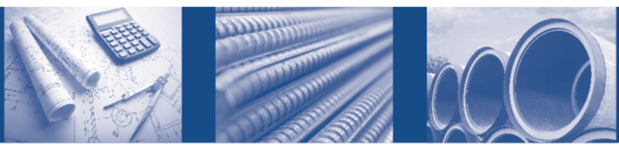
OXFORD ROAD,
BODICOTE
OXON

FLOOD RISK ASSESSMENT & DRAINAGE ADDENDUM REPORT

CREST NICHOLSON MIDLANDS

Date:	20th July 2018
Ref:	AMc/18/0480/**5692**
Rev:	**A**



DOCUMENT CONTROL RECORD

Document Issue:

Rev	Date	Issue Status	Prepared by	Checked by
-	20.07.18	First Issue for comment	C.Pendle	A.McShane
A	03.10.18	Updated following OCC comments	C.Pendle	A.McShane

Notes:

This document has been revised and updated in response to Oxfordhire County Council's objection to the surface water drainage proposals.

This report includes the geotechnical update by Hydrock Consulting, development drainage calculations as well as the preliminary SUDs / drainage maintenance & management plan.

CONTENTS

Page

APPENDICES

REFERENCES

Technical Guidance to the National Planning Policy Framework - NPPF (2012)
Department for Communities and Local Government ISBN: 978-1-4098-3410-6

Contains British Geological Survey materials © NERC (2018)

The SuDS Manual CIRIA C753, London, 2015

CIRIA Report 156 Infiltration drainage – Manual of good practice

1 Introduction

1.1 Scope

Crest Nichlson Midlands are seeking to clear Reserved Matters planning consent for the residential development of 95 units with associated infrastructure and open space.

1.2 MJA Consulting has been appointed to provide an updated Flood Risk Assessment & drainage strategy for the development as part of the planning permission. This report should be read in conjunction with the Flood Risk Assessment produced by Forge Engineerng Design Solutions, Ref: FEDS-214026 approved at outline planning, the Ground Investigation report provided by Hydrock Ref: BDC-HYD-GI-RP-GE-00001, dated April 2017. This statement should also be read with the Flood Risk Assessment undertaken Banners Gate Ltd for the adjacent Cala Homes Development.

1.3 The following report confirms the potential flood risks associated with the site and to provide an updated and suitable strategy for the disposal of surface and foul water based on the current information.

1.4 Report Structure

The National Planning Policy Framework (NPPF) and the Flood Risk and Coastal Planning Practice Guidance (PPG) is the current guidance on development and flood risk in England and Wales.

1.5 This report will take the structure of a 'Flood Risk Assessment' in accordance with the National Planning Policy Framework, the Flood Risk and Coastal Planning Practice Guidance, Environment Agency's Flood Risk Assessment Guidance and CIRIA Report 624 'Development and Flood Risk.

1.6 The objective of this report is:

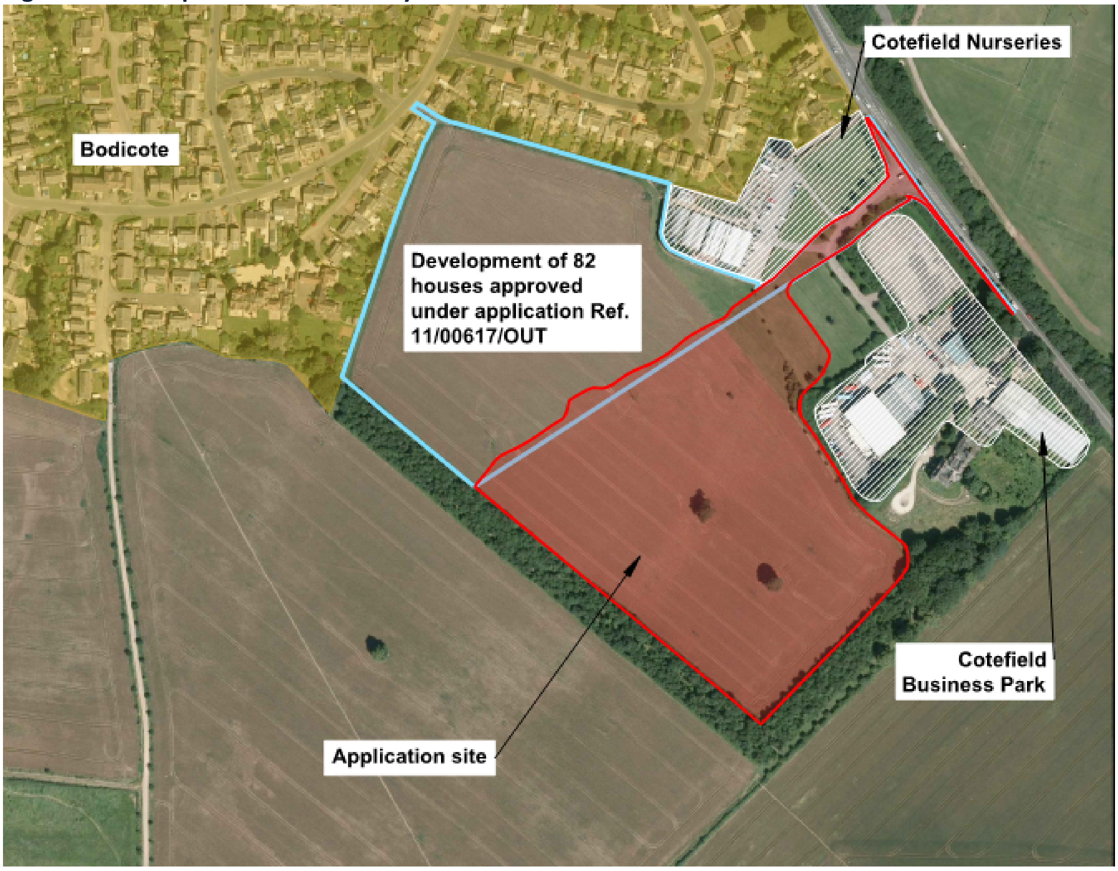
- To confirm whether the proposed development site is affected by current or anticipated future flooding from all sources for the lifetime of the site.
- To confirm that this development will not increase the risk of flooding to any offsite properties and land or increase the population within a floodplain.
- To undertake calculations to establish the foul and surface water runoff rates from the existing site and to assess the potential foul and surface water runoff from the proposed development.
- To detail a suitable strategy for the management of foul and surface water generated from the proposed development allowing for future climate change.
- To satisfy the approving planning authority that the most sustainable foul and surface water drainage solutions have been considered, in line with Environment Agency guidance, The Building Regulations (Document H 2002) and government legislation such as the Flood and Water Management Act 2010 (Defra) and The National Planning Policy Framework (NPPF & PPG).

2 The Development Site

2.1 Site Location and Description

The application site covers an area of approximately 4.5ha, and is located to the west of the A4260 Oxford Road. north west of the A4094 & River Wye. The site is bounded by other new and existing residential dwellings to the north, commercial properties to the north east and east, and agricultural land to the south east, south and south west.

Figure 1: Development site boundary



2.2 Topography

The site is located in a natural valley, with levels ranging from 114.130m to 102.27m AOD with the valley floor sloping down towards the south western boundary. The steepest gradients are in the southwestern part of the site, either side of the valley feature,
up to approximately 1 in 10.

2.3 Geology

The site is indicated by the BGS mapping (Sheet 218 and the mapping portal) to be underlain by Marlstone Rock Formation, comprising sandy, shelly and ooidal ferruginous limestone interbedded with ferruginous calcareous sandstone, and generally subordinate ferruginous mudstone.

The ground conditions found during the original and current investigation are in general accordance with the published geological literature.

Sub strata summary:

	Summary Description	Depth to Top (m bgl)	Thickness (m)
Topsoil	Soft dark brown sandy gravelly clay and clayey gravelly sand with rootlets	0	0.20 – 0.35
Head Deposits (southwest area of site on lower slopes)	Stiff greenish grey mottled orange silty sandy gravelly clay	0.30	>1.50 - >2.40
	Orange brown clayey gravelly sand		
	Soft blue grey / purple gravelly clay / silt		
Marlstone Rock Formation	Firm to stiff orange brown to greenish grey silty sandy gravelly CLAY, with fine to coarse angular to rounded gravel of limestone and ironstone.	0.20 - 0.30	0.50 - >2.80
	Orange brown clayey silty gravelly sand with limestone and ironstone gravel.		
	Moderately strong fractured grey brown limestone		
Dyrham Formation	Stiff blue grey silty CLAY, weathered to firm orange brown clay near the upper surface.	0.60 – 2.60	>0.20 - >1.60

Extract from Hydrock Report

2.5 Hydrogeology

The Marlstone Rock Formation is classified as a 'Secondary A aquifer' by the Environment Agency meaning it comprises 'permeable layers capable of supporting water supplies at a local rather than strategic scale.

The Dyrham Formation is classified as Unproductive Strata and is likely to be lower in permeability than the Marlstone Rock. It is therefore expected that there may be a spring line along the boundary between them and any associated solifluction deposits.

The site is not within a Source Protection Zone for drinking water supply, but groundwater in the Marlstone Rock aquifer is considered to be vulnerable to pollution.

2.6 Groundwater

Groundwater strikes were encountered during the investigation 1.6 – 3.0m below ground. Where groundwater was not encountered, the groundwater level can be assumed to be deeper than the base of the trial pits. On this basis, the depth to groundwater where not encountered in the trial pits varies between >0.70m and >3.20m below existing ground level.

2.7 Soil Permeability

Infiltration testing was carried out as part of the site investigations in accordance with BRE 365.

The tests were undertaken in both within the Limestone & Clay layers. These results indicate fast infiltration into the limestone beds, where these occur as the outflow from the pit was greater than the inflow that could be gained from a water bowser. The clay horizons in the Marlstone Rock Formation are effectively impermeable for soakaway purposes.

Hydrock concluded that limestone beds within the Marlstone Rock are likely to be of limited thickness and may not be continuous, in which case they would not be reliable and may result in water being channelled through the limestone beds to their outcrop, rather than infiltrating generally into the ground. For these reasons, soakaways are not considered suitable.

If infiltration features were to be used within the higher areas of the site there are potential implications with regard to slope stability, this may manifest as spring lines at the interface between the Marlstone rock and Dryham Formation but could in certain circumstances result in slope instability.

Hydrock Consultants Ltd have provided further confirmation on the non-suitability of soakaways within the site with document C-05955-C/002. This statement confirms that the current surface water drainage proposals are geotechnically suitable for this site due to the increased risk of slip planes and spring lines forming. See Appendix D.

2.8 Local Watercourses

The nearest open watercourse is the Sor Brook which is located approximately 500m to the southwest of the Site.

2.9 Existing Utility Appuratus

Following further site investigations it has been found that two existing surface water systems run through the site, one of which takes highway runoff from the A4260 Oxford Road while the other receives runoff from the existing agricultural buildings and yards located to the north east of the site. Both of which discharge to the Sor Brook.
The site is also bisected by a Thames Water raw water main which feeds to the treatment works with Banbury.
All three of these piped systems will be diverted within the development layout.

2.10 Cala Homes Development:

The land associated with the Cala Homes development lies above and to the north of the Crest Nichlson development with falls from north to south from approximately 116.0m to 112.0m AOD. The sub strata found is similar to that on the Crest Nichlson development area.

As part of the approved drainage design the development runoff is attenuated and discharged through a new storm outfall which runs from the Cala Homes site through the Crest Nichlson site. The storm outfall then discharges in a south west direction to the Sor Brook.

The outfall has been designed to also take the attenuated flows from the Crest Nicholson site.

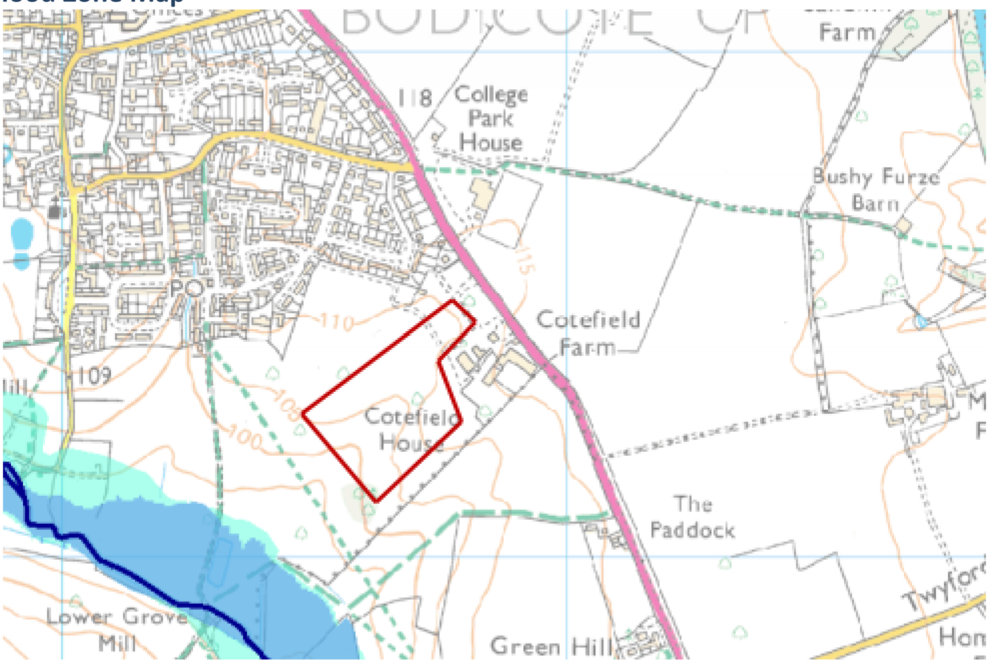
3 Flood Risk Assessment

3.1 A Flood Risk Assessment requires that an evaluation of all potential forms of flood risk to the site are considered.

In accordance with the Environment Agency's Flood Risk Assessment Guidance, NPPF, PPG and CIRIA Report 624, sources of flooding to be assessed include tidal, fluvial (rivers, streams and watercourses), pluvial (overland rainfall runoff), groundwater, artificial sources (canals and reservoirs) and existing / proposed sewerage and water mains infrastructure.

3.2 The Flood Risk Assessment produced by Forge Engineerng Design Solutions, Ref: FEDS-214026 approved at outline planning stage has confirmed that in accordance with the Environment Agency Flood Zone Mapping service indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers. That is land having a less than 1 in 1,000 annual probability of river or sea flooding.

Flood Zone Map



Contains Environment Agency information © Environment Agency 2015

Key:

Main Rivers

Dark Blue ■ : (Flood Zone 3)
Shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded: from the sea by a flood that has a 0.5 per cent (1 in 200) or greater chance of happening each year, or from a river by a flood that has a 1 per cent (1 in 100) or greater chance of happening each year.

Light Blue □ : (Flood Zone 2)
Shows the additional extent of an extreme flood from rivers or the sea.
These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year.
These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

Clear □: (Flood Zone 1)
Shows the area where flooding from rivers and the sea is very unlikely.
There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year.

3.3 As confirmed by the latest Environment Agency 'Flood Zone Map', the site is located within the lowest risk category - Flood Zone 1.

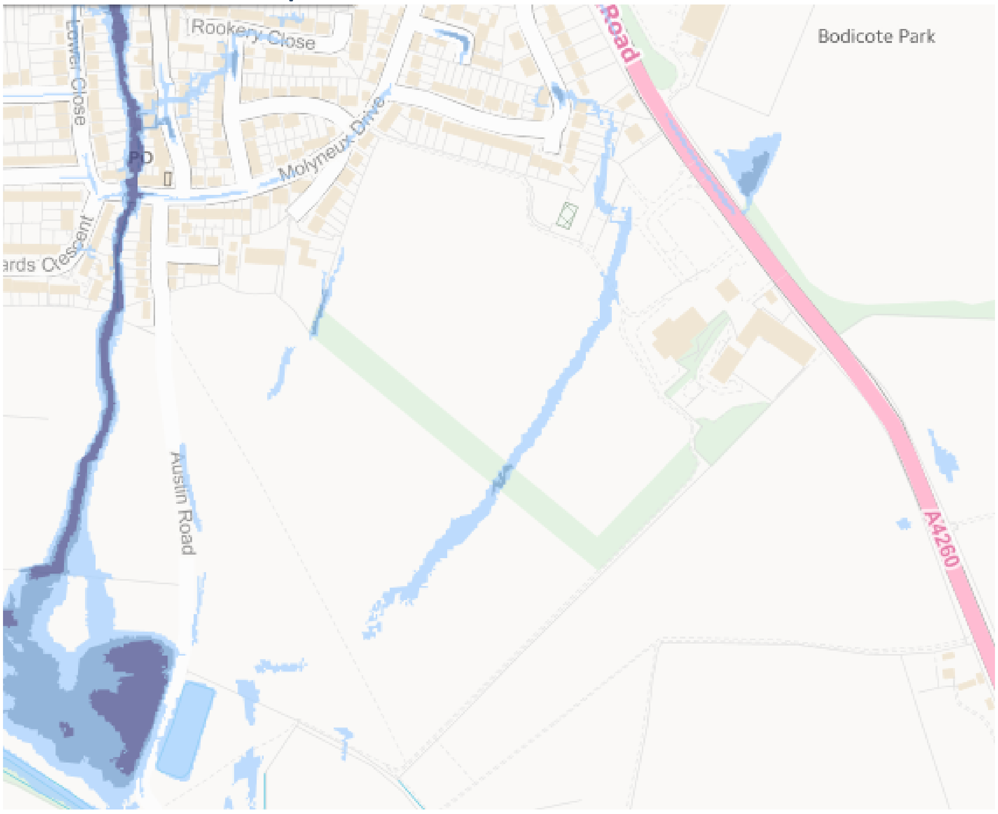
3.4 West Oxfordshire District Council (WODC) and Cherwell District Council (CDC) carried out a joint Level 1 Strategic Flood Risk Assessment (SFRA) for their districts, and published the final report in April 2009.
The aim of WODC and CDC's SFRA is to assess and map the different levels and types of flood risk in the study area for the land use planning process.

3.5 Within the context of the proposed development, there have been no recorded issues of flooding from potential sources including:

- Tidal.
- Fluvial (Main rivers and Ordinary watercourses).
- Groundwater.
- Existing foul and storm sewers and potable water main infrastructure.
- Artificial infrastructure (ponds, sewerage treatment plants etc.).

3.6 Since approval of the FRA the Environment Agency surface water flood mapping service has been updated. This indicates that the site has a strip of potential surface water flooding located on site, as highlighted on the extract plan. This is consistent with the topographical survey which incicates the valley feature running through the centre of the site.

Surface Water Flood Map



Contains Environment Agency information © Environment Agency 2015

3.7 While this is shown as flooding no recorded flooding data has been found within the site boundary and no evidence of additional surface water flooding at the site has been identified.
The route of the indicated flooding does follow the line of an existing surface water and highway drainage system which takes runoff from the A4260 Oxford Road to the Sor Brook.

