



**CLEARSTONE
ENERGY**

DARTFORD ENERGY HUB

HYDROGEOLOGICAL RISK ASSESSMENT

Prepared by Clearstone Energy & Wardell Armstrong
| December 2024 | Document Reference: R019

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DECEMBER 2024

DATE ISSUED: **DECEMBER 2024**
JOB NUMBER: **CA12848**
REPORT NUMBER: **0004**
VERSION: **V2.0**
STATUS: **FINAL**

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DECEMBER 2024

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1 INTRODUCTION

1.1 Report Context

1.1.1 Wardell Armstrong LLP (WA) has been commissioned by Clearstone Energy to prepare a Hydrogeological Risk Assessment (HRA) and Foundation Works Risk Assessment (FWRA) for a proposed battery energy storage system (BESS) and substation development located at Station Road, Southfleet, Gravesend, Kent (National Grid Reference (NGR): TQ 61696 72104) (the Site). The location of the Site is shown in Drawing CA12848-010.

1.1.2 This report sets out the results of the HRA and FWRA that will support the planning application for the proposed development.

1.2 Basis of Report

1.2.1 This report is based on the following reports and documents relating to the Site:

- Dartford Energy Hub Proposed Development Zone Plan (CADmando drawing CST010-DF3.0, 07/11/2024);
- Dartford Energy Hub Ground Conditions Desk Study (WA Report No. CA12848-001, dated December 2024);
- Dartford Energy Hub Flood Risk Assessment and Drainage Strategy (WA report No. CA12828-003, dated December 2024);
- Data acquired from third party sources:
 - Groundsure Report (Ref: GSWA1-SA8-BU1-BY7-MT7) dated 29 June 2023;
 - Topographic survey carried out by Solent Surveys Limited dated June 2023;
 - Environment Agency (EA) LIDAR Digital Terrain Model dated 2022;
 - EA data request, including information on groundwater and surface water abstractions and discharges, and historic and licensed landfills (response dated July 2024);
 - Requests to Dartford Borough Council and Gravesham Council for details of Private Water Supplies (responses dated June 2024 and September 2024, respectively);

- Defra MAGIC map application, including superficial and bedrock aquifer designations;
- EA Hydrology Data Explorer, including regional groundwater elevation data; and
- British Geological Survey (BGS) superficial, bedrock and hydrogeological maps and historic borehole records.

1.3 Report Structure

- 1.3.1 Following this introductory section, Section 2 presents an overview of the risk assessment methodology that has been applied. The Proposed Development is described in Section 3. Baseline conditions for the Site are described in Section 4 and the findings have been interpreted to form a Hydrogeological Conceptual Site Model (HCSM), which is presented in Section 5. The risk assessment is presented in Section 6 and requisite surveillance measures are identified in Section 7. A summary is given in Section 8.

2 ASSESSMENT METHODOLOGY

2.1 Overview

2.1.1 Development, such as construction and operation of infrastructure sites, may introduce hazards that could affect the environment. The purpose of a risk assessment is to quantify the level and likelihood of an effect (i.e the risk) and identify steps that can be taken to reduce this risk to an acceptable level.

2.1.2 The environmental risk posed by a hazard is dependent upon the severity of the effect the hazard may have at a sensitive feature (the consequence) and the likelihood of that effect occurring (Defra, 2011¹). The methodology applied here to evaluate hydrogeological risk uses this approach, building up the assessment of risk in a stepwise process as follows.

- Identify potential hazards.
- Identify potential receptors and determine how sensitive these may be to the hazard.
- Determine the magnitude of effect that the hazard may pose to the receptor.
- Calculate consequence level by combining the magnitude and sensitivity.
- Evaluate the likelihood of the consequence occurring.
- Calculate the level of risk by combining the consequence and likelihood.
- Determine level of confidence (i.e. uncertainty) in the assessment of risk.

2.1.3 A source-pathway-receptor model has been used in the assessment. The source term describes the hazard, for example a source of contamination or a change in hydrological conditions. Features sensitive to the hazard are termed receptors. Not all receptors are sensitive to all hazards. Similarly, one hazard could affect several receptors. Therefore, screening is undertaken to identify which hazards could affect which receptors. Consequence level is a function of the receptor sensitivity and potential magnitude of effect resulting from the hazard at that receptor. It is noted that the development site itself may be a receptor for some effects, such as flooding for example.

2.1.4 The final component is the pathway, which describes the linkage between the hazard and the receptor. The pathway is one of the main considerations when evaluating likelihood in the risk assessment because the absence of a pathway between hazard

¹ Green Leaves III: Guidelines for Environmental Risk Assessment and Management. Defra, November 2011.

and receptor means that the likelihood of there being an effect is similarly absent. Characteristics of the source and receptor may also affect the assessment of likelihood. In combination, the assessment of the source, pathway and receptor characteristics give an assessment of risk.

2.1.5 Following calculation of risk and assessment of uncertainty for each hazard and receptor, decisions are made regarding additional measures that may be taken to reduce risk and uncertainty to a level that is acceptable. Additional measures may take the form of additional control measures, data gathering or further risk assessment.

2.1.6 For the purposes of the assessment presented in this report, a qualitative approach was used to calculate risk. This is consistent with Tier 1 Qualitative Risk Screening of the tiered approach required by the Environment Agency (EA) when completing a groundwater risk assessment (Environment Agency, 2018²).

2.1.7 The following sections describe how qualitative criteria are applied to calculate risk.

2.2 Receptor sensitivity

2.2.1 The sensitivity of receptors to hydrogeological risks has been determined using the criteria set out in Table 1, which documents a hierarchy of factors related to the hydrogeological setting. Examples of the environmental criteria contained within Table 1 include international and national designations, EA categorisation of features or areas, and the professional judgement of the assessment team. When a receptor meets multiple criteria or there is an absence of verified published data, the highest applicable sensitivity category is assigned to allow an assessment of the worst-case scenario.

Table 1 Criteria for Determining Receptor Sensitivity		
Sensitivity	Criteria	Typical Examples
Very High	Receptor has a high quality and rarity on a national or regional scale and limited potential for substitution. Receptor is highly vulnerable to impacts that may arise from the project and recoverability is long-term or not possible.	<u>Groundwater:</u> Source Protection Zone 1 <u>Abstractions:</u> Abstractions for public drinking water supply.
High	Receptor has a high quality and rarity on a local scale and limited potential for substitution. Receptor is	<u>Groundwater:</u> Principal Aquifer providing a regionally important resource or supporting a site protected under EU

² Guidance: Groundwater risk assessment for your environmental permit. Environment Agency, April 2018. [Groundwater risk assessment for your environmental permit - GOV.UK \(www.gov.uk\)](https://www.gov.uk/guidance/groundwater-risk-assessment-for-your-environmental-permit) Accessed September 2024.

Table 1 Criteria for Determining Receptor Sensitivity		
Sensitivity	Criteria	Typical Examples
	generally vulnerable to impacts that may arise from the project and recoverability is slow and/or costly.	and UK habitat legislation (i.e. Groundwater Dependent terrestrial ecosystems (GWDTEs)) Source Protection Zone 2 or 3. <u>Abstractions:</u> Private Water Supplies (potable water) Abstractions for non-potable use >20m ³ /d (e.g., industry / process water, spray irrigation, river augmentation).
Medium	Receptor has a medium quality and rarity, local scale and limited potential for substitution or replacement. Receptor is somewhat vulnerable to impacts that may arise from the project and/or has moderate to high recoverability.	<u>Groundwater:</u> Secondary A Aquifer Secondary B Aquifer providing water supply to private abstractions. Groundwater in peat deposits. <u>Abstractions:</u> Abstractions for non-potable use <20m ³ /d (e.g. industry/process water, spray irrigation, river augmentation).
Low	Receptor with a low quality and rarity, local scale and limited potential for substitution. Receptor is not generally vulnerable to impacts that may arise from the project and/or has high recoverability.	<u>Groundwater:</u> Secondary B Aquifer Secondary Undifferentiated Aquifer Aquifers supporting potentially water dependent ecosystems i.e. Local Wildlife Sites (LWS) wetland. <u>Abstractions:</u> Abstractions for industrial use (e.g. dust suppression/washing machinery).
Note Professional judgement based on the baseline condition of the receptor should be used to determine a receptor's sensitivity.		

2.3 Magnitude of effect

2.3.1 Magnitude of effect describes the scale of change that might be expected at a receptor due to the hazard. Change is assessed relative to the baseline environmental condition at the site. Table 2 describes the guidance criteria used to assess the magnitude of change from the baseline.

Table 2 Criteria for Determining the Magnitude of Effect	
Magnitude of Effect	Typical Example
High	Total loss of, or alteration to, the baseline resource such that post- development characteristics or quality would be fundamentally and irreversibly changed.
Medium	Loss of or alteration to the baseline resource such that post-development characteristics or quality would be partially changed.
Low	Small changes to the baseline resource, which are detectable, but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions.
Negligible	A very slight change to baseline conditions, which is barely or not distinguishable, and approximates to the 'no change' situation.

2.4 Consequence

2.4.1 The consequence of an effect at a receptor is determined by combining the receptor sensitivity and magnitude of effect. The relationship is presented Table 3.

Table 3 Matrix for Determining Consequence from Receptor Sensitivity and Magnitude of Potential Effects					
		Receptor Sensitivity			
		Very High	High	Medium	Low
Magnitude of Effect from Baseline Condition	High	Major	Major	Moderate	Moderate
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

2.5 Likelihood

2.5.1 The likelihood of the consequence identified in the previous step is evaluated by considering the characteristics of the pathway between the hazard and the receptor. This considers both the environmental pathways and pathways that may be introduced or modified by the development. This also includes measures embedded into the scheme design that are intended to isolate or control hazards.

2.5.2 Guideline criteria for evaluating likelihood in a qualitative assessment are given in Table 4.

Table 4 Guideline Criteria for Qualitative Evaluation of Likelihood		
Likelihood	Definition	Examples
Highly likely	High probability of occurrence	Permanent, uncontrolled, direct, proven pathway between hazard and receptor offering no attenuation or control.
Likely	More likely to occur than not	Pathway is present and direct but may provide attenuation or control of the effect.
Moderately Likely	Equally likely and unlikely	Pathway is present but is indirect, intermittent and/or provides some attenuation of effects.
Unlikely	Less likely to occur than not	Pathway may be present but is indirect, intermittent and attenuates the effect.
Very unlikely	Very low probability of occurrence	No or very convoluted pathway between hazard and receptor. Extreme circumstances required to expose receptor to effect.

2.6 Risk

2.6.1 The combination of likelihood and consequence is used to evaluate the level of risk related to each hazard and receptor. The matrix combining likelihood and consequence to derive risk is presented in Table 5. Where consequence is Minor or Negligible, the level of risk is comparably low or absent. Conversely, where consequence is high, risk is high where effects are likely to occur.

Table 5 Matrix for Determining Level of Risk					
		Consequence			
		Major	Moderate	Minor	Negligible
Likelihood	Highly likely	Very High	High	Medium	Low
	Likely	High	Medium	Low	Very Low
	Moderately likely	Medium	Low	Very Low	None
	Unlikely	Low	Very Low	Very Low	None
	Very unlikely	Very Low	Very Low	Very Low	None

3 THE PROPOSED DEVELOPMENT

- 3.1.1 The Proposed Development at the Site involves construction of a BESS comprising 216 battery storage units with inverters, a customer substation, site access and a cable route linking the Site to the National Grid connection point. The area of the site is 9.75 Ha of which 3.84 Ha is for the cable route, 3.06 Ha for BESS and substation infrastructure (including internal access), and 2.85 Ha for landscaped green space.
- 3.1.2 The details of construction and operation of the site are currently at an outline stage and will be confirmed through detailed design following receipt of planning permission. The following aspects of the design are relevant to the assessment of hydrogeological risk.
- 3.1.3 The battery site and substation would be developed on engineered platforms. The topography of the site means that cut and fill earthworks would be required to produce level platforms at the required elevations. Vegetation and soil would be stripped from these areas before cut and fill earthworks are undertaken. For the southern part of the Site (south of Station Road) platform elevations would be 15 and 19 metres Above Ordnance Datum (mAOD). For the northern part of the Site, platform elevations would be 15.5, 20 and 24 mAOD.
- 3.1.4 The surface of each platform is expected to be 0.3 m thick and constructed from compacted granular material. Below this layer, site-won material would be reworked and improved in areas where fill is required to achieve the required final levels. No piling or penetrative ground improvements are expected.
- 3.1.5 The central part of each platform area, where the battery storage units are located, would be engineered to provide flood water storage as described in the Flood Risk Assessment and Drainage Strategy. Key components of this engineered surface would be: a layer of granular material 0.6 to 0.65 m thick with a void ratio of 30%; and a membrane underlying the granular layer to prevent infiltration of stored water.
- 3.1.6 Battery storage units and the substation would be installed on concrete slab installed over the engineered platform surface.
- 3.1.7 Internal site maintenance tracks are expected to be aggregate and will be constructed upon the platform surface. Roads for external and emergency access are expected to be asphalt.
- 3.1.8 Sustainable Drainage Systems (SuDS) would be used to manage drainage and flood risk within and from the Site after development. The membrane-lined engineered

platforms would collect runoff and direct this via pipes to SuDS soakaways. Pipe connections would have shut-off valves to enable water contained within the membrane-lined areas to be retained. This would enable water that might contain hazardous substances (firefighting water for example) to be extracted and taken off-site for treatment rather than being discharged to soakaways at the Site. Soakaways would be located outside the BESS areas and over Chalk outcrop. Infiltration rates where the Thanet Sands is present at the surface are not suitable for infiltration (see Section 4.8 and the Flood Risk Assessment and Drainage Strategy for further details).

- 3.1.9 The natural drainage route that passes from south to north through the Site would be diverted. Runoff entering the site from the south would flow around the eastern perimeter of the platforms and rejoin the natural drainage route on the eastern boundary.
- 3.1.10 It is expected that cables within the battery site and substation area will be installed within conduits placed in trenches dug into the compacted platform capping material. Trenches will be backfilled with comparable material following conduit and cable installation.
- 3.1.11 Oil-filled cables would be used to link the Site to the National Grid (NG) connection point north of the A2. The cables would be laid in trenches that may be 1.2 m deep and 1 m wide. Trenches would be installed in the bed of the proposed metalled roadway along this corridor. The trench would not be lined. Where the cable route crosses other infrastructure, directional drilling would be used to create the cable route.
- 3.1.12 It has been assumed that there will be no sub-surface or drainage related works at the NG connection point.

