Land at Tollgate Road, Colney Heath

Flood Risk Assessment, Surface Water and Foul Water Drainage Strategy

On behalf of Vistry Group

Project Ref: 332510999 | Date: June 2022

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Report Title: **Flood Risk Assessment, Surface Water and Foul Water Drainage Strategy**

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For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved

This report has been prepared by Stantec UK Limited ('Stantec') on behalf of its client to whom this report is addressed ('Client') in connection with the project described in this report and takes into account the Client's particular instructions and requirements. This report was prepared in accordance with the professional services appointment under which Stantec was appointed by its Client. This report is not intended for and should not be relied on by any third party (i.e. parties other than the Client). Stantec accepts no duty or responsibility (including in negligence) to any party other than the Client and disclaims all liability of any nature whatsoever to any such party in respect of this report.

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Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Stantec UK Ltd to accompany an outline planning application for a proposed residential development at Tollgate Road, Colney Heath, St Albans. In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), the FRA demonstrates that:

(i) The development is safe;

(ii) The development does not increase flood risk; and,

(iii) The development does not detrimentally affect third parties.

The Environment Agency (EA) data confirms that the majority of the site lies within Flood Zone 1; however, the western part of the site located adjacent to River Colne lies within Flood Zone 3, with minor areas located within Flood Zone 2. Flood Zones are defined in Planning Practice Guidance (PPG), Flood Risk and Coastal Change, Table 1 as follows:

Flood Zone 1 'Low Probability' less than a 1 in 1000 (0.1%) Annual Probability of flooding from rivers

Flood Zone 2 'Medium Probability' between a 1 in 1000 and 1 in 100 (0.1% - 1%) Annual Probability of flooding from rivers and between a 1 in 1000 and 1 in 200 (0.1% - 0.5%) Annual Probability of flooding from the sea.

Flood Zone 3 'High Probability' greater than a 1 in 100 (1%) Annual Probability of river flooding or greater than a 1 in 200 (0.5%) Annual Probability of flooding from the sea.

The proposals for this residential development constitute a 'More Vulnerable' land use, which is considered appropriate within Flood Zone 1, without the requirement to apply the Exception Test. Similarly, public open space, classified as 'Water Compatible' development in Flood Zones 2 and 3, is considered appropriate without the requirement to apply the Exception Test. The proposed residential development will be located solely within Flood Zone 1.

The majority of the site is predicted to be at a 'Very Low' risk of surface water flooding; however, the area to the west of the site, adjacent to the River Colne is identified to be at 'Low' to High' susceptibility to surface water flooding. Additionally, there is a flowpath of 'Low' to 'High' susceptibility to surface water flooding running along the eastern boundary of the site. These 'High' and 'Medium' areas of surface water flooding result from localised low spots and, therefore, it is considered that the risk of surface water flooding is 'Low'.

The western part of the site falls within an area where groundwater levels are at or near the surface; therefore, the risk of groundwater flooding is therefore considered to be 'Medium'.

The remaining sources of flood risk are considered to be a low risk.

The flood risk mitigation strategy for the development consists of the following elements:

- Application of the sequential approach has been applied following review of local surface water flood maps and the implementation of the surface water drainage strategy;
- Proposed ground floor levels should be set a minimum of 150mm above adjacent ground levels to provide suitable freeboard for buildings and appropriate profiling of exterior ground levels to fall away from building entrances;
- Groundwater monitoring is recommended to be undertaken over a 12-month period to assess seasonal high levels.

- Provision of appropriate surface water drainage attenuation systems, including consideration of projected impacts of climate change and exceedance events;
- Plans in place for future management and maintenance of drainage systems.

Ground investigation indicated that infiltration rates are considered relatively poor. Therefore, for the purposes of this outline application, surface water drainage methods relying solely on infiltration have been discounted in order to provide a robust design. Nevertheless, there might be potential for shallow infiltration drainage schemes that will be assessed in the detailed design stage.

The proposed drainage strategy consists of two lined attenuation basins to the north and south of the site. It is then proposed that two surface water pipes will channel water towards two conveyance swales towards the River Colne. The swales will cross the oil pipeline, which runs through the site, and surface water will be discharged from the swales to the River Colne via two piped surface water outfalls.

In summary, the FRA demonstrates that the proposed development is safe and in accordance with the requirements of national and local planning policy.

Summary of Key FRA Data

Aspect of flood risk	Applicable Guidance/ Source of Data	Summary	Section of FRA
Site Location	n/a	Tollgate Road, Colney Heath Site centre National Grid Reference – Easting 520872 , Northing: 205521 Nearest postcode: AL4 0PA	**3.1**
Existing Ground Levels	Topographic Survey by Terrain Surveys EA LIDAR	The levels across the site range between 75.43m AOD in the narrower part of the site by Tollgate Road to 69.64m AOD along the north-western boundary. The site also slopes from 76.30m AOD to 70.00m AOD along the south-eastern boundary	**3.2**
Primary source of flood risk	EA	River	**5.2**
Presence of flood defences	EA	High ground	**3.6**
Proposed Development	Proposals by Vistry Group	Up to 150 homes, including 35% new affordable homes and up to 10 custom build homes; areas of public open space and a recreational route.	**6**
Planning Aspects			
Flood Risk Vulnerability	Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change'	More Vulnerable and Water Compatible	**6**
Flood Zone		The EA Flood Zone Map for Planning indicates the majority of the site lies within Flood Zone 1 'Low Probability'; however, the western part of the site located adjacent to River Colne lies within Flood Zone 3 'High Probability', with minor areas located within Flood Zone 2 'Medium Probability'.	**5.2**
Sequential Test		Sequential Test passed	**6**
Exception Test		No requirement to apply the Exception Test as residential development will be located within Flood Zone 1	**6**
Applicable Climate Change Allowances	EA climate change allowances guidance	For drainage purposes 40% allowance for climate change should be applied	**4**
Proposed Mitigation Measures			
Ground Floor Levels	Part H Building regulations	Minimum 150mm freeboard above ground floor levels or 300mm above the 1 in 100 + climate change flood level, whichever is higher.	**7.2**
Surface Water Drainage	CIRIA SuDS Manual 2015 (C753) Hertfordshire LLFA summary guidance for developers Part H -Building regulations	The proposed drainage strategy consists of two lined attenuation basins to the north and south of the site. Two surface water pipes will discharge water into two conveyance swales. The swales will channel water towards the River Colne. Surface water will be discharged to the River Colne via two piped surface water outfalls.	**8**

Abbreviations

ABI	-	Association of British Insurers
AEP	-	Annual Exceedance Probability
BGS	-	British Geological Survey
BPA		British Pipeline Agency
CDM	-	Construction (Design and Management)
CIRIA	-	Construction Industry Research and Information Association
DDA	-	Disability Discrimination Act
DEFRA	-	Department for Environment, Food and Rural Affairs
EA	-	Environment Agency
FAS	-	Flood Alleviation Scheme
FDC	-	Flood Defence Consent
FHR	-	Flood Hazard Rating
FRA	-	Flood Risk Assessment
FRAP	-	Flood Risk Activity Permit
FRMP	-	Flood Risk Management Plan
GIS	-	Geographic Information System
HCC		Hertfordshire County Council
LLFA	-	Lead Local Flood Authority
M. AOD	-	Metres Above Ordnance Datum (Newlyn)
NPPF	-	National Planning Policy Framework
PFRA	-	Preliminary Flood Risk Assessment
PPG	-	Planning Practice Guidance
RoSWF	-	Risk of Surface Water Flooding
SuDS	-	Sustainable Drainage Systems
SFRA	-	Strategic Flood Risk Assessment

1 Introduction

1.1 Scope of Report

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec UK Ltd ('Stantec') on behalf of Vistry Group (Client), to support an outline planning application for a residential development at Land at Tollgate Road, Colney Heath, St Albans.

1.1.2 The report is based on the available flood risk information for the site as detailed in **Section 1.3** and prepared in accordance with the planning policy requirements set out in **Section 2**.

1.1.3 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The authors and reviewers of the document are all experienced engineers, and the reviewers are members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

1.2 Existing Site and Proposed Development

1.2.1 The existing site is 7.82 ha - see further details about the existing site in **Section 3**.

1.2.2 The site lies within the administrative boundary of St Albans City and District Council.

1.2.3 The proposal is for *'demolition of the existing house and stables and the erection of up to 150 new homes, including 35% affordable and up to 10 custom build homes*'.

1.3 Sources of Information

1.3.1 The FRA has been prepared based on the following sources of information:

- Environment Agency (EA) published 'Open Data' datasets available online, reproduced with OS mapping under licence to Stantec (contains Ordnance Survey data © Crown copyright and database right [2021], contains Environment Agency information © Environment Agency and database right) (see **Appendix A**);
- Topographic survey of the site (Drawing reference: TS22-058-1, TS22-058-2, TS22-058-3, TS22-058-4 and TS22-058-5) undertaken by Terrain Surveys in February 2022 (see **Appendix B**);
- Concept Masterplan by CSA Environmental (Drawing reference: CSA/3925/117, Rev: A), dated 16th June 2022 (see **Appendix C**);
- St Albans District Council Enquiry (Ref: RE: Land at Tollgate Road - SACDC Data Request, dated 17 February 2022) (see **Appendix D**);
- EA Enquiry (Ref: RE: HNL 253613NR - 220218/DJ05. Land at Tollgate Road - EA Data Request, dated 17 March 2022) (see **Appendix D**);
- EA Product 4 (Land at Tollgate Road – HNL 253613NR, 10/03/2022) (see **Appendix F**);
- EA Products 5,6 and 7 - model and associated report (Halcrow Group Ltd, Hydraulic Modelling Report, Upper Colne SFRM study (TH013 AND TH031), Hydraulic Modelling and Mapping, Final Technical report, December 2010)

- British Pipeline Agency (FW: BPA Affected Consultation 2022-4030 ~ New Development - Tollgate Road ~ 3925-105 CRM:0039300, 24/02/2022 and RE: Tollgate Road, Colney Heath surface water drainage proposals ~ 2022-4030, 26/05/2022) (see **Appendix D**)
- City and District of St Albans District Local Plan Review 1994 - Saved and Detailed Policies Version (July 2020)[1]
- Hertfordshire County Council Local Flood Risk Management Strategy 2019-2029 (February 2019)[2]
- South West Hertfordshire Strategic Flood Risk Assessment Stage 1 (March 2019)[3]
- Hertfordshire County Council Preliminary Flood Risk Assessment (August 2011)[4]
- Hertfordshire County Council Preliminary Flood Risk Assessment Addendum (2017)[5]
- Watford and St Albans Surface Water Management Plan (February 2015)[6]
- Hertfordshire County Council Lead Local Flood Authority Summary Guidance for developers[7]

1.4 Caveats and Exclusions

1.4.1 This FRA has been prepared in accordance with the NPPF, the associated PPG and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice.

1.4.2 Activities during the construction phase may have an impact on the existing and future flood risk. Thus, an assessment of the risks and appropriate mitigation measures should be identified and managed by the contractor.

1.4.3 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves “construction” work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.4.4 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and Hertfordshire County Council in its role as Lead Local Flood Authority (LLFA). The conclusions are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals as outlined in **Section 1.2**. As such, we recommend the end user reviews the validity of the flood data on an annual basis with the EA.

1.4.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing

[1] District Local Plan Review 1994 Saved and Deleted Policies Version [July 2020].pdf (stalbans.gov.uk)

[2] LFRMS 2 (hertfordshire.gov.uk)

[3] https://www.watford.gov.uk/downloads/download/37/south-west-herts-strategic-flood-risk-assessment-stage-1-2019

[4] [ARCHIVED CONTENT] (nationalarchives.gov.uk)

[5] PFRA_Hertfordshire_County_Council_2017.pdf (publishing.service.gov.uk)

[6] watford-and-st-albans-surface-water-management-plan.pdf (hertfordshire.gov.uk)

[7] LLFA Summary Guidance for developers (hertfordshire.gov.uk)

development. Stantec does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

2 Planning Policy Context

2.1.1 This FRA has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as detailed below.

2.2 National Policy and Guidance

2.2.1 National policy in relation to flood risk is contained within the **National Planning Policy Framework (NPPF)[8],** updated July 2021, issued by the Ministry of Housing, Communities and Local Government, with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change'.

2.2.2 The associated **Planning Practice Guidance (PPG)[9]** was released in March 2014 (with reference to the 'Flood Risk and Coastal Change' section) and also last updated August 2021.

2.2.3 The NPPF and PPG demonstrate a flood risk management approach for the lifespan of the proposed development considering the effects of climate change. The document sets the framework to minimise vulnerability, provide resilience to the impacts of climate change, and to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

2.2.4 In May 2022 the guidance within the PPG on the application of climate change allowances in FRAs was significantly updated:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

2.2.5 The guidance provides contingency allowances for the potential increases in peak river flow, peak rainfall intensity and sea level rise which are considered accordingly subject to the site conditions – discussed further in **Section 4**.

2.2.6 The NPPF sets out the requirement for the Sequential Test and Exception Test in paragraphs 162 and 163 respectively – see below.

> *"**162.** The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding).*
>
> ***163.** If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3"*

2.2.7 These Tests are to be applied where appropriate, depending on the proposed development flood risk 'vulnerability' and the Flood Zone in which it is located. This is detailed further in **Section 6**.

[8] National Planning Policy Framework - GOV.UK (www.gov.uk)

[9] Flood risk and coastal change - GOV.UK (www.gov.uk)

2.3 Local Policy and Guidance

City and District of St Albans Local Plan

2.3.1 Local planning policy is contained within the **City and District of St Albans District Local Plan Review 1994 – Saved and Detailed Policies version (2020)**, with particular reference to Policy 84 - 'Flooding and River Catchment management' and Policy 84A – 'Drainage and Infrastructure',

Policy 84: Flooding and River Catchment management

The Council will consult with the National Rivers Authority on all matters likely to affect the water environment in order to reduce the risk of flooding and to ensure proper management of the river catchment. The following principles will apply:

i. in areas liable to flood, development or the intensification of existing development, will not normally be permitted. Appropriate flood protection will generally be required where the redevelopment of existing developed areas is permitted in areas at risk from flooding;

ii. where appropriate, a condition will be attached to planning permissions to ensure that strips are provided alongside 'main river' watercourses and kept free of development in order to allow access for dredging and discretionary maintenance;

iii. all works in, under, over and adjacent to watercourses shall be appropriately designed and implemented and alternatives to culverting should be explored where possible; and

iv. proposals shall not increase flood risk in areas downstream due to additional surface water runoff. If development is permitted, it must include appropriate surface water runoff control measures.

Policy 84A: Drainage and Infrastructure

The Council will consult Thames Water Utilities Ltd. and the National Rivers Authority on all planning applications that might cause sewerage flooding. The following principles will apply:

i. planning permission will not normally be granted for new development in areas which are considered presently at risk of sewerage flooding; or where development would result in an unacceptable increase in sewerage flood risk there or elsewhere;

ii. a detailed drainage impact study may be required at the planning application stage;

iii. where planning permission is granted, it may be subject to a condition or agreement relating to the approval of a drainage strategy, which may include phasing of the development.

South West Hertfordshire Strategic Flood Risk Assessment

2.3.2 The **South West Hertfordshire Strategic Flood Risk Assessment (SFRA) Stage 1** was released in 2019 and forms part of the Local Plan evidence base, to inform future spatial planning and to assist in developing planning policies to address flood risk. Moreover, the document provides an overall understanding of the flood risk within the study area taking into account all potential sources.

2.3.3 Data of specific relevance to the site are shown in **Section 5.7**.

2.3.4 It is essential therefore that the Council are in a position to take informed decisions, providing a careful balance between the risk of flooding and other unrelated planning constraints that may place pressure upon *'at risk'* areas.

Preliminary Flood Risk Assessment

2.3.5 Hertfordshire County Council (HCC) is defined as the Lead Local Flood Authority (LLFA) under the Flood and Water Management Act 2010. The first element of the Flood Risk Regulations (2009) is for LLFAs to produce a **Preliminary Flood Risk Assessment (PFRA)** providing a high-level overview of flood risk from all sources within a local area, including consideration of surface water, groundwater and ordinary (minor) watercourses.

2.3.6 The HCC PFRA was released in 2011 and its Addendum was released in 2017 and has been reviewed to ascertain any details of historic flooding at the site as part of this study – see **Section 5.7**.

3 Site Setting

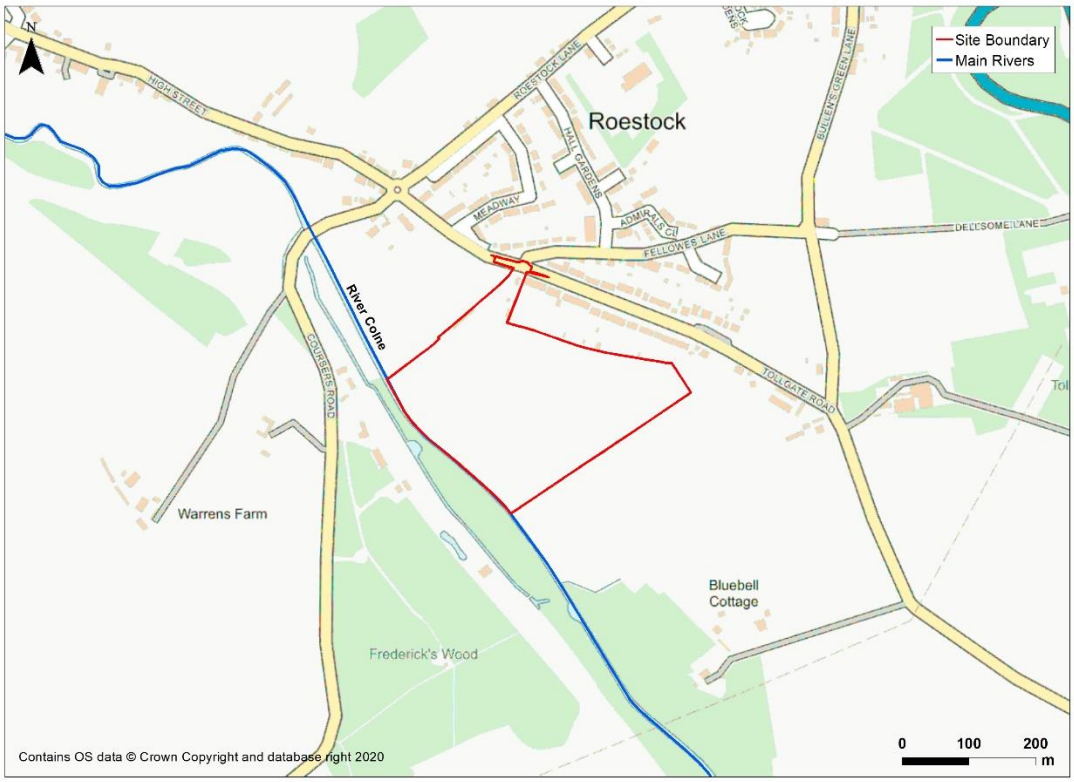
3.1 Site Description

3.1.1 The site is located off Tollgate Road, Colney Heath, St Albans, postcode: AL4 0PA, site centre National Grid Reference 520872 (Easting), 205521 (Northing). See **Figure 3-1**.

3.1.2 The site comprises two fields of horse grazing and the property known as the White Barn (east of Colney Heath Farm). The existing settlement at Colney Heath extends northwards and eastwards from the Site, with woodland and agricultural land extending to the south and west.

3.1.3 The site is bound by the wooded course of the River Colne to the south west; a paddock for horse grazing to the north west; Tollgate Road to the north east, and the rear gardens of the linear development further south along the road to the east; and further paddocks to the south and south east. The farmyard at Colney Heath Farm, including the Grade II Listed farmhouse and associated Listed barn, are located within 180m of the north western site boundary.

Figure 3-1: Site Location Plan

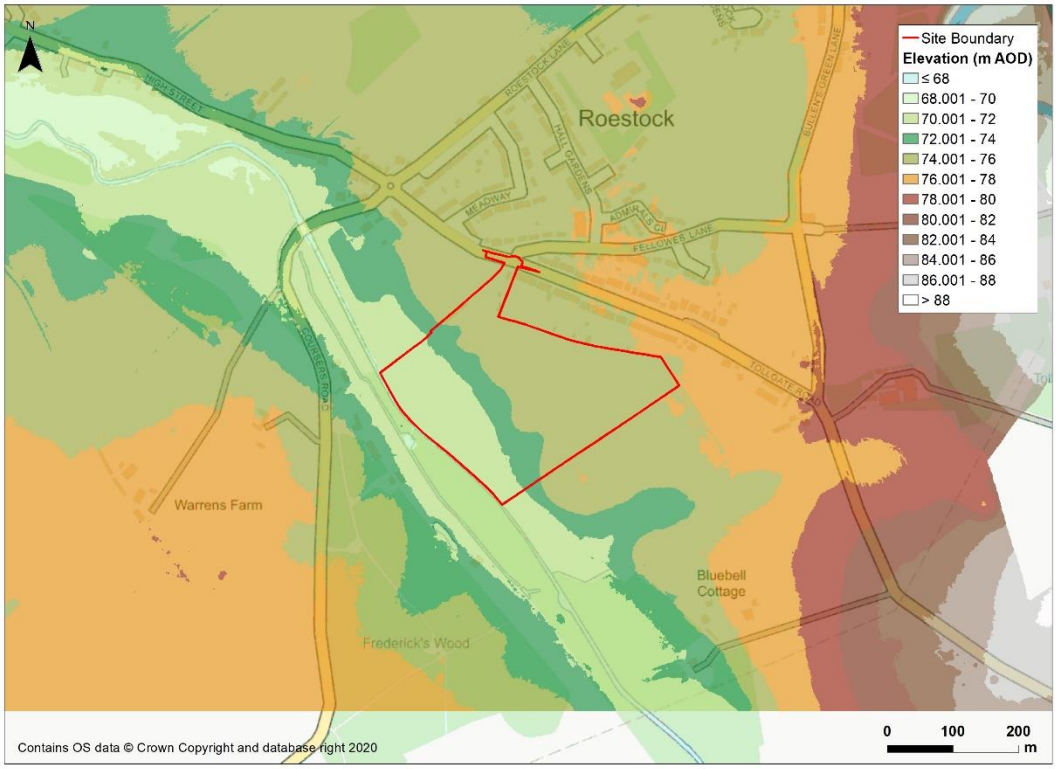


3.2 Topography

3.2.1 The topographic survey in **Appendix B** by Terrain Surveys Ltd was completed in February 2022. The east and the north-east part of the site slopes to the south-west. The levels across the site range from 75.43m AOD in the narrower part of the site by Tollgate Road to 69.64m AOD along the north-western boundary. The site also slopes from 76.30m AOD to 70.00m AOD along the south-eastern boundary.

3.2.2 The topography of the site based on LIDAR data is presented in **Figure 3-2** below and also contained in reference Figure 332510999/GIS002 in **Appendix A.**

Figure 3-2: Site Topography



3.3 Hydrological Setting

3.3.1 The **River Colne**, designated as an EA main river, is the dominant watercourse around the site. It is located along the western boundary of the site and is flowing northwards, as shown in **Figure 3-1**

3.3.2 An ordinary watercourse is also flowing parallel to the River Colne, to the south west, as shown in the OS map in **Figure 3-3**.

