_{PSD} and φ'_{dil} to obtain values of $\varphi'_{pk,k}$ and $\varphi'_{cv,k}$ for siliceous sands and gravels with fines content not exceeding 15%**

Soil property	Determined from	Classification	Parameter D)
Angularity of particles A)	Visual description of soil	Rounded to well-rounded	$\varphi'_{ang} = 0°$
		Sub-angular to sub-rounded	$\varphi'_{ang} = 2°$
		Very angular to angular	$\varphi'_{ang} = 4°$
Uniformity coefficient, C_U B)	Soil grading	$C_U < 2$ (evenly graded)	$\varphi'_{PSD} = 0°$
		$2 \le C_U < 6$ (evenly graded)	$\varphi'_{PSD} = 2°$
		$C_U \ge 6$ (medium to multi graded)	$\varphi'_{PSD} = 4°$
		High C_U (gap graded), with C_U of fines < 2 E)	$\varphi'_{PSD} = 0°$
		High C_U (gap graded), with $2 \le C_U$ of fines < 6 E)	$\varphi'_{PSD} = 2°$
Density index, I_D C)	Standard penetration test blow count, corrected for energy rating and overburden pressure $(N_1)_{60}$	$I_D = 0\%$	$\varphi'_{dil} = 0°$
		$I_D = 25\%$	$\varphi'_{dil} = 0°$
		$I_D = 50\%$	$\varphi'_{dil} = 3°$
		$I_D = 75\%$	$\varphi'_{dil} = 6°$
		$I_D = 100\%$	$\varphi'_{dil} = 9°$

A) Terms for defining particle shape can be found in BS EN ISO 14688-1.
B) The uniformity coefficient C_U is defined in BS EN ISO 14688-2.
C) The density index I_D is defined in BS EN ISO 14688-2. Density terms may be estimated from the results of field tests (e.g. Standard Penetration Test, Cone Penetration Test) using correlations given in BS EN 1997-2.
D) Values of φ'_{dil} are appropriate for siliceous sands and gravels reaching failure at a mean effective stress up to 400 kPa. For non-siliceous sands, see *The strength and dilatancy of sands* [21].
E) "Fines" refers to that fraction of the soil whose particle size is less than 0.063 mm.

Angle of Shearing Resistance (Cohesive Horizons)

5.2.8 For the cohesive horizons in the Alluvium and Head Deposits, the critical state effective angle of shearing resistance has been derived using equation 8, $\varphi'_{cv,k} = (42° - 12.5\log_{10}I_P)$ for $5\% \le I_P \le 100\%$ in BS8004 which takes into account the plasticity index (I_P) of the material.

Angle of Shearing Resistance and Effective Cohesion (Chalk)

5.2.9 The angle of shearing resistance and effective cohesion have been derived using the data from the consolidated undrained triaxial compression test. From the results, the mean effective stress (s') and shear stress (t') have been plotted against one another and a line of best fit through the origin constructed to adopted a cautious approach for the effective cohesion (i.e. the origin is equivalent to a c' = 0). The angle (α') between the line of best fit and the x-axis is used to calculate the effective angle of shearing resistance (ϕ') using the equation $\phi' = \sin^{-1}(\tan \alpha')$

Youngs Modulus (Superficial Deposits)

5.2.10 Values of both horizontal and vertical Young's Modulus (in the undrained and drained condition) have been assumed to be the same for the superficial deposits as these deposits are unlikely to be over consolidated. Values of drained Young's Modulus can be determined using the equation of $E' = 1/m_v$ which is derived from the relationship between coefficient of volume compressibility and drained Young's Modulus (Stroud, 1989).

5.2.11 The undrained Young's Modulus (Eu), can be determined using the equation $E' = 0.73\ E_u$ based on a Poisson's Ratio of 0.1 as presented in CIRIA 143 (1995).

5.3 Made Ground

5.3.1 **Characteristic Values**: Characteristic values of geotechnical parameters have not been provided for the Made Ground due to the limited thickness of the material across the scheme and that it is likely that this material will be removed where encountered during construction and therefore it is not relevant for design purposes.

5.4 Engineered Fill

5.4.1 **Classification** Eleven Atterberg tests were carried out on samples recovered within the Engineered Fill. From the samples tested nine of the samples were on Engineered Fill comprising predominantly of chalk and two tests on cohesive material from WS08. The results of the tests are presented in a Plasticity Chart on **Figure 2**. For the Engineered Fill comprising chalk, measured values of liquid and plastic limit were recorded between 29 and 49, and 16 and 24, respectively. In general, Atterberg tests have only limited use on the Chalk, however high liquid limits (30 to 34 per cent) are indicative of highly porous chalk and may cause problems in earthworks.

5.4.2 **Material Properties** Three Particle Size Distribution tests were carried out on recovered samples of Engineered Fill from WS08, two of which have been carried out on cohesive material and one on Chalk, the results are presented on **Figures 3a and 3b**. The Engineered Chalk Fill sample comprised up to 55 per cent gravel size fraction, 10 per cent sand fraction and 35 per cent fines fraction. However, undertaking a PSD on a sample of chalk is likely to abrade the chalk clasts into finer material, therefore, providing a result not representative of that sample.

5.4.3 Moisture contents of the Engineered Fill were recorded between 16 and 29 per cent reflecting a variable nature of the Engineered Fill and the process in which it may have been placed.

5.4.4 **Penetration Resistance** Standard Penetration Test N values normalised for hammer efficiency (N_{60} values) are presented on **Figure 4a**. The SPT N_{60} for the Engineered Chalk Fill are between 1 and 70.

5.4.5 **Characteristic Values:** Where the Engineered Fill comprises chalk, it is recommended that the characteristic values for Structureless Chalk should be adopted. Where the Engineered Fill comprised a cohesive soil (i.e. as recorded in the WS08), then the characteristic values for Alluvium should be adopted.

5.5 Alluvium (Peat)

5.5.1 No classification testing was carried out on the Peat material recorded in the exploratory holes in the vicinity of the River Itchen.

5.5.2 **Penetration Resistance** A total of 3 Standard Penetration Tests were carried out in the Peat. The results normalised for hammer efficiency varied between 0 and 5 with no correlation with depth.

5.5.3 **Characteristic Values** No laboratory testing and very little in situ testing was carried out on the Peat encountered. The nature of Peat is highly variable and can be highly compressible, therefore, recommending characteristic values for the Peat would not be appropriate without further investigation and testing.

5.6 Alluvium

5.6.1 **Classification** Eight Atterberg tests were carried out on samples recovered from the Alluvium around the River Itchen. The results of the tests are presented in a Plasticity Chart on **Figure 2**. Measured values of liquid and plastic limit were recorded between 31 and 39 per cent, and 16 and 27 per cent, respectively, with corresponding values of plasticity index between 4 and 20 per cent. This indicates that the Alluvium is of typically intermediate plasticity. Moisture contents in the Alluvium were recorded between 13 per cent and 46 per cent reflecting the variable nature of the material.

5.6.2 **Material Properties** One particle size distribution was carried out on a recovered sample of cohesive Alluvium, the result is shown on **Figure 3b**. The result shows the Alluvium sample comprises around 40 per cent gravel sized material, 15 per cent sand and 45 per cent fines (i.e. silt and clay sized material).

5.6.3 **Penetration Resistance** Standard Penetration Test N values normalised for hammer efficiency (N_{60} values) are presented on **Figure 4b**. The SPT N_{60} values for the cohesive strata are between 4 and 28, whereas the SPT N_{60} values for the granular material are between 15 and 40. Typically for both the cohesive and granular material within the Alluvium the SPT N_{60} is around 15.

5.6.4 **Undrained Shear Strength** Visual examination of the cohesive material indicates the material is typically soft to firm in consistency. It is expected that the variation in the noted consistency reflects the variable nature and degree of saturation of the material. Values of undrained shear strength that can be derived using the correlation with SPT N_{60} values are typically in the range of 60 to 80kPa for the cohesive strata.

5.6.5 **Consolidation**. The result of a single one-dimensional consolidation test undertaken on the Alluvium indicates that for a pressure of about 50kPa the value of coefficient of volume compressibility (m_v) is about 0.27m^2/MN and for 200kPa the m_v is 0.15m^2/MN. The result corresponds to a moderate to highly compressible material. Published data suggests that alluvial clays typically have a coefficient of volume compressibility of between 0.30m^2/MN and 1.5m^2/MN (Tomlinson, 2001).

5.6.6 **Characteristic Values** From consideration of the properties and derived values, a uniform value for undrained shear strength of 60 kPa for the cohesive strata within the Alluvium is considered appropriate. From consideration of the average plasticity index of 18 per cent, an effective angle of friction of 26 degrees is considered appropriate for the cohesive strata within the Alluvium. For the granular strata within the Alluvium, using angularity of 2 degrees and a uniformity coefficient of 2 degrees, the effective angle of shearing resistance can be considered to be 34 degrees. For this material effective cohesion may be taken to be zero in the design analysis.

5.6.7 For the purposes of the preliminary design Alluvium should be considered as a cohesive strata due to the interbedding of the granular and cohesive horizons and therefore represents a cautious approach.

5.6.8 Based on the laboratory testing and published values of coefficient of volume compressibility, it is recommended that a value of 0.30m^2/MN should be adopted for design.

5.6.9 Values of drained Young's Modules (E') for the Alluvium can be determined to be 3 MPa. Value for undrained Young's Modulus (E_u) for the Alluvium can be determined to be 4 MPa.

5.6.10 A value of bulk unit weight of 18kN/m^3 may be taken for this material.

5.7 Head Deposits

5.7.1 **Classification** Fifteen Atterberg Tests were carried out in samples recovered within the Head Deposits. The results of the tests are presented in a Plasticity Chart on **Figure 2**. Measured values of liquid and plastic limit were recorded between 23 and 46 per cent, and 16 and 27 per cent, respectively, with corresponding values of plasticity index between 7 and 24 per cent. This indicates that the Head Deposits is of low to intermediate plasticity. Moisture contents in the Head Deposits were recorded between 13 per cent and 24 per cent reflecting the variable nature of the granular and cohesive material within the stratum.

5.7.2 **Material Properties** Six Particle Size Distribution test were carried out on recovered samples of Head Deposits, the results are presented on **Figures 3a** and **3b**. The Head Deposits comprised around 15 to 35 per cent gravel sized material, around 10 per cent sand and 50 to 75 per cent fines (i.e. silt and clay sized material).

5.7.3 **Penetration Resistance** Standard Penetration Test N values normalised for hammer efficiency (N_{60} values) are presented on **Figure 4c** and are typically between 30 at 1.2m bgl decreasing with depth to around 15 at 7.5m bgl, with the majority of the result falling between 10 and 20.

5.7.4 **Undrained Shear Strength** Visual examination of the material indicates that the material is typically firm in consistency although locally the material was described as soft. It is expected that the variation in noted consistency reflects the variable nature and degree of saturation of the material. Values of undrained shear correlated with SPT N_{60} values and are typically in the range of 60 to 100kPa.

5.7.5 **Earthworks** Two maximum dry density (MDD) vs optimum moisture contents (OMC) relationship tests were carried out samples of Head Deposits. The MDD for the Head Deposits was 1.77 and 1.87 Mg/m³ with corresponding OMC values of 17 and 15 per cent using a 2.5kg rammer. A maximum dry density vs optimum moisture content graph is present in **Figure 5a**.

5.7.6 **Consolidation**. The results of a five one-dimensional consolidation tests undertaken on the samples of Head Deposits indicate that for a pressure of about 50 kPa the value of coefficient of volume compressibility (m_v) is between 0.11 and 0.50 m²/MN and for a pressure of 200 kPa, m_v ranges between 0.09 and 0.24 m²/MN. The variation in the values for m_v are likely due to varying proportions of sands and gravels within the Head Deposits, highlighting the variable nature of the material.

5.7.7 **Characteristic Values** From consideration of the properties and determined values, a value for undrained shear strength of 80 kPa is considered appropriate to use in design. From consideration of the average plasticity index of 15 per cent, an effective angle of shear resistance of 27 degrees is considered appropriate. The granular horizons are likely to provide a higher effective angle of shear resistance, however as the cohesive and granular materials are typically interbedded, the lower value of 27 degrees has been adopted as a cautious approach. For this material effective cohesion may be taken to be zero in the design analysis.

5.7.8 Based on the laboratory testing of coefficient of volume compressibility, it is recommended that a value of 0.2m²/MN should be adopted for design.

5.7.9 The value of drained Young's Modulus E' for the Head Deposits has been determined to be 5 MPa and the undrained Young's Modulus E_u as 7 MPa

5.7.10 A value of bulk unit weight of 19kN/m³ may be taken for this material.

5.8 Structureless Chalk

5.8.1 **Material Properties** The natural moisture contents for the Structureless Chalk range from 2.4 to 32 percent. Intact dry densities were tested on 6 samples presumably taken from clasts of intact chalk from within the matrix, with results ranging from 1.42 to 1.57 Mg/m³, this corresponds to a very low to low density chalk as presented on **Figure 6**. Bulk densities ranged from 1.83Mg/m³ to 2.02Mg/m³.

5.8.2 Three Atterberg Limit tests were undertaken giving measured values for liquid limit and plastic limit of between 29 and 47 per cent and 21 and 30 per cent respectively, with a corresponding plasticity index of between 7 and 11 per cent, see **Figure 2**. As stated earlier, Atterberg tests have only limited use on the Chalk, however high liquid limits (30 to 34 per cent) are indicative of highly porous chalk and may cause problems in earthworks.

5.8.3 **Penetration Resistance** Standard Penetration Test N values normalised for hammer efficiency (N_{60} values) are presented on **Figure 4d** and are typically between 5 and 20 with no discernible correlation with depth.

5.8.4 **Earthworks** Thirty-three maximum dry density (MDD) vs optimum moisture contents (OMC) relationship tests were carried out on samples recovered as Structureless Chalk and the results are plotted on **Figure 5b**. The MDD for the Structureless Chalk generally ranges from 1.50 and 1.65 Mg/m³ with corresponding OMC values between 18 and 24 per cent using a 2.5kg rammer. The natural moisture contents of the samples tested range between 22 and 32 per cent. CIRIA C574 states that It is difficult to obtain repeatable compaction test results on chalks. Most chalk is sufficiently weak to undergo significant breakdown during compaction. As the particle sizes of the specimen reduce, the density to which it can be compacted will change, for the given moisture content and compactive effort. Laboratory compaction tests are rarely useful in daily construction practice, because of their lack of repeatability.

5.8.5 **Consolidation** The result of a single one-dimensional consolidation test undertaken on a sample of remoulded Grade Dm structureless chalk at 7.5m bgl indicate for a pressure of 100kPa the value of coefficient of volume compressibility (m_v) is 0.1 m²/MN.

5.8.6 **Effective Strength** Seven remoulded consolidated undrained triaxial tests were carried out on samples of the structureless chalk. The results of s' and t' have been plotted on **Figure 7** and the effective angle of shearing resistance of the remoulded structureless chalk may be derived from these test results as 44 degrees for an effective cohesion of zero.

5.8.7 CIRIA 574 recommends an effective angle of shearing resistance of 33 degrees and an effective cohesion of zero should be used in design for matrix dominated structureless chalk (Grade Dm). No published literature is available for clast dominated structureless chalk (Grade Dc), however, CIRIA C574 indicates that for clast dominated structureless chalk, the effective angle of friction may be greater, due the effect of particle interlocking.

5.8.8 The Young's Modulus for chalk is based off the relationship with dry density, using Figure 4.20 in CIRA 574. Therefore, based on a low-density chalk, the Young's Modulus for a Structureless Chalk would be around 3000MPa. This is considered appropriate for preliminary design until further testing is undertaken

5.8.9 **Characteristic Values** From the review of the testing data and published information, for preliminary design, an effective angle of shearing resistance of 33 degrees and an effective cohesion of zero is considered appropriate for the preliminary design. Further testing will need to be undertaken to confirm whether this value is appropriate for detailed design.

5.8.10 A value of 19kN/m³ should be adopted for the bulk unit weight.

5.9 Structured Chalk

5.9.1 **Material Properties** The natural moisture content of 142 samples of chalk were recorded between 2.4 and 42 per cent. The intact dry densities of the 45 samples were recorded between 1.28 and 1.85 Mg/m³ with corresponding bulk densities ranging from 1.72 and 2.17 Mg/m³. These values correspond to the variable nature of the chalk across the scheme with the chalk ranging between a very low to medium density chalk in accordance with CIRIA C574 (2002). A plot presenting the intact dry densities versus moisture contents is present on **Figure 6.**

5.9.2 Nine Atterberg tests were undertaken on samples of Structured Chalk. Measured values for liquid limit and plastic limit were recorded between 25 and 45 per cent and 19 and 34 per cent respectively, with a corresponding plasticity index of between 9 and 25 per cent. Though the results are presented on **Figure 2**, these tests have little value in determining chalk properties and it is unclear how these tests were undertaken without destroying the fabric of the intact chalk.

5.9.3 **Penetration Resistance** Standard Penetration Test N values normalised for hammer efficiency (N_{60} values) are presented on **Figure 4e** and range between 5 and greater than 50. The N_{60} values show a wide variation in strength with depth, however for preliminary design purposes a cautious trend line has been shown. It should be noted that structure specific strength profiles will need to be developed when additional ground investigation information is available.

5.9.4 **Earthworks** Two maximum dry density (MDD) vs optimum moisture contents (OMC) relationship tests were carried out samples of Structured Chalk. The results of the relationship are present on **Figure 5c**. The MDD for the Structured Chalk were 1.63 and 1.65Mg/m³ with corresponding OMC values between 17 and 13 per cent using a 2.5kg rammer. The natural moisture contents of the samples tested were 23 and 24 per cent. The comments given in 5.8.4(above) also apply to this testing.

5.9.5 **Chalk Crushing Value** One chalk crushing value of 3.7 was determined on a sample of Structured Chalk at 2.10m bgl.

5.9.6 **Effective Strength** Five undisturbed consolidated undrained triaxial tests were carried out on samples of Structured Chalk. From the field descriptions, these were carried out on varying grades of Structured Chalk. The results of s' and t' have been plotted on **Figure 7** and the effective angle of shearing resistance of the undisturbed Structured Chalk from these results is suggested to be 31 degrees for an effective cohesion of zero. However, the limited dataset and sampling methodology means that the derived effective angle of shearing resistance may not be characteristic of the mass properties of the Structured Chalk and further testing is recommended.

5.9.7 CIRIA 574 indicates that moderately conservative strength parameters for structured chalk have been assessed at effective cohesion (c') = 20 kN/m² and effective angle of shearing resistance (ϕ') = 39°, with worst credible parameters of c' = 0 and ϕ' = 34°.

5.9.8 The Young's Modulus for the chalk may be assessed from its relationship with dry density, using Figure 4.20 in CIRA 574. The dry density obtained from laboratory testing on the Structureless Chalk typically ranges from 1.35 to 1.65 Mg/m³ which corresponds to an approximate Young's Modulus of between 1 and 10 GPa for the Structured Chalk.

5.9.9 A total of five uniaxial Compressive Strength Tests were carried out on the structured chalk ranging in depths from 9.60 to 28.15m below ground level. The results of the tests show UCS values of between 1.22 and 1.8MPa failing either by axial splitting or multiple fractures. There are insufficient test results to assess whether there is a correlation with depth.

5.9.10 **Characteristic Values** It is likely that the samples tested were disturbed due to the drilling techniques adopted and therefore, an effective angle of shearing resistance of 34 degrees and an effective cohesion of zero should be appropriate for preliminary design Structured Chalk.

5.9.11 For preliminary pile design, founding within the Structured Chalk, the base resistance should be based on a SPT N_{60} value of 15 from 2.0m bgl to 15.0m bgl and 25 at 15.0m bgl and below. For shaft resistance, the recommendations in CIRIA 574 should be adopted.

5.9.12 Poisson's Ratio for the Structured Chalk typically falls between 0.18 and 0.27 with an average of 0.24. Therefore, for design a Poisson's Ratio of 0.24 is considered appropriate for design (CIRIA, 2002)

5.9.13 Due to high variability in the measured density of the Structured Chalk it is suggested that a value for the Young's Modulus of 5000 MPa is considered appropriate for preliminary design.

5.9.14 A value of 19kN/m^3 should be adopted for the bulk unit weight.

5.10 Groundwater

5.10.1 Continuous groundwater level monitoring was carried out between June 2019 and July 2020 in 4 boreholes using data loggers and in 21 boreholes during the post fieldwork monitoring period between the months of June and August 2019. The depth to groundwater is likely to vary across the scheme with the closest to ground level being recorded in close vicinity of the River Itchen.

5.10.2 For the proposed footbridge over the River Itchen, groundwater is expected to be close to ground level. Groundwater monitoring recorded a groundwater high of 2.60m below ground level, corresponding to an elevation circa 37.5m AOD. However, this was recorded in the summer months and therefore, does not represent the worst case likely or highest groundwater level. Therefore, for the purposes of design it is recommended that the characteristic value of groundwater level is taken to be at ground level in this area.

5.10.3 Boreholes around Junction 9 recorded groundwater between 21.48m and 28.52m below ground level which corresponds to a reduced level of about 37.3m AOD. No data loggers were installed in the vicinity of the junction, the closest data logger is located approximately 450m to the north. However, the monitoring was undertaken in the summer months and correspond to the summer groundwater levels recorded elsewhere on the scheme. Therefore, it is likely that the winter groundwater levels will also correspond to those recorded in the data loggers. Therefore, a characteristic groundwater level of 39.5mAOD should be considered for the new gyratory bridges.

5.10.4 Groundwater levels for the proposed underpass under the M3 to accommodate the new route of the A34 were recorded to be between 9.66m and 18.27m below ground level, corresponding to a reduced level of 37.00m and 39.20m. Therefore, a characteristic groundwater level should be considered to be at 39.50m AOD in the vicinity of the proposed A34 underpass.

Table 5.1 Summary of Characteristic Groundwater Levels (for preliminary design only)

Structure	Groundwater (m AOD)
Junction 9 Gyratory	39.50
A34 underpasses	39.50
Footbridge over the River Itchen	Ground Level

5.11 Geotechnical Parameters Summary Table

5.11.1 Recommended characteristic values of parameters for geotechnical design as determined from consideration of the results of geotechnical testing carried out on samples of the soils recovered during the ground investigation, consideration of published data and correlations with index properties are discussed in Section 4 of this report and are summarised in **Table 5.2** below:

Table 5.2 Summary of Geotechnical Parameters

Formation	Depth to Base (m bgl)	Bulk Unit Weight, kN/m^3	Undrained Shear Strength, kPa	Effective Cohesion, kPa	Effective Angle of Shearing Resistance, degrees	Poisson's Ratio	Drained Youngs Modulus (MPa)	Undrained Youngs Modulus (MPa)
Engineered Fill	1.2 - 11.35	20	-	0	34	0.24	3000	3000
Alluvium	5.0 – 9.0	18	60	0	26	0.1	3	4
Head Deposits	0.8 – 10.0	19	80	0	27	0.1	5	7
Structureless Seaford Chalk Formation	0.5 - >15.0	19	-	0	33	0.24	3000	3000
Structured Seaford Chalk Formation	>30.0	19	-	0	34	0.24	5000	5000

Note:
Values to be updated following further ground investigation.

6 Geoenvironmental Assessment

6.1 Introduction

6.1.1 Online guidance accessed from the government web portal, GOV.UK entitled Land Contamination: Risk Management (LC:RM), states that to manage existing (historical) contamination it is necessary to identify and assess the level of risk, decide if that risk is unacceptable to identified receptor(s) and decide how to manage any unacceptable risks. Further information on the assessment of land contamination is given in the Stantec guide presented in **Appendix C**.

6.1.2 LC:RM presents three stages of risk management (1) Stage 1: Risk assessment (2) Stage 2: Options appraisal and (3) Stage 3: Remediation and each stage has three tiers.

6.1.3 The progressive tiers of a Stage 1 Risk Assessment are:

- Tier 1 Preliminary (qualitative) Risk Assessment (PRA): containing generic factual information with the assessed risks informed by professional judgement.
- Tier 2 Generic Quantitative Risk Assessment (GQRA): which uses site specific factual data from intrusive investigations with the assessed risks stated with reasonable certainty, through to.
- Tier 3 Detailed Quantitative Risk Assessment (DQRA): providing numerical analysis of modelling of the aquifer properties and groundwater quality.

6.1.4 **Section 7** presents the Tier 2 of a Stage 1 Risk Assessment GQRA and the evaluation of site-specific contamination data using published Generic Assessment Criteria (GAC). Where the recorded concentration of a determinant is below the GAC for the specified end use the determinand is not deemed to be a hazard. Exceedance of the criterion indicates that the parameter is a potential hazard, and the identified pollutant linkage may represent an unacceptable risk that needs further evaluation.

