FORTEM

Civil Engineering Consultants Ltd

Proposed Residential Development Nettleham Road, Scothern

Flood Risk Assessment

April 2024

Lindum Homes

Report

This report consists of a Flood Risk Assessment and Drainage Strategy, produced to support the proposed residential development of the site located off Nettleham Road, Scothern. It has been produced by FORTEM Civil Engineering Consultants Ltd.

Revision History

Rev Ref	Date	Amendments	By	Chk'd
1	18.04.2024	First Issue	ML	ADC

Contract

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Executive Summary

Site Description

The proposed development site is located off Nettleham Road, Scothern. The arable grassland site is 2.72ha in size and gently slopes from southwest to northeast with gradients up to 1 in 40.

There are 3No unnamed open watercourses located on the northern, eastern and western boundaries of the site.

Existing foul and surface water sewer networks are located to the east of the site in The Alders, with the foul water pumped across the northern boundary of the site to a foul water system in Nettleham Road.

Proposed Development

It is proposed to construct 49no. residential dwellings on the site, with associated infrastructure.

Flood Risk

Environment Agency Flood Mapping confirms that the site is located in Flood Zone 1. A small area of low-high risk of surface water flooding within the development is highlighted, together with high groundwater.

The identified flood risk is to be mitigated by the elevating the development levels +500mm min above existing ground levels and the installation of a new adopted surface water drainage system and flood routing incorporated into the detailed level design.

The following standard mitigation measures are recommended:

- Finished floor levels to be set a minimum 150mm above external levels to mitigate any risk from blockage and exceedance events;
- Drainage is to be designed with separate foul and surface water systems. The development surface water drainage scheme is to be designed such that there is no external flooding for up to and including the 1 in 100 year event + 40% climate change.
- Detailed blockage and exceedance assessment at detailed design stage.

Drainage

Surface water from the development is proposed to discharge to the existing 225mm diameter surface water sewer in Juniper Drive, located to the east of the development, with discharge restricted to 4l/s. Due to the existing topography and depth of the existing sewer it is necessary to pump surface water flows.

The surface water drainage designed such that there is no flooding in the 1 in 100 year event + 40% climate change.

It is proposed to discharge the foul water flows from the development to the 150mm diameter foul water sewer in Nettleham Road, located to the west of the development. Due to existing topography and the depth of the foul sewer it is necessary to pump foul water flows.

Contents

1. Introduction

1.1. Report Background

1.1.1. This report has been produced to support the planning application by Lindum Homes for the proposed residential development on the land located off Nettleham Road, Scothern.

1.1.2. This report has been produced in accordance with the National Planning Policy Framework (NPPF) and guidance documents produced by Lincolnshire County Council.

1.1.3. The study consists of data collection, consultation, and review with regulatory bodies and third parties in relation to drainage. FORTEM cannot guarantee the reliability of third party information and/or changes in consultee conclusions/responses.

1.2. Site Description

1.2.1. The site is located off Nettleham Road, Scothern OS grid reference TF 03150 77120, see Appendix A for drawing 1193-001 - Development Location Plan. Details of the site are tabled below:

Site Area		2.72ha
Topography		The site gently slopes from southwest to northeast with gradients typically less than 1 in 40, see Appendix A for topographical survey.
Land Use		The site consists of arable grassland.
Boundaries	**North:**	Existing residential properties and parkland area.
	South:	Arable grassland and commercial parking area.
	East:	Existing residential properties.
	West:	Nettleham Road.
Watercourses		Scothern Beck is located to the north (135m) and Nettleham Beck is located to the south (650m). Based upon our site walkover and information provided by Lindum Homes, there are unnamed watercourses bordering three sides of the site: • Northern and eastern boundary open watercourses converging in north-eastern corner with route of downstream culvert unknown; • Western boundary part open watercourse, part culvert routing north, with an assumed discharged to Scothern Beck. There are no records of the unnamed watercourse indicated on drawing 1193-002 - Existing Drainage Networks, other than information taken from the topographical survey and site walkover. See Appendix A for Site Visit Record 22.11.2023.
Public Sewers		Anglian Water records confirm 150mm foul water sewer and 225mm surface water sewer located in The Alders to the east. The foul water sewer network is routed to a foul water pumping station located to the north of The Alders. The rising main is routed west across the northern boundary of this proposed development before discharging to a 150mm diameter gravity foul water sewer located in the verge of Nettleham Road. See Appendix A for drawing 1193-002 - Existing Drainage Networks and Anglian Water records.

Other Drainage	There are no known existing drainage systems serving the proposed development land, however it is anticipated the site may served by a series of land drains.
Ground	Intrusive ground investigation carried out by Evolve Geo-Environmental (Report EGE-23-10-10-01) confirms the site consists of Sandy topsoil (0.3-0.5m thick) overlaying either Clayey GRAVEL (western) or Gravelly CLAY (eastern). Due to high groundwater percolation testing could not be undertaken and as a result infiltration drainage is discounted.

1.3. Proposed Development

1.3.1. The detailed application is for the construction of 49no. residential dwellings complete with associated infrastructure, see Appendix B for Framework Architects Proposed Site Plan J2342-00103.

1.4. Consultation

1.4.1. Consultation with the relevant consultees has been undertaken, see summary below:

Consultee	Response Summary
Lincolnshire County Council (LCC)	In accordance with our early consultation the proposed development drainage has been considered in accordance with the Lincolnshire Development Roads and Sustainable Drainage Design Approach. Supplementary consultation has been sought in relation to the detailing of the highway swales within the scheme. At the time of drafting no response to our enquiry had been received.
Anglian Water (AW)	Anglian Water Records have been received for the site and are included in Appendix A. Anglian Water have been consulted as part of a formal Pre-Planning enquiry. This confirmed: • Foul water discharge to the 150mm diameter sewer in Juniper Drive (manhole 3000); • Surface water discharge to the 225mm diameter sewer in Juniper Drive (manhole 3051), with flows to be restricted to 2l/s. Based upon the outfalls proposed by Anglian Water, supplementary consultation has been issued based upon: • Changing the foul water outfall to the 150mm foul water system in Nettleham Road (bypassing the existing foul water pumping station); • Increasing the restricted surface water discharge in accordance with the requirements of Codes for Adoption (4l/s). At the time of drafting no response to our enquiry had been received.
Withan First District Internal Drainage Board (WFDIDB)	We have written to WFDIDB in relation to the culverting of the unnamed watercourse to enable the site access. At the time of drafting no response to our enquiry had been received.

2. Flood Risk

2.1. Summary

2.1.1. Below is a summary of the sources of flood risk and the potential risk associated to the proposed development:

Source	Risk Level	Notes
Fluvial/Tidal	Low	In accordance with the Environment Agency Flood Maps the site is located within Flood Zone 1.
Surface Water/Pluvial	Low-High	Environmental Agency maps has confirmed an area of low-high risk of surface water flooding. See Section 2.2 below.
Groundwater	Low-Medium	There are no known records of any historic groundwater flooding or risk. However there is high groundwater noted within the intrusive site investigation and evidence of standing water on the site. Mitigation to be provided in combination with surface water risk, see Section 2.2 below.
Sewers	Low	Based upon searches undertaken, no historic incidents of flooding have been recorded within the vicinity of the proposed development.
Other Man-Made Sources	Low	The site is not in an area at risk from a major failure of a reservoir and there are no other known artificial sources of flood risk in the area.