4 BASELINE SITE CONDITIONS

4.1 Site Location

4.1.1 The Site is located on Station Road, approximately 1 km north of the village of Southfleet and approximately 0.4 km south and west of the A2 and the town of Northfleet. The Site is centred approximately on National Grid Reference (NGR) TQ 61696 72104. The nearest postcode to the Site is DA13 9PA. A plan displaying the location of the Site is shown on Drawing CA12848-010

4.2 Site Description

4.2.1 The Site is irregular in shape, comprising two agricultural fields to the north and south of Station Road. The Site lies beneath an overhead power line which runs east to west across the Site. A pylon supporting the overhead power line is located in the southeast of the southern field.

4.3 Site Setting

4.3.1 The Site Setting description considers an area of approximately 250 m around the Site. In other reports we are referring to the neighbouring land being HS1, A2, Waste centre, Garden Centre, Disused railway embankment and DGP Logistics storage yard. On the other side of these features to the south & west is agricultural land

4.3.2 There is a garden centre and waste recycling centre adjacent to the northeastern boundary of the Site. The A2 trunk road passes to the north of the Site (approximately 400 m north east of the Site centre). A railway line bounds the Site to the south with agricultural land beyond. West of the Site is a logistics storage yard and OS maps indicate a dismantled railway running adjacent to the north west-facing boundary. Land west of that is agricultural.

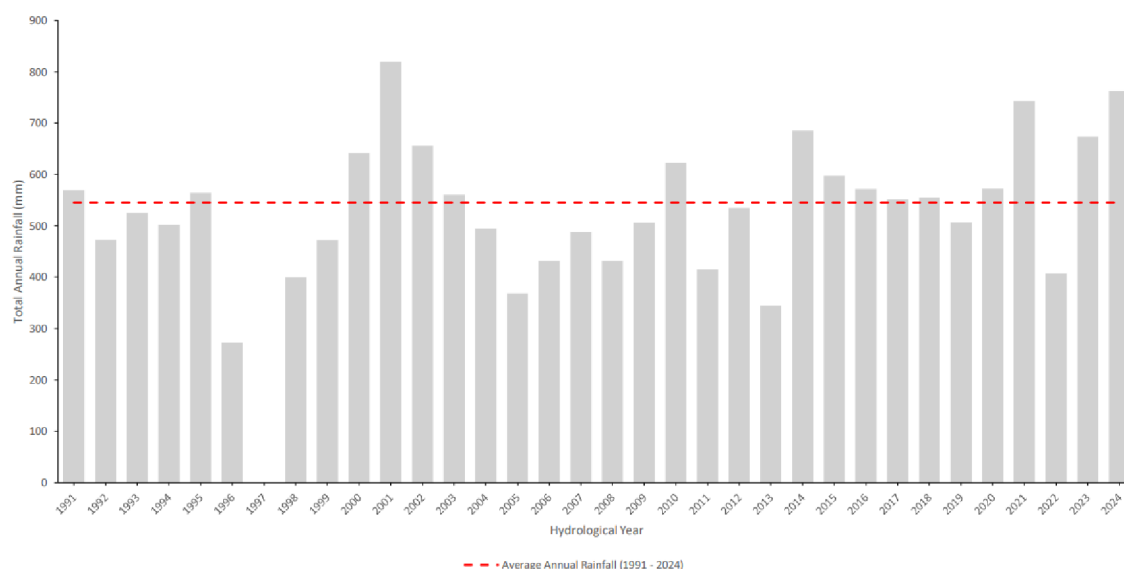
4.4 Topography

4.4.1 Based on the topographic survey carried out by Solent Surveys Limited and data from the EA LIDAR Digital Terrain Model³, ground elevations at the Site range from a maximum of 26.0 mAOD at the southwest corner of the northern field to a minimum of 11.72 mAOD at the southeast corner of the northern field. There is an unnamed pond at the low point of the site. In the northern field ground elevations generally slope from the west at approximately 26 mAOD to the east at approximately

³ Defra (2022), Defra Survey Data Download [Online]. Accessed July 2024. Available at: <https://environment.data.gov.uk/survey>

12 mAOD. In the southern field ground elevations slope from the west to a low point of 14.5 mAOD in the centre of the field, and then rise again in the east of the southern field where ground elevations are 18 to 22 mAOD.

Figure 1. Annual Rainfall at Northfleet



Note: For the period 28 July 1996 to 5 October 1997, the data is reported as "missing".
Hydrological years are defined as October to September.

- 4.4.2 Average rainfall data has been obtained from the nearest Environment Agency Rainfall Station to the Site (located at Northfleet⁴, approximately 1.2km north of the Site at NGR TQ 61899 73489) for the period 1991 to 2024. Rainfall totals for hydrological years (October to September) are presented in Figure 1. It should be noted that for the period 28 July 1996 to 5 October 1997, the rainfall data is reported as "missing". Therefore, the hydrological years of 1996 and 1997 are not considered in the following description of the rainfall data.
- 4.4.3 The graph shows that the minimum total annual rainfall in the period 1991 to 2024 was 345 mm recorded in 2013 and that the maximum total annual rainfall in the period 1991 to 2024 was 820 mm recorded in 2001. The mean average annual rainfall in the period 1991 to 2024 was 545 mm. Drier periods (more than one consecutive year of below-average rainfall) were recorded between 1992 and 1994, 1998 to 1999, 2004 to 2009 and 2011 to 2013 while wetter periods (more than one consecutive year

⁴ Environment Agency (2024), Hydrology Data Explorer: Northfleet [Online]. Accessed September 2024. Available at: <https://environment.data.gov.uk/hydrology/station/3677b439-5ea3-4968-b139-47b4d364d60a>

of above-average rainfall) were recorded between 2000 and 2003, 2014 to 2018, 2020 to 2021 and 2023 to 2024.

4.5 Hydrology

4.5.1 Maps shown an unnamed pond in the southeastern corner of the northern field of the Site. This pond was dry at the time of the topographical site survey. There is also an unnamed pond located approximately 450 m south of the Site.

4.5.2 There are two unnamed watercourses located 91 m east and 107 m east of the Site, which both flow in a northwest direction. The only Statutory Main River within 250 m of the Site is the source of the River Ebbsfleet, a tributary of the Thames, which is located 246 m north of the Site (Drawing CA12848-011). The River Ebbsfleet generally flows north, and ultimately joins the River Thames approximately 2.6 km north of the Site.

4.5.3 There are no permanent surface water courses upstream of the source of the River Ebbsfleet. However, geological mapping clearly shows a network of dry valleys – traced by the presence of ‘head’ deposits – extending south of the source of the river and passing through the site (Drawing CA12848-011). Streams may emerge in these valleys when groundwater levels are particularly high and the valleys will also collect runoff when rainfall is particularly intense. There is a risk of groundwater flooding along the course of the dry valley (Appendix A)

4.5.4 The Site is located within the EA’s Thames River Basin District and is part of the Medway Management Catchment, the Medway Lower Operational Catchment and the Ebbsfleet Water Body. In 2022, the EA classified the Ebbsfleet Water Body as having a “Moderate” ecological status⁵. The EA did not specify as to why the Ebbsfleet Water Body did not achieve “Good” ecological status.

4.5.5 Based on the Defra online MAGIC Map⁶, the Site is not located within a Drinking Water Protected Area (Surface Water) or a Drinking Water Safeguard Zone (Surface Water) but is located within a Surface Water Nitrate Vulnerable Zone (NVZ).

⁵ Environment Agency (2023), Catchment Data Explorer: Ebbsfleet Water Body [Online]. Accessed June 2024. Available at: <https://environment.data.gov.uk/catchment-planning/WaterBody/GB106040024190>

⁶ Defra (2024), MAGIC Map [Online]. Accessed June 2024. Available at: <https://magic.defra.gov.uk/MagicMap.aspx>

4.6 Flood Risk

4.6.1 Flood risk at the Site is considered in the Flood Risk Assessment and Drainage strategy. The baseline risk of flooding is considered to be as follows.

- Fluvial flooding: Low risk.
- Tidal flooding: Risk of flooding from this source is discounted.
- Surface water (pluvial) flooding: Medium risk.
- Groundwater flooding: Most of the Site is of Low risk with some areas of Medium risk.
- Sewer flooding: Low risk.
- Artificial sources: Low risk.

4.6.2 Most of the Site is at low risk of flooding. The areas at medium risk for surface water and groundwater flooding are associated with the lowest topographic elevations in the Site, which follow the course of the dry valley noted in Section 4.5 above.

4.7 Geology and Soils

4.7.1 The geology in the vicinity of the Site is described below based on information from the BGS 1:50,000 scale series geological mapping⁷, the online BGS GeoIndex⁸, the LandIS Soils Guide⁹ together with the records of seven boreholes drilled at and in the vicinity of the Site available from the BGS GeoIndex (referred to below as the BGS borehole logs).

Soils

4.7.2 Based on the LandIS Soils Guide, soils of the Frilsham (0571j) Soil Association are present at the Site. Soils of the Frilsham Association generally consist of well-drained, mainly fine, loamy soils over chalk, some calcareous. Soils may be less well-drained where the Thanet Sands are present at outcrop and the Fyfield 4 (0571g) Association may be present.

4.7.3 Made ground is mapped on the geological map along the southern boundary of the northern field.

⁷ British Geological Survey, 1998. Sheet 271, Dartford, solid and drift edition.

⁸ British Geological Survey (2020), GeoIndex (onshore) [Online]. Accessed June 2024. Available at: <https://www.bgs.ac.uk/map-viewers/geoindex-onshore/>

⁹ The Land Information System (2024), Soil Associations: 0571j FRILSHAM [Online]. Accessed July 2024. Available at: <https://www.landis.org.uk/soilsguide/mapunit.cfm?mu=57110>

Borehole Logs

4.7.4 A summary of the geological and hydrogeological conditions encountered in the BGS Boreholes is provided in Table 6 below. The locations of the boreholes are shown on Drawing CA12848-014. Copies of the BGS borehole logs are presented at Appendix B.

Table 6 Summary of 7 BGS Borehole Logs						
BGS Borehole ID	Eastings	Northings	Ground Elevation (mAOD) *	Base of the Head (mAOD)	Base of the Thanet Formation (mAOD)	Approximate Resting Groundwater Elevation (mAOD)
TQ67SW668	561748	172051	13.81	11.61	-	-
TQ67SW832	561589	172369	17.08	-	13.08	1.98
TQ67SW833	561970	172339	10.07	6.07	-	2.20
TQ67SW890	562108	172146	18.27	-	10.27	1.48
TQ67SW895	561470	171987	27.01	22.31	20.46	-
TQ67SW923	561281	171812	34.26	-	24.36	-
TQ67SW937	561819	171971	22.80	-	18.55	-
Notes * Ground Elevations are derived from the borehole logs. - Formation not present or data not recorded.						

Superficial Geology

4.7.5 There is very little superficial cover over the bedrock at the Site. A map showing the superficial geology is presented on Drawing CA12848-011. Head deposits are the most common and typically comprise silt, sand and clay, with gravel and chalk fragments in places. These deposits underly the Site at the central area of the southern field and the eastern area of the northern field. Borehole data suggest that the Head deposits have a thickness of 2 m to 6 m (where present) within the Site (see Table 6 above).

Bedrock Geology

4.7.6 Beneath the central area of the southern field and the eastern area of the northern field of the Site, the bedrock geology comprises chalk of the Lewes Nodular Chalk Formation, Seaford Chalk Formation and New Haven Chalk Formation

(undifferentiated), which forms part of the White Chalk Subgroup. The White Chalk Subgroup generally consists of chalk with discrete marl seems, nodular chalk and sponge-rich and flint seams throughout¹⁰. Based on the BGS mapping it is considered that the White Chalk Subgroup has a thickness of approximately 200m at the Site.

- 4.7.7 Beneath the remainder of the Site, the Chalk is overlain by the Thanet Formation. The Thanet Formation comprises *“homogeneous, bioturbated, glauconitic silty fine-grained sand, with sandy silt, silt or sandy, silty clay especially in the lower part, forming a coarsening-upwards sequence”*¹¹. Based on the BGS Borehole logs, the Thanet Formation has a thickness of up to 11 m at, and in the vicinity of, the Site (see Table 6 above).
- 4.7.8 A summary of the geological sequence at and in the vicinity of the Site is provided in Table 7 below.

Table 7 – Generalised Local Geology				
Age	Name		Description	Thickness
Holocene	Made Ground	Made Ground (undivided)	Unspecified	Unknown
Quaternary Period (2.58 Ma-present)	Superficial	Head	Silt, sand and clay with variable gravel and chalky in places.	2m to 6m
Thanetian Age (59.2-56.0 Ma)	Bedrock	Thanet Formation	Homogeneous, bioturbated, glauconitic silty fine-grained sand, with sandy silt, silt or sandy, silty clay especially in the lower part, forming a coarsening-upwards sequence	4m to 11m

¹⁰ British Geological Survey (2024), The BGS Lexicon of Names Rock Units: White Chalk Subgroup [Online]. Accessed July 2024. Available at: <https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=WHCK>

¹¹ British Geological Survey (2024), The BGS Lexicon of Names Rock Units: Thanet Formation [Online]. Accessed July 2024. Available at <https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=TAB>

Table 7 – Generalised Local Geology				
Age	Name		Description	Thickness
Cenomanian Age to Maastrichtian Age (100.5-66.0 Ma)		White Chalk Subgroup	Chalk with flints with discrete marl seems, nodular chalk and sponge-rich and flint seams throughout	200m
Note: Ma = mega-annum (or "million years ago")				
Source: British Geological Survey (BGS), 2024. <i>BGS Lexicon of Named Rocked Units</i> . Online: https://www.bgs.ac.uk/technologies/the-bgs-lexicon-of-named-rock-units/ [accessed August 2024].				

4.8 Hydrogeology

- 4.8.1 The hydrogeology at, and in the vicinity of, the Site is summarised below based on information from the BGS GeoIndex, the BGS Borehole logs, the BGS aquifer properties manuals¹², data provided by the EA, Dartford Borough Council and Gravesham Borough Council, together with information presented on the EA's Hydrology Data Explorer¹³.
- 4.8.2 The Thanet Formation is designated as a Secondary A Aquifer. Secondary A aquifers comprise permeable layers that can support local water supplies, and may form an important source of base flow to rivers. The White Chalk Subgroup is designated as a Principal Aquifer. Principal aquifers provide significant quantities of drinking water and water for business needs and may also support rivers, lakes and wetlands. Superficial deposits at the site are designated as Secondary (undifferentiated) aquifers indicating that these deposits are likely to have low groundwater productivity.
- 4.8.3 The Thanet Formation is considered to have a moderate permeability. Hydraulic conductivity measurements reported in the BGS Minor Aquifer Properties Manual ranging between 1.39 m/d and 3.89 m/d, with an average of 2.5 m/d. The Thanet Formation is unsaturated at the Site with the water table being within the Chalk,

¹² Allen et al. 1997. The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R&D Publication 8 and Jones et al., 2000. The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report, WD/00/4. 234pp. Environment Agency R&D Publication 68.

