Flood Risk Assessment and Drainage Strategy

Anyards Road,
Cobham

Prepared for
Shanly Homes

by

Stuart Michael Associates Limited

Coombe House
Coombe Square
Thatcham
Berkshire
RG19 4JF

T: 01635 867711
F: 01635 861715
E: mail@stuartmichael.co.uk
W: www.stuartmichael.co.uk

October 2023

SMA Ref: 7073.FRA

Issue Status: 01

DOCUMENT CONTROL			
Project	**Anyards Road, Cobham**		
Job No.	**7073**		
Document Title	**Flood Risk Assessment and Drainage Strategy**		
File Location	N:\Admin Project\7000 to 7099\7073 - Anyards Road, Cobham\Reports\FRA		
Prepared by	C Gridley	**Date**	29/09/2023
Reviewed by	M Potter	**Date**	29/09/2023
Approved by	J O'Kelly	**Date**	29/09/2023
Document Issue	**Description / Changes**	**Revised by**	**Date**
DRAFT	First Review	EL	29/09/2023
01	Addition of Calculations and Client Comments	EL	13/10/2023

STUART MICHAEL ASSOCIATES
CONSULTING ENGINEERS

Stuart Michael Associates Ltd. Registered in England and Wales. Registration Number: 3739154
Registered Office: Coombe House, Coombe Square, Thatcham, Berkshire RG19 4JF.
Telephone: 01635 867711 Facsimile: 01635 861715.

CONTENTS

SECTIONS

APPENDICES

FIGURES

ACRONYMS AND ABBREVIATIONS

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Society
CC	Climate Change
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EBC	Elmbridge Borough Council
ha	Hectares
km	Kilometres
LLFA	Lead Local Flood Authority
LFRMS	Local Flood Risk Management Strategy
LPA	Local Planning Authority
m	Metres
NPPF	National Planning Policy Framework
NTS	Non-statutory Technical Standards
PPG	Planning Practice Guidance to the National Planning Policy Framework
QBAR	Mean Annual Flood (Report No. 124 Flood Estimation for Small Catchments)
RoSWF	Risk of Surface Water Flooding
SAC	Special Area of Conservation
SCC	Surrey County Council
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SSSI	Site specific Scientific Interest
SUDS	Sustainable Drainage Systems
TWUL	Thames Water Utilities Limited

1.0 INTRODUCTION

1.1 Stuart Michael Associates Limited, Consulting Engineers, has prepared this Flood Risk Assessment and Drainage Strategy, hereafter referred to as the 'Report', on the instruction of Shanly Homes, hereafter referred to as the 'Client'.

1.2 This Report supports a full planning application by the Client for a residential development of 26 units on land in Cobham, Surrey, hereafter referred to as the 'Site'.

1.3 The Site is approximately 0.472 hectares (ha), and currently consists of a corner commercial unit, a bungalow and a series of garages used for storage.

1.4 See **Appendix A** for the Elmbridge Borough Council (EBC) Flood Risk Assessment Pro Forma.

Scope of Report

1.5 The FRA section of the Report focuses on assessing flood risk issues at the Site as follows:

Identification of all potential sources of flooding at the Site (i.e. fluvial, pluvial, groundwater, surface water, etc.);

Assessment of the existing flood risk at the Site and its potential impact on the proposals;

Consideration of flood risk implications, taking into account potential changes in risk due to climate change over the lifetime of the development, and the identification of measures to mitigate flood risk.

1.6 The purpose of the Report is:

To confirm that the proposed development will not be subject to unacceptable flood risk or to show that flood risk can be managed acceptably;

To demonstrate that the proposed development will not increase flood risk elsewhere.

Policy Context

1.7 The Report presents an assessment of flood risk at the Site in accordance with the National Planning Policy Framework (NPPF), last updated July 2021, and its supporting Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change', last updated August 2022, both published by the Department of Communities and Local Government, and the Flood Risk Assessment – Climate Change (CC) Allowances guidance, last updated May 2022.

1.8 The NPPF and supporting PPG provide guidance on how flood risk should be considered during the planning and development processes. The requirement to protect both new and established development from increased risk of flooding forms an essential part of the guidance. Moreover, implementation of Sustainable Drainage Systems (SuDS) for new development is encouraged.

1.9 A major change in the latest update to the PPG is Paragraph: 023 Reference ID: 7-023-20220825, 'The Sequential approach to the location of development' which requires development to be located in areas at little or no risk of flooding from any source by avoiding, so far as possible, development in current and future medium and high flood risk areas considering all sources of flooding including areas at risk of surface water flooding.

1.10 The requirements and policies of Elmbridge Borough Council (EBC), Surrey County Council (SCC), Thames Water Utilities Limited (TWUL) and the Environment Agency (EA) have been taken into account when considering flood risk and drainage issues.

1.11 EBC is the Local Planning Authority (LPA), and SCC is the Lead Local Flood Authority (LLFA) controlling flood risk and water environment issues, through policies and guidance presented in:

EBC Strategic Flood Risk Assessment (SFRA) dated February 2019;

Elmbridge Core Strategy (2011-2026) adopted July 2011;

Elmbridge Local Plan Development Management Plan (2011-2026) adopted April 2015;

Regulation 19 Draft Elmbridge Local Plan dated June 2022;

EBC Flood Risk supplementary planning document (SPD) dated May 2016;

SCC Preliminary Flood Risk Assessment (PFRA), dated June 2011;

SCC Local Flood Risk Management Strategy (2017-2032) published December 2014;

SCC Sustainable Drainage System Design Guidance published September 2022;

SCC Planning Advice - Sustainable Drainage Systems (SuDS) published June 2020;

Thames Catchment Flood Management Plan (CFMP) Summary report published December 2009.

1.12 Relevant policies in the Core Strategy includes Policy CS26 Flooding, which states that risk from flooding must be minimised whilst not increasing flooding elsewhere, the sequential test must be applied in accordance with Planning Policy Statement 25. The policy states the development must not impede the natural function of the flood plain or reduce the storage capacity and that it will contain SuDS.

1.13 Policy CS1 Spatial Strategy where new development will be directed towards previously developed land within existing built-up areas, taking account of the relative flood risk of available sites.

1.14 Policy CS13 Thames Basin Heaths Special Protection Area (SPA) where proposed development within the zone of influence mitigation measures are undertaken to avoid or mitigate any potential adverse effects the development could have on the SPA.

1.15 Relevant policies in the Development Management Plan include Policy DM5 Pollution, which encourages the use of SuDS to improve water quality of surface water run-off and DM6 Landscape and Trees which encourages adaptation to climate change by incorporating SuDS and providing areas for flood mitigation.

1.16 The following scheme is also considered to be compliant with relevant policies within the emerging Regulation 19 Draft Plan. These include:

1.17 Policy CC5 Managing flood risk which will supersede the existing CS26 Flooding, states that development must reduce the overall and local risk of flooding and not impede flood flow or reduce storage capacity.

1.18 Policy DM5 by ENV7 Environmental quality which will supersede the existing DM5 Pollution and states development should seek to improve the quality of groundwater and ensure contaminated run-off is prevented.

1.19 Policy SS1 Responding to the climate emergency, SS2 Sustainable Place-making, and ENV9 Urban design quality all focus on ensuring that developments are resistant to climate change by mitigating and minimising their vulnerability to flooding.

1.20 Policy ENV1 Green and Blue Infrastructure which states blue green infrastructure will be maintained and enhanced for the contribution it makes towards combating and mitigating climate change.

1.21 The Site was allocated in the 2022 Land Availability assessment for 34 residential units delivered within the next 6-10 years. The Site allocation reference is COS12 and the LAA reference is US193. The policy designations and constraints stated for the Site are its proximity to the Thames Basin Heath Special Protection Area and its areas of medium to high risk of surface water flooding.

1.22 The Flood and Water Management Act, 2010, requires the EA to develop, maintain and apply a National Flood and Coastal Erosion Management Strategy. Similarly, the LLFA is required to develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS) for its area. The SCC Local Flood Risk Management Strategy 2017-2032, dated December 2014, sets out legislations and policies for local flood risk, objectives for reducing flood risk, and identifies localised flooding areas in Surrey.

1.23 Rainfall-runoff management for the Site will follow the procedures laid down by the Non-statutory Technical Standards (NTS) for SUDS, which were published by the Department for Environment, Food and Rural Affairs (DEFRA) in March 2015.

1.24 The Water Framework Directive (WFD) (2000/60/EC) introduced a comprehensive river basin management planning system to help protect and improve the ecological health of waterbodies such as rivers, lakes, estuaries and coastal and groundwater. It is transposed into regulations through The Water Environment (Water Framework Directive) Regulations 2017. The WFD has two principal objectives, to prevent deterioration of the status of all water bodies and to protect, enhance and restore those water bodies. The development will be

assessed in terms of the key aim of the WFD to achieve 'good' ecological and chemical status of all water bodies with deadlines set for 2021 and 2027.

Climate change

1.25 In considering flood risk to the Site, it is necessary to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

1.26 In February 2016, the EA released new guidance on the application of climate change allowances in flood risk assessments, which was last updated in May 2022. Guidance can be found at:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change%20allowances

1.27 This guidance provides contingency allowances for potential increases in peak river flow by management catchment, and for potential increases in rainfall intensity. The latter requires consideration in any surface water drainage strategy for new development.

1.28 Guidance for peak river flow climate change allowances states that the central allowance should be used for all assessments except for essential infrastructure, where the higher central allowance should be used. The upper end should be used for 'credible maximum scenario' assessments.

1.29 Guidance for peak rainfall climate change allowances were last updated in May 2022. Peak rainfall allowances are now provided by management catchments instead of at a national scale (for England). Peak rainfall allowances are provided for 1% annual exceedance probability (AEP) events and for 3.3% AEP events, and for 2 epochs rather than 3. The guidance on how to apply peak rainfall allowances has changed, using the central allowance for development with a lifetime up to 2100 and the upper end allowance for development with a lifetime from 2100 to 2125.

2.0 THE SITE

Location

2.1 The Site is located in north Cobham in Surrey. It is situated approximately 0.6km from the A3 and 10km west of Woking.

2.2 The Site is an irregular shape located behind residential properties on Portsmouth Road, Anyards Road and Copse Road. The Site comprises of a corner retail unit with a residential unit above to the northwest, a single storey vacant building in the east and garages surrounded by tarmac in the centre. The Site can be accessed via Copse Road and Anyards road. See **Figure 1** for the Site location Map.

2.3 The Site is within a residential neighbourhood with a large area of woodland located to the north of Portsmouth Road. The existing Site is partially tarmacked, and the remainder of the Site is garden space.

2.4 The approximate centre of the Site is situated at OS national grid reference 510778 E, 160638N.

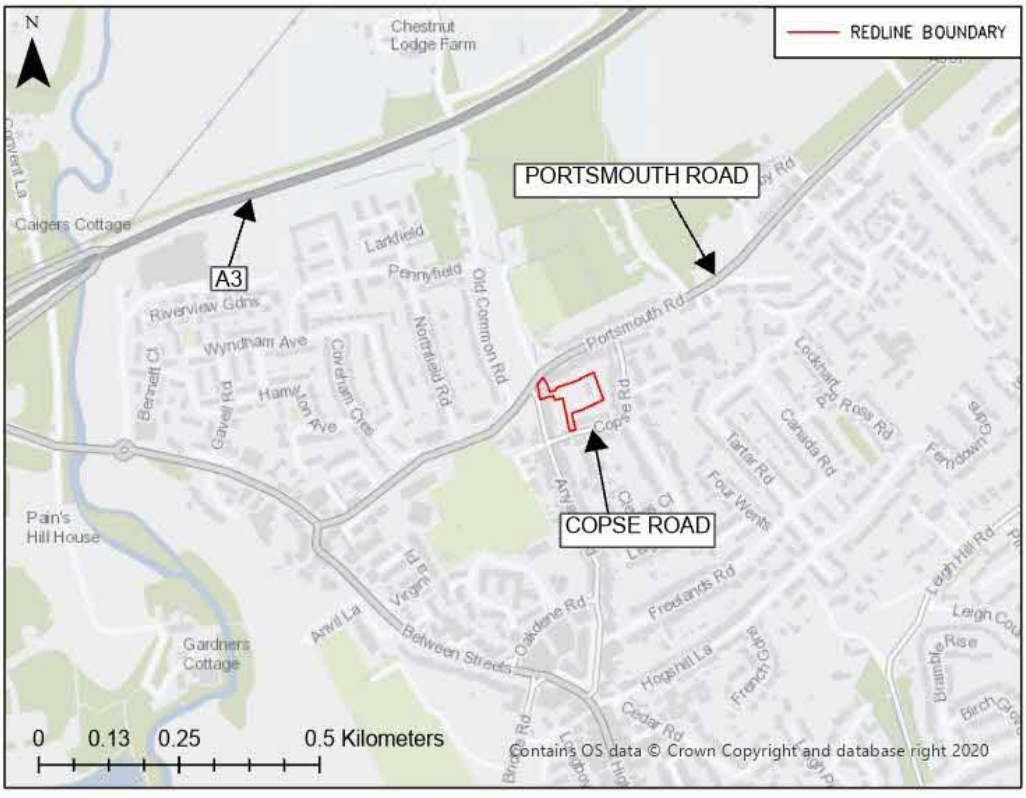


Figure 1 – Site Location Map

Topography

2.5 A topographical survey of the Site was carried out by Oak Surveys LTD in January 2023 and provides levels for the Site. A copy of the topographical survey is contained in **Appendix B.**

2.6 The topographical survey indicates that the Site is very flat with levels varying by 250mm across the Site. The lowest level shown on the survey is 21.67m AOD located south of the bungalow whilst the highest level shown on the survey is 21.92m AOD located within the northeast corner of the Site.

2.7 **Figure 2** below details the wider topographical area based on the Environment Agency's LiDAR Composite DTM 1 (2020) data. The wider topographical area indicates land to the east rises steeply approximately 150m from the Site.

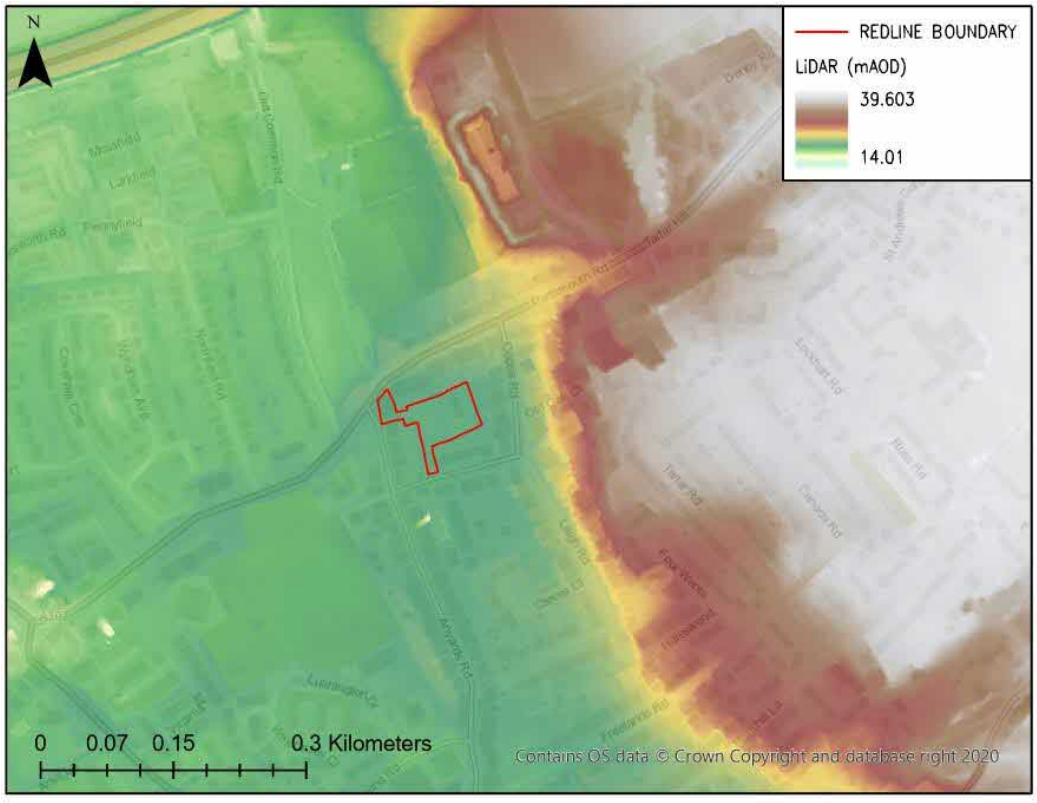


Figure 2 – LiDAR Mapping Data

Geology and Hydrogeology

Soils and geology

2.8 Information contained in 'Soilscapes' defines the Site as comprising of "Freely draining slightly acid loamy soils".

2.9 British Geological Survey (BGS) mapping data indicates that the Site is underlain by superficial deposits comprising of sand and gravel (Taplow gravel member). Furthermore, this mapping indicates that most of the Site is underlain by bedrock geology of sand (Bagshot Formation).

2.10 Soils Limited undertook an intrusive ground investigation and published a Main Investigation Report in June 2023. Results confirmed the above, sand, clay and gravel. Bagshot Formation was encountered in all trial pits, comprising of soft, sandy clay over clayey sand and sandy gravel horizons. See **Appendix C** for the Site Investigation Report.