Copies of the Environment Agency flood maps are included in Appendix C.

2.2. Surface Water/Pluvial Mitigation

2.2.1. Environment Agency maps confirm a small area of low-high surface water flood risk on the site. These areas coincide with low lying topography which by the nature of the land profile and ground conditions could result in water ponding.

2.2.2. The surface water flood risk identified in the mapping is reinforced by the site walkover, with areas of standing waters noted on site to coincide with the mapping.

2.2.3. Surface Water flood risk and high groundwater risk is to be mitigated by elevating the proposed development levels +500mm above existing, together with the installation of an adopted surface water drainage system with flood routing to be incorporated into the detailed design.

2.3. Standard Development Mitigation

2.3.1. In addition to Section 2.2 above the following standard mitigation measures are recommended:

- Finished floor levels to be set a minimum of 150mm above external levels to mitigate any risk from blockage and exceedance events;
- Within the detailed drainage design blockage / exceedance events should be considered ensuring the proposed development and surrounding areas are not put at risk from overland flows;
- Drainage is to be designed with separate foul and surface water systems. The development surface water drainage scheme is to be designed such that there is no external flooding for up to and including the 1 in 100 year event + 40% climate change.

3. Development Drainage

3.1. Existing Site Drainage

3.1.1. As covered in Section 1.2, there is a 150mm foul water sewer in The Alders, discharging to a foul water pumping station, from which the rising main is routed across the northern boundary of the site before discharging to the 150mm/225mm foul water sewer network in Nettleham Road. There is also a 225mm diameter surface water sewer network located in The Alders.

3.1.2. There are 3No unnamed open watercourses located on the northern, eastern and western boundaries of the site. They fall under two catchments, with the northern and eastern converging in the north-eastern corner of the site, after which the system is culverted. The western watercourse flows north before being culverted.

3.1.3. There is no evidence indicating the agricultural land has previously been served by a positive drainage system. During the site walkover some stood water was noted on the surface, suggesting if land drainage has historically been installed, it is not fully functioning.

3.1.4. The existing greenfield run-off for the site has been assessed in accordance with the Ciria SuDS Manual (C753), Section 3.3.1, with a greenfield rate of 2l/s/ha:

Greenfield Runoff	**Total Existing Site Runoff**
2.72ha x 2l/s/ha	= 5.44 l/s

3.2. Development Surface Water Drainage

3.2.1. The potential surface water outfall/discharge options have been considered and are summarised below:

Outfall / Discharge Option **(Ranked in order of Preference)**	✓/✗	**Notes**
1. Infiltration	✗	Percolation testing was scheduled as part of the intrusive site investigation undertaken by Evolve (Report EGE-23-10-01). Due to high groundwater and CLAY strata, the testing was abandoned, confirming infiltration drainage is not suitable for the proposed development.
2. Discharge to Watercourse	✗/✓	Due to the extent of water noted in the eastern boundary watercourse as part of the site walkover, this system has been discounted as a potential outfall. An enquiry has been set in relation to the western boundary watercourse, based upon its condition noted on site. Feedback from Withan First District Internal Drainage Board to determine if this is a viable option.
3. Discharge to Public Surface Water Sewer.	✓	Anglian Water have confirmed it is acceptable to discharge surface water to the 225mm diameter surface water sewer is located in Juniper Drive. Consultation is ongoing in relation to the restricted discharge rate.
4. Discharge to Public Combined Sewer.	✗	No public combined water systems located within the vicinity of the development.

3.2.2. Based upon the findings of the review above and in accordance with the surface water hierarchy it is proposed to discharge surface water from the proposed development to the 225mm diameter surface water sewer in Juniper Drive, see Appendix B for drawing 1193-003- Proposed Drainage Strategy.

3.2.3. Consultation is ongoing with Anglian Water regarding the restricted surface water discharge, with a request for 4l/s in order to meet the requirements of Codes for Adoption. This flow restriction has been utilised in the concept drainage design, see Appendix B for drawing 1193-003- Proposed Drainage Strategy.

3.2.4. In accordance with Lincolnshire Development Roads and Sustainable Drainage Design Approach, highway swales have been integrated into the proposed development. Due to the high recorded groundwater we have not included an underdrain within the swale feature, with a positive (gully) outlet to the surface water sewer system within the carriageway.

3.2.5. The surface water drainage is to be designed in accordance with Lincolnshire County Council design standards with no external flooding for the 1 in 30 year event and all flows retained on site for up to the 1 in 100 year event plus 40% climate change.

3.2.6. Based upon a maximum discharge rate of 4l/s the attenuation required for the development is 1,000m^3 (1 in 100 event+ 40% c/c). The attenuation will be provided in a underground storage tank, see Appendix B for drawing 1193-003 – Proposed Drainage Strategy and the Surface Water Drainage Network Calculations.

3.2.7. Due to the site topography and depth of the downstream receiving sewer network it is necessary to pump the surface water flows, see Appendix B for attenuation calculations and drawing 1193-003 – Proposed Drainage Strategy.

3.3. Surface Water Treatment

3.3.1. The treatment of the surface water run-off has been considered in accordance with CIRIA SuDs Manual 2015 (Chapter 4 and 26) and the assessment is tabled below:

Pollution Hazard / Mitigation Indices for discharge to surface water sewer			
Land Use/Treatment	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Residential development general access road (minimum requirement)	0.5	0.4	0.4
Swale	0.5	0.6	0.6
Total Mitigation	**0.5 ✓**	**0.6 ✓**	**0.6 ✓**

The above review confirms the proposed drainage for the development meets the necessary water quality standards.

3.4. Development Foul Water Drainage

3.4.1. It is proposed to discharge the foul water flows from the development to the existing 150mm diameter foul sewer in Nettleham Road west of the development.

3.4.2. Due to the topography of the site and the depth of the existing sewer network it is proposed to pump foul water flows, see Appendix B for drawing 1193-003 – Proposed Drainage Strategy.

3.5. Maintenance

3.5.1. The foul and surface water drainage networks are to be adopted by Anglian Water or an Independent Water Authority under a Section 104 Agreement. Therefore, the maintenance of the sewers is the responsibility of the adopting Water Authority.

3.5.2. The highway swales are to be adopted by Lincolnshire County Council as part of the Section 38 Agreement. Therefore the maintenance of the swales is the responsibility of Lincolnshire County Council.

4. Conclusion

4.1. Flood Risk

4.1.1. Environment Agency Flood Mapping confirms that the site is located in Flood Zone 1. A small area of low-high risk of surface water flooding within the development is highlighted, together with high groundwater.

4.1.2. The identified flood risk is to be mitigated by the elevating the development levels +500mm min above existing ground levels and the installation of a new adopted surface water drainage system and flood routing incorporated into the detailed level design.

4.1.3. The following standard development mitigation measures are recommended:

- Finished floor levels to be set a minimum of 150mm above external levels to mitigate any risk from blockage and exceedance events;
- Within the detailed drainage design blockage/exceedance events should be considered ensuring the proposed development and surrounding areas are not put at risk from overland flows;
- Drainage is to be designed with separate foul and surface water systems. The development surface water drainage scheme is to be designed such that there is no external flooding for up to and including the 1 in 100 year event + 30% climate change.

4.2. Drainage

4.2.1. Surface water from the development is proposed to discharge to the 225mm diameter surface water sewer in Juniper Drive, with flows restricted to 4/s. Due to the topography of the site and depth of the existing sewer, it is necessary to pump surface water flows.