3.8 Sequential Test

The flood risk technical guidance to the National Planning Policy Framework (NNPF) categorises residential developments as 'More Vulnerable' within the risk classification. 'More vulnerable' developments located within Flood Zone 1 are considered appropriate under the NPPF.

3.9 The NPPF guidance states that planning authorities should complete a risk based 'Sequential Test' at all stages of the planning process, to steer new development to areas with the lowest probability of flooding.
Under the requirements of the 'Sequential Test' and as the proposed development is already located within Flood Zone 1 (lowest risk), there are no more suitable, developable and deliverable alternative sites, better located from a flood risk perspective which could accommodate the proposed development.

4 Surface Water Drainage Strategy

4.1 The National Planning Policy Framework (NPPF) requires that developments do not exacerbate flood risks on the development site or to offsite parties and land. There is, therefore, a need to control surface water drainage and overland runoff to ensure there are no increases in peak rates and volumes of runoff as a result of the development.

4.2 Environment Agency guidance and government legislation such as the Flood and Water Management Act (Defra 2010) requires surface water drainage strategies for new developments to be in accordance with the ideals of 'sustainable development' via the provision of Sustainable Drainage Systems (SuDS).

4.3 The SUDs Manual and Building Regulations Document H (2015) details the appropriate hierarchy of potential methods for disposing of surface water from a development:

1. A soakaway or some other adequate infiltration system, or where that is not practicable;
2. A watercourse, or where that is not practicable;
3. A sewer.

4.4 Following the further ground investigatons which has highlighted that while the areas of limestone have a high potential for infiltration the discharge appears to be running between the layers of clay and limestone creating a high risk for groundwater springs within the site or as a worstcase senereo creation of a slipplane.

4.5 Based on the findings of the ground investigation as highlighted within Hydrock report the most suitable method of surface water disposal for the proposed development will be a fully attenuated surface water system with a controlled discharge to the new storm outfall sewer.

4.6 Existing Surface Water Runoff Peak Runoff Rate & Volume (Greenfield)

As part of the original Forge Engineerng Design FRA an assessment was made of the Greenfield runoff rate. These are calculated to determine the theoretical rate of discharge from the Greenfield site to surrounding areas and receiving watercourses in the vicinity.

4.7 The estimated Greenfield run-off for the site was calculated using the Institute of Hydrology's Report No. 124 methodology for sites with an area between 0 ha and 50 ha:

QBARrural = 0.00108 AREA0.89 SAAR1.17 SOIL2.17

Where,
0.00108 is a conversion factor for the units used
AREA is the site catchment area in km2
SAAR is the Standard Average Annual Rainfall
SOIL is the soil index classification.

4.8 The run-off rate is calculated for a 50 ha (0.5km2) catchment using the site's catchment details, and then interpolated using the site's total area to calculate the site's Greenfield run-off rate.

4.9 Using a SAAR of 654mm and SOIL of 0.400, the estimated existing site's Greenfield surface water run-off rate peak flow is:

QBARrural = 0.00108 x 0.500.89 x 6541.17 x 0.4002.17 = 0.1571 cumecs / 50 ha
which equates to QBarRrural = 157.1 l/s/ 50 ha
which equates to QBarGreenfield = 3.142 l/s/ha,
and for a site area of 4.50 ha = 14.1 l/s

4.10 For the site's catchment area of 4.50ha and specified storm events, the site's estimated Greenfield run-off rates and volumes were calculated to be:

Storm Event 1 in n year	Growth Curve Factor	Estimated Site's Run-off Rate Peak Flows (l/s)	Estimated Site's Run-off Peak Volume (m3)
QBAR Greenfield	-	14.1	304.6
1 in 1 year	0.85	12.0	259.2
1 in 30 year	2.27	32.0	691.2
1 in 100 year	3.19	45.0	972.0
1 in 100 year + 30% CC	4.15	58.5	1263.6

Extract from Flood Risk Assessment produced by Forge Engineerng Design Solutions

4.11 Surface Water design:

The surface water design will follow the principles previously set out in both the approved flood risk assessments undertaken by Forge Engineering Design and Banners Gate Ltd which confirm that a final discharge to the Sor Brook is required. This as previously described has already been provided for the adjacent Cala Homes development.

The surface water drainage strategy for the development is described below:

Roof Runoff:-

- Roof runoff will be collected by a conventional system of guttering and downpipes where it will be discharged to a main storm sewer.
- Water Butts are to be provided per plot where feasible on a rainwater downpipe to collect roof runoff for re-use.

Private Drives & Parking Courts:-

All private drives and parking courts will either drain via a traditional gully & piped system prior to outfalling to a the main storm drain.

Development Roads:-

Runoff from the highway areas will drain via deep trapped road gullies connecting directly to either the main piped storm drain.

Attenuation Tanks:-

Due to the layout and levels of the development the flows from the piped storm drainage system will discharge into an main attenuation tank or storage culvert. The main attenuation will be an offline cellular attenuation tank located within the open space area.
Flows will be controlled downstream via a flow control.

4.12 The final flow from the development will be controlled to a maximum discharge of 14.0 l/sec for all storm events which equates to the agreed QBar Greenfield runoff rate. The attenuation tanks will be designed to accommodate the necessary storage volumes to manage the 1:100 year storm event, plus an extra allowance of 40% for the predicted potential increase in peak rainfall up to 2115.

4.13 This ensures that all surface water drainage features are designed to accommodate the extreme storm event and will minimise the occurrence or potential for surface flooding within the development.

4.14 The development surface water piped drainage network will be offered to Thames Water for adoption under a Section 104 agreement of the Water Industry Act 1991. The main attenuation tank will be constructed using a cellular type crate system and will be maintained via the development management company.

5 Foul water drainage strategy

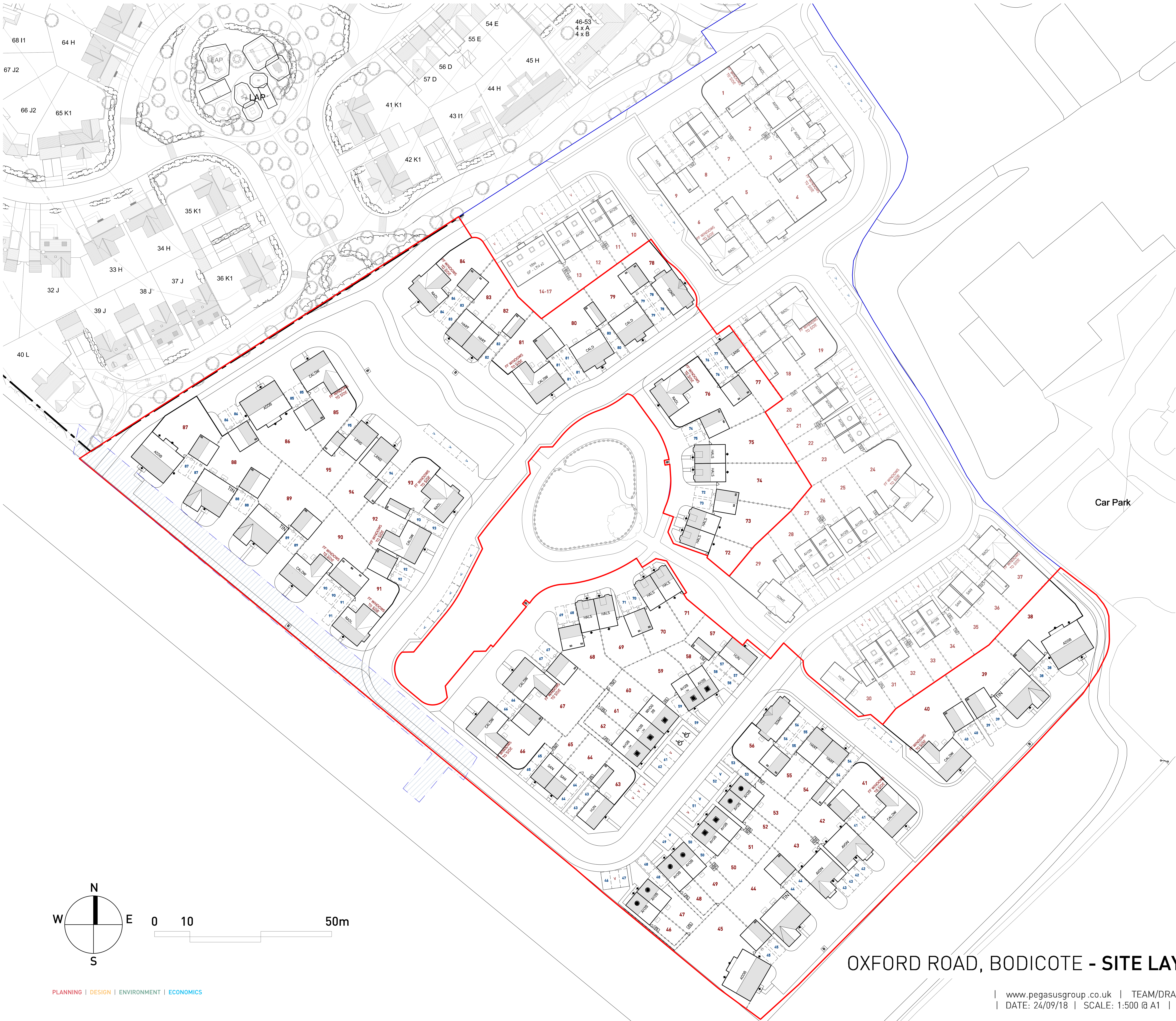
5.1 The foul water generated from each property will drain via gravity through the private house drainage before out-falling to a new sewer located typically within the development road network.

5.2 All plots will drain via a main gravity sewer system which will convey flows to the existing off site foul sewer constructed as part of the adjacent Cala Homes development.

5.3 The predicted peak foul sewer discharge from the site based on the Sewers for Adoption figure (4000 l/dwelling/day) for up to 95 units will be 4.4 l/sec.

5.5 The development foul drainage network will be offered to Thames Water for adoption under a Section 104 agreement of the Water Industry Act 1991.

APPENDIX A
SITE LAYOUT



KEY: SITE LAYOUT

APPLICATION BOUNDARY

SURFACE MATERIALS:

GARDEN/POS/HIGHWAY VERGE
(SEE DETAILED LANDSCAPE PROPOSALS)

TARMACADUM

BLOCK PAVING

CONCRETE SLAB

ENCLOSURE DETAILS:

1.8M HIGH BRICK WALL [BW]

1.8M HIGH TIMBER PANEL FENCING [PF]

1.8M HIGH CLOSE BOARDED FENCING [CBF]

1M HIGH BOW TOP RAILINGS

LANDSCAPING:

RETAINED TREE

INDICATIVE TREE PLANTING
(SEE DETAILED LANDSCAPE PROPOSALS)

OTHER:

AS — DWELLING PLOTTED AS SHOWN IN HOUSE PACK

OPP — DWELLING HANDED FROM HOUSE PACK

AFFORDABLE HOUSING (SHARED OWNERSHIP)

AFFORDABLE HOUSING (RENTED)

B — BIN COLLECTION POINT

GATE/PERSONNEL DOOR

PROPOSED DRAINAGE EASEMENT

SECURE CYCLE PARKING

Accommodation Schedule

Unit Type	No. Beds	Storeys	Sqft./unit	Sqm./unit	No. of
Open Market					
SANDOWN	2	2	771	71.6	2
HARTLEY	3	2	997	92.6	4
HUNTINGDON	3	2	1,027	95.4	2
LANGFORD	3	2	1,105	102.7	3
HALSTEAD	3	2.5	1,173	109.0	8
AVON	4	2	1,399	130.0	2
SOMERTON	4	2	1,514	140.7	2
CALDER	4	2	1,517	140.9	2
RADLEIGH	4	2	1,579	146.7	4
CALDWICK	4	2	1,800	167.2	8
TINDALL	5	2	2,118	196.8	4
ADDERBURY	5	2	2,162	200.9	4
		OM TOTAL			45
Affordable					
RENTED					
AH2B	2	2	769	71.4	4
AH2B WC	2	2	1,130	105.0	1
AH3B	3	2	911	84.6	2
AH3B LTH	3	2	1,028	95.5	2
		sub total	70%		9
INTERMEDIATE					
AH2B	2	2	769	71.4	4
		sub total	30%		4
		AFF TOTAL	54%		13
					22%
		TOTAL UNITS			**58**

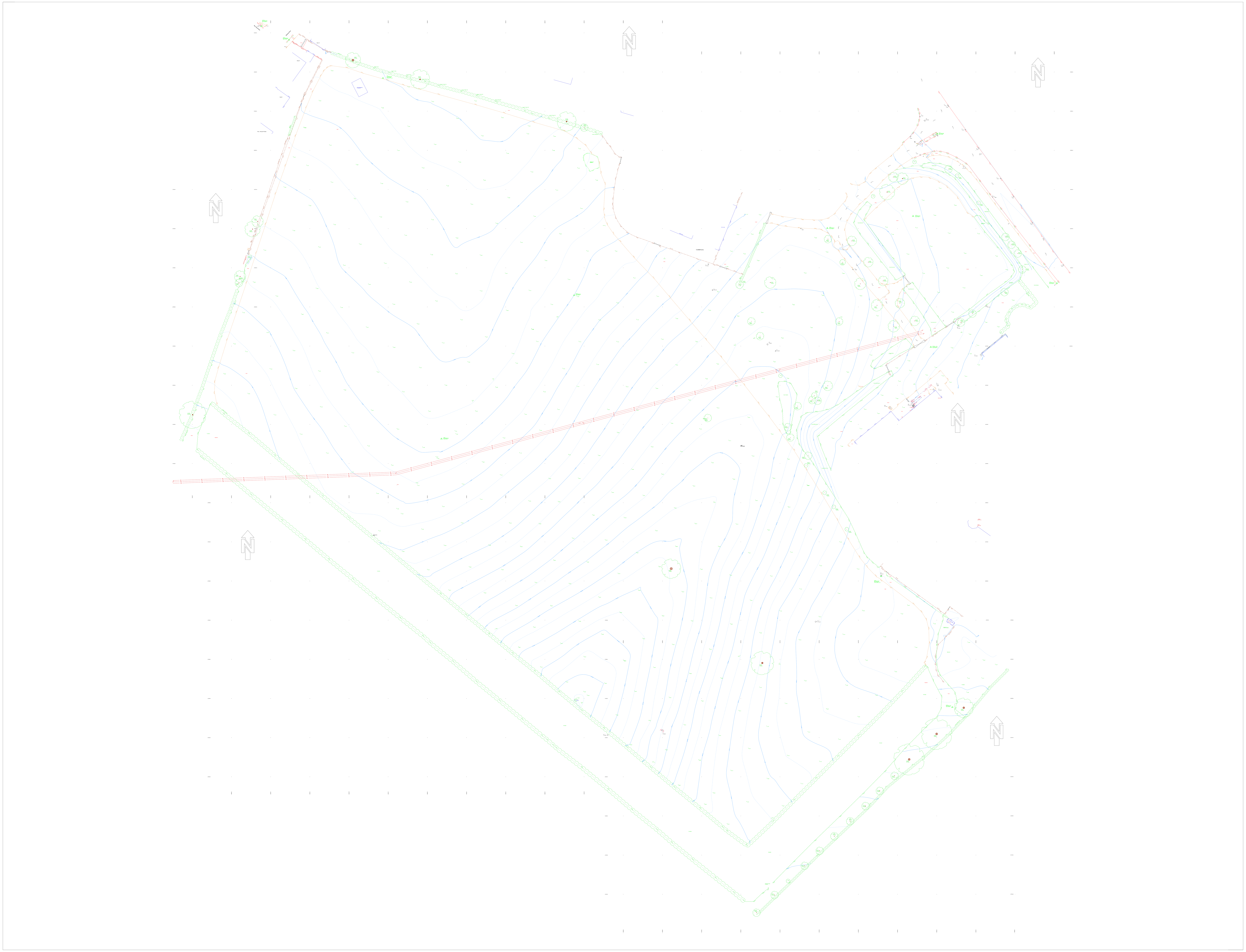
OXFORD ROAD, BODICOTE - **SITE LAYOUT - PHASE 2 (WIP)**

Pegasus Design

PLANNING | DESIGN | ENVIRONMENT | ECONOMICS

| www.pegasusgroup.co.uk | TEAM/DRAWN BY: STH/JBS/THA | APPROVED BY: STH
| DATE: 24/09/18 | SCALE: 1:500 @ A1 | DRWG: **P18-1568**_01 SHEET NO: __ REV: C

APPENDIX B
TOPOGRAPHICAL SURVEY



Notes:

The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points before work starts. The Contractor is to comply in all respects with current Building Legislation, British Standard Specifications, Building Regulations, Construction (Design & Management) Regulations, Party Wall Act, etc. whether or not specifically stated on this drawing. This drawing must be read with and checked against any structural, geotechnical or other specialist documentation provided.

This drawing is not intended to show details of foundations, ground conditions or ground contaminants. Each area of ground relied upon to support any structure depicted (including drainage) must be investigated by the Contractor. A suitable method of foundation should be provided allowing for existing ground conditions. Any suspect or fluid ground, contaminates on or within the ground, should be further investigated by a suitable expert. Any earthwork constructions shown indicate typical slopes for guidance only & should be further investigated by a suitable expert.

Where existing trees are to be retained they should be subject to a full Arboricultural inspection for safety. All trees are to be planted so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services. A suitable method of foundation is to be provided to accommodate the proposed tree planting.

Sketch proposals are for illustrative purposes only & as such are subject to detailed site investigation including ground conditions/contaminants, drainage, design & planning/density negotiations. Sketch proposals may be based upon enlargements of OS sheets & visual estimations of existing site features, accuracy will therefore need to be verified by survey. Sketch proposals have not been considered in respect of CDM Regulations.

Survey carried out to client specification and in accordance with RICS publication:
SURVEYS OF LAND , BUILDING & UTILITY SERVICES AT SCALES 1:500 & LARGER, 3rd EDITION.

Utility Services Location Note:

This survey has been carried out using a combination of observation and detection using electrolocation and ground probing radar equipment. Connections between reference points such as manholes are assumed to be straight unless bends are indicated. The accuracy is limited to the tolerances normally expected from the equipment used.

The following indications of completeness and accuracy are for guidance only:

In areas where there is a large concentration of services, the completeness will be between 80% and 90%. This will be reduced where there are obstructions at ground level.

Positional accuracy will vary with depth and pipe / duct material; an accuracy of +/- 150 mm is achievable in normal circumstances but this will be reduced for plastic pipes.

Existing information from historical plans is likely to be unreliable and is shown for guidance only.

Excavations in the area should be carried out with care and in accordance with HSG 47. No absolute guarantee of accuracy should be inferred from these plans.