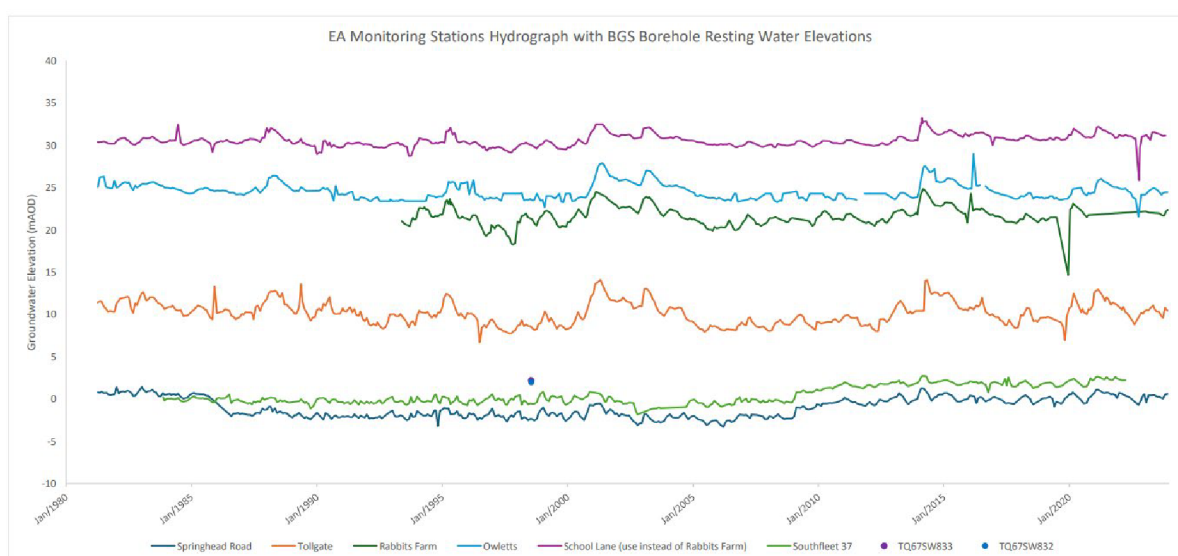
¹³ Environment Agency (2024), Hydrology Data Explorer [Online]. Accessed July 2024. Available at: <https://environment.data.gov.uk/hydrology/explore>

below the base of the Thanet Formation (see Table 6). It is considered that the Thanet Formation is in hydraulic continuity with the underlying White Chalk Subgroup.

4.8.4 The White Chalk Subgroup underlying the Site is water bearing and is considered to have a low primary permeability and a high secondary permeability. Groundwater flow within the White Chalk Subgroup is concentrated within a few large fractures which are most commonly present at or within a few tens of metres of the water table¹⁴. These fractures are often further enhanced due to dissolution as a result of the lithology, groundwater flux and the geochemical nature of the aquifer. Therefore, although the White Chalk Subgroup is approximately 200m thick in the vicinity of the Site, active groundwater flow is limited to the upper part of the unit immediately below the water table.

4.8.5 Groundwater level data are available for a number of monitoring boreholes in the area around the Site. Figure 2 presents the available groundwater monitoring data.

Figure 2. Groundwater level hydrographs for boreholes located near to the Site



4.8.6 Groundwater elevations at the EA groundwater monitoring borehole at Springhead Road, approximately 1.2 km northeast of the Site, have generally varied between -1 mAOD and 1 mAOD since January 2010¹⁵. Levels were lower at this installation before 2010, which is thought to be related to groundwater level drawdown by nearby

¹⁴ Adams, B (editor). 2008. The Chalk aquifer of the North Downs. British Geological Survey Research Report, RR/08/02.

¹⁵ Environment Agency (2023), Hydrology Data Explorer: Springhead Road [Online]. Accessed July 2024. Available at: <https://environment.data.gov.uk/hydrology/station/6dec0656-ba20-42aa-80c7-0569d8091b44>

groundwater abstraction. Groundwater levels near to and down gradient of the site are all likely to be affected by groundwater abstraction to some extent. Groundwater elevations at the EA groundwater monitoring borehole located at Tollgate approximately 2.25 km east of the Site have generally ranged between 8 mAOD and 13 mAOD since January 2010¹⁶. The BGS Boreholes logs of TQ67SW832 (located 110m northwest of the Site), TQ67SW890 (located 300m east of the Site) and TQ67SW883 (located 250m northeast of the Site) had resting groundwater elevations of 1.98 mAOD, 1.48 mAOD and 2.20 mAOD, respectively, when drilled in 1998.

- 4.8.7 Data from these boreholes have been used to prepare a groundwater level contour map for the Chalk aquifer around the Site (Drawing CA12848-015). The contour map presents an interpolation of average groundwater levels for the period 2018-2023. Typical groundwater levels at the site are estimated to be between 6 and 7.5 mAOD, being lower in the north and higher to the south. The groundwater flow in the Chalk aquifer is towards the north. The River Ebbsfleet and the River Thames located approximately 2.75km north of the Site are considered discharge points for groundwater from the Chalk aquifer.
- 4.8.8 Although groundwater levels at the site seem to be slightly lower than those at the nearby Tollgate monitoring borehole on average, in the absence of site specific data, the maximum groundwater level recorded at Tollgate of 13 mAOD can be assumed to be representative of typical high groundwater levels at the site. Groundwater levels may be higher than this during extreme conditions.
- 4.8.9 Based on information provided on the online Defra Magic Map Application, the Site is located in an Outer Source Protection Zone (SPZ2). Being within SPZ2 indicates that groundwater in the Chalk aquifer beneath the Site is within the capture zone of a borehole used for potable water supply and that it will take less than 400 days for groundwater at the site to arrive at the abstraction point. The 400 day travel time is *“based loosely on consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants”*¹⁷. The boundaries of ten Inner Source Protection Zones (SPZ 1) are located within 3 km of the Site and lie at distances of approximately 570 m northwest, 720 m south, 750 m northeast, 950 m west and 1500 m southwest of the Site. SPZ1 is *“defined by a 50-day travel time from*

¹⁶ Environment Agency (2023), Hydrology Data Explorer: Tollgate [Online]. Accessed July 2024. Available at: https://environment.data.gov.uk/hydrology/station/db1d776d-2226-4979-8b90-733c0f352d32_441414004

¹⁷ Environment Agency, 2019. Manual for the production of Groundwater Source Protection Zones, March 2019.

any point below the water table to the source or a minimum 50-metre radius from the source, whichever is larger” (op.cit.). The EA uses SPZ1 to impose controls on a wide range of activities that could affect groundwater. The controls for activities in SPZ1 can be considered as good practice for operating in SPZ2. The SPZ boundaries, together with Licensed Abstractions located within 1.5 km of the Site are shown on Drawing No CA12848-016.

- 4.8.10 The site is considered to have high or medium-high groundwater vulnerability to surface pollution due to the limited superficial cover and generally high infiltration capacity of the Chalk bedrock¹⁸. Infiltration testing at the site supports this general statement, showing that the infiltration rates into the Chalk are high (measured rates were $4.5\text{--}5.9 \times 10^{-4}$ m/s). However, infiltration rates into the Thanet Formation were very much lower and could not be determined through the standard BRE365 methodology¹⁹. This suggests that areas of Thanet Sand overlying the Chalk would have lower vulnerability than the areas where the Chalk is at outcrop (Drawing No CA12848-014).
- 4.8.11 The superficial Head underlying the land immediately adjacent to the south western boundary of the Site is likely also to have a lower permeability for infiltration²⁰.
- 4.8.12 The groundwater vulnerability mapping also indicates that the Site has a risk from soluble rocks. The White Chalk Subgroup is a limestone formation and therefore potentially vulnerable to dissolution. The Groundsure report for the site (citing ²¹) lists three natural dissolution features (karst pipes) within 250 m of the Site, including one adjacent to the site on the northern side. A separate dissolution risk assessment has been completed for the site and identified the highest risk of dissolution to be associated with the steeper parts of the site where the Thanet Formation overlies the Chalk²². This is consistent with the occurrence of the reported solution pipe outside the site boundary.

¹⁸ [Groundwater Vulnerability Maps \(2017\) on MAGIC - data.gov.uk](#), accessed September 2024

¹⁹ RSK Geosciences, 2023. Dartford Energy Hub infiltration testing. Letter ref: 52589-L01, 27 October 2023.

²⁰ Aldiss, D T & Farrant, A R. 2002. An appraisal of the early Palaeogene deposits of North Kent. British Geological Survey Commissioned Report, CR/02/315N.

²¹ WHITAKER, W., The geology of the London Basin, Volume 4, Part 1., HMSO, London., 1872; British Geological Survey Memoir (Sheet 220,221,240)

²² Wardell Armstrong, 2024. Initial dissolution risk assessment. Draft report July 2024.

4.8.13 The Site is located within the EA North Kent Medway Chalk Groundwater Body²³, which was classified by the EA in 2019 as having 'Poor' overall status. The EA's identified reasons as to why the groundwater body is not currently achieving 'Good' status is primarily linked to pollution from rural areas due to poor agriculture and rural land management.

4.8.14 Information regarding groundwater quality was requested from the EA on 30 January 2024 and the EA confirmed that they do not hold any groundwater quality records within 3 km of the Site. The baseline groundwater quality at the site is therefore unknown.

4.8.15 As shown on the OS mapping, the source of the River Ebbsfleet (a number of springs) is located approximately 246m north east of the Site. It is considered that the water within the spring is from the Chalk aquifer. The River Ebbsfleet then flows northwards where it joins the River Thames approximately 2.75km north of the Site.

4.9 Licensed Abstractions, Private Water Supplies and Discharges

4.9.1 Data provided by the EA and presented in the Groundsure Report for the site identify 15 licensed groundwater abstraction points within 1.5 km of the Site (Table 8). Four licences (five abstraction points) are large abstraction licences for public water supply and are licensed to abstract up to 144 Million litres per day (ML/d) in total (87.6 ML/d as an annual average). Other abstractions in the area are for agricultural and industrial uses amounting to 25.7 ML/d (16.9 ML/d as an annual average). The nearest abstraction point to the site is around 200 m to the west at Joyce Hall Farm and is used for spray irrigation. The nearest potable water supply abstraction to the site is at Southfleet Pumping Station around 640 m to the north west of the site.

4.9.2 Dartford Borough Council and Gravesham Borough Council have confirmed that there are no Private Water Supplies (PrWS) located within 1.5 km of the Site.

²³ Environment Agency – Catchment Data Explorer: North Kent Medway Chalk Water Body [Online]. Accessed July 2024. Available at: <https://environment.data.gov.uk/catchment-planning/WaterBody/GB40601G500300>

Table 8 Licensed abstractions within 1.5 km of the Site

Licence No.	Operator	Annual Volume (m³)	Max Daily Volume (m³)	Point	Location relative to site	Licensed purposes
9/40/01/0523/G	Beslee Farms	74066	982	POINT C, BOREHOLE, JOYCE HALL FARM IN SOUTHFLEET	197m W	Spray Irrigation - Direct
9/40/01/0504/G/R01	D T G Elliott & Son Ltd	5910	910	POINT A, BOREHOLE, H5 CHALK, SOUTHFLEET	386m N	Spray Irrigation - Direct
				POINT B, BOREHOLE, H5 CHALK, SOUTHFLEET.	487m N	General Washing/Process Washing
						Spray Irrigation - Direct
						General Washing/Process Washing
9/40/01/0128/GR	Thames Water Utilities Ltd	829650	4000	WELL 1 AT SOUTHFLEET PUMPING STATION	639m NW	Potable Water Supply - Direct
				BOREHOLE 1 AT SOUTHFLEET PUMPING STATION	670m NW	Potable Water Supply - Direct
9/40/01/0500/G	D & M Gedney Ltd	86376	374	BOREHOLE AT COURT LODGE FARM	628m SW	Spray Irrigation - Direct
						Vegetable Washing
						Trickle Irrigation - Direct
SO/040/0037/006/R01	Thames Water Utilities Ltd	6716000	24200	BOREHOLE POINT F, (EPM) SOUTHFLEET (BOREHOLE & TWO AUDITS)	905m NW	Potable Water Supply - Direct
9/40/01/0511/G	Southern Water Services Ltd	17700000	92000	BOREHOLES, WELLS AND ADITS AT HAZELLS PS, NORTHFLEET	1151m S	Potable Water Supply - Direct
01/154/R01	Elis UK Limited	120000	400	POINT A, BOREHOLE AT SPRINGHEAD ENTERPRISE PARK	1241m N	Laundry Use
SO/040/0037/006/R01	Thames Water Utilities Ltd	6716000	24200	POINT I SANDY LANE AT BETSHAM	1369m W	Potable Water Supply - Direct
9/40/01/0051/GR	Tarmac Cement and Lime Limited	1186000	3382	POINT B AT BLUE LAKE NORTHFLEET CEMENT WORKS	1490m N	Non-Evaporative Cooling
						Process Water
						Spray Irrigation - Direct
						General Use (Medium Loss)
				POINT A AT BLUE LAKE NORTHFLEET CEMENT WORKS	1511m N	Non-Evaporative Cooling
						Process Water
						General Use (Medium Loss)
						Spray Irrigation - Direct
9/40/01/0092/B/GR	Kimberly-Clark Limited	4710000	19656	BOREHOLE 1, H5 CHALK, NORTHFLEET.	1509m N	Process Water
				BOREHOLE 2, H5 CHALK, NORTHFLEET.	1529m N	Process Water
				BOREHOLE 3, SPRINGHEAD LAKE, NORTHFLEET.	1529m N	Process Water

5 HYDROGEOLOGICAL CONCEPTUAL SITE MODEL

5.1.1 The purpose of a Hydrological Conceptual Site Model (HCSM) is to draw together the potential sources of groundwater recharge, groundwater flow pathways and potential receptors of the Site. The HCSM is used to undertake the assessment of potential risks from the Proposed Development and is summarised below.