4.2.2. The surface water drainage designed such that there is no flooding in the 1 in 100 year event + 30% climate change.

4.2.3. It is proposed to discharge the foul water flows from the development to the 150mm diameter foul water sewer in Nettleham Road. Due to existing topography and the depth of the existing sewer, it is necessary to pump foul water flows.

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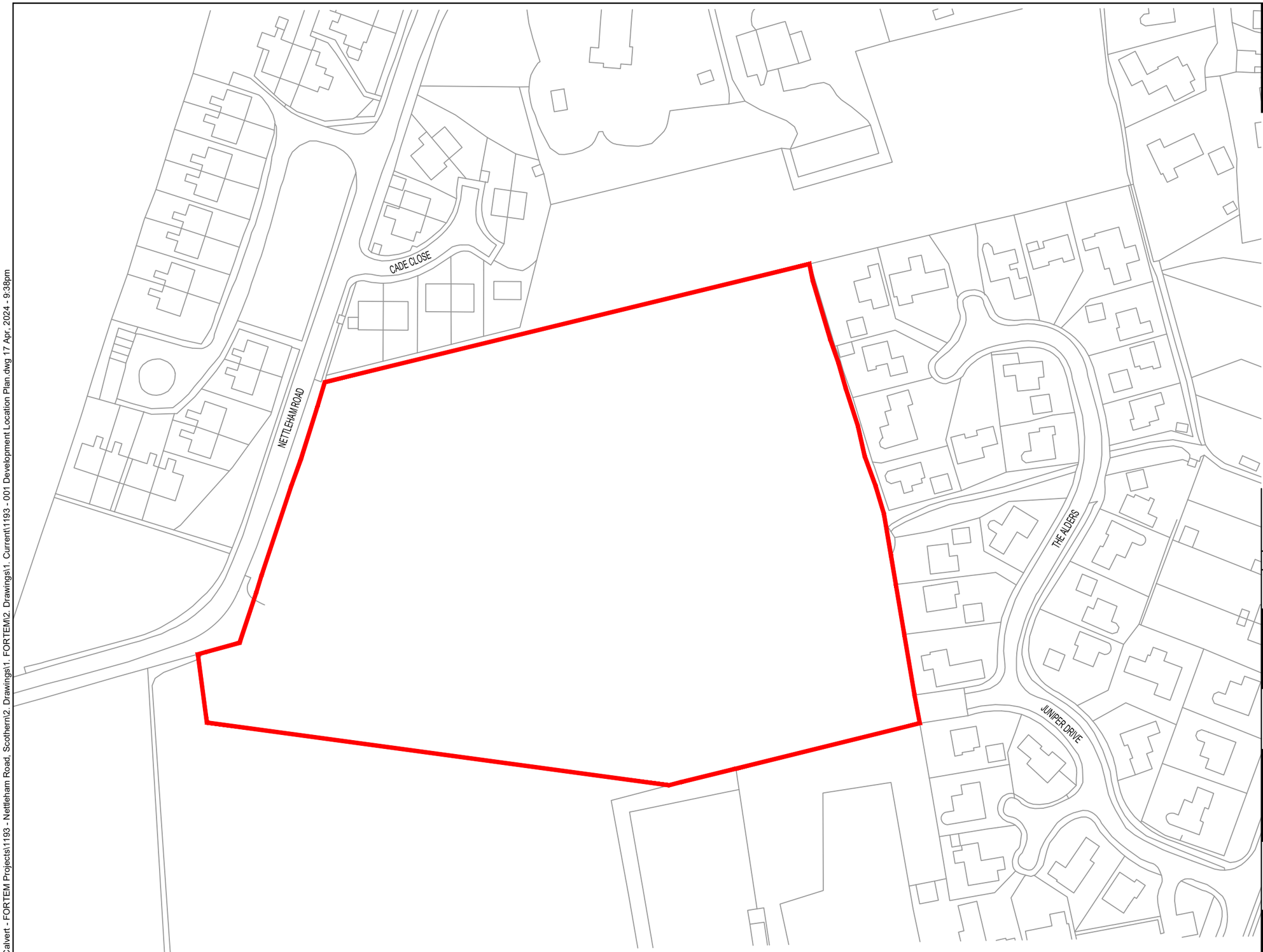
Appendix A **Existing Site**

Drawing 1193-001 - Development Location Plan
Daniel Charles Topographical Survey - 22-36-01A & 02A
Drawing 1193-002 - Existing Drainage Networks
Anglian Water Sewer Records
Site Visit Record sheet 22.11.2023



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NOTES:

1. THIS DRAWING IS BASED UPON FRAMEWORK ARCHITECTS PROPOSED SITE PLAN J2343-00103 (DATED JAN 2024) AND ORDNANCE SURVEY MAPS.

KEY

DEVELOPMENT BOUNDARY

Rev	Date	Amendments	By

Drawing Status.

INFORMATION

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Client

LINDUM HOMES

Project

NETTLEHAM ROAD, SCOTHERN

Drawing Title.

DEVELOPMENT LOCATION PLAN

Drawn: ML
Checked: ADC

Scale: 1:1250 @ A3
Date: APR 2024

Drawing No.

1193 - 001

Rev.

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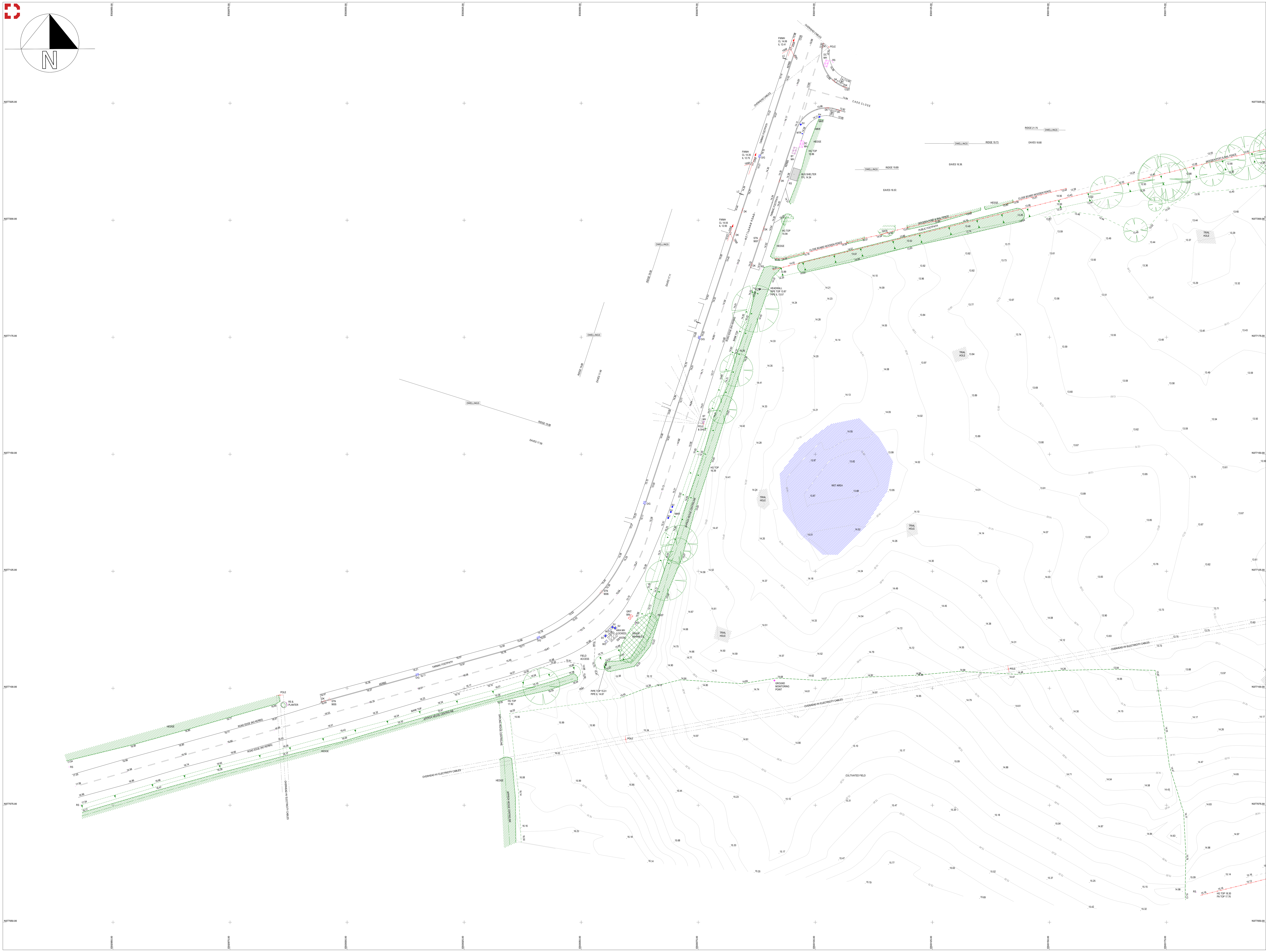