The following text is an extract from Surveys of Land, Buildings and Utility Surveys at scales of 1:500 and Larger, 3rd Edition

"Electronic tracing is a reliable, method of locating buried services. ***On Heavy, built up sites 85% completeness is probably all that can be expected.*** *Plan accuracies of +/- 150mm may be achieved but this figure will depend on the depth of the service below ground level.* ***Where similar services run in close proximity, separation may be impossible. Successful tracing of non-metallic pipes may be limited.*** *Existing record information showing underground services is often incomplete and of doubtful accuracy. It should be regarded only as an indication and cannot be guaranteed"*

STANDARD ABBREVIATIONS

AV	AIR VALVE	FP	FLAG POLE	RL	RIDGE LEVEL
AR	ASSUMED ROUTE	G	GULLY	RMP	RESERVOIR MONITORING POINT
BB	BELISHA BEACON	GIP	GAS INLET POINT	RP	REFLECTOR POST
BdL	BED LEVEL	GP	GUIDE POST	RS	ROAD SIGN
BH	BOREHOLE	Grl	GRILLE COVER	RSP	RAILWAY SIGNAL POST
Bol	BOLLARD	GV	GAS VALVE COVER	RW	RETAINING WALL
BP	BOUNDARY POST	Hrl	HAND RAIL	RWP	RAINWATER PIPE
B Pvg	BLOCK PAVING	IC	INSPECTION COVER	Sap	SAPLING
BRck	BICYCLE RACK	IL	INVERT LEVEL	SB	SIGN BOARD
BS	BUS STOP	I/R	IRON RAILING FENCE	Shlt	SHELTER
BT	BRITISH TELECOM COVER	KO	KERB OUTLET	SL	SOFFIT LEVEL
BW	BRICK WALL	Lby	LIFEBUOY	Slt	SILT LEVEL
BWF	BARBED WIRE FENCE	Lck	LOCK GATE	SP	SIGN POST
Cat	CATENARY LEVEL	Ldr	LADDER	SPt	SAMPLING POINT
CATV	CABLE TV COVER	LOR	LOSS OF REFLECTION	SS	STRUCTURE SUPPORT
CB	CONTROL BOX	LOS	LOSS OF SIGNAL	ST	STOP TAP
C/B	CLOSE BOARDED FENCE	LP	LAMP POST	Sti	STILE
Cgd	CATTLE GRID	Mcy	MACHINERY	STP	STAND PIPE
CI	CAST IRON	MH	MANHOLE	StPo	STAY POST
CIP	CABLE INLET POINT	MgP	MOORING POST	Stu	STUMP
CL	COVER LEVEL	Mkr	MARKER POST	StW	STAY WIRE
C/L	CHAIN LINK FENCE	MS	MILESTONE	SV	STOP VALVE
Conc	CONCRETE	MU	ELECTRIC MOTOR	S/W	STONE WALL
CP	CATCHPIT	NP	NAME PLATE	Tac	TACTILE PAVING
CpL	COPING LEVEL	OSA	OFF SURVEY AREA	TBM	TEMPORARY BENCH MARK
Cpsn	CAPSTAN	OSBM	ORDNANCE SURVEY BENCH MARK	TCB	TELEPHONE CALL BOX
Cul	CULVERT	OGC	OVERGROUND CONDUIT	ThL	THRESHOLD LEVEL
CW	CONCRETE WALL	OHca	OVERHEAD CABLE UNIDENTIFIED	TEL	TELECOM COVER
DI	DUCTILE IRON	OHC	OVERHEAD CONDUIT	TL	TRAFFIC SIGNAL POLE
(dilap)	DILAPIDATED	OHE	OVERHEAD ELECTRIC	TM	TICKET MACHINE
(dis)	DISUSED	OHG	OVERHEAD GANTRY	TP	TELEGRAPH POLE
DPC	DAMP PROOF COURSE	OHStruct	OVERHEAD STRUCTURE	Tr	TROUGH
DSW	DRY STONE WALL	OHT	OVERHEAD TELECOM	UTL	UNABLE TO LOCATE
EIC	ELECTRICITY COVER	P	POST	UTR	UNABLE TO RAISE
EL	EAVES LEVEL	Pcg	PEDESTRIAN CROSSING	UTS	UNABLE TO SURVEY
EOT	END OF TRACE	P/F	PANEL FENCE	UTT	UNABLE TO TRACE
EP	ELECTRICTY POLE	PP	PETROL PUMP	VC	VITRIFIED CLAY
ER	EARTH ROD	P/R	POST & RAIL FENCE	VDP	VEHICLE DETECTION PAD
ESP	ELECTRICITY SUPPLY POINT	Psk	PENSTOCK	VP	VENT PIPE
ESW	ELECTRICITY SWITCH BOX	PV	VERTICAL PIPE	VW	VALVE WHEEL
FB	FOOTBRIDGE	Pyl	PYLON	WM	WATER METER COVER
FFL	FINISHED FLOOR LEVEL	PZ	PIEZOMETER	W/M	WIRE MESH FENCE
FH	FIRE HYDRANT	RE	RODDING EYE	WO	WASH OUT COVER
		RG	RAIN GAUGE	WSR	WATER LEVEL SENSOR

Utility Lines:

	SURVEY EXTENTS	D=1.00m	DEPTH INFORMATION
BT	BRITISH TELECOM	HW	HOT WATER
BT(r)	TAKEN FROM RECORDS	HW(r)	TAKEN FROM RECORDS
CTV	CATV CABLE	O/F	OPTIC FIBRE
CTV(r)	TAKEN FROM RECORDS	O/F(r)	TAKEN FROM RECORDS
CTV	CCTV CABLE	OIL	OIL PIPELINE
CTV(r)	TAKEN FROM RECORDS	OIL(r)	TAKEN FROM RECORDS
CW	COMBINED WATER	PWR	POWER FEATURE
CW(r)	TAKEN FROM RECORDS	SW	SURFACE WATER
DUC	EMPTY DUCT	SW(r)	TAKEN FROM RECORDS
DUC(r)	TAKEN FROM RECORDS	T	TELECOMMUNICATION CABLE
EA	EARTHING FEATURE	T(r)	TAKEN FROM RECORDS
EA(r)	TAKEN FROM RECORDS	TLM	TELEMETRY CABLE
E	ELECTRIC CABLE	TRA	TRAFFIC SIGNALS
E(r)	TAKEN FROM RECORDS	TRA(r)	TAKEN FROM RECORDS
FL	FUEL LINE	UK	UNKNOWN SERVICE
FL(r)	TAKEN FROM RECORDS	UK(r)	TAKEN FROM RECORDS
FW	FOUL WATER	VNT	VENT
FW(r)	TAKEN FROM RECORDS	VNT(r)	TAKEN FROM RECORDS
GAS	GAS	W	WATER
GAS(r)	TAKEN FROM RECORDS	W(r)	TAKEN FROM RECORDS
GPR	GPR FEATURE	11kV	11KV HV ELECTRIC
GPR(r)	TAKEN FROM RECORDS	11kV(r)	TAKEN FROM RECORDS
Helium	HELIUM FEATURE	PHOTO	PHOTO POSITION
Helium(r)	TAKEN FROM RECORDS	VIDEO START/END	VIDEO START/END
	SUB SURFACE ANOMALY		
REF:GPR02	REFERENCE TO GPR DATA IN REPORT		

Grid:	Datum:
Local Grid Deirived from NG GPS Observations to OS Active Network (OSTN02)	Ordnance Datum By GPS Observations to the to the OS Active Network (OSGM02) Stn1 =116.083m

Revision:	Amendments:	Date:	Name:
-	-	-	-
-	-	-	-
-	-	-	-
A	ORIGINAL ISSUE	April '14	JGC

RPS

THE SURVEY ASSOCIATION AFFILIATE MEMBER

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CLIENT:

RPS Planning & Development
(Abingdon)

PROJECT:

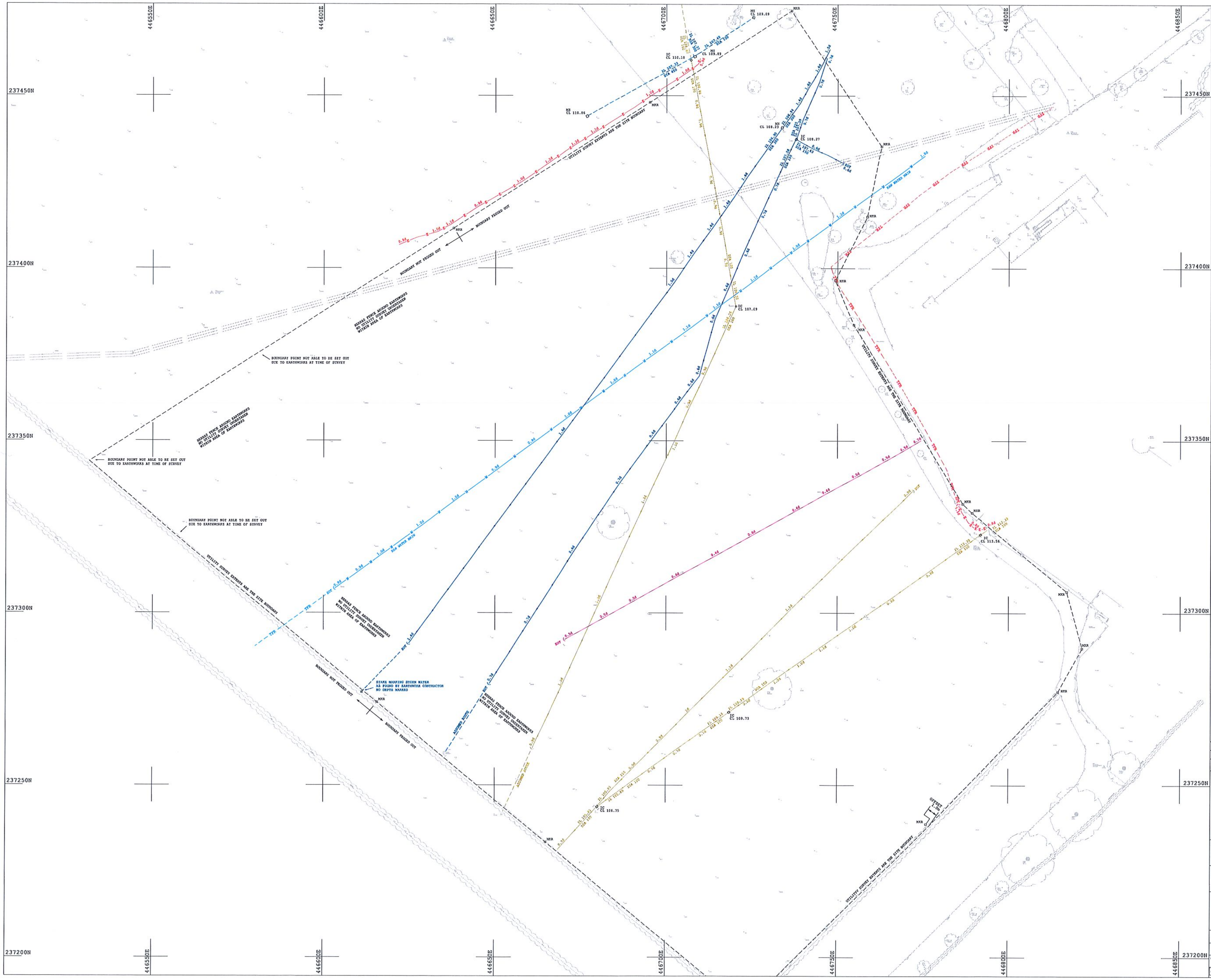
Cotefield Farm Phase II
Bodicote
Nr, Banbury

TITLE:

Topographical
Survey

Drawn:	JGC	Checked:	SP
Date:	April 2014	Scale:	1:600 @ A0
Drg No:	UAG3091_A_2D	Sheet:	1

ASSET & INFRASTRUCTURE MAPPING



KEY (Where Applicable)

UTLITIES AND SERVICES

NB - DASHED LINES ON UTILS INDICATE TAKEN FROM RECORD

A	UNDERGROUND ABANDONED SERVICE
TV	UNDERGROUND CABLE TELEVISION
C	UNDERGROUND COMMS CABLES
D	UNDERGROUND DUCTING
E	UNDERGROUND ELECTRICITY
FO	UNDERGROUND FIBRE OPTIC CABLE
FS	UNDERGROUND FUEL SUPPLY
G	UNDERGROUND GAS
AG	ABOVE GROUND GAS
	UNDERGROUND COMBINED WATER
	UNDERGROUND FOUL WATER
	UNDERGROUND SURFACE WATER
T	UNDERGROUND TELECOMS
S	UNDERGROUND TRAFFIC SIGNALS
	TRENCH SCAR
U	UNDERGROUND UNIDENTIFIED SIGNAL
W	UNDERGROUND WATER SUPPLY
AW	ABOVE GROUND WATER SUPPLY
	OVERHEAD ELECTRIC WIRES
	OVERHEAD TELEGRAPH CABLES
EOT	END OF TRACE
TFR	ROUTE TAKEN FROM RECORDS OR ASSUMED. (DASHED LINE WITH APPROPRIATE STYLE)
	REQUESTED SURVEY AREA
d	DEPTH. NB: SEE ACCURACY STATEMENTS AND ASSOCIATED REPORT.
	SITE BOUNDARY (LINE BETWEEN MARKER PEGS)

DISCLAIMER

DEPTH ESTIMATIONS, WHERE QUOTED, SHOULD BE TAKEN AS APPROXIMATE, DUE TO THE VARYING METHODS OF DETECTION USED MEASURING TO DIFFERENT POINTS ON THE SERVICE. GENERALLY DEPTHS SHOWN ALONG DRAINS AND SEWERS ARE TO THE INVERT LEVELS OF THE RELEVANT PIPE.
ELECTROMAGNETIC DETECTION METHODS ESTIMATE THE DEPTH TO THE CENTRE OF THE SERVICE AND ALLOWANCE SHOULD BE MADE FOR THE TOP OF LARGE DIAMETER SERVICES BEING SHALLOWER THAN THE ESTIMATED DEPTH.
GROUND PENETRATING RADAR DEPTH ESTIMATIONS ARE TAKEN TO THE TOP OF THE DETECTED SERVICE.
IT SHOULD BE NOTED THAT THE PLAN POSITION OF A DETECTED SERVICE IS, AS A GENERAL RULE, GOOD TO +/- 10% OF ITS ESTIMATED DEPTH.
WHERE SERVICES HAVE NOT BEEN ABLE TO BE DETECTED FROM ONSITE SEARCHES, THEN A COMBINATION OF INFORMATION TAKEN FROM RECORD DRAWINGS, RELEVANT SURFACE DETAILS AND TRENCH SCARS HAS BEEN USED WHILST EVERY EFFORT HAS BEEN MADE TO LOCATE ALL SERVICES THE COMPLETENESS OF ANY UTILITY SURVEY CANNOT BE GUARANTEED AND SAFE EXCAVATING PROCEDURES SHOULD BE EMPLOYED IRREGARDLESS OF THE INFORMATION SHOWN ON THIS DRAWING.

REPORT

ALWAYS REFER TO THE REPORT THAT ACCOMPANIES THIS DRAWING.

NOTES

DATUMS

ALL LEVELS RELATED TO PREVIOUS CONTROL.
COORDINATES RELATED TO PREVIOUS CONTROL.
DATA PRESENTED ON A LOCAL PLANE GRID.
DATUMS DETERMINED BY OTHERS.

No	INFORMATION	By	Date	Chkd

REVISIONS

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CLIENT: RIDDINGS MIDLANDS LTD

LOCATION: LAND OFF OXFORD ROAD, BODICOTE, BANBURY

DRAWING TITLE: UTILTIY SURVEY & BOUNDARY SURVEY

SCALE: 1:500	SHEET SIZE: A1
DATE: 30.11.2017	DRAWING No: 17/065_01 REV
DRAWN BY: FD / CHECKED BY: AH	

APPENDIX C
EXTRACTS FROM THE GROUND INVESTIGATION

Executive Summary and Conceptual Site Model

SITE INFORMATION AND SETTING	
Report Purpose	Phase 2 interpretative ground investigation and risk assessment.
Client	Crest Nicholson
Site Name and Location	Bodicote, Banbury, Oxfordshire.
Proposed Development	A development of 96 residential houses with associated infrastructure and gardens.
PHASE 2 – GROUND INVESTIGATION	
Hydrock Site Works	The Hydrock ground investigation comprised: • 18 trial pits to a maximum depth of 3.2m bgl; • 4 infiltration tests; • chemical testing of soils and leachates and geotechnical testing of soils;
Ground Conditions Encountered (All Data)	Marlstone Rock Formation – to >3.2 bgl , comprising brown gravelly clays with limestone beds. Dryham Formation – >3.2m bgl , blue grey silty clays.
Groundwater Encountered (All Data)	Groundwater was encountered at between 1.6m bgl and 3.0m bgl during the investigation.
GEO-ENVIRONMENTAL ASSESSMENT AND CONCLUSIONS	
Conclusions of Contamination Generic Risk Assessment	**Human health:** Pervasive arsenic. **Plant growth:** There are no chemicals of potential concern to plant life. **Ground gases or vapours:** Negligible risk from ground gases **Radon:** The site is in a Radon Affected Area (>10% of existing homes affected). **Water supply pipes:** Greenfield site with no significant contaminants of concern and standard pipework is envisaged. However, confirmation should be sought from the water supply company at the earliest opportunity.
Proposed Mitigation Measures	Full radon protective measures are necessary according to current guidance.

GEOTECHNICAL CONCLUSIONS	
Obstructions	Limestone beds are present within the ground at varying depths.
Groundworks and Earthworks	Excavation to proposed founding depth generally should be readily achievable with standard excavation plant. Heavy duty excavation plant/breaking equipment may be required to excavate the Limestone beds. Water seepages into excavations are likely to be adequately controlled by sump pumping.
Foundations	Strip/trench fill foundations from 0.90 m bgl, subject to the presence of existing trees within medium volume change potential soils. Piled foundations may be required where tree influence makes foundation depths greater than 2.50m. Allowable net bearing pressure of 100 kN/m^2 should be available, keeping total and differential settlement within acceptable limits. Deepening of foundations/heave protection is likely to be required to allow for the effects of trees.
Ground Floor Slabs	Suspended because of depth of presence of medium shrinkage potential clay soils. Suspended over a void where within the influencing distance of trees.
Road Pavement Design (CBR)	it is considered likely an equilibrium CBR of over 2.5% will be achievable over most of the site which can be used for preliminary design purposes, subject to in situ testing during construction.
Soakaways	Soakaway drainage is considered unsuitable for this site.
Buried Concrete	Design Sulfate Class - DS-1 and ACEC Class AC-1. Equivalent to Design Chemical Class DC-1 for a 50 year design life.
FUTURE CONSIDERATIONS	
Uncertainties and Limitations	There is insufficient gas monitoring to fully characterise the site in accordance with CIRIA Report665.
Further Work	The following further works will be required: • further investigation with boreholes and trial pits, together with further laboratory testing and monitoring to provide further information on the issues outlined in this report, particularly the extend and depth of the Head Deposits in the base and sides of the on-site valley feature; • discussions with piling contractors regarding their method for designing and emplacing piles; • discussions with service providers regarding the materials suitable for pipework etc.; • discussions with regulatory bodies regarding the conclusions of this report; • foundation depth in relation to trees assessment, following a tree survey to BS 5837:2012; and • detailed design of foundations.