Figure 3-3: OS mapping

3.4 Existing Drainage Arrangements

On site drainage

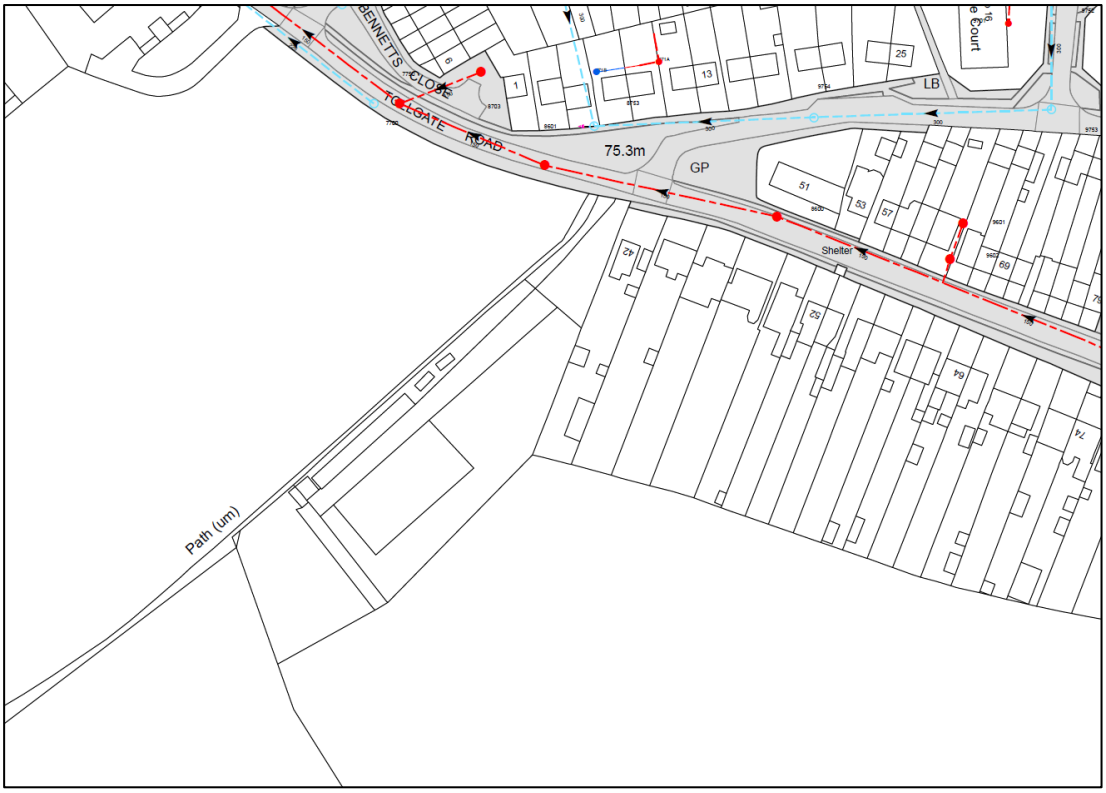
3.4.1 The site consists of agricultural land and there are no formal drainage features within the site. Therefore, it assumed that surface water would drain towards River Colne towards the lowest part of the site (i.e west and south-west area), following the natural topography of the area.

Public Sewers

3.4.2 Thames Water has provided copies of its sewerage infrastructure plans for the site and surrounding area. A copy of the sewer asset plans is provided in **Appendix J**.

3.4.3 A snapshot of the Thames Water Asset Location search Sewer map, showing the surface water and the foul water sewers, is shown in **Figure 3-4**. A 300mm surface water sewer is running along Fellowes Lane to the north of the site. An 150mm foul sewer is also running along Tollgate Road to the north of the site.

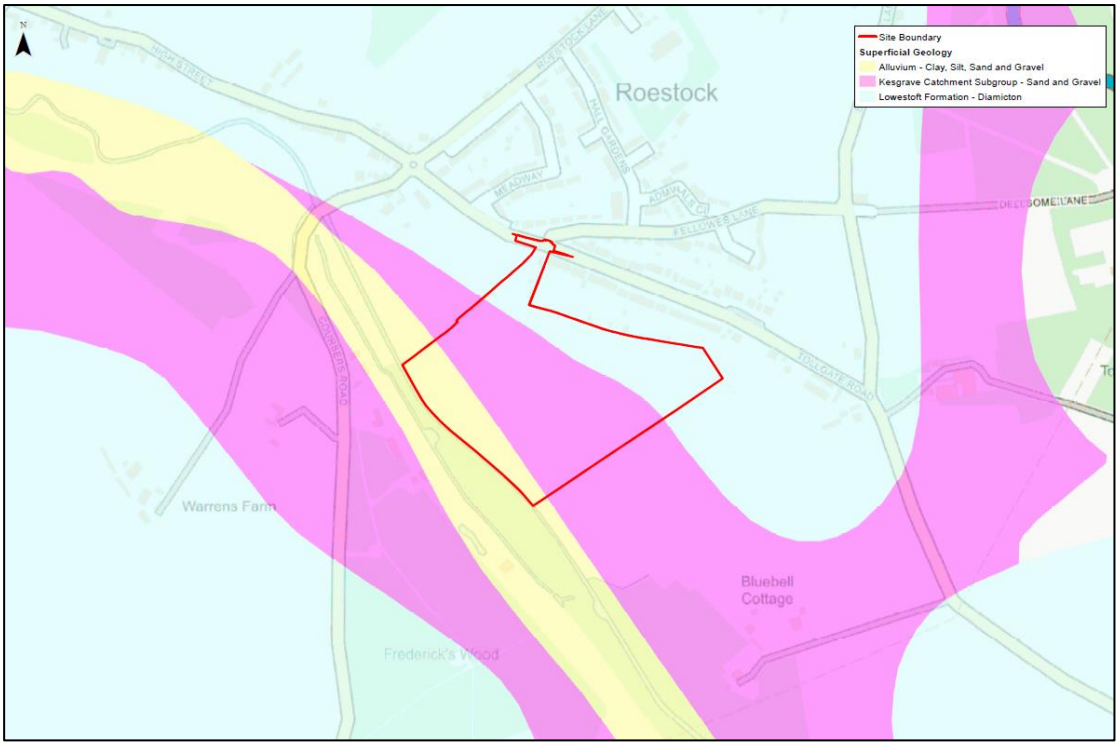
Figure 3-4: Extract from Thames Water Asset Location Search Sewer Map (TL2005NE)



3.5 Geology and Hydrogeology

3.5.1 The British Geological Survey (BGS) Geology of Britain Viewer suggests that the majority of the site lies on Lowestoft Formation, consisting of Diamicton superficial deposits. A small part of the site, located in the western part of the site along the River Colne, lies on Alluvium deposits, consisting of Clay, Silt, Sand and Gravel. The rest of the site lies on Kesgrave Catchment Subgroup deposits, consisting of Sand and Gravel. (refer to **Figure 3-5)**.

Figure 3-5: Superficial Geology



3.5.2 With regards to bedrock geology, the site is underlain by the Lewes Nodular Chalk Formation and Seaford Chalk Formation. The bedrock aquifer is designated as 'Principal'.

3.5.3 The closest BGS borehole to the site, TL20NW14 located approximately 250 south-east of the site, illustrated that groundwater was found at 1.2m bgl and that Upper Chalk is located below 20.0m bgl.

3.5.4 Geological information regarding superficial deposits and bedrock geology is shown in reference Figures 332510999/GIS015 and 332510999/GIS016, enclosed in **Appendix A**.

3.5.5 The ground investigation locations and results, presented in **Appendix I**, include

- Three Boreholes (BH1 – BH3).
  - Maximum borehole depth: 10m
- Three Soakaway Tests pits (SA1 - SA3).
  - Groundwater was encountered at 2.95m bgl, 2.99m bgl and 2.58m bgl within trial pits SA1 to SA3, respectively.
  - Maximum trial pit depth: approximately 3.0m
- Seven Trial Pits (TP1 – TP7).
  - TP5 and TP7 show that standing water was found at 2.80m bgl and 2.90m bgl, respectively and that water was struck at 2.80m bgl and 1.15m bgl, respectively.
  - Maximum trial pit depth: approximately 3.0m
- Three Dynamic Samples (WS1 - WS3).
  - WS2 and WS3 indicated that water was struck at 4.50m bgl and 3.0m bgl.
  - Maximum dynamic sample depth: 5.0m

3.5.6 As noted in the Stantec Phase 2 Ground investigation report (Ref: 332510999/3501, Rev:00, June 2022), groundwater was recorded in the boreholes during the post-fieldwork monitoring. As shown in **Table 3-1** below, monitoring recorded a relatively high groundwater table beneath the site, with groundwater present at approximately 3.0m to 4.0m bgl in the north and east of the site, and at around 0.6m to 2.0m bgl in the south and west of the site. These results show that groundwater is typically shallower approaching the River Colne.

Table 3-1: Summary of groundwater levels post-fieldwork monitoring

Borehole reference	Groundwater Levels Post Fieldwork Monitoring (range)	
	m bgl	m AOD
BH1	3.11 to 4.11	72.20 to 71.20
BH2	3.94 to 4.42	70.12 to 69.64
BH3	0.59 to 1.70	70.54 to 69.43
WS1	2.16 to 2.41	73.04 to 72.79
WS2	4.58 to > 5.00	70.05 to > 69.63
WS3	2.46 to 4.50	69.54 to 68.12

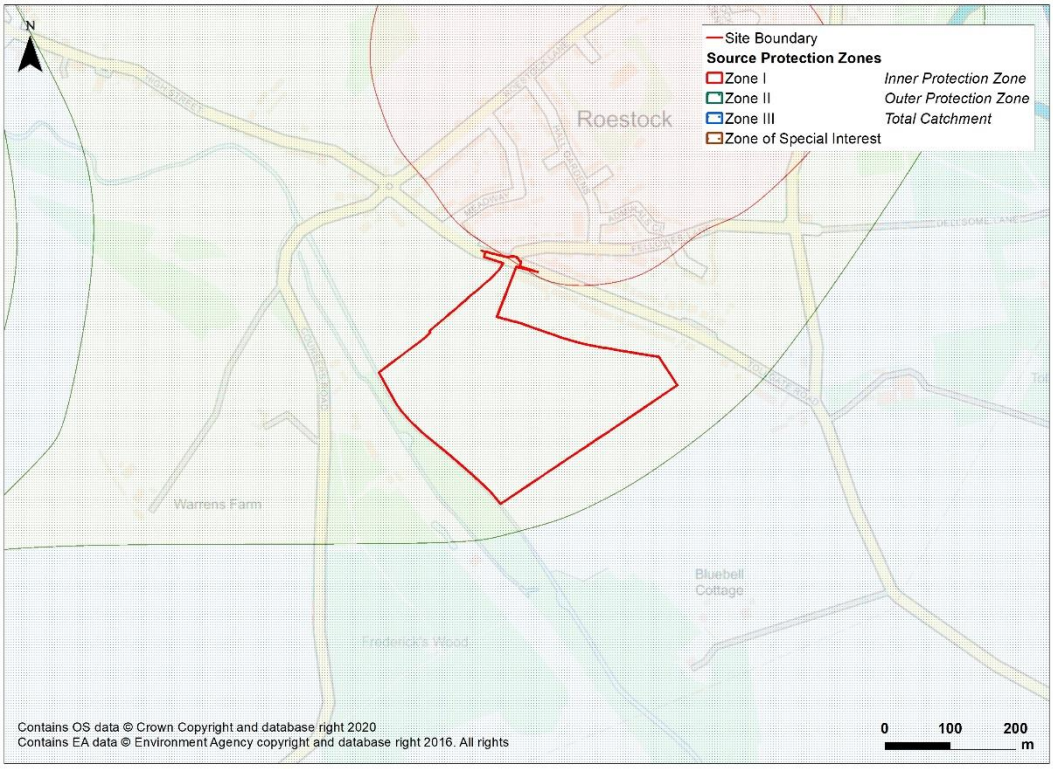
3.5.7 It should be noted that groundwater monitoring was undertaken in early summer only when groundwater levels will not have picked up seasonal fluctuations that may occur. Groundwater levels are generally at their shallowest in later winter.

3.5.8 Soakage test locations SA1 and SA2 identified that infiltration test failed at these locations. Only SA3 showed that infiltration rates from three soakage tests undertaken during two different days varied between 3.08 x 10^{-6} m/s, 2.76 x 10^{-6} m/s and 2.09 x 10^{-6} m/s.

3.5.9 Based on the above infiltration rates, it can be assumed that there is limited potential for using soakaways, ideally an infiltration rate in the order of 1 x 10^{-5}m/s would be preferable, in order to achieve the required half drain down time. Additionally, the shallow groundwater levels, presented above, would possibly limit infiltration potential and the provision of an unsaturated zone. Therefore, for the purposes of this outline application, surface water drainage methods relying solely on infiltration have been discounted in order to provide a robust design. Nevertheless, there might be potential for shallow infiltration drainage schemes that will be assessed in the detailed design stage.

3.5.10 The site is located within Source Protection Zone (SPZ) II – Outer Protection Zone (shown in **Figure 3-6** and reference Figure 332510999/GIS014, enclosed in **Appendix A**), defined as the zone that has 400 day travel time of pollutant to source. This has a 250 or 500 metres minimum radius around the source depending on the amount of water taken. As described in **section 8**, surface water runoff is collected and discharged towards the River Colne, hence away from SPZ I - Inner Protection Zone, which is bordering the site to the north, and therefore, the runoff resulting from the proposed development would not pose a risk to SPZ I.

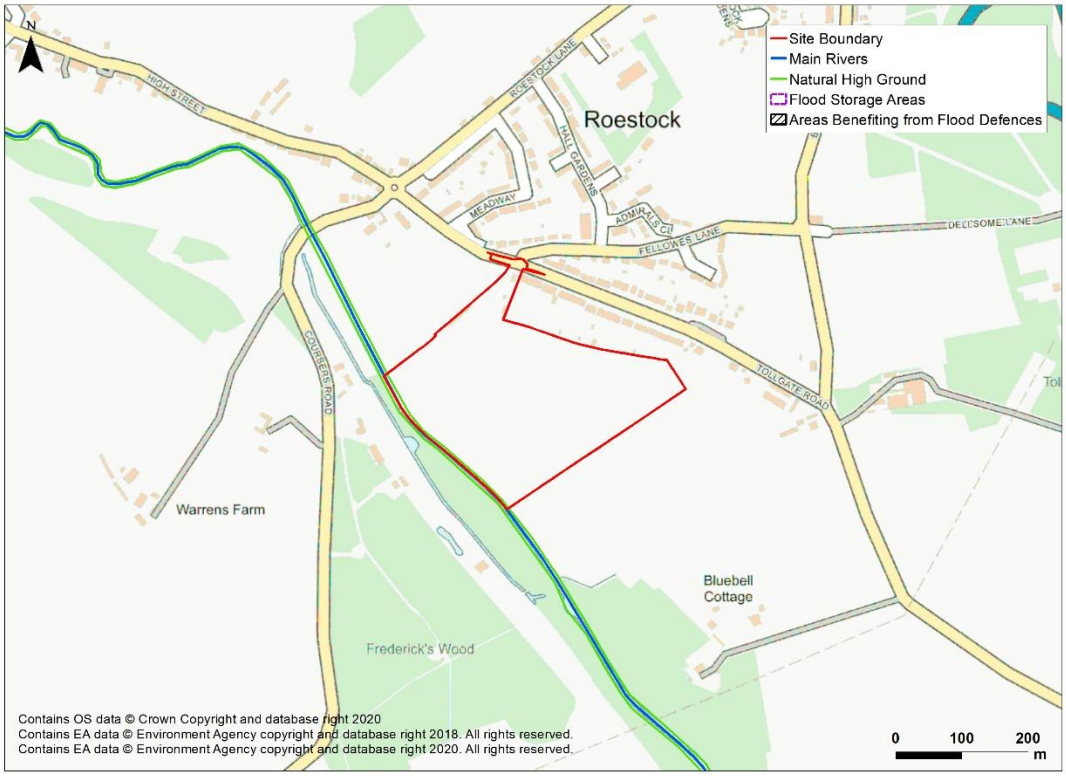
Figure 3-6: Source Protection Zones



3.6 Flood Defences

3.6.1 The defences along the River Colne at the site are classified as 'Natural High Ground' and they were last inspected in October 2021. They are shown in **Figure 3-7** and also in reference Figure 332510999/GIS012, enclosed in **Appendix A.**

Figure 3-7: River Colne Flood Defences



3.6.2 The Upper Colne SFRM Modelling report note on Main Upper Colne Flood Defences has indicated that there are three flood alleviation schemes in the wider area.

- Warrengate Road Flood Defence Walls at Mimshall Brook, located approximately 3.5km to the south-east of the site, to provide flood alleviation in the area west of Brookmans Park;
- Radlett Brook Flood Alleviation Scheme at Organ Hall Farm, located approximately 7.5km south-west of the site, to provide flood alleviation in the area of Elstree and Borehamwood; and
- Hartsbourne flood embankment approximately 15km south-west of the site.

3.6.3 However, these schemes are far away from the site and would not impact on flood levels within the site.

3.7 Other considerations

3.7.1 An oil pipeline is located on the site, to the east of River Colne, running in parallel to the river and the western boundary of the site. **Table 3-2** below illustrates the pipe information.

Table 3-2: Oil pipe information

Pipe Information	Values
Diameter	14'' NB 350 mm
Approximate Depth	0.9 m 3 ft
Appropriate Pressure	1200 psi
Capacity	9181 m^3

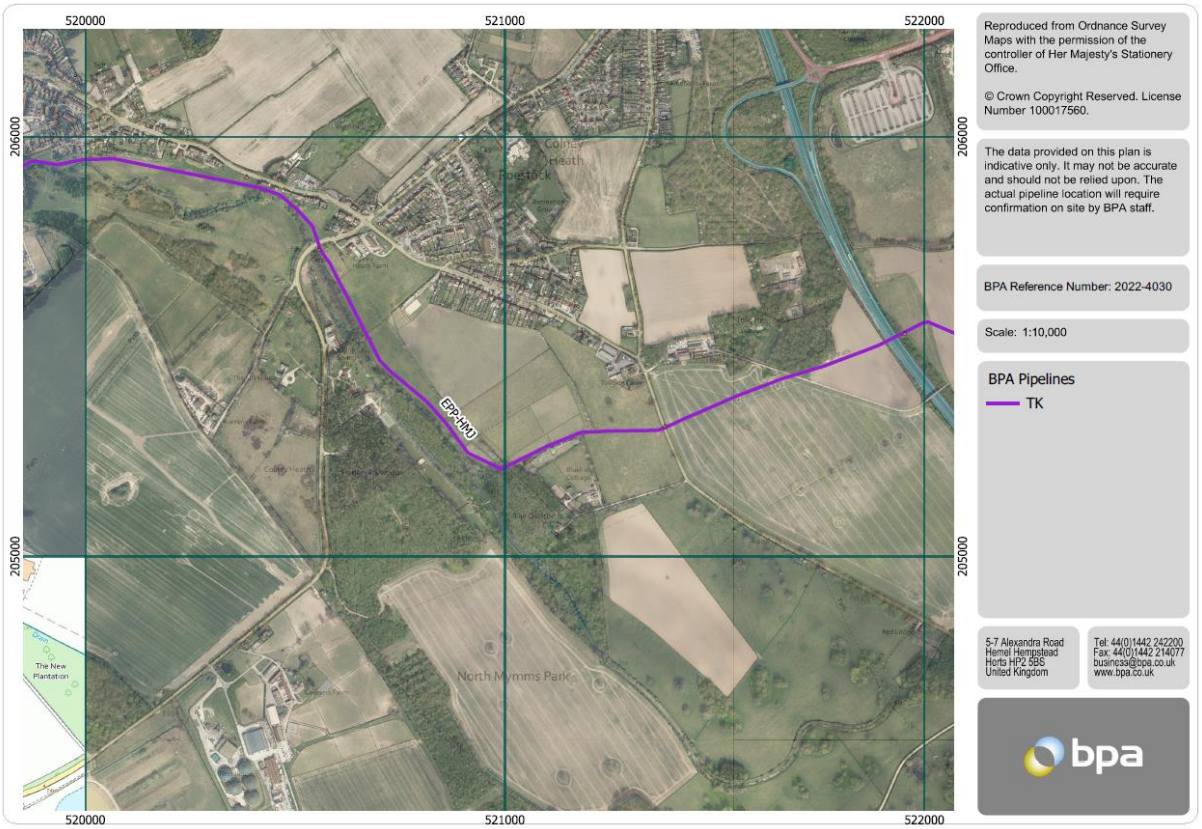
Nominal Wall	7.14 mm
Material	Steel API 5L X52
Contents	Multiproduct – Diesel; Petrol; Kerosine and Jet A1.

3.7.2 The easement of this pipeline is 6m, 3m each side of the pipeline. No buildings or trees can be located within the pipeline easement and heavy vehicle crossing points should be approved before use, across the easement. Additionally, all development proposals must be agreed prior to commencement with British Pipeline Agency (BPA).

3.7.3 Any proposed service crossing will need at least 600mm clearance over or under the BPA pipeline, and if they are 300mm or more in diameter then a crossing consent will also be required.

3.7.4 Correspondence with BPA is shown in **Appendix D** and the route of the pipeline is shown in the drainage strategy in **Appendix G**, as well as in **Figure 3-8** below.

Figure 3-8: BPA oil pipeline route



4 Impact of Climate Change

4.1.1 The NPPF and PPG place emphasis on the need to fully consider – and design for – the impacts of climate change as set out in the planning guidance. This guidance provides contingency allowances for potential increases due to climate change in:

- Peak river flow;
- Rainfall intensity;
- Sea level rise.

4.1.2 These elements are discussed in turn below.

Peak River Flow

4.1.3 The peak river flow allowances provide a range of allowances based on percentile (i.e. the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The applicable values for a Site are dependent on the 'River Management Catchment' in which the site is located, which can be confirmed via the online mapping tool embedded within the guidance.

4.1.4 The applicable allowances are subject to the Flood Zone classification of a site, and the vulnerability classification of the proposed use. The Central allowance is identified as the design standard for most forms of proposed development in all appropriate Flood Zones (the exception being 'Essential Infrastructure' which requires the 'Higher Central' value).

4.1.5 The impact of climate change, for a residential development should be considered for the lifetime of the development and hence should be considered for a minimum of 100 years, therefore the change in rainfall intensity anticipated for the '2080s' (2070 to 2115) is applicable.

4.1.6 The conditions at the site and consequent peak river flow allowances to be considered as part of the FRA are as detailed in **Table 4-1**.

Table 4-1: Climate Change – Peak River Flow Allowances

River Management Catchment	Management Catchment	Flood Zone	Flood Risk Vulnerability Classification	Applicable Climate Change Allowance *(2080s Epoch – 2070-2115)*		
				Central	Higher Central	Upper
River Colne *(Colne Management Catchment)*	*Colne*	*1, 2 and 3*	*More Vulnerable, Water Compatible*	*+21%*	*+35%*	*+72%*

4.1.1 The assessment of the impact of climate change on peak river flow allowances, and therefore fluvial flood risk has been detailed in **Section 5.2**.

Peak Rainfall

4.1.2 The potential increase in peak rainfall intensity needs to be considered in the surface water drainage strategy for new developments.

4.1.3 The anticipated changes in peak rainfall intensity in small catchments (less than 5km^2), or urbanised drainage catchments are summarised in **Table 4-2**. For large rural drainage catchments the peak river flow allowances are applied.