5.2 Baseline

5.2.1 There are two main hydrological inputs to the Site area: precipitation and groundwater flow.

5.2.2 Precipitation that occurs within the Site may follow a number of pathways:

- surface runoff following the site topography towards the north;
- ground surface retention as standing water or interception by vegetation and loss to the atmosphere by evaporation;
- infiltration to the soil and loss to the atmosphere by plant transpiration;
- infiltration into the soil followed by vertical movement through the unsaturated zone and into the Chalk Aquifer that underlies the Site;
- some runoff may also infiltrate into the soil and be transpired by plants or infiltrate more deeply.

5.2.3 Pathways for runoff and flood water are discussed in more depth in the Flood Risk Assessment and Drainage Strategy.

5.2.4 Groundwater flows in the Chalk Aquifer beneath the Site. The Chalk is classed a Principal Aquifer and is regionally important for water supply. The water table in the Chalk is estimated to be typically at 6-7.5 mAOD at the Site (6-18 m below ground surface, being deeper to the south of the Site), but could be expected to reach 13 mAOD during wet winters and possibly higher, which would result in groundwater flooding of the lower-lying parts of the site.

5.2.5 There are no permanent water courses within the Site boundary although there is a pond at the north eastern boundary. The pond appears to be dry under normal conditions. Groundwater may emerge into the pond when groundwater levels are high.

5.2.6 A dry valley runs through the site from south to north and ultimately leads to the source of the River Ebbsfleet that is about 250 m north of the Site (this can be traced

in the occurrence of superficial Head deposits, see Drawing CA12848-011). Runoff from the site follows the dry valley network and flow northwards towards the River Ebbsfleet. However, the A2 trunk road forms a barrier to surface runoff along this flow path (see Flood Risk Assessment and Drainage Strategy).

- 5.2.7 The Chalk outcrops in a north-south trending strip that passes through the centre of the site, following the course of the dry valley where topographic elevations are lowest. The higher parts of the Site are underlain by the Thanet Formation that is 4-11 m thick over the Chalk. Site data show that the infiltration capacity of the Chalk is high whereas the infiltration capacity of the Thanet Formation is much lower. It is therefore expected that rain falling onto the Thanet Formation would be more likely to runoff, or pass laterally through the soil, than infiltrate to the water table whereas the opposite would be the case where the Chalk outcrops. Runoff recharge into the Chalk may occur at the down-slope edge of the Thanet Formation outcrop. In terms of groundwater vulnerability to surface pollution, this suggests that areas underlain by Thanet Sands are less vulnerable than where the Chalk is at outcrop. However, areas around the downslope margin of the Thanet Sands may be more vulnerable because recharge may become focussed on those areas.
- 5.2.8 The prevailing groundwater flow direction at the Site is towards the north. However, groundwater flow directions in the Chalk aquifer will be influenced by large groundwater abstractions located to the west and north west of the Site. Groundwater from within the Site boundary may be drawn towards those abstractions. The Site is located in SPZ2 indicating that travel time in the saturated zone from the Site to these abstractions could be less than 400 days. The fissured nature of the Chalk means that the Chalk is highly permeable and groundwater flow rates are rapid. However, it is noted that the 400 day travel time used to define SPZs is from the water table and does not include the time take for water to pass through the unsaturated zone. Flow through the unsaturated zone can provide protection to groundwater by allowing time for contaminants to be attenuated or diluted. Areas of shallow water table (or seasonal water table may fluctuations may bring it closer to ground surface) are therefore more vulnerable to surface pollution than areas with deeper water tables.
- 5.2.9 The presence of solution features in the limestone bedrock may affect the rate at which infiltrating rainwater moves through the unsaturated zone to the water table. Karstic pipes and enlarged vertical fissure systems may provide routes along which infiltrating water may flow preferentially. Solution features are known in the vicinity

of the Site but not proven within the Site boundary. Dissolution risk assessment suggests that the area where the Thanet Sands overly the Chalk is considered more likely to be at risk from solution features than where the Chalk is at outcrop.

5.2.10 Rates of groundwater abstraction in the vicinity of the Site are high, suggesting that groundwater abstraction is probably the main discharge route for groundwater in the area. However, groundwater will also discharge at springs and as baseflow in rivers. Springs at the source of the River Ebbsfleet to the north of the Site are the main natural discharge of groundwater from the aquifer beneath the Site. It is likely that groundwater preferentially flows towards these springs, following zones of higher permeability in the Chalk that follow the dry valley network.

5.2.11 There is no data on groundwater quality in the vicinity of the Site so the baseline groundwater quality is not known. The site is not contaminated from previous use.

5.3 Construction Phase

5.3.1 During construction, the following hazards may be introduced to the Site:

- sediment mobilised from bare ground by rainfall, vehicle movements and earthworks;
- sediment mobilised below ground surface by earthworks;
- fuel and oils that may be spilled or leak from plant or storage areas;
- cement and cement products; and
- foul water and sewage from temporary staff facilities.

5.3.2 Pathways that water may take through the Site could be changed from the baseline as follows during construction:

- landscaping may change the topography within the site and affect runoff patterns;
- compaction of soil along access routes and platform areas may reduce infiltration and increase runoff;
- soil and vegetation stripping may reduce loss of water by transpiration resulting in more runoff and infiltration;
- earthworks may reduce the thickness of the Thanet Formation, expose Chalk bedrock or expose solution features, allowing more direct infiltration of incident precipitation into the ground;

- earthworks may also increase the thickness of material overlying the Chalk, reducing direct infiltration rates and increasing runoff; and
- cable trenches or borings may provide a new pathway for groundwater flow if groundwater levels are high.

5.3.3 Receptors for construction phase risks are those identified in the baseline and can be grouped as follows:

- River Ebbsfleet and the River Ebbsfleet WFD water body;
- groundwater in the Chalk Aquifer and the North Kent Medway Chalk Groundwater Body;
- groundwater abstraction licences listed in Table 8.

5.3.4 Of the six potential source-pathway-receptor linkages identified in the Foundation Works Risk Assessment guidance²⁴ scenarios that are relevant to the construction phase at this Site are as follows:

- Scenario 1: Creation of preferential pathways, through a low permeability layer to allow potential contamination of an underlying aquifer. For the Site, this would include reducing the thickness of the Thanet Formation.
- Scenario 4: Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration). The depth of the water table in some areas of the site means that engineered structures may come into contact with groundwater if installed too deeply.
- Scenario 6: Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout. This could happen at the Site if cement products are not used correctly or installed beneath the water table.
- Scenarios 2, 3 and 5 are not applicable to this site.

5.3.5 These scenarios are included in the list of changes from the baseline HCSM set out above and have been evaluated as part of the HRA.

²⁴ Environment Agency, 2001. Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention National Groundwater & Contaminated Land Centre report NC/99/73.

5.4 Operational Phase

5.4.1 During operation, the following hazards may be introduced to the Site:

- fuel and oils that may leak from vehicles used at site;
- fuel and oil that may be spilled or leak from plant or equipment during repairs and maintenance;
- contaminants contained in cables, transformers and switch gear;
- water containing additives used for fire fighting; and
- heavy metals contained in batteries.

5.4.2 Pathways that water may take through the Site could be changed from the baseline as follows during operation:

- landscaping may change the topography within the site and affect runoff patterns;
- infiltration into the ground will be prevented along roads, tracks and over the battery platforms;
- infiltration will be increased where SuDS are installed or along the margins of roads/tracks that do not drain to SuDS;
- changes in vegetation types may increase soil water losses by transpiration and reduce infiltration rates to groundwater; and
- cable trenches or borings may provide a new pathway for groundwater flow if groundwater levels are high.

5.4.3 Receptors for operational phase risks are the same as identified for the construction phase.

5.5 Decommissioning

5.5.1 Hazards introduced, pathway changes and receptors for the decommissioning phase will be the same as during construction.

6 HYDROGEOLOGICAL RISK ASSESSMENT

6.1 Receptor Sensitivity

6.1.1 The sensitivity of receptors at potential risk from activities at the site has been assigned using the classification scheme presented in Table 1. The sensitivities are presented in Table 9.

Table 9 Summary of Receptors and Sensitivity			
Receptor	Distance from the site	Summary of Receptor Characteristics	Receptor Sensitivity (determined from Table 1)
Surface Water Bodies			
River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	EA classification of 'Moderate' ecological status	Medium
Groundwater Bodies			
Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	Principal Aquifer	High
Groundwater Abstractions			
9/40/01/0523/G Beslee Farms	197 m West	Licensed Abstraction (Groundwater)- agriculture	High
9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	Licensed Abstraction (Groundwater)- agriculture	High
9/40/01/0500/G D & M Gedney Ltd	628m SW	Licensed Abstraction (Groundwater)- agriculture	High
9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Licensed Abstraction (Groundwater) – public water supply	Very High
SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Licensed Abstraction (Groundwater) – public water supply	Very High
9/40/01/0511/G Southern Water Services Ltd	1151m S	Licensed Abstraction (Groundwater) – public water supply	Very High
01/154/R01 Elis UK Limited	1241m N	Licensed Abstraction (Groundwater) – industry	High
SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Licensed Abstraction (Groundwater) – public water supply	Very High
9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	Licensed Abstraction (Groundwater) – industry	High
9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	Licensed Abstraction (Groundwater) – industry	High

6.2 Source – Pathway – Receptor Linkages

6.2.1 Source – Pathway – Receptor linkages affect the magnitude and likelihood of effects from hazards being observed at receptors. This section presents an assessment of the linkages between each identified hazard and potential receptors that is then used to complete the risk assessment.

6.2.2 **Sediment mobilised from bare ground by rainfall, vehicle movements and earthworks.** Turbid water containing elevated concentrations of suspended sediment is of poor quality and can affect both surface water courses and groundwater. Sediment is most readily mobilised by runoff over unvegetated ground, particularly where disturbed by earth works and vehicle movements and if runoff is concentrated by poor drainage planning. Suspended sediment will tend to settle unless the flow rate of the water is sufficiently high that the particles are kept suspended. This means that likelihood of effects being observed decreases with distance from the hazard, particularly if the pathway is indirect. The magnitude of effect on surface water also decreases with distance from the hazard due to the potential for attenuation and dilution during transport. Mobilisation of sediment from the surface into groundwater would require infiltration rates to be very rapid, which would only occur at the Site during heavy rain and where the Chalk bedrock is exposed, where karst solution features are present or where SuDS ponds create focal points for infiltration. If suspended sediment were to pass rapidly through the unsaturated zone and reach the water table, transport within the aquifer would require groundwater flow rates to be high otherwise the particulate matter would settle out. This could be the case near to abstraction boreholes in fissured aquifers such as the Chalk (e.g. within SPZ1 for public water supply boreholes) but the likelihood of sediment being entrained in groundwater flow decreases as distance from hazard to receptor increases. The potential magnitude of effect also decreases with distance due to the potential for dilution and attenuation during transport. Measures can be put in place to contain and control sediment mobilisation, reducing the likelihood of effects being observed.

6.2.3 **Sediment mobilised below ground surface by earthworks.** Sediment mobilised below ground by earthworks or drilling is more likely to affect groundwater quality than sediment mobilised at the surface. This is because the pathway between the hazard and groundwater receptor is more direct. The effect would be greatest where earthworks take place below the water table because mobilised rock flour and fine sediment could be entrained directly in groundwater flow. As noted above, high rates of groundwater movement are required to keep sediment suspended and these

conditions are most likely to be present very near to abstraction boreholes. It is noted that no sub-water table works (e.g. piling or other ground improvement) are expected for this development and that is reflected in the assessment of risk from this hazard.

- 6.2.4 Fuel and oils that may be spilled or leak from vehicles, plant or storage areas.** Fuel and oils have the potential to cause contamination of surface and groundwater. Even low concentrations may have a serious effect such as putting a public water supply out of service or causing ecological damage to a river. Some of these substances are classed as hazardous substances that must be prevented from entering groundwater. Small spills of fuel and oil contaminants onto the ground could be transported into surface water courses in rainfall runoff or into groundwater if the spill is over permeable ground or if contaminated runoff is able to infiltrate into the ground (e.g. at SuDS ponds). The high rates of infiltration that can occur into the Chalk mean that the contaminant could reach the water table rapidly. Where the Thanet Formation is present over the Chalk, travel times to groundwater would be longer with greater potential for attenuation and lower magnitude of effect. Once at the water table, dissolved contaminants will be transported with the groundwater flow. With the Site being within SPZ2, the contaminant could arrive at an abstraction point used for public supply in less than 400 days and is more likely to have an effect than if the spill were outside SPZ2. However, there is potential for dilution and attenuation during groundwater flow and this will be greater as the distance between hazard and receptor increases. Larger spills of liquid contaminants are most likely to infiltrate into the soil and groundwater at or near to the point of the spill. The contaminants could become dissolved in groundwater and form a persistent and high concentration source of contamination. Measures can be put in place to control these pathways between the hazard and potential receptors.
- 6.2.5 Cement and cement products.** Reaction between uncured cement and water produces highly alkaline water ($\text{pH} > 10$) that is a particular hazard to surface water if able to discharge directly into surface water courses. This can occur where rainfall or site drainage comes into contact with uncured cement products. In the absence of a direct pathway between the hazard and the receptor, the highly alkaline water will be diluted by other runoff and attenuated by buffering reactions with soils and suspended sediments so that the magnitude of potential effect reduces with distance from the hazard. Similarly, groundwater is less susceptible to impacts from highly alkaline water due to the buffering capacity of the aquifer rock. However, where infiltration and groundwater flow rates are high (e.g. at SuDS ponds), or if cement

products are introduced directly to ground, the magnitude of impact may be higher. Measures can be put in place to reduce contact between rainfall/runoff and uncured cement products.