This Executive Summary forms part of Hydrock Consultants Limited report number R/05995/001 (Issue 1) and should not be used as a separate document.

4.0 GROUND INVESTIGATION RECORDS AND DATA

4.1 Physical Ground Conditions

4.1.1 Summary of Strata Encountered

The following sections present a summary of the ground and groundwater conditions encountered and their properties, based on field observations, interpretation of the field data and laboratory test results, taking into account, excavation and sampling methods, transport, handling and specimen preparation.

All relevant data from the Hydrock investigation detailed in Section 3.0 as well as any suitable previous investigations mentioned in Section 1.4 are used from this point forward.

For the purposes of property designation, soils are divided into fine soils (clays and silts) and coarse soils (sands, gravels, cobbles and boulders) in accordance with BS 5930:2015.

Soil plasticity class for fine soils is based on the classification system of BS 5930:2015, adopting modified plasticity index values (based on percentage passing 425 µm sieve). Volume change potential of fine soils on change of moisture content has been assessed using guidance provided in NHBC Standards/BRE Digest 240 - Part 1.

The ground conditions proven during the current investigation are in general accordance with the published geological literature and expectations from the desk study and previous investigation works. However, a stratum derived from Head or solifluction deposits (flow of soil down a slope) was identified and is identified on the exploratory hole logs in Appendix C.

Details of the strata are described in the logs in Appendix C; a summary is presented in Table 4.1 and the individual strata are described in the sections below. Relevant geological cross sections are presented in Appendix A.

Table 4.1: Strata Encountered

Stratum	Summary Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
Topsoil	Soft dark brown sandy gravelly clay and clayey gravelly sand with rootlets.	0	0.20 - 0.35	0.20 – 0.35
Head Deposits (southwest area of site on lower slopes)	Stiff greenish grey mottled orange silty sandy gravelly clay	0.30	>1.80 - >2.70	>1.50 - >2.40
	Orange brown clayey gravelly sand			
	Soft blue grey / purple gravelly clay / silt			
Marlstone Rock Formation	Firm to stiff orange brown to greenish grey silty sandy gravelly CLAY, with fine to coarse angular to rounded gravel of limestone and ironstone.	0.20 - 0.30	0.70 - >3.10	0.50 - >2.80
	Orange brown clayey silty gravelly sand with limestone and ironstone gravel.			
	Moderately strong fractured grey brown limestone			
Dyrham Formation	Stiff blue grey silty CLAY, weathered to firm orange brown clay near the upper surface.	0.60 – 2.60	>2.00 > 3.20	>0.20 - >1.60

Head Deposits, derived from solifluction deposits, were identified in exploratory holes SA104, TP201 and TP202. It is likely that they are present along the lower parts of the slope and the base of the valley feature. Where Head Deposits were encountered, their thickness was not fully proven but as they are generally in the lower parts of the site they are likely to be mostly underlain by the Dyrham Formation.

The level of the boundary between the Marlstone Rock and the underlying Dyrham Formation away from the area potentially affected by cambering and solifluction is between 105.4mOD and 107.2mOD, with an average of approximately 106mOD. Possible cambering in the lower parts of the site may result in the boundary occurring at a slightly lower level.

4.1.2 Topsoil

For the purposes of this report, topsoil is defined in accordance with BS5930: 2015 as the upper layer of an *in situ* soil profile, usually darker in colour and more fertile than the subsoil layer below and which is a product of natural chemical, physical, biological and environmental processes. The topsoil identified in the logs does not imply compliance with BS 3882:2015. Subsoil has not been identified as a separate layer.

4.1.3 Possible Made Ground

Based on local anecdotal information, Made Ground may be present across the eastern corner of the site, although it was not identified in any of the exploratory holes.

4.1.4 Head Deposits

Head Deposits were identified in TP 201, TP202 and SA104. They were encountered in the lower parts of the valley feature in the southwestern part of the site.

The Head Deposits are formed by the down-slope migration of soils from higher up the slope and hence they are of variable composition and formed of disturbed mixtures of the cohesive and granular source materials. Their classification properties are considered to be similar to those described in the following sections, but in TP201 a layer of soft clay was noted between 1.50m and 1.60m depth, resulting from softening caused by water in the sand materials above and below the clay.

In SA104 a single hand shear vane reading of 75kPa was obtained indicating medium strength.

One plasticity index test on Head Deposits showed a plastic limit of 20%, liquid limit 33%, 93% passing the 425um sieve and a modified plasticity of 12% with a natural moisture content of 26%, showing it to be of medium plasticity and of low volume change potential.

However, the materials are inherently variable and its geotechnical properties are likely to vary.

4.1.5 Marlstone Rock Formation

'Marlstone Rock Formation' was encountered underlying the topsoil in the topographically higher parts of the site. This generally consisted of brown sandy gravelly clays with limestone and ironstone gravel and beds of ferruginous limestone.

Natural moisture contents in the fine units of these materials range from 20% to 41%, and modified plasticity indices range from 12% to 29%. On this basis, these soils are classified as of low to high plasticity (CL-CH soils) and of low to medium volume change potential.

Undrained shear strength parameters of the cohesive units of the Marlstone Rock Formation materials based on seven *in situ* hand vane tests undertaken on samples recovered from trial pits recorded values between 76kPa and 103kPa indicating high strength.

4.1.6 'Dyrham Formation'

'Dyrham Formation' strata were encountered underlying the Marlstone Rock Formation. This generally consisted of stiff blue grey silty clay.

Natural moisture contents in the fine units of these materials range from 21% to 29%, and the plasticity index in one sample was 22%. On this basis, these soils are classified as of intermediate plasticity (CI) and of medium volume change potential.

Based on comparison of the plasticity indices with the moisture content, the clays in the Dyrham Formation are stiff to very stiff and a characteristic value of its shear strength is considered to be 75kPa.

4.2 Obstructions

Four of the trial pits encountered obstructions during excavation in the Marlstone Rock Formation as summarised in Table 4.2.

Table 4.2: Obstructions Encountered During Hydrock Investigations

Exploratory Hole	Depth (m)	Description	Stratum
SA101	2.00	Limestone bed.	Marlstone Rock Formation
TP203	1.80	Limestone bed.	Marlstone Rock Formation
TP204	1.00	Limestone bed.	Marlstone Rock Formation
TP205	2.60	Limestone bed.	Marlstone Rock Formation

4.2.1 Sulfate Content

In accordance with BRE (Special Digest 1), the Design Sulfate (DS) classification and the Aggressive Chemical Environment for Concrete (ACEC) classification derived from laboratory tests undertaken are presented in Table 4.3. The assessment summary sheet is presented in Appendix D.

Table 4.3: Aggressive Chemical Environment Concrete Classification

Stratum	No. Tests	DS	ACEC
Marlstone Rock Formation	6	DS-1	AC-1

4.3 Groundwater

4.3.1 Groundwater Levels

Groundwater strikes encountered during the investigation are summarised in Table 4.5.

Table 4.2: Groundwater Data

Stratum	Exploratory Hole	Fieldwork
		Depth Groundwater Encountered (m bgl)
Marlstone rock	TP206	1.60
	TP212	3.00
	SA103	2.00

Where groundwater was not encountered, the groundwater level can be assumed to be deeper than the base of the trial pits. On this basis, the depth to groundwater where not encountered in the trial pits varies between >0.70m and >3.20m below existing ground level.

4.3.2 Infiltration Tests

The results of the infiltration testing undertaken are summarised in Table 4.5. The results sheets are presented in Appendix D. All testing was carried out in accordance with Hydrock's 1-day assessment methodology. This is in general accordance with BRE Digest 365 (BRE 2007) where infiltration rates allow three test runs during a working day (or where there is no infiltration), but where low infiltration rates were encountered the available time may not have been sufficient to fully comply with the BRE test method.

Where less than three tests were possible in a particular location the results provided should be considered indicative only and should not be used for design purposes. Further discussion concerning the suitability of infiltration testing at the site is provided in Section 7.7.

Table 4.5: Infiltration Test Results – Marlstone Rock Formation

Stratum	Trial Pit no.	Depth	Infiltration Rate (m/s)		
			Test 1	Test 2	Test 3
Limestone	SA101	2.0	Drainage too fast to measure	Drainage too fast to measure	Drainage too fast to measure
Clay	SA102	2.4	Too slow to measure	-	-
Clay	SA103	2.0	Too slow to measure	-	-
Clay	SA104	2.1	Too slow to measure	-	-

These results indicate fast infiltration into the limestone beds where these occur as the outflow from the pit was greater than the inflow that could be gained from a water bowser. The clay horizons in the Marlstone Rock Formation are effectively impermeable for soakaway purposes.

4.4 Geo-Environmental Results

The chemical test results for soil, leachate and groundwater are given in Appendix F, which also includes summary tables of the data.

Concentrations of the following determinands in soils were reported as below the laboratory limits of detection:

- Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene, Cadmium (aqua regia extractable), Chromium (hexavalent); and Selenium (aqua regia extractable).

4.5 Updated Ground Model

The preliminary conceptual site model initially developed from the desk study and walk-over survey (Section 2.0) has been confirmed using the findings of the ground investigation.

APPENDIX D

HYDROCK CONSULTING GEOTECHNICAL STATEMENT

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By email only to marcus.thompson@crestnicholson.com

6 September 2018

Land adjacent to Oxford Road, Bodicote - Proposed Residential Development

Dear Marcus,

Following on from our telephone discussion of 23rd August 2018, Hydrock has prepared the following letter to discuss potential geotechnical issues arising from the use of infiltration style SuDs drainage on the site that have been raised by MJA Consulting in the Flood Risk Assessment & Drainage Addendum Report for the site. Hydrock has previously undertaken ground investigation works on the site (Desk Study Review and Ground Investigation Report referenced BDC-HYD-XX-GI-RP-GE-0001 and dated April 2017) to which MJA refer in their FRA.

The 4.5 ha site is located is located off the A4260 Oxford Road, Bodicote, approximately 3km south of Banbury, Oxfordshire. The nearest postcode is OX15 4AQ. The National Grid Reference of the approximate centre of the site is 446715E, 237293N. A site location plan is presented in Hydrock's Ground Investigation Report.

The topography of the site is dominated by a shallow valley feature sloping down from the northeast to the southwest, with slopes orientated towards the valley. Site elevations vary from approximately 110mOD in the northeast to 102mOD in the southwest, over a distance of approximately 225m.

The steepest gradients are in the southwestern part of the site, either side of the valley feature, up to approximately 1(v):10(h).

The ground investigation works have broadly confirmed the British Geological Survey mapping (Sheet 218 - Chipping Norton) with Marlstone Rock Formation comprising ferruginous limestones and sandstones overlying the Dryham Formation: clays with limestone and mudstone beds. Marlstone Rock Formation was encountered underlying the topsoil in the topographically higher parts of the site and generally consisted of brown sandy gravelly clays where weathered, with limestone and ironstone gravel and beds of ferruginous limestone present where less weathering had occurred. Dyrham Formation strata were encountered underlying the Marlstone Rock Formation and generally consisted of stiff blue grey silty clay.

The upper boundary of the Dyrham Formation is shown to outcrop part way down the slope, with the higher parts of the site being underlain by Marlstone Rock and the lower parts by Dyrham Formation. Head Deposits: solifluction deposits, were identified along the lower parts of the slope and the base of the valley feature.

The level of the boundary between the Marlstone Rock and the underlying Dyrham Formation away from the area potentially affected by solifluction, is between 105.4mOD and 107.2mOD, with an average of approximately 106mOD. Possible cambering in the lower parts of the slope may result in the boundary occurring at a slightly lower level. The boundary between the formations is anticipated to be approximately horizontal based upon BGS mapping. Conjectured cross-sections through the site are shown on the enclosed drawing BDC-HYD-XX-XX-DR-GE-0003.

Discussion

The ground model indicates that permeable stratum (limestone bands within the Marlstone Rock Formation), overlie impermeable stratum (clays of the Dyrham Formation). See enclosed cross section through the site.

The Hydrock investigation has shown that the Marlstone Rock Formation has become weathered near surface and has largely deteriorated to a clay (sometimes recorded as sand) overlying intact limestone although the limestone where encountered, increasingly weathers to clay down the slope. Infiltration testing by Hydrock has shown that the weathered clays of the Marlstone Rock Formation and the underlying Dyrham Formation, are effectively impermeable, with infiltration rates too slow to measure (i.e. no significant drop in water level was measured over a six hour time period during an infiltration test).

It is anticipated that infiltration may be possible into the limestone bands. However, Hydrock have previously stated in the ground investigation report that these bands are of limited thickness and therefore only have limited potential to store water. On this basis, there is likely to be excess water pressure within the limestone bands. The effectively impermeable Dyrham Formation beneath the limestone will curtail the vertical infiltration of groundwater and so it is possible that spring-lines will form, at the interface between the Marlstone Rock Formation and the Dyrham Formation. This could therefore result in water flowing out of the slope and potentially flooding parts of the development.

Where the interface between the Marlstone Rock Formation and the underlying Dyrham Formation strata is covered by the Head Deposits there is increased potential for the build-up of excess pore water pressures in the slope that could result in slope failure.

However, these situations are considered to only be plausible risks if infiltration drainage is constructed near the crest of the eastern slope. Under the current natural conditions on the site these situations are unlikely to occur as the weathered clays at the surface limit vertical infiltration into the underlying limestone beds. As such, it is considered that the risk of flooding or slope instability with the site in its current, natural, condition or developed adopting the drainage strategy proposed by MJA, are minimal.

Hydrock therefore consider that the drainage strategy proposed by MJA has fully considered the issues raised by Hydrock in its Ground Investigation Report and is a geotechnically suitable solution for the site.

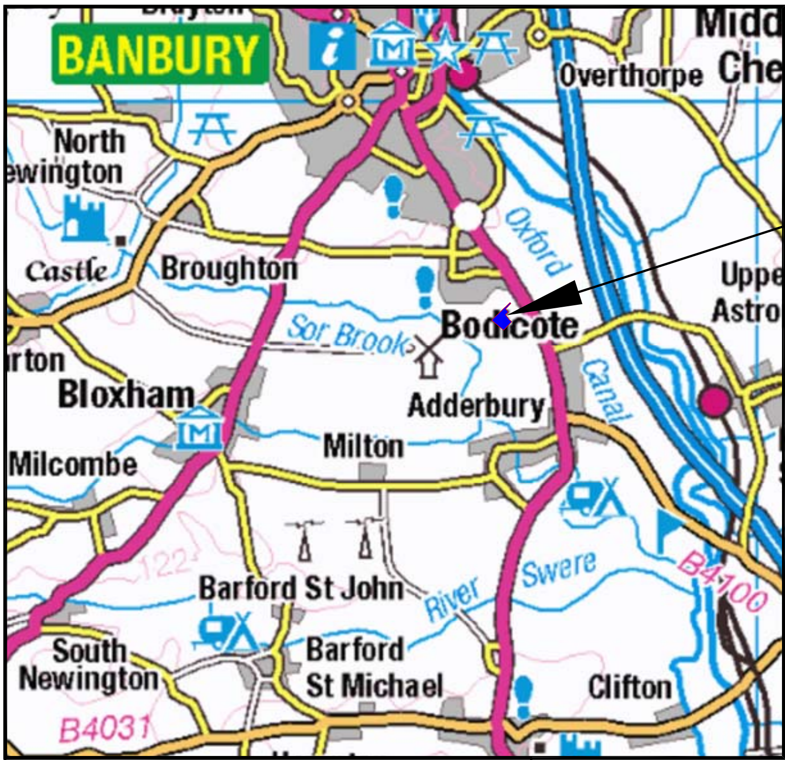
Yours sincerely

Julian Charlesworth
Principal Geo-environmental Consultant

E: juliancharlesworth@hydrock.com

Encl. Hydrock Drawing BDC-HYD-XX-ZZ-DR-GE-0003-P1.1-S0 - Conjectured Geological Cross Sections

Notes:
1. Contains Ordnance Survey data © Crown copyright and database right 2015



THE SITE

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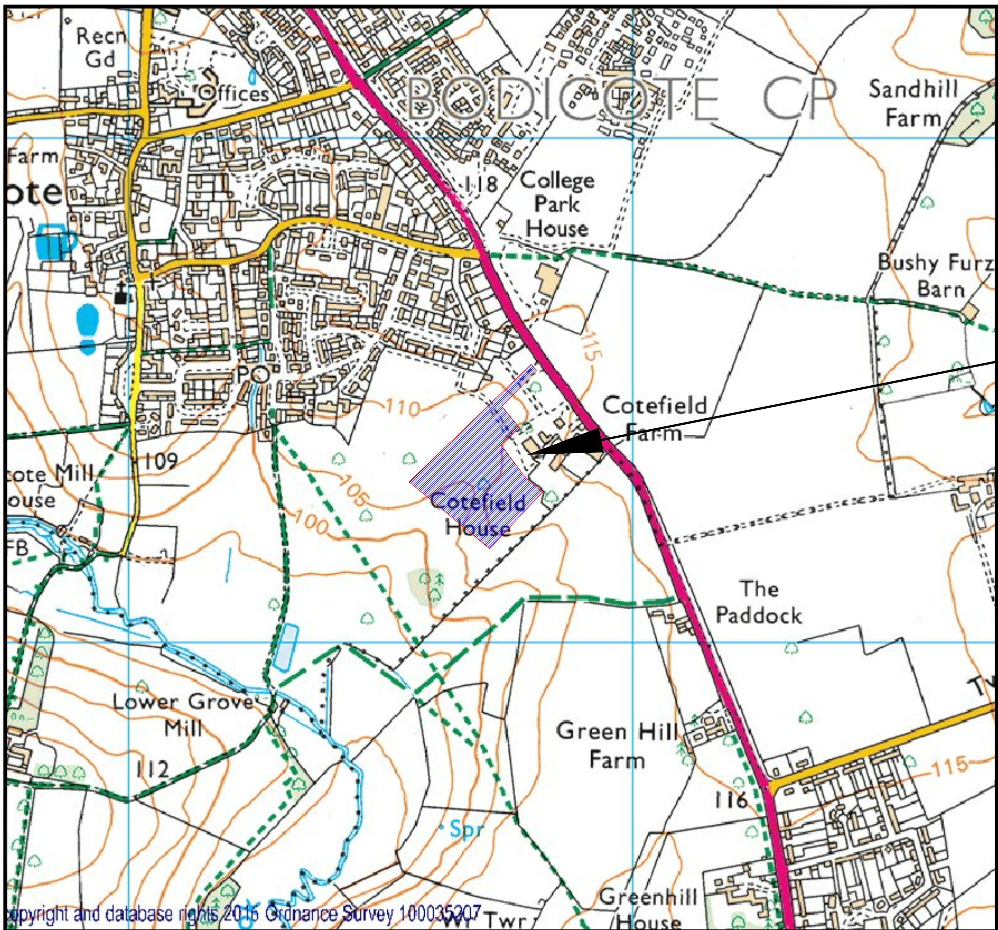