6.1.5 Geochemical testing was carried out on 126 samples of soils for a range of general industrial contaminants, together with polynuclear aromatic hydrocarbons (PAH) and carbon banding of total petroleum hydrocarbons (TPH). The results of the analysis for general industrial contaminants, PAHs and TPHs of soil samples carried out are summarised in **Appendix D**. Full results of the chemical analysis are presented in the factual report of the ground investigation (Soils, 2020). Stantec's methodology for the assessment of potentially contaminated land and the GACs adopted are presented in **Appendix C**.

6.1.6 Geochemical testing was carried out on 9 samples of groundwater for a range of general industrial contaminants, together with polynuclear aromatic hydrocarbons (PAH) and carbon banding of total petroleum hydrocarbons (TPH). The result of the analysis for the general industrial contaminants, PAHs and TPHs of the groundwater samples carried out are summarised in **Appendix E**. Full results of the chemical analysis are presented in the factual report of the ground investigation (Soils, 2020).

6.2 Generic Assessment Criteria

Soils

6.2.1 The results of the geochemical testing on the soil samples have been compared to the Category 4 Screening Levels (C4SL) for Public Open Space land uses prepared under the auspices of Defra (CLAIRE, 2014). Where C4SL is not available the concentrations were compared against

Land Quality Management Ltd (LQM) Suitable 4 Use Levels (S4UL) for a commercial/industrial land uses (CIEH, 2015).

6.2.2 The additive effect of any hydrocarbon fractions is considered by calculating a hazard quotient for each carbon banding which the concentration dived by the fraction S4UL criterion for the selected land use. The hazard quotients are added together to give a Hazard Index for each sample assessed. A Hazard Index that exceeds unity can be indicative of a potentially significant human health hazard

6.2.3 The measured concentrations of potential contaminants are summarised in **Appendix D**.

Controlled Waters

6.2.4 The results of the analysis have been compared against the Environmental Quality Standards (EQS) for Freshwater, in accordance with the Water Framework Directive (WFD) (DEFRA, 2010) for the protection of surface waters and ecological systems, and also compared with the Drinking Water Standard (DWS) (DETR, 2000) assessment criteria, on the basis that the groundwater is abstracted for potable supply.

6.2.5 Summary tables of the results are summarised in Appendix CWRA 3 of the Controlled Water Risk Assessment presented in **Appendix E** of this report.

Ground Gas

6.2.6 For each monitoring well the maximum gas concentration and steady flow rate for each round of monitoring was used to calculate the Gas Screening Value and determine the Characteristic Situation in accordance with BS8485 (2019) and CIRIA 665 (2007) in the chalk.

6.3 Waste Assessment

6.3.1 In addition, waste acceptance criteria (WAC) testing of 10 samples of near surface material was undertaken to allow a preliminary determination of the waste classification of any material to be disposed of off-site as part of the proposed Stage 3B scheme. The results of the WAC tests analysis classify the near surface material tested as Inert Waste. Full results for the WAC testing are presented in the factual report of the ground investigation (Soils, 2020).

6.3.2 However, classification of material for disposal off site will depend on the acceptability of the elevated concentrations to the EA regional office that regulates the landfill where material can be disposed. The soils on the site do not contain significant concentrations of contaminants and in accordance with the criteria set in Part 3 Landfill (England and Wales) Amendment Regulation 2004 and are likely to be accepted at an inert facility.

6.3.3 Particular care will be required in excavating material to identify and wherever practicable to segregate any potentially contaminated materials to ensure they do not adversely affect the classification of other excavated materials.

6.3.4 It is possible that additional testing may be required by the landfill operator prior to disposal to the soils to an off-site licensed facility.

6.4 Assessment of Soil Results

Potential Risks to Human Health

6.4.1 Summary tables of the soil results from both the Soils Limited ground investigation highlighting the exceedance of the selected GAC are presented in **Appendix D**.

6.4.2 The vast majority of the soil results are below the selected assessment criteria. The exception to this is one sample out of the 126 samples tested which indicates a marginal exceedances of the Public Open Space assessment criteria for Beryllium (2.3mg/kg compared to an assessment criteria of 2.2mg/kg). This is not considered significant.

6.5 Assessment of Groundwater Results

6.5.1 A full assessment of the groundwater monitoring results is presented in **Appendix E**.

6.5.2 In summary, the vast majority of the groundwater samples are below the selected assessment criteria for the protection of controlled waters as an ecological receptor and as a drinking water resource. The exceptions to this are elevated concentrations of Nickel and Mercury when compared to the EQS and DWS at two specific locations and elevated concentrations of Nitrate as NO_3 when compared to the DWS in one location.

6.5.3 The laboratory limits of detection (LOD) were above the assessment criteria for the protection of ecological receptors for cadmium, hexavalent chromium and cyanide.

6.6 Assessment of Ground Gas Results

6.6.1 A full assessment of the ground gas monitoring results is presented in **Appendix F**.

6.6.2 In all of the monitoring rounds in all locations monitored, the measured concentrations of carbon dioxide were below 3% v/v and methane were not detected in any location.

6.6.3 Very low gas flow rates were detected in all wells and typically <0.2l/hr. The exception to this was in DS207 on one occasion which recorded a gas flow of -0.5l/hr.

7 Tier 2 Geoenvironmental Summary and Risk Estimation

7.1 Hazard Identification

7.1.1 This Tier 2 risk assessment builds on the findings of the Preliminary Tier 1 assessments undertaken at the Site by Stantec (2020) and WSP (2017).

7.1.2 **Table 7.1** summarises the potential contaminative land uses and sources based on the current and historical land uses along with the contaminants of potential concern.

Table 7.1 Potential Sources of Contamination

Description	Contaminants of Potential Concern
Motorway/'A' Road	Metals and metalloids, chloride, polycyclic aromatic hydrocarbons (PAHs), oil/fuel hydrocarbons, sulphates, asbestos.
Inert Landfill - Infilled ground	Composition assumed to be naturally occurring arisings from road construction; but possible localised slightly elevated general industrial contaminants should be considered including metals, hydrocarbons, PAHs, asbestos and ground gases
Agricultural Usage	Hydrocarbons and lubricating oils associated with machinery and nitrates from fertilisers. Potential pesticides and herbicides. Asbestos (e.g. on farm tracks due to possible use of demolition rubble for surfacing).
Historical Land Use (Railway line, gas works, iron works, mixed industrial)	Metals and metalloids, PAHs, Polychlorinated Biphenyls (PCBs), oil/fuel hydrocarbons, lubricating oils, coal tars, creosotes, sulphates, inorganic compounds, asbestos PFAS
Peat and Organic Matter within Alluvial Deposits	Methane and Carbon Dioxide
Seaford Chalk – dissolution of calcium carbonate by acidic water	Carbon Dioxide

Soils

7.1.3 The ground investigation undertaken by Soils Limited investigated the agricultural land usages and roads source identified in **Table 7.1**. The ground investigation revealed that concentrations of potential contaminants are, for the vast majority of samples, below the relevant assessment criteria. The exception to this is 1No. sample which identified a marginal exceedance of the Public Open Space assessment criteria for Beryllium, however this is not considered significant.

Controlled Waters as an Ecological Receptor

7.1.4 The data reviewed indicates that at the majority of locations, concentrations of the potential contaminants tested, are below the relevant assessment criteria. However, some laboratory limits of detection (LOD) were above the assessment criteria that Stantec use for cadmium, hexavalent chromium and cyanide. It is not considered that this represents a significant risk to controlled waters, and this preliminary assessment should be further supported through additional sampling and analysis – using LODs below the assessment criteria where commercially available, and the use of the UK-TAG Metal Bioavailability Assessment tool.

7.1.5 Nickel and Mercury were also identified above the assessment criteria in two specific locations which are located close to two of the historical landfills; and whilst this is also not considered to represent a significant risk to controlled waters, further sampling and analysis is recommended to confirm this preliminary assessment and rule out possible previous sampling/testing errors. Further details on the assessment and conclusions can be found within **Appendix E**.

7.1.6 Based on the information available, there is no evidence to suggest that the groundwater at the site has been significantly impacted by anthropogenic contamination arising from within the scheme boundary and therefore the potential for the works to impact groundwater below the site and to give rise to a hazard to ecological receptors is considered to be **Low.**

Controlled Waters as a Drinking Water Resource

7.1.7 The majority of the groundwater samples did not record any exceedances of the Drinking Water Standards (DWS), however exceedances were recorded within DS110, DS203 and DS216 for Mercury, Nickel and Nitrate as NO_3. The source of the Nitrate is likely to be off site agriculture and therefore unrelated to the Site. As described above (Section 5.1.3), whilst the Mercury and Nickel concentrations at these limited locations are not considered to represent a significant risk to controlled waters, further sampling and analysis is recommended.

7.1.8 Based on the information available, there is no evidence to suggest that the groundwater at the site has been significantly impacted by anthropogenic contamination arising from within the scheme boundary and therefore the potential for the works to impact groundwater below the site and to give rise to a hazard to public water supply sources is considered to be **Low.**

Ground Gas

7.1.9 In accordance with Figure 6 within BS 8576:2013 the Gas Generation Potential of the Made Ground/Engineered fill, Alluvium and Peat is considered to be Low to Very Low given the limited degradable content indicated within the exploratory hole records. Further degradable organic content (DOC) testing should be undertaken on the natural strata to confirm this assessment.

7.1.10 It has been assessed from the ground gas monitoring data that the gas regime within the Seaford Chalk Formation is a Characteristic Situation 1 whereby no gas protection measures are required and therefore the potential for a significant ground gas risk to arise from the works is considered to be **Very Low** in accordance with BS8485+A1 (2019). Although this classification is designed for new buildings, it does give a reasonable indication of the ground gas risk.

7.1.11 It is also recognised that any construction activities and follow on maintenance work will be managed under an appropriate Environmental Management Plan, CDM regulations and compliance-based risk assessments which will further protect Construction and Maintenance workers.

7.2 Receptor Identification

7.2.1 Details of the potential receptors considered, and their sensitivity is presented in **Table 7.2** below:

Table 7.2 Summary of the Potential Receptors and their Sensitivity

Receptor Type	Comment	Sensitivity Score
Human Health – Current	Road Users, Ad-hoc access by agricultural workers and potential access by public (dog walkers etc).	4

Receptor Type	Comment	Sensitivity Score
Human Health – Future	Road, Users, Ad-hoc access by agricultural workers and potential access by public (dog walkers etc).	4
Human Health - Neighbours	Residential and Commercial	5
Human Health – Construction / Maintenance Workers	The proposed Stage 3B scheme is considered likely to include extensive earthworks that could expose construction workers to any potential contamination in the soil material.	4
Groundwater	The site is underlain by a Principal chalk aquifer, which is abstracted for potable supply.	5
Surface Water	The River Itchen flows across the north and along the west of the Proposed Scheme area with several associated water courses. The River Itchen is designated a SSSI and a Special Area of Conservation (SAC). Nun's Walk Stream flows in a channel approximately parallel to the River Itchen and is classified by the EA as a Main River.	5
Property - Buildings	Mixed use surrounding the M3 J9 Improvement works, including residential, commercial properties and agricultural land.	2
Property - Animal or Crop Effect	Some areas will be restored to agricultural land.	1
Ecological Systems	The nearest environmentally sensitive area is the River Itchen SSSI and SAC and flows through the study area. The Proposed Scheme area also lies partly within the South Downs National Park.	5

7.3 Risk Estimation

7.3.1 Following the recent ground investigation, the Conceptual Model has been updated to reflect the knowledge and understanding of the ground conditions. However, these investigations were not undertaken within some areas of potential landfill because they were outside the Stage 3a order limits, therefore this potential source of contamination was not adequately investigated at the time of writing this report.

7.3.2 The ground conditions encountered during the investigation and the results of the geoenvironmental testing, indicate that the potential for significant contamination to present is considered to be **Low to Very Low**.

7.3.3 Risk estimation involves predicting the likely consequence (what degree of harm might result) and the probability that the consequences will arise (how likely the outcome is).

7.3.4 Based on the information available, there are a number of plausible pollutant linkages, assuming a worst-case scenario, the estimated risks have been classed as follows:

- Human Health (Current) – Very Low

- Human Health (Future Users) – Very Low
- Human Health (Construction/Maintenance Workers) – Very Low
- Human Health (Neighbouring residents) – Very Low
- Groundwater – Low
- Surface Water - Low
- Property (Buildings) – Very Low
- Property (animal or Crop Effect) – Very Low
- Ecological Systems - Low

7.4 Risk Evaluation

7.4.1 Possible pollutant linkages are determined using professional judgement. If a linkage is considered possible, it is considered that this represents a potentially 'unacceptable risk' and therefore requires further consideration. This may be through remediation or mitigation or through further tiers of assessment.

7.5 Recommendations

7.5.1 On the basis of this Tier 2 Risk Assessment, it is not currently considered that a Tier 3 Detailed Risk Assessment is required, although further supplementary Tier 2 Risk Assessment is recommended following additional ground investigation and soils, groundwater and surface water sampling and laboratory analysis.

7.5.2 It is recommended boreholes are undertaken and that monitoring wells are installed, and soils and groundwater sampling is undertaken within the areas of suspected landfill, deeper Made Ground and within areas that have not been previously investigated, together with additional groundwater sampling of existing monitoring wells.

7.5.3 It is also recommended that surface water samples are taken from the River Itchen to determine the baseline conditions in the River, and this should include upstream and downstream samples.

7.5.4 Whilst the current ground gas assessment would advise that no special protection measures are required, it is recognised that this assessment of a CS1 situation is based on a limited data set, as such it is recommended that further boreholes are drilled, and gas monitoring undertaken within the areas of suspected landfill, made ground/fill if it is found to contain considerable degradable material and within areas that have not been previously investigated.

8 Geotechnical Risk Register

8.1.1 Based on review of available information and results of the ground investigation, the geotechnical risk register has been updated to identify and rate the potential risk to the project for each of the principal geotechnical hazards identified for the proposed Stage 3B scheme. The main aim of the risk register is to allow for planning to prevent the risks occurring or to mitigate their consequences. The risk register is included as **Appendix G**.

8.1.2 The risk register gives a description of the activity and potential geotechnical hazard, the consequence should the hazard occur and mitigation measures and actions to be taken to limit the impact of the hazard on the proposed Stage 3B scheme. The risk register also includes an assessment of the likelihood of occurrence and the impact on the project should the hazard occur.

8.1.3 Rating of the risk has been carried out so that greater effort can be spent planning the prevention and mitigation of those risks considered more serious in terms of the likelihood of their occurrence and their impact on the project if they do occur.

8.1.4 In relation to each risk there should be set out a simple action plan for the prevention/mitigation of relevant risk. Any action plan should be drawn up applying the principles of "SMART" that is actions should be Specific, Measurable, Agreed, Realistic and Time-bounded. A statement of the objective of the relevant action should be given as this will enable subsequent reviews of the risk register to consider whether any further action is necessary to achieve the objective.

8.1.5 Responsibility for the management of each risk should be allocated to a particular party or organisation as indicated on the risk register.

8.1.6 A review of the proposed scheme and project risks, as given in the geotechnical risk register, has been carried out to determine the geotechnical classification of the project and thus the requirement for geotechnical certification. On the basis of this review, the proposed Stage 3B scheme has been classified as a Geotechnical Category 2 Project. A Category 2 project is one that only includes conventional types of earthworks structures and foundations with no abnormal risk or unusual or exceptionally difficult ground conditions. It should be noted that both the geotechnical risk register and the geotechnical category of the scheme are considered as love and can be changed and updated as more information becomes available.

9 Engineering Assessment

9.1 Introduction

9.1.1 For the proposed Stage 3B scheme, the principal geotechnical consideration will be the strength and compressibility of the founding soils and hence, the foundations for the bridges, retaining walls and proposed embankments and cuttings along the length of the scheme. This section of the report presents comments on the ground conditions in relation to design and construction of the geotechnical elements of the proposed structures. The proposed structures are shown on Drawing HE551511-VFK-SGN-X_XXXX-XX-DR-CB-0100.

9.1.2 Recommended characteristic values of parameters for geotechnical design as determined from consideration of the available geotechnical testing carried out on samples recovered during the previous ground investigation, consideration of published data and correlations with index properties are discussed in **Section 5** of the report and are summarised in **Table 5.2**.

9.2 Natural and Mining Cavities

9.2.1 A technical note on the risks of natural and mining cavities along the scheme is presented in **Appendix A** for this report. The technical note identifies areas of the scheme where issues may arise from the presence of natural and mining cavities. The risk associated with the potential for cavities to be present has been assessed based on a review of geology, hydrogeology, geomorphology and historical records.

Natural Cavities

9.2.2 Where chalk is exposed and forms either the topographic hill top, or a slope face where Palaeogene/Quaternary deposits are absent at higher elevations, and therefore surface water is not anticipated to be directed towards, or accumulate in, areas of the chalk, the hazard rating for solution features to be present is considered Very Low.

9.2.3 Where Alluvium overlies the Chalk, and groundwater is anticipated to be at or above the chalk interface due to the influence of the floodplain, the hazard rating for solution features to be present is considered Low.

9.2.4 Where chalk is exposed and forms a slope face where Palaeogene/Quaternary deposits are present at higher elevations, and therefore surface water is anticipated to have originated upon the cover deposits and be directed onto the Chalk, the hazard rating for solution features to be present is considered Moderately Low.

9.2.5 Where either Head (1) or Head (2) deposits are present, the irregular contact between the deposit and the chalk presents favourable conditions for solution piping, creating conduits for surface water to underdrain into the chalk below, resulting in a hazard rating of Moderate.

9.2.6 The Clay-with-Flints forms a younger, successive cover deposit over the chalk surface and commonly infills any hollows and dissolution pipes in the weathered chalk surface. This produces potential for underdrainage into the chalk below, creating favourable circumstances for solution feature development. Previous experience of studying sites underlain by Clay-with-Flints has shown that natural cavities are frequent and pose a risk of differential settlement and possible ground collapse. This subsequently results in a hazard rating of Moderately High.

9.2.7 Therefore, with reference to the Natural Cavities risk assessment outlined in **Appendix A**, the risk to the scheme from the presence of natural cavities is considered to range from Very Low to Medium.

Mining Cavities

9.2.8 From a review of the history of the scheme area, the GDMS hazard rating, the geological, hydrogeological and geomorphological setting of the scheme, the likelihood for mining cavities to be present is considered to range from Low to Moderately Low across the majority of the scheme. However, where historical mining has been recorded, it should be considered to be Very High

9.3 Earthworks

Cuttings and Embankments

9.3.1 The majority of the material excavated within the cuttings will be the Seaford Chalk Formation. A small volume of Head Deposits will likely be excavated in cuttings to the east and south of the River Itchen. The materials are likely to be re-used as engineered fill in areas of embankments along the scheme. The major cuttings are for the M3 southbound diverge, the M3 Underpass, the A34 southbound link to the M3 and the NMU route.

9.3.2 Engineered fill will be required for the embankments for the M3 slip road southbound from the A34, the approach road to Junction 9 from the M3 southbound off slip, the A34 northbound from the M3 and the A33 Link road roundabout.

9.3.3 From a review of the geotechnical parameters of the insitu materials, it is anticipated that the proposed side slopes for cuttings of 1 (v) in 2 (h) and for embankments at 1 (v) in 3 (h) or shallower are likely to be stable in the long-term subject to detailed stability analysis during geotechnical design. Cutting side slopes may be able to stand at a steeper angle, however consultations with South Downs National Park have indicated their preference for shallower slopes to reduce the visual impact of the scheme on the landscape.

9.3.4 The areas of the cuttings and embankments are presented on drawings the overall scheme plan on Drawing HE551511-VFK-HGT-X_XXXX-XX-DR-GI-0001. The depths and height of each of the cuttings and embankments are presented on the Proposed Contours Drawings HE551511-VFK-HGN-X_XXXX_XX_DR-CH-0051 to 0055. These drawings are presented in the Drawings section of this report.

Materials

9.3.5 The materials that will arise from the cuttings within the scheme will comprise Engineered Fill, Alluvium, Head Deposits, Structureless Chalk and Structured Chalk.

9.3.6 Based on the available particle size distribution testing, it is likely that the excavated Alluvium and Head Deposits will meet the requirements of a Class 2C material and the less granular horizons as a Class 2A/2B. There is insufficient testing on these materials to confirm how they will behave as an embankment fill. The material arising from the cuttings within the chalk, if suitable for re-use will be classed as a Class 3 material in accordance within the Specification for Highways Works, Series 600 (SHW, 2016).

9.3.7 A total of twenty-four Moisture Condition Value tests were undertaken on samples of Structureless Chalk. The Moisture Condition Values ranged from 8.5 to 13 for corresponding optimum moisture contents ranging between 19 and 24 per cent. One Moisture Condition Value test was undertaken on the Head Deposits with the value of 12 for a corresponding optimum moisture content of 17 percent.

9.3.8 Notwithstanding the shortcomings of the MDD vs OMC relationship data and the Intact Dry Density data described in **Section 5,** we have undertaken an initial preliminary assessment of site won material for reuse as an engineered fill. **Table 9.1** summarises the guidance presented in the CIRIA C574 and should be read in conjunction with **Figures 5a to 5c** and **Figure 6**.

Figure 6 also includes the available intact dry density information from the 1973 ground investigation.

Table 9.1 Summary of Initial Material Properties for Reuse in Earthworks

Properties	Guidance
Alluvium/Head Deposits	
OMC – Insufficient data 95% MDD – Insufficient data	Insufficient testing data to determine a moisture content range to achieve 95% compaction with less than 10% air voids
Structureless Chalk	
OMC – 22 per cent 95% MDD– 1.49 Mg/m³	Moisture Content Range –21 to 27 per cent Natural Moisture Content – 22 and 32 per cent, therefore, the material will likely require moisture conditioning e.g. by drying or the addition of lime/cement.
Structured Chalk	
IDD - 1.25 to 1.45 Mg/m³ MC- >32 per cent	Unlikely to be economical for drying by lime/cement
IDD - 1.25 to 1.58 Mg/m³ MC – 28 to 32 per cent	Moisture conditioning required by lime/cement
IDD - 1.25 to 1.45 Mg/m³ MC – 16 to 28 per cent	Compaction trial needed to confirm the 10% air voids
IDD – 1.45 to 1.90 Mg/m³ MC – 16 to 28 per cent	Min 10% air voids should be achievable
IDD - 1.45 to 1.70 Mg/m³ MC - <25 per cent	Water may need to be added to achieve 10% air voids
IDD - >1.70 Mg/m³ MC - >15 per cent	Material may require wetting and/or crushing to achieve min 10% air voids
IDD - <1.55 Mg/m³ MC - < 16 per cent	Material unlikely to be suitable for reuse

9.3.9 Some of the results for intact dry density and moisture content provided in the Factual Report plot above the 100% saturation line in **Figure 6**, which indicates that the measured natural moisture of the chalk is above the saturation moisture content determined from the dry density and specific gravity of the chalk. These spurious results indicate possible errors in the reporting or testing procedures. Further laboratory testing is required to be able to assess the suitability of the chalk for reuse.

9.4 Site Preparation

Excavation Works

9.4.1 The materials excavated from cuttings across the scheme will vary depending on the location of the cutting and the local geology. Cuttings located in the vicinity of the River Itchen are likely to encounter a thickness of superficial deposits comprising of Alluvium and/or Head Deposits over Chalk. Elsewhere chalk should be encountered near surface. Excavation of these materials should be possible using conventional plant and equipment.

9.4.2 Excavation of the surface pavements and any existing foundations and below ground structures may require pre-treatment by use of hydraulic breakers to fracture the material. Once fractured, it should be possible to excavate these materials using conventional tracked excavators. Any remains of walls, foundation et cetera within 1.0m of foundation formation level should be removed to prevent any development of concentrations of stress in foundation or pavements.

9.4.3 Particular care will be required in excavating material to identify and wherever practicable to segregate any potentially contaminated materials to ensure they do not adversely affect the classification of other excavated materials. In addition, materials of similar earthworks classification and properties will need to be segregated e.g. anything too wet will need to be separated for pre-treatment, prior to reuse.

9.4.4 It is essential that contractors carefully inspect and check the exposed formation for evidence of localised weak areas and possible voids, such as solutions features, and take appropriate measures to ensure the adequacy of the exposed formation.