NOTES

ABBREVIATIONS & SYMBOLS

AV	AIR VALVE	OHC	OVERHEAD CABLE
BH	BORE HOLE	PB	POST BOX
BOL	BOLLARD	PINV	PIPE INVERT LEVEL
CATV	CABLE TV MH	PM	PARKING METER
CCTV	SECURITY CAM	PO	POST
CL	COVER LEVEL	PT	PIPE TOP LEVEL
CH	CHANNEL	P/R	POST & RAIL FENCE
COL	COLUMN	P/W	POST & WIRE FENCE
DC	CABLE TV LID	RD	EDGE OF ROAD/NO KERB
DP	DOWN PIPE	RE	RODDING EYE/POINT
DR	DRAIN	RL	RIDGE LEVEL
EL	EAVES LEVEL	RP	REFLECTIVE POST
EP	ELECTRIC POLE	RS	ROAD SIGN
ER	EARTH ROD	SLVL	STONE LEVEL
FB	FLOWER BED	SOFF	SOFFIT LEVEL
FH	FIRE HYDRANT	SV	VALVE
FFL	FINISHED FLOOR LEVEL	SW	SURFACE WATER
FP	FLAG POLE	Tac	TACTILE PAVING
FW	FOUL WATER	TH	TRIAL HOLE
GV	GAS VALVE	TL	TRAFFIC LIGHTS
HW	HEADWALL	TLVL	TARMAC LEVEL
IC	INSPECTION COVER	TOW	TOP OF WALL LEVEL
IL	I NVERT LEVEL	TP	TELEGRAPH POLE
KB	KERB BOTTOM	TRK	TRACK
KO	KERB OFFLET	UTL	UNABLE TO LIFT
KT	KERB TOP	VP	VENT PIPE
LP	LAMP POST	WL	WATER LEVEL
LC	LIGHT COLUMN	WLVL	WATER LEVEL
MH	MANHOLE	WM	WATER METER
MP	MARKER POST	WO	WASH OUT POINT

FENCE
HEDGE
ELECTRIC
BANK EDGE
STORM LINE
FOUL LINE
TELECOM LINE
GAS LINE
LARSON PILES
CHANNELS
WATER MAIN

TREE
BOREHOLE
STATION
TBM
MANHOLE
GULLY
BATTER
WATER LVL
GATE

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SURVEY CONTROL POINT INFORMATION

Point	Easting	Northing	Elevation
9000	503296.331	377089.579	14.475
9002	503317.822	377089.659	14.525
9003	503338.579	377161.525	13.151
9004	503271.665	377143.926	13.701
9005	502996.197	377097.533	16.509
9006	503054.304	377120.556	15.463
9007	503088.223	377195.984	14.553

SURVEY DATE	17/03/2022	INITIALS	EH/MJW

Rev	Amendments	Drn	Date
A	GROUND LVLS UPDATED POST SITE CLEARANCE	MJW	01/02/24

Client:
LINDUM HOMES

Project Title:
LAND OFF -
NETTLEHAM ROAD
SCOTHERN - LINCS

Drawing Title:
TOPOGRAPHICAL SURVEY 1 of 2

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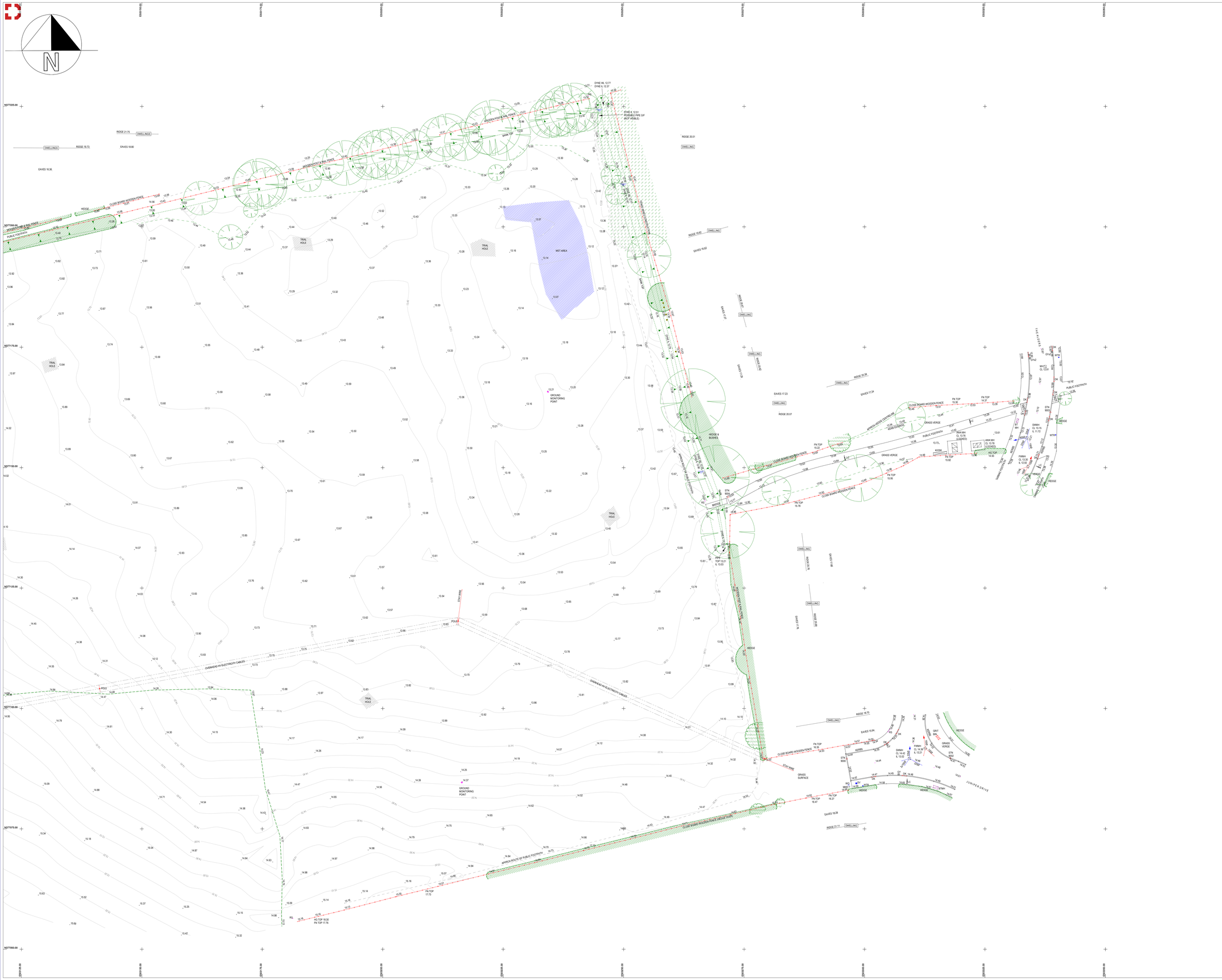