THE SITE

0m 200m 400m 600m 800m 1000m Scale = 1:15,000

Rev	Date	Description	By	Ckd

Architect :

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Client : Crest Nicholson

Project Title: BODICOTE, OXFORDSHIRE

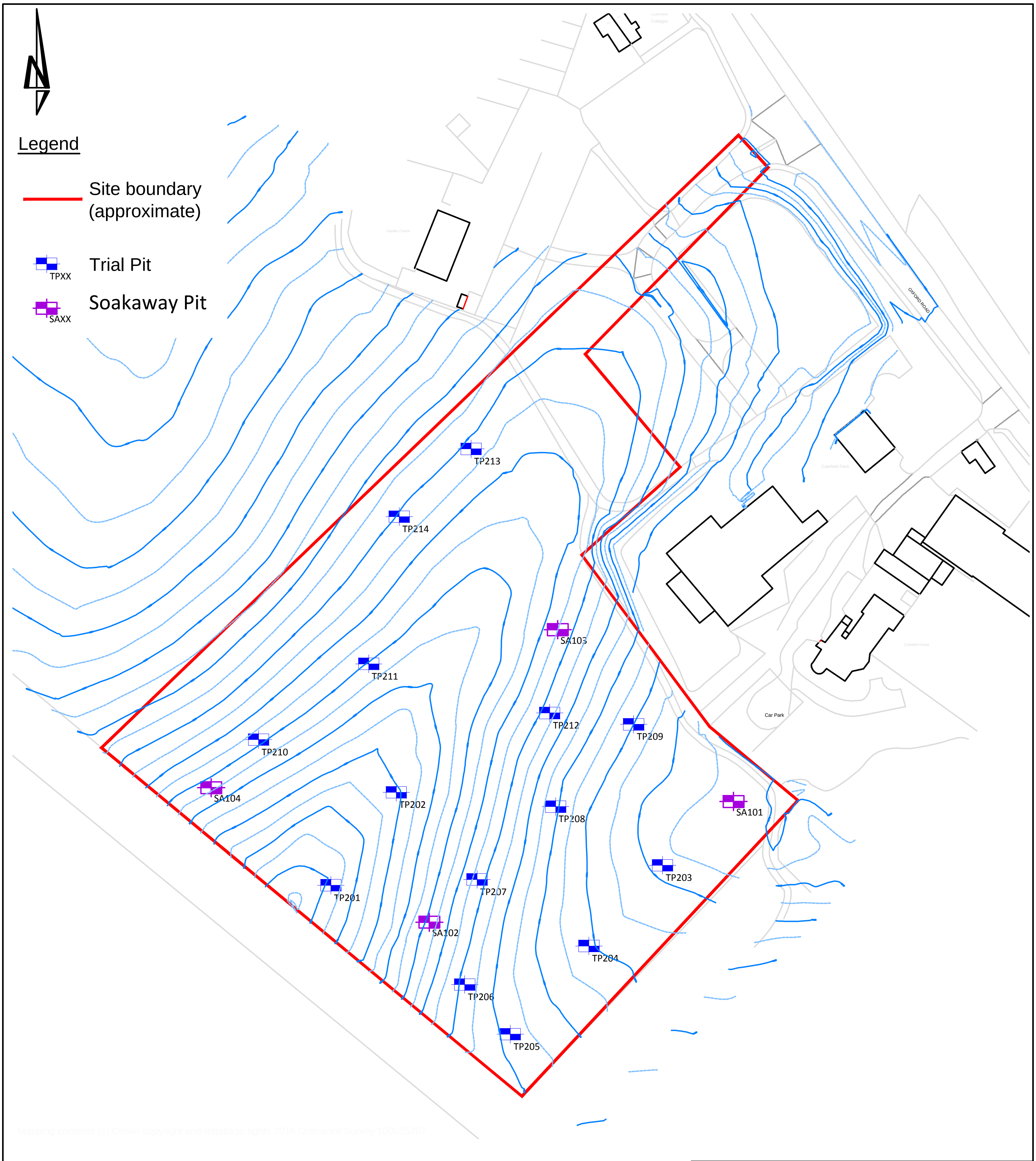
Drawing Title: Site Location Plan

Reference: BDC-HYD-XX-ZZ-DR-GE-0001

Hydrock Job No: C-05955-C

Drawn	Checked	Scale @ A4	Date	Issue Date
SD	SC	See Drawing	21/03/17	21/03/17

Revision: P1.1 Status: S0



Rev	Date	Description	By	Ckd

Reference: BDC-HYD-XX-ZZ-DR-GE-0002

Client : Crest Nicholson

Project Title:

BODICOTE, OXFORDSHIRE

Hydrock

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Notes:

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.
2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.
3. Topographical survey drawing number: UAG3091_A_2D by RPS, dated: April 2014.

Drawing Title:

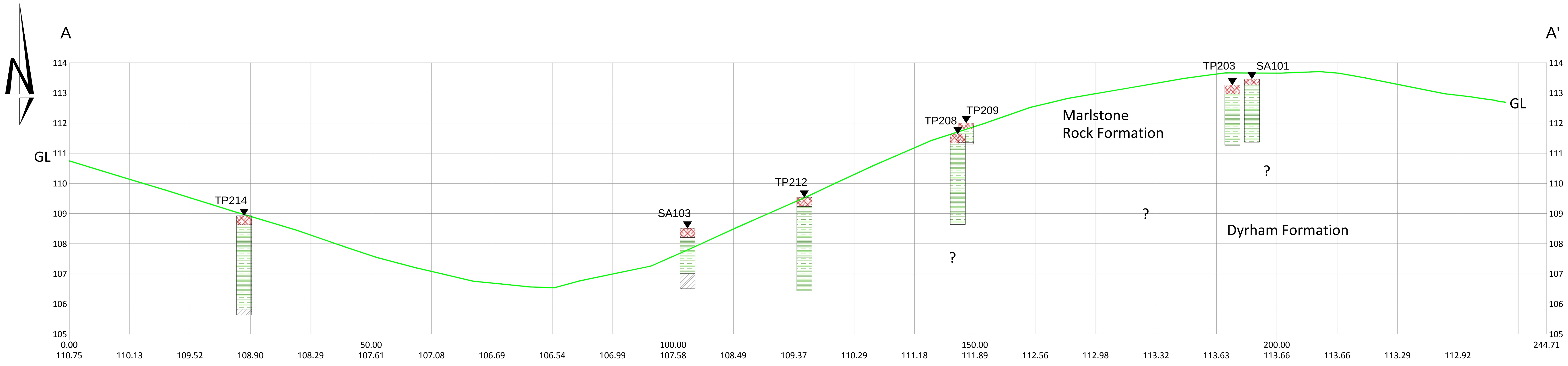
Exploratory Hole Location Plan

Hydrock Job No: C-05955-C

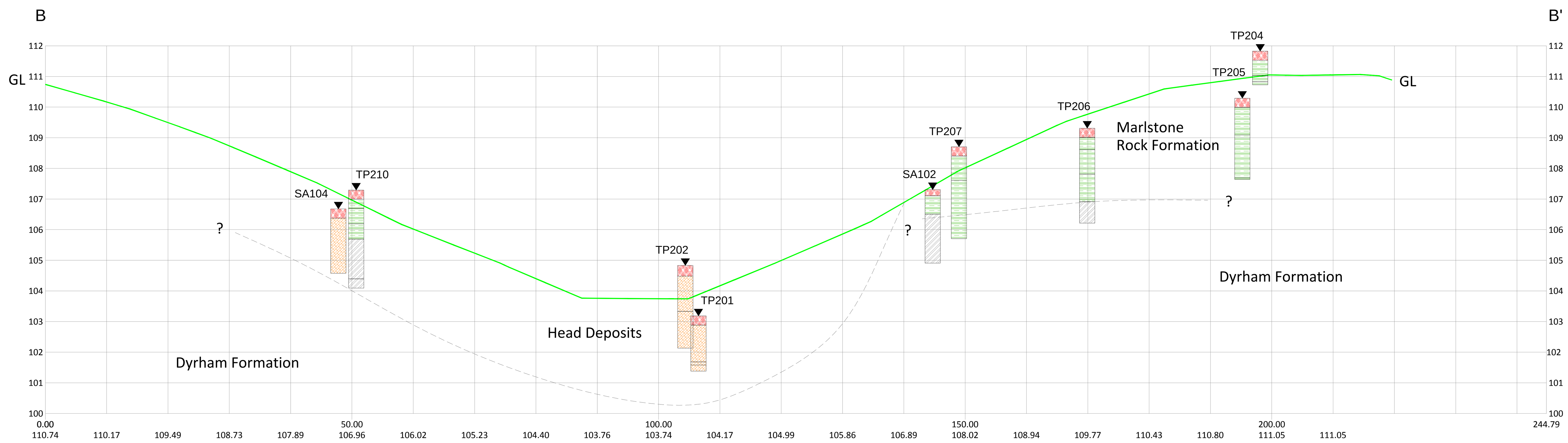
Drawn	Checked	Scale @ A4	Date	Issue Date
SD	JC	1:2000	20/03/17	20/03/17

Revision: P1.1

Status: S0



Scale Horiz 1:500 Vert 1:100



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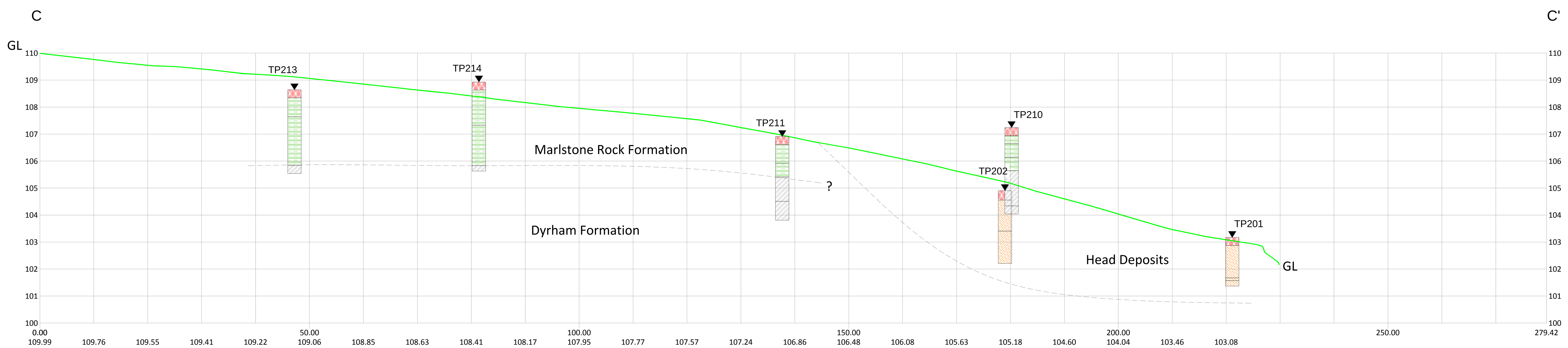

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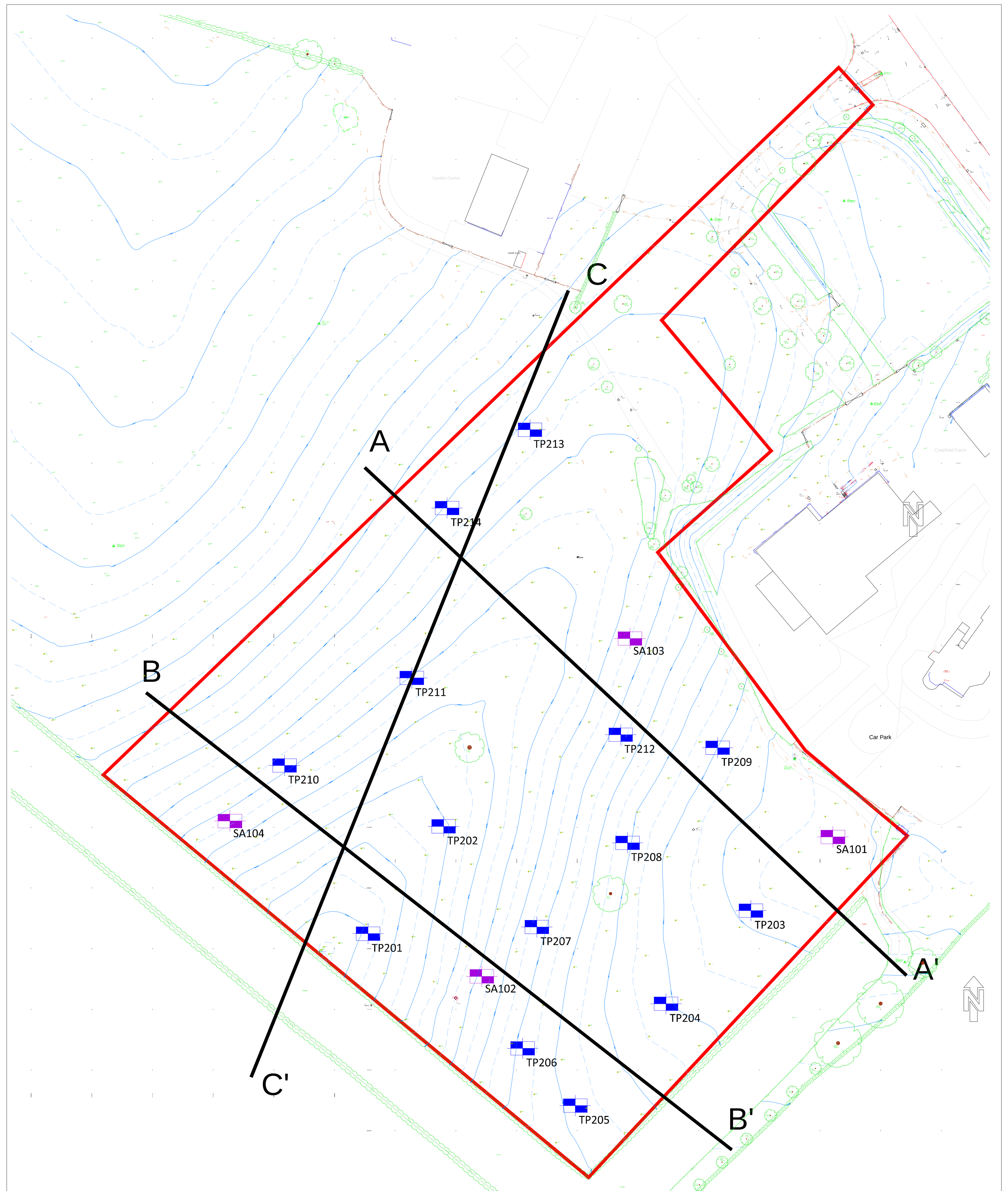


Notes:

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.
2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.
3. Topographical survey drawing number: UAG3091_A_2D by RPS, dated: April 2014.

Legend

- Site boundary (approximate)
- TPXX Trial Pit
- SAXX Soakaway Pit
- Topsoil
- Marlstone Rock Formation
- Dyrham Formation
- Head Deposits

Rev	Date	Description	By	Ckd

Client : Crest Nicholson

Architect :

Project Title: BODICOTE, OXFORDSHIRE

Drawing Title: Conjectured Geological Cross Sections

Reference: BDC-HYD-XX-ZZ-DR-GE-0003

Hydrock
Hydrock Consultants Ltd
3 Hawthorn Park
Holdenby Road
Spratton, Northampton
NN6 8LD
T +44 (0)1604 842888
northampton@hydrock.com
www.hydrock.com

Hydrock Job No: C-05955-C

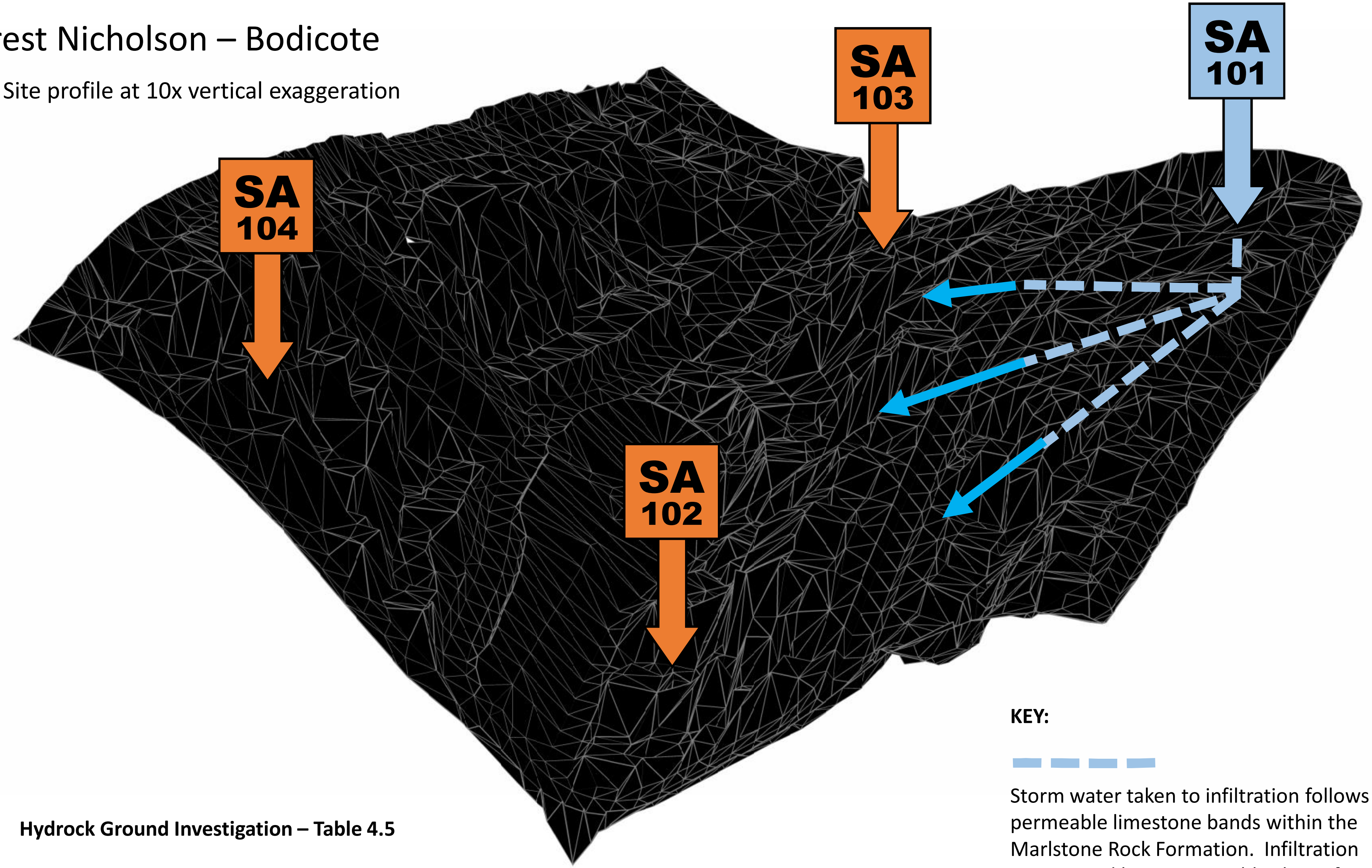
Drawn	Checked	Scale @ A1	Date	Issue Date
SD	CV	As shown	04/04/17	04/04/17