9.4.5 Chalk can be a difficult material to use as an engineering fill as it is properties change with moisture content and it is susceptible to crushing and degradation from handling and transportation. Strict materials control will be required on site in accordance with Clause 605 of the Specification for Highways Works Series 600 Earthworks (SHW, 2016). Stockpiles, excavations and placed material will require protection from the weather to avoid deterioration of the chalk. Double handling of excavated chalk should be avoided to reduce the breakdown of the material into fines. There is a significant surplus of fill material to be generated from site, therefore the better-quality structured chalk could be segregated and used as engineering fill. The use of binders e.g. lime or cement may be required to allow the wetter chalk to be reused.

9.4.6 Where the formation on exposed chalk surfaces will be used for haulage routes, appropriate protection measures will be required in order not to degrade the surface of the chalk.

Stability of Temporary Excavations

9.4.7 Although the sides of open cut may stand with near vertical side slopes in the short term, these may need to be battered back to an appropriate slope angle or restrained by full face support to ensure stability in the short to medium term. The temporary slope angles will depend on the nature and strength of the material around excavation. It is anticipated that a temporary slope angles for cuttings within the Head Deposits and the Structureless Chalk will typically be between a 1 (v) in 1.5 (h) to 1 (v) in 2 (h). For temporary slopes within the Structured Chalk, a safe slope angle of 1 (v) :1 (h) is considered appropriate.

Groundwater Control

9.4.8 The groundwater levels encountered during the fieldwork and monitoring are summarised in **Table 5.1** of this report.

9.4.9 Based on this data, groundwater is unlikely to be encountered in any of the cuttings or excavations within the scheme with the exception of any excavations associated with the footbridge across the River Itchen. The footbridge is sited within the River Itchen flood plain and therefore consideration should be given to the time of year excavations in this area are undertaken.

9.4.10 Further assessment of groundwater levels and their likely range of fluctuation will be required during the supplementary ground investigation. However, in the meantime allowance should be made for controlling groundwater and surface water that may enter into cuttings in order the reduce the degradation of the cutting faces within the chalk.

9.4.11 In addition, surface water needs to be controlled at the base of the proposed embankments to reduce the risk of inundation collapse settlement.

9.5 Highways Structures

M3 J9 Gyratory Bridges (North and South)

9.5.1 The proposed bridges at Junction 9 are to span a distance of 45m over the M3, the north bridge is proposed to be 11.8m wide and the south bridge is proposed to be 15.5m wide. Three options were considered for the M3 Junction 9 Gyratory Bridges as presented in Structure Options Report (Stantec, 2021a). The options presented in the report are the following:

- Option 1 – Single span steel-concrete composite deck with reinforced concrete abutments and wing walls
- Option 2 – Three span steel-concrete composite deck
- Option 3 – Four-span beam and slab deck or solid infill deck

9.5.2 The Structures Options Report recommends Option 1.

9.5.3 The ground conditions encountered in the vicinity of the gyratory roundabout comprise a limited thickness of Made Ground over the Seaford Chalk Formation. The available information on the ground conditions indicate that either shallow spread foundations (based on foundations adopted for the current gyratory bridges) or piled foundations could be adopted.

9.5.4 From review of the ground investigation data, it is considered that there is sufficient information to develop a preliminary ground model for the north and south gyratory bridges.

River Itchen Footbridge

9.5.5 The proposed bridge over the River Itchen will span 35m and have a width of up to 4m. Three options were considered for the footbridge as presented in Structure Options Report (Stantec 2021b). The options presented in the report are as follows:

- Option 1 – Single-span timber truss
- Option 2 – Single span steel truss
- Option 3 – Two-span fibre reinforced polymer (FRP) footbridge

9.5.6 Option1 is recommended in the Structure Options Report.

9.5.7 The ground conditions in the vicinity of the footbridge were not fully investigated. In particular the base of the peat and the top of the chalk was not determined at the location of the proposed bridge. Based on the information available the ground conditions are likely to comprise a layer of Made Ground/ Topsoil over a layer of Alluvium possibly containing layers of Peat over Head Deposits over the Seaford Chalk. Given the presence of Alluvium and Peat it is anticipated that piles founding in chalk will be required for the abutment foundations.

9.5.8 In order to design the foundations for the proposed bridge additional boreholes will be required within the footprint of the abutments to determine the full lateral and vertical extent of the Alluvium and any layers of Peat, and to investigate the founding properties of the underlying chalk to a depth of 5m below the likely base depth of the toes of the piles .

M3 Underpass

9.5.9 The underpass to accommodate the new A34 southbound route under the M3 is proposed to be 125m long, 15m width and 6.2m high with a 200m long entry cutting on its north side and a 140m long exit cutting to the south. The underpass is proposed to be constructed using a reinforced concrete box culvert. The entry and exit cuttings will be in open cut slopes and partly fully retained within vertical sides. The box culvert will be founded on the Seaford Chalk Formation.

9.5.10 Three methods of construction are presented in the Structure Options Report (Stantec 2021c) for the M3 Underpass as presented below:

- Option 1 – Bottom-up construction (open excavation)
- Option 2 – Bottom-up construction (multi-propped embedded retaining wall)
- Option 3 – Top-down construction

9.5.11 Option 1 and 2 are considered appropriate for the construction of the underpass with the reinforced buried box constructed within an open or temporarily supported excavation. Option 3 is not recommended for reasons related to whole-life cost, appearance and maintenance.

9.5.12 During the 2019 ground investigation one borehole was located to the north of the northern portal and one to the south of the southern portal to a depth of only 6.0m. In order to design the underpass, its approaches and any temporary works required, additional deeper boreholes will be required at either end of the underpass.

9.5.13 The nature of the material currently comprising the M3 embankment is currently unknown. However, it is anticipated that the materials will comprise Engineered Chalk Fill. Additional exploratory holes will be required to understand the composition of the material beneath the M3.

A34 Northbound Underpass

9.5.14 The proposed A34 Northbound Underpass will be 100m long, 12m wide and 5.8m high with the approaches comprising partial cuttings and retaining walls up to 12m in height. The underpass is proposed to be constructed using a reinforced concrete box culvert. The box culvert will be founded on the Seaford Chalk Formation.

9.5.15 Two methods of construction have been presented in the Structure Options Report (Stantec, 2021d) for the A34 Northbound Underpass. The options are presented below:

- Option 1 - Top-down construction at existing ground level using contiguous bored pile abutments, wingwalls and adjoining retaining walls. The underpass ‘roof’ being formed by precast beams or in situ reinforced concrete deck slab.
- Option 2 - Bottom-up construction built using a proposed sheet pile temporarily for the underpass and permanent tied cantilever sheet piles for the wingwalls and adjoining retaining walls.

9.5.16 Option 1 has been recommended to construct the A34 Northbound Underpass.

9.5.17 The borehole information within the vicinity of the proposed underpass is not considered sufficient to develop a ground model, with two boreholes to between 15.0m and 20.0m below ground level and one trial pit to 4.0m bgl. Additional exploratory holes will be required in order for detailed design to be undertaken.

M3 J9 Gyratory Subways

9.5.18 Three subways are proposed to be constructed for the NMU around the proposed gyratory. The subways vary in length from 24m to 28m, 4m wide and 3m in height with the approaches in cutting. The options for the subways within the M3 J9 Gyratory are included within the Structure Options Report for the NMU Route (Stantec 2021b). The options are presented below:

- Option 1 – In-situ reinforced concrete box structure
- Option 2 – precast concrete box structure.

9.5.19 Option 1 has been recommended for the M3 J9 Gyratory Subways.

9.5.20 All three subways are to be founded on the Seaford Chalk Formation. The ground investigation information in this area of the scheme is considered sufficient in order to develop a ground model and undertake geotechnical design for the subways.

A34 Northbound Subway

9.5.21 The A34 Northbound Subway is proposed to be 24m long, 4m wide and 3m high and will be founded on the Seaford Chalk Formation. The approaches to the subway will be in cutting.

9.5.22 The ground investigation information in the vicinity of the subway is considered sufficient in order to develop a ground model and undertake geotechnical design for the subway.

9.5.23 The options for the A34 subway are included within the Structure Option Report for the NMU Route (Stantec 2021b) and comprise an in-situ reinforced concrete box structure and precast concrete box structure. Both options are considered viable for this subway.

Retaining Walls

9.5.24 The proposed scheme will require the construction of 4 retaining walls (excluding wing walls to underpass portals and bridges) to support the proposed earthworks. The proposed retaining walls will range from 90m to 120m long and vary from 2.0m to 12m in height.

9.5.25 Two retaining walls are located along the east side of the A33 Link Road to the north and the south of the proposed underpass of the A34 Northbound with a maximum retained height of around 12m.

9.5.26 Five options have been considered in the Structure Option Report (Stantec 2021d) for the A33 Link Retaining Walls. The options are presented below:

- Option A – Steel sheet pile wall
- Option B – Contiguous bored pile wall
- Option C – Diaphragm walls
- Option D – Reinforced soil
- Option E – Reinforced concrete cantilever wall

9.5.27 Option B with Option D are considered to be the preferred options. A contiguous bored pile portal bridge structure with adjoining contiguous bored piles retaining walls that transition into reinforced soil vegetated. Additional ground investigation will be required in order to undertake the detailed design for these structures.

9.5.28 Another retaining wall is proposed to support the A34 Northbound carriageway. The retaining wall has a maximum height of 2.0m. Four options (Stantec 2021b) were considered for this retaining:

- Option 1 – Modular concrete block retaining wall system
- Option 2 – Vegetated wall system
- Option 3 – Precast (Option 3a) or in-situ (Option 3b) reinforced concrete cantilever wall
- Option 4 – Gabion retaining wall

9.5.29 Option 2 is considered to be the preferred option. No further ground investigation information is considered to be required as this wall will be constructed above existing ground level.

9.5.30 The four retaining wall is located adjacent to the A272 and is required to provide suitable visibility for the A272 northbound approach to the M3 gyratory roundabout. The maximum retained height will be 1.2m. There is no ground investigation information in this area and therefore all wall options should be considered.

9.6 Pavement Design

9.6.1 No in situ or laboratory California Bearing Ratio (CBR) or subgrade stiffness modulus testing was undertaken as part of the 2019 ground investigation, therefore, recommended CBR values for preliminary pavement design have been obtained from the review of published literature. CIRIA 574 recommends that for highways schemes cut into chalk, typically a design CBR of greater than 15 per cent is adopted for structured insitu chalk and for structureless in situ chalk a design CBR of 2 per cent is recommended. It should be noted that chalk is highly susceptible to frost action and therefore pavements need to be thick enough to prevent frost action on the sub-formation. Typically, minimum pavement thicknesses of 450mm are adopted.

9.6.2 CIRIA recommends for embankments comprising Engineered Chalk Fill using structured chalk, the guidance suggests that a CBR of 8 per cent is achievable. However, a higher CBR of 15 per cent or more is achievable if the reworked chalk is compacted to achieve air voids of not more than 10 per cent. For reworked structureless chalk forming embankment fill, a CBR of less than 2% is expected, dependent on the air voids and the degree of recementing within the matrix. Therefore, stabilisation with the use of lime or cement will be required for the structureless chalk if a higher the CBR value is to be achieved or if structured chalk comprises too much fines.

9.6.3 Without any available testing the CBR values presented in **Table 9.2** are considered a conservative estimate preliminary design purposes only. Further in-situ and laboratory testing should be undertaken to provide more appropriate CBR values/subgrade surface moduli for detailed design.

Table 9.2 Preliminary Design CBR Values

Material	Preliminary CBR Value	Subgrade Surface Modulus (MPa)
Insitu Structureless Chalk	2%	25
Insitu Structured Chalk	5%	50
Engineered Fill (Structureless Chalk)	2.5%	30
Engineered Fill (Structured Chalk)	5%	50

9.6.4 Testing of the subgrade will be required in during construction to confirm the design CBR values have been achieved.

9.7 Mix Design of Buried Concrete

9.7.1 The measured pH values and concentrations of water-soluble sulphate on soil samples recovered during the ground investigation are presented in the factual report and are summarised in **Table 9.3** below:

Table 9.3 Summary of pH and Sulphate Results

Stratum	Number of Tests	pH Value	Water Soluble Sulphate (mg/l)	Total Sulphur (%)
Made Ground	35	6.5 – 11.0	10 - 40	0.02
Alluvium	12	6.4 – 8.6	10	0.02
Head Deposits	15	6.4 – 8.5	10 - 40	0.02
Seaford Chalk Formation	136	7.2 – 8.5	10 - 93	0.02

9.7.2 For mobile groundwater conditions pH and sulphate concentrations in the samples from the Alluvium, Head Deposits and Seaford Chalk Formation generally correspond to Design Sulphate Class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) class AC-1 as defined in BRE Special Digest 1 (BRE (2017).

9.7.3 The recommendations of BRE (2017) should be followed for the mix design of buried concrete for the classification given.

9.8 Drainage

9.8.1 As part of the ground investigation, 5 variable head permeability tests were undertaken in boreholes across the scheme. The reported results of the variable head permeability tests are summarised in **Table 9.4** below.

Table 9.4 Summary of the Variable Head Permeability Tests

Location	Test Depth Range (m bgl)	Geology as per borehole records (m bgl)	Water Level Fall (m)	Test Duration (sec)	Result
DS104	0 - 4	0.3-3.0 sandy gravelly clay (Alluvium) 3.0-4.0 No description (Alluvium)	0.96	3600 (1 hr)	Insufficient fall in water to calculate permeability.
DS107	0 - 4	0.4-1.2 Structureless chalk 1.7-4.0 Chalk (Grade B2)	2.78	3600	1.48×10^{-6} m/s
DS109	0 - 3	0.5-1.2 Structureless chalk 1.2-3.0 Chalk (Grade B2)	1.31	3600	Insufficient fall in water to calculate permeability.
DS210	0 - 4	0-1.7 Structureless chalk (Grade Dc) 1.7 -4.0 Chalk (Grade B2)	1.52	9000 (2.5 hr)	Insufficient fall in water to calculate permeability.
DS301	5.7 – 10.15	5.7-7.0 Chalk Grade A3-A4 7.0-10.15 Chalk (Grade A3)	4.42	1800	7.6×10^{-6} m/s (Note the result in factual report is 8.2×10^{-6} m/s because start and end test water levels have been entered incorrectly)

9.8.2 It has been identified that the permeability calculated from the variable head permeability tests has been determined using the wrong method. The Factual Report states the tests were undertaken in accordance with BS EN ISO 22282-2:2012 and calculated using the Hvorslev method. However, Section B.4.2 of the British Standard states 'The Hvorslev method can only be applied below the water table', yet the factual report notes the boreholes were dry prior to the commencement of the tests. Therefore, the permeability results provided are considered not to reflect the in-situ permeability of the chalk.

9.8.3 Soil infiltration rates have, therefore, been derived by Stantec using the soil infiltration calculation as stated within BRE DG 365 and the raw data recorded from the variable head permeability tests undertaken as part of the ground investigation to give an indication of likely values for preliminary design purposes. A summary of the results is presented in **Table 9.5** below.

Table 9.5 Summary of calculated Soil Infiltration Rates

Location	Test Depth Range (m bgl)	Geology as per borehole records logs (m bgl)	Soil Infiltration - Calculated (m/s)	Soil Infiltration (m/hr)
DS104	0 - 4	0.3-3.0 sandy gravelly clay (Alluvium) 3.0-4.0 No description (Alluvium)	9.5×10^{-6}	3.4×10^{-2}

Location	Test Depth Range (m bgl)	Geology as per borehole records logs (m bgl)	Soil Infiltration - Calculated (m/s)	Soil Infiltration (m/hr)
DS107	0 - 4	0.4-1.2 Structureless chalk 1.7-4.0 Chalk Grade B2	1.4×10^{-5}	5.2×10^{-2}
DS109	0 - 3	0.5-1.2 Structureless chalk 1.2-3.0 Chalk Grade B2	2.8×10^{-5}	1.0×10^{-1}
DS210	0 - 4	0-1.7 Structureless chalk (Grade Dc) 1.7 -4.0 Chalk Grade B2	4.2×10^{-6}	1.5×10^{-2}
DS301	5.7 – 10.15	5.7-7.0 Chalk Grade A3-A4 7.0-10.15 Chalk Grade A3	1.1×10^{-4}	4.1×10^{-1}

9.8.4 It should be noted the soil infiltration rates provided in **Table 9.5** were derived from the variable head permeability tests which were not undertaken in accordance with BRE DG 365 and therefore may not provide a true representation of the Site's infiltration rates.

9.8.5 Structureless Chalk is unlikely to be suitable for infiltration drainage because of the predominance of silt like matrix and infiltration into the Structured Chalk will be affected by the presence of fractures and fissures and whether these have been infilled. CIRIA C574 only provides permeabilities for chalk, which is not the same parameter as infiltration rate,

9.8.6 Therefore, in the interim, until appropriate soil infiltration testing in accordance with BRE DG 365 can be undertaken, the infiltration rates have been reduced by an order of magnitude to ensure the scheme is not over reliant upon the derived infiltration rates. The infiltration rates for preliminary Stage 3B surface water drainage design are summarised in **Table 9.6** below.

9.8.7 It should be noted that given that the infiltration rates are based upon variable head permeability tests, their localised proximity in relation to the extent of the scheme is not representative. The infiltration rates have, therefore, been categorised based upon the underlying geology rather than location.

Table 9.6 Adopted Infiltration Rates

Underlying Geology	Soil Infiltration (m/s)	Soil Infiltration (m/hr)
Alluvium / Head Deposits	1×10^{-6}	2×10^{-3}
Structured Chalk (where encountered within the top 2m)	1×10^{-6}	2×10^{-3}
Structured Chalk (where encountered 2m below ground level or deeper	1×10^{-5}	2×10^{-2}

9.8.8 Soil infiltration testing will need to be undertaken to be targeted at the locations and depths where surface water infiltration drainage is proposed.

10 Additional Ground Investigation

10.1.1 In order to confirm the design assumptions made in this report and to meet the requirements of the BS EN 1997-2, additional exploratory holes are required to be undertaken prior to the construction stage. These are provisionally summarised in **Table 10.1** below:

Table 10.1 Summary of Provisional Additional Exploratory Holes

Location	No. of Exploratory Holes	Anticipated Depth (m bgl)	Purpose
M3 Underpass	3 - 5 (e.g. boreholes)	Up to 35	To obtain ground and groundwater conditions around the underpass in order to design the underpass foundations, assess settlement and assess the material for reuse.
A34 Northbound Underpass	3 - 5 (e.g. boreholes)	Up to 20	To obtain ground and groundwater conditions around the underpass in order to design the underpass foundations, assess settlement and assess the material for reuse.
M3 South bound Diverge	4 - 6 (e.g. boreholes and trial pits)	Up to 12	To obtain ground conditions and assess the material for reuse
River Itchen Footbridge	2 - 4 (e.g. boreholes)	Up to 20	To obtain ground and groundwater conditions to inform pile design.
A33 Link Retaining Wall (North)	2 - 3 (e.g. boreholes)	Up to 30	To obtain ground and groundwater conditions to inform the design of the retaining structure
A33 Link Retaining Wall (South)	2 - 3 (e.g. boreholes)	Up to 30	To obtain ground and groundwater conditions to inform the design of the retaining structure
Motorway Signals and Gantries	8 (e.g. boreholes)	Up to 20	To obtain the ground and groundwater conditions at each gantry location to inform the design of the foundations
Infiltration Testing	12 - 15 (e.g. trial pits)	Up to 3	To obtain the infiltration rates across the scheme to inform the drainage design.
Earthworks Information	10 - 15	Up to 4	To obtain bulk samples for earthworks testing
Deposition and Compound areas	40 – 45 (e.g. boreholes and trial pits)	Up to 35	To obtain ground and groundwater conditions within proposed deposition and compound areas and within identified landfill areas that have not been investigated.

10.1.2 In situ testing is to be undertaken and appropriate samples are to be obtained and tested to confirm the characteristic values of the geotechnical parameters adopted in the design. Further details of the proposed ground investigation will be provided in the Ground Investigation Scope Report as required. It should be noted that scope of the ground investigation presented above may be modified to meet the requirements for the detailed design of the scheme.

10.1.3 The results of the additional ground investigation will be reported in a factual report provided by the ground investigation contractor accompanied with a separate AGS File. An Addendum Ground Investigation Report will be produced following the receipt of the factual information.

References

BGS (2002) 1:50 000 Geology Series, England and Wales Sheet 299 (Winchester). British Geological Survey, Keyworth, Notts.

BGS (2002) Geological Memoir, Geology of the Winchester District, a brief explanation of the geological map sheet 299. British Geological Survey, Keyworth, Notts.

BRE (2017) Concrete in aggressive ground. Special Digest 1, Building Research Establishment, Garston, Herts.

BS 1377 (1990) Methods of test for soils for civil engineering purposes. British Standards Institution, London.

BS 5930 (2015) Code of Practice for Ground Investigations. British Standards Institution, London.

BS 6031 (2209) Code of Practice for Earthworks. British Standards Institution, London.

BS 8004 (2015) Code of Practice for Foundations. British Standards Institution, London.

BS 8485+ A1 (2019) Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. British Standards Institution, London.

BS 8576 (2013) Guidance on investigations for ground gas -Permanent gases and Volatile Organic Compounds (VOCs) British Standards Institution, London

BS EN 1997-1 (2004+A1:2013) Eurocode 7 – Geotechnical design – Part 1: General rules. British Standards Institution, London.

BS EN 1997-1 (2004+A1:2014) National Annex to Eurocode 7 – Geotechnical Design – Part 1: Genera Rules. British Standards Institution, London.

BS EN 1997-2 (2007) Eurocode 7 – Geotechnical design – Part 2: Ground Investigation and testing. British Standards Institution, London.

BS EN ISO 14688-1 (2018) Geotechnical investigation and testing – Identification and classification of soil. Part 1: Identification and description. British Standards Institution.

BS EN ISO 14688-2 (2018) Geotechnical investigation and testing – Identification and classification of soil. Part 2: Principles for a classification. British Standards Institution.

BS EN ISO 17892 (2014) Geotechnical investigation and testing. Laboratory testing of soil. British Standards Institution, London.

BS EN ISO 22282-2 (2012) Geotechnical investigation and testing — Geohydraulic testing. Part 2: Water permeability tests in a borehole using open systems. British Standard Institution.

CIEH (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C. and Nathanail, J.F. Land Quality Press, Nottingham.

CIRIA (2002) C574 Engineering in Chalk. CIRIA, London.

CIRIA (2007) C665 Assessing risks posed by hazardous gases to buildings. London.

CLAIRE (2014) SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. Department for Environment, Food and Rural Affairs September 2014

Clayton, C.R.I (1995) The Standard Penetration Test (SPT): Methods and Use. Report 143. CIRIA, London.

DEFRA (2010) Water Framework Directive, Directive 2000/60/EC, Department of the Environment, Food and Rural Affairs, London.

DETR (2000) The Water Supply (Water Quality) Regulations, 2000. Statutory Instrument 2000 No. 3184. Department of the Environment, Food and Rural Affairs (formerly Department of the Environment, Transport and Regions), London.

HE (2016) Manual of Contract Documents for Highways Work, Volume 1 Specification for Highway Work, Series 600 Earthworks. Highways England, February 2016.

HE (2019) Design Manual for Roads and Bridges– CD622 Managing geotechnical risk. Rev 1. March 2020. Highways England.

HE (2020) Design Manual for Roads and Bridges – CD 229 Data for pavement assessment (formerly HD 29/08). Highways England, Birmingham.

Soils Ltd (2020) M3 Junction 9 Improvement. Factual Ground Investigation Report. Document ref: 17486/FGIR/Rev 1.02, July 2020.

Stantec (2020) PCF Stage 3B: Phase 1 Ground Condition Assessment (Contamination and Stability for Proposed Deposition and Compound Areas. Document ref: HE551511-VFK-EGT-X_XXXX_XX-RP-GE-0001. Dated: December 2020.

Stantec (2021a) Stage 3B: Structure Option Report M3 J9 Gyratory Bridges. Document ref: HE551511-VFK-SBR-E_RNBT_01-RP-CB-001.C01. Dated: February 2021.

Stantec (2021b) Stage 3B: Structure Option Report NMU Route Structures. Document ref: HE551511-VFK-SBR-W_MNUX_01-RP-CB-004.C01. Dated: March 2021.

Stantec (2021c) Stage 3B: Structure Options Report M3 Underpass. Document ref HE551511-VFK-SBR-W_A34S_XX-RP-CB-002.C01. Dated: February 2021.

Stantec (2021d) Stage 3B: Structure Options Report A34 Northbound Underpass and A33 Link Retaining Walls Document ref HE551511-VFK-SBR-W_A33X_S2-RP-CB-0003.C01 Dated: February 2021.