2.11 Extracts from the BGS mapping tool are found below in **Figure 3.**

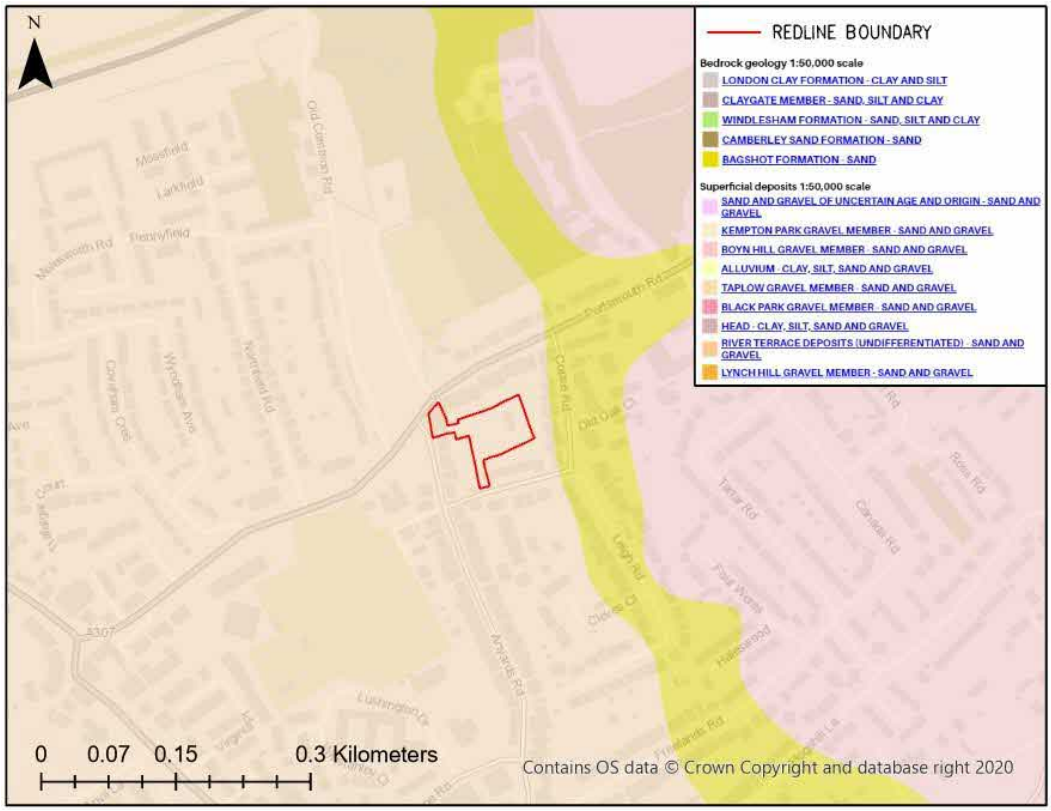


Figure 3 – BGS Mapping

Hydrogeology

2.12 UK Government DEFRA mapping indicates that the Site is:

Not located within Nitrate Vulnerable Zone

Located within Drinking Water Safeguard Zone.

Located within a bedrock aquifer (Secondary A) and superficial drift aquifer (Secondary A)

Not located within a Ground Water Source Protection Zone as demonstrated by **Figure 4.**

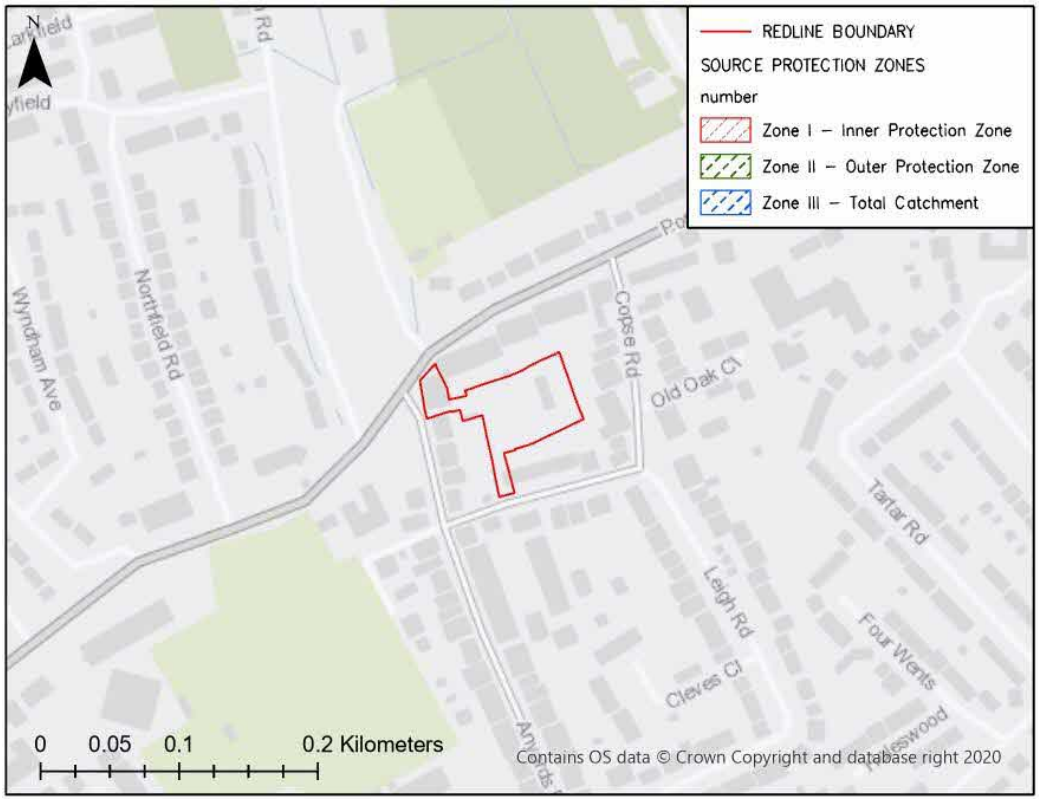


Figure 4 – Source Protection Zones

Hydrological setting

2.13 The Site is located within the River Mole river basin. The basin is separated into several management catchments and the Site is situated within the Mole Lower and Rythe Operational Catchment. Of the fourteen water bodies in the catchment, the Site is located within the catchment area of the section of the River Mole between Leatherhead and Hersham.

2.14 There are no main rivers managed by the EA on Site as shown in **Figure 5**. The main river nearest to the Site is the River Mole which is situated approximately 740m from the Site. The closest other main river is the Downside Ditches and Bookham Brook Water Body 1.4km from Site.

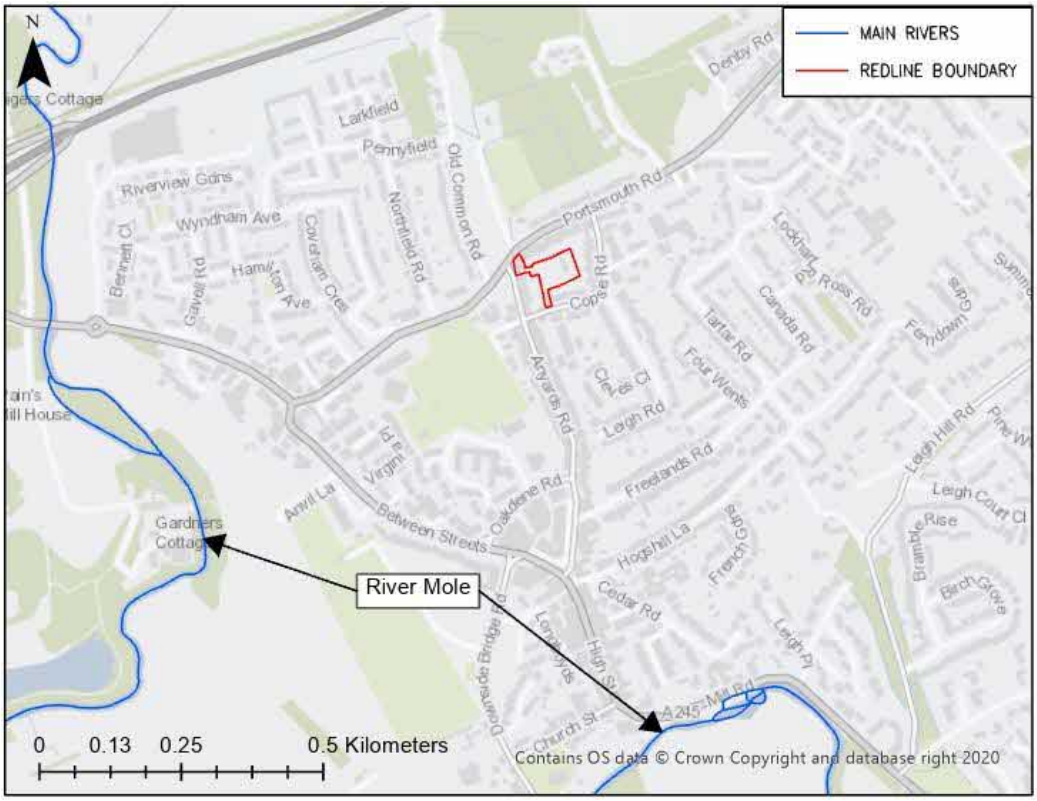


Figure 5 – Main River Map

Existing Drainage

Wastewater sewers

2.15 Existing foul water sewers for the bungalow and building on the corner of Portsmouth Road and Anyards Road connect downstream of TWUL Manhole reference 7601 on Anyards Road (sewer records can be found in **Appendix D**).

Surface Water Sewers

2.16 Existing surface water sewers connect the building on the corner of Anyards Road and Portsmouth Road to a sewer downstream of TWUL Manhole reference 6654 on Anyards Road. Whereas the bungalow and surround area flows into a surface water sewer which connects downstream of TWUL Manhole reference 7552 on Copse Road.

Site Sensitivity

Designated Sites

2.17 According to the UK DEFRA mapping, the Site is not located within the green belt or any statutory designated areas such as Ramsar, Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), and SPA's.

2.18 The closest SSSI to the Site is Esher Commons located 1.7km from Site with the second closest SSSI being Ockham and Wisley Commons at 2.5km from Site. The Site lies within the impact zones of both these SSSI's.

2.19 The closest SPA is Thames Basin Heath SPA located 2.8km west of the Site. The Site is located within Zone B of the Thames Basin Heath SPA, the zone of influence. Furthermore, the National Nature Reserve, Ashtead Common is located 6km to the east of Site.

3.0 DEVELOPMENT PROPOSALS

Site Layout

3.1 This report has been prepared to inform the evidence base in support of the Clients development proposals at Anyards Road, Cobham.

3.2 The proposed development is as follows: “The demolition of the existing buildings and the erection of 26 residential dwellings, together with the associated access, car parking and landscaping at Anyards Road, Cobham.”

3.3 The Site layout is presented in **Appendix E.**

3.4 The proposed mitigation is based on a design life for the development of 100 years and climate change allowances within the mitigation measures and drainage design are based on this assumption.

Vulnerability Classification

3.5 The NPPF PPG ‘Flood Risk and Coastal Change’ Table 2 specifies the ‘Flood risk vulnerability classification of a Site, depending upon the proposed usage. This classification is subsequently applied to the PPG Table 3 to determine whether:

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

3.6 Table 2 classes the proposed residential development as a ‘More Vulnerable’ development.

NPPF Sequential Test

3.7 The NPPF requires the LPA to apply a Sequential Test in consideration of any new development. The NPPF follows a sequential risk-based approach in determining the suitability of land for development in areas at little or no risk of flooding from any source by avoiding, so far as possible, development in current and future medium and high flood risk areas considering all sources of flooding including areas at risk of surface water flooding. This is following the latest update to the PPG (refer to section 1.9). The principle of sequential test is applied on a site-specific basis.

4.0 FLOOD RISK ASSESSMENT

Coastal Flooding

4.1 The Site is located a sufficient distance inland and at an elevation in excess of approximately 21.67m AOD that does not expose it to the risk of tidal flooding.

Historical Flooding

4.2 The Site has no recorded events of historic flooding as indicated by the EA 'Historic Flood Map' (**Figure 6**).

Figure 6 – Historic Flood Map

4.3 The EBC SFRA indicates Portsmouth Road was a historic flood incident location and there are two recorded instances of highway enquires regarding flooding along Portsmouth Road (SFRA mapping extracts can be found in **Appendix F**).

Flooding from Reservoirs

4.4 Major reservoirs throughout the UK are normally well maintained and the likelihood of a failure causing downstream flooding is extremely low. In the very unlikely event of a dam failure, a large volume of water could be released, quickly

flooding a large area and possibly causing significant property damage or even loss of life.

4.5 The EA map 'Flood Risk from Reservoirs' indicates that the Site is not at risk of flooding from reservoirs (**Figure 7**).

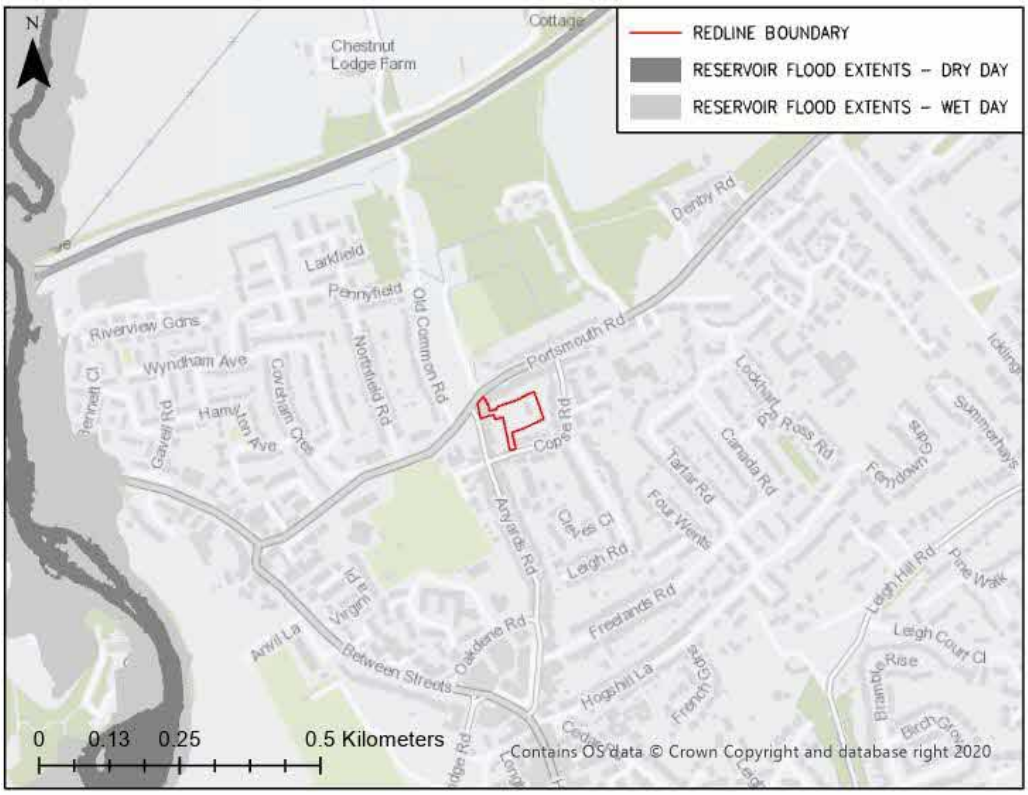


Figure 7 - Reservoir Flood Extents Map

Flooding from Artificial Drainage Systems

4.6 Artificial drainage systems, such as pipes, land drains, sewers and drainage channels, are provided to manage and convey runoff from developed land. During heavy rainfall, flooding of these drainage systems may occur if: runoff exceeds the capacity of the systems; debris or sediment blocks the system; or, if the system becomes surcharged due to high water levels in the downstream system.

4.7 The EBC SFRA does not have any records of internal sewer flooding within the Site. However, it does record 3 instances of external sewer flooding within the postcode of the Site (SFRA extracts included within **Appendix F).**

Fluvial Flooding

4.8 Fluvial (river) flooding occurs when a watercourse cannot accommodate the volume of water draining into it from the surrounding catchment.

4.9 EA Flood Zone mapping of different probability events offers the LPA an initial assessment of flood risk to inform development control decisions. Flood Zones 1, 2 and 3 refer to low, medium and high risks of flooding which correspond to AEP of less than 0.1%, in the range of 0.1-1% and greater than 1% probability in any given year, respectively.

4.10 An extract from the EA's 'Flood Map for Planning' in **Figure 8** indicates that the Site is situated within Flood Zone 1 (Low probability).

4.11 Flood Zone 1 – "Land having less than 0.1% annual probability of river or sea flooding (low probability)."

4.12 Flood Zone 2 – "Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding (medium probability)."

4.13 Flood Zone 3 – "Land having a 1% of greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea (high probability)."

4.14 The EA Flood Zone mapping shows the Site is located within flood zone 1 as shown below in **Figure 8**.

Figure 8 – Flood Map for Planning

Surface Water Flooding

4.15 The EA map 'Risk of Surface Water Flooding' (RoFSW) (**Figure 9**) indicates that the majority of the Site has a low risk of surface water flooding. The areas that appear at very low risk of flooding are the result of the existing buildings onsite. There is an area of medium risk at the centre of the Site located by the access area for the garages and an area of high risk south of the bungalow in the southeastern corner.

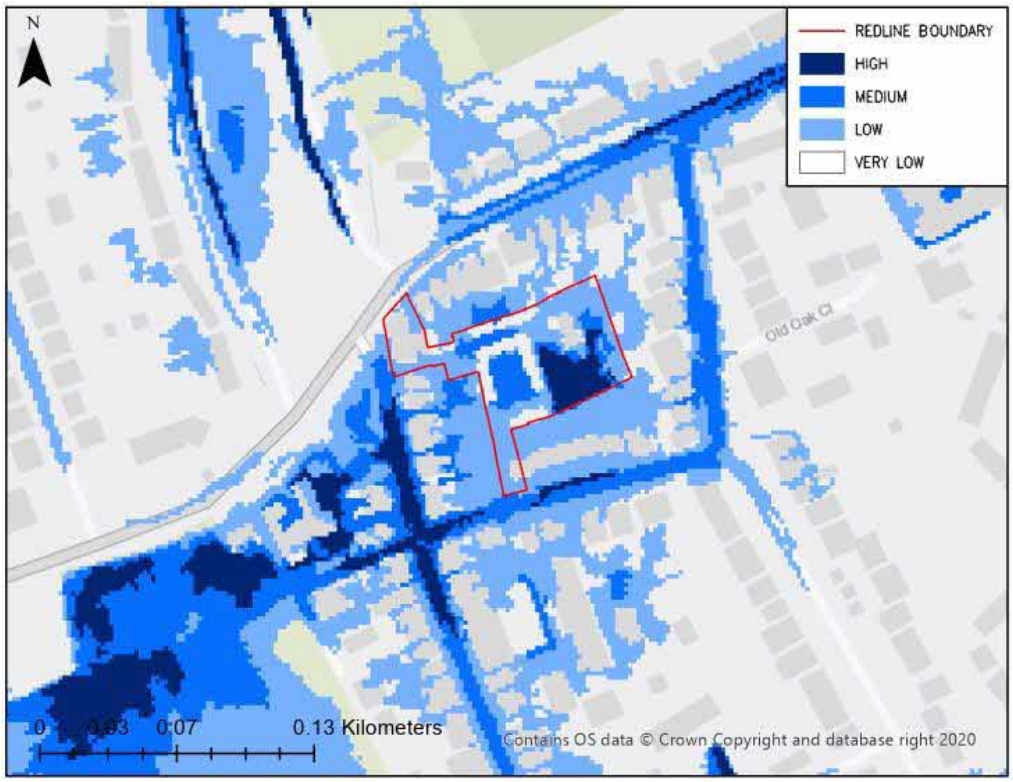


Figure 9 – Risk of Surface Water Flood Map

Mitigation

4.16 Finished flood levels (FFLs) on the Site are proposed to be at 22.45mm AOD, which is 300mm above the modelled 1 in 1000-year flood level. Therefore, the proposed development will be mitigated from any potential risk of surface water flooding.