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C.A.D.Title: lindum nettleham rd scothern\master topo (22-36-01+02 rev A).mjo			
Drawn By: MJW		Checked By: EAH	

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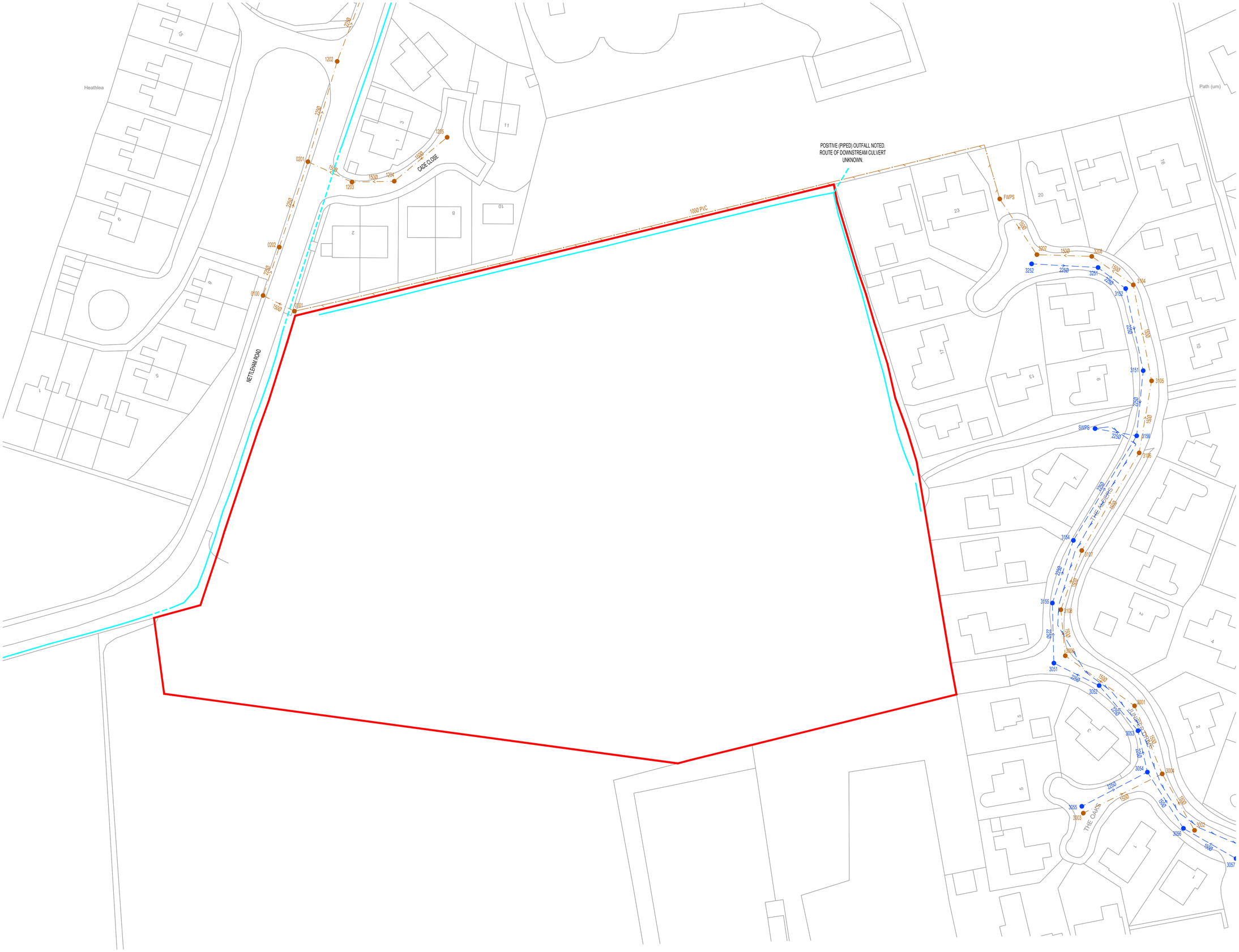
www.daniel-charles.co.uk



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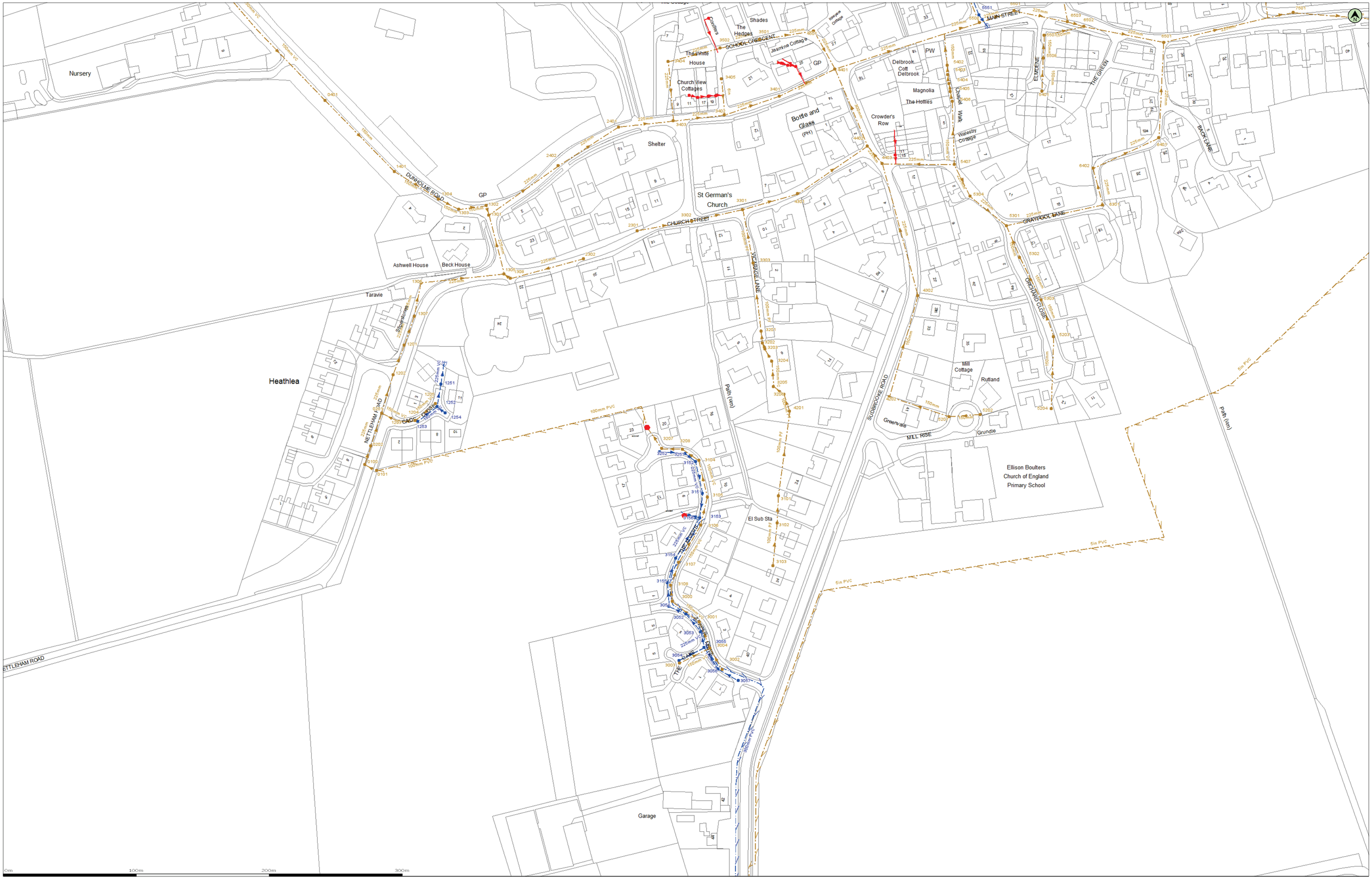