- 6.2.6 Foul water and sewage from temporary staff facilities.** Leaks and spills of foul water from staff facilities have the potential to contaminate both surface and groundwater with a range of inorganic, organic and biological (pathogen) contaminants. Spilled water may infiltrate directly into the ground or runoff with other surface water and mix with site drainage. Infiltration from SuDS ponds may provide a pathway into groundwater. The potential magnitude of effect and likelihood of occurrence decreases as the distance between the hazard and the receptor increases due to dilution and attenuation. As with suspended sediment, mobilisation of pathogens into groundwater requires high rates of infiltration and rapid groundwater flow, which can occur in the Chalk aquifer. The potential for a higher magnitude of effect is greatest within SPZ1 for public water supply abstractions. Pathogens will tend to be attenuated in the soil or unsaturated zone if infiltration rates are lower. Measures can be put in place to control the pathways for foul water to enter the water environment.
- 6.2.7 Contaminants contained in cables, transformers and switch gear; Heavy metals contained in batteries.** Oils used in electrical equipment and metals contained in batteries have the potential to cause contamination of surface and groundwater. This would only occur if the installations were seriously damaged. Both these groups of substances can be classes as hazardous substances and should be prevented from entering groundwater. The pathways by which these contaminants may enter surface or groundwater are the same as discussed for fuel and oil spillages and it is also possible that cables within trenches could become damaged and contaminants could come into contact with groundwater in the sub-surface, with the cable routes acting as pathways. Measures can be put in place to control the pathways.
- 6.2.8 Water containing additives used for fire fighting.** Responding to electrical fires often involves using fire-fighting foam that contains hazardous substances, most notably Perfluoroalkyl Substances (PFAS). In addition, damage to the BESS infrastructure in a fire may allow other contaminants to be released (e.g. heavy metals, organic pollutants) that could also pose a risk to water quality. Hazardous substances should be prevented from entering groundwater. During fire fighting, large amounts of water would be used and this water containing foam residues would infiltrate into the ground as well as runoff to surface water. Contaminated water would then be transported to surface water courses in runoff and with groundwater flow towards

abstraction borehole receptors. Although the concentrations of these contaminants would decrease with distance between the hazard and receptor due to dilution and possibly attenuation, safe levels of substances such as PFAS in drinking water are extremely low so a larger magnitude of effect could be expected at a receptor for these pollutants than for pollutants such as fuels and oils. Measures may be put in place to control the pathways for contaminants related to fire fighting water.

6.3 Embedded Mitigation

- 6.3.1 The construction and operation the Site would be undertaken in line with the guidance and codes of best practice specified in Table 10. These would limit the potential for disturbance or contamination of water resources.

Table 10 Good Practice Guide and Guidance Documents to Protect the Water Environment
Guidance for Pollution Prevention (GPP) 1 Understanding your environmental responsibilities – good environmental practices GPP 2 Above ground oil storage GPP 5 Works and maintenance in or near water GPP 8 Safe storage and disposal of used oils GPP 21 Pollution incident response planning GPP 22 Dealing with spills CIRIA C502 Environmental Good Practice on Site CIRIA C515 Groundwater Control-Design and Practice CIRIA C753 The SuDS Manual CIRIA C650 Environmental Good Practice on Site (Expansion Of C502) UK Technical Advisory Group on the WFD, UK Environmental Standards and Conditions (Phase 2), Final, March 2008

- 6.3.2 It is noted that all Pollution Prevention Guidance (PPGs) have been withdrawn by the EA as the legislative requirements contained within the documents are, in many cases, no longer correct. In Scotland and Northern Ireland, some PPGs have been replaced by Guidance on Pollution Prevention (GPP). The PPGs and GPPs are, however, still considered to be a relevant and effective source of best practice information and are widely used and accepted within the construction industry.
- 6.3.3 Site specific measures that should be implemented for construction and development are:
- Avoid storing fuel/oil/chemicals on areas underlain by Chalk bedrock unless a constructed system is in place to capture all spills and runoff from the storage area so that it does not infiltrate into the Chalk.

- Avoid removing the full thickness of the Thanet Formation when constructing platforms to maintain protection for groundwater.
- Avoid excavation below the water table (except for the purposes of site investigation/monitoring). This may affect the lower-lying parts of the site, including the cable route, if groundwater levels are particularly high.
- Cover cable trenches with impermeable capping to prevent infiltration of water into and through the trench.
- Include drainage within cable trenches to direct any groundwater seepage (e.g. at times of very high groundwater level) to suitable discharge points so as to reduce risk of groundwater flooding around the trenches.
- Implement the drainage strategy set out in the Flood Risk Assessment and Drainage Strategy.

6.4 Hydrogeological Risk Assessment

6.4.1 The hydrogeological risk assessment is presented in Table 11.

6.4.2 The hazards identified pose a low or very low risk to receptors meaning that embedded measures are sufficient to manage the risks to groundwater from the proposed development. Additional measures are not required.

6.5 Limitations and Assumptions

6.5.1 The assessments are affected by the following assumptions and limitations.

- The assessment has been based on the proposed development described in Section 3 of this report. Some aspects of the development have been assumed because design details have not yet been finalised.
- The assessment assumes that the generic and specific measures stated in Section 6.3 are in place and effective.
- There is no groundwater level data available for the Site therefore regional groundwater data gathered from the Environment Agency's (EA's) Hydrology Data Explorer has been used to estimate typical and maximum groundwater levels at the site. It has been assumed that the EA's Springhead Road borehole, which is approximately 1.3 km northeast of the site gives a good approximation of the groundwater levels underlying the Site.

- There is no baseline groundwater quality data for the site. For the assessment it has been assumed that the site is uncontaminated and that the only hazards present at the Site will be those introduced as a result of the proposed development.

6.5.2 If these assumptions are found to be incorrect in the future when additional work is completed at the site, this assessment may need to be updated.

Table 11. Hydrogeological Risk Assessment

Hazard	Receptor	Distance and direction	Sensitivity	Pathway	Magnitude of effect	Consequence	Likelihood with embedded mitigation	Level of risk with embedded mitigation	Explanation	Are additional measures required?
Sediment mobilised from bare ground by rainfall, vehicle movements and earthworks	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	Surface runoff	High	Moderate	Unlikely	Very Low	Runoff pathway controlled by embedded mitigation so effects unlikely.	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Indirect infiltration	Low	Minor	Unlikely	Very Low	Effect on groundwater overall is small and expected to be controlled by embedded mitigation.	No
	9/40/01/0523/G Beslee Farms	197 m West	High	Indirect infiltration and transport in groundwater	Medium	Moderate	Unlikely	Very Low	Borehole close to site but effect expected to be controlled by embedded mitigation.	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Indirect infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Distance from site reduces magnitude of effect and likelihood.	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Indirect infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Indirect infiltration and transport in groundwater	Low	Moderate	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Indirect infiltration and transport in groundwater	Low	Moderate	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Indirect infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Indirect infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Indirect infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Indirect infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Indirect infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
Sediment mobilised below ground surface by earthworks	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	No pathway	Low	Minor	Very unlikely	Very Low	No pathway	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Infiltration through the unsaturated zone	Medium	Moderate	Moderately Likely	Low	Effect on groundwater overall is small and subsurface earthworks very limited in extent so embedded measures reduce risk to very low level.	No
	9/40/01/0523/G Beslee Farms	197 m West	High	Infiltration through the unsaturated zone and transport in groundwater flow	High	Major	Unlikely	Low	Borehole close to site but subsurface earthworks very limited in extent so embedded measures reduce risk to very low level.	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Infiltration through the unsaturated zone and transport in groundwater flow	Medium	Moderate	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Infiltration through the unsaturated zone and transport in groundwater flow	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Infiltration through the unsaturated zone and transport in groundwater flow	Low	Moderate	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Infiltration through the unsaturated zone and transport in groundwater flow	Low	Moderate	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Infiltration through the unsaturated zone and transport in groundwater flow	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Infiltration through the unsaturated zone and transport in groundwater flow	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Infiltration through the unsaturated zone and transport in groundwater flow	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Infiltration through the unsaturated zone and transport in groundwater flow	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Infiltration through the unsaturated zone and transport in groundwater flow	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	Surface runoff	High	Moderate	Unlikely	Very Low	Runoff pathway controlled by embedded mitigation so effects unlikely.	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Indirect or direct infiltration	High	Major	Unlikely	Low	Effect has high magnitude but risk is low due to embedded mitigation	No

Hazard	Receptor	Distance and direction	Sensitivity	Pathway	Magnitude of effect	Consequence	Likelihood with embedded mitigation	Level of risk with embedded mitigation	Explanation	Are additional measures required?
Fuel and oils that may be spilled or leak from vehicles, plant or storage areas	9/40/01/0523/G Beslee Farms	197 m West	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole is near to site and potential for major consequence but risk is low due to embedded mitigation	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole is near to site and potential for major consequence but risk is low due to embedded mitigation	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Indirect or direct infiltration and transport in groundwater	Medium	Major	Unlikely	Low	Closest public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Risk is lowered by embedded measures.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Indirect or direct infiltration and transport in groundwater	Medium	Major	Unlikely	Low	Public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Risk is lowered by embedded measures.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Indirect or direct infiltration and transport in groundwater	Low	Moderate	Very unlikely	Very Low	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
Cement and cement products.	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	Surface runoff	High	Moderate	Unlikely	Very Low	Runoff pathway controlled by embedded mitigation so effects unlikely.	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Indirect or direct infiltration	Medium	Moderate	Unlikely	Very Low	Effect on groundwater overall is small and expected to be controlled by embedded mitigation.	No
	9/40/01/0523/G Beslee Farms	197 m West	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole is near to site and potential for major consequence but risk is low due to embedded mitigation and nature of groundwater pathway.	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole is near to site but distance reduces magnitude of effect. Risk is low due to embedded mitigation and nature of groundwater pathway.	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Indirect or direct infiltration and transport in groundwater	Low	Moderate	Very unlikely	Very Low	Closest public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the site. Risk is lowered by embedded measures and nature of groundwater pathway.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Indirect or direct infiltration and transport in groundwater	Low	Moderate	Very unlikely	Very Low	Closest public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the site. Risk is lowered by embedded measures and nature of groundwater pathway.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No

Hazard	Receptor	Distance and direction	Sensitivity	Pathway	Magnitude of effect	Consequence	Likelihood with embedded mitigation	Level of risk with embedded mitigation	Explanation	Are additional measures required?
Contaminants contained in cables, transformers and switch gear; Heavy metals contained in batteries.	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	Surface runoff	High	Moderate	Unlikely	Very Low	Runoff pathway controlled by embedded mitigation so effects unlikely.	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Indirect or direct infiltration	High	Major	Unlikely	Low	Effect has high magnitude but risk is low due to embedded mitigation	No
	9/40/01/0523/G Beslee Farms	197 m West	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole is near to site and potential for major consequence but risk is low due to embedded mitigation	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Indirect or direct infiltration and transport in groundwater	High	Major	Very unlikely	Very Low	Borehole is near to site and potential for major consequence but risk is low due to embedded mitigation	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Indirect or direct infiltration and transport in groundwater	Medium	Major	Very unlikely	Very Low	Closest public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Risk is lowered by embedded measures.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Indirect or direct infiltration and transport in groundwater	Medium	Major	Very unlikely	Very Low	Public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Risk is lowered by embedded measures.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
Foul water and sewage from temporary staff facilities	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	Surface runoff	High	Moderate	Unlikely	Very Low	Runoff pathway controlled by embedded mitigation so effects unlikely.	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Indirect or direct infiltration	High	Major	Unlikely	Low	Effect has high magnitude but risk is low due to embedded mitigation.	No
	9/40/01/0523/G Beslee Farms	197 m West	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole close to Site, effect has high magnitude but risk is low due to embedded mitigation and potential for attenuation along pathway.	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Unlikely	Very Low	Magnitude of effect reduced compared with boreholes closer to site due to distance. Risk is removed due to embedded mitigation and potential for attenuation along pathway.	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Indirect or direct infiltration and transport in groundwater	Low	Moderate	Unlikely	Very Low	Closest public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Risk is lowered by embedded measures and attenuation along pathway.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Indirect or direct infiltration and transport in groundwater	Low	Moderate	Very unlikely	Very Low	Public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Risk is lowered by embedded measures.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No

Hazard	Receptor	Distance and direction	Sensitivity	Pathway	Magnitude of effect	Consequence	Likelihood with embedded mitigation	Level of risk with embedded mitigation	Explanation	Are additional measures required?
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Indirect or direct infiltration and transport in groundwater	Low	Minor	Very unlikely	Very Low	Borehole down-gradient from site. Distance from site reduces magnitude of effect and overall level of risk.	No
Water containing additives used for fire fighting	River Ebbsfleet and EA River Ebbsfleet water body	246 m north of the Site	Medium	Surface runoff	High	Moderate	Unlikely	Very Low	Runoff pathway controlled by embedded mitigation so effects unlikely.	No
	Groundwater in the White Chalk Subgroup / EA North Kent Chalk groundwater body	Underlies the site	High	Indirect or direct infiltration	High	Major	Unlikely	Low	Embedded mitigation would prevent infiltration of fire-fighting water to groundwater within the site.	No
	9/40/01/0523/G Beslee Farms	197 m West	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole is near to site and potential for major consequence. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No
	9/40/01/0504/G/R01 D T G Elliott & Son Ltd	386 m North	High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Borehole is near to site and potential for major consequence. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No
	9/40/01/0500/G D & M Gedney Ltd	628m SW	High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0128/GR Thames Water Utilities Ltd	639m NW	Very High	Indirect or direct infiltration and transport in groundwater	High	Major	Unlikely	Low	Closest public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site, although sensitivity is very high. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	905m NW	Very High	Indirect or direct infiltration and transport in groundwater	Medium	Major	Unlikely	Low	Public water supply down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site, although sensitivity is very high. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No
	9/40/01/0511/G Southern Water Services Ltd	1151m S	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	01/154/R01 Elis UK Limited	1241m N	High	Indirect or direct infiltration and transport in groundwater	Medium	Moderate	Unlikely	Very Low	Borehole down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No
	SO/040/0037/006/R01 Thames Water Utilities Ltd	1369m W	Very High	Indirect or direct infiltration and transport in groundwater	Negligible	Negligible	Very unlikely	None	Up-gradient from site therefore no pathway for effect	No
	9/40/01/0051/GR Tarmac Cement and Lime Limited	1490m N	High	Indirect or direct infiltration and transport in groundwater	Medium	Moderate	Unlikely	Very Low	Borehole down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No
	9/40/01/0092/B/GR Kimberly-Clark Limited.	1509m N	High	Indirect or direct infiltration and transport in groundwater	Medium	Moderate	Unlikely	Very Low	Borehole down-gradient of site. Distance from site reduces magnitude of effect compared with abstractions closer to the Site. Embedded mitigation prevents infiltration of firefighting water and therefore removes pathway for risk.	No

7 REQUISITE SURVEILLANCE

- 7.1.1 The Hydrogeological Risk Assessment has identified that levels of risk from the Site are low in most cases with the embedded measures in place. A programme of monitoring and surveillance is needed during construction and operation to ensure that these measures remain in place and effective. For the construction phase, the surveillance requirements should be set out in a Construction Environmental Management Plan (CEMP). For the operational phase, an Environmental Management System (EMS) should be put in place that will similarly set out the level of surveillance required. Ensuring that the measures outlined to manage infiltration set out in the Flood Risk Assessment and Drainage Strategy are constructed appropriately and continue to function as designed during operation is vital for protecting groundwater quality at the Site and nearby receptors.
- 7.1.2 No environmental monitoring data for the Site were available to support the assessment. It is recommended that baseline soil and groundwater quality sampling is completed before construction starts at the Site to establish whether there is any existing contamination at the Site. There is also some uncertainty over groundwater levels at the site and it would be beneficial to collect data that could validate the assumptions made to support this assessment.