4.17 SMA has undertaken site specific surface water modelling for the pre and post development flood risk scenarios. The post development drawings show that surface water flood risk can be managed onsite through redevelopment, with runoff being steered away from properties via the new access roads.

4.18 See **Appendix G** for the pre- and post-development surface water flood risk drawings.

Groundwater Flooding

4.19 Mapping extracts from the EBC SFRA indicate that the risk of groundwater flooding is less than 25% and can be found in **Appendix F.**

Sequential and Exception Tests

4.20 The Site is an allocated site in the Elmbridge Local plan, site reference COS12 and as such has passed the sequential test according to the EBC Local Plan 2022. As the sequential test has already been undertaken and the Site has passed, it does not need to be re-tested.

Climate Change

4.21 In considering flood risk to the Site, together with its mitigation, it is necessary to fully consider the potential impacts of climate change over the lifetime of the development. Making an allowance for climate change will help to minimise the vulnerability and provide resilience to flooding in the future.

4.22 In February 2016, the EA released guidance on the application of climate change allowances in flood risk assessments. Allowances are based on climate change projections and different scenarios of carbon dioxide (CO_2) emissions to the atmosphere. There are different allowances for different epochs or periods of time over the next century. The guidance provides contingency allowances for potential increases in peak river flow and for potential increases in rainfall intensity.

4.23 The guidance recommends that a 'central' allowance should be used for all assessments except for essential infrastructure, where the 'higher central' allowance should be used. An 'upper end' allowance should be used for 'credible maximum scenario' assessments.

4.24 In accordance with PPG, residential development should be considered to have a minimum of 100 years life-span. Therefore, drainage design for the proposed development will consider rainfall adjustments for the most distant epoch (2070s) and will conservatively assume an upper end projection scenario (+40%).

Peak Rainfall Allowances

4.25 Increased rainfall affects river levels and land and urban drainage systems. **Table 1** shows the anticipated changes in extreme rainfall intensity in the Mole management catchment.

4.26 For Flood Risk Assessments and Strategic Flood Risk assessments for developments with a lifetime beyond 2100, guidance states assess the upper end allowances. This must be done for both the 1% and 3.3% AEP events for the

2070s epoch (2061 to 2125). For development with a lifetime between 2061 and 2100 take the same approach by use the central allowance for the 2070s epoch. Development with a lifetime up to 2060, take the same approach but use the central allowance for the 2050s epoch (2022 to 2060).

4.27 An allowance for increased rainfall will require consideration in the surface water drainage strategy for the proposed development.

Table 1: Peak rainfall intensity allowance for the Mole Management Catchment

	Allowance Category	Total potential change anticipated for the '2050s' (up to 2060) (1% AEP)	Total potential change anticipated for the '2050s' (up to 2060) (3.3% AEP)	Total potential change anticipated for the '2070s' (2061 to 2125) (1% AEP)	Total potential change anticipated for the '2070s' (2061 to 2125) (3.3% AEP
Mole Management Catchment	Upper end	40%	35%	40%	35%
	Central	20%	20%	25%	20%

Peak River Flow Allowances

4.28 The climate change allowances include predictions of anticipated change for peak river flows by management catchment.

4.29 Statutory main rivers near the Site are located within the Mole Management Catchment. River flow allowances for the management catchment are presented in **Table 2**.

Table 2: Peak River flow allowances for the Mole Management Catchment.

Management Catchment	Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Mole Management Catchment	Upper End	27%	26%	40%
	Higher Central	16%	13%	20%
	Central	11%	6%	12%

5.0 SURFACE WATER DRAINAGE STRATEGY

Discharge Destination

5.1 In order to ensure that surface water runoff from a developed Site does not have a detrimental impact on the downstream catchment it is important to prioritise where surface water runoff is discharged, control how fast the runoff is discharged and also control how much runoff is discharged from the Site.

5.2 The proposed development will lead to an increase in impermeable area. As such, it is proposed to employ Sustainable Drainage Systems (SuDS) measures to ensure surface water is managed effectively.

5.3 Any development presents an opportunity to incorporate SuDS, which might include infiltration techniques or attenuation of flows to protect receiving sewers or watercourses. The choice of methods is dependent upon ground conditions and availability of suitable areas within the particular scheme layout.

5.4 In line with national and local planning policy, it is proposed to employ SuDS to manage surface water runoff close to source using guidance given in CIRIA report C753 'The SuDS Manual' and NTS for SuDS by DEFRA (March 2015). Runoff will be managed both at source and across the Site as a whole.

5.5 Water is a valuable resource and priority should be given to the reuse of runoff on Site (rainwater harvesting) once it has been appropriately treated. The destination of any surplus runoff should be prioritised in accordance with 'Requirement H3 Part 3' of the Building Regulations Approved Document H (2002 Edition), which states:

5.6 "Rainwater from a system provided pursuant to sub-paragraphs (1) and (2) should discharge to one of the following listed in order of priority:

a) an adequate soakaway or some adequate infiltration system; or, where this is not reasonably practicable,

b) a watercourse; or, where that is not reasonably practicable,

c) a sewer".

5.7 This guidance is replicated in the PPG (Paragraph 080) which states: "Generally, 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".

Surface water Drainage Strategy

5.8 In accordance with the discharge destination hierarchies of the Building Regulation H3 and the PPG, an assessment of the suitability of the Site to utilise infiltration drainage techniques has been undertaken.

5.9 **Table 3** provides a summary of SuDS components suitability at the Site.

Table 3 - SuDS Components Suitability

SuDS Component	Site Suitability	Reasoning
Rainwater Harvesting	No	Water butts do not count as storage when calculating Site runoff. They are also unreliable as residents could remove them.
Green Roofs	No	Not appropriate for pitched roofs on residential dwelling and high maintenance costs. Have potential suitability for commercial buildings or retail areas.
Infiltration Systems	No	Infiltration testing undertaken by Soils Limited in June 2023 indicates that infiltration is not viable for the Site.
Proprietary Treatment Systems	No	As the development is residential, it is not expected that there will be highly contaminated roads within the proposed development and therefore are deemed unnecessary for the proposed development.
Filter Strips	No	Filter strips are best suited to treating runoff from relatively small drainage areas. Filter strips are typically located on cropland immediately adjacent to streams, lakes, ponds, ditches, sinkholes, wetlands, or groundwater recharge areas.
Filter Drains	Yes	A filter drain proposed to the east to collect runoff from residential gardens.

Swales	No	Due to the limited space within the Site, it is not deemed feasible or practicable to incorporate swales within the proposed drainage strategy.
Bioretention Systems	Yes	Bioretention is proposed to pick up runoff from adjacent road and convey water to the surface water sewer to the west of the Site.
Pervious Pavements	Yes	Can be used on private drives and parking areas, either as a permeable system or with a connection to the piped drainage system. Permeable paving will be dependent on location of services and utilities along with gradients on driveways and private roads.
Detention Basins	No	Lack of area on the Site means that a detention basin is not feasible.

5.10 BGS mapping indicates that the east of the Site is underlain by superficial deposits of sand and gravel (Taplow gravel member). BGS mapping indicates that the majority of the Site is underlain by bedrock geology of Sand from the Bagshot formation. Ground Investigations undertaken by Soils Limited indicate that the groundwater level was 1.45m bgl, therefore it is not considered appropriate or practicable to dispose of surface water runoff from the proposed development via infiltration.

5.11 There are no water courses in close enough proximity to the Site, which are viable, to discharge into.

5.12 TWUL asset records indicate an existing 600mm diameter surface water sewer that runs adjacent to the Western Site boundary running north along Anyards Road. Records also indicate two 300mm surface water sewers that run southwest adjacent to the most southern Site boundary. Therefore, it is deemed practicable to discharge the surface water sewers adjacent to the Site boundaries. TWUL confirmation will be required to ensure that there is sufficient capacity within the existing network. There are existing TWUL surface water sewer connections on the Site which are proposed to be reused.

5.13 A pre-application enquiry has been submitted to TWUL and SMA are awaiting a response.

5.14 Porous paving can be provided in certain locations throughout the Site to provide attenuation, source control, conveyance of surface water, and water quality benefits.

5.15 Bioretention systems are also proposed adjacent to the roads which will provide attenuation, water quality benefits, and a reduced runoff rate.

5.16 A filter drain is proposed on the eastern boundary of the Site to help collect runoff from residential back gardens. This will provide further water quality and reduced runoff in the Site boundary.

5.17 Crates are proposed along the access road to provide additional storage.

5.18 The drainage strategy drawing has been included as **Appendix H**.

5.19 Surface water calculations are included as **Appendix I**, showing that the proposed strategy can provide the storage requirements for all impermeable areas on Site including a 10% allowance for Urban Creep.

Existing Discharge Rates

5.20 In compliance with the NTS, the drainage systems across the Site will be designed so that the surface water runoff from the proposed development is contained within the drainage network, with no flooding for all storms up to, and including, the 1 in 30 year-event. Furthermore, the drainage system will be designed so that flooding to any new or existing buildings does not occur during a 1 in 100-year event, including +40% allowance for climate change.

5.21 The Site is currently brownfield with total area of 0.472ha. The Site currently consists of 0.267ha of impervious area and 0.205ha pervious area. See **Table 4** and **Table 5** for the existing runoff rates for the Site.

Table 4: Existing Runoff Rates - Western Catchment

Return Period 1 in X year	Greenfield Discharge Rate (l/s)	Brownfield Discharge Rate (l/s)	Total
1	0.08	4.47	4.55
QBAR	0.09	6.00	6.09
30	0.18	11.65	11.83
100	0.23	15.31	15.54

Table 5: Existing Runoff Rates – Southern Catchment

Return Period 1 in X year	Greenfield Discharge Rate (l/s)	Brownfield Discharge Rate (l/s)	Total
1	0.23	12.65	12.88
QBAR	0.26	17.10	17.36
30	0.52	33.15	33.67
100	0.67	43.59	44.26

Development Runoff

5.22 In order to comply with both the peak flow and volume discharge requirements of the NTS and to ensure that flood risk is not increased further downstream, discharge for the Site will be restricted to the 1 in 100-year greenfield runoff rate for all storms up to and including the 1 in 100 year + 40% climate change event.

5.23 The pre- and post-development runoff rates for the western and southern outfall points are presented below in **Table 6** and **Table 7**. The tables also provide betterment from existing to proposed discharge rates for both catchments.

Table 6: Western catchment pre- and post-development runoff rates

Return Period 1 in X year	Pre-development Runoff Rate (l/s)	Post-development Runoff Rate (l/s)	Betterment (%)
1	4.55	1.0	78
QBar	6.09	1.0	83
30	11.83	1.0	91
100	15.54	1.0	93

Table 7: Southern catchment pre- and post-development runoff rates

Return Period 1 in X year	Pre-development Runoff Rate (l/s)	Post-development Runoff Rate (l/s)	Betterment (%)
1	12.88	5.0	61
QBar	17.36	5.0	71
30	33.67	5.0	85
100	44.26	5.0	88

Exceedance Design

5.24 Very high rainfall intensities can overwhelm pipe-based drainage systems for brief periods, whereas SuDS tend to have longer-duration critical storm events. In all cases, there will be events that cause flooding at points in the network if the storm event exceeds the design event.

5.25 Flows resulting from rainfall in excess of a 1% annual probability event plus 40% climate change event will be managed in exceedance routes following the natural slope to minimise the risks to people and property.

5.26 Levels on the Site will be designed to steer exceedance flow routes away from properties towards the outfall points to the north and south of the Site for surface water discharge.

5.27 The exceedance flow routes drawing for the Site is presented within **Appendix J**.

Surface Water Management & Treatment Train

5.28 In accordance with CIRIA Report C753: The SuDS Manual, a "SuDS Management Train" process will be undertaken to assure that the proposed drainage strategy mimics the natural catchment of the Site as closely as possible.

5.29 The proposed Management Train (**Table 8)** will provide appropriate levels of risk management to protect the receiving water body.

Table 8: SuDS Management Train

SuDS Component	Interception	Primary Treatment	Secondary Treatment	Tertiary Treatment
Rain Gardens (Bioretention)	Y	Y	Y	
Porous Pavements	Y	Y		

5.30 Source control techniques will be incorporated into the drainage strategy to ensure that storm water runoff is managed as close to source as possible.

Porous Paving

5.31 Porous pavements are structures that allow rainwater to infiltrate through the surface layer and into the underlying sub-structure, where it will be temporarily stored before discharging into the nearest sewer.

5.32 As runoff percolates through the sub-layers, pollutants and contaminates are filtered out by the surfacing layer and biological process in the sub-base.

5.33 Porous pavements are built as an alternative to impermeable surfaces and therefore require no extra development space for their construction.

5.34 It is proposed, where possible, to provide permeable pavements on all private drives and car park areas within the development.

Bioretention

5.35 Bioretention is a form of SuDS that is used to provide treatment and retention of water. They can be strips of vegetation along roadsides where water drains and receives treatment.

5.36 It is proposed to incorporate bioretention strips along the main road of the development.

Filter Drain

5.37 Filter drains comprise of a gravel filled trench with a perforated carrier pipe at the base and provide initial cleansing and reduce the runoff rate of the receiving flow.

5.38 A filter drain is proposed to the eastern boundary of the Site to help collect runoff from the adjacent residential gardens.

Water Quality Management

5.39 CIRIA C753 states that “whatever possible, when discharging runoff from the site to surface waters, SuDS should be designed to intercept (i.e. prevent) runoff (and the associated pollutants) for most rainfall events approximately 5mm in depth”.

5.40 When runoff does occur, treatment within SuDS components is essential for frequent rainfall events, for example up to a 1:1 year return period event, where urban contaminants are being mobilised and washed off urban surfaces, and the aggregated contribution to the total pollutant load to the receiving body is potentially high.

5.41 **Table 9** details the pollution hazard indices for the Site as stated by CIRIA C753. The indices range from 0 (no pollution hazard for this contaminant type) to 1 (high pollution hazard for this contaminant type).

Table 9: Pollution Hazard indices for different land use classifications

Land Use	Pollution Hazard	Total Suspended solids (TSS)	Metals	Hydro-carbons
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change	Low	0.5	0.4	0.4

5.42 To deliver adequate treatment, selected SuDS components must have a total pollution index (for each contaminant type) that equals or exceeds the pollution hazard index. The proposed SuDS components for the Site, and their mitigation indices, are produced in **Table 10**.

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

Table 10: Indicative SuDS mitigation indices for residential discharges to surface waters

Land Use	Total Suspended solids (TSS)	Metals	Hydro-carbons
Permeable pavement	0.7	0.6	0.7
Bioretention	0.8	0.8	0.8

Maintenance

5.44 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 in order to ensure the systems continue to work effectively.

5.45 A maintenance schedule (indicating with whom any responsibilities lie) will need to be produced as part of the detailed design works. Management and maintenance schedules for the proposed SuDS features on-site are included within **Appendix K.**

6.0 WASTEWATER DRAINAGE STRATEGY

6.1 It is proposed to discharge foul water flows from the proposed development into the existing public sewerage network to the west of the Site and to the south.

6.2 The proposed foul water sewer connections to the Site are 225mm diameter mains that are located to the south of the Site heading south-west and then proceeds north adjacent to the northern area of the Site. There are existing TWUL foul water sewer connections on the Site that are proposed to be reused.

6.3 Confirmation from TWUL will be required to ensure there is enough capacity in the existing network. A pre-application has been sent to TWUL and SMA are awaiting a response.

6.4 A preliminary drainage strategy drawing depicting an indicative location of the foul water drainage strategy for the Site is shown within the Drainage Strategy drawing included as **Appendix H**.

7.0 SUMMARY AND CONCLUSIONS

Summary

7.1 A Flood Risk Assessment and Drainage Strategy report has been prepared to inform the preparation of a detail planning application at Anyards Road, Cobham.

7.2 This Report presents an assessment of flood risk in accordance with the guidelines set out in NPPF and the National PPG. It also refers to, and complies with, DEFRA standard and the policies of the EBC, TWUL, and the EA have been taken into account when considering flood risk and drainage issues.

Flood Risk

7.3 The EA's 'Flood Map for Planning' shows the Site is located in a Flood Zone 1 and is therefore at low risk of fluvial flooding. The Site is indicated to be at risk of surface water flooding pre-development, however SMA have undertaken surface water modelling and shown that risk can be managed through redevelopment. This is due to proposed levels being 300mm above the flood level for the modelled 1 in 1000-year flood. The Site is not indicated to be at risk of flooding from reservoirs, groundwater flooding or flooding from artificial drainage systems.

Surface Water Drainage Strategy

7.4 The surface water drainage strategy for the development consists of a series of SuDS, including bioretention systems, porous paving, and a filter drain. This strategy is shown to be designed in compliance with the current legislation and design criteria, utilising SuDS to control surface water and mitigate risk of flooding to and from the Site.

7.5 The proposed SuDS Management Train provides sufficient pollution treatment minimising risk to water quality.

Wastewater

7.6 Two points of connection are proposed for foul water flows, to the north of the Site and to the south. Confirmation from TWUL will be required to ensure there is sufficient capacity in the existing network.