Table 4-2: Climate Change – Peak Rainfall Intensity Allowances (for the 3.3% annual exceedance rainfall event)

	Total potential change anticipated in 2070s *(2061 – 2125)*	
	3.3% annual exceedance rainfall event	**1% annual exceedance rainfall event**
Central	*25%*	*25%*
Upper end	*35%*	*40%*

4.1.4 For developments with a lifetime beyond 2100, the Upper end allowances should be assessed. This should be done for both the 1% and the 3.3% annual exceedance probability events for the 2070s epoch (2061 to 2125).

4.1.5 The development should be designed so that for the upper end allowance in the 1% annual exceedance probability (AEP) event there is no increase in flood risk elsewhere and the development will be safe from surface water.

4.1.6 For drainage design purposes, HCC required that for a development with a lifetime that extends beyond 2060, the system must be able to cater for a rainfall event up to and including the 1 in 100 AEP + 40% allowance for climate change[10].

[10] hcc-cc-allowances-note-v3-201711.pdf (hertfordshire.gov.uk)

5 Assessment of Flood Risk

5.1 Introduction

5.1.1 The assessment of flood risk has been undertaken based on the sources of information listed in **Section 1.3**.

5.1.2 The baseline flood maps have been taken from the Stantec GIS flood maps report in Appendix A, utilising the EA Open Data datasets available online and reproduced with OS mapping under licence to Stantec.

5.2 Fluvial (River) Flood Risk

5.2.1 Fluvial flooding occurs when rivers are unable to cope with the volume of water draining from the surrounding land as a result of sustained or intense rainfall. The increase in water causes the river to rise above its banks and/or retaining structures and flow across land.

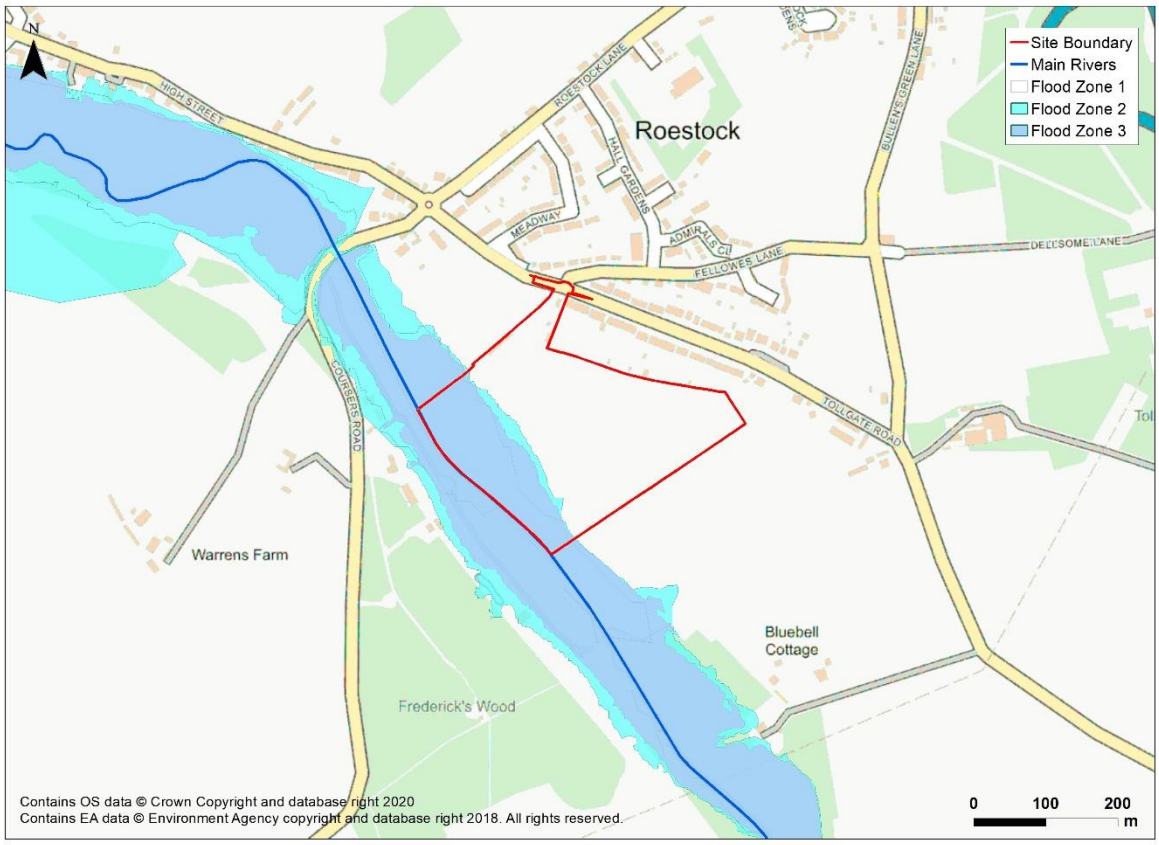
5.2.2 The first phase in identifying whether a site is potentially at risk of fluvial or tidal flooding is to consult the EA's Flood Zone maps, available on the EA's website. To verify if the flooding is associated with sea and/or river, and for completeness the EA Product 4 dataset has been used to analyse the site in more details.

5.2.3 The Flood Zones are defined in Table 1 of the PPG 'Flood Risk and Coastal Change' section as follows:

- **Flood Zone 1 'Low Probability'** – Land at less than 1 in 1000 (0.1%) annual probability of river or sea flooding;
- **Flood Zone 2 'Medium Probability'** – Land between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding, or between 1 in 200 (0.5%) and 1 in 1000 (0.1%) annual probability of sea flooding;
- **Flood Zone 3 'High Probability'** – Land at 1 in 100 (1%) or greater annual probability of river flooding, or 1 in 200 (0.5%) or greater annual probability of sea flooding.

5.2.4 The EA Flood Zone Map for Planning indicates the majority of the site lies within **Flood Zone 1 'Low Probability'**; however, the western part of the site located adjacent to River Colne lies within **Flood Zone 3 'High Probability'**, with minor areas located within **Flood Zone 2 'Medium Probability'**, see **Figure 5-1** and reference Figure 332510999/GIS003, enclosed in **Appendix A**.

Figure 5-1: EA Flood Zone Map



EA modelling (Upper Colne Flood Risk Mapping Study)

5.2.5 The EA has provided their detailed Product 4 (EA ref: HNL 253613NR, 10/03/2022), presented in **Appendix F**, as well as the associated model and reports in Products 5, 6 and 7.

5.2.6 Products 5, 6 and 7 include outputs from the Upper Colne Flood Risk Mapping Study (Halcrow, 2010).

5.2.7 It should be noted that the 20% climate change allowance has been superseded by the new climate change allowances in the EA guidance released in May 2022. The updated climate change allowance to assess the future impact of climate change on fluvial flood risk, as defined in **Table 4-1**, is 21% (central allowance), and therefore, the difference between the current and the previously modelled climate change allowances, can be considered to be minimal.

5.2.8 We can therefore assume that the 1 in 1000 AEP event could act as a proxy for the 1 in 100 AEP event including a 21% allowance for climate change.

5.2.9 In Flood Zones 2 and 3, for 'More Vulnerable' and 'Water compatible developments' – the central climate change allowance should be applied.

5.2.10 The modelled maximum fluvial flood level across the site and at specific sampled locations, are summarised in **Table 5-1** below and the corresponding flood depths are shown in **Table 5-2**. Maximum flood depths were produced using the EA modelled maximum fluvial flood levels together with the topographical survey (see **Appendix B**).

5.2.11 The EA Modelled nodes are presented in **Figure 5-2**.

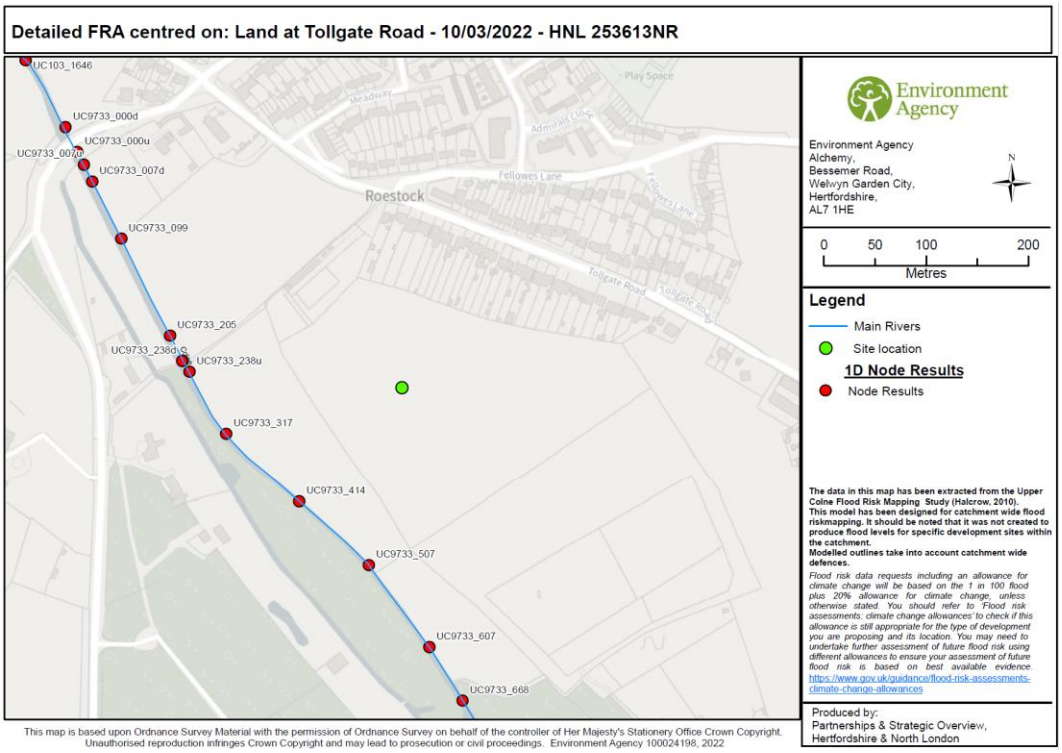
Table 5-1: EA Modelled Maximum Fluvial Flood Levels

	Return Period			
Node Label	**100 yr**	**100 yr +20% cc**	**200 yr**	**1000 yr**
UC9733_238d	71.48	71.68	71.6	71.95
UC9733_238u	71.50	71.69	71.61	71.96
UC9733_317	71.55	71.73	71.66	71.99
UC9733_414	71.62	71.79	71.72	72.03
UC9733_507	71.68	71.84	71.77	72.07

Table 5-2: Maximum Fluvial Flood Depths

		Return Period			
Node Label	**Elevation**	**100 yr**	**100 yr +20% cc**	**200 yr**	**1000 yr**
UC9733_238d	69.805	1.675	1.875	1.795	2.145
UC9733_238u	69.855	1.645	1.835	1.755	2.105
UC9733_317	70.255	1.295	1.475	1.405	1.735
UC9733_414	70.035	1.585	1.755	1.685	1.995
UC9733_507	70.435	1.245	1.405	1.335	1.635

Figure 5-2: EA Product 4 model nodes (EA ref: 10/03/2022 – HNL 253613NR)



5.2.12 The potential impacts of climate change over the lifetime of the proposed development have been considered so that mitigation measures can be designed accordingly for a worst-case scenario and are discussed in **Section 7**.

5.3 Surface Water (Pluvial) Flood Risk

5.3.1 The EA 'Risk of Flooding from Surface Water' mapping identifies areas that could be susceptible to surface water flooding in various rainfall events. The latest mapping assesses flooding resulting from severe rainfall events based on the following three scenarios:

- 'High' Risk: 1 in 30 (3.3%) or greater AEP rainfall event;
- 'Medium' Risk: Between a 1 in 100 (1%) and 1 in 30 (3.3%) AEP rainfall event;
- 'Low' Risk: Between 1 in 1000 (0.1%) and 1 in 100 (1%) AEP rainfall event;
- 'Very Low' Risk: Lower than 1 in 1000 (0.1%) AEP rainfall event.

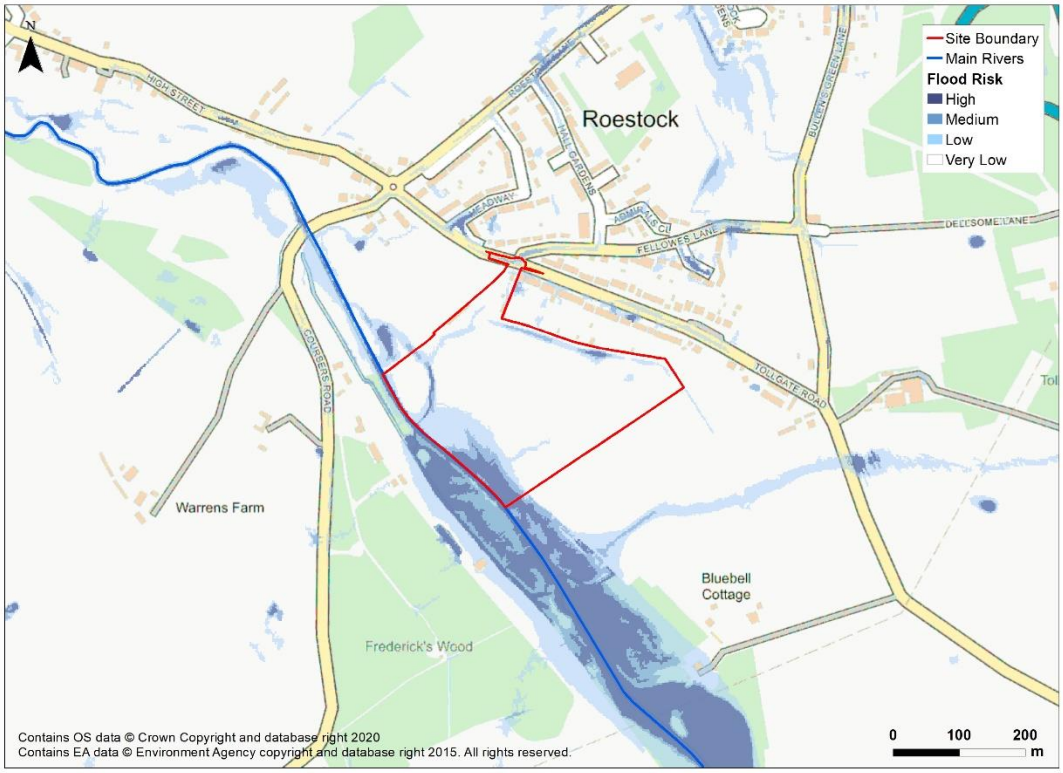
5.3.2 The EA mapping shows that the majority of the site is predicted to be at a 'Very Low' risk of surface water flooding; see **Figure 5-3** and reference maps 332510999/GIS004 to 332510999/GIS010, enclosed in **Appendix A**.

5.3.3 However, the area to the west of the site, adjacent to the River Colne is identified to be at 'Low' to High' susceptibility to surface water flooding. According to the EA map, for the 'Low' risk scenario, this area shows an indicative flood depth of 300mm-900mm and the velocity is shown to be over 0.25m/s.

5.3.4 Additionally, there is a flowpath of 'Low' to 'High' susceptibility to surface water flooding running along the eastern boundary of the site. According to the EA map, for the 'Low' risk scenario, this flowpath has an indicative flood depth of less than 300mm; however the velocity is shown to be higher than 0.25 m/s.

5.3.5 Reviewing the topographical survey (**Appendix B**), the areas of 'High' and 'Medium' risk from surface water flooding, are considered to result from localised low spots and therefore, it is considered that the risk of surface water flooding is 'Low'.

Figure 5-3: EA Risk of Flooding from Surface Water Map



5.3.6 It should be noted that the surface water maps are generated using a generic methodology on a national scale, whereby rainfall is routed over a ground surface model. The analysis does not take account of any specific local information on below-ground drainage infrastructure and infiltration, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently, the mapping provides a guide to potentially vulnerable areas based on the general topography of an area.

5.4 Groundwater Flood Risk

5.4.1 The South West Hertfordshire SFRA indicates that the western part of the site falls within an area where groundwater levels are at or near the surface (less than 0.025m from the surface). An extract of the South West HCC SFRA is shown in **Appendix E**.

5.4.2 As also detailed in **section 3.5**, the post-fieldwork monitoring recorded a relatively high groundwater table beneath the site, with groundwater present at approximately 3.0m to 4.0m bgl in the north and east of the site, and at around 0.6m to 2.0m bgl in the south and west of the site.

5.4.3 Therefore, the risk of groundwater flooding is therefore considered to be 'Medium'.

5.4.4 On an additional note, Groundwater monitoring is recommended to be undertaken over a 12-month period to assess seasonal high levels.

5.5 Reservoir Flood Risk

5.5.1 A review of the EA online reservoir map, illustrated in reference Figure 332510999/GIS011 enclosed in **Appendix A**, shows that the site lies outside of an area at risk of reservoir flooding. Therefore, there is no risk associated with this flood source and the risk of reservoir flooding is considered to be 'Very Low'.

5.6 Sewer Flood Risk

5.6.1 The South West HCC SFRA shows that within the postcode where the site is located, there have been 11-15 Thames Water records of sewer flooding. However, the Thames Water sewer flooding register for St Albans does not present any internal or external property sewer flooding within Colney Heath.

5.6.2 Therefore the risk of sewer flooding is considered to be 'Low'.

5.7 Historical Flooding

5.7.1 The EA 'Historic Flood Map' is a dataset showing the maximum extent of all individual recorded flood outlines from river, the sea and groundwater and shows areas of land that have previously been subject to flooding.

5.7.2 An extract of the Recorded Flood Outlines map, reference 332510999/GIS013, enclosed in **Appendix A**, indicates that there have been recorded floods at the site.

5.7.3 The EA Product 4 Historic Flood Maps, enclosed in **Appendix F**, indicate the flood outlines along the western part of the site for events occurring in 1987, 1992, 2000, 2009, 2011 and 2012.

5.7.4 Data of specific relevant to the site's surrounding areas as follows:

- According to the South West HCC SFRA, the following historic flood events have occurred in Colney Heath:
    - 1947, 1979, 1992, 1993 & 2000 – Park Lane, Colney Heath (approximately 930m north-west of the site) - Properties have long history of flooding. Flooding on average every 10 years. Six properties flooded during 1992 and 2000/2001 flood events.
    - 1947, 1979, 1992, 1993 & 2000 - St Mark's Close, Colney Heath (approximately 1.3km north-west of the site) - Properties have long history of flooding. Flooding on average every 10 years. One property flooded in 1992 and 2000/2001 flood events.
    - May 2007 - Park Lane, Colney Heath (approximately 930m north-west of the site) - Four properties flooded and extensive external flooding to properties at Waterside and Lowbell Lane.

5.8 Summary of Flood Risk

5.8.1 Table 5-3 provides an overview of flood risk to and from the site, based on the information obtained and detailed in this chapter.

Table 5-3: Summary of Sources of Flood Risk

Source of Flooding	Flood Risk Impact to the Site	Flood Risk Impact from the Site	Comment
Fluvial	The majority of the Site is located in Flood Zone 1 and a smaller part of the western area of the site is located within Flood Zones 2 and 3.	Residential development will be restricted within Flood Zone 1 and will not impact Flood Zones 2 and 3.	Residential development will be located within Flood Zone 1.
Surface Water/ Pluvial	The majority of the site is located in an area of Very Low of surface water flooding. A smaller part of the western area of the site is located in Low to High surface water flood risk. There is another flowpath at the eastern part of the site, also located in Low to High risk of surface water flooding. These areas are likely to be associated with localised low spots and therefore, the risk of surface water flooding is considered to be 'Low.	A surface water drainage strategy is developed so that the proposed development will not impact surface water within the site.	Ground floor levels are set a suitable freeboard above either 150mm above surrounding ground levels or 300mm above the 1 in 100 AEP including climate change event, whichever is higher. Finished floor levels are further discussed in section 7.2. Exterior ground levels across the site are appropriately contoured to direct surface water away from dwellings. Liaise with the LLFA in development of surface water strategy
Groundwater	The SFRA indicated shallow groundwater levels within the site. The site is considered to have a 'High' risk of groundwater flooding.	The proposed development will not affect groundwater flooding within the site. No basements are currently proposed.	Allow for waterproofing in service trench installations, and for the lining of pipes and SuDS features
Artificial Sources	There is no flood risk from reservoirs within the site.	N/A	N/A
Sewers and Water Mains	No historic records of flooding.	N/A	N/A

Key:		**Low/Negligible Risk** – No noticeable impact to or from the Site and not considered to be a constraint to development
		Medium Risk – Issue requires consideration but not a significant constraint to development
		High Risk – Major constraint to development requiring active consideration in mitigation proposals

5.8.2 The proceeding chapters, specifically Chapters 6 and 7 outline the required mitigation to manage the flood risk impacts identified to have a medium or high risk (see Table 5-3). The management of residual flood risk is covered in Chapter 10.

6 Proposed Development and Sequential Test

Proposed Development

6.1.1 This FRA accompanies an outline planning application for up to 150 homes, including 35% new affordable homes and up to 10 custom build homes; and areas of public open space.

6.1.2 Details of the proposals by CSA Environmental are included in **Appendix C**.

6.1.3 The proposed mitigation is based on a design life for the development of 100 years, and the climate change allowances described in **Section 4** are also based on this assumption.

Flood Risk Vulnerability

6.1.4 PPG 'Flood Risk and Coastal Change' Table 2 confirms the *'Flood risk vulnerability classification'* of a site, depending upon the proposed usage. This classification is subsequently applied to PPG 'Flood Risk and Coastal Change' Table 3 to determine whether:

- The proposed development is suitable for the flood zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

6.1.5 The proposed residential development is classed as 'More Vulnerable' development. The public open space and recreational routes are classed as 'Water Compatible development.

6.1.6 The location of the proposed residential development, classed as 'More Vulnerable', is located within Flood Zone 1.

NPPF Sequential Test

6.1.7 The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.

6.1.8 The site is currently located within the Green Belt and the relevant Saved Policy of the St Albans District Local Plan Review is Policy 1 (Metropolitan Green Belt).

6.1.9 The site has been identified in the St Albans City and District Council Strategic Housing Land Availability Assessment (SHLAA 005 Update 2018)[11].

NPPF Exception Test

6.1.10 With reference to Table 3 of the NPPF and PPG tit can be seen that 'More Vulnerable' development in Flood Zone 1 is considered appropriate without the requirement to apply the Exception Test.

6.1.11 Similarly, 'Water Compatible' development in Flood Zones 2 and 3, are considered appropriate without the requirement to apply the Exception Test.

[11] Print Template - SHLAA Update 2018 - Colney Heath, Sleaphyde, Smallford and Surrounds Background Sites (stalbans.gov.uk)

7 Flood Mitigation Strategy

7.1 Sequential Approach

7.1.1 The NPPF encourages the application of the 'sequential approach' in the master-planning process for new development, i.e. locating the more sensitive/vulnerable elements of new development in the areas which lie at lowest probability of flooding and, conversely, reserve the areas of the site at greatest risk of flooding for the least vulnerable elements of the development (or, preferably, leave such areas undeveloped or as soft landscaping).

7.2 Building Design

Ground Floor Levels

7.2.1 Standard requirements for ground floor levels of new development are set out in BS8533:2017 'Assessing and Managing Flood Risk in New Development – Code of Practice'. This recommends floor levels are set a minimum of 300mm above the modelled 1 in 100 annual probability plus allowance for climate change flood level.