(c) Crown Copyright and database rights 2011 Ordnance Survey 100018507 | Date: 25/07/14 | Scale: 1:1250 | Map Centre: 503323,377214 | Data updated: 09/07/14 | Our Ref: 106875 - 1 | Wastewater Plan A1

Foul Sewer		Outfall (Colour denotes effluent type)	
Surface Sewer / Combined Sewer		Inlet (Colour denotes effluent type)	
Final Effluent		Manhole (Colour denotes effluent type)	
Rising Main (Colour denotes effluent type)		Sewage Treatment Works	
Private Sewer (Colour denotes effluent type)		Pumping Station	
Decommissioned Sewer (Colour denotes effluent type)			

josephine.green@bwbconsulting.com
NTW2288

love every drop anglianwater

Document Set ID: 459062
Version: 1, Version Date: 25/06/2015

SITE VISIT RECORD SHEET

FORTEM

E: info@fortemconsultants.co.uk
W: www.fortemconsultants.co.uk

Location: Nettleham Road, Scothern

Purpose: Site Walkover

Job No: 1193

Attendees: Andrew Calvert (FORTEM)

Visit Date: 22.11.2023

1. View on development site.

2. Juniper Drive.

3. View on western watercourse (at site access).

4. View on eastern watercourse.

5. Northern watercourse.

6. North-western corner (standing water).

Appendix B **Proposed Development**

Framework Architects Proposed Site Plan J2342-00103

Drawing 1193-003 – Proposed Drainage Strategy

Surface Water Drainage Calculations

0 25 50

N

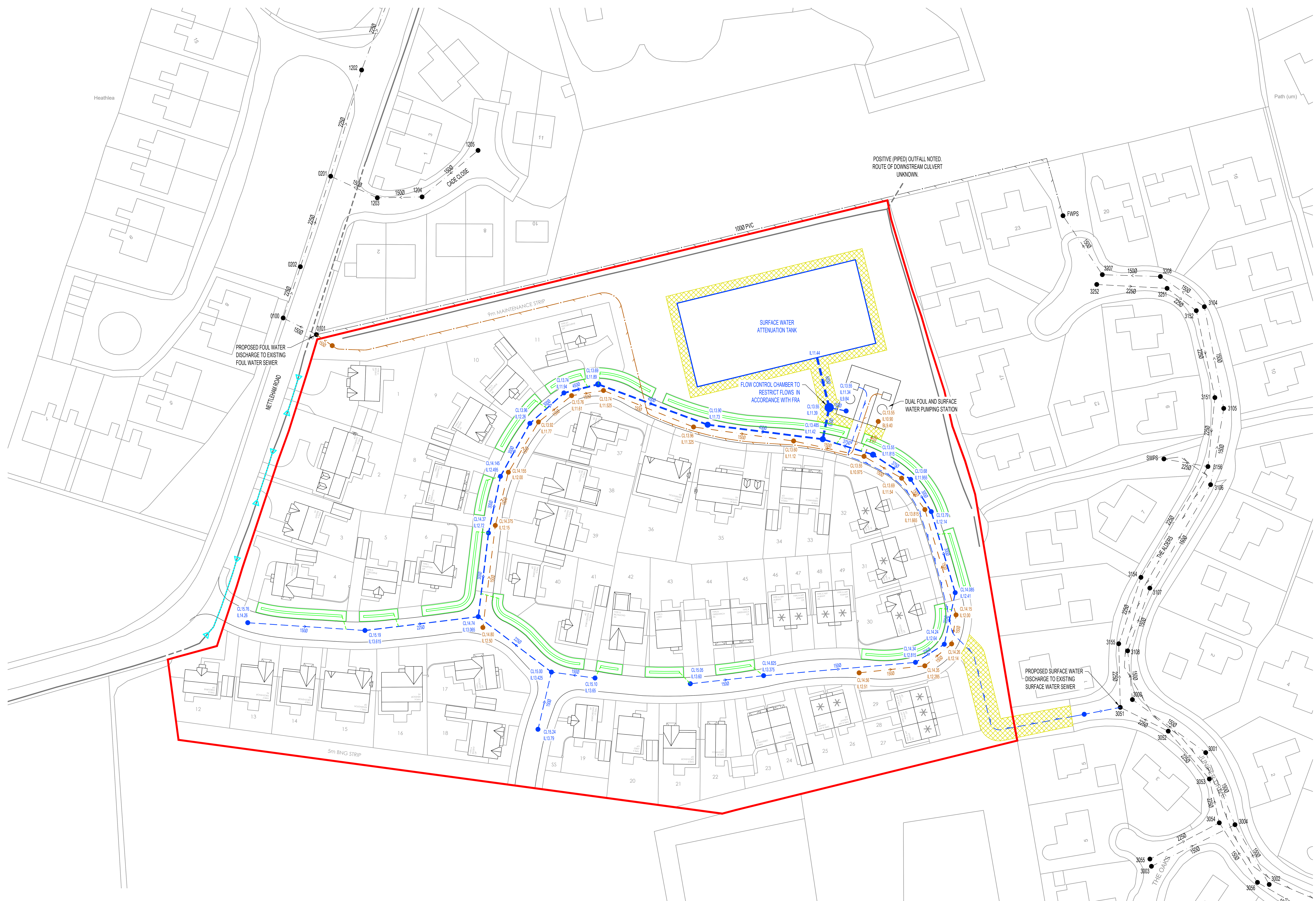
Rev	Revision note	Date	Drawn by

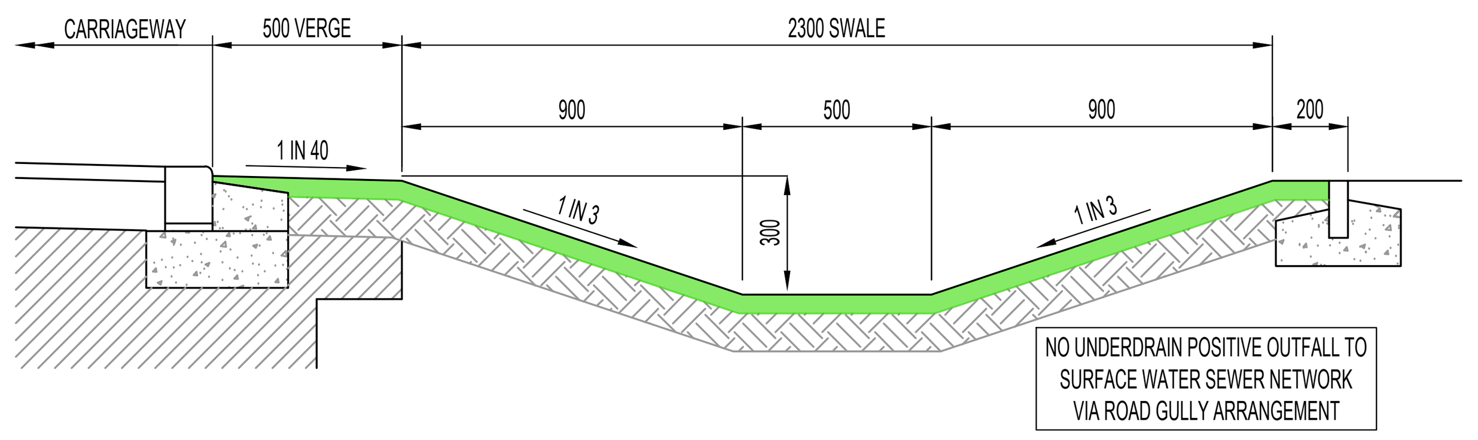
PROPOSED RESIDENTIAL DEVELOPMENT
AT LAND OFF NETTLEHAM ROAD
SCOTHERN

Drawn by	Issue	Date	Scale
HU	PRELIMINARY	JAN 2024	1:500 at A1
PROPOSED SITE PLAN		Dwg No J2342 00103	Rev

Framework Architects

3 MARINE STUDIOS, BURTON LANE END, BURTON WATERS, LINCOLN, LN1 2UA
T 01522 535383 E info@frameworklincoln.co.uk W frameworkarchitects.co.uk





TYPICAL SWALE DETAIL

SCALE 1:20

N

NOTES:

1. THIS DRAWING IS BASED UPON FRAMEWORK ARCHITECTS PROPOSED SITE PLAN J2343-00103 (DATED JAN 2024), DANIEL CHARLES TOPOGRAPHICAL SURVEY 22-36-01A & 02A, ANGLIAN WATER RECORD DRAWINGS AND ORDNANCE SURVEY MAPS.
2. PROPOSED SEWER LEVELS AND DIAMETERS ARE SUBJECT TO DETAILED DESIGN REFINEMENT.
3. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE FORTEM FLOOD RISK ASSESSMENT 1193-R001-V1

KEY

- DEVELOPMENT BOUNDARY
- EXISTING SURFACE WATER SEWER / MANHOLE (INCLUDING ANGLIAN WATER RECORD INFORMATION)
- EXISTING SURFACE WATER RISING MAIN
- EXISTING FOUL WATER SEWER / MANHOLE (INCLUDING ANGLIAN WATER RECORD INFORMATION)
- EXISTING FOUL WATER RISING MAIN
- UNNAMED WATERCOURSE (SITE WALKOVER / CLIENT INFORMATION)
- ASSUMED CULVERTED WATERCOURSE (CLIENT INFORMATION)
- PROPOSED SURFACE WATER SEWER / MANHOLE
- PROPOSED FOUL WATER SEWER / MANHOLE
- PROPOSED SURFACE WATER RISING MAIN
- PROPOSED FOUL WATER RISING MAIN
- PROPOSED SWALE
- PROPOSED SWALE OUTFALL PIPE
- PROPOSED CULVERTING OF EXISTING WATERCOURSE
- PROPOSED EASEMENT (SEWER NETWORK LOCATED OUTSIDE OF ADOPTABLE HIGHWAY)

Rev	Date	Amendments	By

Drawing Status.

PLANNING

FORTEM

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Client

LINDUM HOMES

Project

NETTLEHAM ROAD, SCOTHERN

Drawing Title.

PROPOSED DRAINAGE STRATEGY

Drawn: ML
Checked: ADC
Scale: 1:500 @ A1
Date: APR 2024