APPENDIX A

Flood Risk Assessment Pro Forma

Flood Risk Assessment Proforma

Please note: Not all elements of this Profroma will need to be completed for all developments. The level and scope of the FRA will depend on the degree and type of flood risk, scale and nature of the development, its vulnerability classification and whether or not the Sequential and Exceptions Tests are required. Applicants should use Flood Risk SPD to scope out the requirements and are strongly encouraged to use the pre-applications services available (Section 2.1). **The completion of an FRA will not automatically mean that the development is acceptable in flood risk terms.**

1. Site Description

What to Include in the FRA		Source(s) of information	Summary	Reference to Section of FRA
Site address	-	-	Portsmouth Road, Cobham KT11 1HX, UK	1.2
Site description	-	-	0.456 ha, currently a brownfield site	1.3
Location Plan	Including geographical features, street names, catchment areas, watercourses and other bodies of water	SFRA Appendix B		Figure 1
Site plan	Plan of site showing development proposals and any structures which may influence local hydraulics e.g. bridges, pipes/ducts crossing watercourses, culverts, screens, embankments, walls, outfalls and condition of channel	OS Mapping	Development proposal for 26 residential units	Appendix C

2. Proposed Development

What to Include in the FRA		Source(s) of information	Summary	Reference to Section of FRA
Vulnerability Classification	Determine the vulnerability classification of the development. Is the vulnerability classification appropriate within the Flood Zone?	SPD Appendix 1	'More vulnerable'	Section 3

3. Assessing Flood Risk

What to Include in the FRA		Source(s) of information	Summary	Reference to Section of FRA
The level of assessment will depend on the degree of flood risk and the scale, nature and location of the proposed development. Refer to Table 7-1 of the SFRA regarding the levels of assessment. Not all of the prompts listed below will be relevant for every application.				
Topography	Include general description of the topography local to the site. Where necessary, site survey may be required to confirm site levels (in relation to Ordnance datum).	Topography	Topographical surveys indicate that the site is very flat with levels varying from 250mm across the site	Section 2.6
Landscape and Vegetation	Include a description of the landscape and existing vegetation on the site.	SPD Section 3.1	The Site comprises of a corner retail unit with a residential unit above to the northwest, a single storey vacant building in the east and garages surrounded by tarmac in the centre	Section 2.2
Geology	General description of geology local to the site.	SPD Section 3.1	Bedrock - bagshot formation superficial depsoit - taplow gravel member	Section 2.9
Watercourses	Identify Main Rivers and Ordinary Watercourses local to the site.	SPD Section 3.2	River Mole 1.4km from Site	Section 2.12
Flooding from Rivers	Provide a plan of the site and Flood Zones.	SPD Section 3.2 SFRA Appendix C		

	Identify any historic flooding that has affected the site, including dates and depths where possible. How is the site likely to be affected by climate change? Determine flood levels on the site for the 1% annual probability (1 in 100 chance each year) flood event including an allowance for climate change. Determine flood hazard on the site (in terms of flood depth and velocity). Undertake new hydraulic modelling to determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.	Environment Agency Products 1-7. New hydraulic model.	Site located in flood zone 1 - 'land less than 0.1% annual probability of river or sea flooding (low probability)' No historic flooding has occurred on the site, according to the EA. Flood level for 1 in 1000 year flood event is 22.15m AOD. Finished floor levels will be 22.45m AOD, which is 300mm above the 1 in 1000 year flood event. Hydraulic modelling undertaken to determine flood level stated above.	Section 4.14 Section 4.2 Section 4.16
Flooding from Land	Identify any historic flooding that has affected the site.	SPD Section 3.2 SFRA Appendix D. Topographic survey. Site walkover. New modelling study.	No historic flooding has occurred on the site, according to the EA.	Section 4.2
Flooding from Groundwater	Desk based assessment based on high level BGS mapping in the SFRA.	SPD Section 3.2 SFRA Appendix B, Figure B2, B3, B5. Ground Investigation Report Hydrology Report	EBC SFRA maps indicate that the risk of groundwater flooding is less than 25%.	Section 4.16

Flooding from Sewers	Identify any historic flooding that has affected the site.	SPD Section 3.2 SFRA Appendix B Figures B7 and B8. Where appropriate an asset location survey can be provided by Thames Water Utilities Ltd www.thameswater-propertysearches.co.uk/	EBC SFRA has no records of internal sewer flooding within the site.	Section 4.7
Reservoirs, canals and other artificial sources	Identify any historic flooding that has affected the site.	SPD Section 3.2 Risk of Flooding from Reservoirs mapping (EA website).	Site not at risk of reservoir flooding.	Section 4.5

This form is completed using factual information and can be used as a summary of the Flood Risk Assessment on this site.

Form Completed By Ellie Lebbon

Qualification of person responsible for signing off this template Graduate Environmental Engineer

Company Stuart Michael Associates

On behalf of (Client's details) Shanly Homes

Date 12/10/2023

Contact information

tplan@elmbridge.gov.uk
www.elmbridge.gov.uk/planning

View our privacy notice here

APPENDIX B

Topographical Survey

LEGEND

CATV	CABLE TELEVISION COVER	BD	BACK DROP
EIC	ELECTRIC INSPECTION COVER	BL	BASE/BED LEVEL
EJB	ELECTRIC JUNCTION BOX	CL	COVER LEVEL
EP	ELECTRICITY POLE	CP	CATCH PIT
ER	EARTHING ROD	DC	DRAINAGE CHANNEL
FH	FIRE HYDRANT	DP	DOWN PIPE
GJB	GAS JUNCTION BOX	G	GULLY
GV	GAS VENT	IC	INSPECTION COVER
JB	JUNCTION BOX	IL	INVERT LEVEL
MK(E)	SERVICE MARKER (ELECTRIC)	MH(C)	MANHOLE (COMBINED)
MK(G)	SERVICE MARKER (GAS)	MH(F)	MANHOLE (FOUL)
MK(W)	SERVICE MARKER (WATER)	MH(S)	MANHOLE (SURFACE WATER)
OHW	OVERHEAD WIRE	RE	RODDING EYE
SC(G)	STOP COCK (GAS)	RWP	RAIN WATER PIPE
SC(W)	STOP COCK (W)	SEG	SIDE ENTRY GULLY
STAY	SUPPORT FOR TELEPHONE POLE	SVP	SOIL VENT PIPE
SV	STOP VALVE	UTL	UNABLE TO LIFT
BT	TELEPHONE INSPECTION COVER	VP	VENT PIPE
TJB	TELEPHONE JUNCTION BOX	WO	WASH OUT
TP	TELEPHONE POLE	B	BOLLARD
WIC	WATER INSPECTION COVER	BH	BORE HOLE
WM	WATER METER	BP	BRICK PILLAR
DPC	DAMP PROOF COURSE	BS	BUS STOP
THL	THRESHOLD LEVEL	CPS	CONCRETE PAVING SLABS
T.O.W	TOP OF WALL	FB	FLOWER BED
WL	WATER LEVEL	LB	LITTER BIN
CLG	CEILING LEVEL	LC	LIGHTING COLUMN
DHL	DOOR HEAD LEVEL	P	POST
FL	FLOOR LEVEL	PB	POST BOX
SCLG	SUSPENDED CEILING LEVEL	RNP	ROAD NAME PLATE
US	UNDERSIDE	RS	ROAD SIGN
USB	UNDERSIDE OF BEAM	RW	RETAINING WALL
WCL	WINDOW CILL LEVEL	SP	SIGN POST
WHL	WINDOW HEAD LEVEL	SU	STEP(S) UP
		TCB	TELEPHONE CALL BOX
		TS	TREE STUMP

OSBM	ORDNANCE SURVEY BENCH MARK
STN	SURVEY STATION
TBM	TEMPORARY BENCH MARK

TREE — Species, Trunk Ø, Canopy Ø, Height

SURVEY STATION

GATE - GATES	
FENCE	TOP OF BANK
BUILDING	BOTTOM OF BANK
OVER HEAD BUILDING LINE	KERB
FACE OF WALL	DROP KERB
CHANGE OF SURFACE	CONTOUR WITH VALUE
EDGE OF UNDERGROWTH	OVER HEAD CABLE
TREE LINE/HEDGE ROOT LINE	FOOTPATH LINE

ALL LEVELS AND CO-ORDINATES ARE RELATED TO THE ORDNANCE SURVEY NATIONAL GRID OSTN15, UNLESS OTHERWISE NOTED.

CONTOUR INTERVALS SET AT 1.0M WHERE APPLICABLE

TREE SPECIES AND DETAILS ARE QUOTED AS A MEAN SIZE AND SHOWN TO SCALE, HOWEVER NO RESPONSIBILITY CAN BE TAKEN FOR WRONG SPECIES IDENTIFICATIONS.

ANY INVERT LEVEL INFORMATION SHOWN HAVE BEEN MEASURED FROM ABOVE GROUND, LEVELS MAY BE SUBJECT TO CHANGE. ANY PIPE FLOW DIRECTIONS AND LATERALS ARE INDICATIVE POSITION ONLY.

IT IS RECOMMENDED THAT FOR ANY WORKS INVOLVING DRAINAGE, THAT ADDITIONAL CHECKS ARE CARRIED OUT BY THE CONTRACTOR PRIOR TO ANY CONSTRUCTION COMMENCING.

THIS SURVEY PROVIDES POSITION AND DESCRIPTION OF FEATURE IN RELATION TO SURVEY CONTROL STATION AND IN NO WAY IMPLIES LEGAL TITLE OR BOUNDARY OWNERSHIP.

DO NOT SCALE FROM A PDF.

DRAWING IS CORRECT AT TIME OF SURVEY.

OAK SURVEYS LTD ACCEPTS NO RESPONSIBILITY FOR THE UNAUTHORISED PASSING OF THIS DRAWING TO THIRD PARTIES.

OS DATA SHOWN IN THE BACKGROUND HAS BEEN OBTAINED THROUGH THE OFFICIAL PROMAP WEB SITE DATA BASE AND NO RESPONSIBILITY CAN BE TAKEN FOR ITS ACCURACY. ALL RIGHTS RESERVED, CROWN COPYRIGHT.

N

OAK SURVEYS LTD

OAK SURVEYS LIMITED
1 The Orchids
Mersham
Kent, TN25 6PQ Tel: 07792572772

Site: LAND OFF ANYARDS ROAD

Drawing: TOPOGRAPHICAL SURVEY

Drawn by	C.H.	Date	24/01/2023
Scale	1/200 @ A0	Revision	

Drawing No.: Oak_23-034

APPENDIX C

Site Investigation Report

Main Investigation Report

at
Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH

for
Shanly Homes Ltd

Reference: 20737/MIR
June 2023

Control Document

Project
Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH

Document Type
Main Investigation Report

Document Reference
20737/MIR

Document Status
Final

Date
June 2023

Prepared by
D V Tedesco MSc, PhD, ChIta, CEng MICE, RoGEP
[redacted]

C G Swainston BSc, PGCE, CGeol, FGS, CLaireQP, MIAH
[redacted]

First check by
R Biney BSc (Hons) MSc CEng MICE CEnv CSci MIEnvSc MCMI MIET FGS RoGEP
[redacted]

Second check by
Eur Ing R B Higginson BSc, PGDip, CEng, MICE, FGS.
[redacted]

This is not a valid document for use in the design of the project unless it is titled Final in the document status box.

Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Commission

This document comprises the Main Investigation Report (MIR) and incorporates the results, discussion, and conclusions to this intrusive works. General site data is recorded below:

Commission Record	
Client	Shanly Homes Ltd
Site Name	Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH
Grid Reference	TQ 10799 60645
Soils Limited Quotation Ref	Q27527 Rev102 Dated 09/02/2023
Clients Purchase Order	Q27527 Rev102 Dated 09/02/2023

Note(s):

The record of revision to this document is presented below:

Record Of Revisions		
Revision	**Date**	**Reason**

Note(s): The latest revised document supersedes all previous revisions of the MIR produced by Soils Limited.

Documents associated with this development that must be referred to are given below.

Record Of Associated Documents			
Reference	**Type**	**Date**	**Creator**
20737/PIR	Preliminary Investigation Report	March 2023	Soils Limited

Note(s):

Limitations and Disclaimers

The report was prepared solely for the brief described in Section 1.1 of this report.

The contents, recommendations and advice given in the report are subject to the Terms and Conditions given in Soils Limited's Quotation

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the Client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

If the term "competent person" is used in this report or any Soils Limited document, it means an engineering geologist or civil engineer with a minimum of three years post graduate experience in the understanding and application of the appropriate codes of practice.

Unless the site investigation works have been designed and specified in accordance with EC7, this report is a Geotechnical Investigation Report and is not necessarily a Ground Investigation Report as defined by EC7 (Eurocode 7 Part 1, §3.4, Part 2, §6.1) or a Geotechnical Design Report (Eurocode 7 Part 1, §2.8) as defined by Eurocode 7 and as such may not characterise the ground conditions and additional works may be required to comply with the requirements of EC7.

Within the report reference to ground level relates to the site level at the time of the investigation, unless otherwise stated.

Exploratory hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce an exploratory hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The Client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data or any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice were adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The chemical analyses were undertaken by Derwentside Environmental Testing Services (DETS) in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. “Contaminated Land” is defined in Section 57 of the Environment Act 1995 (as updated 2021) as:

“Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused”.

It must be noted that a detailed survey of the possible presence or absence of invasive species, such as Japanese Knotweed, is outside of the scope of investigation.

Deleterious materials may be present in any Made Ground that pose a potential risk to site workers, end users and adjacent vulnerable receptors. These could include a range of contaminants, including asbestos, especially if the material includes large fractions of demolition derived materials.

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible

best practice at the date of preparation of the report. The investigation and report do not address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

All environmental works are undertaken in the context of, and in compliance with, BS10175+A2 2017 and LCRM (EA 2021) and all other pertinent planning, standards, documentation and guidance appropriate to the site at the time of production which may include, but are not necessarily limited to, documents provided by BS/CEN/ISO, NHBC, AGS, CIEH, CIRIA, SoBRA and CLAIRE.

Contents

List of Figures

List of Tables

List of Appendices

Section 1 Introduction

1.1 Objective of Investigation

The Client commissioned Soils Limited to undertake an intrusive ground investigation and to prepare a Main Investigation Report to supply the Client and their designers with information regarding ground conditions, to assist in preparing a foundation scheme for development that was appropriate to the settings present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed development. The investigation was to be made by means of in-situ testing and geotechnical laboratory testing undertaken on soil samples taken from the exploratory holes.

Soil and groundwater samples were to be taken for chemical laboratory testing to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified as dictated by the Conceptual Site Model (CSM) in the Preliminary Investigation Report undertaken for the site by Soils Limited (20737/PIR, March 2023) and/or the Revised Conceptual Site Model presented in Appendix D.1.

1.2 Site Description

At the time Soils Limited visited the site (February 2023), the site comprised private garages and a single storey detached dwelling. The undeveloped areas of the site covering was variable and mainly comprised concrete, tarmac, turf and gravel. Vegetation was limited to grass, former garden areas and remains of former mature trees. The onsite topography was flat, with a <1° dip observed to the west. The wider area gently sloped downwards to the west with a slope angle of <3°. The property was bounded to the west by the terraced houses at 132 – 158 Anyards Road, to the south by the terraced houses at 35 – 51 Copse Road, to the east by the terraced and semi-detached houses at 3 – 23 Copse Road and to the north by the semi-detached houses at 100 – 134 Portsmouth Road.

The site location plan is given in Figure 1. An aerial photograph of the site and its close environs has been included in Figure 2.

1.3 Proposed Development

The feasibility proposal indicated the demolition of the existing structures and the erection or redevelopment of the commercial property to the northwest as commercial ground floor and flats (Plots 21-28), a block of flats (Plots 17-20), terraced housing or flats (Plots 1-8) and 4 semi-detached houses (Plots 9-16). Most plots appear to have either private gardens or open spaces, hardstanding access and parking spaces.

In compiling this report reliance was placed on drawing number AR/Feas/111, dated 1st February 2023 and prepared by Shanly Homes. The recommendations provided within this report are made exclusively in relation to the scheme outlined above, and must not

be applied to any other scheme without further consultation with Soils Limited. Soils Limited must be notified about any change or deviation from the scheme outlined.

Development plans provided by the Client are presented in Appendix G.

1.4 Anticipated Geology

The 1:50,000 BGS map showed the site to be located directly upon the bedrock Bagshot Formation which overlies the London Clay Formation, with overlying superficial deposits of Taplow Gravel Member.

1.4.1 Taplow Gravel Member

The rivers of the south-east of England, including the River Thames and its tributaries, have been subject to at least three changes of level since Pleistocene times. One result has been the formation of a complex series of River Terrace Gravels. These terraces represent ancient floodplain deposits that became isolated as the river cut downwards to lower levels. The Taplow Gravel Formation is found at an elevation that approximates to the present floodplain gravel.

1.4.2 Bagshot Formation

Bagshot Formation comprises mainly fine grained yellow, pink and brown sand with ferruginous concretions. Beds of grey clay "pipe clay" occur frequently as do beds of black flint gravel.

1.4.3 London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of gypsum (Selenite) are often found within the weathered part of the London Clay, and precautions against sulphate attack to concrete are sometimes required.

The upper boundary member of the London Clay Formation is known as the Claygate Member and marks the transition between the deep water, predominantly clay environment and succeeding shallow-water, sand environment of the Bagshot Formation.

The lower boundary is generally marked by a thin bed of well-rounded flint gravel and/or a glauconitic horizon. The formation overlies the Harwich Formation or where the Harwich Formation is absent the Lambeth Group.

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed residential development. The intended investigation, as outlined within the Soils Limited quotation (Q27527 Rev102, dated 9th February 2023), was to comprise the following items:

- Service clearance of the proposed locations via CAT scanning
- 8No. windowless sampler boreholes and dynamic probes, maximum 5.00m deep
- 3No. gas and groundwater monitoring wells
- 3No. gas and groundwater monitoring visits
- CBR testing using the TRL DCP
- 2No. infiltration tests compliant to BRE365:2016
- Geotechnical laboratory testing
- Contamination laboratory testing including 2No. WAC tests.

2.1.1 Actual Project Works

The actual project works were undertaken between 27th February and 3rd March 2023, with subsequent sample logging, laboratory testing, monitoring, and reporting. The actual works comprised:

- Service clearance of the proposed locations via CAT scanning
- 8No. windowless sampler boreholes, 3.70m to 5.40m deep
- 8No. dynamic probes, 6.00m deep
- 3No. gas and groundwater monitoring wells, 2.70m o 5.00m deep
- 9No. CBR tests using the TRL DCP, 0.42m to 0.93m deep
- 2No. infiltration tests compliant to BRE365:2016
- 1No. percolation test
- Geotechnical laboratory testing
- Contamination laboratory testing including 2No. WAC tests.