7.2.2 It is recommended that ground floor levels are set a suitable freeboard either 150mm above the surrounding ground levels or 300m above the 1 in 100 AEP including climate change, whichever is higher. Due to the fact that the climate change allowance has been updated from 20% to 21%, as mentioned in **section 5.2**, the 1 in 1000 AEP event will also be assessed as a proxy.

- The modelled water levels for the 1 in 100 AEP including 20% climate change allowance and the 1 in 1000 AEP events, adding a 300mm freeboard, are indicated in **Table 7-1**.
- The minimum ground level within the residential area (where the minimum level within the residential area is 72.3m AOD) adding an 150mm freeboard would be 72.45m AOD.

Table 7-1: EA Modelled Maximum Fluvial Flood Levels plus 300mm

Node Label	100 yr +20% cc	1000 yr
UC9733_238d	71.98	72.25
UC9733_238u	71.99	72.26
UC9733_317	72.03	72.29
UC9733_414	72.09	72.33
UC9733_507	72.14	72.37

7.2.3 The maximum fluvial flood levels, including a 300mm freeboard, presented in **Table 7-1,** are all lower than 72.45 m AOD.

7.2.4 Therefore, it is recommended that ground floor levels should be set 150mm above the surrounding ground.

7.3 Safe Access

7.3.1 It is necessary to consider and incorporate safe access arrangements as part of the mitigation, to ensure the users/occupants of the development are safe in times of flooding.

7.3.2 Consideration of the safety of any pedestrian route has been based on the guidance in the EA document '*Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1*'.

7.3.3 Safe access and egress to and from the stie can be provided through Tollgate Road, which is located within Flood Zone 1.

7.4 Flood Risk Activity Permit Requirements

7.4.1 Proposed works in, over, under or near a main river or a flood defence require a 'Flood Risk Activity Permit' (FRAP) application to be made to the EA (this replaced the previous 'Flood Defence Consent' (FDC) procedure). This is required to demonstrate any new development does not have a detrimental impact on flood risk, either through impacting the integrity of the existing defence or through preventing maintenance access to the defence.

7.4.2 The south-western boundary of the site is falling within the wooded course of the River Colne and the associated natural high ground defences. As there are proposed drainage works through this area, that would eventually discharge to the river, these works are likely to require a FRAP.

8 Surface Water Drainage Strategy

8.1 Overview

8.1.1 The Lead Local Flood Authority (LLFA) is the statutory consultee on planning applications for surface water management. As the LLFA, HCC Council is therefore responsible for the approval of surface water drainage systems within new major development. Major development consists of any of the following:

a) the provision of dwelling houses where residential development of 10 or more units; or where the development is to be carried out on a site having an area of 0.5 hectares or more and the number of units is not known;

b) the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or

c) development carried out on a site having an area of 1 hectare or more.

8.1.2 The following section provides an overview of the existing surface water drainage arrangements and the proposed strategy for the management of surface water from the new development.

8.1.3 The surface water drainage strategy has been informed through best practise guidance documents including the 'CIRIA SuDS Manual 2015 (C753)'.

8.1.4 This section of the report should be read in conjunction with the surface water management strategy drawings contained within **Appendix G.**

8.2 Planning Policy Requirements

8.2.1 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development, this being complementary to the control of development within the floodplain.

8.2.2 As the intention of SuDS is to mimic the natural drainage regime of the undeveloped site, the NPPF PPG states the following (consistent with the Building Regulations H3 hierarchy):

> *"...the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:*
>
> *- into the ground (infiltration),*
>
> *- to a surface water body,*
>
> *- to a surface water sewer, highway drain or another drainage system,*
>
> *- to a combined sewer"*

Consideration of Infiltration Drainage

8.2.3 As discussed in **section 3.5**, soakaway testing illustrated that only one soakaway test location showed some infiltration potential; however, the infiltration rate is considered relatively poor. Therefore, for the purposes of this outline application, surface water drainage methods relying solely on infiltration have been discounted in order to provide a robust design. Nevertheless,

there might be potential for shallow infiltration drainage schemes that will be assessed in the detailed design stage.

Consideration of Discharge to Watercourse

8.2.4 Where infiltration is not appropriate, the next preference in the Building Regulations H3 Hierarchy is discharge to a watercourse.

8.2.5 River Colne is flowing in parallel to the western boundary of the site and it is proposed that surface water would be discharged to the River Colne. It is proposed that surface water runoff will discharge to the river via two conveyance swales.

8.2.6 It should be noted that an oil pipeline, described in **section 3.7** , is running in parallel to the western boundary of the site and that the proposed conveyance swales will need to cross it.

Consideration of Discharge to Sewer

8.2.7 Where discharge via infiltration or watercourse is not appropriate, the final preference is discharge to a sewer.

8.2.8 As shown in **Figure 3-4**, a Thames Water surface water pipe is running along Fellows Lane. However, in order to be able to discharge surface water to the Thames Water network, pumping would be required due to the topography of the area.

8.2.9 Therefore, it is concluded that discharge to sewer would not be an appropriate surface water disposal option.

8.3 Greenfield Runoff Rates

8.3.1 For this assessment, the site has been considered as 100% greenfield with poor infiltration based in the underlying infiltration tests, detailed in **section 3.5**.

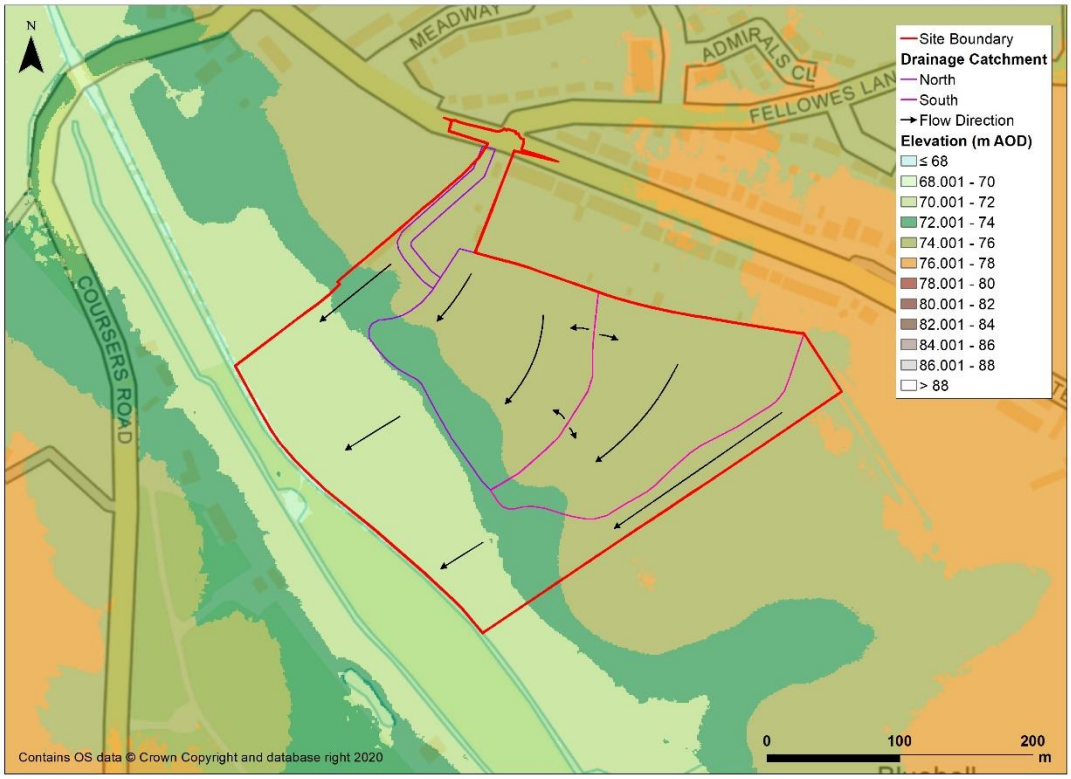
8.3.2 The greenfield runoff rate has been estimated using the FEH Statistical method based on the site's catchment descriptors. This method resulted in a QBAR (1 in 2.33 annual probability event) greenfield runoff rate of 2.82 l/s/ha, as detailed in **Appendix H**.

8.4 Proposed Drainage Catchments and Impermeable areas

8.4.1 The site has been divided into two drainage catchments through a very gentle ridgeline that crosses the site from the north boundary to the south boundary. Surface runoff falls via gravity from the eastern part of the site towards the River Colne.

8.4.2 The drainage catchments are shown in **Figure 8-1** below and in reference Figure 332510999/GIS017 in **Appendix A**.

Figure 8-1: Proposed drainage catchments



8.4.3 At this outline stage, an impermeability factor of 50% has been assumed for all residential areas, based on the CSA Development Framework Plan, to form the basis of the discharge rate calculations.

8.4.4 An urban creep allowance of 10% is applied for calculating the required attenuated volumes, resulting in a total impermeability factor of 55%.

8.5 Outline Surface Water Drainage Strategy

8.5.1 The drainage strategy for the site, shown in **Appendix G**, has been designed in accordance with the Hertfordshire LLFA Summary Guidance for developers. The guidance states that peak discharge rates from site should not increase as a result of the proposed development, up to a 1 in 100 chance in any year including an allowance for climate change storm event. The LLFA expects all applicants to achieve greenfield runoff rates for greenfield development sites

8.5.2 The total storage required has been modelled using MicroDrainage, assuming the following design criteria:

- Rainfall data generated by FEH
- Development should be designed with the upper end allowance (40% climate change allowance) for the 1 in 100 AEP event, and;
  - There should be no increase in flood risk elsewhere.
  - The development should be safe from surface water flooding.
- QBAR rate of 2.82 l/s/ha.

8.5.3 The surface water drainage strategy can be summarised as follows:

- Attenuation storage is provided within two lined basins; north and south of the site, ignoring any storage provided within the drainage network.

- Two surface water pipes (from the north and south attenuation basins) are discharging attenuated surface water flows into two swales. The swales are crossing the oil pipeline and water will be discharged to the River Colne via two piped surface water outfalls.

- The abovementioned proposed SuDS features seek to deliver long term mitigation by attenuating and treating the development generated surface water runoff and where possible provide betterment. The SuDS will also form an important part of the project's biodiversity strategy and features will be designed so that they maximise opportunities for habitat creation.

8.5.4 A summary of the storage required for each drainage catchment is listed in **Table 8-1**.

Table 8-1: Impermeable areas and attenuation storage volumes calculations

Catchment	Total area (ha)	Impermeable area (ha) *assuming 50% impermeability*	Impermeable area (ha) *assuming 55% impermeability*	Maximum permitted discharge rate (l/s)	Attenuation Storage required (m^3)
North	1.983	0.99	1.09	2.80	987
South	1.961	0.98	1.08	2.76	971
Total	3.944				1,958

+Coefficients of volumetric runoff (Cv) for summer and winter months have been assumed to be 0.85 and 0.90, respectively.

8.5.5 The attenuation basin features are presented in **Table 8-2** below.

Table 8-2: Proposed Attenuation Basin features

Catchment	Side slopes	Depth (m)	Minimum freeboard (mm)	Attenuation Storage Provided (m^3)
North	1 in 4	1.5	300	1,093
South	1 in 4	1.5	300	1,080
Total				2,173

8.5.6 At this stage, it is assumed that a total storage of 2,173 m^3 will be provided to contain the 1 in 100 annual probability event with 40% allowance for climate change safely on site.

8.5.7 It should be noted that the lining of the attenuation basins and the swales is subject to floatation calculations that are going to take place in the detailed design stage of the development.

8.6 Designing for Exceedance

8.6.1 The piped system will be designed to accommodate runoff during storm events up to the 1 in 30-year event. In excess of this it is possible that the design standard for the system will be exceeded.

8.6.2 The proposed site levels will be designed so that exceedance flow (runoff generated in events in excess of the 1 in 100 annual probability rainfall event + 40% climate change) is directed away from proposed properties and towards public open space areas where shallow flooding can occur.

8.7 Other Considerations

Pollution Control

8.7.1 Appropriate pollution control measures will be included in the surface water drainage system to minimise the risk of contamination or pollution entering the receiving systems from surface water runoff from the development.

8.7.2 The drainage system will therefore be designed to comply with the requirements of the SuDS treatment train as laid out in CIRIA C753 'The SuDS Manual', described as the 'Simple Index' Approach.

8.7.3 The final strategy for pollution control will be confirmed as part of the detailed design, however at this stage of the assessment an appropriate upstream SuDS treatment train has been incorporated into the design prior to the discharge to River Colne.

8.7.4 To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index for each contaminant type that equals or exceeds the pollution hazard index for each contaminant type. Therefore, the following will have to be achieved for the surface water running off the site.

Total SuDS mitigation index ≥ pollution hazard index

8.7.5 In accordance with Table 26.2 of the SuDS Manual Simple Index Approach, the proposed development will have the pollution hazard indices as tabulated in Table **8-3**.

Table 8-3: Pollution hazard indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential roof	Very Low	0.2	0.2	0.05
Access roads and car parks	Low	0.5	0.4	0.4

8.7.6 The SuDS pollutant mitigation indices for the proposed SuDS components are shown in **Table 8-4**, extracted from Table 26.3 in the SuDS Manual.

Table 8-4: SuDS Mitigation Index

Runoff source	SuDS components	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Hardstanding areas	Attenuation storage	0.5	0.5	0.6

Hardstanding areas	Conveyance swales	0.5	0.6	0.6

8.7.7 As the proposed drainage strategy includes more than two SuDS components, the total SuDS mitigation index is calculated as:

Total SuDS mitigation index = mitigation index$_1$ + 0.5 (mitigation index$_2$), where mitigation index$_n$ = mitigation index for component n

8.7.8 A factor of 0.5 is used to account for the reduced performance of secondary components associated with already reduced inflow concentrations.

8.7.9 Therefore, the SuDS Mitigation Index:

- For TSS would be 0.5+0.5x0.5 = 0.75;
- For Metals would be 0.5+0.5x0.6 = 0.8; and
- For Hydrocarbons would be 0.6+0.5x0.6 = 0.9.

8.7.10 Therefore, it is concluded that the treatment within the proposed SuDS components is acceptable.

Adoption and Management

8.7.11 All proposed drains and sewers should be designed in accordance with the Building Regulations – Approved Document H, the Design Manual for Roads and Bridges and/or Sewerage Sector Guidance as appropriate.

8.7.12 It is envisaged that the Client will seek to have the surface water infrastructure adopted by Thames Water under a Section 104 agreement (Water Industries Act 1991). A private management company will need to be employed to undertake the ongoing maintenance of any surface water infrastructure that is not adopted.

8.7.13 The long-term management of surface water drainage assets, including any SuDS components, is essential to ensure they continue to function to their design standard. As such, a management and maintenance plan will need to be developed to ensure the systems continue to work effectively.

8.8 SuDS Operation and Maintenance

Maintenance schedule overview

8.8.1 All drainage systems require regular maintenance. Although SuDS are usually designed so that they require the minimal amount, their maintenance should be included alongside other regular maintenance tasks. **Table 8-5** gives a summary of typical maintenance tasks and the frequency that these should be undertaken.

Table 8-5: Overview of surface water drainage typical maintenance

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Inspection of inlets and outlets and control structures, litter and debris removal, grass cutting	Monthly, Quarterly or as required
Occasional maintenance	Removal of silt building up in drainage features, manage vegetation around components	Annually or as required
Remedial actions	Repair from damage, inlets and outlets repair, erosion repairs, reinstatement following pollution	As required

8.8.2 Specific recommendations for different SuDS features are provided in the following sections and they are based on the CIRIA SuDS Manual 2015 (C753).

Attenuation basin maintenance schedule

8.8.3 The maintenance schedule that needs to be adhered to ensure effective operation of the lined attenuation basin, throughout its service life, is shown in **Table 8-6**.

8.8.4 Typical stated design life of the attenuation basin varies between 20 and 50 years[12], but this varies depending on the basin's maintenance regimes and site conditions. EA's recommendation is for basin sediments to be disposed after 10-15 years.

Table 8-6: Operation and maintenance requirements for attenuation basins

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually, or as required
	Check any penstocks and other mechanical devices	Annually

[12] https://assets.publishing.service.gov.uk/media/6034ee6c8fa8f54334a5a6a9/Cost_estimation_for_SUDS.pdf

Maintenance Schedule	Required Action	Typical Frequency
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirement where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Swale maintenance schedule

8.8.5 The maintenance schedule that needs to be adhered to ensure effective operation of the swale, throughout its service life, is shown in **Table 8-7**. Maintenance of the underdrain section is referenced in the filter drain / perforated pipe maintenance schedule below.

8.8.6 Typical stated design life of swales is unlimited[12], but this varies depending on maintenance regimes, system design and site conditions.

Table 8-7: Operation and maintenance requirements for swales

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly

Maintenance Schedule	Required Action	Typical Frequency
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, after plant types to better suit conditions, if required	As required if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing of reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Surface water pipe maintenance schedule

8.8.7 The maintenance schedule that needs to be followed to ensure effective operation of the surface water pipe network throughout its service life is shown in Table 8-8. Surface water pipes should be visually inspected at least every month for the first three months following installation and then as minimum in accordance with **Table 8-8**.

Table 8-8: Operation and maintenance requirements for surface water pipe

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Visual inspection from chambers	Annually or as required
	CCTV inspection and jetting	Every 5 years or as required
	Litter / debris removal	As required
Occasional maintenance	Sediment removal	As required
Remedial actions	Repair from damage	As required

Headwalls and catchpit manholes

8.8.8 The maintenance schedule that needs to be followed to ensure effective operation of the outfall headwalls throughout their service life is shown in **Table 8-9**. It is recommended outfall

headwalls are inspected at least once a month for the first three months and installation and then the minimum as detailed in this plan.

8.8.9 Design life of catch pit manholes depends on the manhole material, maintenance regime, and site conditions; it varies between 60 to 120 years[13] [14] [15].

Table 8-9: Operation and maintenance requirements for headwalls and inspection chambers

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Inspect surface structures removing obstructions and silt as necessary. Check there is no physical damage.	Monthly
	Strim vegetation 1m min surround to structures and keep hard aprons free from silt and debris.	Monthly
	Remove cover and inspect ensuring water is flowing freely and that the exit route for water is unobstructed.	Annually (or as required)
	Remove debris and silt.	Annually (or as required)
	Undertake inspection after leaf fall in autumn	Annually
Occasional maintenance	Check topsoil levels are 20mm above chambers covers to avoid mower damage	As necessary
Remedial actions	Repair physical damage if necessary	As required

[13] https://media.marshalls.co.uk/image/upload/v1622127827/MCD-Water-Management-Brochure.pdf

[14] https://www.drainagepipe.co.uk/twinwall-drainage/twinwall-inspection-chambers-when-to-use-twinwall/

[15] https://www.civilsstore.co.uk/content/large/products/5b2b992bd042b1.34417284.pdf

9 Foul Water Drainage

9.1.1 The foul water drainage strategy has been informed by the Development Framework Plan and the site topography.

9.1.2 Foul water discharge rates are expected to increase as a consequence of the proposed development however Thames Water have been consulted and confirmed there is adequate capacity within the existing sewer network to serve the development (see Thames Water correspondence included in **Appendix D**). Foul water will discharge into manhole 8601, located on Tollgate Road. Estimated wastewater volumes arising as a result of the proposed development (in a fully operational event day scenario) have been calculated as part of the Utility Assessment.

9.1.3 Due to the natural topography of the site, part of the foul water discharge will discharge by gravity and the remaining will be pumped.

9.1.4 A pumping station is proposed to be located to the south of the site, as shown in **Appendix G**. It should be noted that a small part of the pumping station will be located just within Flood Zone 2 and therefore, the surrounding ground levels should be set such that if the pumping station was to break down, then flood water would be contained within the area of the pumping compound.

9.1.5 The Sewarage Sector Guidance document[16] details the minimum distances from the wet well of the pumping station to any habitable buildings, as shown in **Table 9-1** below, in order to minimise the risk of odour, noise and nuisance.

Table 9-1: Minimum distance of Wet Wells from Habitable Buildings

Pumping station type	Minimum distance (m)*
Type 1	5
Type 2	10
Type 3	15

*This dimension may be subject to change, depending on the local circumstances and submission of proposals.

9.1.6 The pumping station should not be located where it might be susceptible to flooding at a frequency of more than 1 in 30 years. All electrical control equipment should be water resistant or sited above the 1 in 200 AEP event flood levels[16] (flood levels are shown in **Table 5-1**).

9.1.7 The pumping station should be located so that it is accessible and visible to the water company at all times.

9.1.8 An indicative foul drainage layout has been prepared to demonstrate how the site can be drained to the confirmed discharge point, see **Appendix G**.

[16] Sewerage Sector Guidance-approved documents | Water UK

10 Residual Risk

10.1.1 It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible however, it is practicable to minimise the risk by allowing a substantial freeboard (safety margin) and by using suitable construction and management techniques.

10.1.2 The below points set out how residual risk has been considered:

- Application of the sequential approach to locate development outside areas at higher risk of flooding.
- Proposed ground floor levels should be set a minimum of 150mm above adjacent ground levels to provide a suitable freeboard for buildings and appropriate profiling of exterior ground levels to fall away from building entrances.
- Provision of appropriate surface water drainage attenuation systems, including consideration of projected impacts of climate change and exceedance events.
- Groundwater monitoring is recommended to be undertaken over a 12-month period to assess seasonal high levels.
- Plans in place for future management and maintenance of drainage systems.

10.1.3 As such, the residual risk is considered to be acceptable for the lifetime of the development.

11 Conclusions

11.1.1 This FRA has been prepared by Stantec on behalf of our Client, Vistry Group, to support and outline planning application for a residential development at Tollgate Road, Colney Heath, St Albans.

Flood Risk

11.1.2 The majority of the site lies within Flood Zone 1; however, the western part of the site located adjacent to River Colne lies within Flood Zone 3, with minor areas located within Flood Zone 2.

11.1.3 The majority of the site is predicted to be at a 'Very Low' risk of surface water flooding; however, the area to the west of the site, adjacent to the River Colne is identified to be at 'Low' to High' susceptibility to surface water flooding. Additionally, there is a flowpath of 'Low' to 'High' susceptibility to surface water flooding running along the eastern boundary of the site. These 'High' and 'Medium' areas of surface water flooding are resulting from localised low spots and therefore, it is considered that the risk of surface water flooding is 'Low'.

11.1.4 The western part of the site falls within an area where groundwater levels are at or near the surface; therefore, the risk of groundwater flooding is therefore considered to be 'Medium'.

11.1.5 The remaining sources of flood risk are considered to be a low risk.

11.1.6 Proposed ground floor levels should be set a minimum of 150mm above adjacent ground levels to provide suitable freeboard for buildings and appropriate profiling of exterior ground levels to fall away from building entrances.

Vulnerability and Sequential Test

11.1.7 The proposed residential development is classed as 'More Vulnerable' development. The public open space and recreational routes are classed as 'Water Compatible' development.

11.1.8 The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. The proposed residential development will be located solely within Flood Zone 1.

11.1.9 'More Vulnerable' development in Flood Zone 1 is considered appropriate without the requirement to apply the Exception Test. 'Water Compatible' development in Flood Zones 2 and 3, is considered appropriate without the requirement to apply the Exception Test.