Drawing No. 1193 - 003
Rev. -

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	11.763	0.323	4.0	322.9	O K
30 min Summer	11.864	0.424	4.0	423.6	O K
60 min Summer	11.968	0.528	4.0	528.4	O K
120 min Summer	12.075	0.635	4.0	635.2	O K
180 min Summer	12.136	0.696	4.0	695.9	O K
240 min Summer	12.176	0.736	4.0	736.1	O K
360 min Summer	12.226	0.786	4.0	785.6	O K
480 min Summer	12.256	0.816	4.0	816.4	O K
600 min Summer	12.278	0.838	4.0	837.7	O K
720 min Summer	12.292	0.852	4.0	852.1	O K
960 min Summer	12.308	0.868	4.0	867.7	O K
1440 min Summer	12.309	0.869	4.0	868.9	O K
2160 min Summer	12.282	0.842	4.0	842.2	O K
2880 min Summer	12.254	0.814	4.0	813.6	O K
4320 min Summer	12.197	0.757	4.0	756.8	O K
5760 min Summer	12.141	0.701	4.0	701.0	O K
7200 min Summer	12.084	0.644	4.0	644.5	O K
8640 min Summer	12.021	0.581	4.0	581.4	O K
10080 min Summer	11.965	0.525	4.0	524.8	O K
15 min Winter	11.802	0.362	4.0	362.0	O K
30 min Winter	11.915	0.475	4.0	475.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	124.574	0.0	278.5	27
30 min Summer	81.917	0.0	330.0	41
60 min Summer	51.407	0.0	511.9	72
120 min Summer	31.242	0.0	603.6	130
180 min Summer	23.069	0.0	629.9	190
240 min Summer	18.507	0.0	627.7	250
360 min Summer	13.462	0.0	616.8	368
480 min Summer	10.721	0.0	606.9	488
600 min Summer	8.989	0.0	598.3	606
720 min Summer	7.780	0.0	590.9	726
960 min Summer	6.190	0.0	578.4	964
1440 min Summer	4.479	0.0	558.7	1442
2160 min Summer	3.235	0.0	1159.9	1868
2880 min Summer	2.566	0.0	1146.1	2252
4320 min Summer	1.848	0.0	1043.1	3032
5760 min Summer	1.463	0.0	1467.1	3872
7200 min Summer	1.220	0.0	1527.8	4696
8640 min Summer	1.051	0.0	1578.2	5456
10080 min Summer	0.927	0.0	1618.6	6168
15 min Winter	124.574	0.0	304.5	27
30 min Winter	81.917	0.0	335.5	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	12.033	0.593	4.0	593.2	O K
120 min Winter	12.154	0.714	4.0	713.8	O K
180 min Winter	12.222	0.782	4.0	782.3	O K
240 min Winter	12.268	0.828	4.0	828.1	O K
360 min Winter	12.325	0.885	4.0	885.4	O K
480 min Winter	12.362	0.922	4.0	921.7	O K
600 min Winter	12.388	0.948	4.0	947.6	O K
720 min Winter	12.406	0.966	4.0	965.7	O K
960 min Winter	12.427	0.987	4.0	987.2	O K
1440 min Winter	12.437	0.997	4.0	997.0	O K
2160 min Winter	12.414	0.974	4.0	973.5	O K
2880 min Winter	12.375	0.935	4.0	934.6	O K
4320 min Winter	12.303	0.863	4.0	862.6	O K
5760 min Winter	12.226	0.786	4.0	785.5	O K
7200 min Winter	12.147	0.707	4.0	706.7	O K
8640 min Winter	12.058	0.618	4.0	618.0	O K
10080 min Winter	11.965	0.525	4.0	525.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	51.407	0.0	567.2	70
120 min Winter	31.242	0.0	633.2	128
180 min Winter	23.069	0.0	628.8	188
240 min Winter	18.507	0.0	621.9	246
360 min Winter	13.462	0.0	611.7	362
480 min Winter	10.721	0.0	604.7	480
600 min Winter	8.989	0.0	599.6	596
720 min Winter	7.780	0.0	595.7	712
960 min Winter	6.190	0.0	590.8	942
1440 min Winter	4.479	0.0	588.0	1394
2160 min Winter	3.235	0.0	1209.3	2036
2880 min Winter	2.566	0.0	1171.1	2344
4320 min Winter	1.848	0.0	1081.4	3248
5760 min Winter	1.463	0.0	1642.8	4200
7200 min Winter	1.220	0.0	1710.1	5120
8640 min Winter	1.051	0.0	1765.9	5976
10080 min Winter	0.927	0.0	1812.4	6664