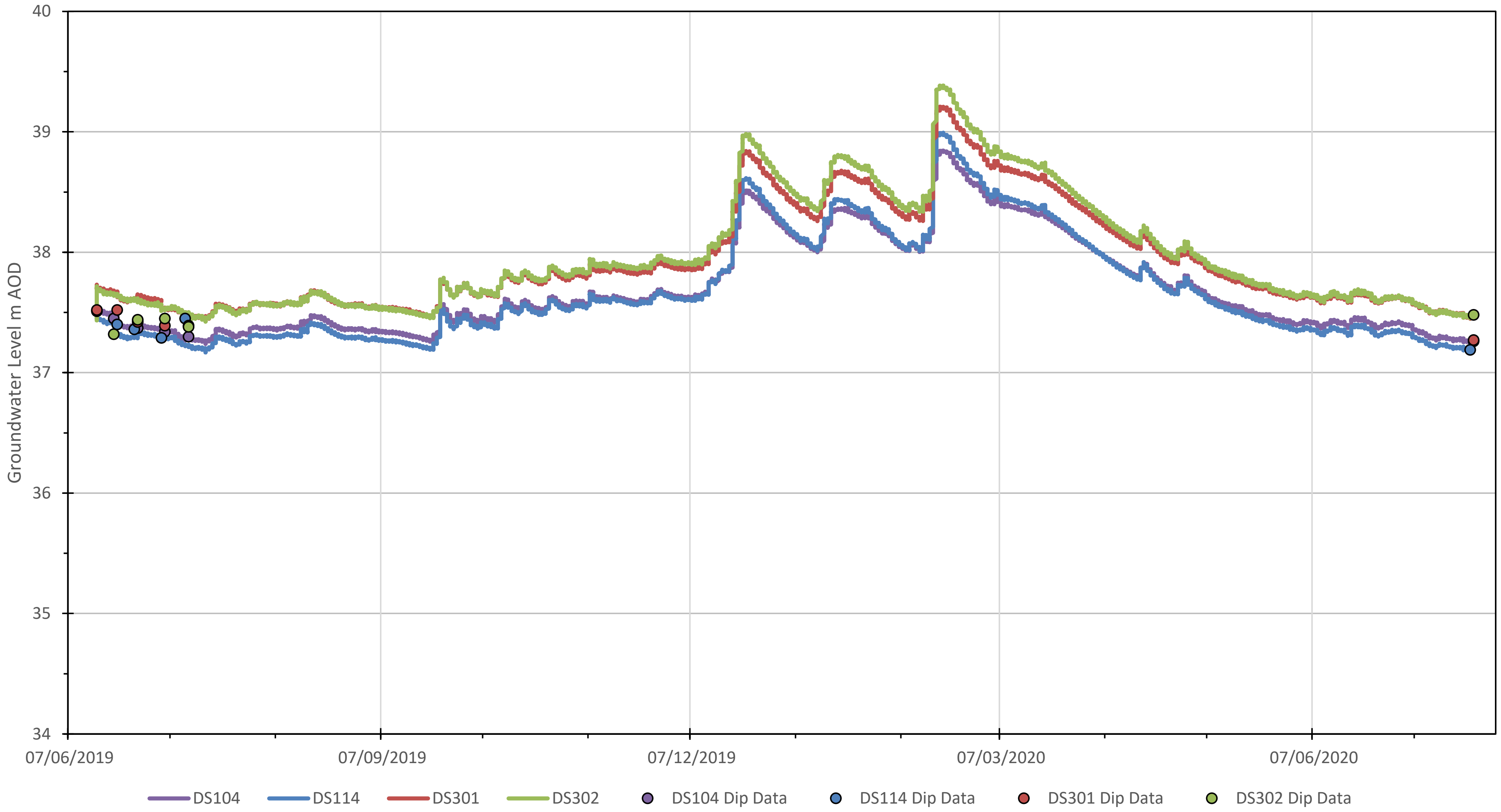
Stroud M S (1989) The standard penetration test, its application and interpretation. ICE Conference on Penetration Testing in the UK, Birmingham, pp 29-50.

Tomlinson (2001) Foundation Design and Construction 7th Edition. Pearson Education.

WEA (2019) M3 Junction 9, Winchester Hampshire. Archaeological Evaluation Report. Document ref HE551511-WEA-EGN-0_00_00-RP-LE-0001 dated May 2019.

WSP (2017) M3 Junction 9 Improvement Scheme. Preliminary Sources Study Report. HAGDMS ref: 29434. Document ref: HE551511-WSP-GEN-M3J9PCF2-RP-CE-00019. WSP Ltd. September 2017.

Figures



stantec.com/uk

Client

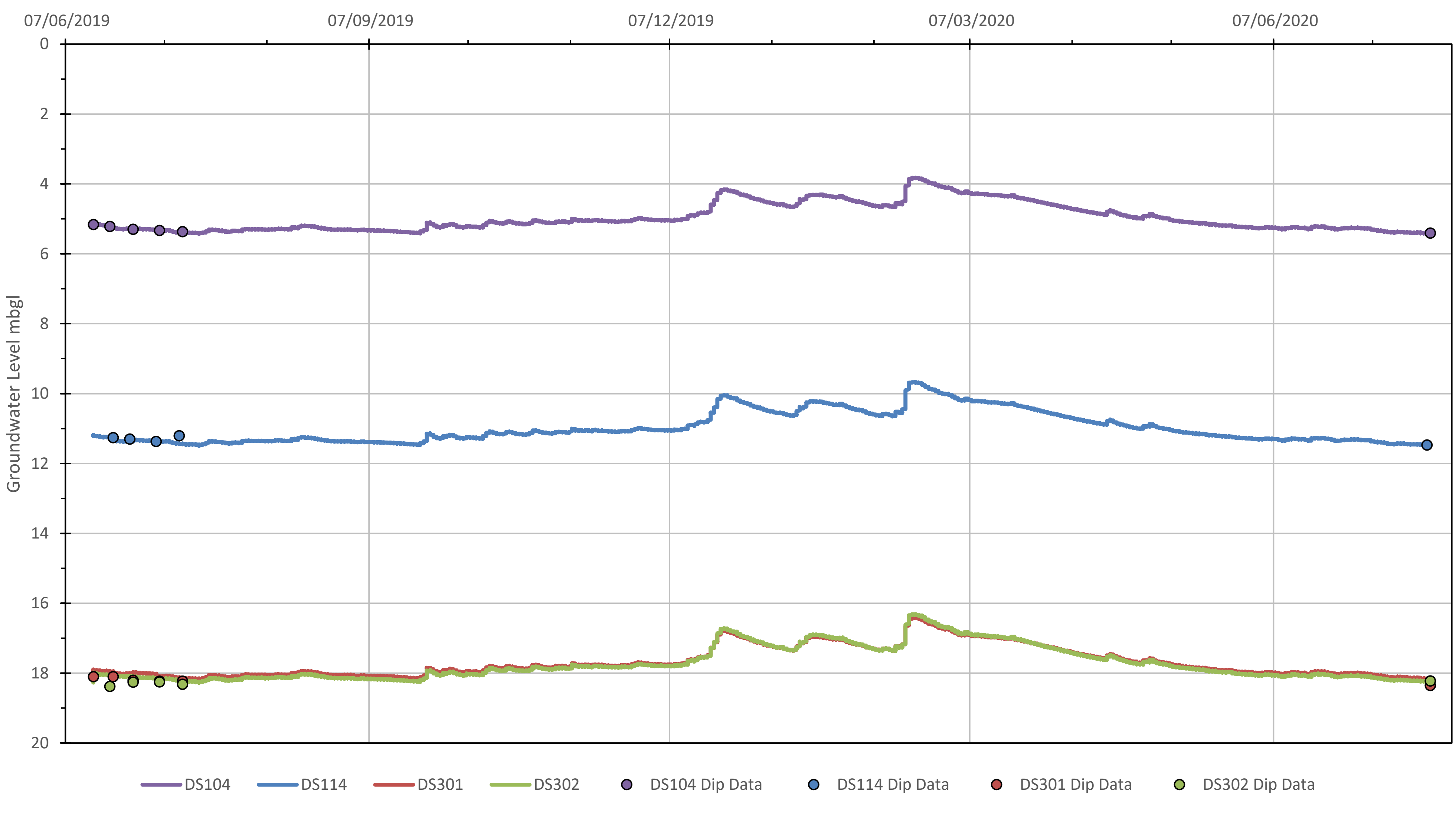
Highways England & Volkerfitzpatrick

M3 Junction 9 Improvements

Barometrically Compensated Groundwater Level (m Above Ordnance Datum)

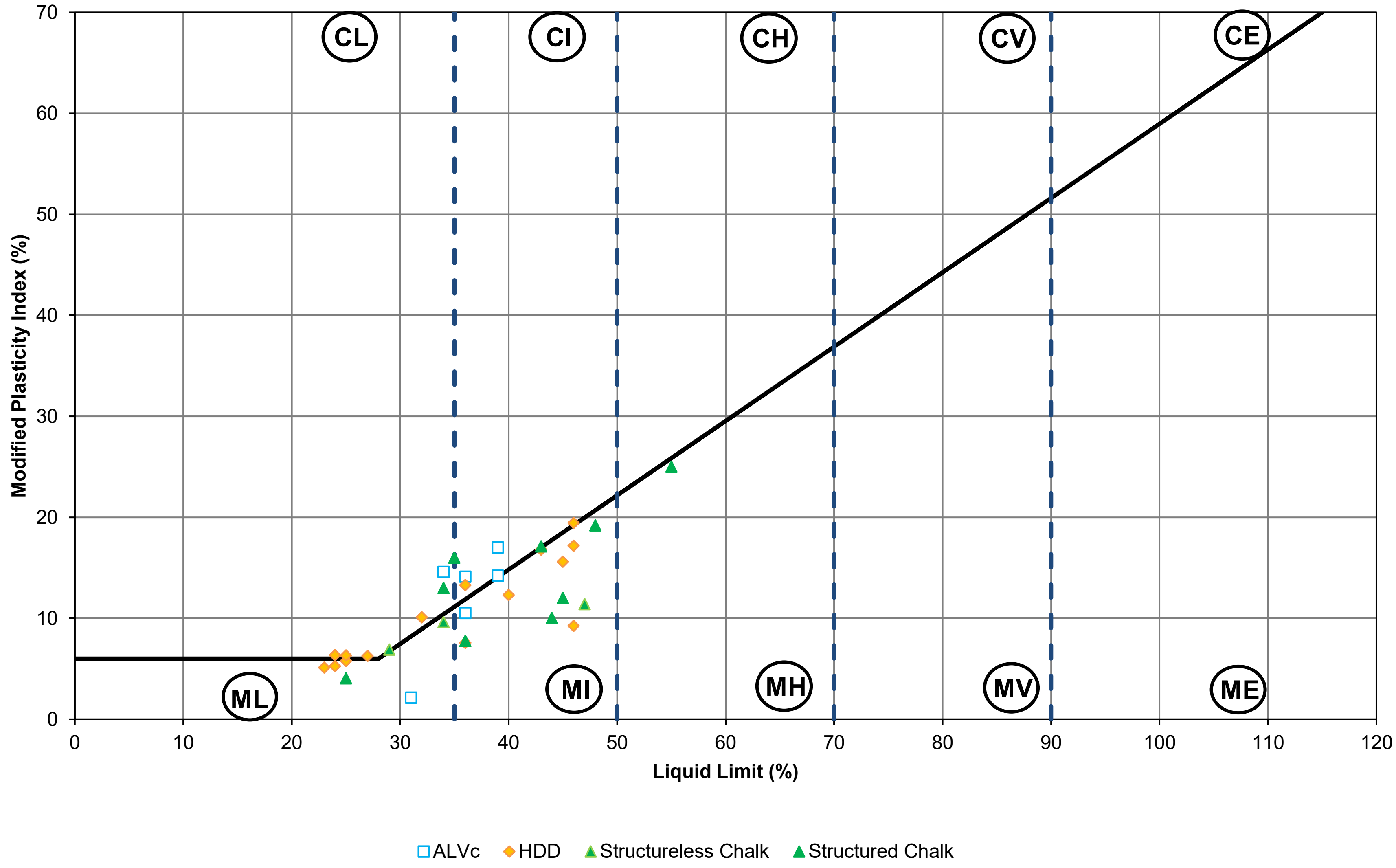
Date	December 2020
A4 Scale	NTS
Drawn	TT
Checked	AD
Figure	**1a**

J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\[Data Logger GW Levels Fig.xlsx]M AOD



Stantec stantec.com/uk © Stantec UK Limited	Client **Highways England & Volkerfitzpatrick**	**M3 Junction 9 Improvements** **Barometrically Compensated Groundwater Level (m below ground level)**	Date: December 2020 A4 Scale: NTS Drawn: TT Checked: AD **Figure 1b**

J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\[Data Logger GW Levels Fig.xlsx] M BGL



Stantec

stantec.com/uk

Client

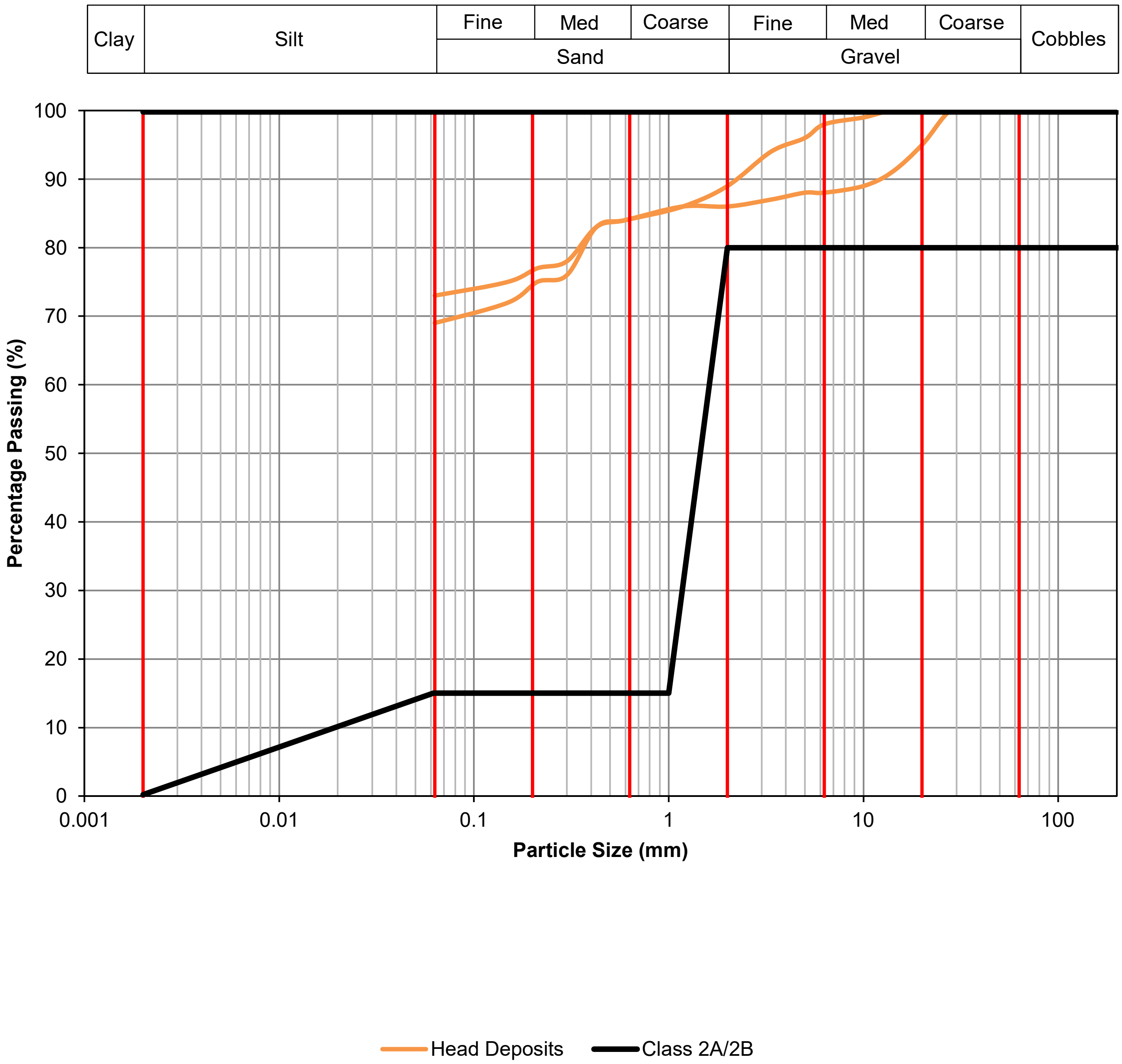
Highways England & Volkerfitzpatrick

M3 Junction 9 Improvements

Atterberg Limits

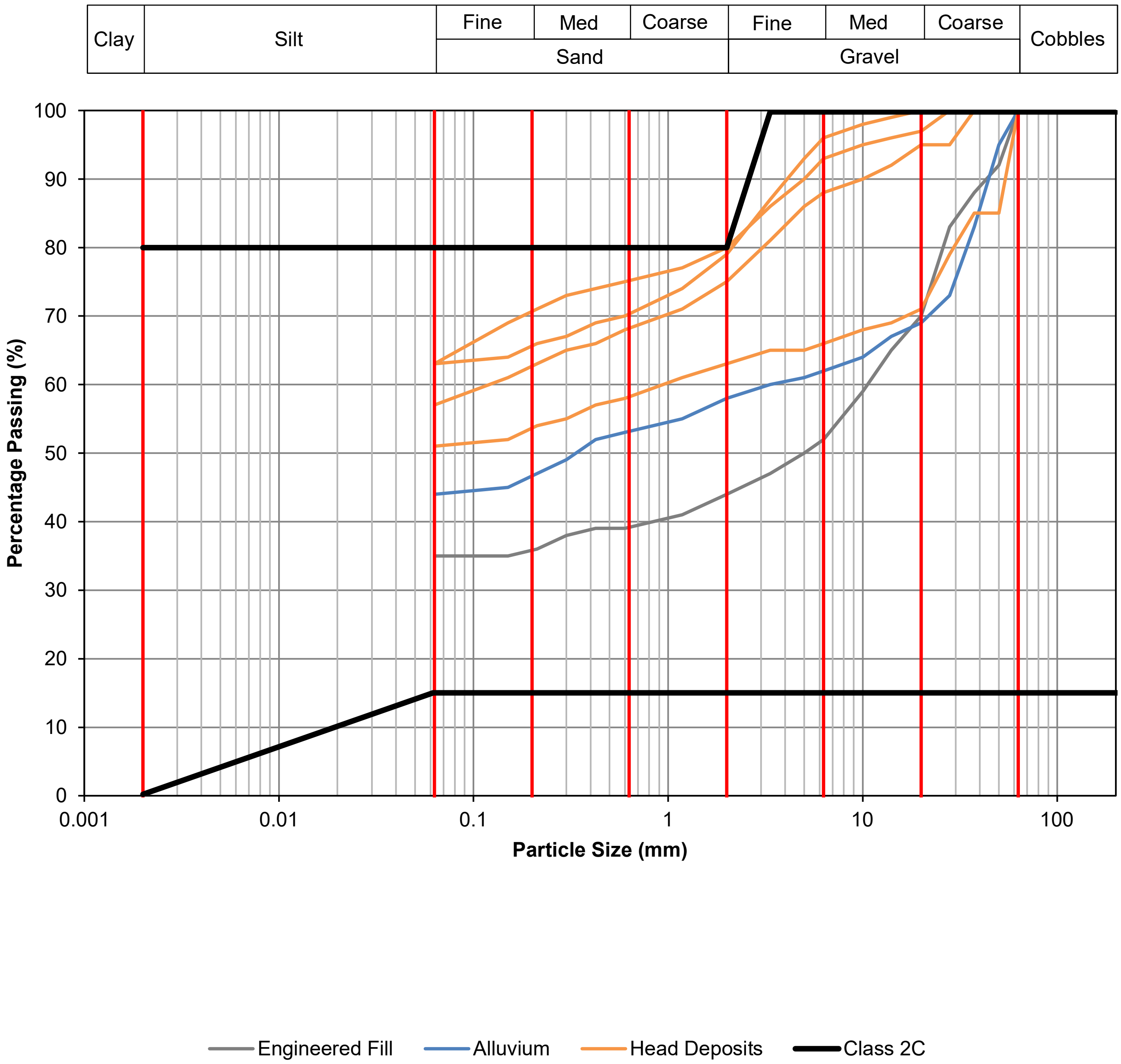
Date	December 2020
A4 Scale	nts
Drawn	TT
Checked	AD
Figure	**2**

J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\Figure 2 Atterbergs.xlsm



HA Specification for Highway Works Table 6/2 Grading Envelope for Class 2A/2B

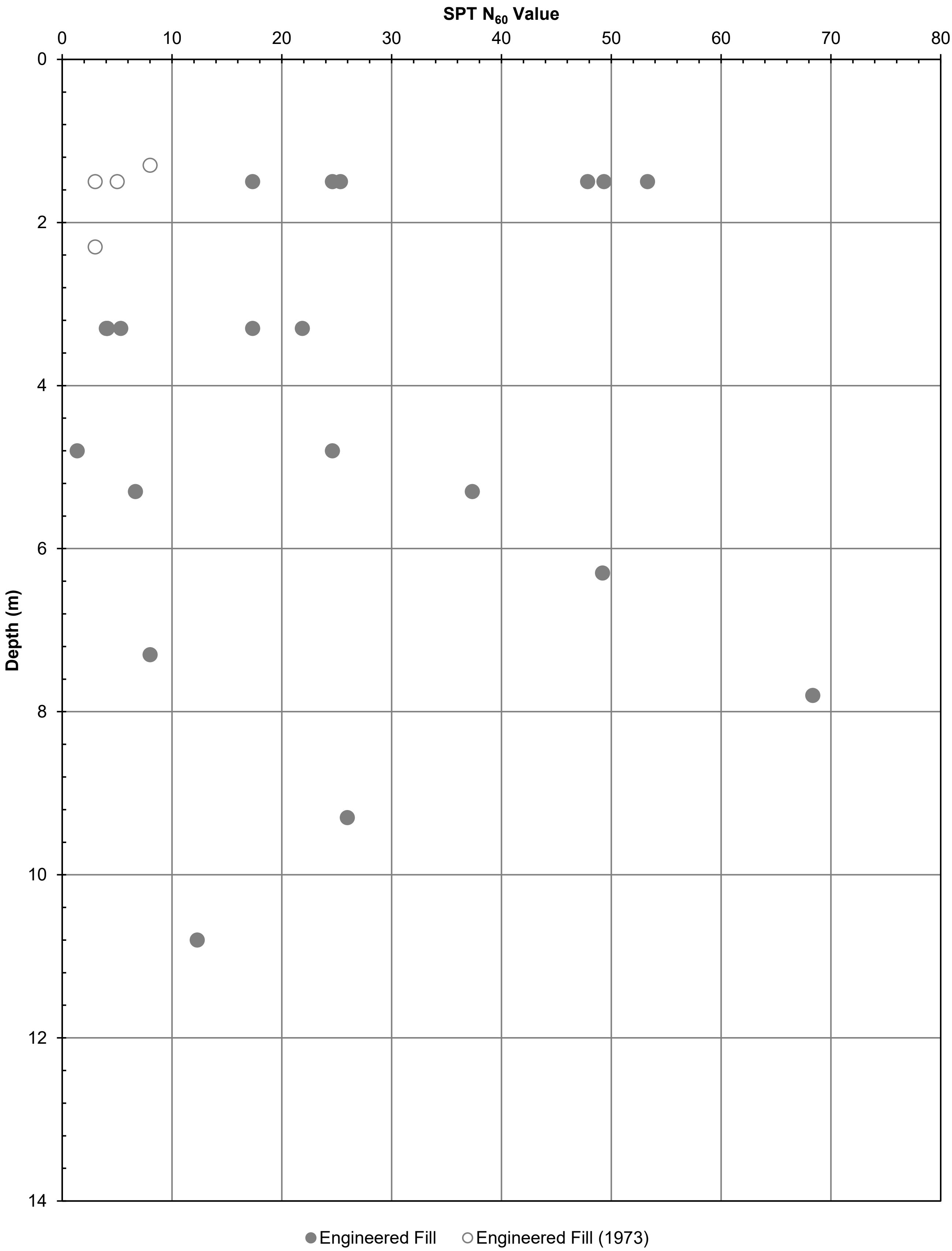
Stantec stantec.com © Stantec UK Limited	Client **Highways England & Volkerfitzpatrick**	**M3 Junction 9 Improvements** **Particle Size Distribution - Class 2A/2B**	Date: December 2020 A4 Scale: NTS Drawn: TT Checked: AD Figure: **3a**