Three windowless sampler boreholes (WS1, WS4 and WS6) were backfilled with gravel and bentonite following the installation of monitoring wells. The remaining five boreholes (WS2, WS3, WS5, WS7 and WS8) were backfilled with gravel.

Two machine excavated trial pits for the undertaking of infiltration tests (TPSK1 and TPSK2) and one hand excavated trial pit (Perc1) for the development of a percolation test were backfilled with arisings

All exploratory hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged and sub sampled so that samples could be sent to the laboratory for both contamination and geotechnical testing.

2.2 Ground Conditions

On 27th February 2023 eight windowless sampler boreholes (WS1 – WS8) were drilled, using a Premier 110 Compact drilling rig, to depths ranging between 3.70m (WS3) and 5.40m (WS6) below ground level (bgl) at locations selected by Soils Limited using a development plan provided by the Client.

One standpipe per hole was installed within window sample borehole locations (WS1, WS4 and WS6) to allow for continued monitoring of both groundwater and ground gas, where present.

Eight super heavy dynamic probes, (DP1 – DP8) were driven prior and adjacent to their corresponding windowless sampler borehole to a depth of 6.00m bgl.

Two trial pits (TPSK1 and TPSK2) were machine excavated between 2nd and 3rd March 2023 to depths of 1.50m (TPSK2) and 1.80m bgl (TPSK1). One trial pit (Perc1) was hand excavated to a depth of 0.80m bgl on 2nd March 2023.

Nine DCP tests (DCP1-DCP5 and DCP7-DCP10) were also conducted across the site to depths of up to 1.00m bgl.

The maximum depths of exploratory holes have been included in Table 2.1.

Table 2.1 Final Depth of Exploratory Holes

Exploratory Hole	Depth (m bgl)	Exploratory Hole	Depth (m bgl)
WS1[w]	3.80	DP5	6.00
WS2	5.00	DP6	6.00
WS3	3.70	DP7	6.00
WS4[w]	5.00	DP8	6.00
WS5	5.00	DCP1	0.928
WS6[w]	5.40	DCP2	0.875
WS7	4.80	DCP3	0.425
WS8	4.50	DCP4	0.875
TPSK1	1.80	DCP5	0.875
TPSK2	1.50	DCP7	0.875
Perc1	0.80	DCP8	0.875
DP1	6.00	DCP9	0.928
DP2	6.00	DCP10	0.928
DP3	6.00	DCP9	0.928
DP4	6.00		
Notes:			

The approximate exploratory hole locations are shown on Figure 3.

All exploratory holes were scanned with a Cable Avoidance Tool (C.A.T.) and GENNY prior to excavation to ensure the health and safety of the operatives.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the exploratory hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference must be made to the detailed records given within Appendix B, but for the purposes of discussion, the succession of conditions encountered in the exploratory holes in descending order can be summarised as:

Made Ground (MG)
Taplow Gravel Member (TPGR) – Not encountered
Bagshot Formation (BGS)
London Clay Formation (LCF)

The ground conditions encountered in the exploratory holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
	Top	Bottom		
MG	GL	0.30 – 0.80	0.50	Soft, dark brown mottled black, slightly gravelly, slightly sandy CLAY overlain by tarmac/construction gravel and multicoloured sandy GRAVEL to the west of the site. Gravel was flint, brick, concrete, clinker, tarmac, glass, ash and charcoal.
BGS	0.30 – 0.80	3.70[1] – 5.00	4.20	Soft, yellowish brown, orangish brown, greenish grey and light grey mottled, sandy CLAY over clayey SAND, gravelly SAND and sandy GRAVEL horizons.
LCF	4.20 – 5.00	5.00[1] – 6.00[13]	Not proven[2]	Soft to firm, grey sandy CLAY.

Note(s): [1] Final depth of exploratory hole. [2] Base of strata not encountered. [3] Inferred from dynamic probing. The depths given in this table are taken from the ground level on-site at the time of investigation.

2.3 Ground Conditions Encountered in Exploratory Holes

The ground conditions encountered in exploratory holes have been described below in descending order. The engineering logs are presented in Appendix B.1.

2.3.1 Made Ground

Soils described as Made Ground were encountered in ten out of the eleven exploratory holes (WS1 – WS6, WS8, TPSK1, TPSK2 and Perc1) from ground level to depths ranging between 0.30m (WS1, WS6 and TPSK2) and 0.80m bgl (WS3). Suspect Made Ground, probably representing reworked soil due to the similarities with the materials observed in the adjacent trial holes, was encountered in one out of the ten exploratory holes (WS7).

The Made Ground comprised soft, dark brown mottled black, slightly gravelly, slightly sandy CLAY overlain by tarmac/construction gravel and multicoloured sandy GRAVEL to the west of the site. Sand was fine to coarse and included rare brick fragments. Gravel was fine to coarse, sub-angular to angular, locally sub-rounded, flint, brick, concrete, clinker, tarmac, glass, ash and charcoal. Occasional brick cobbles.

The established depth of Made Ground found at each exploratory hole location have been included in Table 2.3.

Table 2.3 Established Depth of Made Ground

Exploratory Hole	Depth (m bgl)	Exploratory Hole	Depth (m bgl)
WS1	0.30	TPSK1	0.50
WS2	0.70	TPSK2	0.30
WS3	0.80	Perc1	0.40
WS4	0.60	-	-
WS5	0.40	-	-
WS6	0.30	-	-
WS7	0.50[2]	-	-
WS8	0.50	-	-

Note(s): [1] Final depth of exploratory hole. [2] Suspected Made Ground.

2.3.2 Bagshot Formation

Soils described as Bagshot Formation were encountered each of the eleven exploratory holes (WS1 – WS8, TPSK1, TPSK2 and Perc1) from directly below the Made Ground to depths ranging between 1.50m (the final depth of TPSK2) and 5.00m bgl (WS6 and the final depth of WS2 and WS4). The presence of the soils of the Bagshot Formation was also inferred from the results of dynamic probing to depths ranging between 4.20m (WS8) and 5.00m bgl (WS2, WS4 and WS6).

The Bagshot Formation typically comprised soft, yellowish brown, orangish brown, greenish grey and light grey mottled, sandy CLAY over clayey SAND, gravelly SAND and sandy GRAVEL horizons. Sand was fine to coarse. Gravel was fine to coarse, sub-rounded to sub-angular, medium flint.

The established depth of Bagshot Formation found at each exploratory hole location have been included in Table 2.4.

Table 2.4 Established Depth of Bagshot Formation

Exploratory Hole	Depth (m bgl)	Exploratory Hole	Depth (m bgl)
WS1/DP1	3.80[1]/4.90	TPSK1	1.80[1]
WS2/DP2	5.00[1]/5.00	TPSK2	1.50[1]
WS3/DP3	3.70[1]/4.50	Perc1	0.80[1]
WS4/DP4	5.00[1]/5.00	-	-
WS5/DP5	4.60/4.60	-	-
WS6/DP6	5.00/5.00	-	-
WS7/DP7	4.50/4.50	-	-
WS8/DP8	4.20/4.20	-	-

Note(s): [1] Final depth of exploratory hole. [2] Inferred from the results of dynamic probing.

2.3.3 London Clay Formation

Soils described as London Clay Formation were encountered in four out of the ten exploratory holes (WS5 – WS8) from directly below the Bagshot Formation to the final investigated depths ranging between 4.50m (WS8) and 5.40m bgl (WS6). The presence of the soils of the London Clay Formation was also inferred from the results of dynamic probing to the final investigated depth of 6.00m bgl.

The London Clay Formation typically comprised soft to firm, grey sandy CLAY. Sand was fine to medium.

The established depth of London Clay Formation found at each exploratory hole location have been included in Table 2.5.

Table 2.5 Established Depth of London Clay Formation

Exploratory Hole	Depth (m bgl)	Exploratory Hole	Depth (m bgl)
WS1/DP1	-/6.00[1]	TPSK1	Not encountered
WS2/DP2	-/6.00[1]	TPSK2	Not encountered
WS3/DP3	-/6.00[1]	Perc1	Not encountered
WS4/DP4	-/6.00[1]	-	-
WS5/DP5	5.00[1]/6.00[1]	-	-
WS6/DP6	5.40[1]/6.00[1]	-	-
WS7/DP7	4.80[1]/6.00[1]	-	-
WS8/DP8	4.50[1]/6.00[1]	-	-

Note(s): [1] Final depth of exploratory hole. [2] Inferred from the results of dynamic probing.

2.4 Roots

Roots were encountered in nine out of the eleven exploratory holes at depths ranging between 0.80m (WS3 and Perc1) and 1.50m bgl (TPSK2). The established depth of root penetration found at the exploratory hole locations has been included in Table 2.6.

Table 2.6 Established Depth of Root Penetration

Exploratory Hole	Depth (m bgl)	Exploratory Hole	Depth (m bgl)
W S1	Not encountered	TPSK1	Not encountered
WS2	1.20	TPSK2	1.50
WS3	0.80	Perc1	0.80[1]
WS4	1.00	-	-
WS5	1.20	-	-
WS6	1.00	-	-
WS7	1.00	-	-
WS8	1.00	-	-

Note: [1] Final depth of exploratory hole

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. A direct observation such as from within a trial pit is necessary to gain a better indication of the maximum root depth.

2.5 Groundwater

Groundwater was encountered within nine of the ten exploratory holes (WS1 – WS8, TPSK1 and TPSK2) at depths ranging between 1.40m and 2.00m bgl during the drilling works and at depths between 0.32m and 1.42m bgl during the groundwater monitoring.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage, tidal effects. The investigation was conducted in February and April (2023), when groundwater levels should be approaching their annual maximum (highest) elevation, which typically occurs around March.

Further groundwater monitoring was conducted within the standpipes installed on site following completion of site works. Groundwater monitoring was complete, and the results have been presented in Table 2.7.

The groundwater details as encountered during the site works and monitoring to date are presented in Table 2.7.

Table 2.7 Groundwater Record

Trial Hole	Well Depth (m bgl)	Depth to Water (m bgl)			
		8/03/2023	13.03.23	14.03.23	04.04.23
W S1	2.80	1.80[12]	1.42	0.57	0.51
WS 4	5.00	2.00[1]/1.40[2]	1.25	0.95	0.60
WS 6	5.00	2.00[1]/1.40[2]	0.99	0.70	0.32
WS2	None	2.00[1]/1.40[2]		No installation	
WS3	None	1.90[1]/1.50[2]		No installation	

Trial Hole	Well Depth (m bgl)	Depth to Water (m bgl)			
		8/03/2023	13.03.23	14.03.23	04.04.23
WS5	None	1.80[1]/1.40[2]		No installation	
WS6	None	2.00[1]/1.40[2]		No installation	
WS7	None	2.00[1]/1.40[2]		No installation	
WS8	None	2.00[1]/1.80[2]		No installation	
TPSK1	None	1.80[3]		No installation	
TPSK2	None	Dry at 1.50		No installation	
Perc1	None	Dry at 0.80		No installation	

Note: [1] Groundwater strike. [2] Groundwater level after 20/30mins of ceased drilling. Groundwater level observed.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells.

Section 3 Geotechnical In-Situ and Laboratory Testing

3.1 Dynamic Probe Tests

The results were converted to equivalent SPT "N60" values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix C.1,Table C.1.1 to **Error! Reference source not found.**.

Table 3.1 SPT Hammer Efficiency

Rig Reference	Energy Ratio Er (%)
Premier 1 (110-60)	90.25
Premier 3 (110-105)	87.45

Table 3.2 Inferred SPT Interpretation

Strata	Inferred N60 Range	Cohesive Soils Classification	Inferred Cohesion
Bagshot Formation	0 – 17	Extremely low to medium	<10 – 85
London Clay Formation	8 – 29	Medium to high	40 – 145
Strata	**Inferred N60 Range**	**Granular Soils Classification**	**Relative Density**
Bagshot Formation	0 - >50		Very loose to very dense

Note(s): SPT "N60" values presented have been corrected in accordance with BS EN 22476 Part 3

A full interpretation of the DPSH tests, are outlined in Appendix C.2, Table C.2.1.

3.2 Dynamic Cone Penetrometer Tests

The Transport Research Laboratory (TRL), Dynamic Cone Penetrometer (DCP) was undertaken at nine locations (DCP1 – DCP5, DCP7 – DCP10). The results were interpreted based on the classification outlined in Appendix C.1.

The results from DCP testing indicated CBR values of between 3% and 104% for the soils encountered in the top 0.425m – 0.928m bgl. The high CBR values encountered were anticipated to be large gravel clasts or Made Ground inclusions struck during the test.

The DCP results are presented in Appendix C.3.

3.3 Infiltration Tests

Infiltration testing was undertaken in TPSK1 and TPSK2 within the Bagshot Formation following the principles of BRE Digest 365 Soakaway design: 1991

A single test was carried in TPSK1 and TPSK2 due to insufficient infiltration within the test time to permit three test cycles as required by the Code.

3.4 Percolation Tests

One percolation test was undertaken within Perc1. No results can be provided due to insufficient infiltration.

3.5 Atterberg Limit Tests

Atterberg Limit tests were performed on nine samples, eight obtained from the Bagshot Formation and the remaining one from the London Clay Formation. The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

Table 3.2 Atterberg Limit Results Classification

Strata	Depth (m bgl)	Classification	
		NHBC	BRE 240
BGS	0.50	Medium	Medium
	1.60	Medium	Medium
	1.50	Medium	Medium
	0.60	Medium	Medium
	0.50	Medium	Medium
	0.80	Medium	Medium
	0.90	Medium	Medium
	0.50	Medium	Medium
LCF	4.60	Medium	Medium

A full interpretation of the Atterberg Limit tests, are outlined in Table C.2.2, Appendix C.2 and the laboratory report in Appendix C.3.

3.6 Particle Size Distribution Tests

Particle Size Distribution (PSD) tests were performed on four samples from the Bagshot Formation.

Table 3.2 Particle Size Distribution Classification

Strata	Depth (m bgl)	Classification	
		NHBC	BRE 240
BGS	1.20-1.40	Yes	No
	2.40-3.40	No	No
	1.70-2.00	No	No
	3.20-3.70	No	No

Note that a cohesive soil is only classified as having a volume change potential if it is also plastic and an Atterberg Limit test can be conducted on the strata.

A full interpretation of the PSD tests, are outlined in Table C.2.3, Appendix C.2 and the laboratory report in Appendix C.3.

3.7 Sulphate and pH Tests

Water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'.

Table 3.2 Sulphate and pH Test Results

Strata	Depth (m bgl)	Sulphate Concentration (mg/l)	pH
MG	0.20 -0.40	307	8.5
	0.20	12	6.0
BGS	0.90	<10	7.1
	1.90	<10	7.2
	1.40	15	7.0
	3.50	<10	6.9
	2.20	10	6.5
	1.20	58	5.2
	2.00	14	8.2
LCF	4.30	94	7.4

The significance of the sulphate and pH Test results are discussed in Section 5.2 and the laboratory report in Appendix C.3.

Section 4 Engineering Appraisal

4.1 Established Ground Conditions

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the exploratory holes.

4.1.1 Made Ground and Topsoil

Foundations must not be placed on non-engineered fill unless such use can be justified on the basis of a thorough ground investigation and detailed design. Foundations must be taken through any Topsoil and/or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Soils described as Made Ground were encountered in ten out of the eleven exploratory holes (WS1 – WS6, WS8, TPSK1, TPSK2 and Perc1) from ground level to depths ranging between 0.30m (WS1, WS6 and TPSK2) and 0.80m bgl (WS3). Suspect Made Ground, probably representing reworked soil due to the similarities with the materials observed in the adjacent trial holes, was encountered in one out of the ten exploratory holes (WS7).

4.1.2 Bagshot Formation

Soils described as Bagshot Formation were encountered each of the eleven exploratory holes (WS1 – WS8, TPSK1, TPSK2 and Perc1) from directly below the Made Ground to depths ranging between 1.50m (the final depth of TPSK2) and 5.00m bgl (WS6 and the final depth of WS2 and WS4). The presence of the soils of the Bagshot Formation was also inferred from the results of dynamic probing to depths ranging between 4.20m (WS8) and 5.00m bgl (WS2, WS4 and WS6).

Soils of the Bagshot Formation are predominantly granular soils and as such are expected to display moderate bearing capacities with moderate settlement characteristics. It is recommended to avoid setting the foundations within the cohesive lenses of the Bagshot Formation encountered below the Made Ground. The granular soils of the Bagshot Formation were considered as a suitable foundation layer for the proposed development.

4.1.3 London Clay Formation

Soils described as London Clay Formation were encountered in four out of the ten exploratory holes (WS5 – WS8) from directly below the Bagshot Formation to the final investigated depths ranging between 4.50m (WS8) and 5.40m bgl (WS6). The presence of the soils of the London Clay Formation was also inferred from the results of dynamic probing to the final investigated depth of 6.00m bgl.

Soils of the London Clay Formation are overconsolidated, predominantly cohesive soils and as such are expected to display moderate bearing capacities with moderate settlement characteristics at this specific site. The soils of the London Clay Formation were considered as a suitable foundation layer for the proposed development in the case

of the adoption of piled foundations.

4.1.4 Guidance on Shrinkable Soils

The ground conditions were established as Bagshot Formation, with a typical thickness of 4.20m, overlying the London Clay Formation.

The volume change potential for each strata was established and presented in Table 4.1.

Table 4.1 Established Volume Change Potential by Strata

Strata	Volume Change Potential		Established Lower Boundary (m bgl)
	BRE	NHBC	
BGS	Medium	Medium	4.20
LCF	Medium	Medium	Not determined

The overall volume change potential of the soils of the Bagshot Formation was recorded as medium with reference to the tests undertaken on samples from the cohesive beds. Although no volume change potential can be considered for the granular soils of the Bagshot Formation, the presence of cohesive layers or lenses within the predominantly granular matrix cannot be excluded.

4.1.5 Groundwater

Groundwater was encountered within nine of the ten exploratory holes (WS1 – WS8, TPSK1 and TPSK2) at depths ranging between 1.40m and 2.00m bgl during the drilling works and at depths between 0.32m and 1.42m bgl during the groundwater monitoring.

The high groundwater table encountered on this site could impact on the foundation options.

Section 5 Foundation Scheme

5.1 Foundation Recommendations

Foundations **must not** be constructed within any Made Ground/Topsoil and cohesive beds of the Bagshot Formation due to the likely variability and potential for large load induced settlements both total and differential.