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.200	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.400

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.467	4	8	0.467	8	12	0.467

Model Details

Storage is Online Cover Level (m) 13.400

Tank or Pond Structure

Invert Level (m) 11.440

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1000.0	1.000	1000.0	1.005	1.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0095-4000-1000-4000
Design Head (m)	1.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	95
Invert Level (m)	11.440
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	4.0	Kick-Flo®	0.629	3.2
Flush-Flo™	0.294	4.0	Mean Flow over Head Range	-	3.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.3	3.000	6.7	7.000	10.0
0.200	3.9	1.400	4.7	3.500	7.2	7.500	10.3
0.300	4.0	1.600	5.0	4.000	7.6	8.000	10.6
0.400	3.9	1.800	5.3	4.500	8.1	8.500	10.9
0.500	3.8	2.000	5.5	5.000	8.5	9.000	11.2
0.600	3.4	2.200	5.8	5.500	8.9	9.500	11.5
0.800	3.6	2.400	6.0	6.000	9.3		
1.000	4.0	2.600	6.2	6.500	9.6		

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Appendix C **Flood Risk Mapping**

EA Flood Maps, Risk from Rivers or Sea

EA Flood Maps, Risk from Surface Water

EA Flood Maps, Risk from Reservoirs

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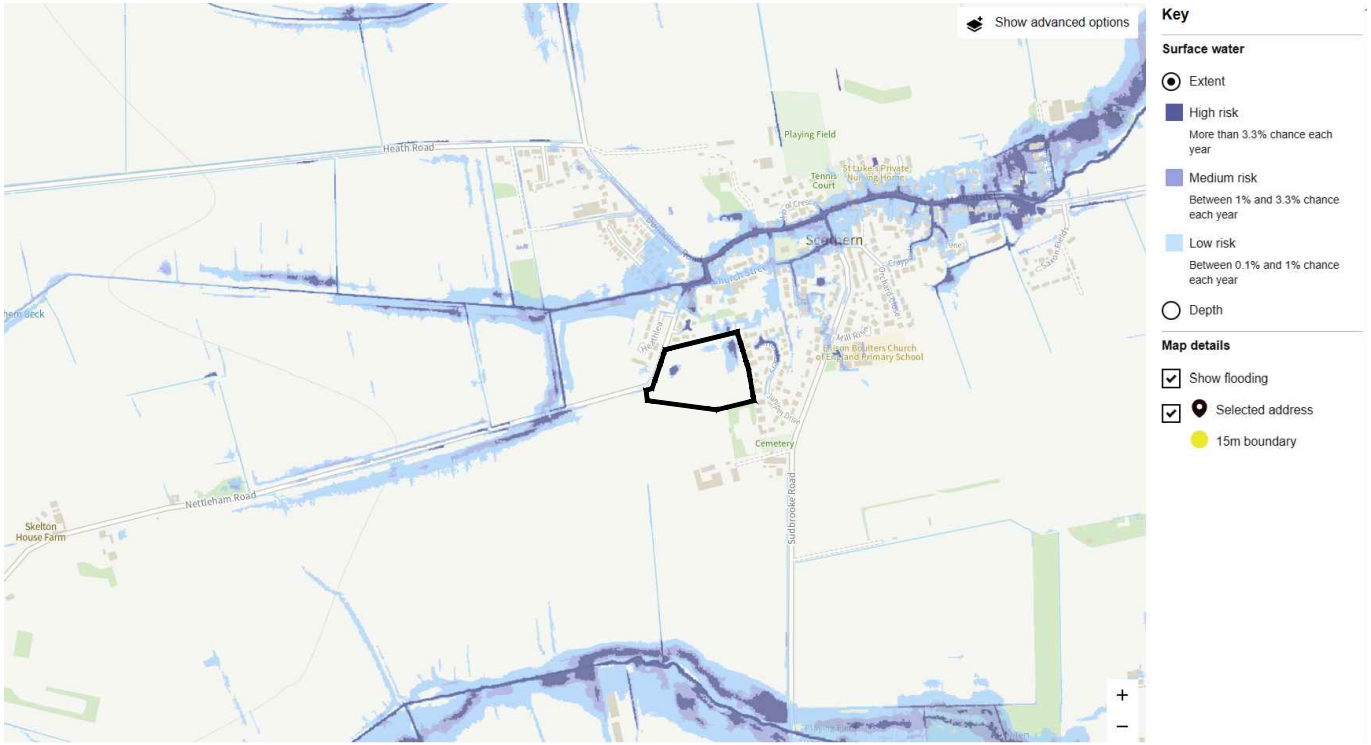
Development Boundary

NETTLEHAM ROAD, SCOTHERN
EXTRACT FROM ENVIRONMENT AGENCY MAPPING (GOV.UK)
RISK OF FLOODING FROM RIVERS OR SEA
EXTRACT TAKEN 05.03.2024 : NTS

FORTEM

Development Boundary



NETTLEHAM ROAD, SCOTHERN
EXTRACT FROM ENVIRONMENT AGENCY MAPPING (GOV.UK)
RISK OF FLOODING FROM SURFACE WATER
EXTRACT TAKEN 05.03.2024 : NTS

FORTEM

Development Boundary

NETTLEHAM ROAD, SCOTHERN
EXTRACT FROM ENVIRONMENT AGENCY MAPPING (GOV.UK)
RISK OF FLOODING FROM RESERVOIR
EXTRACT TAKEN 05.03.2024 : NTS