HA Specification for Highway Works Table 6/2 Grading Envelope for Class 2C

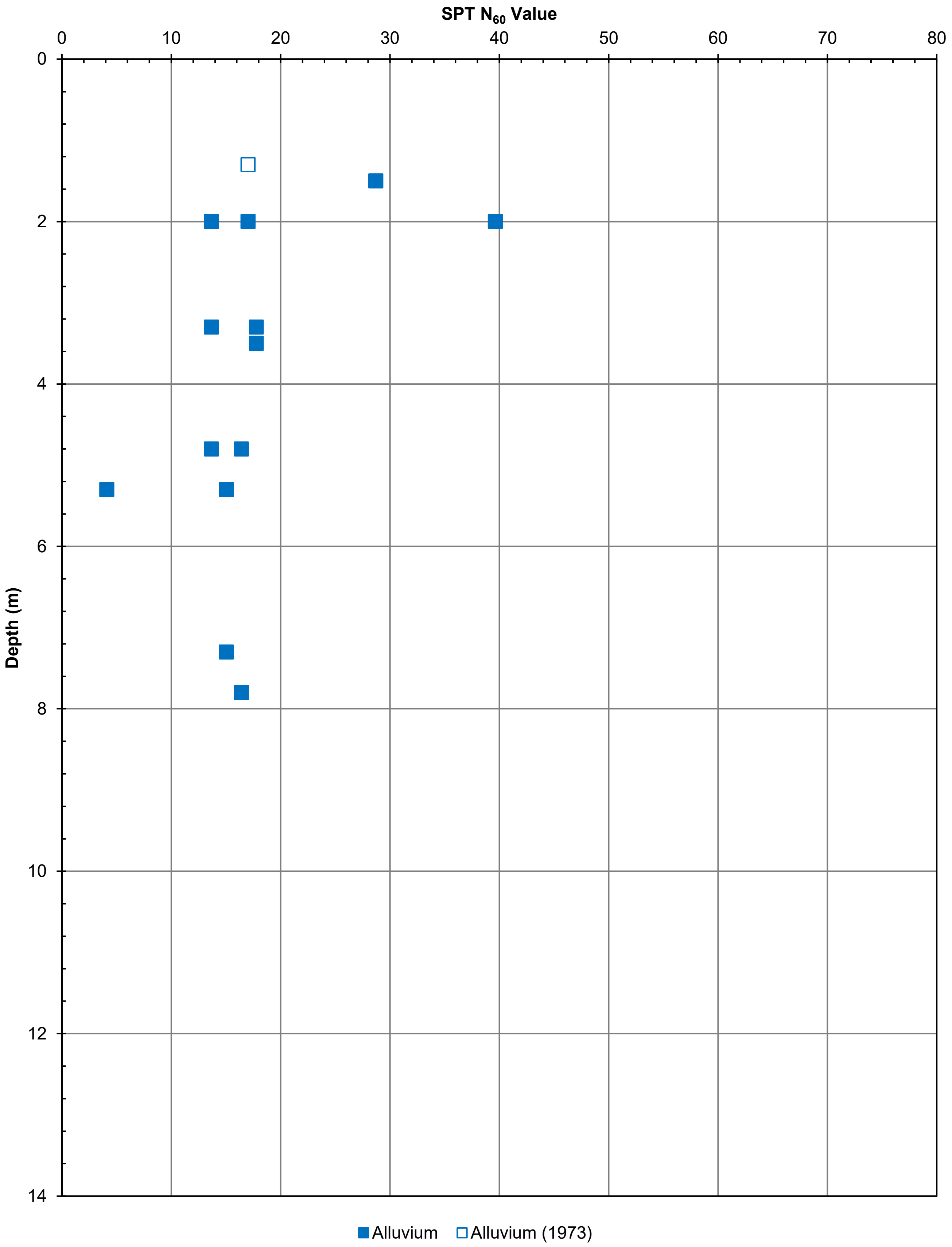
Stantec stantec.com © Stantec UK Limited	Client **Highways England & Volkerfitzpatrick**	**M3 Junction 9 Improvements** **Particle Size Distribution - Class 2C**	Date: December 2020 A4 Scale: NTS Drawn: TT Checked: AD Figure: **3b**

J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\PBA Compaction by Geology edit.xlsm



Stantec stantec.com © Stantec UK Limited	Client **Highways England & VolkerFitzpatrick**	**M3 Junction 9 Improvements** **SPT N_{60} vs Depth Engineered Fill**	Date	May 2021
			A4 Scale	NTS
			Drawn	AD
			Checked	TT
			Figure	**4a**

\\Cbh-vfil-001\cbh\Projects\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\SPT N60\PBA SPT N60 v Depth all data.xlsm



Stantec

stantec.com

Client

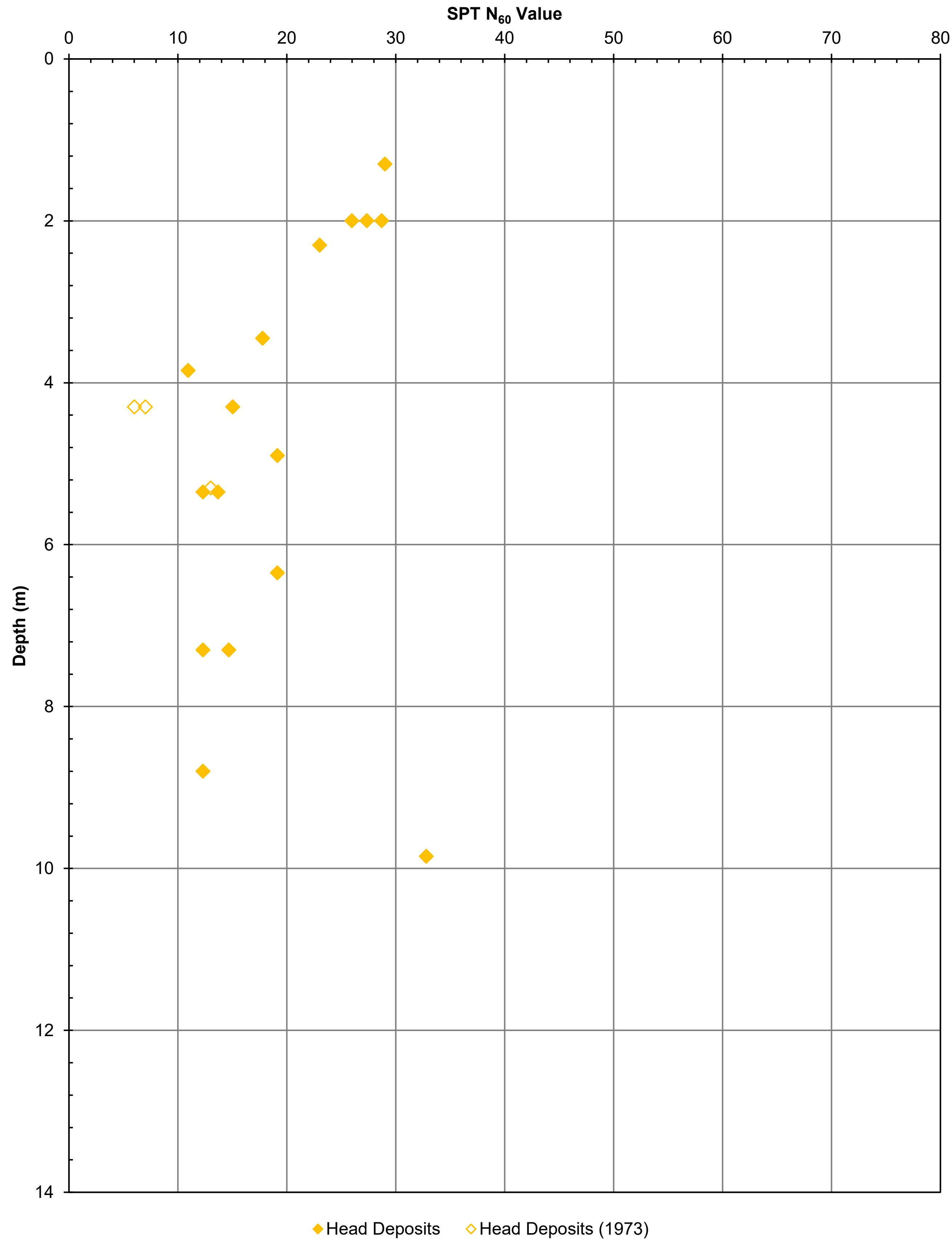
Highways England & VolkerFitzpatrick

M3 Junction 9 Improvements

SPT N_{60} vs Depth Alluvium

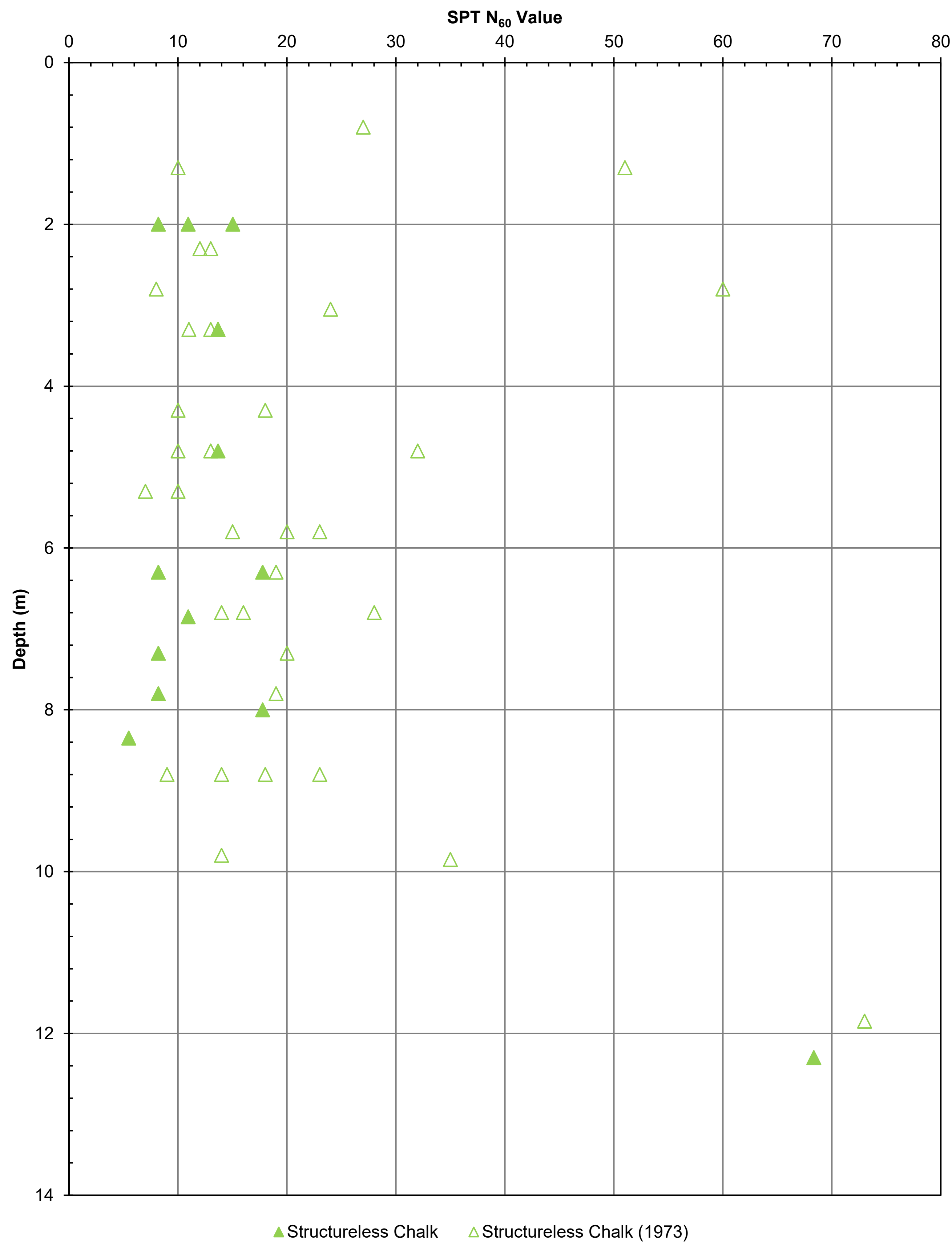
Date	May 2021
A4 Scale	NTS
Drawn	TT
Checked	AD
Figure	**4b**

\\Cbh-vfil-001\cbh\Projects\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\SPT N60\PBA SPT N60 v Depth all data.xlsm



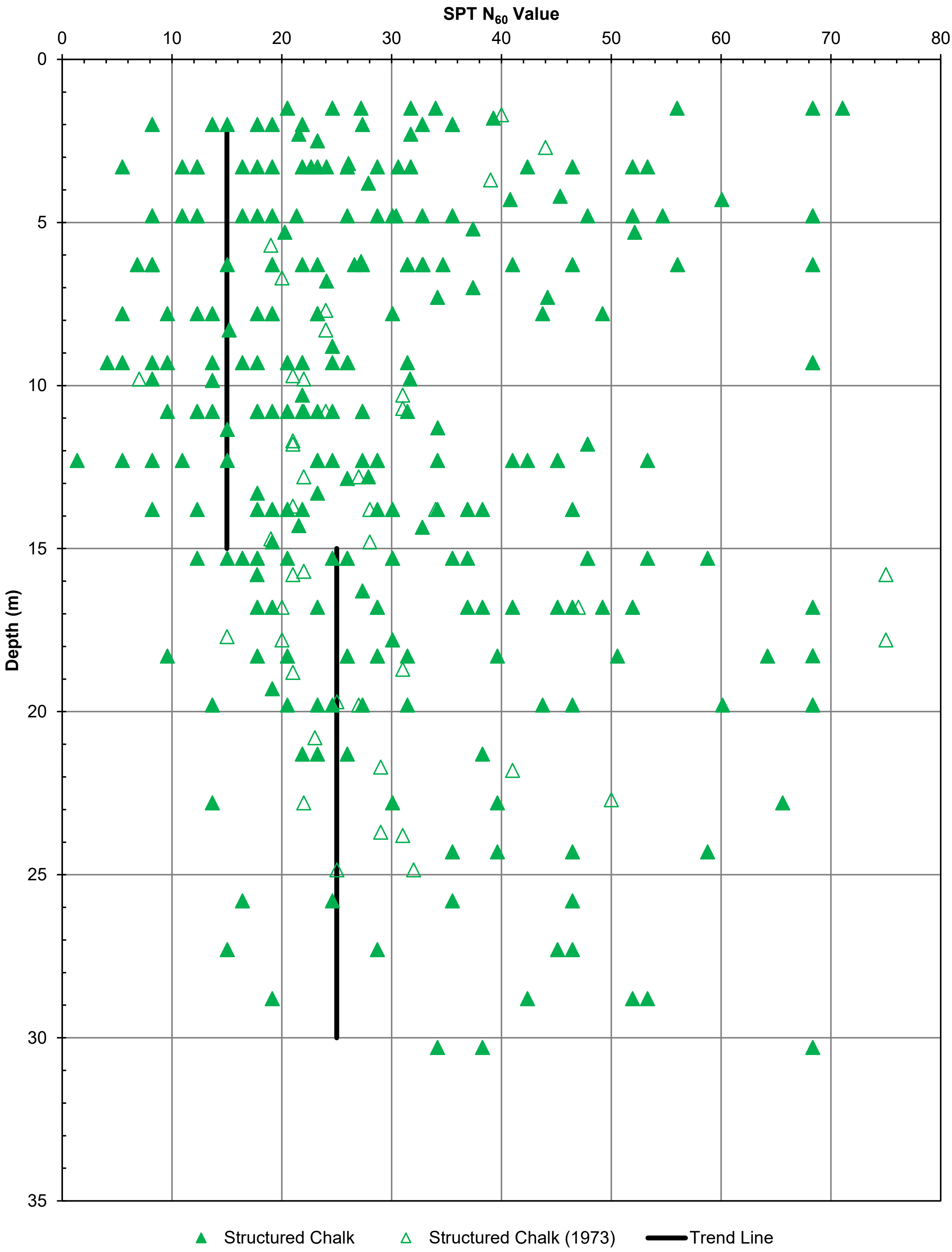
Stantec stantec.com © Stantec UK Limited	Client **Highways England & VolkerFitzpatrick**	**M3 Junction 9 Improvements** **SPT N_{60} vs Depth** **Head Deposits**	Date May 2021 A4 Scale NTS Drawn TT Checked AD Figure **4c**

\\Cbh-vfil-001\cbh\Projects\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\SPT N60\PBA SPT N60 v Depth all data.xlsm



Stantec	Client		Date	May 2021
stantec.com	Highways England & VolkerFitzpatrick	**M3 Junction 9 Improvements**	A4 Scale	NTS
© Stantec UK Limited		**SPT N_{60} vs Depth Structureless Chalk**	Drawn	TT
			Checked	AD
			Figure	**4d**

\\Cbh-vfil-001\cbh\Projects\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\SPT N60\PBA SPT N60 v Depth all data.xlsm



Stantec
stantec.com

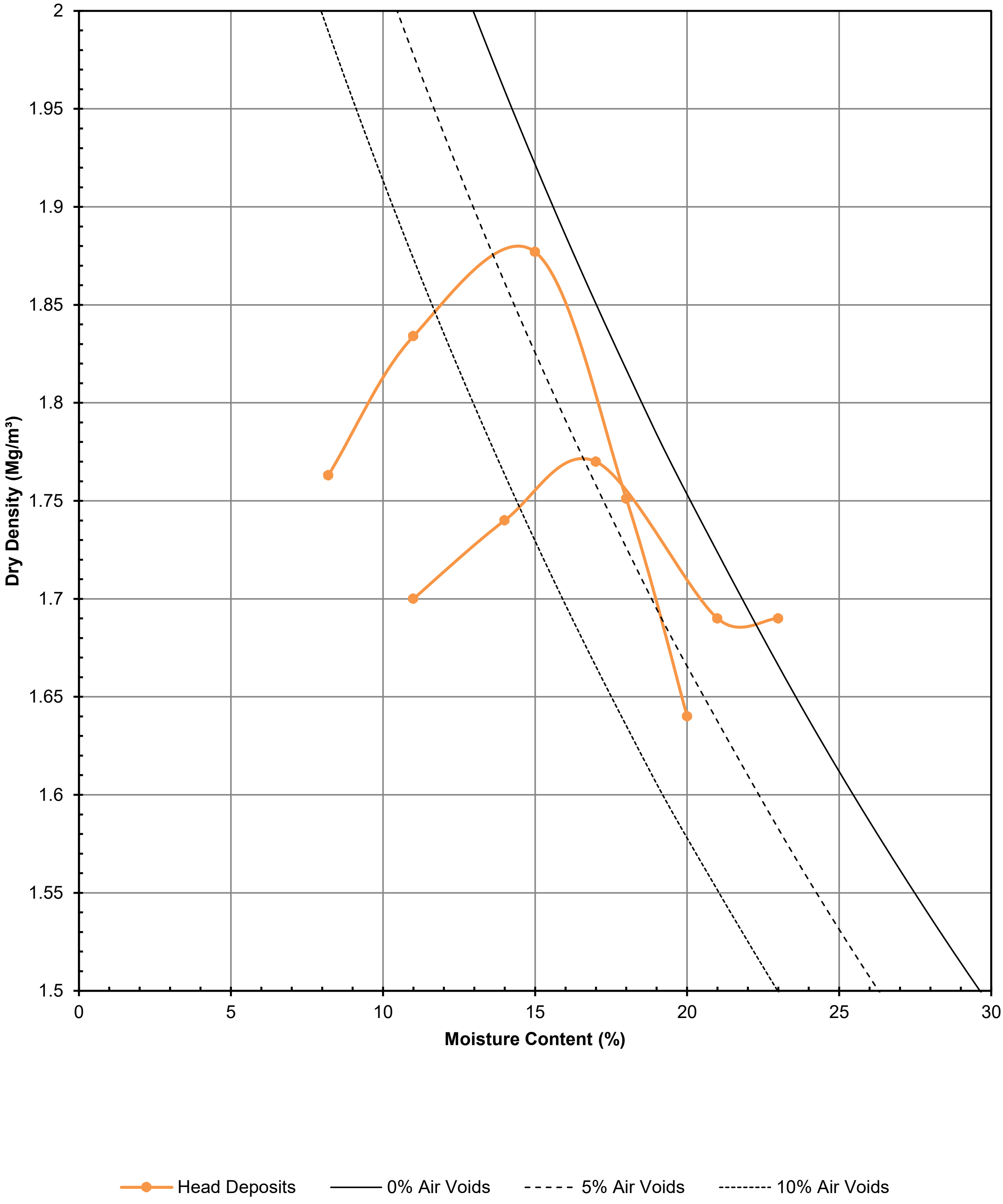
Client
Highways England & VolkerFitzpatrick

M3 Junction 9 Improvements

SPT N_{60} vs Depth Structured Chalk

Date	May 2021
A4 Scale	NTS
Drawn	TT
Checked	AD
Figure	4e

\\Cbh-vfil-001\cbh\Projects\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\SPT N60\PBA SPT N60 v Depth all data.xlsm