8 SUMMARY AND CONCLUSIONS

- 8.1.1 The Site lies within the Ebbsfleet Water Body catchment. Runoff from the Site will drain down-topographic gradient and travel north. The Site is located on Thanet Formation and the White Chalk Subgroup bedrock which are Secondary A and Principal Aquifers, respectively. The Chalk aquifer is vulnerable to surface contamination due to high infiltration rates and high groundwater flow rates. The Thanet Formation provides some protection for the underlying Chalk because infiltration rates are lower. The site is located in the Outer Source Protection Zone (SPZ2) for groundwater abstractions used for public water supply. This demonstrates that the groundwater environment is both vulnerable and sensitive to changes.
- 8.1.2 A range of hazards to surface and groundwater may be introduced during construction and operation of the site. These hazards are mainly those that could cause contamination of groundwater and affect the quality of water in rivers and at nearby groundwater abstraction boreholes.
- 8.1.3 The risk posed by the hazards has been assessed and, with embedded measures in place, the hazards identified were found to pose a low or very low risk to groundwater and surface water receptors. No additional measures would be required.
- 8.1.4 Surveillance is required during construction and operation to ensure that the proposed measures are in place and remain effective. Baseline monitoring of groundwater quality and levels at the Site should be undertaken to confirm assumptions made during this assessment.

APPENDICES

APPENDIX A

Groundsure Report Extract – Groundwater Flooding

Station Road, Southfleet, DA13 9PA

Order Details

Date: 29/06/2023
Your ref: CA11305
Our Ref: GSWA1-SA8-BU1-BY7-MT7

Site Details

Location: 561757 172112
Area: 8.39 ha
Authority: [Dartford Borough Council](#) ↗



Summary of findings

[p. 2 >](#) **Aerial image**

[p. 9 >](#)

OS MasterMap site plan

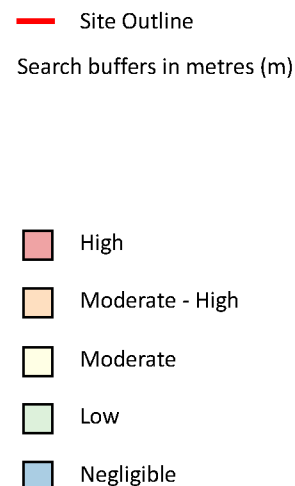
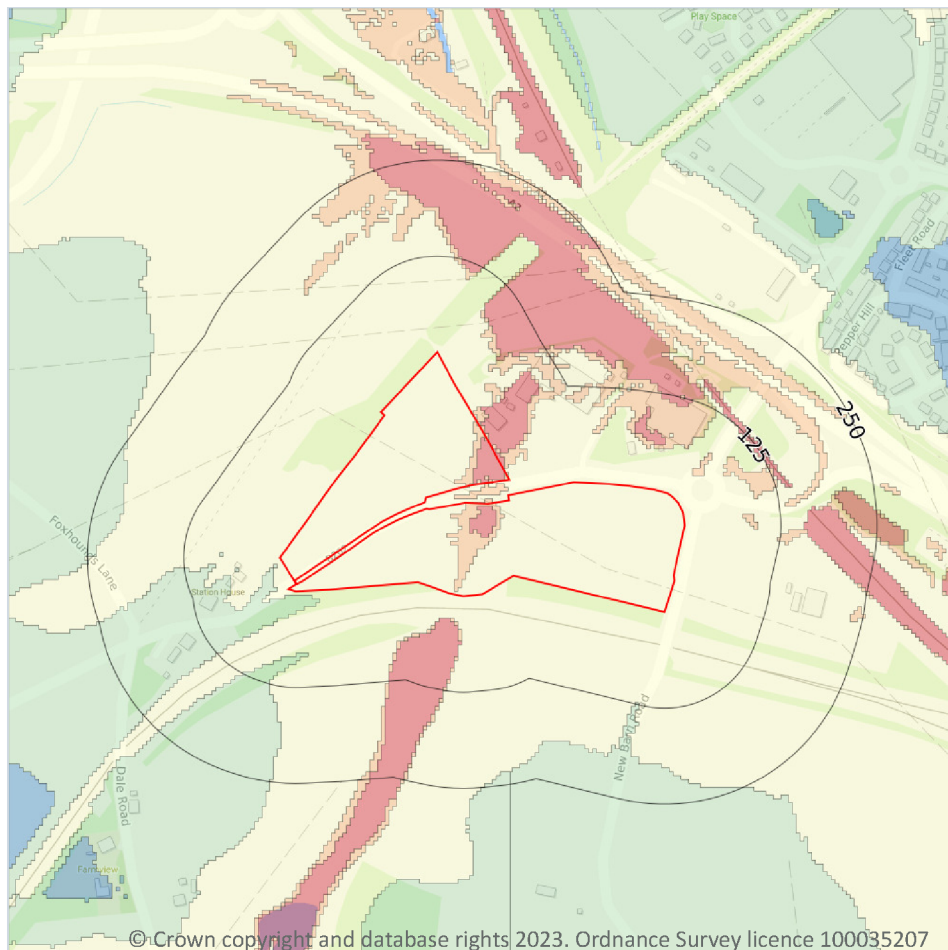
[p.14 >](#) groundsure.com/insightuserguide ↗

Contact us with any questions at:

info@groundsure.com ↗

01273 257 755

9 Groundwater flooding



9.1 Groundwater flooding

Highest risk on site

High

Highest risk within 50m

High

Groundwater flooding is caused by unusually high groundwater levels. It occurs when the water table rises above the ground surface or within underground structures such as basements or cellars. Groundwater flooding tends to exhibit a longer duration than surface water flooding, possibly lasting for weeks or months, and as a result it can cause significant damage to property. This risk assessment is based on a 1 in 100 year return period and a 5m Digital Terrain Model (DTM).

Features are displayed on the Groundwater flooding map on [page 79 >](#)

This data is sourced from Ambiantal Risk Analytics.

APPENDIX B

Collated Borehole Logs



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL					Site CTRL GI DATA - Entire NDATA19 data set		Trial Pit Number TP7944		
Excavation Method Trial Pit		Dimensions		Ground Level (mOD) 13.81		Client UR/LCE		Job Number Issue 1	
		Location 561748 E 172051 N		Dates 23/10/1997- 24/10/1997		Engineer RLE		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend	Water
0.50 0.50	D2 B1			13.51	(0.30) 0.30	Brown slightly sandy (fine and medium) SILT with a little angular to rounded fine to coarse flint gravel.;(TOPSOIL)			
					(1.10)	Firm red brown very silty CLAY with a little angular to rounded fine to coarse flint gravel.;(HEAD)			
1.50 1.50	D4 B3			12.41	1.40	Firm light brown very silty CLAY, locally with a little fine sand.;(HEAD)			
					(0.80)				
2.50 2.50	D6 B5			11.61	2.20	Structureless CHALK composed of white and greenish cream sandy silt size comminuted chalk with some subangular gravel sized moderately weathered, very weak, low density chalk fragments.;(UPPER CHALK - GRADE VI, low density,Dm);At 2.20m; with occasional rinded flint cobbles and boulders.			
				10.61	3.20	Complete at 3.20m			
Plan					Remarks				
					1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out.;2. Groundwater was not apparent during excavation.;3. The sides of the trial pit remained stable during excavation.;4. Two soakaway tests were carried out in the trial pit prior to backfilling.;5. The trial pit was fenced and covered overnight from 23/10/1997 to 24/10/1997.;6. On completion the trial pit was backfilled with arisings.				
					Scale (approx) 1:50		Logged By SMC/jw		Figure No.

 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set			Borehole Number RC8900	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 17.08		Client UR/LCE		Job Number Issue 1		
		Location 561589 E 172369 N		Dates 20/07/1998		Engineer RLE		Sheet 1/3		
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.00 0.00 0.00-0.30 0.30-0.90	W2 W1 D1 D2				16.78	(0.30) 0.30	TOPSOIL			
						(0.90)	Grey and brown angular to rounded GRAVEL of flint with much brown fine sand. (HEAD)			
0.90-1.20	D3				15.88	1.20	Grey brown slightly clayey fine SAND with occasional fine gravel of flint. (HEAD)			
						(2.80)	Below 3.00m becoming red brown and grey brown.			
					13.08	4.00	CHALK (UPPER CHALK)			
						(6.00)				
					7.08	10.00				
Remarks 1. See sheet 5 for installation details.								Scale (approx) 1:50	Logged By RS	
								Figure No.		



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number RC8900	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 17.08		Client UR/LCE		Job Number Issue 1	
		Location 561589 E 172369 N		Dates 20/07/1998		Engineer RLE		Sheet 2/3	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
							CHALK (AS SHEET 1)		
						(10.00)			▼1
				Water strike(1) at 16.00m, rose to 15.10m in 20 mins. 20/07/1998:16.00m					▽1
				Run time - 3m:05s					
					-2.92	20.00			
Remarks							Scale (approx) 1:50	Logged By RS	
							Figure No.		



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL					Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number RC8900		
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 17.08		Client UR/LCE		Job Number Issue 1	
		Location 561589 E 172369 N		Dates 20/07/1998		Engineer RLE		Sheet 3/3	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
							CHALK (AS SHEET 2)		
						(1.00)			
					-3.92	21.00	Complete at 21.00m		
Remarks							Scale (approx)	Logged By	
							1:50	RS	
							Figure No.		



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number RC8901	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 10.07		Client UR/LCE		Job Number Issue 1	
		Location 561970 E 172339 N		Dates 19/07/1998		Engineer RLE		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00 0.00 0.20-0.20	W2 W1 D1				9.87	0.20	TOPSOIL Brown CLAY with occasional fine gravel of flint. (HEAD)		
0.75-0.75	D2					(1.80)			
					8.07	2.00	Black brown angular fine to medium GRAVEL of flint with a little clay. (HEAD)		
						(2.00)			
					6.07	4.00	CHALK (UPPER CHALK)		
						(6.00)			
					0.07	10.00			
Remarks 1. See sheet 4 for installation details.							Scale (approx) 1:50	Logged By RS	
							Figure No.		



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number RC8901	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 10.07		Client UR/LCE		Job Number Issue 1	
		Location 561970 E 172339 N		Dates 19/07/1998		Engineer RLE		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				Water strike(1) at 11.50m, rose to 7.87m in 20 mins. 19/07/1998:11.50m			CHALK (AS SHEET 1)		✓
				Run time - 2m:50s		(10.00)			
					-9.93	20.00			
Remarks							Scale (approx) 1:50	Logged By RS	
							Figure No.		



British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA6513		
Boring Method Cable Percussion		Diameter			Ground Level (mOD) 18.27		Client UR/LCE		Job Number Issue 1	
		Location 562108 E 172146 N			Dates 02/07/1996-04/07/1996		Engineer RLE		Sheet 1/3	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.50	B1	1.65		50 blows	17.82	(0.65)	Dense, brown clayey fine to coarse SAND with much angular fine to coarse flint, brick, chalk and slag gravel.:(MADE GROUND)			
						(0.45)	Dense, orange brown sandy (fine) very clayey SILT with a little angular and subangular fine and medium chalk, flint and brick gravel.:(MADE GROUND)			
1.20-1.65	U2					17.17	1.10	Firm, brown and grey green sandy (fine) CLAY with a little angular to rounded fine to coarse flint, brick, charcoal and ceramic gravel and occasional angular fine and medium gravel sized shell fragments.:(MADE GROUND);From 1.10m to 1.40m; thinly laminated.;From 2.20m to 2.50m; with some angular to rounded fine and medium charcoal, flint and chalk gravel.		
1.70 1.70-2.15	D3 U4					(1.40)				
2.20-2.65 2.20 2.20-2.65 2.20-2.70 2.70-3.15	SPT N=12 D5 D6 B7 U8	3.20		2,2/4,3,2,3 26 blows	15.77	2.50	Soft to firm, brown green very sandy (fine) CLAY, locally clayey silty sand, with pockets (up to 50mm long) of grey green very sandy (fine) clay and occasional angular coarse sand and fine gravelsize white shell fragments.:(MADE GROUND)			
						(1.00)				
3.20 3.20-3.65	D9 U10					14.77	3.50	Stiff, brown green slightly sandy to sandy (fine to coarse) CLAY with a little, locally some, angular to subrounded fine to coarse flint and chalk gravel and occasional pockets of dark grey organicclay.:(MADE GROUND)		
3.70-4.15 3.70 3.70-4.15 3.70-4.20 4.20-4.65	SPT N=23 D11 D12 B13 U14	4.65		2,4/6,6,4,7 60 blows	13.17	5.10	Firm, orange brown locally slightly sandy (fine) very silty CLAY with occasional pockets (up to 50mm x 100mm) of mottled green/black organic slightly sandy (fine and medium) clay and rare coarsesand and fine gravel size white shell fragments.:(MADE GROUND);From 5.20m to 5.30m; locally orange brown very clayey silt.			
						(1.10)				
4.70 4.70-5.15	D15 U16									
5.20-5.65 5.20 5.20-5.65 5.20-5.70 5.70-6.15	SPT N=15 D17 D18 B19 U20	6.15		2,3/3,3,4,5 35 blows	12.07	6.20	Firm orange brown slightly sandy (predominantly fine) very silty CLAY.:(HEAD);Below 6.70m; becoming stiff.			
6.20 6.20-6.65	D21 U22									
6.70-7.15 6.70 6.70-7.15 6.70-7.20 7.20-7.65	SPT N=19 D23 D24 B25 U26	8.00		3,3/4,5,4,6 50 blows	10.27	8.00	Dense to very dense, brown slightly clayey slightly sandy to sandy (fine to coarse) angular to rounded fine to coarse flint GRAVEL with occasional subangular and subrounded flint cobbles.:(HEAD)			
						(1.60)				
7.70 7.70-7.95 8.00-8.45 8.00 8.00-8.50	D27 U28 CPT N=47 D29 B30									
9.00-9.44 9.00-9.50	CPT 50/285 B31	9.00	7.80	7,9/12,12,14,12						
9.60-10.05	U32				8.67	9.60	Off white and cream structureless CHALK composed of firm cream sandy silt sized fragments with occasional subangular to subrounded predominantly fine and medium			
Remarks 1) Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was then excavated by hand to 1.20m depth. ;2) Groundwater was encountered at 18.60m; during the subsequent monitoring period the water level in the borehole rose to 17.94m in 5 minutes, 17.36m in 10 minutes, 17.02m in 15 minutes, and 16.79m in 20 minutes.;3) Water was added to assist boringfrom 8.50m to 10.00m and from 14.55m to 18.60m.;4) Approximate boundary in chalk based on differences between successive U100 sample descriptions. Boundary placed at increase in SPT 'N' value.;4) On completion of boring, a 25mm standpipe piezometer was installed with the Casagrande tip at 12.00m depthand the following detail: From 21.10m to 15.00m, cement/bentonite grout; from 15.00m to 13.50m, bentonite seal; from 13.50m to 10.50m, pea gravel filter response zone; from 10.50m to 9.50m, bentonite seal; from 9.50m to 0.50m, cement/bentonite grout; and from 0.50m to ground level concrete and a double flush stopcock cover.								Scale (approx) 1:50	Logged By TF	
								Figure No.		