Revision: P1.1

Status: S0

Crest Nicholson – Bodicote

3D Site profile at 10x vertical exaggeration



Hydrock Ground Investigation – Table 4.5

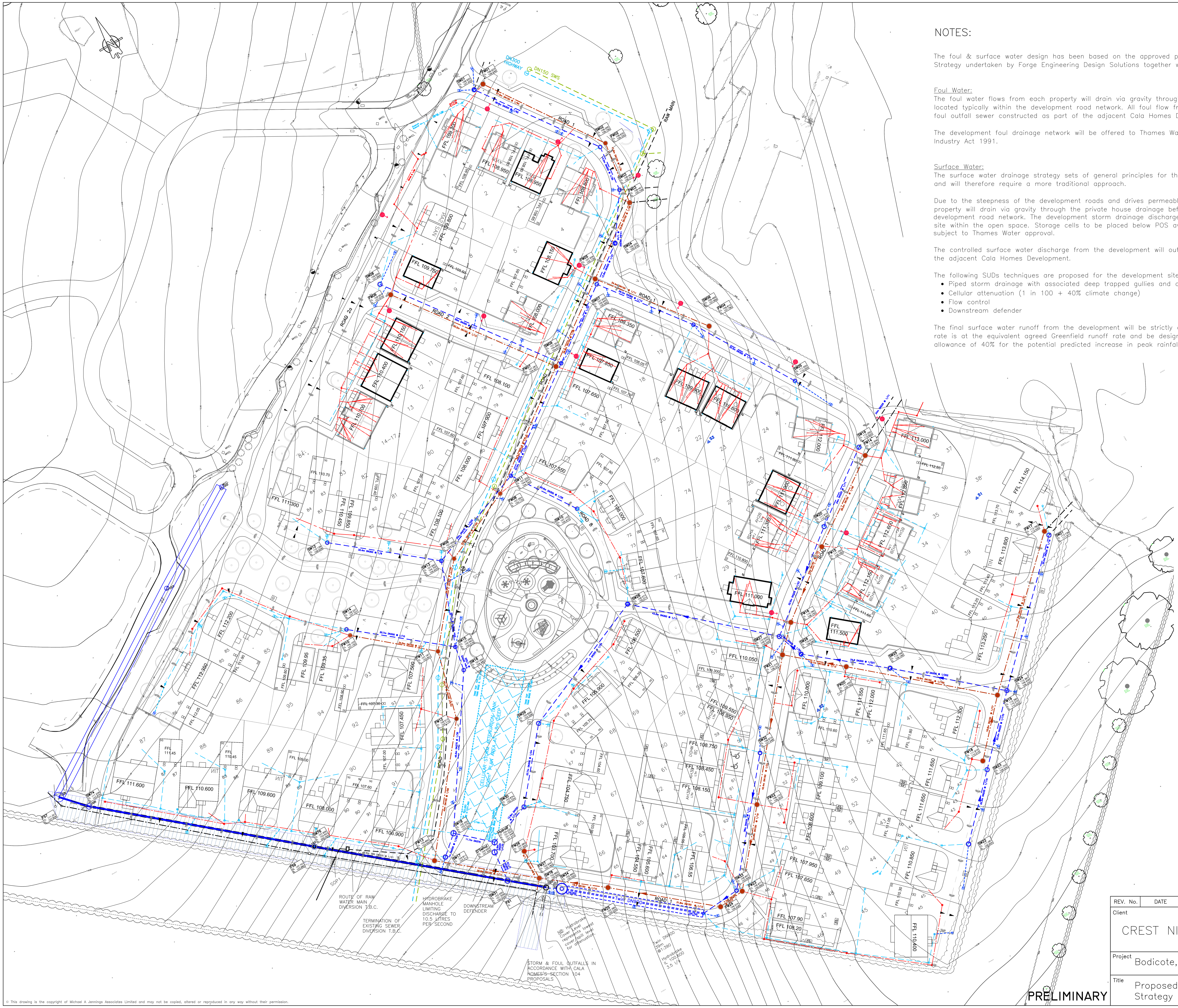
Stratum	**Trial Pit no.**	**Infiltration Rate (m/s)**
Limestone	SA101	Fail - Drainage too fast to measure
Clay	SA102	Fail - Drainage too slow to measure
Clay	SA103	Fail - Drainage too slow to measure
Clay	SA104	Fail - Drainage too slow to measure

KEY:

Storm water taken to infiltration follows permeable limestone bands within the Marlstone Rock Formation. Infiltration constrained by impermeable clays of Dryham Formation resulting in lateral flow, rather than further infiltration.

Lateral storm flow and steep gradients (exaggerated to illustrate site topography) result in risk of springs forming lower down the site and/or risk of slope instability.

APPENDIX E
FOUL & SURFACE DRAINAGE STRATEGY LAYOUT



NOTES:

The foul & surface water design has been based on the approved principles outlined within the Flood Risk Assessment & Drainage Strategy undertaken by Forge Engineering Design Solutions together with the MJA Consulting FRA Addendum.

Foul Water:
The foul water flows from each property will drain via gravity through the private house drainage before out-falling to a new sewer located typically within the development road network. All foul flow from the development gravitates in a southerly direction to a new foul outfall sewer constructed as part of the adjacent Cala Homes Development.

The development foul drainage network will be offered to Thames Water for adoption under a Section 104 agreement of the Water Industry Act 1991.

Surface Water:
The surface water drainage strategy sets of general principles for the designs. The sub strata is unsuitable for infiltration type SUDs and will therefore require a more traditional approach.

Due to the steepness of the development roads and drives permeable type paving is unsuitable. The surface water flows from each property will drain via gravity through the private house drainage before out-falling to a new storm drain located typically within the development road network. The development storm drainage discharges to an attenuation tank located towards the southern end of the site within the open space. Storage cells to be placed below POS avoiding LEAP and to be an off line design. Detail design to be subject to Thames Water approval.

The controlled surface water discharge from the development will outfall to a new surface water outfall sewer constructed as part of the adjacent Cala Homes Development.

The following SUDs techniques are proposed for the development site and form part of the drainage treatment train.
- Piped storm drainage with associated deep trapped gullies and catchpits
- Cellular attenuation (1 in 100 + 40% climate change)
- Flow control
- Downstream defender

The final surface water runoff from the development will be strictly controlled via the above Sustainable Drainage Systems. The runoff rate is at the equivalent agreed Greenfield runoff rate and be designed to manage the 1 in 100 year return storm plus an extra allowance of 40% for the potential predicted increase in peak rainfall up to 2115.

KEY:

Proposed Adoptable Sewers:

Foul sewer

Storm sewer

Road Gully
(no distinction between private or adopted at this time)

Proposed Private Drainage:

Foul drain

Storm drain

Storm Attenuation
(see plan for details)

Diversionary Works to Existing:

RAW Water Main
(subject to Thames Water approval)

Private Storm

Highway DN300

REV. No.	DATE	DESCRIPTION	INITIALS

Client: CREST NICHOLSON

Project: Bodicote, Banbury

Title: Proposed Drainage Strategy Plan

MJA CONSULTING
CIVIL AND STRUCTURAL ENGINEERS
Monarch House, Barton Lane,
Abingdon, Oxon, OX14 3NB
Tel: 01235 555173
Fax: 01235 523226

Scale	Date	Drawing No.	Rev
1:500 @A1	Nov' 2017	5692:DS	
Checked: KTG	Drawn: AJW		

PRELIMINARY

Notes:

Key:

Flood Flow Route

PRELIMINARY

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REV. No.	DATE	DESCRIPTION	INITIALS

Client: CREST NICHOLSON

MJA CONSULTING
CIVIL AND STRUCTURAL ENGINEERS
Monarch House, Barton Lane,
Abingdon, Oxon, OX14 3NB
Tel: 01235 555173
Fax: 01235 523226

Project: Bodicote, Banbury

Title: Flood Exceedance Route Plan

Scale	Date	Drawing No.	Rev
1:500 @A1	Nov' 2017	5692:FE	
Checked KTG	Drawn AJW		

APPENDIX F
DEVELOPMENT DRAINAGE CALCULATIONS

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Main

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.000	37.935	1.102	34.4	0.000	2	0.0	1.500	o	150	Pipe/Conduit	
F1.001	18.013	0.501	36.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F1.002	22.946	0.767	29.9	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F2.000	13.868	0.916	15.1	0.000	7	0.0	1.500	o	150	Pipe/Conduit	
F2.001	21.599	1.910	11.3	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F1.003	40.050	0.730	54.9	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F3.000	32.015	2.765	11.6	0.000	16	0.2	1.500	o	150	Pipe/Conduit	
F1.004	24.187	0.160	151.2	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F1.005	15.821	0.101	156.6	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F1.006	29.234	0.193	151.5	0.000	5	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	107.433	0.000	0.0	2	0.0	7	0.32	1.50	26.4	0.1
F1.001	106.331	0.000	0.0	2	0.0	7	0.32	1.46	25.9	0.1
F1.002	105.830	0.000	0.0	5	0.0	10	0.46	1.61	28.4	0.2
F2.000	107.889	0.000	0.0	7	0.0	10	0.65	2.26	39.9	0.3
F2.001	106.973	0.000	0.0	7	0.0	9	0.72	2.61	46.2	0.3
F1.003	105.063	0.000	0.0	15	0.0	19	0.53	1.18	20.9	0.7
F3.000	107.098	0.000	0.2	16	0.0	15	1.00	2.58	45.7	0.9
F1.004	104.333	0.000	0.2	31	0.0	37	0.49	0.71	12.6	1.6
F1.005	104.173	0.000	0.2	34	0.0	39	0.49	0.70	12.3	1.8
F1.006	104.072	0.000	0.2	39	0.0	41	0.52	0.71	12.6	2.0

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F4.000	24.464	3.271	7.5	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F1.007	12.448	0.082	151.8	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F1.008	22.689	0.437	51.9	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
F1.009	29.062	0.195	149.0	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
F1.010	31.939	1.558	20.5	0.000	5	0.0	1.500	o	150	Pipe/Conduit	
F5.000	28.196	0.471	59.9	0.000	4	0.0	1.500	o	150	Pipe/Conduit	
F5.001	22.879	1.149	19.9	0.000	6	0.0	1.500	o	150	Pipe/Conduit	
F5.002	9.364	0.392	23.9	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F6.000	47.544	2.243	21.2	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F7.000	19.835	0.236	84.0	0.000	2	0.0	1.500	o	100	Pipe/Conduit	
F6.001	42.937	0.430	99.9	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F6.002	18.089	1.406	12.9	0.000	2	0.0	1.500	o	150	Pipe/Conduit	
F5.003	42.406	2.042	20.8	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
F5.004	24.527	1.354	18.1	0.000	6	0.0	1.500	o	150	Pipe/Conduit	
F5.005	8.875	0.702	12.6	0.000	4	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F4.000	107.150	0.000	0.0	3	0.0	6	0.62	3.22	56.8	0.1
F1.007	103.879	0.000	0.2	42	0.0	42	0.53	0.71	12.5	2.1
F1.008	103.797	0.000	0.2	43	0.0	32	0.78	1.22	21.5	2.2
F1.009	103.360	0.000	0.2	44	0.0	43	0.54	0.72	12.7	2.2
F1.010	103.165	0.000	0.2	49	0.0	27	1.11	1.94	34.3	2.5
F5.000	110.398	0.000	0.0	4	0.0	11	0.34	1.13	20.0	0.2
F5.001	109.927	0.000	0.0	10	0.0	12	0.67	1.97	34.8	0.5
F5.002	108.778	0.000	0.0	13	0.0	15	0.68	1.80	31.8	0.6
F6.000	112.465	0.000	0.0	3	0.0	7	0.44	1.91	33.7	0.1
F7.000	110.508	0.000	0.0	2	0.0	9	0.26	0.73	5.7	0.1
F6.001	110.222	0.000	0.0	5	0.0	13	0.31	0.88	15.5	0.2
F6.002	109.792	0.000	0.0	7	0.0	10	0.69	2.45	43.3	0.3
F5.003	108.386	0.000	0.0	21	0.0	18	0.83	1.93	34.1	1.0
F5.004	106.344	0.000	0.0	27	0.0	19	0.94	2.07	36.5	1.2
F5.005	104.990	0.000	0.0	31	0.0	19	1.12	2.47	43.7	1.4

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F5.006	30.583	2.337	13.1	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
F5.007	22.277	0.344	64.8	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
F1.011	4.091	1.482	2.8	0.000	4	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F5.006	104.288	0.000	0.0	32	0.0	19	1.11	2.43	42.9	1.5
F5.007	101.951	0.000	0.0	33	0.0	29	0.64	1.09	19.3	1.5
F1.011	101.607	0.000	0.2	86	0.0	22	2.63	5.30	93.6	4.2

PIPELINE SCHEDULES for Foul - Main

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	o	150	F1	109.233	107.433	1.650	Open Manhole	1200
F1.001	o	150	F2	108.554	106.331	2.073	Open Manhole	1200
F1.002	o	150	F3	108.244	105.830	2.264	Open Manhole	1200
F2.000	o	150	F4	109.908	107.889	1.869	Open Manhole	1200
F2.001	o	150	F5	108.982	106.973	1.859	Open Manhole	1200
F1.003	o	150	F6	107.829	105.063	2.616	Open Manhole	1200
F3.000	o	150	F7	109.012	107.098	1.764	Open Manhole	1200
F1.004	o	150	F8	107.115	104.333	2.632	Open Manhole	1200
F1.005	o	150	F9	107.294	104.173	2.971	Open Manhole	1200
F1.006	o	150	F10	107.715	104.072	3.493	Open Manhole	1200
F4.000	o	150	F11	109.056	107.150	1.756	Open Manhole	1200
F1.007	o	150	F12	107.479	103.879	3.450	Open Manhole	1200
F1.008	o	150	F13	107.125	103.797	3.178	Open Manhole	1200
F1.009	o	150	F14	106.237	103.360	2.727	Open Manhole	1200
F1.010	o	150	F15	105.234	103.165	1.919	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	37.935	34.4	F2	108.554	106.331	2.073	Open Manhole	1200
F1.001	18.013	36.0	F3	108.244	105.830	2.264	Open Manhole	1200
F1.002	22.946	29.9	F6	107.829	105.063	2.616	Open Manhole	1200
F2.000	13.868	15.1	F5	108.982	106.973	1.859	Open Manhole	1200
F2.001	21.599	11.3	F6	107.829	105.063	2.616	Open Manhole	1200
F1.003	40.050	54.9	F8	107.115	104.333	2.632	Open Manhole	1200
F3.000	32.015	11.6	F8	107.115	104.333	2.632	Open Manhole	1200
F1.004	24.187	151.2	F9	107.294	104.173	2.971	Open Manhole	1200
F1.005	15.821	156.6	F10	107.715	104.072	3.493	Open Manhole	1200
F1.006	29.234	151.5	F12	107.479	103.879	3.450	Open Manhole	1200
F4.000	24.464	7.5	F12	107.479	103.879	3.450	Open Manhole	1200
F1.007	12.448	151.8	F13	107.125	103.797	3.178	Open Manhole	1200
F1.008	22.689	51.9	F14	106.237	103.360	2.727	Open Manhole	1200
F1.009	29.062	149.0	F15	105.234	103.165	1.919	Open Manhole	1200
F1.010	31.939	20.5	F28	102.957	101.607	1.200	Open Manhole	1200

PIPELINE SCHEDULES for Foul - Main

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F5.000	o	150	F20	112.338	110.398	1.790	Open Manhole	1200
F5.001	o	150	F21	111.880	109.927	1.803	Open Manhole	1200
F5.002	o	150	F22	110.994	108.778	2.066	Open Manhole	1200
F6.000	o	150	F16	113.815	112.465	1.200	Open Manhole	1200
F7.000	o	100	F17	111.808	110.508	1.200	Open Manhole	1200
F6.001	o	150	F18	112.411	110.222	2.039	Open Manhole	1200
F6.002	o	150	F19	111.455	109.792	1.513	Open Manhole	1200
F5.003	o	150	F23	110.478	108.386	1.942	Open Manhole	1200
F5.004	o	150	F24	108.349	106.344	1.855	Open Manhole	1200
F5.005	o	150	F25	106.879	104.990	1.739	Open Manhole	1200
F5.006	o	150	F26	106.200	104.288	1.762	Open Manhole	1200
F5.007	o	150	F27	103.629	101.951	1.528	Open Manhole	1200
F1.011	o	150	F28	102.957	101.607	1.200	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F5.000	28.196	59.9	F21	111.880	109.927	1.803	Open Manhole	1200
F5.001	22.879	19.9	F22	110.994	108.778	2.066	Open Manhole	1200
F5.002	9.364	23.9	F23	110.478	108.386	1.942	Open Manhole	1200
F6.000	47.544	21.2	F18	112.411	110.222	2.039	Open Manhole	1200
F7.000	19.835	84.0	F18	112.411	110.272	2.039	Open Manhole	1200
F6.001	42.937	99.9	F19	111.455	109.792	1.513	Open Manhole	1200
F6.002	18.089	12.9	F23	110.478	108.386	1.942	Open Manhole	1200
F5.003	42.406	20.8	F24	108.349	106.344	1.855	Open Manhole	1200
F5.004	24.527	18.1	F25	106.879	104.990	1.739	Open Manhole	1200
F5.005	8.875	12.6	F26	106.200	104.288	1.762	Open Manhole	1200
F5.006	30.583	13.1	F27	103.629	101.951	1.528	Open Manhole	1200
F5.007	22.277	64.8	F28	102.957	101.607	1.200	Open Manhole	1200
F1.011	4.091	2.8	F	102.549	100.125	2.274	Open Manhole	0

Free Flowing Outfall Details for Foul - Main

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F1.011	F	102.549	100.125	0.000	0	0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.800	Add Flow / Climate Change (%)	0
Ratio R	0.404	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	550	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.854	4-8	0.605