Assumed Specific Gravity = 2.7 Mg/m³

Stantec

stantec.com

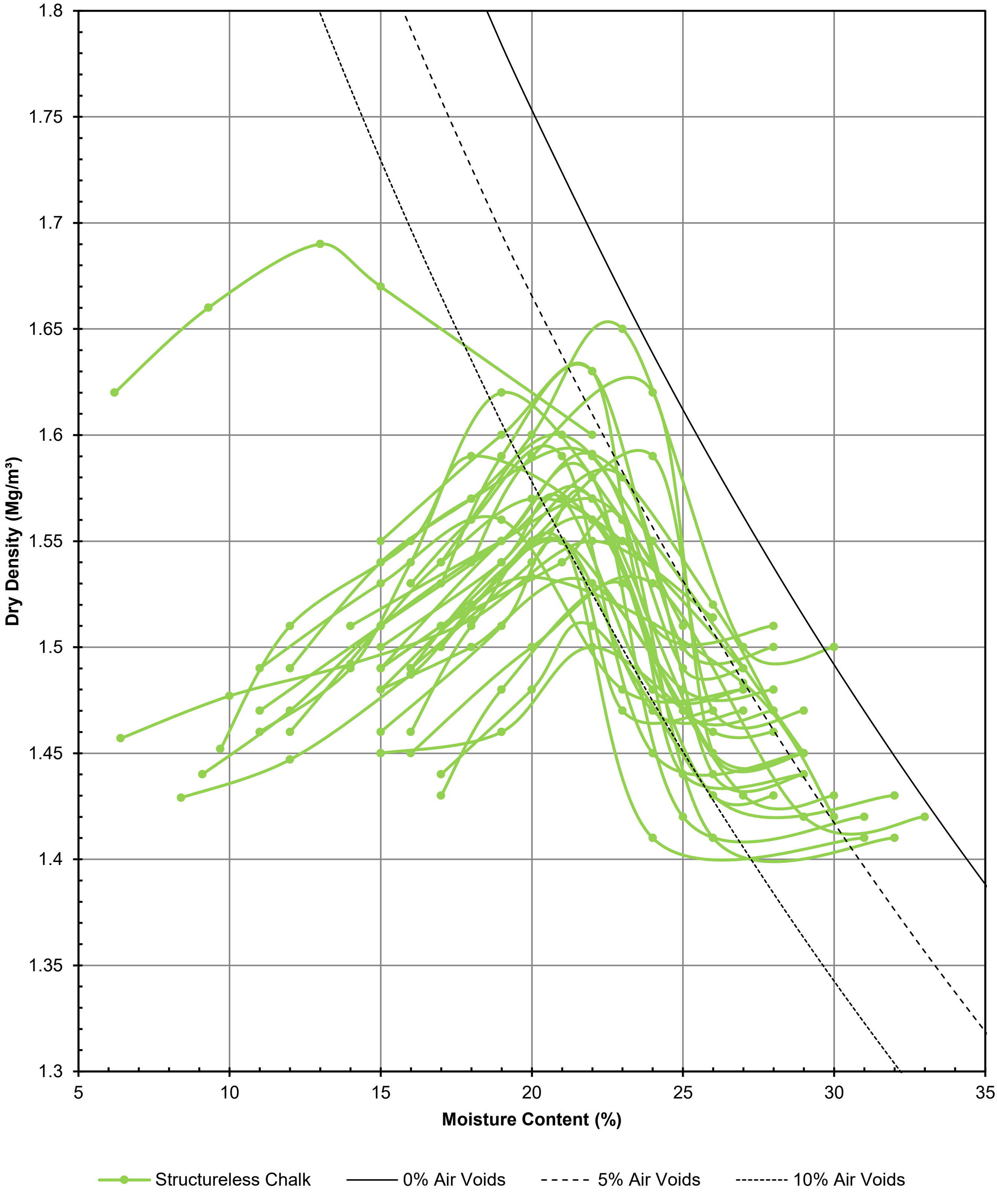
Client

Highways England & VolkerFitzpatrick

M3 Junction 9 Improvements

MDD vs OMC Relationship - Head Deposits

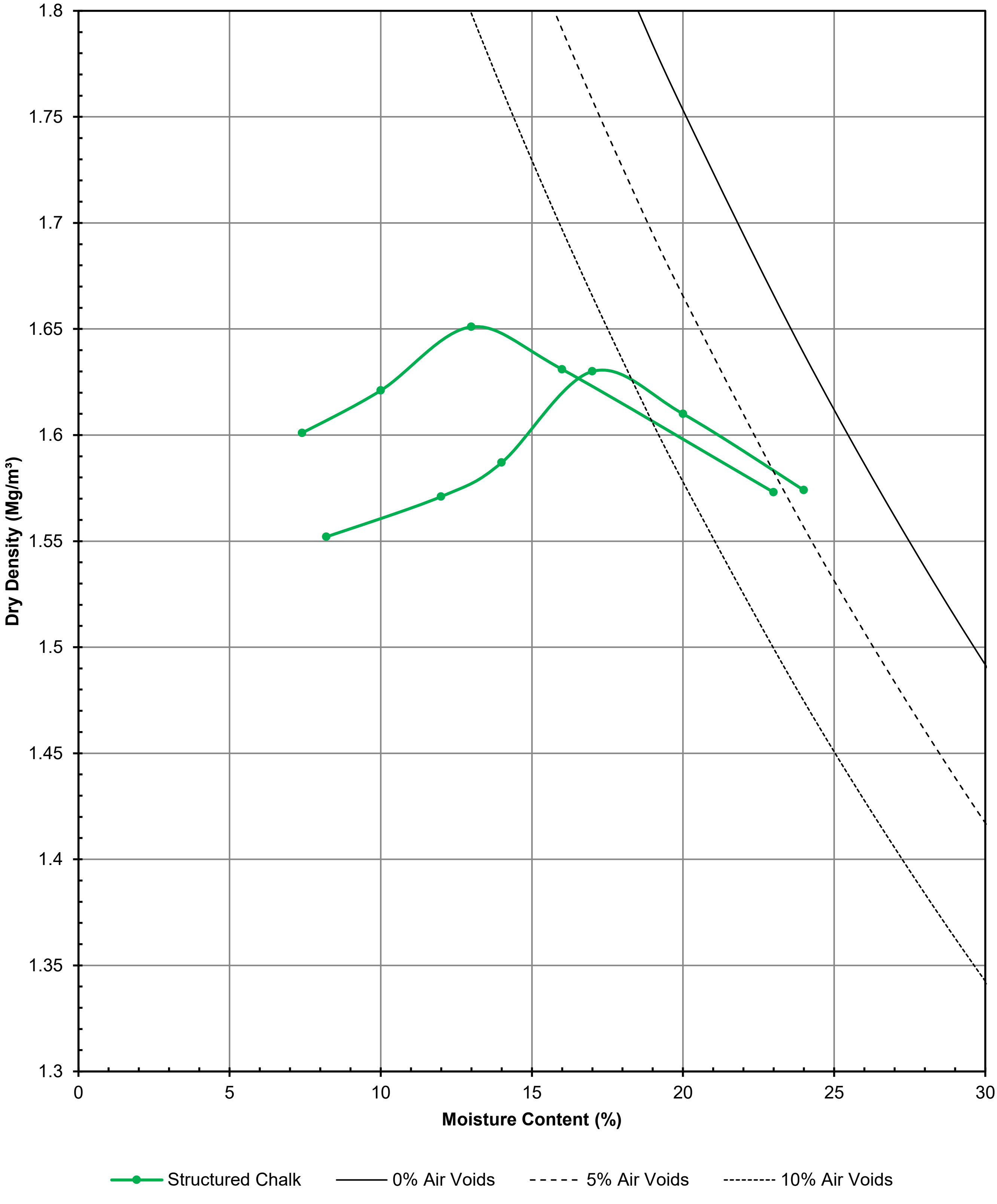
Date	December 2020
A4 Scale	NTS
Drawn	TT
Checked	AD
Figure	5a



Assumed Specific Gravity = 2.7 Mg/m³

Stantec stantec.com © Stantec UK Limited	Client **Highways England & VolkerFitzpatrick**	**M3 Junction 9 Improvements** **MDD vs OMC Relationship - Structureless Chalk**	Date: December 2020 A4 Scale: NTS Drawn: TT Checked: AD Figure: **5b**

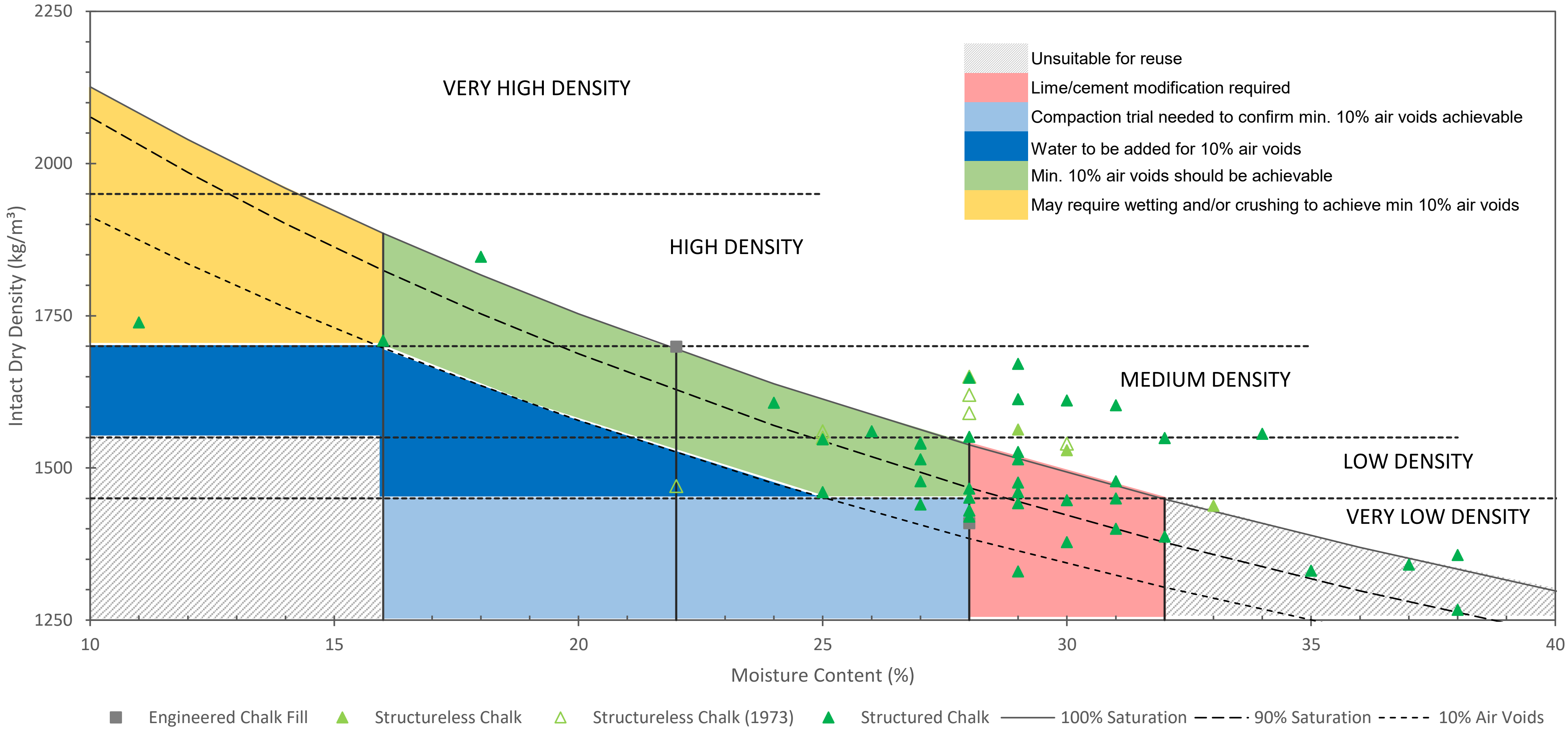
J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\PBA Compaction by Geology edit.xlsm



Assumed Specific Gravity = 2.7 Mg/m³

Stantec stantec.com © Stantec UK Limited	Client **Highways England & VolkerFitzpatrick**	**M3 Junction 9 Improvements** **MDD vs OMC Relationship - Structured Chalk**	Date: December 2020 A4 Scale: NTS Drawn: TT Checked: AD Figure: **5c**

J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\PBA Compaction by Geology edit.xlsm



Chalk Classification for Earthworks based on CIRIA C574

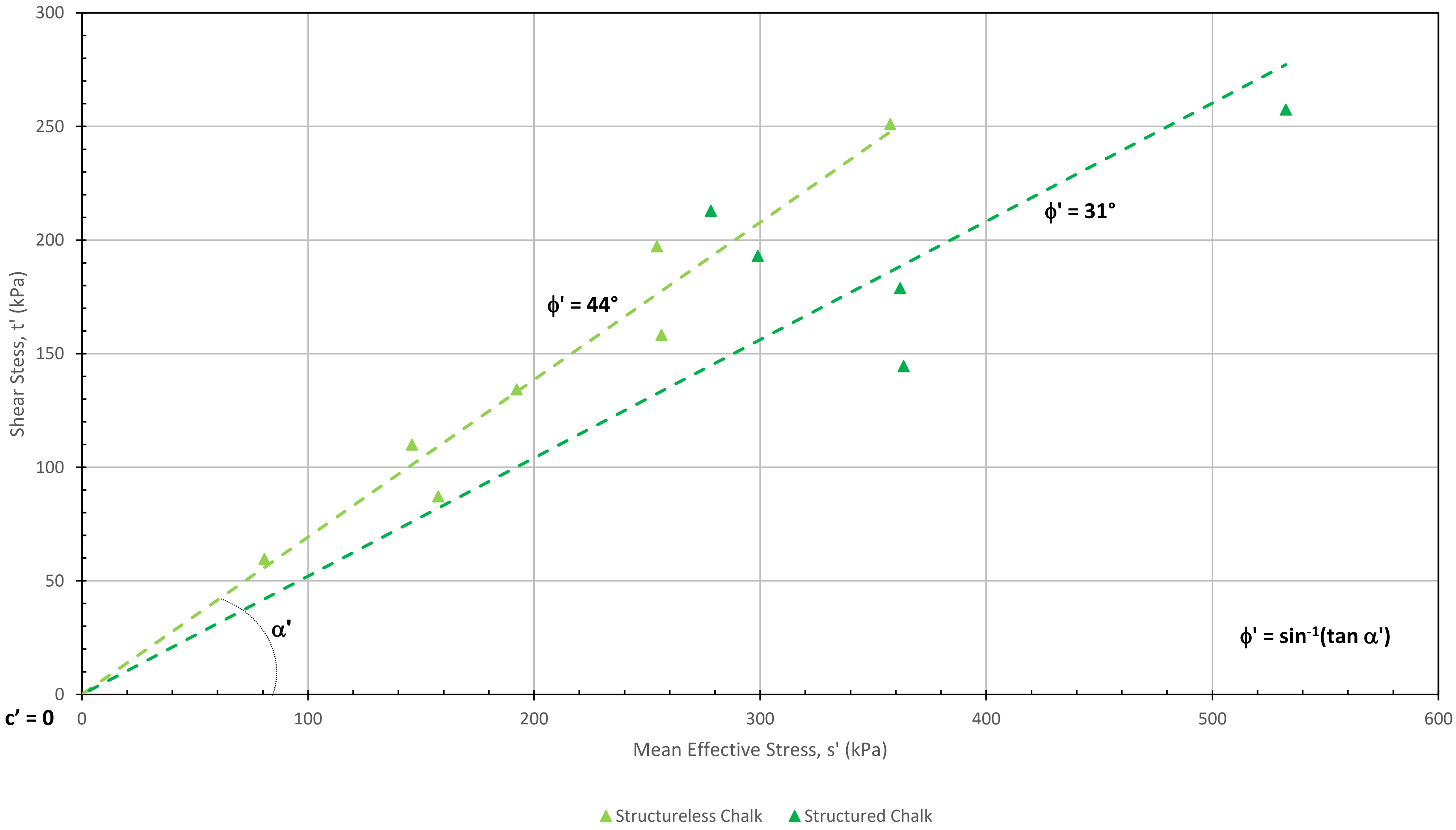
Intact Dry Density plotted against the Moisture Contents provided in the Factual Report.

Saturation and Air Voids lines are based on specific gravity value of 2.70

Points plotted above the 100% saturation line indicate reporting or testing procedure error

Stantec stantec.com/uk © Stantec UK Limited	Client **Highways England and Volkerfitzpatrick**	**M3 Junction 9 Improvements** **Preliminary Earthworks Chalk Classification**	Date: April 2021 A4 Scale: NTS Drawn: AD Checked: RHT Figure: **6**

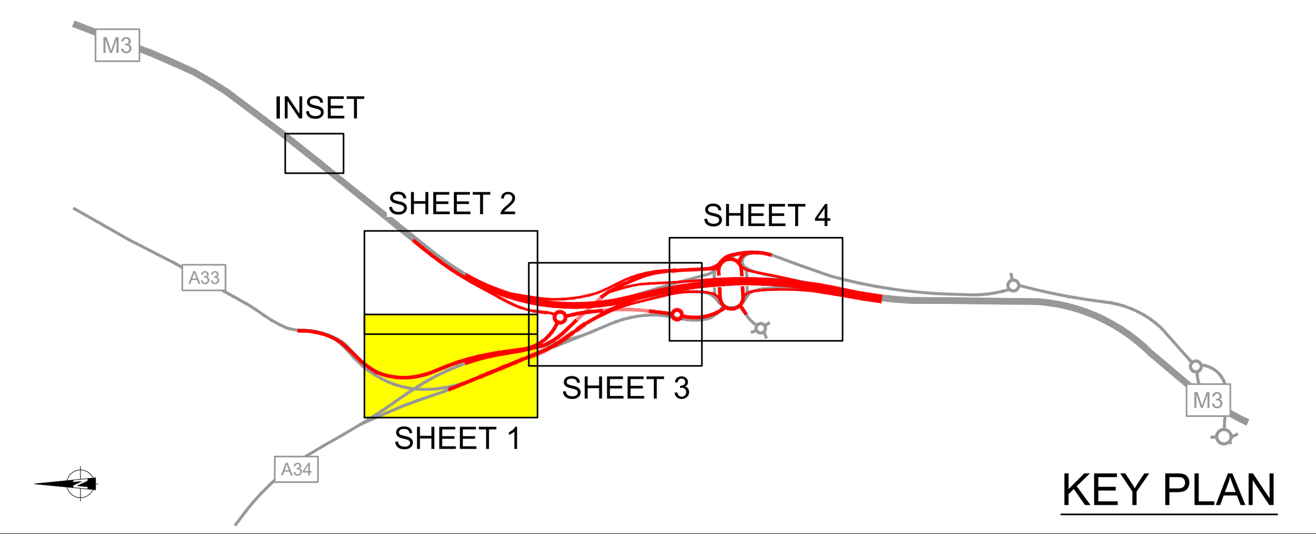
J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\[Rock Density Tests edit.xlsx]A4 LS TT



Stantec	Client		Date	December 2020
stantec.com/uk	**Highways England & Volkerfitzpatrick**	**M3 Junction 9 Improvements**	A4 Scale	NTS
© Stantec UK Limited		**Effective Stress Plot from Consolidated Undrained Triaxial Tests**	Drawn	TT
			Checked	AD
			Figure	**7**

J:\48176 M3 Junction 9\3500 - Geotechnical\04 Data\Geo lab\[Effect Paramteres for Chalk T vs S.xlsx]s vs t

Drawings



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 1 OF 4

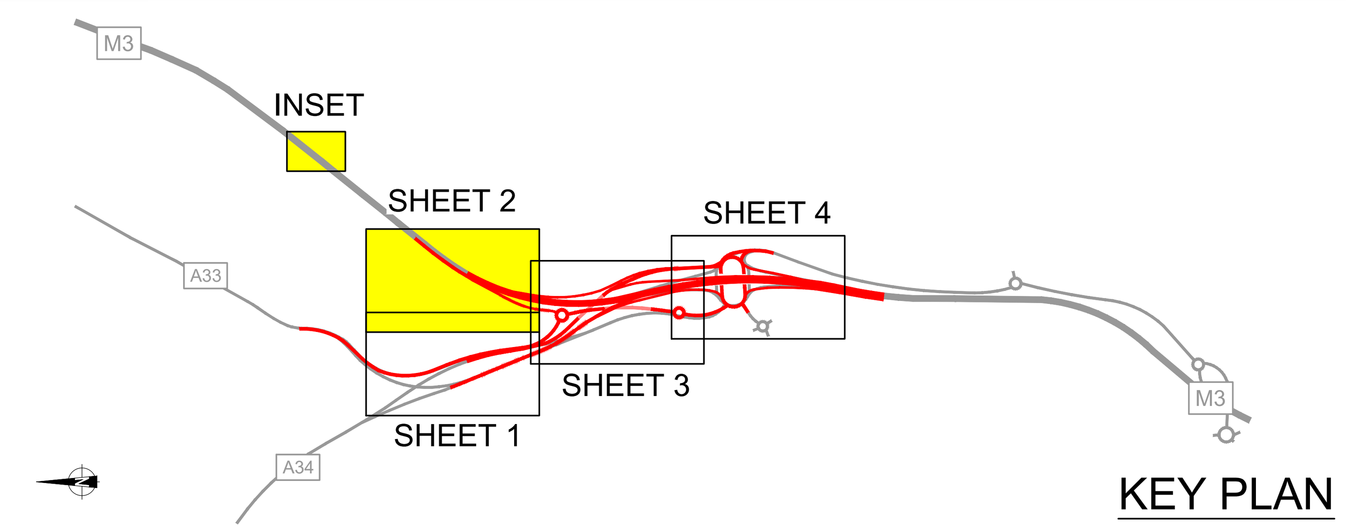
Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size: A1	Date: 05.05.21	Date: 05.05.21	Date: 05.05.21	Date: 06.05.21

Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0001

Project Ref. No.: 48176

Revision: P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 2 OF 4

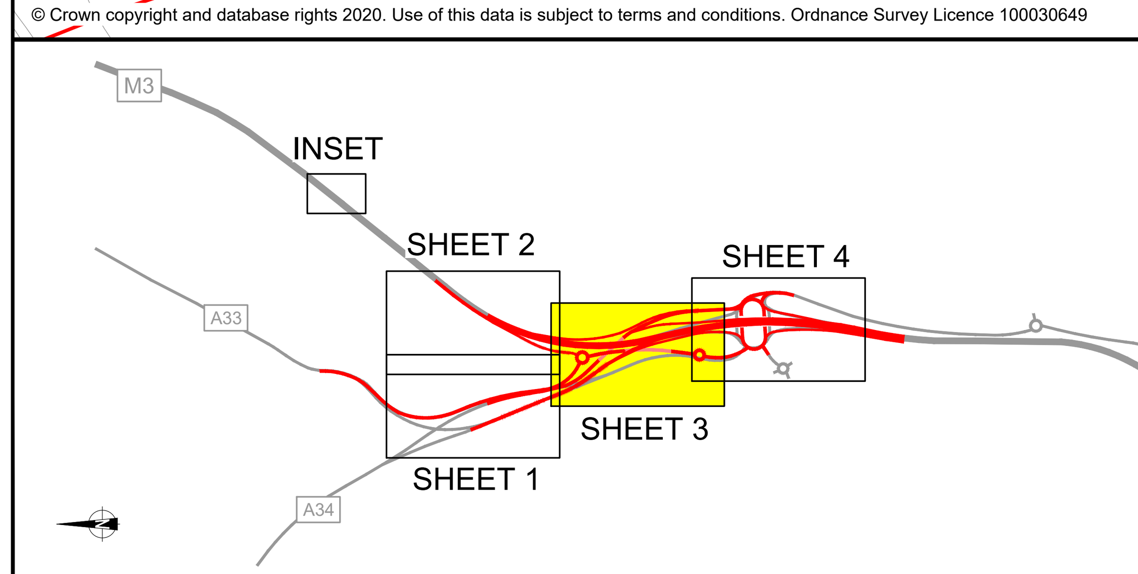
Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size: A1	Date: 05.05.21	Date: 05.05.21	Date: 05.05.21	Date: 06.05.21

Drawing Number: HE PIN / Originator / Volume / Location / Type / Role / Number

HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0002

Project Ref. No.: 48176

Revision: P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

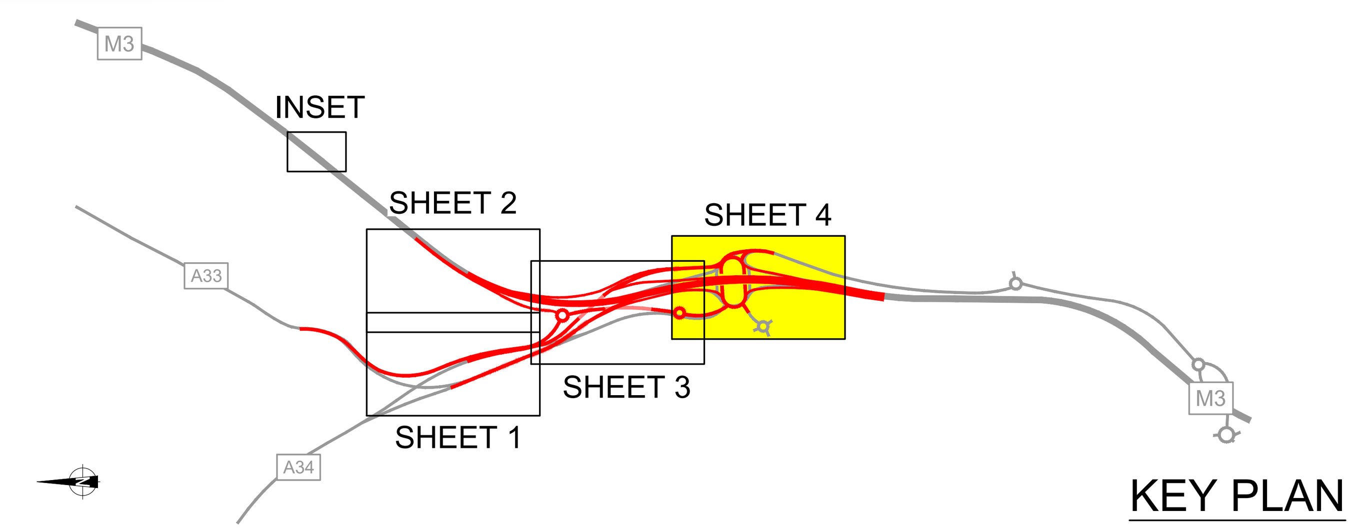
SHEET 3 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size A1	Date 05.05.21	Date 05.05.21	Date 05.05.21	Date 06.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX - DR - GE - 0003 (Location, Type, Role, Number)

Project Ref. No. 48176

Revision P01



KEY PLAN

GDMS HISTORICAL EXPLORATORY HOLES

- TRIAL PIT
- CABLE PERCUSSION BOREHOLE
- WINDOWLESS SAMPLING BOREHOLE

SOILS LIMITED 2019 EXPLORATORY HOLES

- TRIAL PIT
- DYNAMIC SAMPLING WITH ROTARY CORE FOLLOW ON
- WINDOWLESS SAMPLING BOREHOLE

Rev.	Date	Description	Drawn	Chk'd	App'd

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

SHEET 4 OF 4

Scale	Designed	Drawn	Checked	Approved
1:1000	AD	davco	AD	RHT
Original Size A1	Date 05.05.21	Date 05.05.21	Date 05.05.21	Date 06.05.21

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX - Location - DR - Type - GE - Role - 0004 Number

Project Ref. No. 48176

Revision P01

Key

- Made Ground
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL PLAN

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size A1	Date 01.12.20	Date 01.12.20	Date 04.12.20	Date 08.12.20