Roots were encountered in eight out of the ten exploratory holes at depths ranging between 0.80m (WS3) and 1.50m bgl (TPSK2). If roots are encountered during the construction phase foundations **must not be placed within any live root penetrated** or desiccated **cohesive soils or those with a volume change potential**. Should the foundation excavations reveal such materials, the excavations **must** be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

Considering the type of development, a shallow foundation solution set within the granular soils of the Bagshot Formation was considered the suitable.

Although shallow foundation can be considered suitable for the proposed development albeit without potentially constructional challenges given the given the high groundwater table and the likely rapid nature of flows within the granular horizons.

The proposed development was likely to be both light and brittle. It is therefore considered that foundation design is undertaken using NHBC Standards Chapter 4.2.

5.1.1 Shallow Foundations into the Bagshot Formation

Based on a 5.00 by 0.75m strip foundation and a 1.00 by 1.00m pad footing, using commercial software Table 5.1 and Table 5.2 show the calculated bearing values and anticipated settlement characteristics respectively within the western and eastern portions of the site. The maximum encountered depth of Made Ground and of the underlying unsuitable cohesive soils of the Bagshot Formation was 1.70m bgl to the west and 1.00m bgl to the east of the site. Bearing capacities were calculated below these depths.

Given the groundwater levels on the site the shallowest being 0.32m bgl and likely to have rapid inflow be within the granular horizons, consideration must be given to piled foundation solution.

If foundations are to be constructed in the summer months then the groundwater level may be sufficiently lower to permit the construction of shallow (strip, deep strip) foundations.

Table 5.1 Allowable Bearing Capacities in the Bagshot Formation (West of the Site)

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.70	5.00 x 0.75	130	20
2.00		160	20
2.50		180	25
1.70	1.00 x 1.00	140	20
2.00		170	20
2.50		190	20

Note(s): The above values are applicable to the area of WS1, WS2 and WS3. Further investigation must be undertaken along the proposed footprint to ensure no unsuitable soil was underlying the foundation.

Given the groundwater levels on the site the shallowest being 0.32m bgl and likely to have rapid inflow be within the granular horizons, consideration must be given to piled foundation solution.

If foundations are to be constructed in the summer months then the groundwater level may be sufficiently lower to permit the construction of shallow (strip, deep strip) foundations.

Table 5.2 Allowable Bearing Capacities in the Bagshot Formation (East of the Site)

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.00	5.00 x 0.75	90	20
1.50		110	20
2.00		150	20
2.50		170	20
1.00	1.00 x 1.00	100	20
1.50		120	20
2.00		150	20
2.50		170	20

Note(s): The above values are applicable to the area of WS4, WS5, WS6, WS7 and WS8. Further investigation must be undertaken along the proposed footprint to ensure no unsuitable soil was underlying the foundation.

All foundation formations must be examined, recorded, and signed off by a competent person.

The use of reinforced trench fill foundations reduces the potential for differential settlement affecting the foundations.

For the allowable bearing value given above, settlements should not exceed the presented values, provided that excavation bases are carefully bottomed out and blinded or concreted as soon after excavation as possible and kept dry.

Foundations must not be constructed over former structures and other hard spots. The foundations design must be suitable for the conditions present at the site.

Isolated pad foundations must be kept at least 1.5 times the width of the largest adjacent

pad apart (face to adjacent face) to ensure that their vertical stress “bowls” do not interact. Failure to do so may result in additional settlements.

The anticipated settlement includes both elastic settlement and long-term drained settlement (in the case of cohesive soils).

Anticipated settlements may be taken as proportional to the bearing capacity adopted (for the same configuration of foundation), therefore if the bearing value is halved the anticipated settlement will halve.

All loose material, soft spots and Made Ground must be removed from the base of the excavations. Failure to do so could results in increased settlements.

It has been assumed that the foundations to any existing structures have been grubbed out. Where foundations have been grubbed out the new foundation must be taken through any backfill material into suitable natural ground as outlined in this report.

Piled foundation solution can be considered given the potentially constructional challenges associated with strips foundations and the like.

5.1.2 Pile Foundations

If adopted, the piled foundations should be taken through any Topsoil, Topsoil/Made Ground or Made Ground, Taplow Gravel Formation, and disturbed and/or desiccated ground, below any roots and into the soils of the Bagshot Formation and/or the London Clay Formation.

The construction of a piled foundation is a specialist job, and the advice of a reputable contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the foundation design, as the actual pile working load will depend on the particular type of pile and method of installation.

Should piled foundation solution be adopted then cable percussive boreholes would be required to be drilled to enable testing and sampling at greater depth to obtain parameters aid the design.

5.1.3 Ground Floor Slab

NHBC Standards 2023 states ground floors should be constructed as suspended floors where:

> *“the foundation depth dictated by the NHBC Standards 2023, Chapter 4.2.10 would exceed 1.5m bgl;”*
>
> *“ground floor construction is undertaken when the surface soils are seasonally desiccated;”*
>
> *“the depth of fill exceeds 600mm;”*
>
> *“there is shrinkable soil that could be subject to movement, expansive material or other unstable soils;”*
>
> *“the ground has been subject to vibratory improvement;” or*

"ground or fill is not suitable to support ground-bearing slabs."

The use of suspended floor slabs is recommended within the western portion of the site, where the minimum recommended foundation depth exceeded 1.50m bgl.

In the eastern portion of the site the observed thickness of the Made Ground did not exceed 0.60m bgl. However, there was clay horizon underlying the Made Ground with roots and the former trees, which would dictate the adoption of suspended floor slabs.

Based on the above, suspended floor slabs must be adopted for the entire site.

5.2 Subsurface Concrete

The sulphate and pH tests carried out in accordance with BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground', established the site concrete classifications for each stratum as presented in Table 5.3.

Table 5.3 Concrete Classification

Stratum	Design Sulphate Class	ACEC Class
MG	DS-1	AC-1
BGS	DS-1	AC-3z
LC	DS-1	AC-1

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, *'Concrete in Aggressive Ground'* taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

5.3 Excavations

Shallow excavations in the Made Ground/Topsoil and Bagshot Formation are likely to be marginally stable in the short term at best especially with shallow groundwater being found within the site .

Deeper excavations taken into the Bagshot Formation and London Clay Formation are likely to be unstable and require support. Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions must therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose.

Excavations beneath the groundwater table would be unstable and dewatering of foundation trenches would be necessary. The groundwater table has been found to be high on this site and the flow will be rapid within the granular horizons.

Section 6 Pavements

6.1 Pavements

The Transport Research Laboratory (TRL) Dynamic Cone Penetrometer (DCP) was undertaken at nine locations onsite (DCP1 – DCP5. DCP7 – DCP10). The results from dynamic cone penetrometer tests indicated **CBR values of between 3% and 104%** for the soils encountered in the top 0.425m – 0.928m bgl. The high CBR values encountered were anticipated to be large gravel clasts struck during the test.

When removing 700mm of either Made Ground or Bagshot Formation the worst case CBR value was 7% which was considered suitable for design purposes for the majority of the road layout. During the interpretation the areas of DCP4, DCP5 and DCP7 were highlighted as potentially problematic with CBR values of 4% persisting to 0.875mm.

As CBR values were highly variable due to changes in moisture content and ground conditions, **in-situ testing must be undertaken** immediately prior to the installation of pavements/roads. Any soft spots at formation level, as identified in the areas around DCP4, DCP5 and DCP7, must be dug out and replaced with a suitably compacted granular fill. Prior to construction the formation level must be proof rolled.

The shallow cohesive soils of the Bagshot Formation were regarded as non-frost-susceptible as their plasticity index was >20%.

The overall thickness of the pavement will be dictated by the frost susceptibly of the sub-grade.

Section 7 Site Drainage

7.1 Soakaways

The results of in-situ infiltration and percolation tests showed poor infiltration rates within the soils of the Bagshot Formation in the top 0.80m – 1.80m bgl. These indicate the Bagshot Formation to be of poor drainage characteristics.

It is recommended that the results of the in-situ permeability testing are passed to a drainage engineer for commentary and design.

Section 8 Determination of Chemical Analysis

8.1 Site Characterisation and Revised Conceptual Site Model

The Preliminary Investigation Report undertaken by Soils Limited (report ref: 20737/PIR, March 2023) identified a low to very low risk of ground contamination in general except from the Asbestos noted in the garage areas (and possibly in other structures) to which a high risk had been assigned and regarding which specialist advice should be retained to comply with current guidance and legislation.

The Contamination Investigation identified Made Ground to depths between 0.30m and 0.80m bgl. Potential hydrocarbon type odours were identified in WS1, WS3 and TP1.

Superficial deposits of Bagshot Formation were encountered underlying the Made Ground. Shallow groundwater was encountered within the Made Ground and Bagshot Formation. The conceptual site model was updated to take account of the shallow groundwater encountered at the site and is presented in Appendix D.1.

The groundwater flow direction was shown, by groundwater levelling and plotting, to be in a northerly direction, based on monitoring undertaken. A groundwater flow direction map is presented in Figure 4.

8.2 Soil Sampling

Exploratory hole locations were established to provide an overview of ground conditions across the site in relation to the proposed construction, together with enabling the collection of samples to enable chemical characterisation of the underlying strata. Representative samples for potential environmental testing were obtained from the exploratory holes to allow appropriate representation of the materials encountered, with additional samples to be obtained, if necessary, where there was visual or olfactory evidence of contamination (WS1 0.90, WS3 0.60m and TP1 0.40m).

Unless otherwise stated, analytical testing was based initially on a screening suite of commonly identified inorganic and organic contaminants, taking into account the prevailing site conditions and the findings of the initial conceptual site model.

8.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Preliminary Investigation and Contamination intrusive investigation.

The driver for determination of the analysis suite was the information obtained from the Preliminary Investigation Report and Contamination Investigation Report intrusive investigation.

The chemical analyses were carried out on 9 samples of Made Ground (MG) and 1 sample of the underlying Bagshot Formation (BGS), with the latter evidencing olfactory

indications of hydrocarbons as noted on the logs. The nature of the analyses is detailed in Table 8.1.

Table 8.1 Chemical Analyses Suites - Soil

No. of Tests	Determinants	Soil Tested	
		MG	BGS
6	Metal suites: Arsenic, Boron (Water Soluble), Cadmium, Chromium (total & hexavalent), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc		
6	Organic Matter		
8	pH		
7	Polycyclic aromatic hydrocarbons (PAH) – (EPA 16)		
6	Phenols – total monohydric		
8	Extractable petroleum hydrocarbons (EPH) – Texas banding		
1	Extractable petroleum hydrocarbons (EPH) – Texas banding		
6	Cyanide total & free		
2	Waste acceptance criteria (WAC)		
6	Asbestos screening		

The soil testing was carried out in compliance with the MCERTS performance standard, and the results are shown in Appendix D.2, test reports 23-03360.

The groundwater chemical analysis was carried on 3No, samples, with the nature of the analyses detailed in Table 8.2.

Table 8.2 Chemical Analyses Suites - W ater

No. of Tests	Determinants
3	Metal suites: Arsenic, Boron, Cadmium, Chromium (total & hexavalent), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc
3	Total organic carbon (TOC)
3	pH
3	Polycyclic aromatic hydrocarbons (PAH) – (EPA 16)
3	Phenols – total monohydric
3	Cyanide total & free
3	Total petroleum hydrocarbons (TPH) – CWG banding
3	BTEX and MTBE
3	Hardness – total (as $CaCO_3$)
3	Dissolved oxygen
3	Semi-volatile organic compounds (SVOC)
3	Volatile organic compounds (VOC)

The groundwater test report 23-04796 is presented in Appendix D.2.

Section 9 Qualitative Risk Assessment

9.1 Assessment Criteria

The assessment criteria used to determine risks to human health are derived and explained within Appendix D.3.

9.2 Representative Contamination Criteria - Soil

In compiling this report reliance was placed on drawing AR/Feas/111 for Shanly Homes dated 01.02.2023. The recommendations provided within this report are made exclusively in relation to the scheme outlined above and must not be applied to any other scheme without further consultation with Soils Limited. Soils Limited must be notified about any change or deviation from the scheme outlined and for planning approval purposes will have to be considered and revised in light of the final plans presented in support of the application.

Based on the proposed development, the results of the chemical analysis have been compared against generic assessment criteria (GAC) for a '***Residential with home grown produce'*** end use, as presented in SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination December 2014 (C4SL), derived for the protection of human health. Where this document has not published screening values for determinants, GACs derived for the same end use have been adopted from the following published guidance; DEFRA Soil Guideline Values (SGV) and LQM/CIEH/Suitable 4 Use Level (S4UL).

To assess the potential toxicity of organic determinants (Petroleum Hydrocarbons and Polyaromatic Hydrocarbons) to the human health, soils samples were analysed for Soil Organic Matter (SOM). The selected samples analysed recorded, SOM values of between 2.2% and 5.6%. For each soil sample tested, the resultant SOM allowed for the correct comparison to be made with the appropriate guideline value for each organic determinants analysed.

9.3 Risk Assessment – Made Ground

Table 9.1 outlines the sample that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix D.2.

Table 9.1 Summary of GAC Exceedances – Made Ground

Location	Depth (m bgl)	Contaminant	Concentration	Guidance Level
WS2	0.20-0.40	Lead	365	210
WS5	0.20	Lead	213	210
WS8	0.20-0.40	Lead	247	210

Location	Depth (m bgl)	Contaminant	Concentration	Guidance Level
WS8	0.20-0.40	Benzo(a)pyrene	13.8	5
WS8	0.20-0.40	Benzo(b)fluoranthene	17.5	3.3
WS8	0.20-0.40	Di-benzo(a,h)anthracene	1.67	0.28

Note(s): Units mg/kg

The risk assessment has established potential pollutant linkages in relation to human health from an elevated Lead concentrations at several locations in the Made Ground (WS2, WS5 and WS8) and a probable PAH outlier in Made Ground at WS8. None of the underlying superficial materials indicated any exceedance for the reported analytes.

The elevated Lead is probably in an insoluble form most likely associated with the Glass and Clinker noted in the logs and does not appear to be systematic across the site or Made Ground. Most relict Lead (as opposed to depositional Lead from vehicle emissions etc.) would be expected to be sporadic in nature as relict outliers and fragments which indeed appears to be the case at this site.

As such the Lead levels may not actually be significant in context as they are unlikely to be significantly bioavailable. This appears to be confirmed in the WAC/Leachate analysis undertaken on two samples (WS02 and WS05) both with elevated levels which record no leachable Lead in excess of the method limit <0.05mg/kg. This generally also equates to a very low bioavailability and generation of no risk allowable or remediation values of around 450mg/kg, which is in excess of all noted values to date and co-incidentally approximated to the previous EA guideline value for residential site use.

Recommendations in relation to this material are made in Section 9.9.

9.4 Risk Assessment – Bagshot Formation

Table 9.2 outlines the samples that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix D.2.

Table 9.2 Summary of GAC Exceedances – Bagshot Formation

Location	Depth (m bgl)	Contaminant	Concentration	Guidance Level
None				

Note(s): Units mg/kg

The risk assessment has established no potential pollutant linkage in relation to human health from the samples analysed within the Bagshot Formation.

9.5 Asbestos

The test certificate for each sample submitted for contamination analysis during this investigation includes the results of an Asbestos Screen.

In each case ‘Not detected’ was reported.

This finding does not obviate the risk of asbestos being present on the site and the Client must seek advice from qualified and competent asbestos specialist during and prior to undertaking works to ensure compliance with appropriate legislation and guidance.

9.6 Risk to Groundwater

The site is located on a Principal Aquifer (Taplow Gravel) overlying Secondary A Aquifer (Bagshot Formation) and is not within a groundwater source protection zone and there are no potable groundwater abstractions within 1km of the site, the closest is located 927m NW of the site and is for agricultural purposes.

The groundwater flow was established to be in a northerly direction based on groundwater levelling and plotting.

The nearest surface watercourse feature was an un-named Inland River (Thames Catchment), located approximately 26m to the northwest of the site.

An initial assessment of the risk to controlled waters has been conducted on the basis of the groundwater testing undertaken.

The chemical laboratory results were compared against the Surface Fresh Water (SFW). If no SFW was available, standards from the UK Drinking Water Standard (DWS) were used, and if no DWS was available, standards from the World Health Organisation (WHO) were used.

Groundwater samples were recovered from the standpipes installed within WS01, WS04 and WS06 to establish whether groundwater on site had been impacted.

Based on the depths of groundwater, the hydraulic gradient of the site has been calculated as flowing in a northerly direction.

Error! Reference source not found.3 outlines the samples that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix D.2

Table 9.3 Summary of Chemical Analysis for Groundwater Samples Exceedances

Location	Contaminant	Concentration	Guidance Value
WS01	Chromium	10	4.7
WS01	Lead	56	7.2
WS04	Lead	153	7.2
WS06	Nickel	24	20
WS01	Vanadium	22	20
WS01	Zinc	95	75
WS01	Fluoranthene	1.47	1
WS01	Benzo(b)fluoranthene	1.51	0.03
WS01	Benzo(k)fluoranthene	1.01	0.03
WS01	Benzo(a)pyrene	1.57	0.05

Note(s): Units µg/l

The groundwater chemical testing has identified a range of determinands in WS01, WS04 and WS06, which were over their guideline values.

PAHs (fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene and benzo(a)pyrene) were found in WS01 and none within WS04, and given that WS01 was located within the southwest portion of the site up hydraulic gradient, this was likely to be due to an offsite source. Although PAHs were found on the site at the location of WS08 which was northeastern portion of the site, none at the location where the groundwater was impacted with PAHs.

Chromium, vanadium and zinc were found in WS01 and none within WS04, which implied that the source of these contaminants is likely to be from an offsite source.

Nickel was found to be over the screening value in WS06 which was located within the southeast portion of the site up the hydraulic gradient, and none within WS04 down the hydraulic gradient. This implied that the presence of nickel within the groundwater was likely due to an offsite source.

Lead was found within WS01 (up hydraulic gradient with concentration of 56µg/l) and WS04 (down hydraulic gradient with concentration of 153µg/l), which implied that the site was likely contributing to the groundwater contamination. Although, lead was found within the Made Ground on the site in WS02, WS05 and WS08, the leachate analysis as part of WAC testing showed the lead was not leachable, and therefore, it was considered unlikely to have been impacted by the Made Ground. Given the former and historical use of the site being domestic garages, it is possible that lead from localised sources, such as broken up car batteries, could be the source, however, this was considered to be low likelihood. Based on the above, the source of the lead was inconclusive, and therefore, further groundwater assessment was considered necessary.