Surface Water Drainage

11.1.10 According to the ground investigation, infiltration rates are considered relatively poor. Therefore, for the purposes of this outline application, surface water drainage methods relying solely on infiltration have been discounted in order to provide a robust design. Nevertheless, there might be potential for shallow infiltration drainage schemes that will be assessed in the detailed design stage.

11.1.11 The proposed design is based on a 1 in 100 AEP rainfall event, including 40% climate change allowance.

11.1.12 The proposed drainage strategy consists of two lined attenuation basins to the north and south of the site. It is then proposed that two surface water pipes will channel water towards two conveyance swales towards the River Colne. The swales will cross the oil pipeline and surface

water will eventually be discharged from the swales via two piped surface water outfalls to the River Colne.

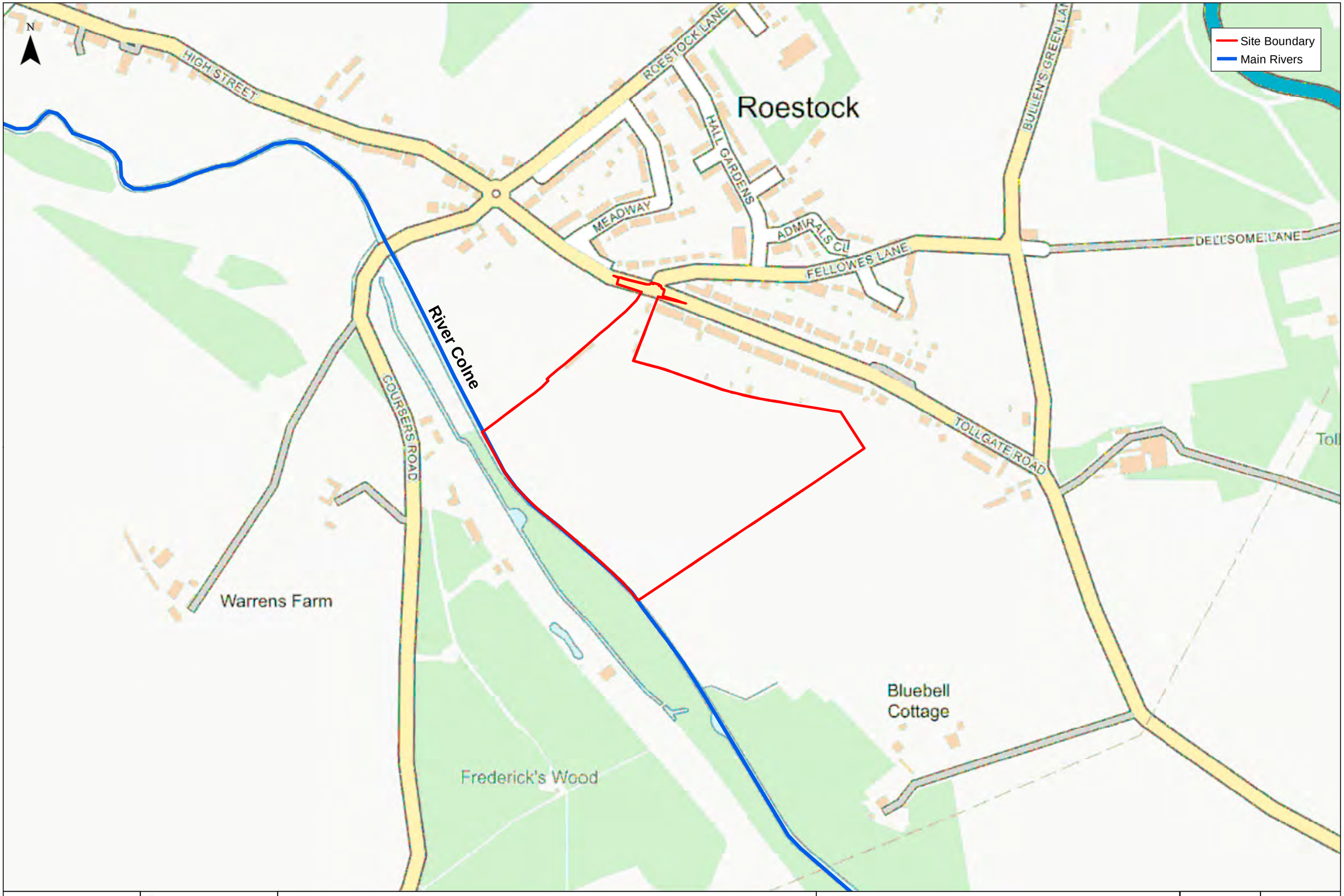
11.1.13 The two lined attenuation basins will have a total storage capacity of approximately 2,173 m^3.

Summary

11.1.14 In conclusion, the users of the proposed development will be safe from flooding and there will be no detrimental impact on third parties. The proposal complies with the NPPF and local planning policy with respect to flood risk and is an appropriate development at this location.

Appendix A OpenData Flood Maps

- Site Location Plan
- Site Location (Aerial Photography)
- Area Topography (LiDAR)
- EA Flood Zone Map
- EA Surface Water Flood Risk
- EA Reservoir Flood Map
- Flood Defences, Areas Benefiting from Defences and Flood Storage Areas
- EA Historic Flood Map
- EA Groundwater Source Protection Zone
- Bedrock Geology
- Superficial Deposits Geology
- Catchment Plan



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Stantec

Client
Vistry Group

LAND AT TOLLGATE ROAD, COLNEY HEATH
Site Location (Aerial)

0 200 400 m

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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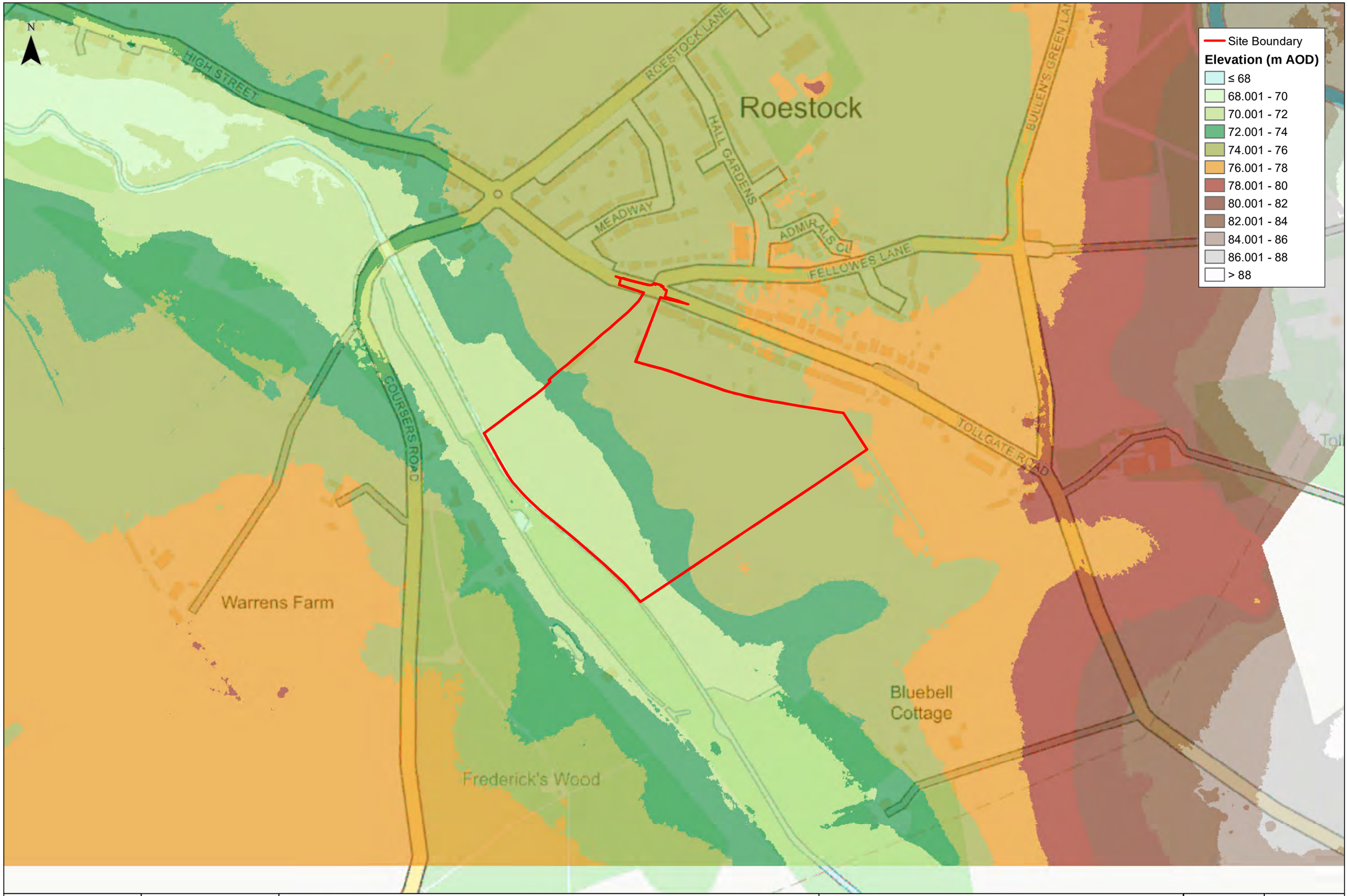

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LAND AT TOLLGATE ROAD, COLNEY HEATH

Site Topography (1m LiDAR)

0 200 400 m

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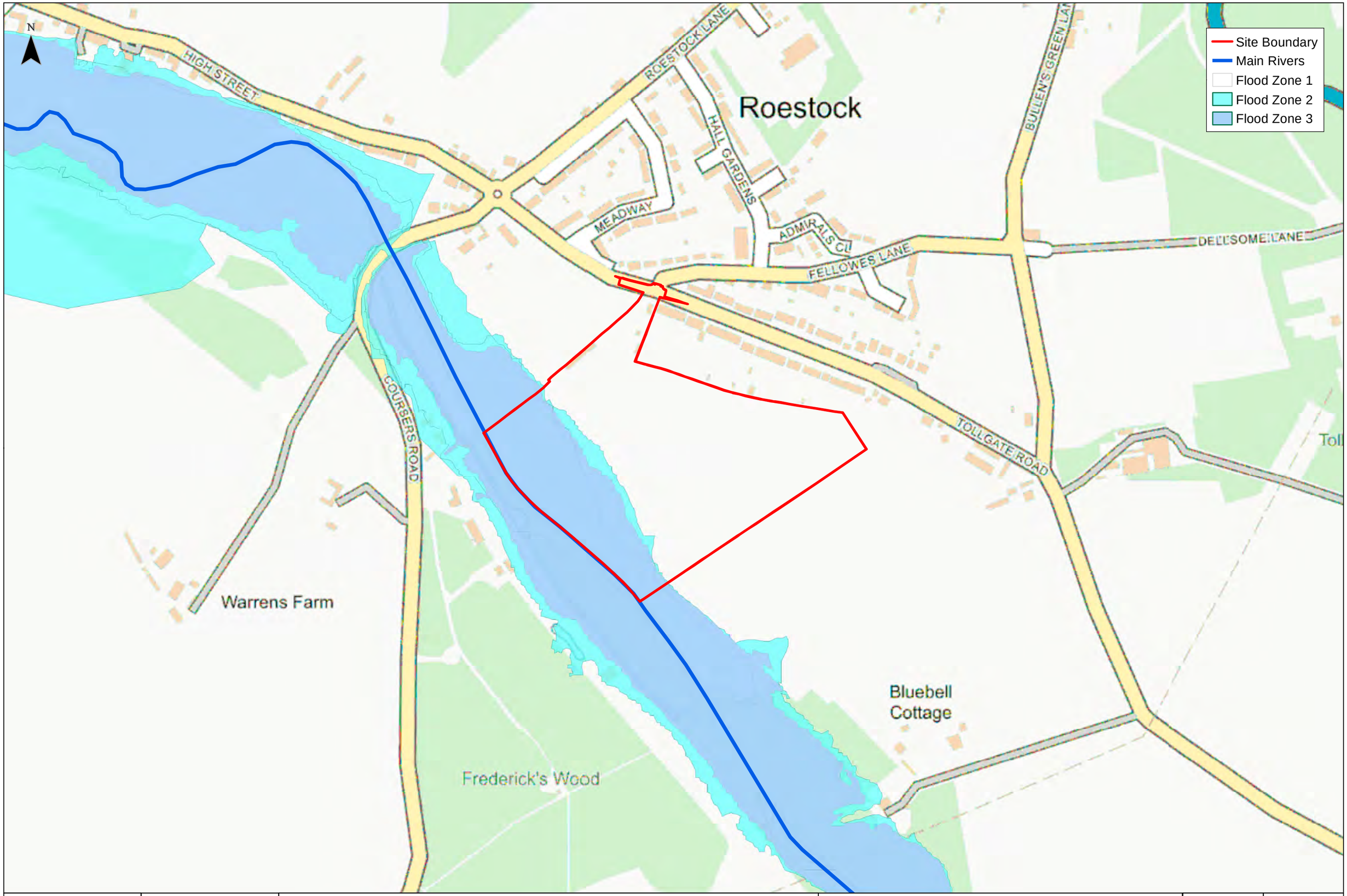

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LAND AT TOLLGATE ROAD, COLNEY HEATH

Environment Agency Flood Zones for Planning

0 200 400 m

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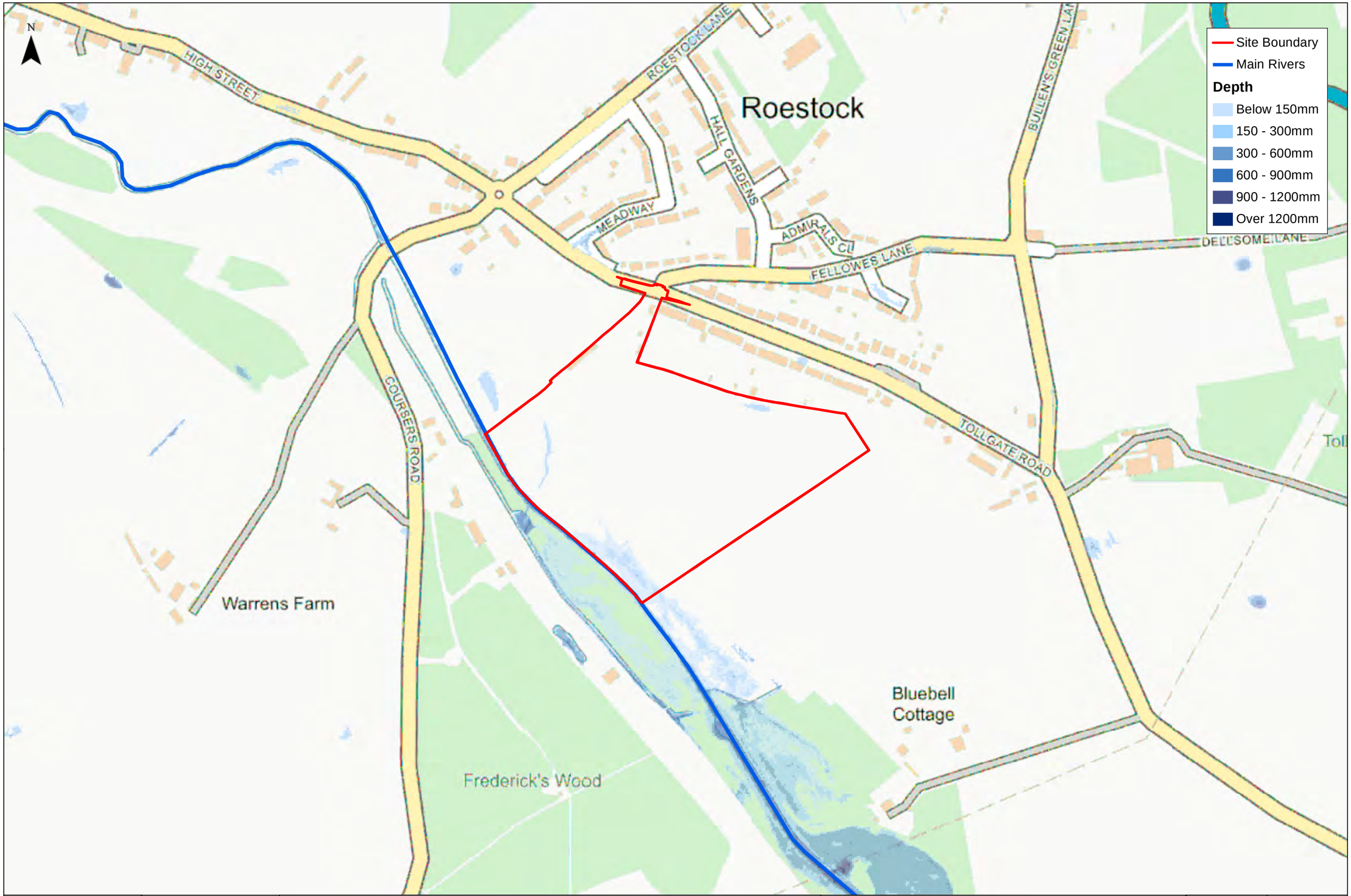

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LAND AT TOLLGATE ROAD, COLNEY HEATH

Flood Risk from Surface Water
(High Risk Depth)

0 200 400 m

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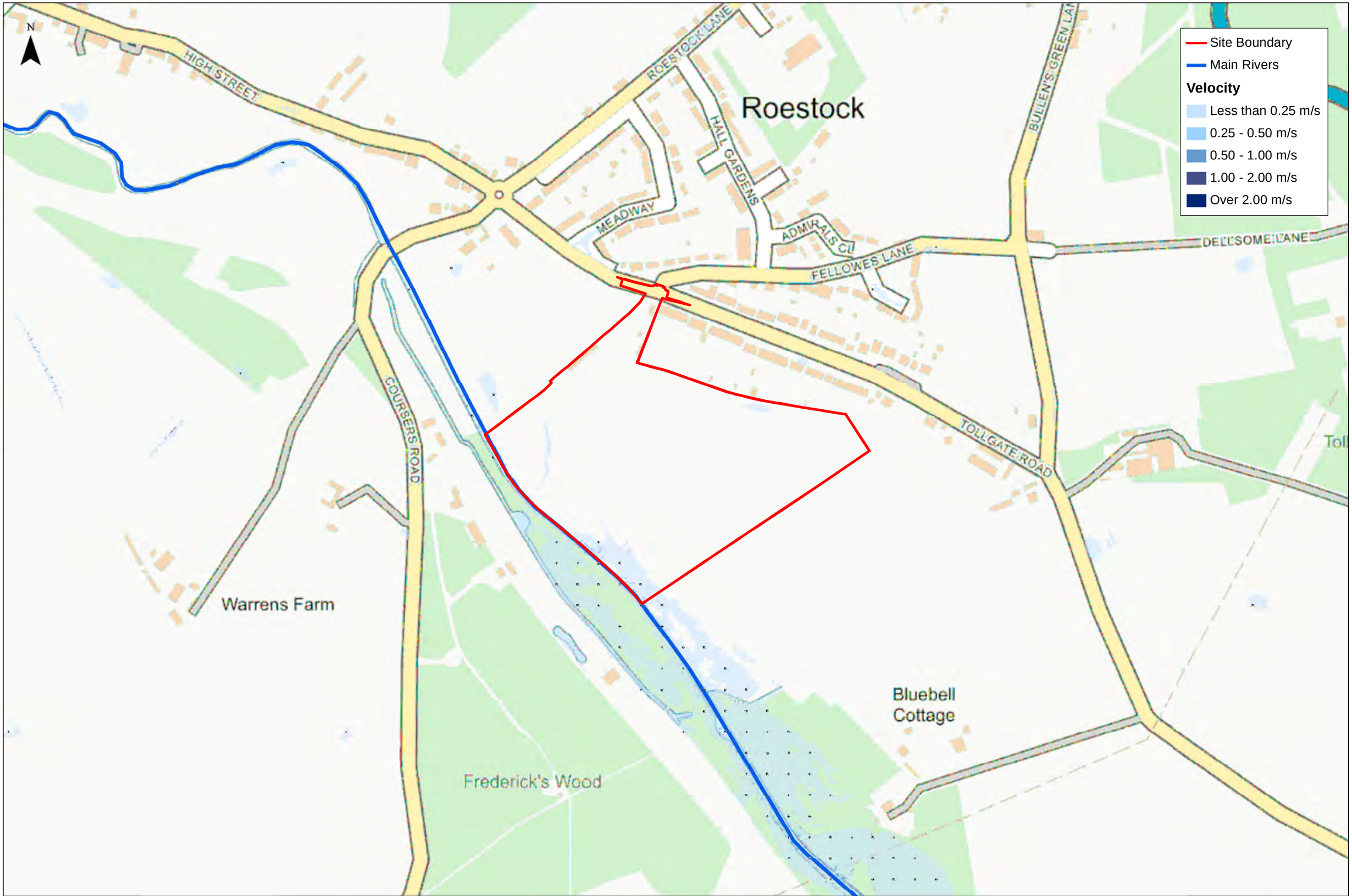

Stantec	Client: Vistry Group	**LAND AT TOLLGATE ROAD, COLNEY HEATH** Flood Risk from Surface Water (High Risk Velocity)	0 200 400 m Contains OS data © Crown Copyright and database right 2020 Contains EA data © Environment Agency copyright and database right 2015. All rights reserved.	1:4,000 @ A3	Date: 23/06/2022
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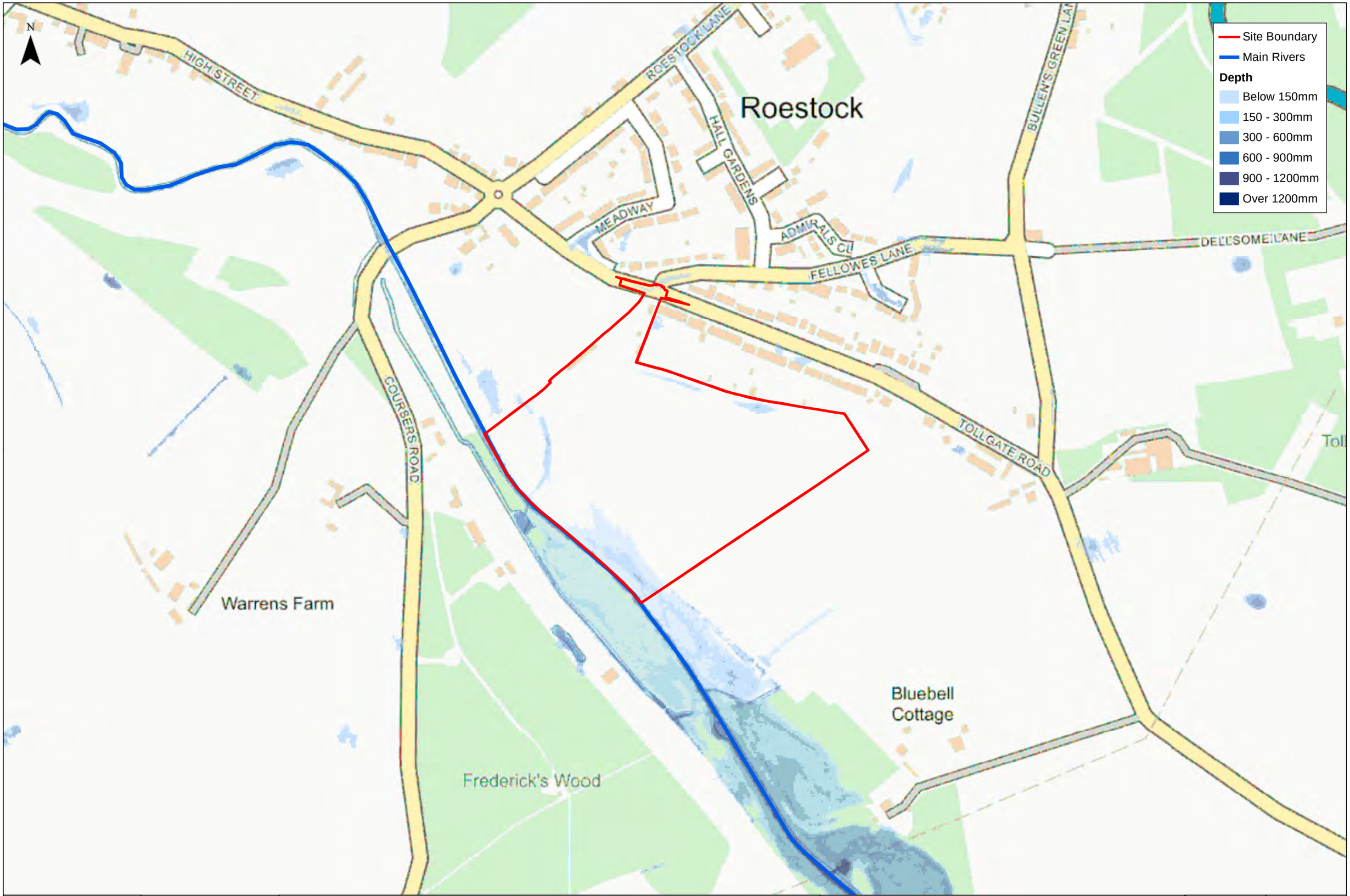