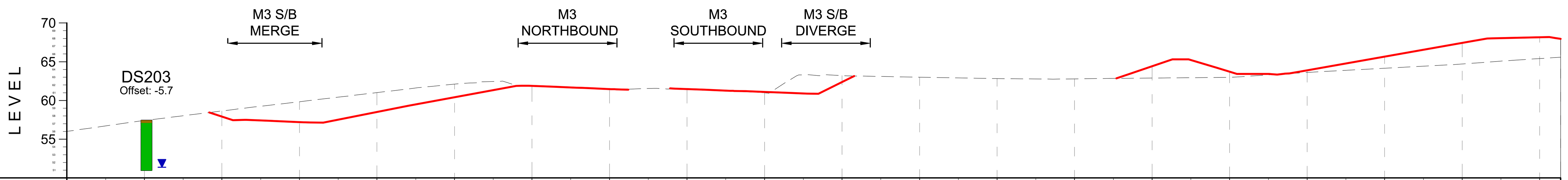
Drawing Number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0020

Project Ref. No. 48176

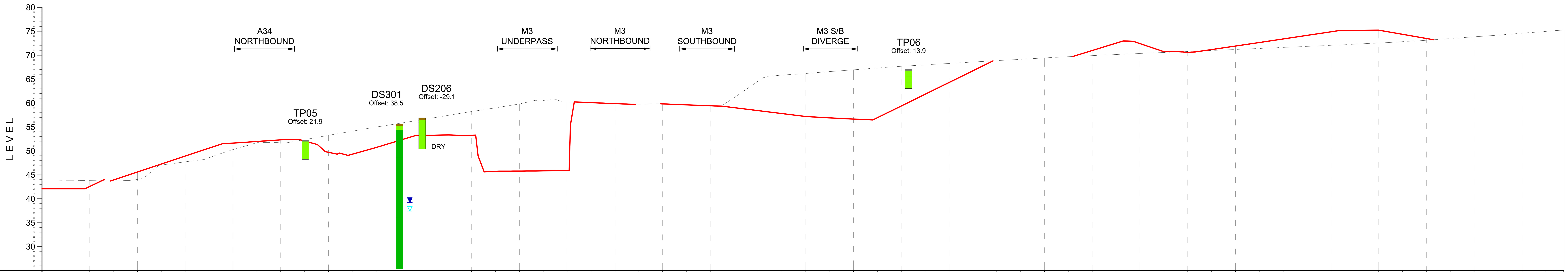
Revision P02

SECTION A
SCALE: Hz 1:500, Vt 1:500



CHAINAGE	EXISTING LEVEL	PROPOSED LEVEL
0.000	56.000	
5.000	56.720	
10.000	57.420	
15.000	58.028	
20.000	58.649	57.918
25.000	59.258	57.423
30.000	59.838	57.211
35.000	60.428	57.525
40.000	61.011	58.519
45.000	61.609	59.499
50.000	62.108	60.416
55.000	62.456	61.333
60.000	61.862	61.889
65.000	61.663	61.682
70.000	61.475	61.474
75.000	61.545	
80.000	61.391	61.472
85.000	61.197	61.274
90.000	60.985	61.100
95.000	63.304	60.903
100.000	63.211	62.374
105.000	63.099	
110.000	63.006	
115.000	62.913	
120.000	62.822	
125.000	62.776	
130.000	62.793	
135.000	62.848	
140.000	62.892	64.417
145.000	62.936	65.225
150.000	62.980	63.714
155.000	63.295	63.423
160.000	63.617	63.888
165.000	63.885	64.771
170.000	64.153	65.654
175.000	64.421	66.539
180.000	64.711	67.423
185.000	65.073	68.037
190.000	65.409	68.161
192.707	65.582	67.947

SECTION B
SCALE: Hz 1:500, Vt 1:500



CHAINAGE	EXISTING LEVEL	PROPOSED LEVEL
0.000	43.881	42.075
5.000	43.863	42.075
10.000	43.802	42.557
15.000	43.707	43.940
20.000	44.052	45.604
25.000	47.040	47.263
30.000	47.711	48.923
35.000	48.574	50.578
40.000	50.275	51.628
45.000	51.708	51.966
50.000	51.643	52.315
55.000	52.357	52.067
60.000	53.251	49.710
65.000	54.127	49.314
70.000	54.986	50.711
75.000	55.771	52.228
80.000	56.586	53.274
85.000	57.413	53.330
90.000	58.226	53.281
95.000	59.002	45.729
100.000	59.819	45.783
105.000	60.540	45.840
110.000	60.261	45.909
115.000	60.086	60.093
120.000	59.892	59.890
125.000	59.803	
130.000	59.820	59.821
135.000	59.626	59.626
140.000	59.433	59.431
145.000	61.151	59.045
150.000	64.566	58.429
155.000	65.855	57.813
160.000	66.183	57.198
165.000	66.576	56.907
170.000	66.955	56.650
175.000	67.333	56.932
180.000	67.682	59.388
185.000	67.987	61.844
190.000	68.282	64.299
195.000	68.573	66.751
200.000	68.861	
205.000	69.147	
210.000	69.432	
215.000	69.689	
220.000	69.923	70.980
225.000	70.146	72.519
230.000	70.368	72.432
235.000	70.576	70.818
240.000	70.777	70.579
245.000	70.992	71.181
250.000	71.202	71.921
255.000	71.413	72.661
260.000	71.631	73.405
265.000	71.853	74.148
270.000	72.074	74.891
275.000	72.301	75.188
280.000	72.554	75.241
285.000	72.831	74.370
290.000	73.126	73.499
295.000	73.485	
300.000	73.844	
305.000	74.202	
310.000	74.594	
315.000	74.979	
318.806	75.271	

Key
- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located NORTH of the section line. Positive offsets are SOUTH of the section. Values are in linear metres

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL CROSS SECTIONS

SHEET 1 OF 3

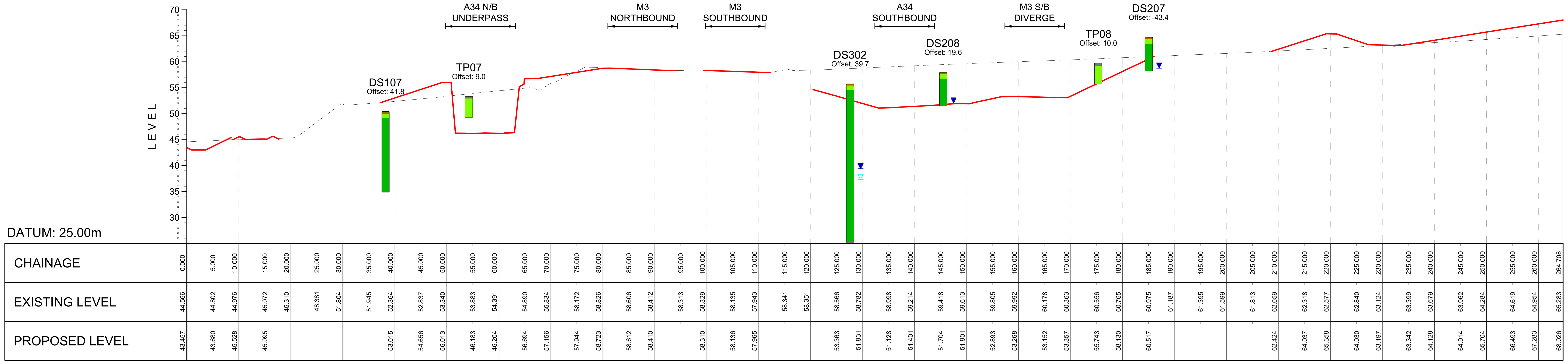
Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20

Drawing Number: HE PIN | Originator | Volume
HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0021
Location | Type | Role | Number

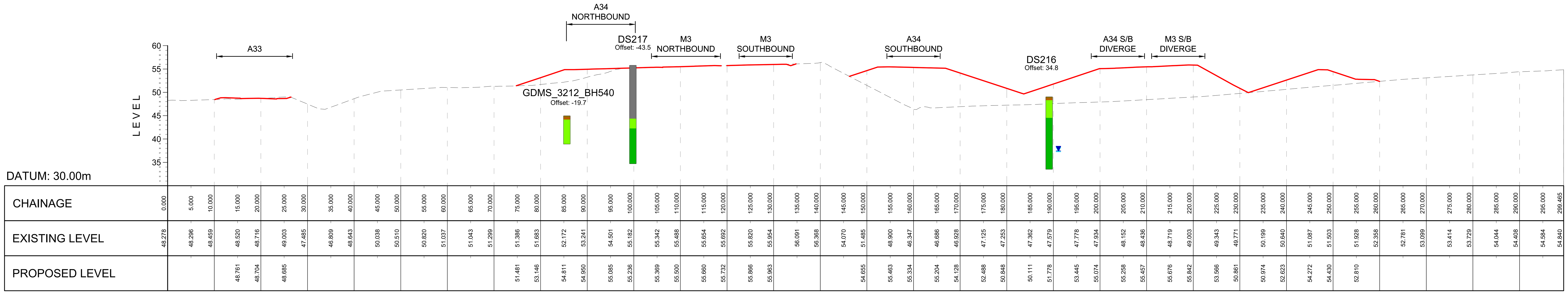
Project Ref. No.: 48176

Revision: P02

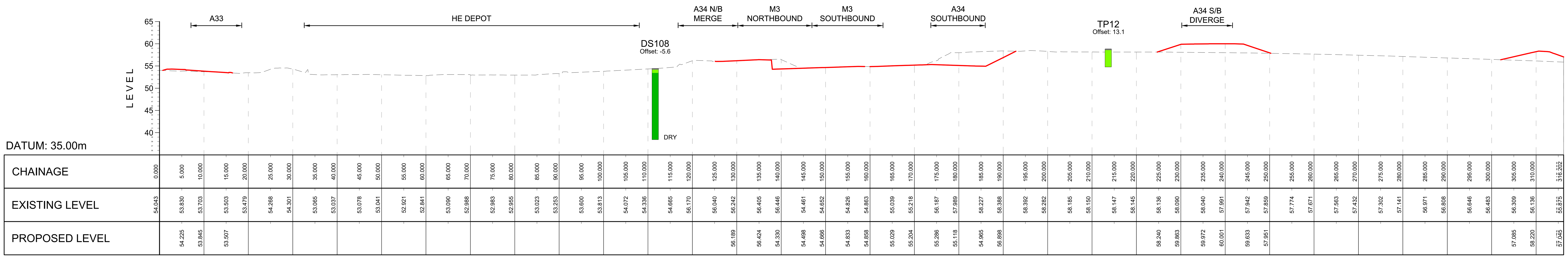
SECTION C
SCALE: Hz 1:500, Vt 1:500



SECTION D
SCALE: Hz 1:500, Vt 1:500



SECTION E
SCALE: Hz 1:500, Vt 1:500



Key

- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located NORTH of the section line. Positive offsets are SOUTH of the section. Values are in linear metres

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL CROSS SECTIONS

SHEET 2 OF 3

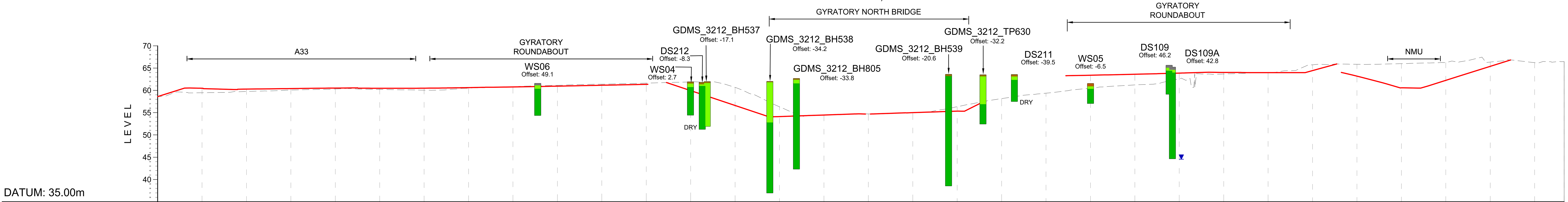
Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20

Drawing Number: HE PIN | Originator | Volume
HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0022
Location | Type | Role | Number

Project Ref. No. 48176

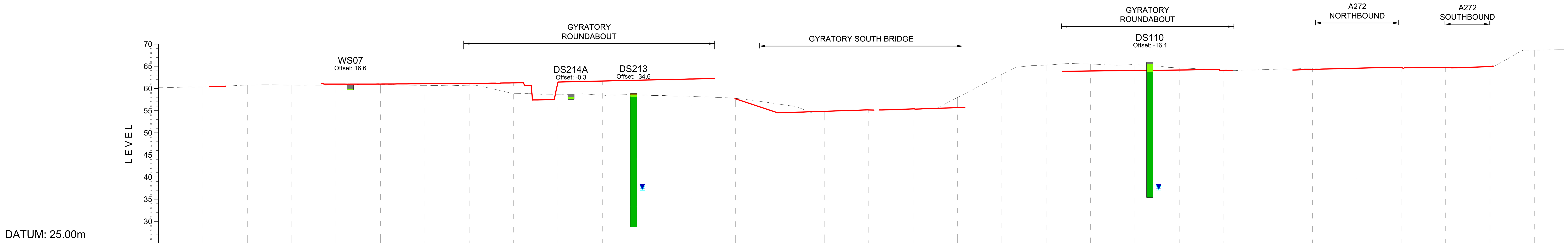
Revision P02

SECTION F
SCALE: Hz 1:500, Vt 1:500



CHAINAGE	EXISTING LEVEL	PROPOSED LEVEL
0.000	58.607	
5.000	59.622	60.180
10.000	59.462	60.469
15.000	59.539	60.253
20.000	59.751	60.281
25.000	59.864	60.344
30.000	60.063	60.404
35.000	60.181	60.460
40.000	60.305	60.516
45.000	60.287	60.562
50.000	60.217	60.469
55.000	60.113	60.459
60.000	60.049	60.489
65.000	60.126	60.539
70.000	60.470	60.615
75.000	60.667	60.703
80.000	60.853	60.768
85.000	61.002	60.851
90.000	61.126	60.948
95.000	61.298	61.049
100.000	61.386	61.150
105.000	61.499	61.250
110.000	61.629	61.351
115.000	61.766	61.604
120.000	61.894	59.937
125.000	61.902	58.271
130.000	60.664	56.604
135.000	58.718	54.937
140.000	56.317	54.118
145.000	54.312	54.291
150.000	54.460	54.463
155.000	54.631	54.636
160.000	54.710	
165.000	54.832	54.843
170.000	54.999	54.998
175.000	55.432	55.173
180.000	56.326	55.348
185.000	57.345	56.994
190.000	58.158	
195.000	58.914	
200.000	59.368	
205.000	59.948	63.295
210.000	60.484	63.399
215.000	60.942	63.504
220.000	61.232	63.613
225.000	61.472	63.736
230.000	62.577	63.871
235.000	63.669	64.014
240.000	63.668	64.017
245.000	63.841	63.994
250.000	63.958	63.974
255.000	64.402	63.980
260.000	65.729	64.434
265.000	65.928	65.797
270.000	65.852	63.188
275.000	65.870	61.899
280.000	65.989	60.568
285.000	66.135	60.697
290.000	66.228	62.250
295.000	66.715	63.819
300.000	66.350	65.382
305.000	66.796	
310.000	66.209	
315.000	66.436	
316.638	66.461	

SECTION G
SCALE: Hz 1:500, Vt 1:500



CHAINAGE	EXISTING LEVEL	PROPOSED LEVEL
0.000	60.175	
5.000	60.261	
10.000	60.363	
15.000	60.430	60.512
20.000	60.794	
25.000	60.830	
30.000	60.748	
35.000	60.743	
40.000	60.758	60.979
45.000	60.866	60.979
50.000	60.905	60.997
55.000	60.761	61.028
60.000	60.685	61.067
65.000	60.633	61.108
70.000	60.712	61.141
75.000	59.974	61.192
80.000	58.884	61.260
85.000	58.776	57.409
90.000	58.594	61.432
95.000	58.790	61.561
100.000	58.514	61.674
105.000	58.600	61.788
110.000	58.485	61.901
115.000	58.331	62.014
120.000	58.220	62.128
125.000	58.011	62.241
130.000	57.755	57.672
135.000	57.158	56.006
140.000	56.436	54.524
145.000	55.377	54.679
150.000	54.810	54.842
155.000	55.004	55.006
160.000	55.174	55.152
165.000	55.183	55.214
170.000	55.350	55.387
175.000	55.413	55.495
180.000	57.953	55.669
185.000	60.542	
190.000	63.163	
195.000	64.966	
200.000	65.277	
205.000	65.624	63.883
210.000	65.501	63.939
215.000	65.278	63.987
220.000	65.351	64.029
225.000	65.084	64.084
230.000	64.645	64.154
235.000	64.417	64.234
240.000	64.068	64.063
245.000	64.119	
250.000	64.283	
255.000	64.408	
260.000	64.560	64.297
265.000	64.641	64.441
270.000	64.637	64.575
275.000	64.647	64.696
280.000	64.648	64.717
285.000	64.649	64.724
290.000	64.652	64.765
295.000	64.749	64.762
300.000	64.964	64.966
305.000	67.292	
310.000	68.620	
315.000	68.748	
316.702	68.748	

Key
- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located NORTH of the section line. Positive offsets are SOUTH of the section. Values are in linear metres

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL CROSS SECTIONS

SHEET 3 OF 3

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20

Drawing Number: HE PIN / Originator / Volume / Location / Type / Role / Number

HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0023

Project Ref. No.: 48176

Revision: P02

A34 SOUTHBOUND
SCALE: Hz 1:500, Vt 1:500

Key
- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located EAST of the section line. Positive offsets are WEST of the section. Values are in linear metres.

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL LONG-SECTIONS A34 SOUTHBOUND

SHEET 1 OF 4

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT

Original Size	Date	Date	Date	Date
A1	01.12.20	01.12.20	01.12.20	02.12.20

Drawing Number: HE PIN | Originator | Volume
HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0031
Location | Type | Role | Number

Project Ref. No. 48176

Revision P02

A34 NORTHBOUND
SCALE: Hz 1:500, Vt 1:500

Key

- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located EAST of the section line. Positive offsets are WEST of the section. Values are in linear metres.

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL LONG-SECTIONS A34 NORTHBOUND

SHEET 2 OF 4

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size A1	Date 01.12.20	Date 01.12.20	Date 01.12.20	Date 02.12.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - X_XXXX_XX - Location DR - Type GE - Role 0032 Number

Project Ref. No. 48176

Revision P02

Key

- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located EAST of the section line. Positive offsets are WEST of the section. Values are in linear metres.

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL LONG-SECTIONS A33

SHEET 3 OF 4

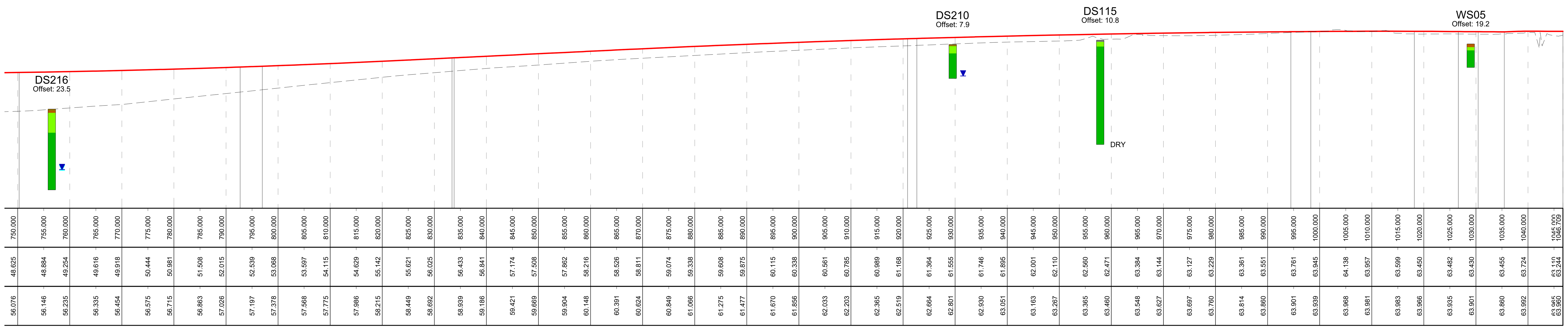
Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20

Drawing Number: HE PIN / Originator / Volume / Location / Type / Role / Number
HE551511 - VFK - HGT - X_XXXX_XX - DR - GE - 0033

Project Ref. No.: 48176

Revision: P02

M3 SB DIVERGE
SCALE: Hz 1:500, Vt 1:500



Key
- Made Ground
- Topsoil
- Peat
- Alluvium
- Head
- Structureless Chalk (Grade Dm and Dc)
- Structured Chalk (Grade A to C)
- Maximum Recorded Groundwater Level
- Minimum Recorded Groundwater Level
- Existing Ground Level
- Proposed Ground Level

Note: Exploratory holes with negative offset values are located EAST of the section line. Positive offsets are WEST of the section. Values are in linear metres.

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	05.05.21	INCORPORATING HE COMMENTS	davco	AD	RHT

Drawing Status: FOR SGAR 3B

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GEOLOGICAL LONG-SECTIONS M3 SOUTHBOUND DIVERGE

SHEET 4 OF 4

Scale	Designed	Drawn	Checked	Approved
1:2500	AD	davco	AD	RHT
Original Size: A1	Date: 01.12.20	Date: 01.12.20	Date: 01.12.20	Date: 02.12.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HGT - Location X_XXXX_XX - Type DR - Role GE - Number 0034

Project Ref. No. 48176

Revision P02

KEY

- 45 — PROPOSED MAJOR CONTOURS (1m INTERVALS)
- PROPOSED MINOR CONTOURS (0.25m INTERVALS)
- EXISTING MAJOR CONTOURS (5m INTERVALS)
- EXISTING MINOR CONTOURS (1m INTERVALS)
- 1:3.0 — SLOPE GRADIENT

NOTES

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS AND DOCUMENTS
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS VOLUME 1 AND CONTRACT SPECIFIC APPENDICES
4. THE CONTRACTOR SHALL VALIDATE THE ACCURACY OF THE TOPOGRAPHIC SURVEY PRIOR TO WORKS COMMENCING

0 20 40 60 80 100m

SCALE 1:1000

Rev.	Date	Description	Drawn	Chk'd	App'd
P01					

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: PROPOSED CONTOURS AT 0.25 AND 1m INTERVALS

SHEET 1 OF 5

Scale	Designed	Drawn	Checked	Approved
1:1000	GP	GP	AC	TRA
Original Size A1	Date 21.04.21	Date 21.04.21	Date 21.04.21	Date 21.04.21

Drawing Number: HE551511 - VFK - HGN - X_XXXX_XX - DR - CH - 0051

Project Ref. No. 48176

Revision P01

KEY

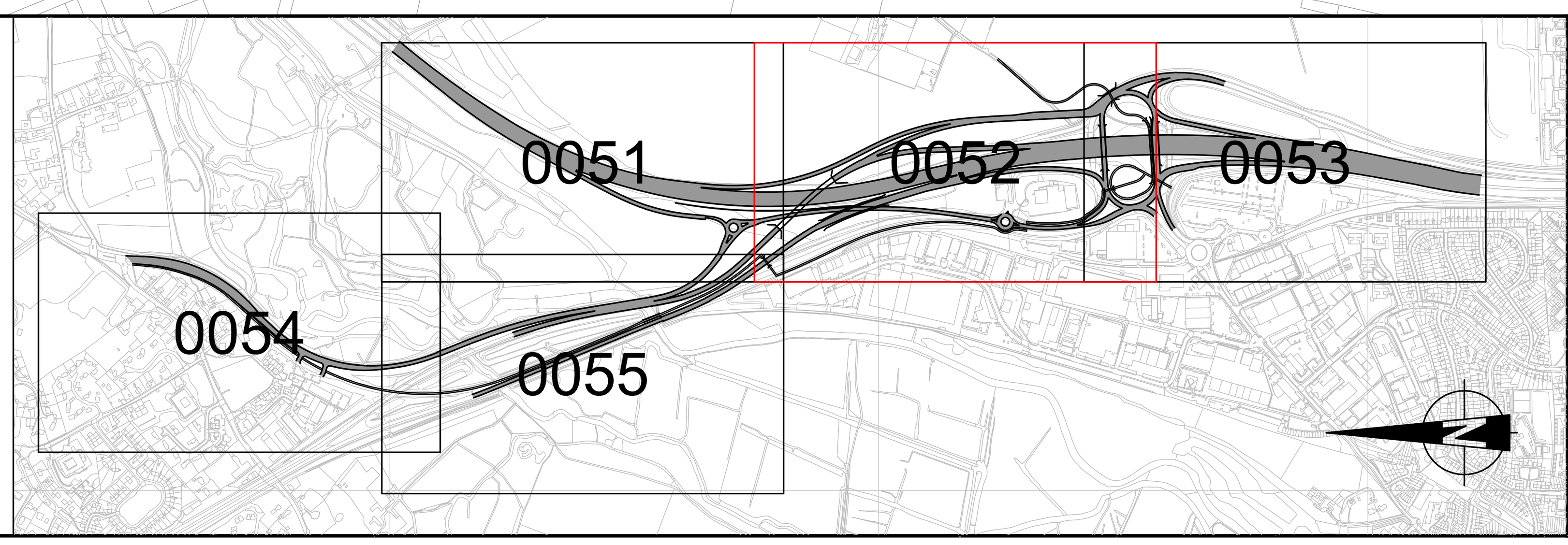
- 45 — PROPOSED MAJOR CONTOURS (1m INTERVALS)
- PROPOSED MINOR CONTOURS (0.25m INTERVALS)
- EXISTING MAJOR CONTOURS (5m INTERVALS)
- EXISTING MINOR CONTOURS (1m INTERVALS)
- 1:3.0 SLOPE GRADIENT