9.7 Risk from Ground Gas Ingression

Potential sources of ground gas within influencing distance of the site identified within the CSM comprise:

On Site Made Ground

Local Garages

Risk from on-site sources is confirmed as low to very low as no significant sources have been identified or confirmed during this investigation. However, the client requested 3no monitoring to be undertaken as a precautionary measure.

The summary of the gas monitoring is presented in Table 9.4. and the field data provided in Appendix E.

Table 9.4 Ground Gas Monitoring Results

Date	Pressure Trend	WS (BOH mbgl)	CH_4 (%)	CO_2 (%)	O_2 (%)	H_2S (ppm)	CO (ppm)	LEL (%)	aP (mb)	Flow (l/h)	H_2O (m bgl)
03/03/23	Rising	ATM	0.0	0.0	21.5	0.0	0.0	0.0	1026	N/A	N/A
		WS1 (2.21)	0.0	0.1	21.4	0.0	10	0.0	1026	0.0	1.42
		WS4 (3.60)	0.0	3.1	13.9	0.0	0.0	0.0	1026	0.0	1.25
		WS6 (2.85)	0.0	0.0	21.7	0.0	3.0	0.0	1025	0.0	0.99
14/03/13	Rising	ATM	0.0	0.0	21.1	0.0	0.0	0.0	999	N/A	N/A
		WS1 (2.10)	0.0	0.0	19.3	0.0	0.0	0.0	998	0.0	0.57
		WS4 (3.60)	0.0	1.9	18.3	0.0	0.0	0.0	997	0.0	0.95
		WS6 (2.90)	0.0	0.0	21.0	0.0	0.0	0.0	1000	0.0	0.70
04/04/23	Falling	ATM	0.0	0.0	20.4	0.0	0.0	0.0	1027	N/A	N/A
		WS1 (2.01)	0.0	0.0	20.8	0.0	0.0	0.0	1026	0.0	0.51
		WS4 (3.39)	0.0	0.4	19.1	0.0	0.0	0.0	1027	0.4	0.60
		WS6 (2.86)	0.0	0.0	20.7	0.0	2.0	0.0	1025	0.0	0.32
Minimum			*0.0*	*0.0*	*13.9*	*0.0*	*0.0*	*0.0*	*997*	*0.0*	*0.32*
Maximum			*0.0*	*3.1*	*21.7*	*0.0*	*0.0*	*0.0*	*1027*	*0.4*	*1.42*

Note: reading of 0.0 = not detected (below detection level). VOC=Volatile Organic Compounds. Dp=Pressure Difference. BOH = Base of Hole. BOH=Base of Hole. DAB=Damp at Base. The pressure trend was obtained from a weather station at Cobham.

A maximum carbon dioxide concentration of 3.1% has been recorded. No methane concentrations have been recorded above the Level of Detection (LoD) and negligible flow rates have been observed, with a peak of 0.4 litres/hour recorded.

Using the worst-case values, a carbon dioxide Gas Screening Value (GSV) of 0.0124 l/h has been calculated.

Based on the GSVs derived and the method for determining the CS presented within Table 2 of BS8485:2015, the site has been characterised as CS1, where the installation of gas protection measures will not be required.

Given that there was no significant source and that the risk from ground gas has been considered as low to very low, and the fact that no significant ground gas has been found with the initial monitoring, it was therefore considered no further monitoring was considered necessary and no remediation was deemed necessary. However, the regulators must be consulted before finalising foundation design.

9.7.1 Radon

As noted in the Soils Limited PIR, the BGS Radon interactive Atlas accessed in March 2023 indicated that the site is not located in a radon affected area. Risk is between 0 and <1% that a property will be in excess of the guideline value. No Radon protection measures would be anticipated in new developments or extensions.

9.8 Generic Quantitative Risk Assessment

Quantitative risk assessments are undertaken for soil, groundwater and ground gas. The CSM has been updated to take account of the assessments below and presented in Appendix D.1. The full laboratory chemical report is presented in Appendix D.2.

9.8.1 Soils

The Tier 1 Quantitative risk assessment has established that there was a **potential risk to human health receptors** from Lead and PAH's.

This risk is considered low overall and may be related in the case of PAHs to a single hotspot, possibly as relict Tarmac or clinker as the PAH ratio analysis indicates Coal Tar materials as the source. This will require further investigation and/or mitigation agreement with the regulator to resolve.

It is also probable that the elevated Lead may not actually be significant in context but again this would require the agreement of the regulator and may require additional investigation and analysis to confirm as it remains unknown and unquantified.

9.8.2 Asbestos

Asbestos was not detected in any of the soil samples analysed. However, asbestos could be encountered in other parts of the site.

There was asbestos associated with the structures onsite (domestic garages). Asbestos risk assessment / removal must be undertaken by professional competent person in agreement with regulators.

9.8.3 Groundwater

The Groundwater Risk Assessment has established the groundwater underlying the site has been impacted by lead from likely onsite source and further groundwater assessment was required to establish whether remediation is necessary.

9.8.4 Ground Gas

The ground gas risk assessment established that ground gas was unlikely to be an issue to the site and the no ground gas protection was considered necessary. However, agreement with the regulator would be required.

As noted in the Soils Limited PIR, the BGS Radon interactive Atlas accessed in March 2023 indicated that the site is not located in a radon affected area. No Radon protection measures would be anticipated in new developments or extensions.

9.9 Recommendations

Soil chemical analysis recorded three samples with substance levels over their representative guideline values. Therefore, there was a risk to the Human Health receptors, which could require agreement of a remediation strategy or additional investigation and analysis.

The remedial objective for any site is to ensure site clean-up removes any unacceptable risk to the identified receptors. In essence the remedial objective must sever any source-pathway-receptor pollutant linkages that have been established. Once this has been achieved, by whatever means, there can theoretically be no risk.

There was asbestos associated with the structures onsite (domestic garages). Asbestos

risk assessment / removal must be undertaken by professional competent person in agreement with regulators.

The groundwater underlying the site was impacted by lead from likely onsite source and further groundwater assessment was required to establish whether remediation is necessary.

9.10 Protection of Services

Contamination of the ground may pose a risk to human health by permeating potable water supply pipes. To fulfil their statutory obligations, UK water supply companies require robust evidence from developers to demonstrate either that the ground in which new plastic supply pipes will be laid is free from contaminants specified in UKWIR Report 10/WM/03/21 Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (UKWIR, 2010), or that the proposed remedial strategy will mitigate any existing risk.

9.11 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

9.12 Excavated Material

Excavated material as waste must be defined or classified prior to any disposal, transport, recycling or re-use at or by an appropriately licensed or exempt carrier and/or off-site disposal facility. The requirements inherent in both Duty of Care and Health and Safety must also be complied with. In order to determine what is to happen, what is suitable, appropriate and most effective in the disposal of wastes, especially those subject to CDM waste management plan requirements, several factors must be considered, and competent advice must always be sought.

9.13 HazWasteOnline

The waste classification tool HazWasteOnlineTM was used on the entire data set to provide a general indication for future waste removal. The samples were all classified as Non-Hazardous, with the HazWasteOnlineTM report being presented in Appendix G. The WAC certificate is presented in Appendix E.2, within Test Report 23-0660.1, and also indicated that the materials analysed could be suitable for disposal at a landfill capable of receiving inert wastes.

9.14 Re-use of Excavated Material On-site

The re-use of on-site soils may be undertaken either under the Environmental Permitting Regulations 2007 (EPR), in which case soils other than uncontaminated soils are classed as waste, or under the CL:AIRE Voluntary Code of Practice (CoP) which was published in September 2008 and is accepted as an alternative regime to the EPR.

9.15 Imported Material

Any soil, which is to be imported onto the site, must undergo chemical analysis to permit classification prior to its importation and placement in order to ascertain its status with specific regard to contamination, i.e. to prove that it is suitable for the purpose for which it is intended.

9.16 Discovery Strategy

There may be areas of contamination not identified during the course of the investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

List of Figures

List of Appendices

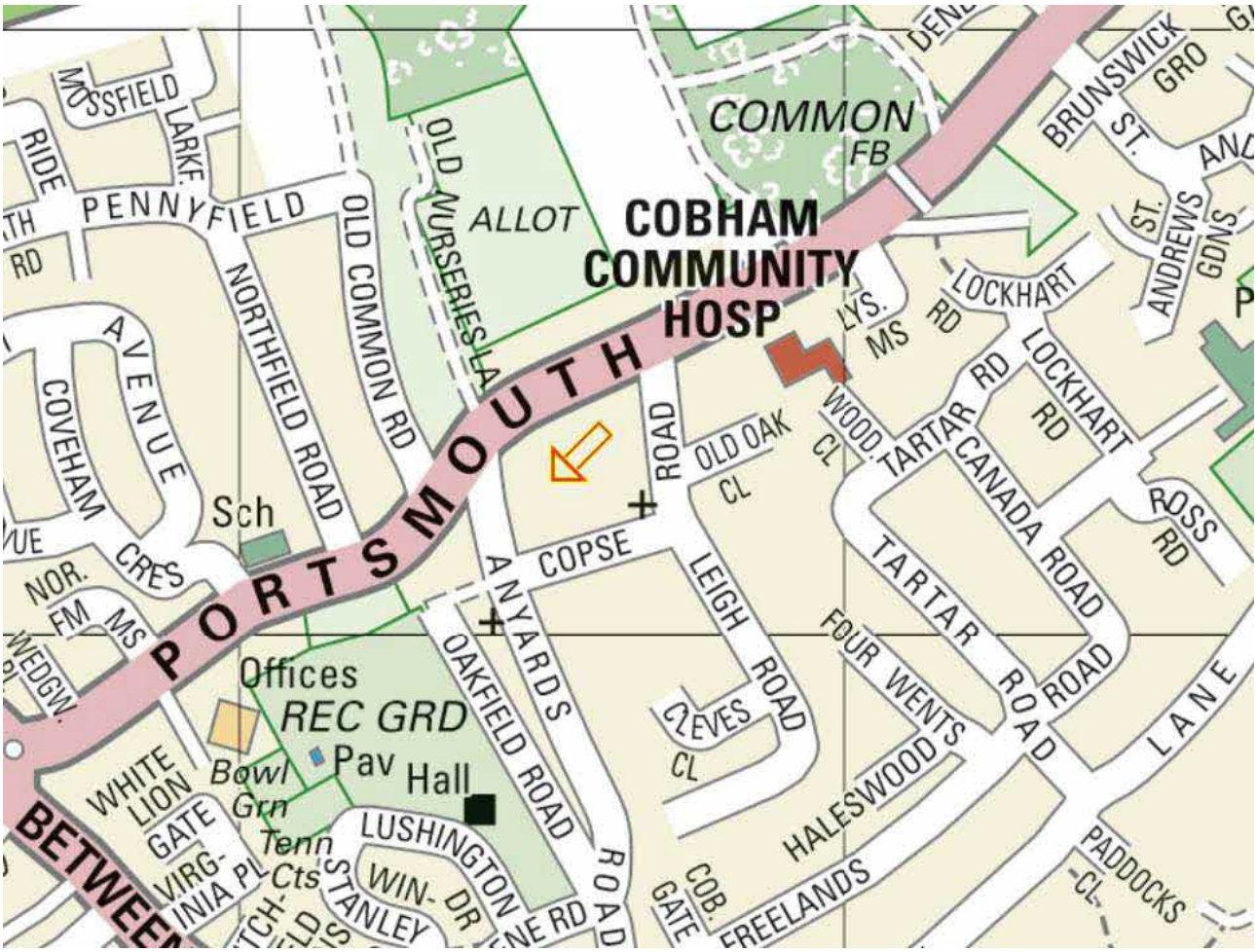


Figure 1 – Site Location Map

N

Job Number 20737	**Project** Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH
Client Shanly Homes Ltd	**Date** June 2023

Figure 2 – Aerial Photograph

Project
Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH

Client
Shanly Homes Ltd

Date
June 2023

Job Number
20737

Figure 3 – Exploratory Hole Plan

Project
Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH

Client
Shanly Homes Ltd

Date
June 2023

Job Number
20737

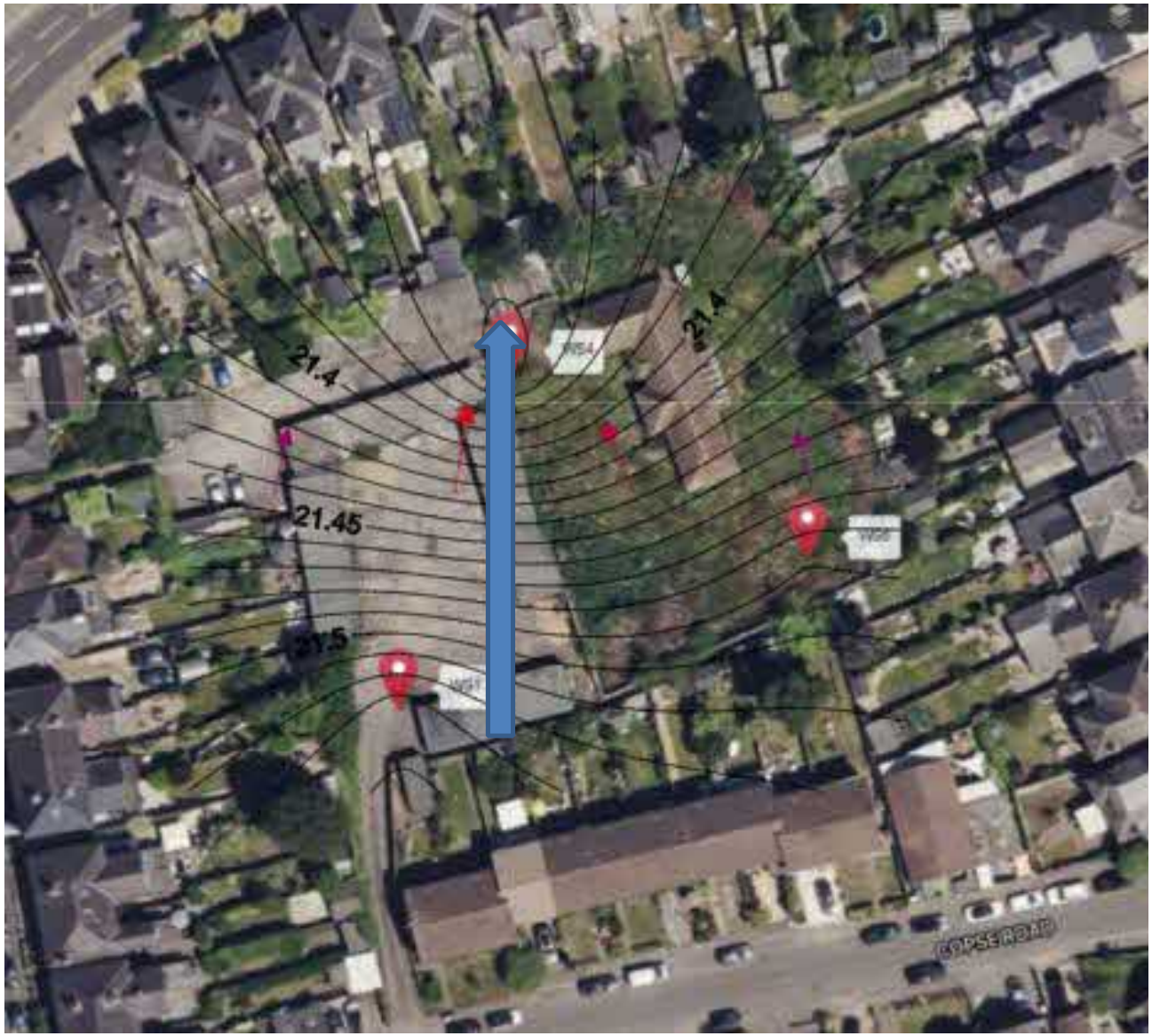


Figure 4 – Groundwater Flow Direction

Project
Land at Glenham, Anyards Road, Cobham, Surrey KT11 2LH

Client
Shanly Homes Ltd

Date
June 2023

Job Number
20737

N

Appendix A Standards and Resources

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards were applicable:

BS 5930:2015 and BS EN ISO 22476-2 2005+A1:2011

BS 5930:2015 and BS EN ISO 22476-2&3:2005+A1:2011

BS 5930:2015 and BS EN ISO 22476-3:2005+A1:2011

BS EN 1997-1:2004+A1:2013 Eurocode 7. Geotechnical design

BS EN ISO 14688-1:2018 - Geotechnical investigation and testing - Identification and description

BS EN ISO 14688-2:2018 - Geotechnical investigation and testing - Principles for a classification

BS 10175:2011+A2:2017 - Investigation of potentially contaminated sites

LCRM 2021 Environment Agency

BS 8004:2015 – Code of practice for foundations

BS 1377:1990 Parts 1 to 8

BRE Digest 241 “Low-rise buildings on shrinkable clay soils: Part 2

BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’

Stroud, M. A. 1974, “The Standard Penetration Test – its application and interpretation”, Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.

Robertson, P.K., 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27, pp. 151 – 158.

Robertson, P.K., 2010, “Soil Behaviour type from the CPT: an update”, 2nd International Symposium on Cone Penetration Testing, Huntington Beach, CA, Vol.2. pp575-583.

N.E. Simons, B.K. Menzies, “A Short Course in Foundation Engineering”

NHBC Standards Chapter 4.2, January 2023.

SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination December 2014

CIRIA C733, Asbestos in soil and made ground: a guide to understanding and managing risks and CAR2012 regulations.