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LAND AT TOLLGATE ROAD, COLNEY HEATH

Flood Risk from Surface Water
(Medium Risk Depth)

0 200 400 m

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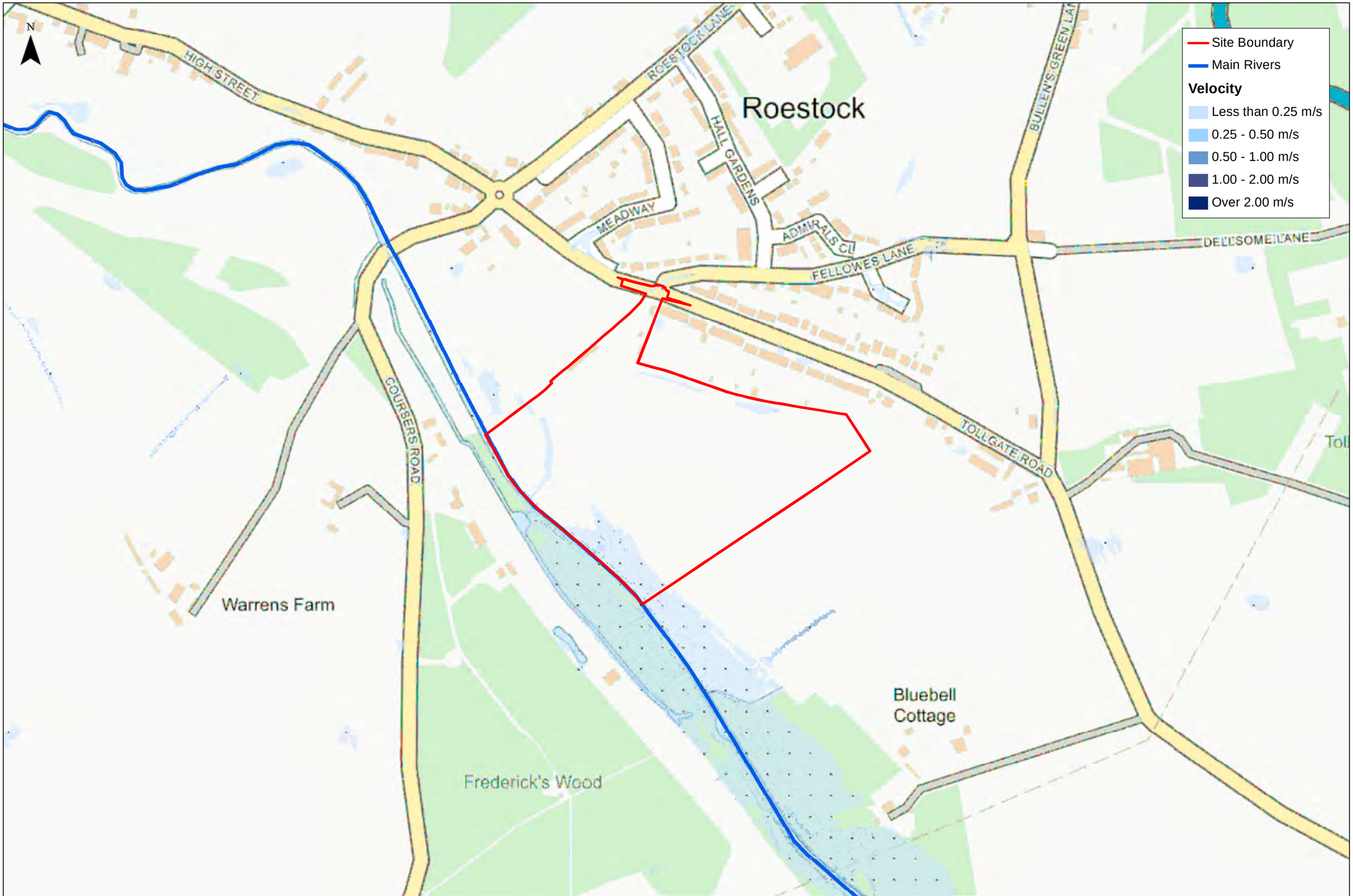

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LAND AT TOLLGATE ROAD, COLNEY HEATH

Flood Risk from Surface Water
(Medium Risk Velocity)

0 200 400 m

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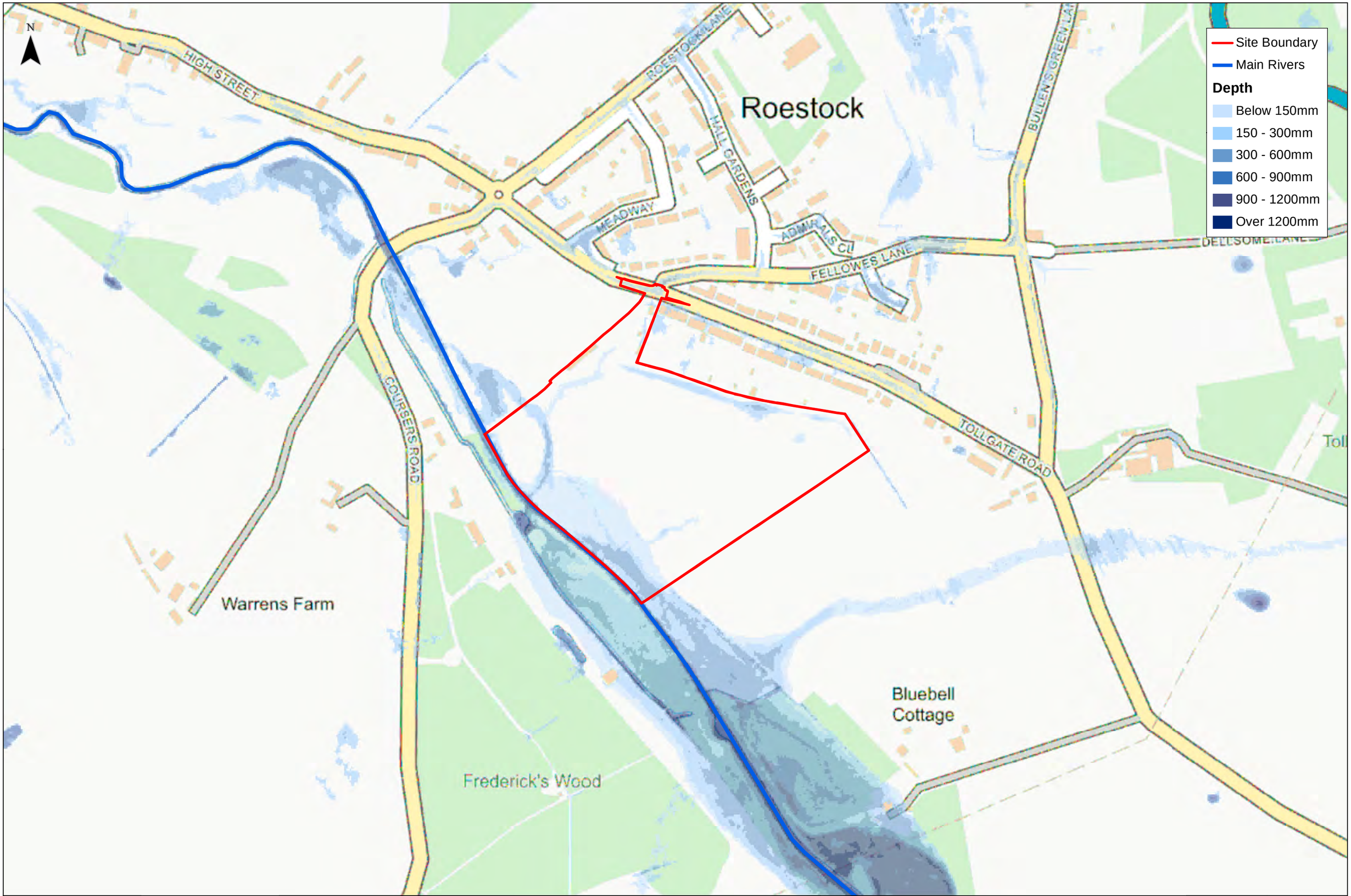

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LAND AT TOLLGATE ROAD, COLNEY HEATH

Flood Risk from Surface Water
(Low Risk Depth)

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Figure 332510999/4002/009	Rev A

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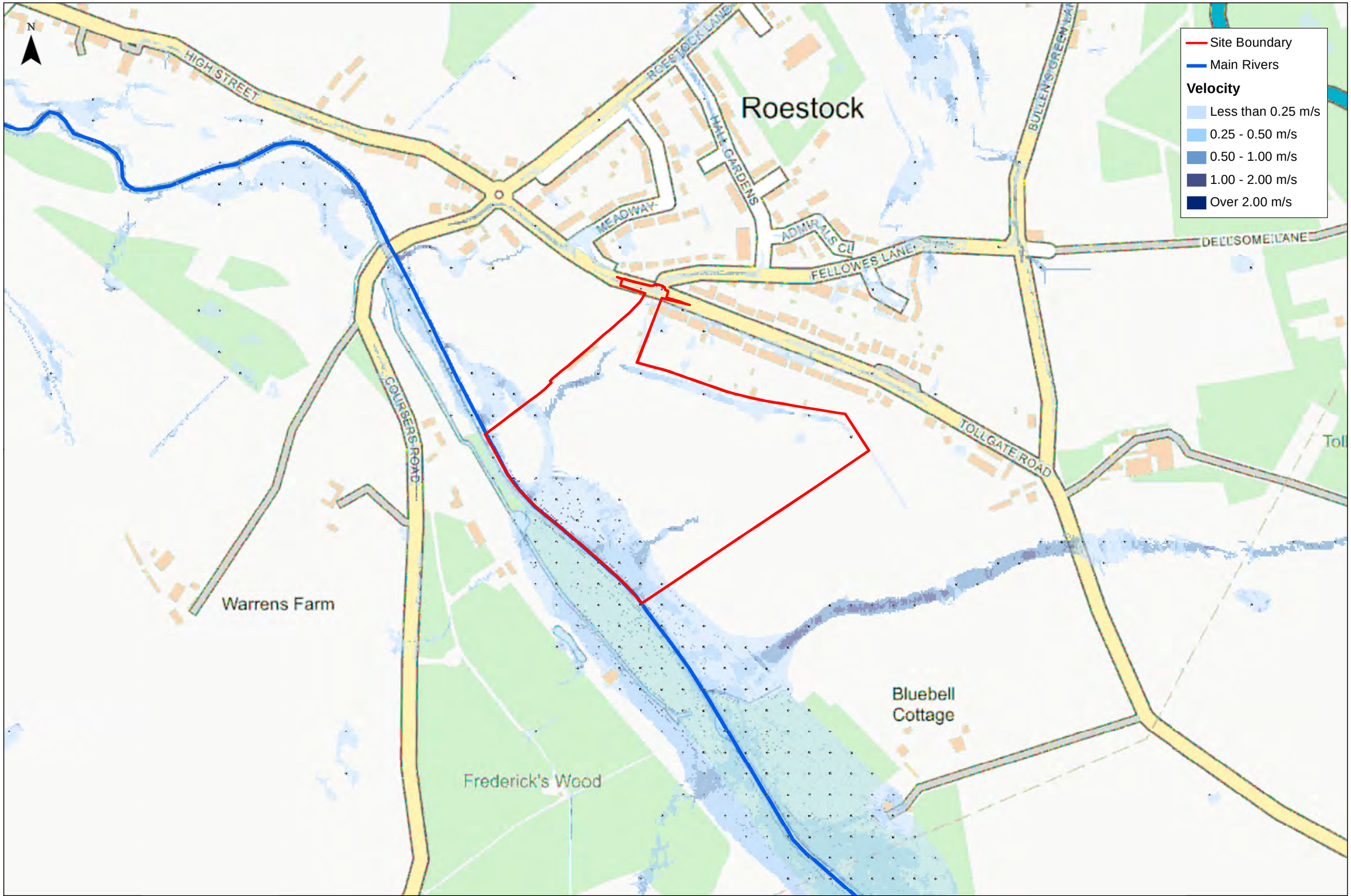

Stantec	Client: Vistry Group	**LAND AT TOLLGATE ROAD, COLNEY HEATH** Flood Risk from Surface Water (Low Risk Velocity)	0 200 400 m Contains OS data © Crown Copyright and database right 2020 Contains EA data © Environment Agency copyright and database right 2015. All rights reserved.	1:4,000 @ A3	Date: 23/06/2022
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				Figure 332510999/4002/010	Rev A

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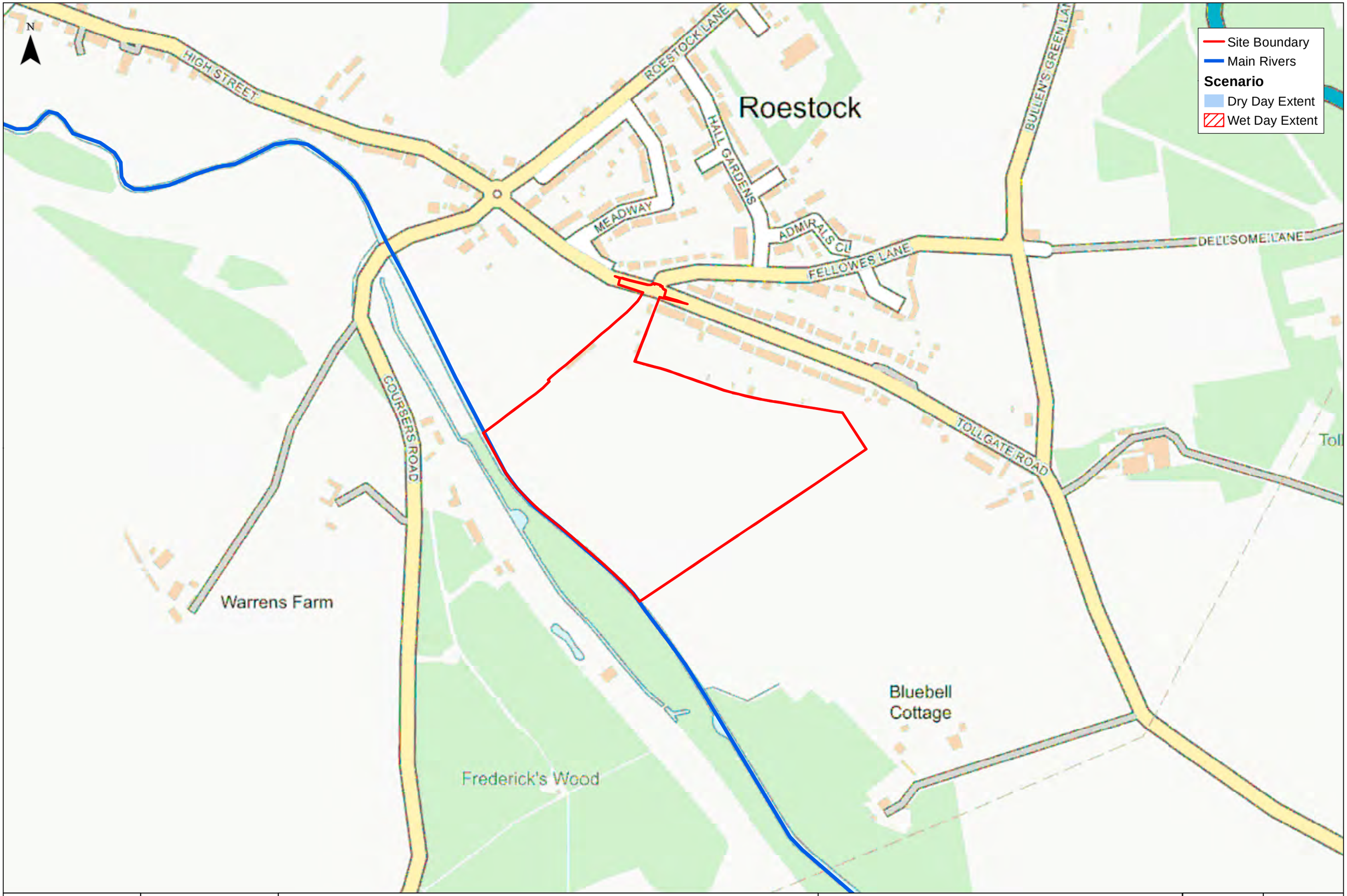

Stantec	Client: Vistry Group	**LAND AT TOLLGATE ROAD, COLNEY HEATH** Flood Risk from Reservoirs	0 200 400 m Contains OS data © Crown Copyright and database right 2020 Contains EA data © Environment Agency copyright and/or database right 2021. All rights reserved.	1:4,000 @ A3	Date: 23/06/2022
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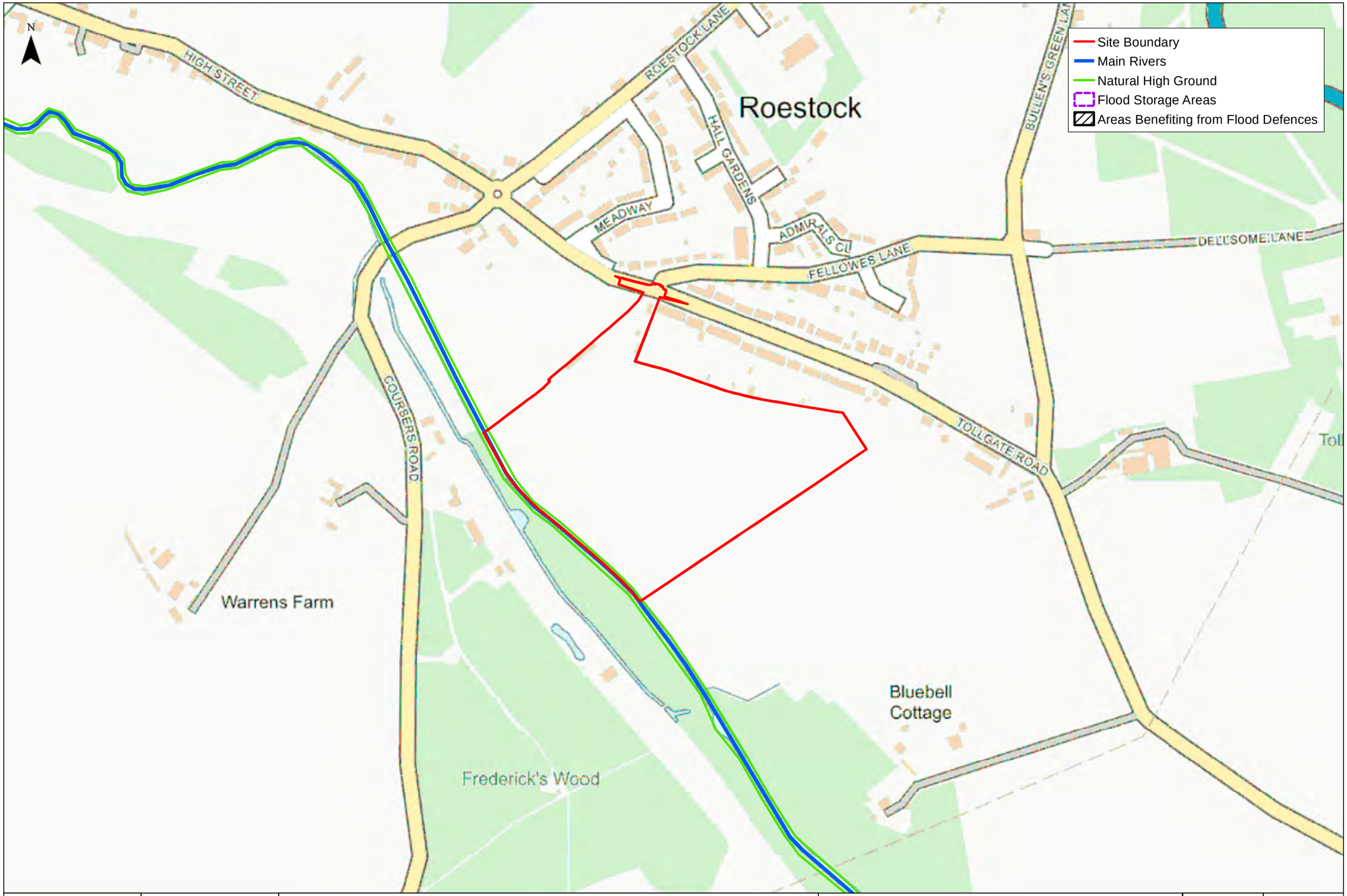

Stantec	Client: Vistry Group	**LAND AT TOLLGATE ROAD, COLNEY HEATH** Flood Defences, Areas Benefiting from Flood Defences, and Flood Storage Areas	0 200 400 m Contains OS data © Crown Copyright and database right 2020 Contains EA data © Environment Agency copyright and database right 2018. All rights reserved. Contains EA data © Environment Agency copyright and database right 2020. All rights reserved.	1:4,000 @ A3	Date: 23/06/2022
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				Figure 332510999/4002/012	Rev A