NOTES

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS AND DOCUMENTS
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS VOLUME 1 AND CONTRACT SPECIFIC APPENDICES
4. THE CONTRACTOR SHALL VALIDATE THE ACCURACY OF THE TOPOGRAPHIC SURVEY PRIOR TO WORKS COMMENCING

0 20 40 60 80 100m

SCALE 1:1000



Rev.	Date	Description	Drawn	Chk'd	App'd
P01					

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: PROPOSED CONTOURS AT 0.25 AND 1m INTERVALS

SHEET 2 OF 5

Scale	Designed	Drawn	Checked	Approved
1:1000	GP	GP	AC	TRA
Original Size A1	Date 21.04.21	Date 21.04.21	Date 21.04.21	Date 21.04.21

Drawing Number: HE PIN HE551511 | Originator VFK | Volume HGN | X_XXXX_XX (Location) | DR (Type) | CH (Role) | 0052 (Number)

Project Ref. No. 48176

Revision P01

KEY

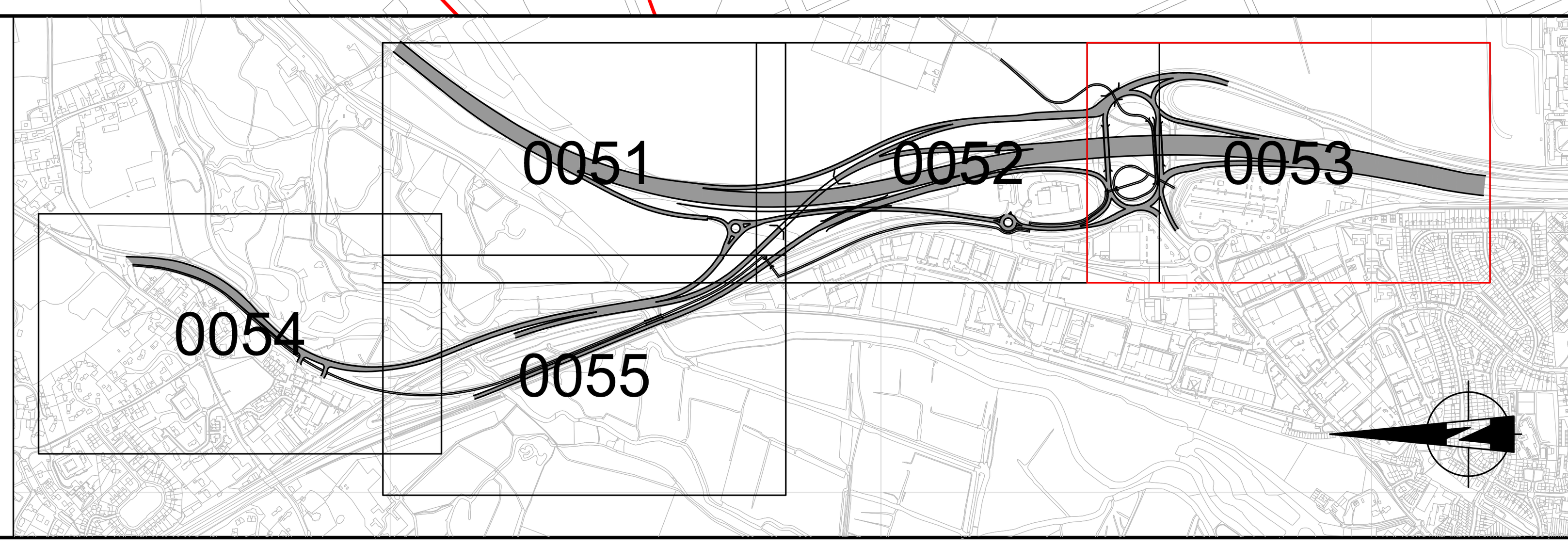
- 45 PROPOSED MAJOR CONTOURS (1m INTERVALS)
- PROPOSED MINOR CONTOURS (0.25m INTERVALS)
- EXISTING MAJOR CONTOURS (5m INTERVALS)
- EXISTING MINOR CONTOURS (1m INTERVALS)
- 1:3.0 SLOPE GRADIENT

NOTES

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS AND DOCUMENTS
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS VOLUME 1 AND CONTRACT SPECIFIC APPENDICES
4. THE CONTRACTOR SHALL VALIDATE THE ACCURACY OF THE TOPOGRAPHIC SURVEY PRIOR TO WORKS COMMENCING

0 20 40 60 80 100m

SCALE 1:1000



Rev.	Date	Description	Drawn	Chk'd	App'd
P01					

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: PROPOSED CONTOURS AT 0.25 AND 1m INTERVALS

SHEET 3 OF 5

Scale	Designed	Drawn	Checked	Approved
1:1000	GP	GP	AC	TRA
Original Size A1	Date 21.04.21	Date 21.04.21	Date 21.04.21	Date 21.04.21

Drawing Number: HE PIN HE551511 | Originator VFK | Volume HGN | Location X_XXXX_XX | Type DR | Role CH | Number 0053

Project Ref. No. 48176

Revision P01

KEY

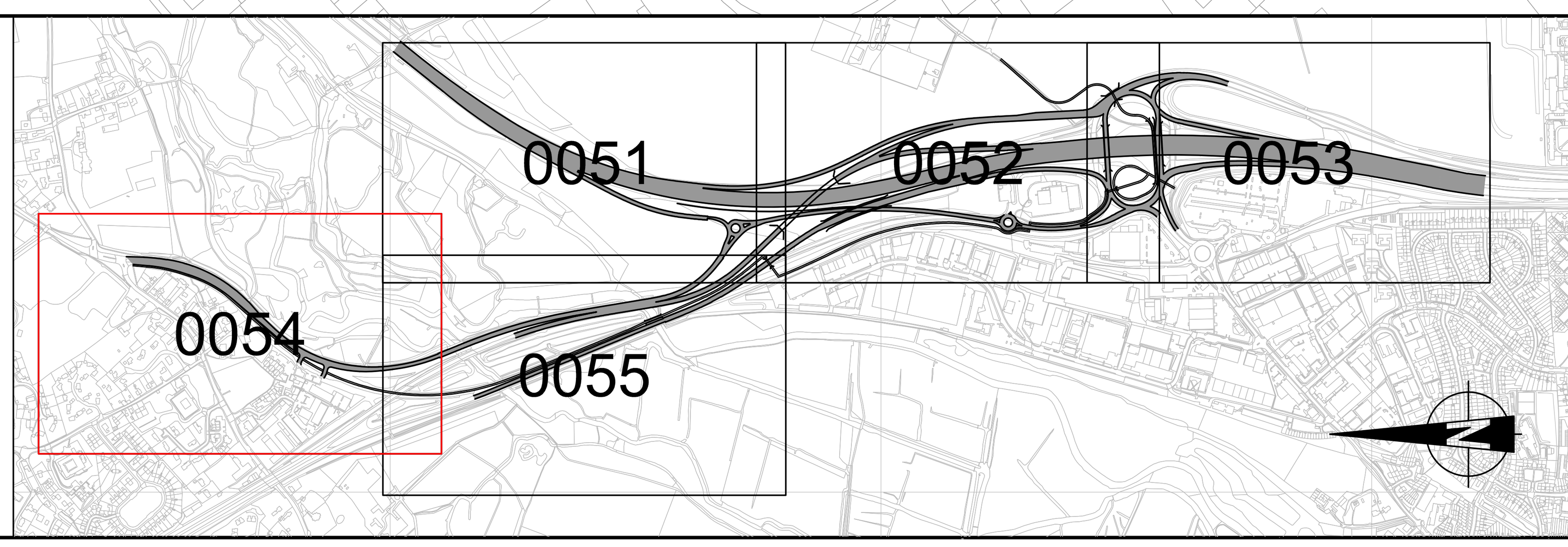
- 45 PROPOSED MAJOR CONTOURS (1m INTERVALS)
- PROPOSED MINOR CONTOURS (0.25m INTERVALS)
- EXISTING MAJOR CONTOURS (5m INTERVALS)
- EXISTING MINOR CONTOURS (1m INTERVALS)
- 1:3.0 SLOPE GRADIENT

NOTES

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS AND DOCUMENTS
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS VOLUME 1 AND CONTRACT SPECIFIC APPENDICES
4. THE CONTRACTOR SHALL VALIDATE THE ACCURACY OF THE TOPOGRAPHIC SURVEY PRIOR TO WORKS COMMENCING

0 20 40 60 80 100m

SCALE 1:1000



Rev.	Date	Description	Drawn	Chk'd	App'd
P01					

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: PROPOSED CONTOURS AT 0.25 AND 1m INTERVALS

SHEET 4 OF 5

Scale	Designed	Drawn	Checked	Approved
1:1000	GP	GP	AC	TRA
Original Size A1	Date 21.04.21	Date 21.04.21	Date 21.04.21	Date 21.04.21

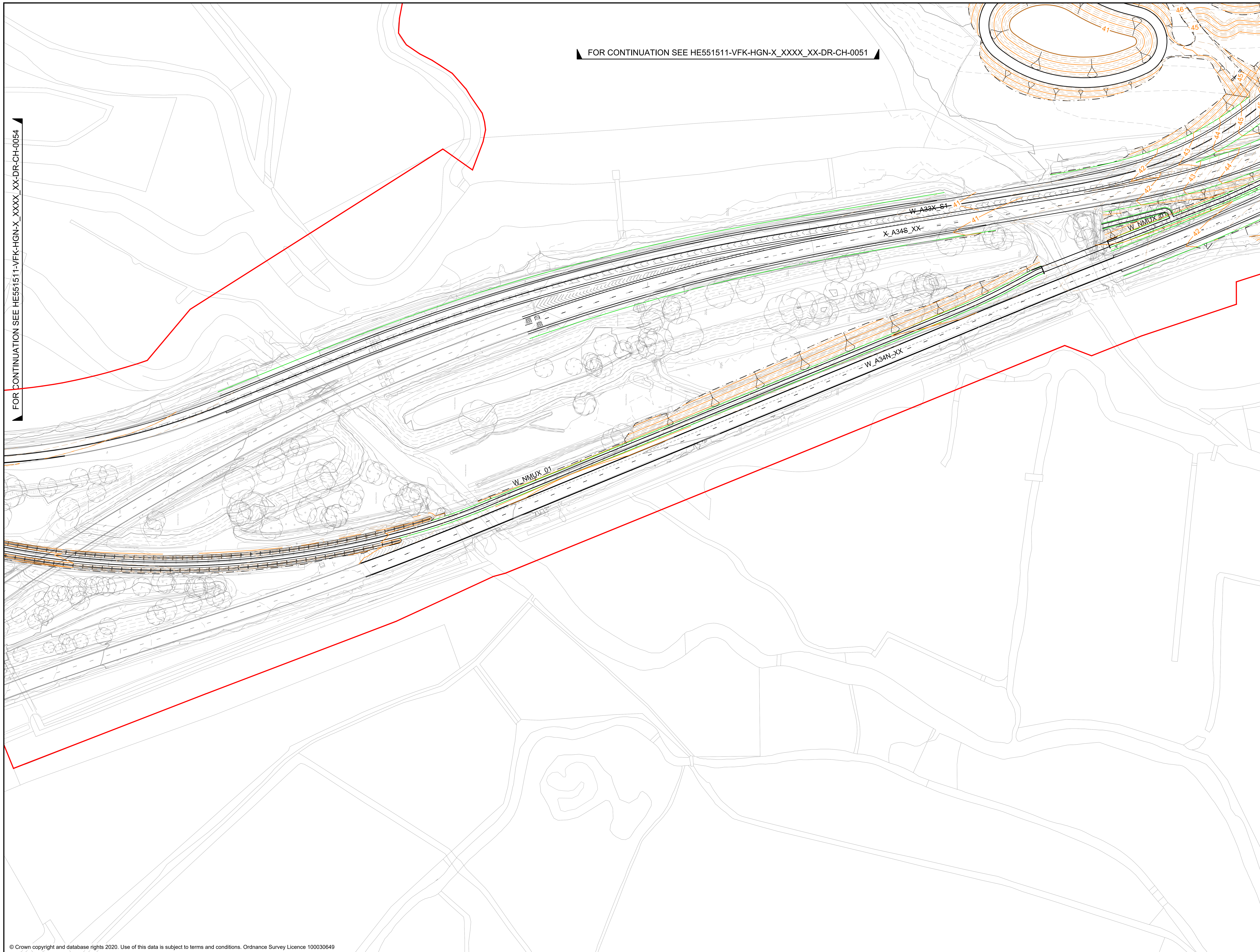
Drawing Number: HE PIN HE551511 | Originator VFK | Volume HGN | Location X_XXXX_XX | Type DR | Role CH | Number 0054

Project Ref. No. 48176

Revision P01

FOR CONTINUATION SEE HE551511-VFK-HGN-X_XXXX_XX-DR-CH-0051

FOR CONTINUATION SEE HE551511-VFK-HGN-X_XXXX_XX-DR-CH-0054



KEY

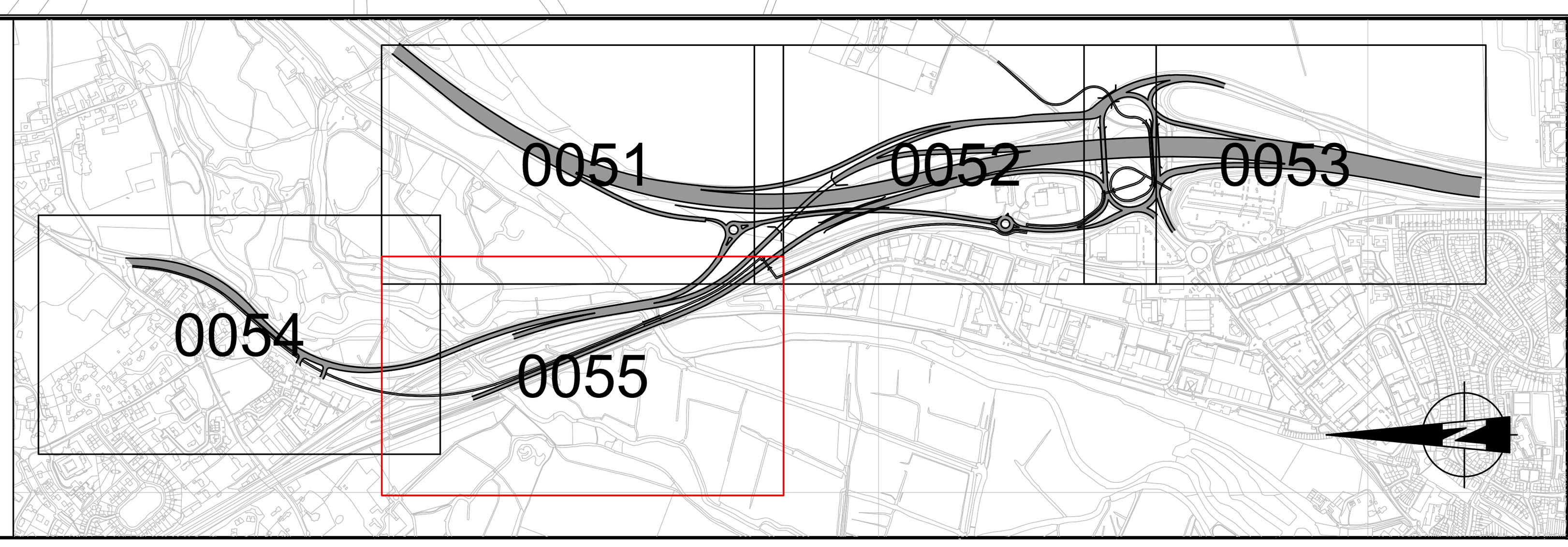
- 45 — PROPOSED MAJOR CONTOURS (1m INTERVALS)
- PROPOSED MINOR CONTOURS (0.25m INTERVALS)
- EXISTING MAJOR CONTOURS (5m INTERVALS)
- EXISTING MINOR CONTOURS (1m INTERVALS)
- 1:3.0 — SLOPE GRADIENT

NOTES

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS AND DOCUMENTS
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS VOLUME 1 AND CONTRACT SPECIFIC APPENDICES
4. THE CONTRACTOR SHALL VALIDATE THE ACCURACY OF THE TOPOGRAPHIC SURVEY PRIOR TO WORKS COMMENCING

0 20 40 60 80 100m

SCALE 1:1000



Rev.	Date	Description	Drawn	Chk'd	App'd
P01					

Drawing Status: S2 - FOR INFORMATION

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: PROPOSED CONTOURS AT 0.25 AND 1m INTERVALS

SHEET 5 OF 5

VolkerFitzpatrick

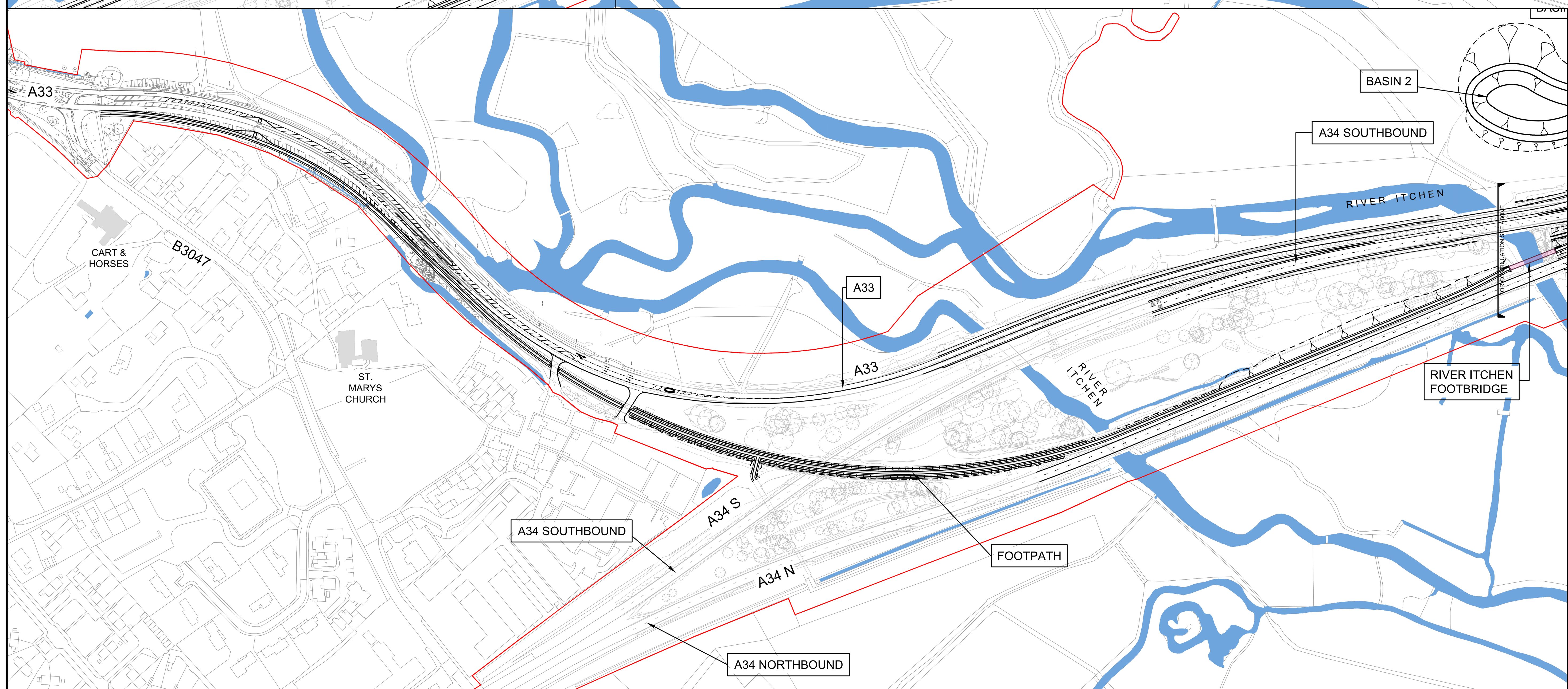
Client: highways england

Scale	Designed	Drawn	Checked	Approved
1:1000	GP	GP	AC	TRA
Original Size A1	Date 21.04.21	Date 21.04.21	Date 21.04.21	Date 21.04.21

Drawing Number: HE PIN HE551511 | Originator VFK | Volume HGN | X_XXXX_XX (Location) | DR (Type) | CH (Role) | 0055 (Number)

Project Ref. No. 48176

Revision P01



KEY:

- PROPOSED UNDERPASS/SUBWAY
- PROPOSED BRIDGE
- INDICATIVE APPLICATION BOUNDARY

0 50 100 150 200 250m

SCALE 1:2500

NOTES:

1. THIS DRAWING SHOULD BE PRINTED IN COLOUR.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER CONTRACT DRAWINGS AND DOCUMENTS.
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS VOLUME 1 AND CONTRACT SPECIFIC APPENDICES.

CONFIDENTIAL

THIS DRAWING IS FOR INFORMATION ONLY AND REPRESENTS CURRENT DESIGN DEVELOPMENT. THIS DRAWING SHALL BE USED FOR THE PURPOSE SUPPLIED AND SHALL BE CONSIDERED CONFIDENTIAL AND NOT DISCLOSED TO THIRD PARTIES OR PERSONS NOT INVOLVED WITH THIS PROJECT.

Rev.	Date	Description	Drawn	Chk'd	App'd
P02	06.05.21	LAYOUT & LABELS UPDATED	RR	AC	TRA
P01	13.11.20	FIRST ISSUE	ME	AC	TRA

Drawing Status: S2 - FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: GENERAL OVERVIEW LAYOUT

Scale	Designed	Drawn	Checked	Approved
1:2500	N/A	ME	AC	TRA
Original Size: A1	Date: -	Date: 13.11.20	Date: 13.11.20	Date: 13.11.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume HML - Location X_XXXX_XX - Type DR - Role CH - Number 0101

Project Ref. No.: 48176

Revision: P02

STAGE 3A: 5 No. MOTORWAY SIGNAL MARK 4 (MS4), 1 No. PORTAL GANTRY AND 1No. LONG SPAN CANTILEVER GANTRY

STAGE 3B: (TBC) 5 No. MOTORWAY SIGNAL MARK 4 (MS4), 1 No. CANTILEVER GANTRY, 1 No. CANTILEVER GANTRY

KEY

- EXISTING STRUCTURE RETAINED (blue)
- EXISTING STRUCTURE TO BE REMOVED (green)
- PROPOSED STRUCTURE (red)

Rev.	Date	Description	Drawn	Chk'd	App'd
P04	16.02.21	FOR INFORMATION	GCP	JAS	JWS
P03	01.12.20	PRELIMINARY DESIGN INFORMATION UPDATED	GCP	JAS	JWS
P02	13.11.20	PRELIMINARY DESIGN INFORMATION ADDED	AJA	JAS	JWS
P01	15.10.20	FOR DISCUSSION	GCP	JAS	JWS

Drawing Status: FOR INFORMATION

VolkerFitzpatrick

Client: highways england

Project Title: M3 JUNCTION 9 IMPROVEMENTS

Drawing Title: STAGE 3B STRUCTURES GENERAL ARRANGEMENT

Scale	Designed	Drawn	Checked	Approved
1:2500	GCP	GCP	JAS	JWS
Original Size: A1	Date: 14.10.20	Date: 14.10.20	Date: 15.10.20	Date: 15.10.20

Drawing Number: HE PIN HE551511 - Originator VFK - Volume SGN - Location X_XXXX_XX - Type DR - Role CB - Number 0100

Project Ref. No.: 48176

Revision: P04