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA6513	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 18.27		Client UR/LCE		Job Number Issue 1	
		Location 562108 E 172146 N		Dates 02/07/1996- 04/07/1996		Engineer RLE		Sheet 2/3	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.10 10.10-10.55	D33 U34			44 blows			gravel sized white, locally slightly speckled black and stained pale yellow, moderately weathered, weak, medium density fragments. Occasional, up to cobble sized, locally rinded, flint nodules and angular fragments.,(UPPER CHALK - GRADE VI, medium density, Dm);APPROXIMATE BOUNDARY		
10.60-11.05 10.60 10.60-11.05 10.60-11.10 11.10-11.55	SPT N=6 D35 D36 B37 U38	10.60	9.00	1,2/1,2,1,2 38 blows					
11.60 11.60-12.05	D39 U40			44 blows					
12.10-12.55 12.10 12.10-12.55 12.10-12.60 12.60-13.05	SPT N=6 D41 D42 B43 U44	11.60	10.90	2,1/1,2,2,1 30 blows					
13.10 13.10-13.55	D45 U46			30 blows					
13.60-14.05 13.60 13.60-14.05 13.60-14.10 14.10-14.55	SPT N=5 D47 D48 B49 U50	13.10	12.90	1/1,2,1,1 40 blows					
14.60 14.60-15.05	D51 U52			32 blows		(10.00)			
15.10-15.55 15.10 15.10-15.55 15.10-15.60 15.60-16.05	SPT N=13 D53 D54 B55 U56	13.10		1/2,3,3,5 54 blows					
16.10 16.10-16.55	D57 U58			90 blows					
16.60-17.05 16.60 16.60-17.05 16.60-17.10 17.10-17.55	SPT N=17 D59 D60 B61 U62	13.10		1,3/4,4,5,4 62 blows				▽ ₁	
17.60-18.05 17.60 17.60-18.05 17.60-18.10 18.10-18.55	SPT N=7 D63 D64 B65 U66	17.10	17.40	3,3/2,2,2,1 54 blows					
18.60 18.60 18.60-19.05 18.60-19.05 18.60-19.10 19.10-19.55	D67 W70 D68 SPT N=10 B69 U71	18.10	18.10	Water strike(1) at 18.60m, rose to 16.79m in 20 mins. 2,2/3,2,2,3 100 blows 03/07/1900:15.95m				▽ ₁	
19.60 19.60-20.05 19.60-20.10	D72 D73 B74			03/07/1900 03/07/1900:8.29m	-1.33	19.60	Off white moderately weathered CHALK, weak, medium density. Fractures probably closely spaced, randomly orientated, generally clean, surfaces tightly speckled black		
Remarks							Scale (approx) 1:50	Logged By TF	Figure No.



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA6513	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 18.27		Client UR/LCE		Job Number Issue 1	
		Location 562108 E 172146 N		Dates 02/07/1996- 04/07/1996		Engineer RLE		Sheet 3/3	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
19.60-20.05 20.10-20.55	SPT N=21 U75	19.10	16.30	3,4/4,6,5,6 100 blows		(1.50)	and lightly stained light orange brown.;(UPPER CHALK - GRADE I/III, medium density, A3)		
20.60-21.05 20.60 20.60-21.05	SPT N=26 D76 D77	19.50	16.80	3,4/4,6,9,7	-2.83	21.10	Complete at 21.10m		
Remarks							Scale (approx) 1:50	Logged By TF	Figure No.



British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA6684	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 27.01		Client UR/LCE		Job Number Issue 1	
Location 561470 E 171987 N		Dates 11/07/1996- 12/07/1996		Engineer RLE		Sheet 1/2			
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.35-1.20	B1				26.66	(0.35) 0.35	Dark brown sandy (fine to coarse) SILT with some angular to rounded fine to coarse flint and chalk gravel.:(HEAD) Firm to stiff, brown grey and orange mottled sandy (predominantly fine), locally very clayey SILT with a little angular to subrounded fine and medium chalk and flint gravel.:(HEAD);At 0.35m; locally clay.;Below 2.20m; becoming stiff.;Below 4.35m; becoming very sandy.		
1.20-1.65	U2			40 blows					
1.70 1.70-2.15	D3 U4			64 blows					
2.20-2.65 2.20 2.20-2.65 2.20-2.70 2.70-3.15	SPT N=25 D5 D7 B6 U8			3,4/5,6,7,7 56 blows		(4.35)			
3.20 3.20-3.65	D9 U10			60 blows					
3.70-4.15 3.70 3.70-4.15 3.70-4.35	SPT N=18 D11 D13 B12	2.60		2,3/4,3,5,6					
4.35-4.80	U14			91 blows					
4.85-5.30 4.85 4.85-5.30 4.85-5.40 4.85-6.55 5.40-5.85	SPT N=27 D15 D17 B16 B16+20 U18	4.00		3,5/6,5,7,9 65 blows	22.31	4.70 (1.85)	Medium dense, dark grey green and brown sandy (predominantly fine) SILT, locally with some fine to coarse gravel.:(HEAD)		
5.90 5.90-6.20 5.90-6.55	D19 U B20			120 blows					
6.55 6.60-6.80 6.80-7.03 6.80-7.16 6.80-7.30	D21 U22 SPT 51/75 D24 B23	6.10		100 blows 11,14/18,15,18	20.46 20.01	6.55 (0.45) 7.00	Recovered as: Structureless CHALK composed of angular fine to coarse gravel sized cream, locally speckled black, highly weathered, very weak to weak, low to medium density fragments with a little matrix of cream and light brown sandy silt sized fragments. With a little subangular fine to coarse flint gravel and occasional cobbles.:(UPPER CHALK - GRADE?)		
7.70-7.82 7.70-8.30	CPT 25*/115 B25	7.60		21,4/50			Off white moderately weathered CHALK, weak, medium density. Fractures probably very closely spaced, randomly orientated, generally clean, surfaces slightly speckled black, locally moderately stained light orange brown.:(UPPER CHALK - GRADE III, medium density, A4);From 7.70m to 8.30m; with many rounded flint cobbles.		
8.30-8.75	U26			47 blows					
8.80 8.80-9.25	D27 U28			68 blows					
9.30-9.75 9.30 9.30-9.75 9.30-9.80 9.80-10.25	SPT N=30 D29 D31 B30 U32	8.10		5,6/7,7,8,8 59 blows					
Remarks 1) Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was excavated by hand to 1.20m depth. ;2) The presence of groundwater was not apparent during boring, however groundwater could have been obscured by the addition of water to assist progress from 7.50m to 10.70m.;3) The borehole was advanced by chiselling from 6.20m to 6.55m for 45 minutes and from 7.70m to 8.30m for 90 minutes.;4) On completion of boring, a 25mm standpipe piezometer was installed with the Casagrande tip at 9.50m depth and the following detail: From 10.30m to 7.00m, gravel filter response zone; from 7.00m to 6.00m, bentonite seal; from 6.00m to 0.50m, cement/bentonite grout; and from 0.50m to ground level concrete and a flush stopcock cover.							Scale (approx) 1:50	Logged By TF	Figure No.



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA6684	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 27.01		Client UR/LCE		Job Number Issue 1	
		Location 561470 E 171987 N		Dates 11/07/1996- 12/07/1996		Engineer RLE		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.30	D33				16.71	(3.30) 10.30	Complete at 10.30m		
Remarks							Scale (approx) 1:50	Logged By TF	Figure No.



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA7892	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 34.26		Client UR/LCE		Job Number Issue 1	
		Location 561281 E 171812 N		Dates 28/10/1997- 29/10/1997		Engineer RLE		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50-1.00	B1				33.96	(0.30) 0.30	Brown sandy SILT with a little flint gravel.:(TOPSOIL)		
1.20-1.65 1.20-1.65	SPT N=33 D2			2,6/5,8,10,10		(2.40)	Stiff brown sandy (fine) very silty CLAY, locally grading into SILT, with a little chalk gravel.:(HEAD?)		
1.70-2.20	B3								
2.20-2.65 2.20-2.65	SPT N=23 D4			5,6/5,6,6,6					
				28/10/1900	31.56	2.70	Medium dense light grey brown and orange brown mottled very silty fine SAND. :(THANET SAND);Below 3.20m; sandy (fine) SILT. ;Below 5.20m; slightly clayey.		
3.20-3.65 3.20-3.65 3.20-3.70	D5 SPT N=25 B6	3.10		29/10/1900 5,6/6,6,6,7					
4.20-4.65 4.20-4.65	SPT N=35 D7	3.10		4,6/7,8,9,11		(3.50)			
4.70-5.20	B8								
5.20-5.65 5.20-5.65	SPT N=30 D9	3.10		4,6/6,7,7,10					
6.20-6.65 6.20-6.65 6.20-6.70	SPT N=27 D10 B11	3.10		3,4/5,6,7,9	28.06	6.20	Stiff grey brown and orange brown mottled sandy (fine) very silty CLAY, locally grading into clayey sandy silt.:(THANET SAND);Below 8.00m; becoming grey. ;Below 9.20m; becoming sandy (fine to coarse) with some angular to subrounded gravel and cobble sized flints.		
6.70-7.15	U12			100 blows					
7.20-7.65 7.20 7.20-7.65	SPT N=20 D13 D14	3.10		2,3/4,4,6,6		(3.00)			
7.70-8.15 7.70-8.20	U16 B15			100 blows					
8.20-8.65 8.20 8.20-8.65	SPT N=33 D17 D18	3.10		3,5/7,9,8,9					
8.70-9.05	U19			100 blows					
9.10 9.20-9.54 9.20-9.62 9.20-9.70	D20 SPT 50/190 D21 B22	3.10		3,5/9,21,20	25.06	9.20 (0.70)	Grey brown sandy (fine to coarse) with a little angular to rounded gravel and cobble sized flints.:(BULLHEAD BEDS)		
9.70-10.20	B23				24.36	9.90			
Remarks 1. Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was handdug to 1.20m. (1 hour);2. Groundwater was not apparent during boring.;3. The substratum description at 10.20m is based on the description of an extruded U100 sample.;4. On completion the borehole was backfilled with cement/bentonite grout to ground level.								Scale (approx) 1:50	Logged By DM/jw
								Figure No.	



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA7892	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 34.26		Client UR/LCE		Job Number Issue 1	
		Location 561281 E 171812 N		Dates 28/10/1997- 29/10/1997		Engineer RLE		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.20-10.62 10.20-10.40 10.45	SPT 28/265 U24 D25	3.10		13,12/9,8,6,5			Cream white CHALK. Recovered as cream white subangular gravel to cobble sized moderately weathered, very weak, low density fragments with some cream white clayey silt sized comminuted chalk Occasional gravel to cobble sized flints. (UPPER CHALK - GRADE ?); At 10.20m; structureless CHALK composed of sandy silt sized fragments with occasional subhorizontal fine and medium gravel sized very weak, low density fragments. (GRADE VI, low density, Dm)		
10.70-11.15 10.70-11.15	SPT N=32 D26	3.10		4,7/8,8,8,8					
11.20-11.65 11.20-11.70	U27 B30			100 blows					
11.70-12.15 11.70 11.70-12.15	SPT N=21 D28 D29	3.10		3,4/5,5,6,5					
12.20-12.50 12.55	U31 D32			100 blows		(5.10)			
12.70-13.15 12.70-13.15 12.70-13.20	SPT N=17 D33 B34	3.10		2,4/4,4,4,5					
13.20-13.50 13.55	U35 D36			100 blows					
13.70-14.15 13.70-14.15	SPT N=17 D37	3.10		3,4/3,5,3,6					
14.20-14.65 14.20-14.70	U38 B41			90 blows					
14.70-15.15 14.70 14.70-15.15	SPT N=19 D39 D40	3.10		3,3/4,4,5,6					
				29/10/1900 29/10/1900 29/10/1900	19.26	15.00	Complete at 15.15m		
Remarks							Scale (approx) 1:50	Logged By DM/jw	Figure No.