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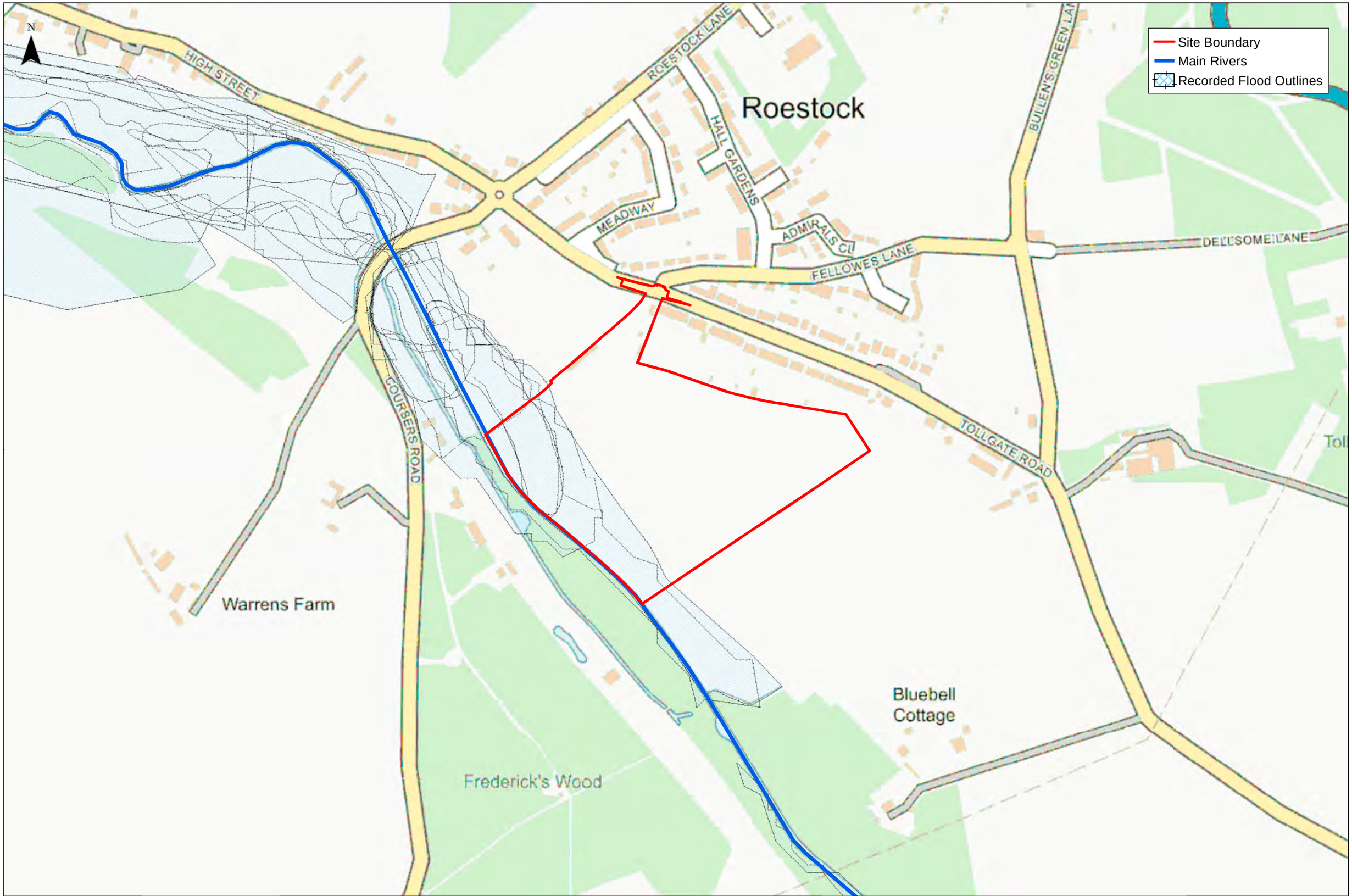

Stantec	Client: Vistry Group	**LAND AT TOLLGATE ROAD, COLNEY HEATH** Recorded Flood Outlines	0 200 400 m Contains OS data © Crown Copyright and database right 2020 Contains EA data © Environment Agency copyright and database right 2018. All rights reserved.	1:4,000 @ A3	Date: 23/06/2022
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				Figure 332510999/4002/013	Rev A

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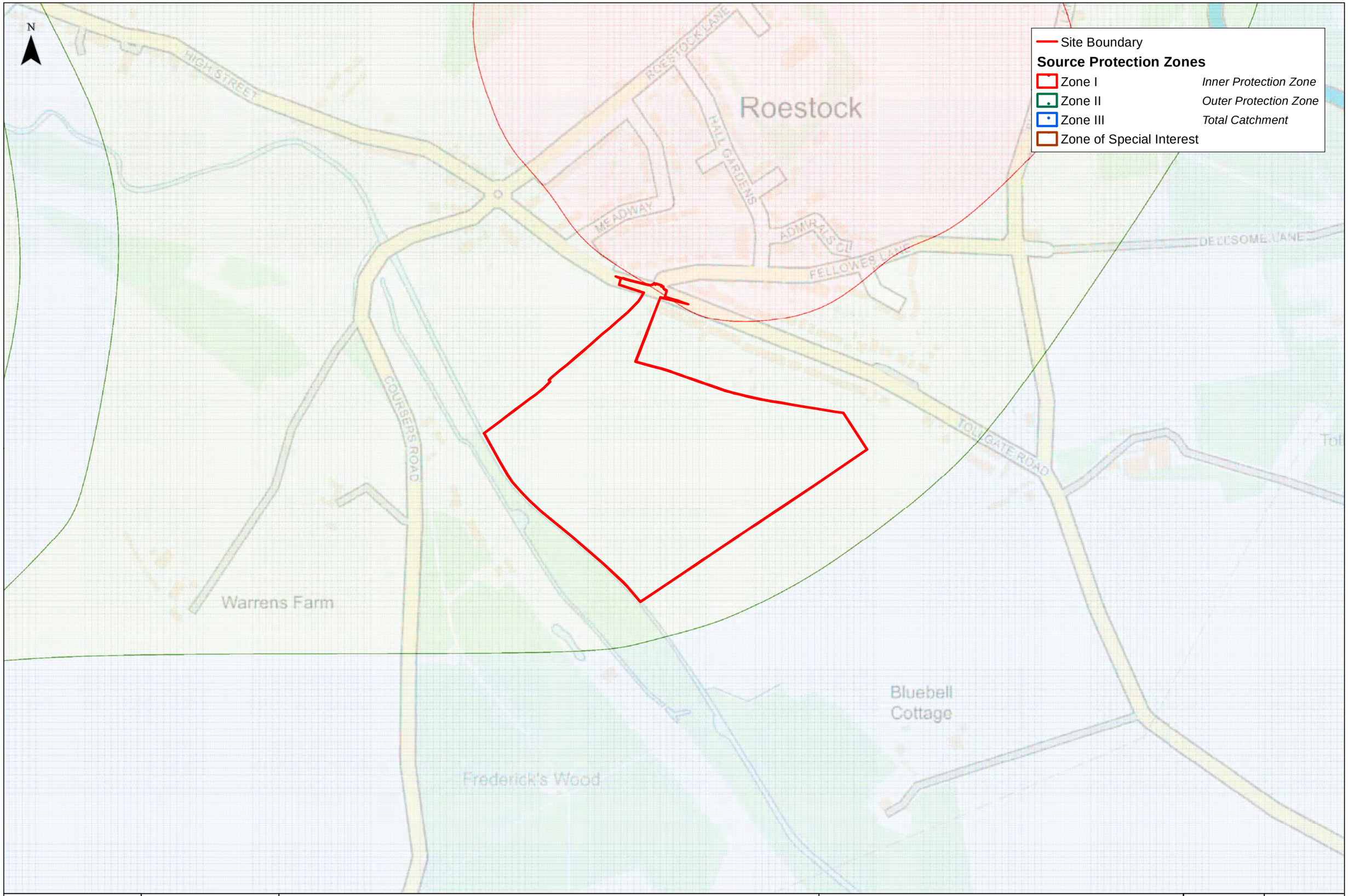

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Client: Vistry Group

LAND AT TOLLGATE ROAD, COLNEY HEATH

Source Protection Zones

0 200 400 m

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Drawn: MD	Checked: CB
Figure 332510999/4002/014	Rev A

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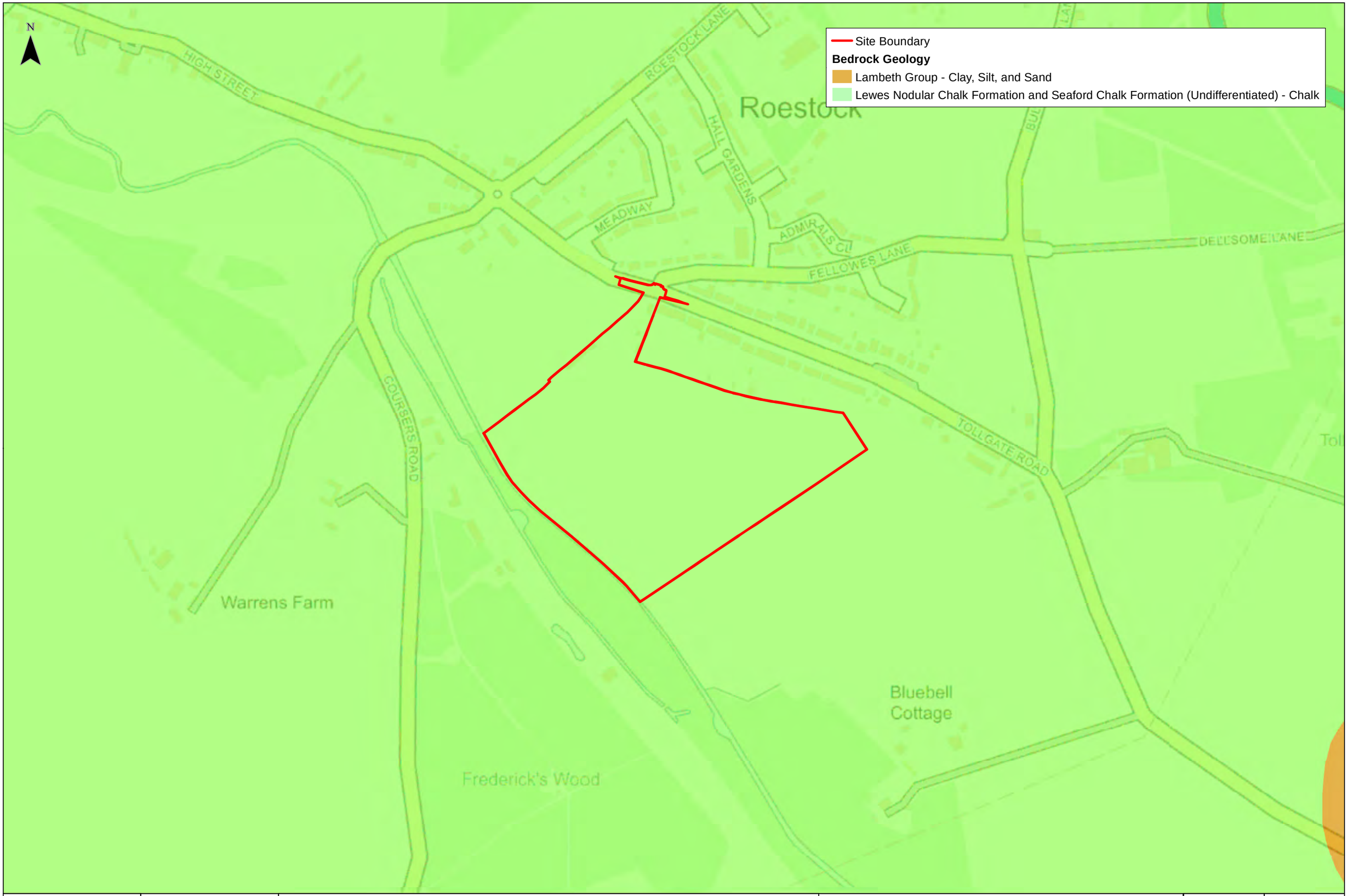

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Client: Vistry Group

LAND AT TOLLGATE ROAD, COLNEY HEATH

Bedrock Geology

0 200 400 m

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Drawn: MD	Checked: CB
Figure 332510999/4002/015	Rev A

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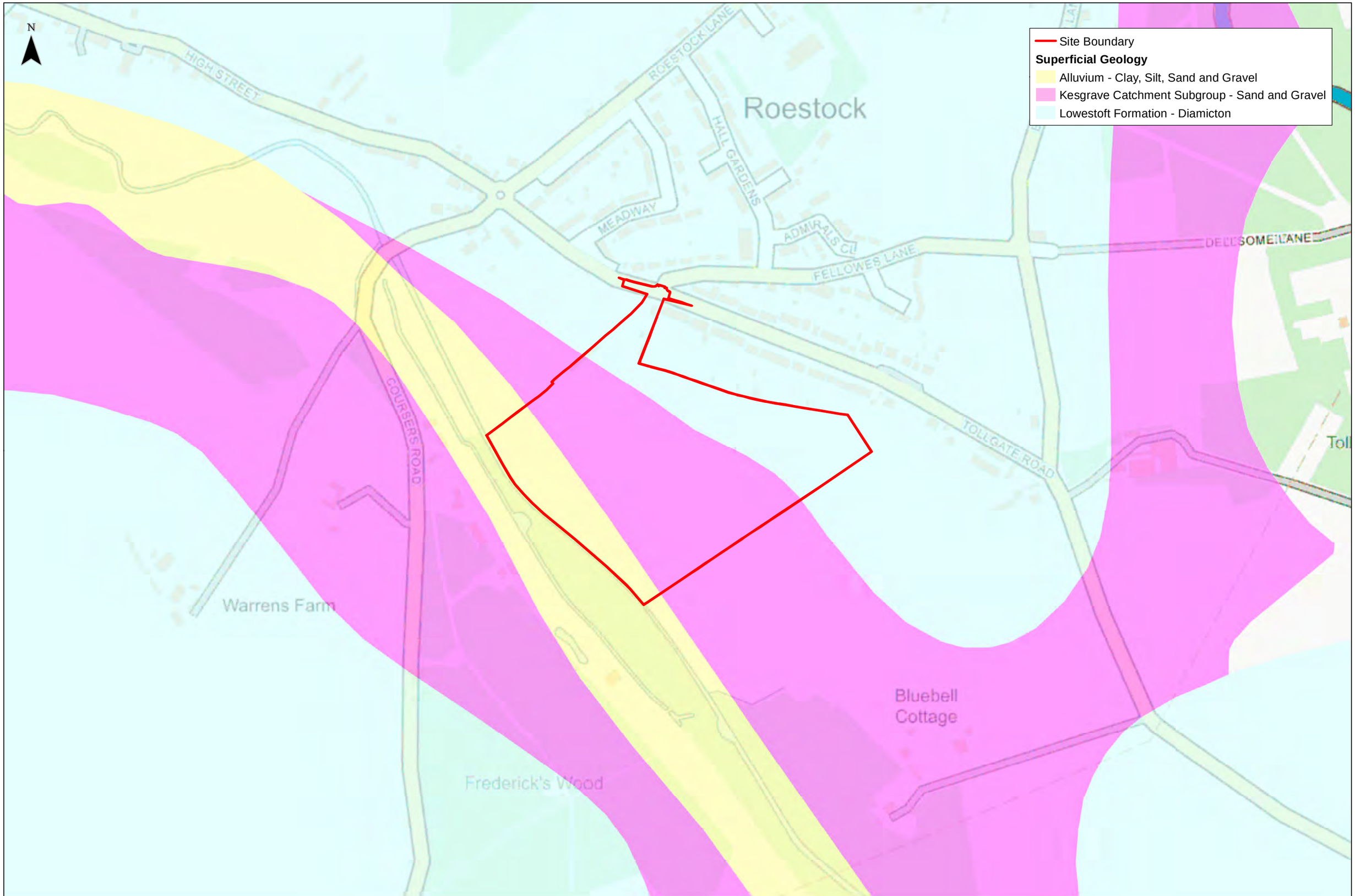

Stantec	Client: Vistry Group	**LAND AT TOLLGATE ROAD, COLNEY HEATH** Superficial Geology	0 200 400 m Contains OS data © Crown Copyright and database right 2020 Contains British Geological Survey materials © UKRI 2020.	1:4,000 @ A3	Date: 23/06/2022
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				Figure 332510999/4002/016	Rev A

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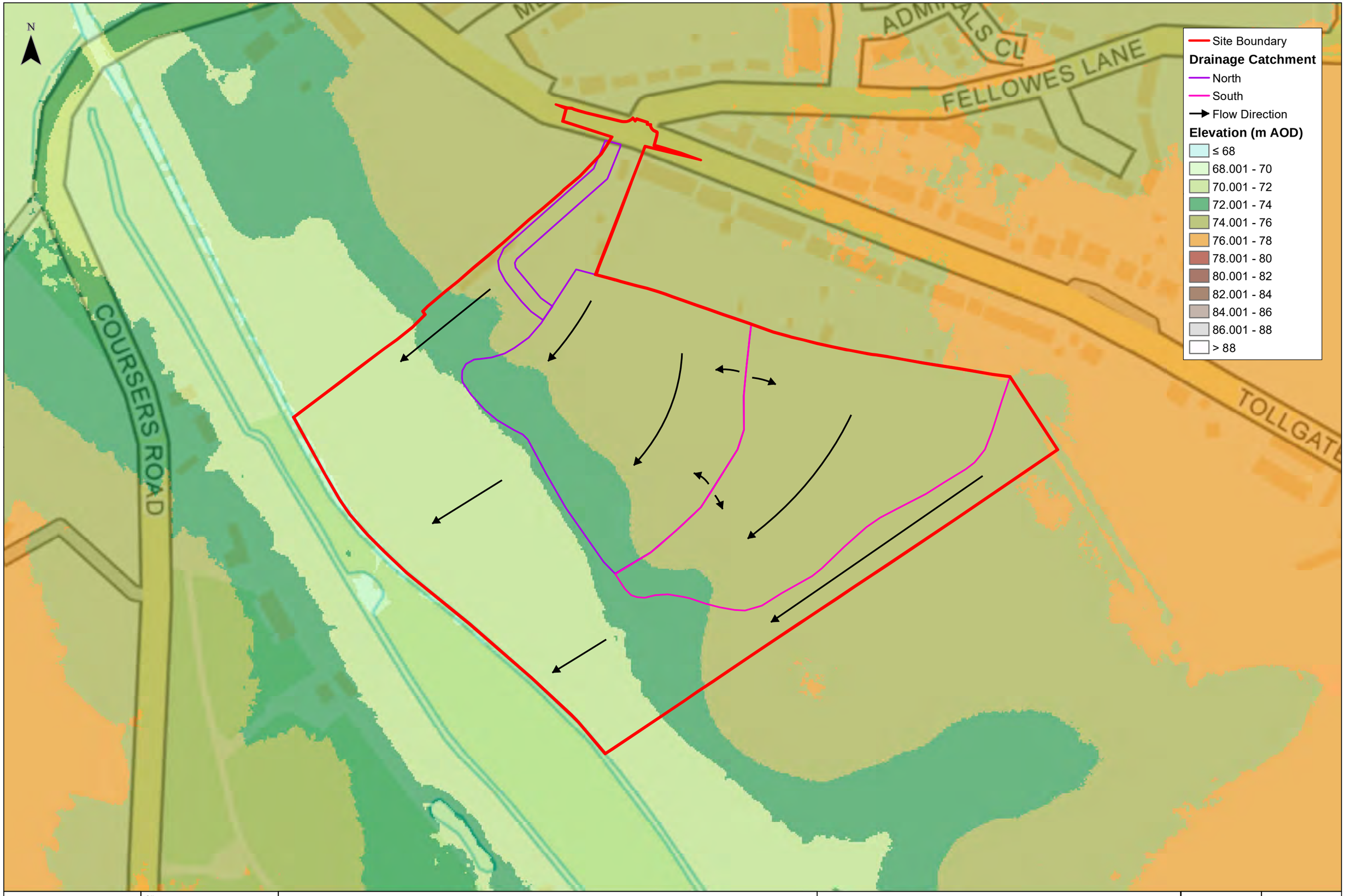

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Client: Vistry Group

LAND AT TOLLGATE ROAD, COLNEY HEATH

Drainage Catchment Plan

0 100 200 m

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Drawn: MD | Checked: CB

Figure 332510999/4002/017 | Rev A

Document Path: \\Cam-vfps-001\cam\Projects\332510999 Land at Tollgate Road, Colney Heath\GIS\Workspaces\332510999 4002 017 Catchment Plan.mxd

Appendix B Surveys

- Terrain Surveys, Topographical Survey, Land at rear of Tollgate Road, Colney Heath, Drawing Number TS22-058-1 (February 2022)
- Terrain Surveys, Topographical Survey, Land at rear of Tollgate Road, Colney Heath, Drawing Number TS22-058-2 (February 2022)
- Terrain Surveys, Topographical Survey, Land at rear of Tollgate Road, Colney Heath, Drawing Number TS22-058-3 (February 2022)
- Terrain Surveys, Topographical Survey, Land at rear of Tollgate Road, Colney Heath, Drawing Number TS22-058-4 (February 2022)
- Terrain Surveys, Topographical Survey, Land at rear of Tollgate Road, Colney Heath, Drawing Number TS22-058-5 (February 2022)

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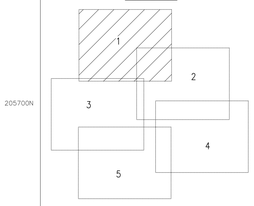
NORTH

Co-ordinate Table			
Station	Easting	Northing	Level
1	520771.935	205709.552	75.497
2	520849.985	205689.445	75.449
3	520957.769	205653.080	76.143
4	521038.903	205621.291	76.243
20	520855.245	205666.935	75.248
21	520844.897	205637.855	75.296
22	520842.831	205655.278	75.340
23	520848.222	205670.218	75.221
200	520807.196	205627.127	74.950
201	520739.487	205541.578	72.060
202	520896.404	205462.077	75.306
300	521127.449	205582.578	76.434
J21	520827.088	205605.164	75.350

All levels related to Ordnance Survey active GPS network, at survey station 202.

SHEET LAYOUT



DISCLAIMERS

This survey is related to OSGB36(15) coordinate system by GPS 'rapid static' methods. No scale factor has been applied to the survey information. All horizontal distances taken from this drawing are ground distances.

Every effort has been made to confirm drainage run, type and size on site, yet it is advised to check these details against statutory authority records before proceeding with any design.

KEY

Survey control station △ 5
Gate (single)
Gate (double)
Tree Spread and Girth shown to scale
Banking
Foliage Line
Drainage run, direction of flow and pipe size 100
Approximate Position

ABBREVIATIONS

Air Handling Unit	AHU	Water Meter	WM
Belisha Beacon	BB	Eaves Level	EL
Bollard	BD	Ridge Level	RL
Borehole	BH	Roof Level	RFL
BT Inspection Cover	BT	Soffit Level	SFL
Cable Television Cover	CTV	Threshold Level	THL
Drainage Channel	DC	Parapet Wall Level	PWL
Electricity Cover	EC	Finished Floor Level	FFL
Electricity Pole	EP	Head Level	HL
Earth Rod	ER	Sill Level	SL
Fire Hydrant	FH	Cover Level	CL
Gas Valve	GV	Invert Level	IL
Gate Post	GP	No Visible Pipes	NVP
Gully	GY	Unable to Lift	UTL
Inspection Cover	IC	Foul Water	FW
Junction Box	JB	Sump Level	SUL
Kerb Outlet	KO	Surface Water	SW
Lamp Post	LP	Brick Paviors	BP
Manhole	MH	Concrete	CON
Marker Post	MK	Concrete Paving Slabs	CPS
Post	P	Flower Bed	F\B
Pipe	PE	Shrub Bed	S\B
Road Sign	RS	Tactile Paving	TAC
Rodding Eye	RE	Unsurfaced	U\S
Marker Post	MK	Brick Wall	BW
Sign Post	SP	Retaining Wall	RW
Stop Valve	SV	Chainlink Fence	CLF
Stop Tap	ST	Chestnut Paling Fence	CPF
Telegraph Pole	TP	Iron Railing Fence	IRF
Traffic Light	TL	Metal Security Fence	MSF
Vent Pipe	VP	Post and Chain Fence	PCF
Post and Rail Fence	PRF	Post and Wire Fence	PWF
Wooden Panel Fence	WPF		

Client

DLA TOWN PLANNING LTD

Project

LAND AT REAR OF TOLLGATE RD
COLNEY HEATH

Title

TOPOGRAPHICAL SURVEY

Drawing Number

TS22-058-1

Revision	Description	Date

Scale 1:200@A0 — Sheet 1 of 5

Drawn by	Checked by	Date of Survey
ER	PG	FEB 2022

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NORTH

Co-ordinate Table			
Station	Easting	Northing	Level
1	520771.935	205709.552	75.497
2	520849.985	205689.445	75.449
3	520957.769	205653.080	76.143
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20	520855.245	205666.935	75.248
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23	520848.222	205670.218	75.221
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201	520739.487	205541.578	72.060
202	520896.404	205462.077	75.306
300	521127.449	205582.578	76.434
J21	520827.088	205605.164	75.350

All levels related to Ordnance Survey active GPS network, at survey station 202.