Total Area Contributing (ha) = 1.459

Total Pipe Volume (m³) = 66.908

Network Design Table for Storm

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
S1.000	38.625	0.624	61.9	0.039	5.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S1.001	13.106	0.479	27.4	0.064	0.00	0.0	0.600	o	300	Pipe/Conduit	🔓
S1.002	14.956	0.339	44.1	0.015	0.00	0.0	0.600	o	300	Pipe/Conduit	🔓
S1.003	12.517	0.338	37.0	0.066	0.00	0.0	0.600	o	300	Pipe/Conduit	🔓
S2.000	32.393	2.086	15.5	0.088	5.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S2.001	29.226	2.329	12.5	0.040	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)
S1.000	68.06	5.32	107.420	0.039	0.0	0.0	0.0	2.00	141.5	7.2
S1.001	67.66	5.39	106.796	0.103	0.0	0.0	0.0	3.02	213.3	18.9
S1.002	67.09	5.50	106.317	0.118	0.0	0.0	0.0	2.37	167.8	21.4
S1.003	66.66	5.58	105.978	0.184	0.0	0.0	0.0	2.59	183.2	33.2
S2.000	69.12	5.13	110.055	0.088	0.0	0.0	0.0	4.01	283.4	16.5
S2.001	68.50	5.24	107.969	0.128	0.0	0.0	0.0	4.46	315.4	23.7

Network Design Table for Storm

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
S1.004	24.205	0.650	37.2	0.037	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.000	55.141	2.979	18.5	0.100	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	34.396	0.153	224.8	0.099	0.00	0.0	0.600	o	450	Pipe/Conduit	
S4.000	20.657	0.838	24.7	0.046	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.006	30.680	0.137	223.9	0.066	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	32.241	3.928	8.2	0.052	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.007	24.318	0.182	133.6	0.010	0.00	0.0	0.600	o	450	Pipe/Conduit	
S6.000	30.768	3.134	9.8	0.113	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.008	6.883	0.033	208.6	0.009	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.009	45.635	1.285	35.5	0.019	0.00	0.0	0.600	o	450	Pipe/Conduit	
S7.000	7.034	0.036	195.4	0.015	5.00	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)
S1.004	65.95	5.71	105.565	0.349	0.0	0.0	0.0	2.98	328.8	62.3
S3.000	68.46	5.25	107.969	0.100	0.0	0.0	0.0	3.67	259.5	18.5
S1.005	63.83	6.14	104.840	0.548	0.0	0.0	0.0	1.35	215.0	94.7
S4.000	69.28	5.11	105.675	0.046	0.0	0.0	0.0	3.18	224.8	8.6
S1.006	62.08	6.52	104.687	0.660	0.0	0.0	0.0	1.35	215.4	111.0
S5.000	69.34	5.10	108.628	0.052	0.0	0.0	0.0	5.52	390.2	9.8
S1.007	61.06	6.75	104.550	0.722	0.0	0.0	0.0	1.76	279.5	119.4
S6.000	69.32	5.10	107.727	0.113	0.0	0.0	0.0	5.05	356.7	21.2
S1.008	60.71	6.83	104.368	0.844	0.0	0.0	0.0	1.40	223.3	138.8
S1.009	59.77	7.05	104.335	0.863	0.0	0.0	0.0	3.42	544.0	139.7
S7.000	69.30	5.10	103.311	0.015	0.0	0.0	0.0	1.12	79.3	2.8

Network Design Table for Storm

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
S1.010	11.751	0.130	90.4	0.005	0.00	0.0	0.600	o	450	Pipe/Conduit	
S8.000	44.965	2.462	18.3	0.084	5.00	0.0	0.600	o	225	Pipe/Conduit	
S9.000	21.388	0.120	178.2	0.085	5.00	0.0	0.600	o	225	Pipe/Conduit	
S9.001	22.722	0.125	181.8	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.001	33.206	0.138	240.6	0.025	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.002	25.135	0.111	226.4	0.056	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.003	7.826	0.085	92.1	0.027	0.00	0.0	0.600	o	300	Pipe/Conduit	
S10.000	24.178	0.350	69.1	0.032	5.00	0.0	0.600	o	225	Pipe/Conduit	
S10.001	33.145	1.410	23.5	0.049	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.004	43.294	3.929	11.0	0.058	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.005	41.544	1.743	23.8	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.006	23.635	0.994	23.8	0.063	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.007	12.871	0.886	14.5	0.034	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.011	2.818	0.017	165.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.012	8.681	0.047	184.7	0.000	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)
S1.010	59.40	7.14	103.050	0.883	0.0	0.0	0.0	2.14	340.2	142.0
S8.000	68.50	5.24	111.871	0.084	0.0	0.0	0.0	3.08	122.3	15.6
S9.000	67.82	5.37	109.654	0.085	0.0	0.0	0.0	0.98	38.8	15.6
S9.001	65.73	5.76	109.534	0.125	0.0	0.0	0.0	0.97	38.4	22.3
S8.001	63.05	6.31	109.334	0.234	0.0	0.0	0.0	1.01	71.3	40.0
S8.002	61.23	6.71	109.196	0.290	0.0	0.0	0.0	1.04	73.6	48.1
S8.003	60.88	6.79	109.085	0.317	0.0	0.0	0.0	1.64	115.9	52.3
S10.000	68.43	5.26	110.835	0.032	0.0	0.0	0.0	1.58	62.6	5.9
S10.001	67.30	5.46	110.485	0.081	0.0	0.0	0.0	2.71	107.8	14.8
S8.004	60.24	6.94	109.000	0.456	0.0	0.0	0.0	4.76	336.6	74.4
S8.005	59.35	7.15	105.071	0.479	0.0	0.0	0.0	3.23	228.6	77.0
S8.006	58.87	7.27	103.328	0.542	0.0	0.0	0.0	3.24	228.9	86.4
S8.007	58.66	7.33	102.334	0.576	0.0	0.0	0.0	4.15	293.1	91.5
S1.011	69.64	5.05	101.373	0.000	10.5	0.0	0.0	1.01	40.3	10.5
S1.012	68.76	5.20	101.356	0.000	10.5	0.0	0.0	0.96	38.1	10.5

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.039	0.039	0.039
1.001	-	-	100	0.064	0.064	0.064
1.002	-	-	100	0.015	0.015	0.015
1.003	-	-	100	0.066	0.066	0.066
2.000	-	-	100	0.088	0.088	0.088
2.001	-	-	100	0.040	0.040	0.040
1.004	-	-	100	0.037	0.037	0.037
3.000	-	-	100	0.100	0.100	0.100
1.005	-	-	100	0.099	0.099	0.099
4.000	-	-	100	0.046	0.046	0.046
1.006	-	-	100	0.066	0.066	0.066
5.000	-	-	100	0.052	0.052	0.052
1.007	-	-	100	0.010	0.010	0.010
6.000	-	-	100	0.113	0.113	0.113
1.008	-	-	100	0.009	0.009	0.009
1.009	-	-	100	0.019	0.019	0.019
7.000	-	-	100	0.015	0.015	0.015
1.010	-	-	100	0.005	0.005	0.005
8.000	-	-	100	0.084	0.084	0.084
9.000	-	-	100	0.085	0.085	0.085
9.001	-	-	100	0.040	0.040	0.040
8.001	-	-	100	0.025	0.025	0.025
8.002	-	-	100	0.056	0.056	0.056
8.003	-	-	100	0.027	0.027	0.027
10.000	-	-	100	0.032	0.032	0.032
10.001	-	-	100	0.049	0.049	0.049
8.004	-	-	100	0.058	0.058	0.058
8.005	-	-	100	0.023	0.023	0.023
8.006	-	-	100	0.063	0.063	0.063
8.007	-	-	100	0.034	0.034	0.034
1.011	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.459	1.459	1.459

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.012	S	104.225	101.309	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
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)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.800	Storm Duration (mins)	30
Ratio R	0.404		

Online Controls for Storm

Complex Manhole: S19, DS/PN: S1.011, Volume (m^3): 7.4

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0137-1050-1825-1050
Design Head (m)	1.825
Design Flow (l/s)	10.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	101.373
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.825	10.5
Flush-Flo™	0.538	10.5
Kick-Flo®	1.114	8.3
Mean Flow over Head Range	-	9.2

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	4.9	1.200	8.6	3.000	13.3	7.000	19.9
0.200	9.0	1.400	9.3	3.500	14.3	7.500	20.6
0.300	9.9	1.600	9.9	4.000	15.2	8.000	21.2
0.400	10.3	1.800	10.4	4.500	16.1	8.500	21.8
0.500	10.5	2.000	11.0	5.000	16.9	9.000	22.4
0.600	10.5	2.200	11.5	5.500	17.7	9.500	23.0
0.800	10.2	2.400	11.9	6.000	18.5		
1.000	9.3	2.600	12.4	6.500	19.2		

Weir

Discharge Coef 0.544 Width (m) 0.500 Invert Level (m) 103.198

Storage Structures for Storm

Cellular Storage Manhole: S19, DS/PN: S1.011

Invert Level (m) 101.373 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	500.0	500.0	1.300	500.0	616.3
0.100	500.0	508.9	1.400	500.0	625.2
0.200	500.0	517.9	1.500	500.0	634.2
0.300	500.0	526.8	1.600	500.0	643.1
0.400	500.0	535.8	1.700	500.0	652.1
0.500	500.0	544.7	1.800	500.0	661.0
0.600	500.0	553.7	1.900	500.0	669.9
0.700	500.0	562.6	2.000	500.0	678.9
0.800	500.0	571.6	2.100	500.0	687.8
0.900	500.0	580.5	2.200	500.0	696.8
1.000	500.0	589.4	2.300	500.0	705.7
1.100	500.0	598.4	2.400	500.0	714.7
1.200	500.0	607.3	2.500	500.0	723.6

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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	FSR	Ratio R	0.409
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS 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)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	1	+0%					107.459
S1.001	S2	15 Winter	1	+0%	100/15 Winter				106.851
S1.002	S3	15 Winter	1	+0%	100/15 Summer				106.382
S1.003	S4	15 Winter	1	+0%	100/15 Summer				106.057
S2.000	S5	15 Winter	1	+0%					110.097
S2.001	S6	15 Winter	1	+0%					108.017
S1.004	S7	15 Winter	1	+0%	100/15 Summer				105.664
S3.000	S8	15 Winter	1	+0%					108.015
S1.005	S9	15 Winter	1	+0%	30/15 Summer				105.030
S4.000	S10	15 Winter	1	+0%	100/15 Summer				105.710
S1.006	S11	15 Winter	1	+0%	30/15 Summer				104.897
S5.000	S12	15 Winter	1	+0%					108.657
S1.007	S13	15 Winter	1	+0%	30/15 Summer				104.743
S6.000	S14	15 Winter	1	+0%					107.770
S1.008	S15	15 Winter	1	+0%	30/15 Summer				104.658
S1.009	S16	15 Winter	1	+0%	100/15 Summer				104.476
S7.000	S17	15 Winter	1	+0%	100/15 Summer				103.348
S1.010	S18	15 Winter	1	+0%	30/15 Summer				103.284
S8.000	S21	15 Winter	1	+0%					111.919

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.261	0.000	0.04		5.4	OK	
S1.001	S2	-0.245	0.000	0.07		12.9	OK	
S1.002	S3	-0.235	0.000	0.11		14.8	OK	
S1.003	S4	-0.221	0.000	0.16		22.6	OK	
S2.000	S5	-0.258	0.000	0.05		12.3	OK	
S2.001	S6	-0.252	0.000	0.06		17.0	OK	
S1.004	S7	-0.276	0.000	0.16		44.0	OK	
S3.000	S8	-0.254	0.000	0.06		14.0	OK	
S1.005	S9	-0.260	0.000	0.37		69.3	OK	
S4.000	S10	-0.265	0.000	0.03		6.5	OK	
S1.006	S11	-0.240	0.000	0.44		81.8	OK	
S5.000	S12	-0.271	0.000	0.02		7.3	OK	
S1.007	S13	-0.257	0.000	0.38		89.7	OK	
S6.000	S14	-0.257	0.000	0.05		15.8	OK	
S1.008	S15	-0.160	0.000	0.74		104.0	OK	
S1.009	S16	-0.309	0.000	0.22		105.7	OK	
S7.000	S17	-0.263	0.000	0.04		2.1	OK	
S1.010	S18	-0.216	0.000	0.53		107.1	OK	
S8.000	S21	-0.177	0.000	0.10		11.8	OK	

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S9.000	S22	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
S9.001	S23	15 Winter	1	+0%	30/15 Summer			
S8.001	S24	15 Winter	1	+0%	30/15 Summer			
S8.002	S25	15 Winter	1	+0%	30/15 Summer			
S8.003	S26	15 Winter	1	+0%	30/15 Summer			
S10.000	S19	15 Winter	1	+0%				
S10.001	S20	15 Winter	1	+0%				
S8.004	S27	15 Winter	1	+0%				
S8.005	S28	15 Winter	1	+0%	100/15 Summer	100/15 Winter		
S8.006	S29	15 Winter	1	+0%	100/15 Summer			
S8.007	S30	15 Winter	1	+0%	100/15 Summer			
S1.011	S19	240 Winter	1	+0%	1/30 Winter			
S1.012	S20	240 Winter	1	+0%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S9.000	S22	109.744	-0.135	0.000	0.33		11.7	OK	2
S9.001	S23	109.643	-0.116	0.000	0.47		16.4	OK	
S8.001	S24	109.479	-0.155	0.000	0.46		30.2	OK	
S8.002	S25	109.356	-0.140	0.000	0.55		36.3	OK	
S8.003	S26	109.241	-0.144	0.000	0.53		38.7	OK	
S10.000	S19	110.877	-0.183	0.000	0.08		4.4	OK	
S10.001	S20	110.533	-0.177	0.000	0.10		10.2	OK	
S8.004	S27	109.084	-0.216	0.000	0.17		54.1	OK	
S8.005	S28	105.176	-0.195	0.000	0.27		56.4	OK	1
S8.006	S29	103.442	-0.186	0.000	0.31		62.9	OK	
S8.007	S30	102.442	-0.192	0.000	0.28		66.3	OK	
S1.011	S19	101.714	0.116	0.000	0.36		9.7	SURCHARGED	
S1.012	S20	101.443	-0.138	0.000	0.32		9.7	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 FSR Ratio R 0.409
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS 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) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	30	+0%					107.484
S1.001	S2	15 Winter	30	+0%	100/15 Winter				106.890
S1.002	S3	15 Winter	30	+0%	100/15 Summer				106.430
S1.003	S4	15 Winter	30	+0%	100/15 Summer				106.121
S2.000	S5	15 Winter	30	+0%					110.123
S2.001	S6	15 Winter	30	+0%					108.048
S1.004	S7	15 Winter	30	+0%	100/15 Summer				105.740
S3.000	S8	15 Winter	30	+0%					108.044
S1.005	S9	15 Winter	30	+0%	30/15 Summer				105.452
S4.000	S10	15 Winter	30	+0%	100/15 Summer				105.732
S1.006	S11	15 Winter	30	+0%	30/15 Summer				105.324
S5.000	S12	15 Winter	30	+0%					108.671
S1.007	S13	15 Winter	30	+0%	30/15 Summer				105.152
S6.000	S14	15 Winter	30	+0%					107.796
S1.008	S15	15 Winter	30	+0%	30/15 Summer				104.980
S1.009	S16	15 Winter	30	+0%	100/15 Summer				104.572
S7.000	S17	15 Winter	30	+0%	100/15 Summer				103.577
S1.010	S18	15 Winter	30	+0%	30/15 Summer				103.575
S8.000	S21	15 Winter	30	+0%					111.947

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.236	0.000	0.10		13.3	OK	
S1.001	S2	-0.206	0.000	0.21		36.7	OK	
S1.002	S3	-0.187	0.000	0.30		42.0	OK	
S1.003	S4	-0.157	0.000	0.45		66.1	OK	
S2.000	S5	-0.232	0.000	0.12		30.3	OK	
S2.001	S6	-0.221	0.000	0.16		44.8	OK	
S1.004	S7	-0.200	0.000	0.44		123.9	OK	
S3.000	S8	-0.225	0.000	0.14		34.5	OK	
S1.005	S9	0.162	0.000	0.94		176.0	SURCHARGED	
S4.000	S10	-0.243	0.000	0.08		15.8	OK	
S1.006	S11	0.187	0.000	1.10		204.5	SURCHARGED	
S5.000	S12	-0.257	0.000	0.05		17.9	OK	
S1.007	S13	0.152	0.000	0.96		223.8	SURCHARGED	
S6.000	S14	-0.231	0.000	0.12		39.0	OK	
S1.008	S15	0.162	0.000	1.85		259.3	SURCHARGED	
S1.009	S16	-0.213	0.000	0.54		264.2	OK	
S7.000	S17	-0.034	0.000	0.08		4.5	OK	
S1.010	S18	0.075	0.000	1.31		267.1	SURCHARGED	
S8.000	S21	-0.149	0.000	0.25		28.9	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S9.000	S22	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
S9.001	S23	15 Winter	30	+0%	30/15 Summer			
S8.001	S24	15 Winter	30	+0%	30/15 Summer			
S8.002	S25	15 Winter	30	+0%	30/15 Summer			
S8.003	S26	15 Winter	30	+0%	30/15 Summer			
S10.000	S19	15 Winter	30	+0%				
S10.001	S20	15 Winter	30	+0%				
S8.004	S27	15 Winter	30	+0%				
S8.005	S28	15 Winter	30	+0%	100/15 Summer	100/15 Winter		
S8.006	S29	15 Winter	30	+0%	100/15 Summer			
S8.007	S30	15 Winter	30	+0%	100/15 Summer			
S1.011	S19	240 Winter	30	+0%	1/30 Winter			
S1.012	S20	960 Winter	30	+0%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S9.000	S22	109.960	0.081	0.000	0.73		26.0	SURCHARGED	2
S9.001	S23	109.897	0.138	0.000	1.03		36.4	SURCHARGED	
S8.001	S24	109.760	0.126	0.000	1.05		68.8	SURCHARGED	
S8.002	S25	109.600	0.104	0.000	1.26		83.1	SURCHARGED	
S8.003	S26	109.415	0.030	0.000	1.23		89.6	SURCHARGED	
S10.000	S19	110.902	-0.158	0.000	0.19		10.9	OK	
S10.001	S20	110.567	-0.143	0.000	0.28		28.8	OK	
S8.004	S27	109.136	-0.164	0.000	0.41		127.9	OK	
S8.005	S28	105.249	-0.122	0.000	0.63		133.9	OK	1
S8.006	S29	103.529	-0.099	0.000	0.75		153.0	OK	
S8.007	S30	102.522	-0.112	0.000	0.69		163.9	OK	
S1.011	S19	102.279	0.681	0.000	0.38		10.5	SURCHARGED	
S1.012	S20	101.447	-0.134	0.000	0.34		10.5	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