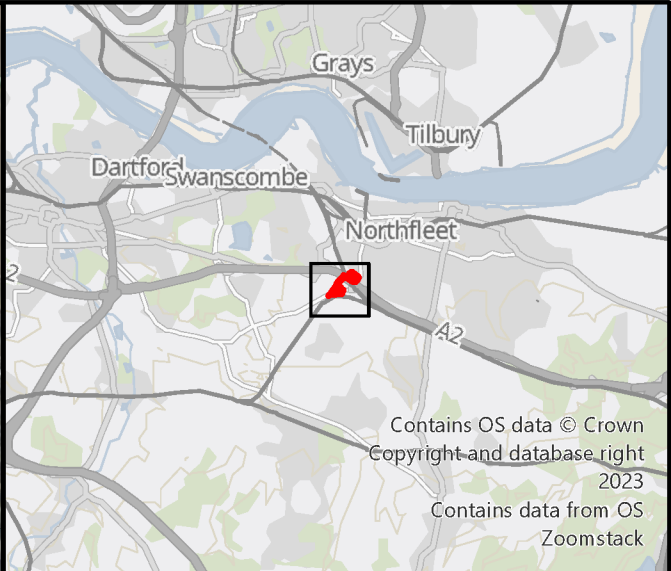


 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA9394	
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 22.80		Client UR/LCE		Job Number Issue 1	
		Location 561819 E 171971 N		Dates 02/11/1998- 03/11/1998		Engineer RLE		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
1.20-1.65 1.20-1.70	CPT N=46 B1			7,10/13,10,10,13		(1.80)	Dense, orange brown angular to rounded, fine to coarse flint GRAVEL and fine to coarse SAND with a little clay. Occasional nodular flint cobbles (up to 150mm).;(HEAD)		
1.80-1.90	D2				21.00	1.80	Loose, grey and orange brown fine occasionally medium and coarse SAND with much clay. Occasional partings of light grey brown fine and medium sand with a little clay. Occasional subangular to subrounded, fine to coarse flint gravel. Some iron staining.;(THANET SAND)		
3.00-3.45 3.00-3.45 3.00-4.00	SPT N=9 D3 B4	3.00		1,2/2,2,2,3		(2.45)			
4.50-4.95	U5			38 blows	18.55	4.25	Off white, CHALK: recovered as; silt sized fragments with some subangular to subrounded 2 to 40mm locally up to 120m fragments. Occasional nodular flints up to 150mm. Occasional iron staining and occasional black speckling.;(UPPER CHALK, Grade ?);From 6.00m to 6.40m; off white slightly weathered chalk, weak, medium density. Fractures very closely spaced, irregular, clean, surfaces slightly stained orange brown and speckled black. (Grade -, medium density, A4);From 10.50m to 10.95m; off white slightly weathered chalk, weak, medium density. Fractures very closely spaced, irregular, clean, surfaces slightly stained orange brown and speckled black. (Grade -, medium density, A4)		
4.95-5.00 5.00-5.45 5.00-5.45 5.00-5.50	D6 SPT N=10 D7 B6	4.50		2,2/2,3,2,3					
6.00-6.45	U9			30 blows					
6.45-6.50 6.50-6.95 6.50-6.95 6.50-7.00	D10 SPT N=10 D11 B12	4.50		2,2/1,2,4,3					
7.50-7.95	U			50 blows					
8.00-8.45 8.00-8.45	SPT N=13 D13	4.50		3,2/3,2,3,5					
8.50-9.00	B14								
9.00-9.45	U15			30 blows					
9.45-9.50 9.50-9.95 9.50-9.95	D16 SPT N=17 D17	4.50		3,4/3,4,4,6					
Remarks 1) Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was excavated by hand to 1.20m depth. ;2) The presence of groundwater was not apparent during boring. ;3) Water was added to assist boring from 1.70m to 4.50m depth. ;4) On completion the borehole was backfilled from base of hole to ground level with 1:2 cement/bentonite grout. ;5) The sub stratum descriptions at 6.00m and 10.50m are based on the description of extruded U100 samples.							Scale (approx) 1:50	Logged By DL/jmb	Figure No.



 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL					Site CTRL GI DATA - Entire NDATA19 data set		Borehole Number SA9394		
Boring Method Cable Percussion		Diameter		Ground Level (mOD) 22.80		Client UR/LCE		Job Number Issue 1	
		Location 561819 E 171971 N		Dates 02/11/1998- 03/11/1998		Engineer RLE		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50-10.95	U18			35 blows		(10.75)			
10.95-11.00 11.00-11.45 11.00-11.45 11.00-11.50	D19 SPT N=27 D20 B21	4.50		3,4/6,6,8,7					
12.00-12.45	U22			50 blows					
12.45-12.50 12.50-12.95 12.50-12.95	D23 SPT N=16 D24	4.50		3,3/3,4,4,5					
13.50-13.95	U25			55 blows					
13.95-14.00 14.00-14.45 14.00-14.45 14.50-15.00	D26 SPT N=21 D27 B28	4.50		5,7/6,5,4,6					
					7.80	15.00	Complete at 15.00m		
Remarks							Scale (approx) 1:50	Logged By DL/jmb	Figure No.

DRAWINGS



KEY
 Site Boundary

Notes:
Boundaries are indicative. Aerial imagery shown for context purposes only.
Site boundary extracted from CAD file "CST010 - MASTER XREF_rev09.dwg" provided by the client.

B A	UPDATED PROJECT NAME FIRST ISSUE	18/12/24 13/12/24	BL BL	RI AO	RI LP
REVISION	DETAILS	DATE	DRAWN	CHK'D	APPR'D

CLIENT

CLEARSTONE ENERGY

PROJECT

DARTFORD ENERGY HUB

DRAWING TITLE

SITE LOCATION PLAN

DRG No.	CA12848-010	REV	B	SUIT. CODE	--
DRG SIZE	A3	SCALE	1:5,000	DATE	18/12/2024
DRAWN BY	BL	CHECKED BY	AO	APPROVED BY	LP


PART OF 





KEY

Site Boundary

ALLUVIUM - CLAY, SILT, SAND AND GRAVEL

BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL

HEAD - CLAY, SILT, SAND AND GRAVEL

EA Statutory Main Rivers

Notes:

Boundaries are indicative. Aerial imagery shown for context purposes only.

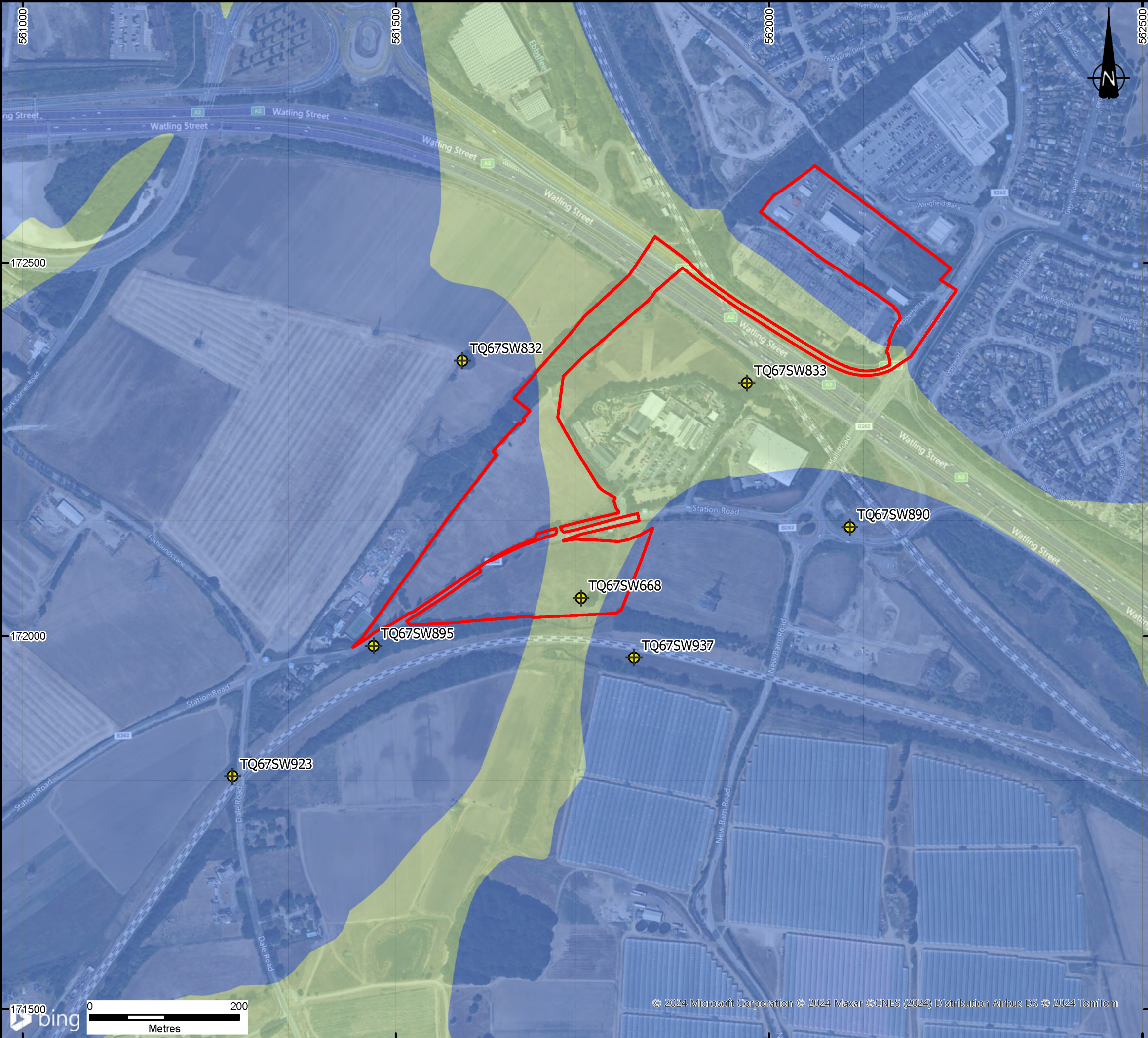
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BGS 1:50,000 Superficial Geology - Contains British Geological Survey materials © NERC 2024.

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PROJECT									
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DRAWING TITLE									
BGS 1:50,000 SUPERFICIAL GEOLOGY									
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CA12848-011					A		--		
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A3			1:15,000		18/12/2024				
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BL			RI		RI				

wardell
armstrong

PART OF SLR



KEY

-  Site Boundary
-  LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK
-  THANET FORMATION - SAND
-  Approximate Location of BGS Borehole

Notes:

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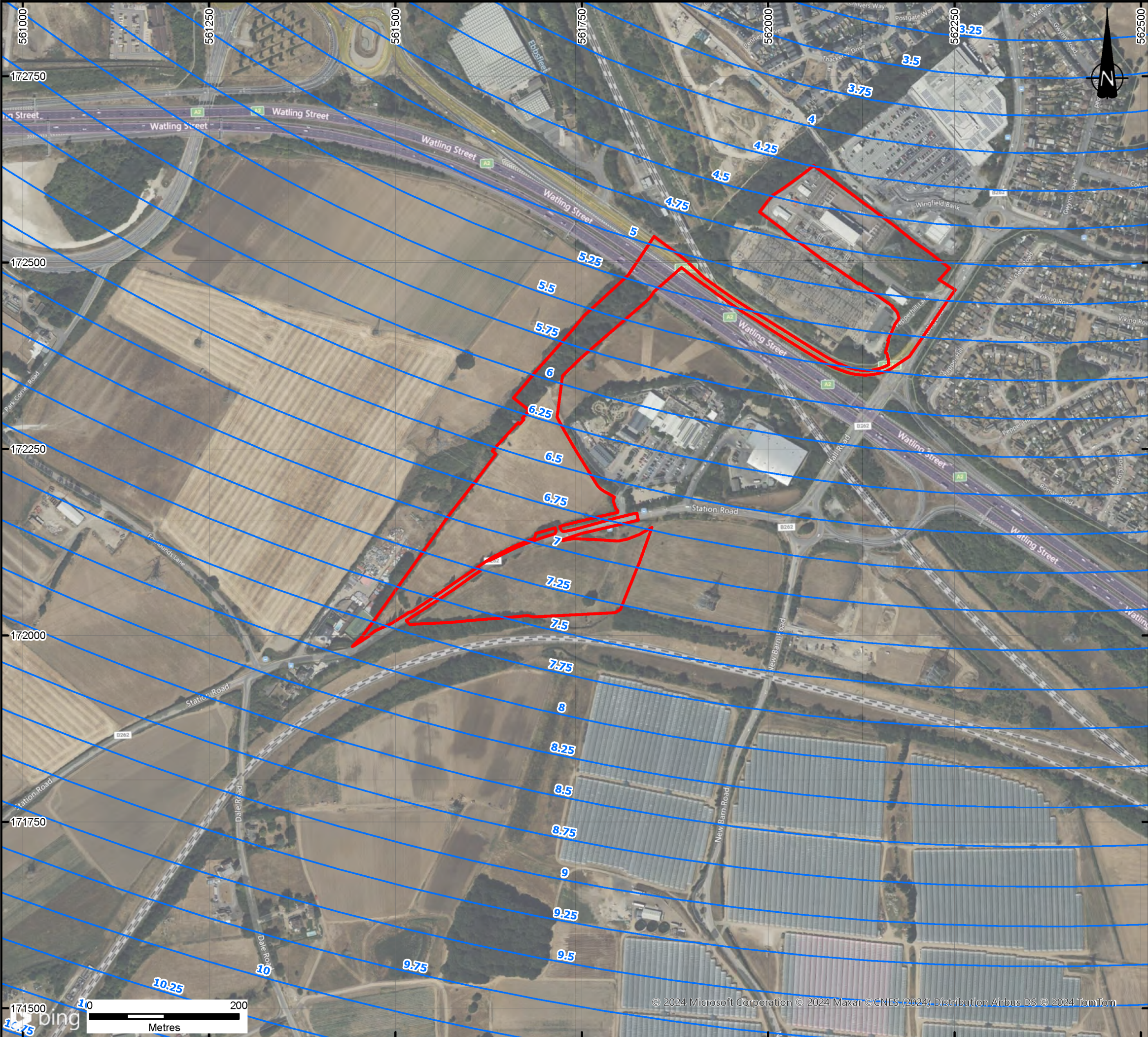
CLIENT	CLEARSTONE ENERGY
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PROJECT	DARTFORD ENERGY HUB
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DRAWING TITLE	BGS 1:50,000 BEDROCK GEOLOGY WITH BGS BOREHOLE LOCATIONS
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DRG No.	CA12848-014	REV	A	SUIT. CODE	--
DRG SIZE	A3	SCALE	1:5,000	DATE	18/12/2024
DRAWN BY	BL	CHECKED BY	RI	APPROVED BY	RI





KEY

Site Boundary

Average Groundwater Elevation Contour for the Period 1981 to 2023

Notes:
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Site boundary extracted from CAD file "CST010 - MASTER XREF_rev09.dwg" provided by the client.

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CLIENT					
CLEARSTONE ENERGY					
PROJECT					
DARTFORD ENERGY HUB					
DRAWING TITLE					
AVERAGE GROUNDWATER ELEVATION CONTOURS FOR THE PERIOD 1981 TO 2023					
DRG No.		CA12848-016		REV	A
DRG SIZE		A3		SUIT. CODE	--
SCALE		1:5,000		DATE	18/12/2024
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CHECKED BY		RI			

PART OF SLR

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N:\CA\CA12848 - Northfleet BESS GI\03 - Design\ArcGIS\CA12848-015 Average Groundwater Elevation Contours for the period 2018 to 2023\CA12848-015 Average Groundwater Elevation Contours for the period 2018 to 2023.aprx

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