SHEET LAYOUT

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KEY

Survey control station △ 5
Gate (single)
Gate (double)
Tree Spread and Girth shown to scale
Banking
Foliage Line
Drainage run, direction of flow and pipe size 100
Approximate Position

ABBREVIATIONS

Air Handling Unit	AHU	Water Meter WM
Belisha Beacon	BB	Eaves Level EL
Bollard	BD	Ridge Level RL
Borehole	BH	Roof Level RFL
BT Inspection Cover	BT	Soffit Level SFL
Cable Television Cover	CTV	Threshold Level THL
Drainage Channel	DC	Parapet Wall Level PWL
Electricity Cover	EC	Finished Floor Level FFL
Electricity Pole	EP	Head Level HL
Earth Rod	ER	Sill Level SL
Fire Hydrant	FH	Cover Level CL
Gas Valve	GV	Invert Level IL
Gate Post	GP	No Visible Pipes NVP
Gully	GY	Unable to Lift UTL
Inspection Cover	IC	Foul Water FW
Junction Box	JB	Sump Level SUL
Kerb Outlet	KO	Surface Water SW
Lamp Post	LP	Brick Paviors BP
Manhole	MH	Concrete CON
Marker Post	MK	Concrete Paving Slabs CPS
Post	P	Flower Bed F\B
Pipe	PE	Shrub Bed S\B
Road Sign	RS	Tactile Paving TAC
Rodding Eye	RE	Unsurfaced U\S
Marker Post	MK	Brick Wall BW
Sign Post	SP	Retaining Wall RW
Stop Valve	SV	Chainlink Fence CLF
Stop Tap	ST	Chestnut Paling Fence CPF
Telegraph Pole	TP	Iron Railing Fence IRF
Traffic Light	TL	Metal Security Fence MSF
Vent Pipe	VP	Post and Chain Fence PCF
Post and Rail Fence	PRF	Post and Wire Fence PWF
Wooden Panel Fence	WPF	

Client
DLA TOWN PLANNING LTD

Project
LAND AT REAR OF TOLLGATE RD
COLNEY HEATH

Title
TOPOGRAPHICAL SURVEY

Drawing Number
TS22-058-2

Revision	Description	Date

Scale 1:200@A0 Sheet 2 of 5

Drawn by	Checked by	Date of Survey
ER	PG	FEB 2022

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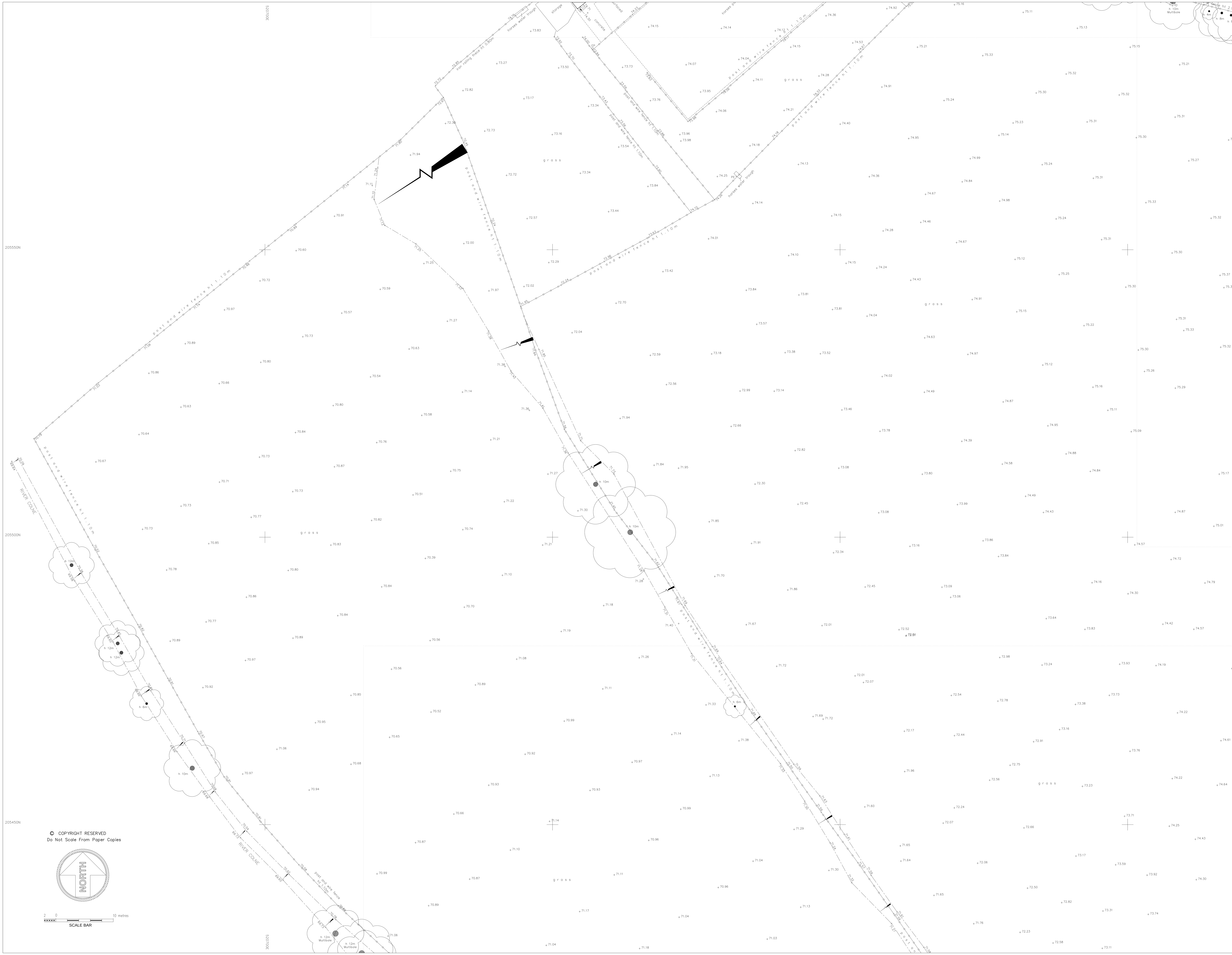

Co-ordinate Table

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2	520849.985	205689.445	75.449
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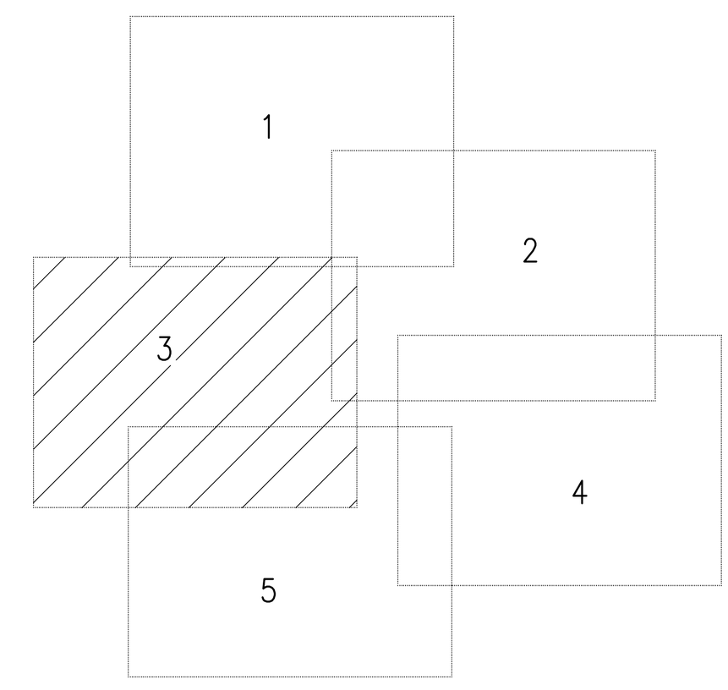
202	520896.404	205462.077	75.306
300	521127.449	205582.578	76.434
J21	520827.088	205605.164	75.350

All levels related to Ordnance Survey active GPS network, at survey station 202.

SHEET LAYOUT



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KEY

Survey control station △ 5
Banking
Gate (single)
Foliage Line
Gate (double)
Drainage run, direction of flow and pipe size 100
Tree Spread and Girth shown to scale
Approximate Position

ABBREVIATIONS

Air Handling Unit	AHU	Water Meter	WM
Belisha Beacon	BB	Eaves Level	EL
Bollard	BD	Ridge Level	RL
Borehole	BH	Roof Level	RFL
BT Inspection Cover	BT	Soffit Level	SFL
Cable Television Cover	CTV	Threshold Level	THL
Drainage Channel	DC	Parapet Wall Level	PWL
Electricity Cover	EC	Finished Floor Level	FFL
Electricity Pole	EP	Head Level	HL
Earth Rod	ER	Sill Level	SL
Fire Hydrant	FH	Cover Level	CL
Gas Valve	GV	Invert Level	IL
Gate Post	GP	No Visible Pipes	NVP
Gully	GY	Unable to Lift	UTL
Inspection Cover	IC	Foul Water	FW
Junction Box	JB	Sump Level	SUL
Kerb Outlet	KO	Surface Water	SW
Lamp Post	LP	Brick Paviors	BP
Manhole	MH	Concrete	CON
Marker Post	MK	Concrete Paving Slabs	CPS
Post	P	Flower Bed	F\B
Pipe	PE	Shrub Bed	S\B
Road Sign	RS	Tactile Paving	TAC
Rodding Eye	RE	Unsurfaced	U\S
Marker Post	MK	Brick Wall	BW
Sign Post	SP	Retaining Wall	RW
Stop Valve	SV	Chainlink Fence	CLF
Stop Tap	ST	Chestnut Paling Fence	CPF
Telegraph Pole	TP	Iron Railing Fence	IRF
Traffic Light	TL	Metal Security Fence	MSF
Vent Pipe	VP	Post and Chain Fence	PCF
Post and Rail Fence	PRF	Post and Wire Fence	PWF
Wooden Panel Fence	WPF		

Client
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COLNEY HEATH

Title
TOPOGRAPHICAL SURVEY

Drawing Number
TS22-058-3

Revision	Description	Date

Scale 1:200@A0 *Sheet* 3 *of* 5

Drawn by	Checked by	Date of Survey
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Co-ordinate Table			
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2	520849.985	205689.445	75.449
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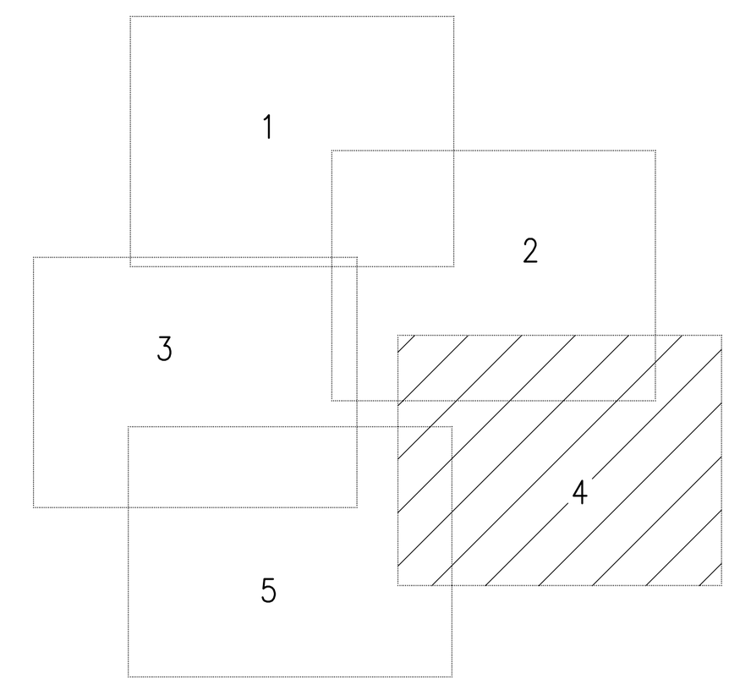
202	520896.404	205462.077	75.306
300	521127.449	205582.578	76.434
J21	520827.088	205605.164	75.350

All levels related to Ordnance Survey active GPS network, at survey station 202.

SHEET LAYOUT



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Every effort has been made to confirm drainage run, type and size on site, yet it is advised to check these details against statutory authority records before proceeding with any design.

KEY

Survey control station	△ 5	Banking	
Gate (single)		Foliage Line	
Gate (double)		Drainage run, direction of flow and pipe size	100
Tree Spread and Girth shown to scale		Approximate Position	

ABBREVIATIONS

Air Handling Unit	AHU	Water Meter	WM
Belisha Beacon	BB	Eaves Level	EL
Bollard	BD	Ridge Level	RL
Borehole	BH	Roof Level	RFL
BT Inspection Cover	BT	Soffit Level	SFL
Cable Television Cover	CTV	Threshold Level	THL
Drainage Channel	DC	Parapet Wall Level	PWL
Electricity Cover	EC	Finished Floor Level	FFL
Electricity Pole	EP	Head Level	HL
Earth Rod	ER	Sill Level	SL
Fire Hydrant	FH	Cover Level	CL
Gas Valve	GV	Invert Level	IL
Gate Post	GP	No Visible Pipes	NVP
Gully	GY	Unable to Lift	UTL
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Kerb Outlet	KO	Surface Water	SW
Lamp Post	LP	Brick Paviors	BP
Manhole	MH	Concrete	CON
Marker Post	MK	Concrete Paving Slabs	CPS
Post	P	Flower Bed	F\B
Pipe	PE	Shrub Bed	S\B
Road Sign	RS	Tactile Paving	TAC
Rodding Eye	RE	Unsurfaced	U\S
Marker Post	MK	Brick Wall	BW
Sign Post	SP	Retaining Wall	RW
Stop Valve	SV	Chainlink Fence	CLF
Stop Tap	ST	Chestnut Paling Fence	CPF
Telegraph Pole	TP	Iron Railing Fence	IRF
Traffic Light	TL	Metal Security Fence	MSF
Vent Pipe	VP	Post and Chain Fence	PCF
Post and Rail Fence	PRF	Post and Wire Fence	PWF
Wooden Panel Fence	WPF		

Client

DLA TOWN PLANNING LTD

Project

LAND AT REAR OF TOLLGATE RD COLNEY HEATH

Title

TOPOGRAPHICAL SURVEY

Drawing Number

TS22-058-4

Revision	Description	Date

Scale 1:200@A0		Sheet 4 of 5
Drawn by ER	Checked by PG	Date of Survey FEB 2022

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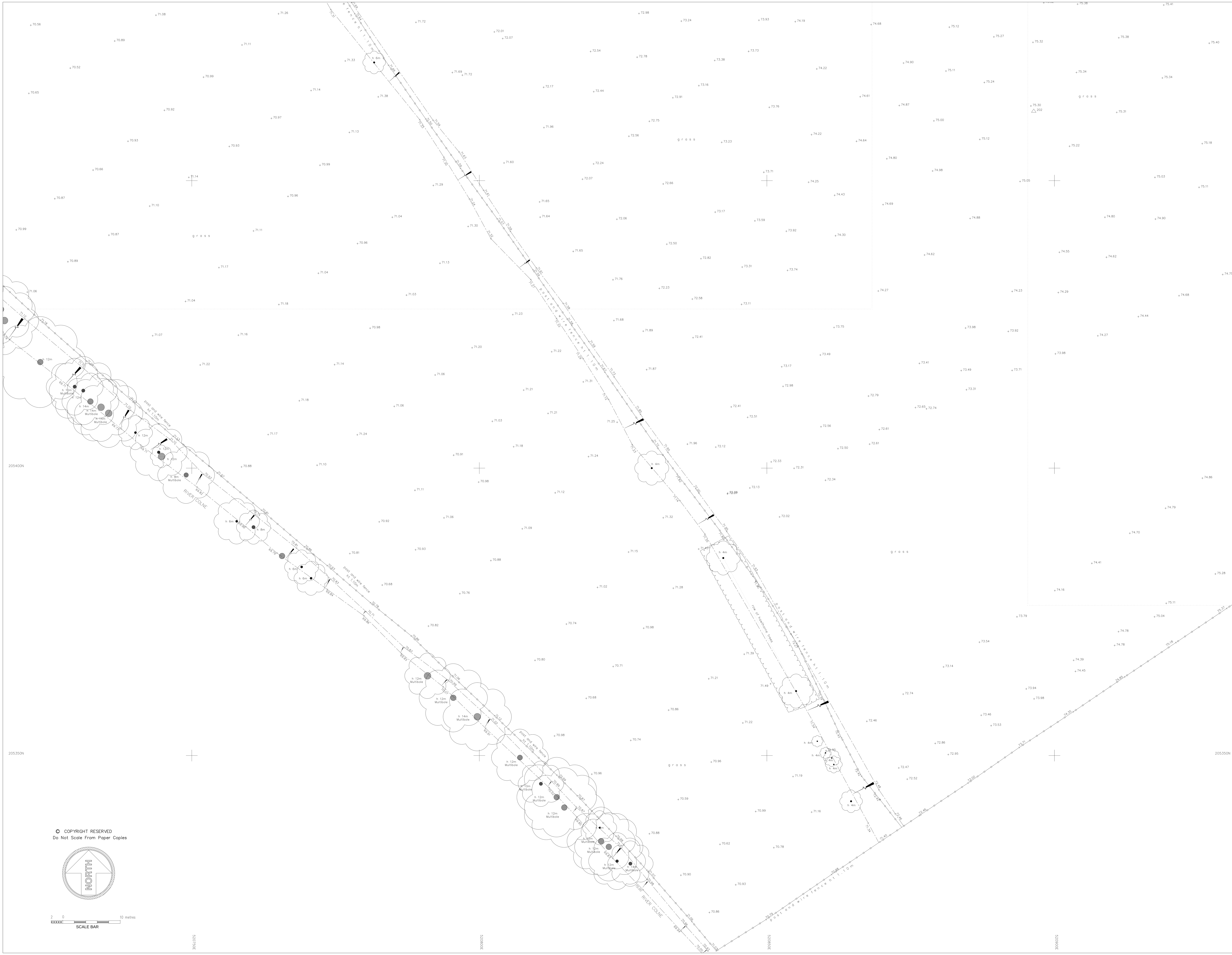

Co-ordinate Table			
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3	520957.769	205653.080	76.143
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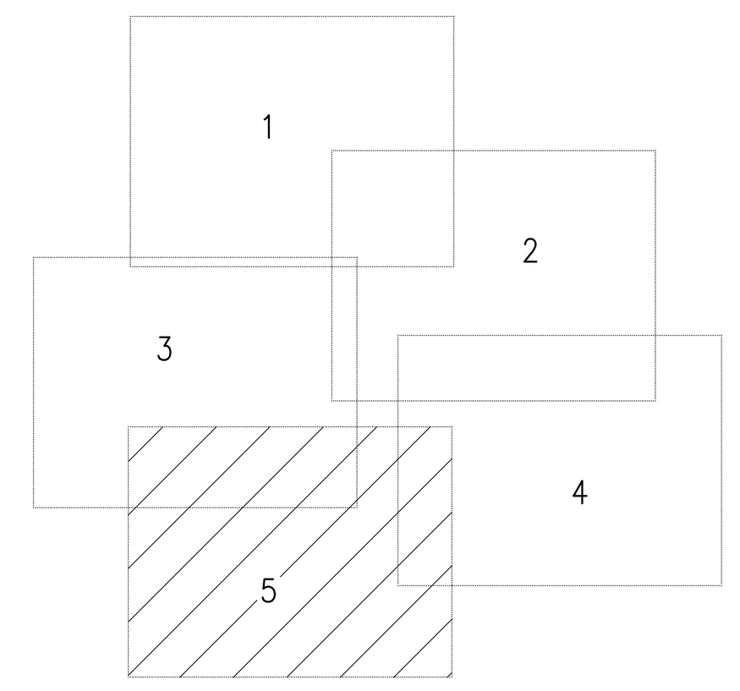
202	520896.404	205462.077	75.306
300	521127.449	205582.578	76.434
J21	520827.088	205605.164	75.350

All levels related to Ordnance Survey active GPS network, at survey station 202.

SHEET LAYOUT



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KEY

Survey control station △ 5 | Banking
Gate (single) | Foliage Line
Gate (double) | Drainage run, direction of flow and pipe size (100)
Tree Spread and Girth shown to scale | Approximate Position

ABBREVIATIONS

Air Handling Unit	AHU	Water Meter	WM
Belisha Beacon	BB	Eaves Level	EL
Bollard	BD	Ridge Level	RL
Borehole	BH	Roof Level	RFL
BT Inspection Cover	BT	Soffit Level	SFL
Cable Television Cover	CTV	Threshold Level	THL
Drainage Channel	DC	Parapet Wall Level	PWL
Electricity Cover	EC	Finished Floor Level	FFL
Electricity Pole	EP	Head Level	HL
Earth Rod	ER	Sill Level	SL
Fire Hydrant	FH	Cover Level	CL
Gas Valve	GV	Invert Level	IL
Gate Post	GP	No Visible Pipes	NVP
Gully	GY	Unable to Lift	UTL
Inspection Cover	IC	Foul Water	FW
Junction Box	JB	Sump Level	SUL
Kerb Outlet	KO	Surface Water	SW
Lamp Post	LP	Brick Paviors	BP
Manhole	MH	Concrete	CON
Marker Post	MK	Concrete Paving Slabs	CPS
Post	P	Flower Bed	F\B
Pipe	PE	Shrub Bed	S\B
Road Sign	RS	Tactile Paving	TAC
Rodding Eye	RE	Unsurfaced	U\S
Marker Post	MK	Brick Wall	BW
Sign Post	SP	Retaining Wall	RW
Stop Valve	SV	Chainlink Fence	CLF
Stop Tap	ST	Chestnut Paling Fence	CPF
Telegraph Pole	TP	Iron Railing Fence	IRF
Traffic Light	TL	Metal Security Fence	MSF
Vent Pipe	VP	Post and Chain Fence	PCF
Post and Rail Fence	PRF	Post and Wire Fence	PWF
Wooden Panel Fence	WPF		

Client
DLA TOWN PLANNING LTD

Project
LAND AT REAR OF TOLLGATE RD
COLNEY HEATH

Title
TOPOGRAPHICAL SURVEY

Drawing Number
TS22-058-5

Revision	Description	Date

Scale 1:200@A0 | Sheet 5 of 5

Drawn by	Checked by	Date of Survey
ER	PG	FEB 2022

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