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	FSR	Ratio R	0.409
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS 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)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+40%					107.508
S1.001	S2	15 Winter	100	+40%	100/15 Winter				107.162
S1.002	S3	15 Winter	100	+40%	100/15 Summer				107.127
S1.003	S4	15 Winter	100	+40%	100/15 Summer				107.082
S2.000	S5	15 Winter	100	+40%					110.149
S2.001	S6	15 Winter	100	+40%					108.079
S1.004	S7	15 Winter	100	+40%	100/15 Summer				106.977
S3.000	S8	15 Winter	100	+40%					108.072
S1.005	S9	15 Winter	100	+40%	30/15 Summer				106.739
S4.000	S10	15 Winter	100	+40%	100/15 Summer				106.430
S1.006	S11	15 Winter	100	+40%	30/15 Summer				106.407
S5.000	S12	15 Winter	100	+40%					108.689
S1.007	S13	15 Winter	100	+40%	30/15 Summer				105.968
S6.000	S14	15 Winter	100	+40%					107.822
S1.008	S15	15 Winter	100	+40%	30/15 Summer				105.529
S1.009	S16	15 Winter	100	+40%	100/15 Summer				104.952
S7.000	S17	15 Winter	100	+40%	100/15 Summer				103.967
S1.010	S18	15 Winter	100	+40%	30/15 Summer				103.963
S8.000	S21	15 Winter	100	+40%					111.977

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.212	0.000	0.18		24.1	OK	
S1.001	S2	0.066	0.000	0.37		63.4	SURCHARGED	
S1.002	S3	0.510	0.000	0.49		68.7	SURCHARGED	
S1.003	S4	0.804	0.000	0.67		98.1	SURCHARGED	
S2.000	S5	-0.206	0.000	0.21		55.2	OK	
S2.001	S6	-0.190	0.000	0.28		81.4	OK	
S1.004	S7	1.037	0.000	0.62		176.6	SURCHARGED	
S3.000	S8	-0.197	0.000	0.26		62.7	OK	
S1.005	S9	1.449	0.000	1.50		281.4	SURCHARGED	
S4.000	S10	0.455	0.000	0.13		25.8	SURCHARGED	
S1.006	S11	1.270	0.000	1.77		329.0	SURCHARGED	
S5.000	S12	-0.239	0.000	0.09		32.6	OK	
S1.007	S13	0.968	0.000	1.55		361.3	SURCHARGED	
S6.000	S14	-0.205	0.000	0.22		70.8	OK	
S1.008	S15	0.711	0.000	3.04		424.7	SURCHARGED	
S1.009	S16	0.167	0.000	0.88		432.6	SURCHARGED	
S7.000	S17	0.356	0.000	0.12		7.2	SURCHARGED	
S1.010	S18	0.463	0.000	2.16		438.5	SURCHARGED	
S8.000	S21	-0.119	0.000	0.45		52.6	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S9.000	S22	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
S9.001	S23	15 Winter	100	+40%	30/15 Summer			
S8.001	S24	15 Winter	100	+40%	30/15 Summer			
S8.002	S25	15 Winter	100	+40%	30/15 Summer			
S8.003	S26	15 Winter	100	+40%	30/15 Summer			
S10.000	S19	15 Winter	100	+40%				
S10.001	S20	15 Winter	100	+40%				
S8.004	S27	15 Winter	100	+40%				
S8.005	S28	15 Winter	100	+40%	100/15 Summer	100/15 Winter		
S8.006	S29	15 Winter	100	+40%	100/15 Summer			
S8.007	S30	480 Winter	100	+40%	100/15 Summer			
S1.011	S19	480 Winter	100	+40%	1/30 Winter			
S1.012	S20	15 Summer	100	+40%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S9.000	S22	111.062	1.183	1.117	1.34		47.4	FLOOD	2
S9.001	S23	110.976	1.217	0.000	1.80		63.4	SURCHARGED	
S8.001	S24	110.674	1.040	0.000	1.77		115.5	SURCHARGED	
S8.002	S25	110.227	0.731	0.000	2.17		142.4	SURCHARGED	
S8.003	S26	109.682	0.297	0.000	2.12		155.0	SURCHARGED	
S10.000	S19	110.927	-0.133	0.000	0.34		19.8	OK	
S10.001	S20	110.601	-0.109	0.000	0.52		52.4	OK	
S8.004	S27	109.197	-0.103	0.000	0.75		234.6	OK	
S8.005	S28	106.571	1.200	0.263	1.09		232.9	FLOOD	1
S8.006	S29	104.513	0.885	0.000	1.26		256.2	SURCHARGED	
S8.007	S30	103.254	0.620	0.000	0.16		38.8	SURCHARGED	
S1.011	S19	103.251	1.653	0.000	0.38		10.5	SURCHARGED	
S1.012	S20	101.447	-0.134	0.000	0.34		10.5	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm Sys 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.800	Add Flow / Climate Change (%)	0
Ratio R	0.404	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm Sys 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.201	4-8	0.066

Total Area Contributing (ha) = 0.267

Total Pipe Volume (m³) = 53.571

Network Design Table for Storm Sys 2

- Indicates pipe length does not match coordinates

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
S10.000	38.967	3.502	11.1	0.068	5.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S11.000	5.000#	0.050	100.0	0.046	5.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S11.001	5.000#	0.050	100.0	0.000	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)
S10.000	50.00	5.16	107.448	0.068	0.0	0.0	0.0	3.95	156.9	9.2
S11.000	50.00	5.08	105.750	0.046	0.0	0.0	0.0	1.00	17.8	6.2
S11.001	50.00	5.08	105.700	0.000	1.0	0.0	0.0	1.00	17.8	1.0

Network Design Table for Storm Sys 2

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
S10.001	11.259	2.571	4.4	0.020	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S12.000	5.000#	0.050	100.0	0.085	5.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S12.001	5.000#	0.050	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S10.002	40.118	0.150	267.5	0.046	0.00	0.0	0.600	H3	-3	Pipe/Conduit	🔓
S10.003	4.418	0.100	44.2	0.002	0.00	0.0	0.600	oo	225	Double Pipe	🔓

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)
S10.001	50.00	5.19	103.946	0.088	1.0	0.0	0.0	6.30	250.3	12.9
S12.000	50.00	5.08	101.900	0.085	0.0	0.0	0.0	1.00	17.8	11.5
S12.001	50.00	5.08	101.850	0.000	1.0	0.0	0.0	1.00	17.8	1.0
S10.002	50.00	5.49	100.600	0.134	2.0	0.0	0.0	2.29	2909.0	20.1
S10.003	50.00	5.04	100.450	0.000	3.5	0.0	0.0	1.97	156.9	3.5

Conduit Sections for Storm Sys 2

NOTE: Diameters less than 66 refer to section numbers of hydraulic conduits. These conduits are marked by the symbols:- [] box culvert, \/ open channel, oo dual pipe, ooo triple pipe, O egg.

Section numbers < 0 are taken from user conduit table

Section Number	Conduit Type	Major Dimn. (mm)	Minor Dimn. (mm)	Side Slope (Deg)	Corner Splay (mm)	4*Hyd Radius (m)	XSect Area (m²)
-3	H3	1650	1000			1.210	1.268

Area Summary for Storm Sys 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
10.000	-	-	100	0.068	0.068	0.068
11.000	-	-	100	0.046	0.046	0.046
11.001	-	-	100	0.000	0.000	0.000
10.001	-	-	100	0.020	0.020	0.020
12.000	-	-	100	0.085	0.085	0.085
12.001	-	-	100	0.000	0.000	0.000
10.002	-	-	100	0.046	0.046	0.046
10.003	-	-	100	0.002	0.002	0.002
				Total 0.267	Total 0.267	Total 0.267

Free Flowing Outfall Details for Storm Sys 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S10.003	S	102.850	100.350	0.000	0	0

Simulation Criteria for Storm Sys 2

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
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)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	2
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	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.800	Storm Duration (mins)	30
Ratio R	0.404		

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Sys 2

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 2
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 FSR Ratio R 0.409
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS 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) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S10.000	S32	15 Winter	1	+0%				
S11.000	S2	15 Winter	1	+0%	30/15 Summer			
S11.001	S3	360 Winter	1	+0%	30/30 Summer			
S10.001	S33	15 Winter	1	+0%				
S12.000	S3	360 Winter	1	+0%	1/180 Winter			
S12.001	S4	360 Winter	1	+0%	1/60 Winter			
S10.002	S34A	30 Winter	1	+0%	100/180 Winter			
S10.003	S34B	30 Winter	1	+0%	1/15 Winter			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S10.000	S32	107.485	-0.188	0.000	0.06		9.5	OK	
S11.000	S2	105.822	-0.078	0.000	0.46		6.4	OK	
S11.001	S3	105.809	-0.041	0.000	0.02		0.3	OK	
S10.001	S33	103.981	-0.190	0.000	0.06		11.9	OK	
S12.000	S3	102.063	0.013	0.000	0.12		1.7	SURCHARGED	

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Sys 2

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S12.001	S4	102.062	0.062	0.000	0.03		0.4	SURCHARGED	
S10.002	S34A	100.707	-0.893	0.000	0.01		13.1	OK	
S10.003	S34B	100.707	0.032	0.000	0.04		3.5	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Sys 2

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 2
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 FSR Ratio R 0.409
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS 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) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S10.000	S32	15 Winter	30	+0%				
S11.000	S2	240 Winter	30	+0%	30/15 Summer			
S11.001	S3	240 Winter	30	+0%	30/30 Summer			
S10.001	S33	15 Winter	30	+0%				
S12.000	S3	360 Winter	30	+0%	1/180 Winter			
S12.001	S4	360 Winter	30	+0%	1/60 Winter			
S10.002	S34A	60 Winter	30	+0%	100/180 Winter			
S10.003	S34B	60 Winter	30	+0%	1/15 Winter			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S10.000	S32	107.508	-0.165	0.000	0.16		23.4	OK	
S11.000	S2	105.963	0.063	0.000	0.20		2.8	SURCHARGED	
S11.001	S3	105.962	0.112	0.000	0.03		0.4	SURCHARGED	
S10.001	S33	104.003	-0.168	0.000	0.14		30.7	OK	
S12.000	S3	102.364	0.314	0.000	0.27		3.8	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Sys 2

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S12.001	S4	102.362	0.362	0.000	0.04		0.6	SURCHARGED	
S10.002	S34A	100.992	-0.608	0.000	0.01		21.6	OK	
S10.003	S34B	100.992	0.317	0.000	0.04		3.5	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Sys 2

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	2
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	FSR	Ratio R	0.409
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS 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)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S10.000	S32	15 Winter	100	+40%				
S11.000	S2	360 Winter	100	+40%	30/15 Summer			
S11.001	S3	360 Winter	100	+40%	30/30 Summer			
S10.001	S33	15 Winter	100	+40%				
S12.000	S3	480 Winter	100	+40%	1/180 Winter			
S12.001	S4	480 Winter	100	+40%	1/60 Winter			
S10.002	S34A	180 Winter	100	+40%	100/180 Winter			
S10.003	S34B	180 Winter	100	+40%	1/15 Winter			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S10.000	S32	107.530	-0.143	0.000	0.29		42.6	OK	
S11.000	S2	106.209	0.309	0.000	0.27		3.8	SURCHARGED	
S11.001	S3	106.207	0.357	0.000	0.04		0.6	SURCHARGED	
S10.001	S33	104.025	-0.146	0.000	0.26		55.9	OK	
S12.000	S3	102.844	0.794	0.000	0.39		5.5	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Sys 2

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S12.001	S4	102.842	0.842	0.000	0.06		0.8	SURCHARGED	
S10.002	S34A	101.607	0.007	0.000	0.01		18.8	SURCHARGED	
S10.003	S34B	101.607	0.932	0.000	0.04		3.6	SURCHARGED	

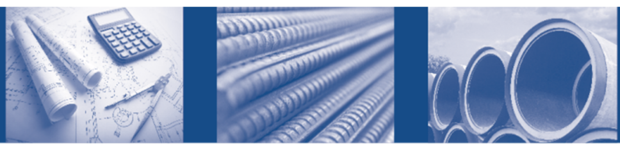
APPENDIX G

SUDS MANAGEMENT & MAINTENANCE PLAN

OXFORD ROAD,
BODICOTE
OXON

SUDS MANAGEMENT
&
MAINTENANCE PLAN

Date: 4th October 2018
Ref: AMc/18/**5627**
Rev: -



DOCUMENT CONTROL RECORD

Document Issue:

Rev	Date	Issue Status	Prepared by	Checked by
-	04.10.17	First Issue	A. Mcshane	C. Pendle

References:

The SUDS manual – CIRIA C753 (2015) ISBN 9780-86017-760-9

National Planning Policy Framework (NPPF) – Communities and Local Government
Technical Guidance - Flood Risk & Coastal Change (March 2012)

1 Introduction

1.1 This document sets out the principles for the long term management and maintenance of the proposed surface water Sustainable Drainage Systems (SuDS) installed at the residential development located at Oxford Road, Bodicote, Oxon for Crest Nicholson Midlands.

1.2 The purpose of this document is to set out the basis of the development SUDs Maintenance Plan and to ensure that the adopting management company is entrusted with a robust inspection and maintenance programme, ensuring the optimum operation of the surface water drainage network is continually maintained for the lifetime of the development and to prevent the increased risk of flooding both on and off site in accordance with The National Planning Policy Framework (NPPF).

1.3 The principle storm water drainage strategy for the development is to utilise an attenuated and controlled discharge to the existing surface water outfall sewer for all surface water runoff generated from the site.

1.4 This document details the SuDS structures within development and their required maintenance processes to ensure that no polluted runoff is discharged downstream.

1.5 This plan has been comprised of and is directly referenced from the latest technical SuDS guidance within the *CIRIA Report C753 The SuDS Manual* (2015) and other applicable guidance.

1.6 The activities listed are specific to the relative SuDS types and represent the minimum maintenance and inspection requirements, however additional tasks or varied maintenance frequency may be instructed by the maintenance company as required.
Specific maintenance needs of the SuDS elements to be monitored and maintenance schedules adjusted to suit requirements.

1.7 All those responsible for maintenance must follow relevant health and safety legislation for all activities listed within this report (including lone working and confined space if relevant) and risk assessments for inspections and maintenance activities must always be undertaken.

1.8 This report is to read in conjunction with the Engineering design layouts for the type and location of all SuDS systems present on this site.

2 SuDS Layout & Design

2.1 The installed SuDS system at this development are the responsibility of Crest Nicholson Midlands Ltd and their appointed Management Company.

2.2 Following installation and after transfer, all SuDS are to be maintained in perpetuity by the Management Company and shall ensure that it or any contractor employed by it carries out periodic maintenance of all such SuDS in accordance with the schedules listed in this report. Inspection checks shall be carried out by a qualified and competent person, at the minimum intervals listed within the schedules and the appropriate work carried out.

2.3 In terms of water quality, the proposed surface water system offers a suitable level of mitigation in accordance with the Environment Agency pollution prevention guidance GP3, NPPF, CIRIA C753 and DEFRA guidance.

2.4 There are three categories of maintenance activities referred to in this report:

- **Regular maintenance** (including inspections and monitoring).
  Consists of basic tasks done on a frequent and predictable schedule, including vegetation management, litter and debris removal, inspections and sampling.

- **Occasional maintenance**
  Comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (sediment removal is an example).

- **Remedial maintenance**
  Comprises intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design.
  Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and as such timings are difficult to predict.

3 SUDS Management & Maintenance

Storm water pipework and road gullies

3.1 The key maintenance requirement for the surface water drainage system includes the removal of sediments and debris from the system as required.

3.2 All storm water pipe work should be visually inspected a minimum of monthly for the first three months after installation and then a minimum of once year.

As road gullies are the first on the treatment train and susceptible to higher silt loadings, these will need to be inspected a minimum of monthly for the first three months after installation and then a minimum of every four months.

3.3 During this inspection identify any gully pots or pipes that require remedial maintenance such removal of sediment, debris, leaves and litter as required.
This involves the removal all protective covers and grids and the cleaning out of channels or gully pots by hand or with suitable jetting equipment.

3.4 The main highways will be offered to OCC for adoption. As part of this adoption the associated gullies and any highway drainage pipework will transfer to OCC ownership and be maintained as part of the standard highway maintenance procedures.

3.5 The main storm drainage will be offered to Thames Water for adoption. As part of this adoption the associated pipework and manholes will transfer to Thames Water Utilities ownership and be maintained as part of their term maintenance procedures.

Parking Court Drainage

3.6 General yard gully and linear channel maintenance involves the removal of dead leaves, soil, litter from the gratings and sediments from the sump within the gully pot or channel.
This involves the removal all protective covers and grids and the cleaning out of channels or gully pots by hand or with suitable jetting equipment.
During the first year of operation each gully and channel to be inspected every 3 months, and every 6 months thereafter for structural integrity and cleaned out as required.

Cellular Attenuation Tank

3.7 The key maintenance requirement for the cellular attenuation tank will be the visual inspection of the internal units via built in access chambers and integral maintenance tunnel for the removal of sediment and jetting as required.

A visual inspection of the impermeable geomembrane that envelopes the structure should also be carried out to check for structural integrity.

3.8 The attenuation tank is to be constructed from cellular units that allow internal CCTV and jetting access for inspection and maintenance (Hydro StormBloc, Aco Stormbrixx, Wavin Aquacell or similar approved).

The built in modular inspection unit and maintenance tunnels within the attenuation tank allow almost the entire volume of the structure to be inspected via CCTV camera and flushed through.
A catchpit chamber is to be installed immediately upstream of the attenuation tank to reduce the amount of silt entering the tank and it will generally only be necessary to ensure that the upstream catchpits / silt traps are free from debris such as leaves or sediment.

3.9 It is recommended that the attenuation tank system be inspected no less frequently than at monthly intervals for the first 3 months and thereafter at 6 monthly intervals.
In addition, it is suggested that the installation is inspected immediately following the first storm event, whenever this should occur post installation.

3.10 It should also be noted that more regular inspections may be required should the catchpit(s) fill more frequently and/or if the initial inspections reveal that maintenance / cleaning will be required more regularly than at six month intervals.

3.11 Any silt & debris should be flushed to the inspection or catchpit manhole and removed in accordance with the Management Company policy for waste management.

Cellular Systems - Operation and Maintenance Requirements

Maintenance schedule	Required action	Recommended Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly (and after large storms)
	Remove sediment from pre-treatment structures	Annually, or as required
Remedial actions	Repair/rehabilitation of inlets, outlet , overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually and after large storms

Flow Control Chamber

3.12 The key maintenance requirement for the flow control chambers will be the inspection of the units for blockages of the vortex flow control unit and silt removal from sump of chamber.

3.13 The hydraulic vortex flow control unit has no moving parts and is self-activating, requiring minimal maintenance. After initial installation, it is recommended that the unit be inspected monthly for three months.

3.14 Thereafter the manhole chamber and control device should be inspected at least every six months to verify the condition and operation of the unit and check for blockages within the inlet of the chamber and of the flow control device.
During these inspections, accumulated silts should be removed and the sump cleaned out using a conventional sump vacuum cleaner.
Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur.

3.15 As part of the main storm pipework adoption the flow control will be included and transfer to Thames Water Utilities ownership. Management & maintenance will be included within the term maintenance procedures.

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