CIRIA C574, Engineering in Chalk; 2002

Google Earth

British Geological Survey Website & iGeology App

Appendix B Field Work

Appendix B.1 Engineers Logs

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				0.10	
				0.30	
				(0.35)	
				0.65	
				(0.35)	
				1.00	
				(0.50)	
				1.50	
				(0.30)	
				1.80	
				(0.30)	
				2.10	
				(0.50)	
				2.60	
				(0.90)	
				3.50	
				(0.30)	
				3.80	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				0.05	
				0.30	
				(0.40)	
				0.70	
				(0.50)	
				1.20	
				(1.00)	
				2.20	
				(1.60)	
				3.80	
				(1.00)	
				4.80	
				5.00	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				0.10	
				(0.30)	
				0.40	
				(0.40)	
				0.80	
				(0.90)	
				1.70	
				(0.30)	
				2.00	
				(0.30)	
				2.30	
				(0.50)	
				2.80	
				(0.40)	
				3.20	
				(0.50)	
				3.70	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				0.10	
				0.35	
				0.60	
				(1.30)	
				1.90	
				(0.40)	
				2.30	
				(0.70)	
				3.00	
				(2.00)	
				5.00	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				(0.40)	
				0.40	
				0.65	
				(0.95)	
				1.60	
				(1.20)	
				2.80	
				3.00	
				(0.50)	
				3.50	
				(1.10)	
				4.60	
				(0.40)	
				5.00	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				(0.30)	
				0.30	
				(0.70)	
				1.00	
				(1.00)	
				2.00	
				(0.40)	
				2.40	
				(1.60)	
				4.00	
				(1.00)	
				5.00	
				(0.40)	
				5.40	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				(0.50)	
				0.50	
				(0.40)	
				0.90	
				(0.90)	
				1.80	
				(0.80)	
				2.60	
				2.70	
				(0.55)	
				3.25	
				(1.25)	
				4.50	
				(0.30)	
				4.80	

Samples & In Situ Testing			Strata Details		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend
				(0.30)	
				0.30	
				0.50	
				(0.50)	
				1.00	
				(0.70)	
				1.70	
				(0.80)	
				2.50	
				(1.00)	
				3.50	
				(0.50)	
				4.00	
				4.20	
				(0.30)	
				4.50	

Water Strike	Samples & In Situ Testing			Depth (m)	Level (mAOD)	Legend
	Depth	Type	Results			
				0.08		
				0.28		
				0.50		
				1.60		
▼				1.80		

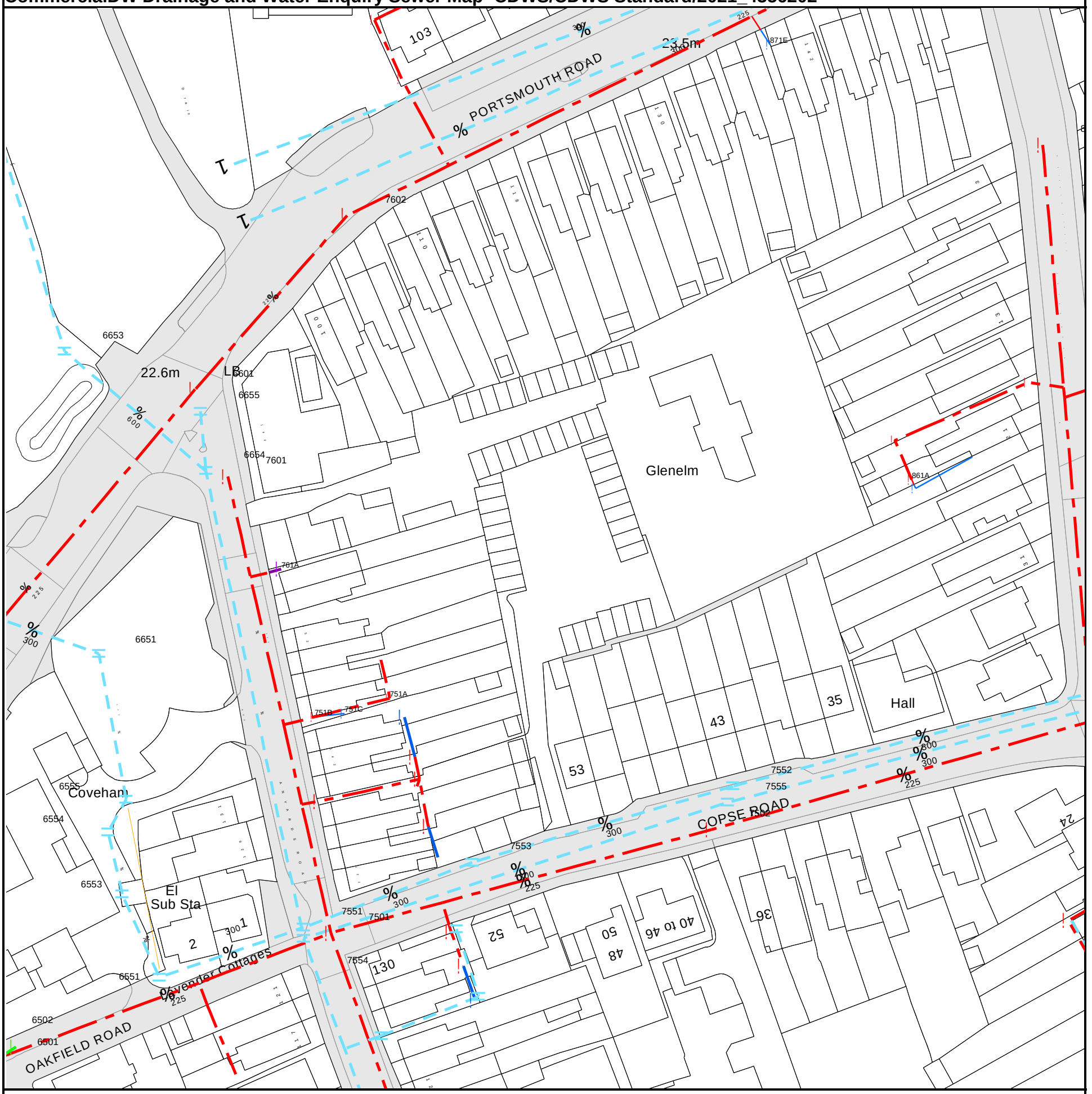
Water Strike	Samples & In Situ Testing			Depth (m)	Level (mAOD)	Legend
	Depth	Type	Results			
				0.30		
				1.30		
				1.50		

Water Strike	Samples & In Situ Testing			Depth (m)	Level (mAOD)	Legend
	Depth	Type	Results			
				0.40		
				0.80		

APPENDIX D

Sewer Records and Correspondence

CommercialDW Drainage and Water Enquiry Sewer Map- CDWS/CDWS Standard/2021_4356202



The width of the displayed area is 200m

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates no survey information is available.

Manhole Reference	Manhole Cover Level	Manhole Invert Level
871E	n/a	n/a
86NK	n/a	n/a
86NJ	n/a	n/a
8601	22.87	21.48
871B	n/a	n/a
6502	n/a	n/a
6651	22.16	20.63
6554	n/a	n/a
6553	n/a	n/a
6555	n/a	n/a
6551	21.86	20.66
6654	21.93	19
7601	21.85	20.23
761A	n/a	n/a
7551	21.56	20.67
7554	21.62	20.49
751B	n/a	n/a
75DD	n/a	n/a
7501	21.65	19.22
751C	n/a	n/a
75EK	n/a	n/a
751A	n/a	n/a
75DL	n/a	n/a
75DK	n/a	n/a
75EC	n/a	n/a
75DM	n/a	n/a
75FD	n/a	n/a
75EN	n/a	n/a
6653	21.88	19
6601	22.42	20.09
6655	22.22	21.24
7602	22.67	20.38
77MM	n/a	n/a
77ML	n/a	n/a
75FE	n/a	n/a
7553	21.77	20.77
75FF	n/a	n/a
75EL	n/a	n/a
7502	21.93	20
7555	21.94	20.71
7552	21.84	20.79
861A	n/a	n/a
86NL	n/a	n/a
85FC	n/a	n/a
85FD	n/a	n/a
8502	22.32	20.79

Sewer Key - Commercial Drainage and Water Enquiry

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

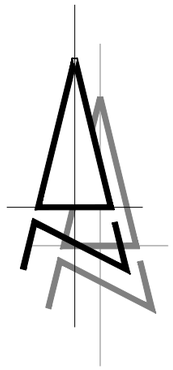
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Searches on 0800 009 4540.

APPENDIX E

Development Proposals

1:500

0 10m 20m 30m 40m 50m



*	**	***
Rev	Date	Description

SHANLY HOMES

Project

Land off Anyards Road
Cobham

Planning

Drawing

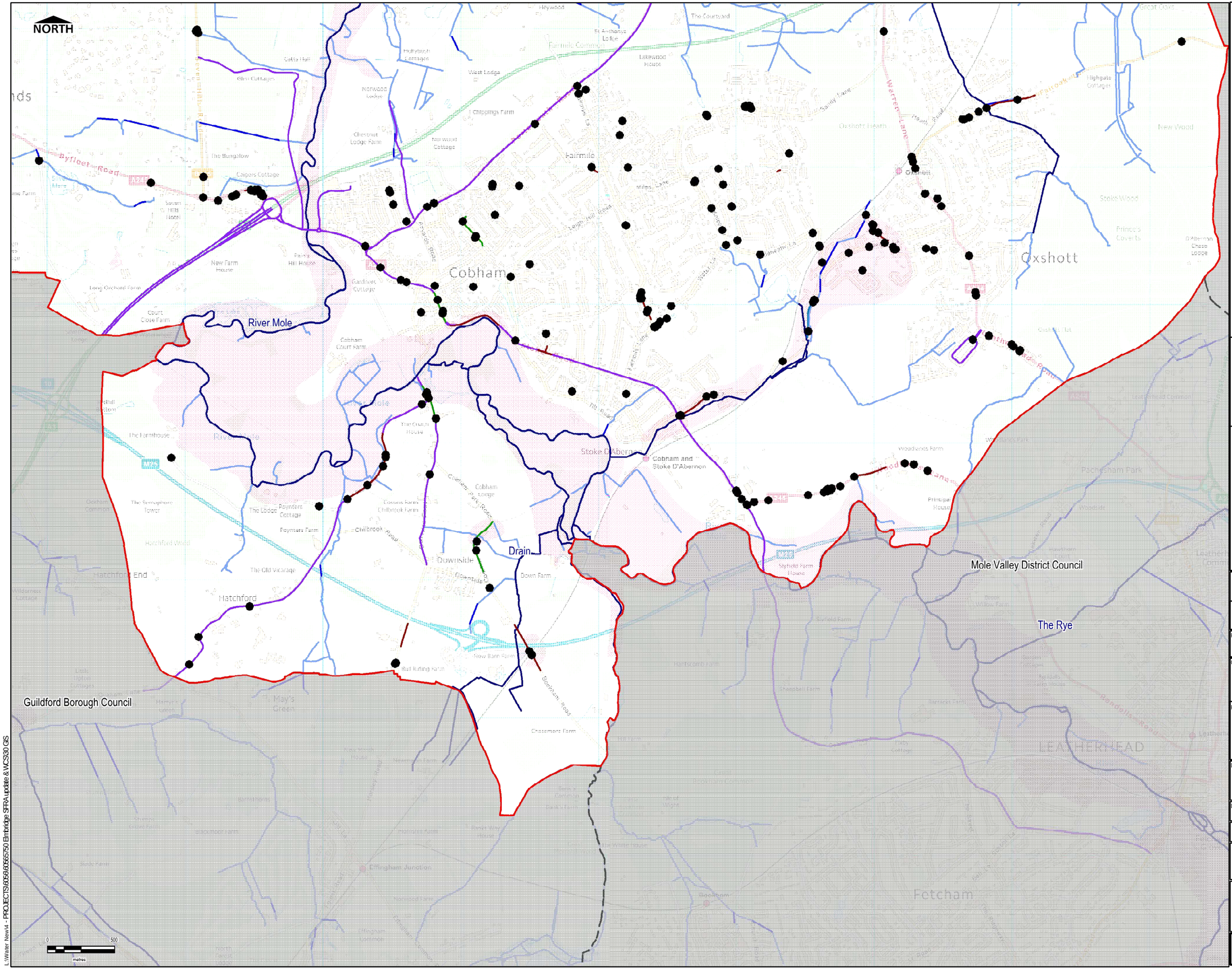
Site layout

Date	Scale @ A3	Drawn
03.10.23	1:500	CE

Drawing number	Revision
1409/Pln/101	-

APPENDIX F

SFRA Mapping Extracts



L:\Water New\4 - PROJECTS\60565750 Elmbridge SFRA update & WCS\30 GIS

LEGEND

- Borough Boundary
- LPAS

Watercourses

- Main River
- Ordinary Watercourses- Culverted
- Ordinary Watercourse- Surface

Environment Agency Historic Flooding

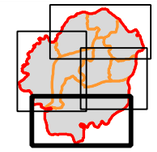
- Historic Flood Map
- West Thames Properties Affected

Elmbridge Borough Council

- Register of Flooded Properties

Surrey County Council (LLFA)

- Highways Enquiries
- Surrey Wetspots
- Internal Property Flooding
- External Property Flooding
- Historic Flooding Incidents



Notes
1. Flood Incidents data has been provided by the Environment Agency, Surrey County Council (Lead Local Flood Authority) and Elmbridge Borough Council. Further information on these flood records is provided within the Level 1 SFRA report

Intended Use
This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue
FINAL

Client
Elmbridge Borough Council

Project Title
Elmbridge Borough Council Level 1 Strategic Flood Risk Assessment

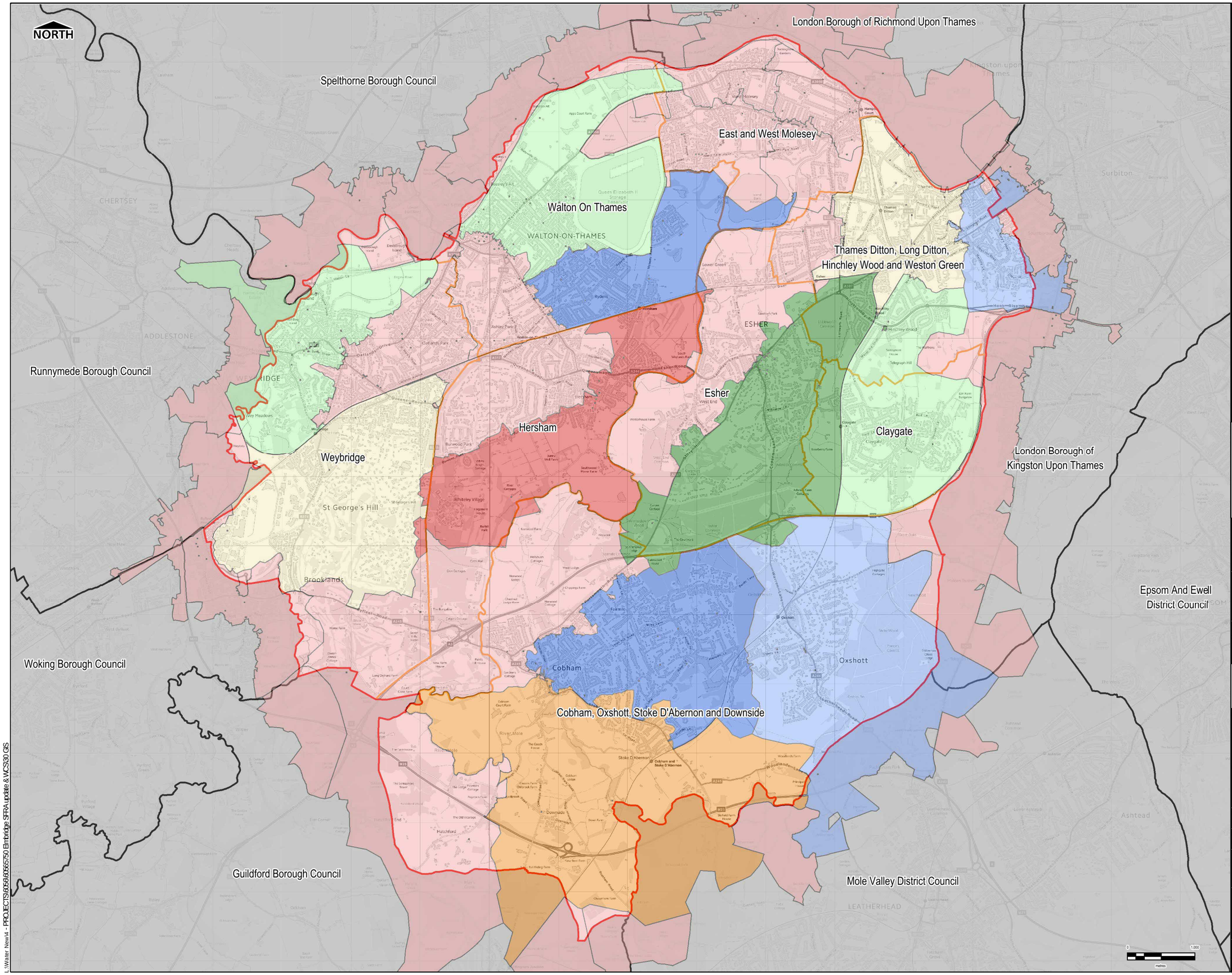
Drawing Title
Historic Flood Incidents (View 4)

Drawn	Checked	Approved	Date
HB	SL	SK	September 2018

Internal Project No.	Scale at A3
60565750	1:25,000

AECOM Infrastructure & Environment UK Limited
Midpoint
Alencon Link
Basingstoke
RG21 7PP
Telephone 01256 310300

Drawing Number	Rev
FIGURE E4	01



THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

LEGEND

- Elmbridge BC boundary
- Local Planning Authority boundary
- Settlement Area boundary
- Post Code Sector Boundary

No. of TWUL Sewer Records by postcode

- 0
- 1
- 2
- 3
- 4
- 6
- 7
- 18

Notes

1. TWUL has supplied records of sewer flooding for the Borough through their DG5 register on the total number of properties affected by and at risk of sewer flooding based on historic flooding. This data has been displayed using the 4 digit postcode boundaries in the Borough.

Intended Use

This map is intended to provide a strategic overview of historic sewer flooding and should not be used to assess flood risk for individual properties.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Elmbridge Borough Council – bridging the communities

Project Title: Elmbridge Borough Council Level 1 Strategic Flood Risk Assessment

Drawing Title: Recorded Incidents of External Sewer Flooding

Drawn	Checked	Approved	Date
HB	SL		September 2018

Internal Project No.	Scale at A3
60565750	1:50,000

AECOM Infrastructure & Environment UK Limited
Midpoint
Alencon Link
Basingstoke
RG21 7PP
Telephone 01256 310300

Drawing Number	Rev
FIGURE B8	01

L:\Water New\4 - PROJECTS\60565606\60565750 Elmbridge SFRA Update & WCS\30 GIS