



Hyro Energy Ltd

Kimberly-Clark Industrial Estate, Crete Hall Road, Northfleet, Gravesham

Flood Risk Assessment

681775-R1(2)-FRA
August 2023



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RSK GENERAL NOTES

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Hyro Energy Ltd
 Kimberly-Clark Industrial Estate
 Flood Risk Assessment
 681775-R1(2)-FRA

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1 INTRODUCTION

RSK Land and Development Engineering Ltd were commissioned by Hyro Energy Ltd (the client) to provide a Flood Risk Assessment (FRA) to support the detailed planning application to install a hydrogen facility at Kimberly-Clark Industrial Estate, Crete Hall Road, Northfleet, Gravesham (the site).

The purpose of the FRA is to establish the risk associated with the proposed development and to propose suitable mitigation, if required, to reduce the flood risk to a more acceptable level. The FRA must demonstrate that the development will be safe for its lifetime (in this case taken to be 75 as a conservative approach) taking account of the vulnerability of its users, without increasing flood risk elsewhere.

This document has been produced to assess the flood risk from tidal, fluvial, surface water, groundwater, sewer and artificial sources in line with the National Planning Policy Framework (NPPF)¹ and its corresponding Planning Practice Guidance (PPG)².

This assessment has been undertaken in consultation with the relevant authorities, and with reference to data, documents and guidance published by the Environment Agency (EA), the Lead Local Flood Authority (LLFA) (Kent County Council), the Local Planning Authority (LPA) (Gravesham Borough Council), and the Water Authority (Thames Water).

The comments given in this report and opinions expressed are subject to RSK Group Service Constraints provided in **Appendix A**.

¹ Communities and Local Government, 'National Planning Policy Framework', published March 2012 and last updated July 2021.

² Communities and Local Government, 'Planning Practice Guidance - Flood Risk and Coastal Change, ID 7', published March 2014 and last updated August 2022.

2 SITE DESCRIPTION & PROPOSALS

2.1 Existing site

2.1.1 Site description

The site is located to the north of Crete Hall Road, and west of Granby Road in the county of Kent and can be located at National Grid Reference 562676E, 174587N and postcode DA11 9HD. A site location plan is included as **Figure 2.1**.

The red line application site covers an area of approximately 22000m² (2.2ha) and currently comprises a storage yard for paper mulch associated with a paper mill. The site is almost entirely laid to hardstanding with small areas of soft landscaping around the site periphery adjacent to Crete Hall Road. The proposed works relate to the rectangular area (approximately 3728m²) towards the north of the wider red line boundary. A linear section of the red line boundary extends southwards and represents the pathway of the proposed pipeline.



Figure 2.1: Site location plan

2.1.2 Topography

A site-specific topographic survey has been carried out by Premier Surveys. The survey shows the existing site levels vary from 3.60m above ordnance datum (mAOD) to 5.40mAOD. The land generally slopes from north to south, the main site compound at the north is a relatively level hardstanding yard with a ground level of approximately 5.30mAOD to 5.40mAOD, though there is a slight fall across the yard in a western

direction, with yard levels at approximately 5.25mAOD at the western extents. The site slopes downwards to the southern extent of the linear boundary line down to 3.60mAOD.

Granby Road to the west of the site is higher than the site, with a ground level of approximately 5.70mAOD at the northern extent, and 9.5mAOD at the southern extent.

The topographic survey is included in **Appendix B**.

2.1.3 Existing drainage

2.1.3.1 Public

Thames Water sewer plans have been obtained for the site and are included in **Appendix C**. These plans indicate the following network of sewers in the vicinity of the site:

- A 900mm diameter public surface water pipe aligned north to south on the eastern side of Crete Hall Road. The sewer takes upstream flows from a 300mm diameter sewer to the south of the site. The sewer discharges to the River Thames to the north of the site. Historic reports written for the site suggest the outfall to the River Thames has an invert level of -3.05mAOD³;
- There is a 300mm diameter public foul sewer aligned in a north-west to south-east direction.

2.1.3.2 Private

The existing drainage of the site has been surveyed and included in the topographic survey (**Appendix B**). These plans indicate the following:

- A 225mm diameter surface water pipe outside the northern boundary of the site boundary, several gullies along the hardstanding yard drain into this pipe, the pipe drains westwards for a length and turns 90 degrees to drain southwards to MH065;
- The 225mm diameter pipe as described above upsizes to a 300mm diameter pipe at MH065 along the eastern boundary of the yard. The 300mm pipe continues to drain southwards and receives inflows from several gullies and strip gullies along the route;
- The 300mm pipe as described above upsizes to a 375mm diameter pipe and crosses westwards at MH033 over the public 900mm diameter surface water sewer. Via another two 90 degree turns the 375mm pipe turns and drains into the 900mm diameter sewer described above at MH030, subsequently discharging into the River Thames.

2.2 Development proposals

The development proposals for the site include the construction of a hydrogen facility. The facility would be operated by Hyro Energy Ltd, and would provide hydrogen to the existing Kimberly-Clark paper mill. The facility would be un-manned and under normal conditions would require a maintenance visit once each month. In accordance with the PPG for non residential development, the design life of the facility is taken to be 75 years for the purpose of this assessment as a conservative approach, although the client has

³ Flood Risk Assessment, 22959-FRA-R1(2), RSK, March 2010

indicated that the facility is likely to be in operation for a much shorter time period (c.25 years). The relevant proposed site plans are included as **Appendix D**.

3 ENVIRONMENTAL SETTING

3.1 Hydrology

Reference to Ordnance Survey (OS) mapping and the EA's web-based mapping indicates that the nearest EA Main River is River Thames, which is located approximately 50m north from the site. The River Thames flows west to east, though at this location will be strongly tidally influenced.

There are no known ordinary watercourses or other waterbodies within the site boundary.

3.2 Geology

Based on published geological records for the area (British Geological Survey online mapping), the site exhibits the following geology:

- Superficial Geology: No recorded information
- Bedrock Geology: Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation - Chalk.

BGS Borehole data shows several borehole records to the east of the site. The closest record is located approximately 80m east from the site, BGS Reference TQ67SW438. The borehole was taken from a starting ground level of 5.37mAOD, the borehole records ash, brick, rubble and chalk fragments to a level of 3.0m below ground level (bgl). Chalk flints and silty clay is recorded to 4.10m bgl. White chalk and flints is recorded to borehole completion at 10.0m bgl. A water level is recorded at approximately 5.0mbgl.

At the time of writing, no site-specific intrusive ground investigations have been undertaken for the site to confirm the underlying geology, potential contamination, permeability or groundwater levels on site.

3.3 Hydrogeology

Hydrogeological information was obtained from the online Magic Maps service. These maps indicate that the site is underlain by a Principal bedrock aquifer. The maps indicate that the site is not underlain by a bedrock aquifer due to the there being no recorded superficial geology.

The site is located within a groundwater Source Protection Zone (GSPZ). The site appears to be predominately within GSPZ 2 – Outer Protection Zone. The southern extent of the linear boundary appears to encroach into GSPZ 1 – Inner Protection Zone which is located south of the site. There is also an isolated area of GSPZ 1 outside of the north-east of the site.

The site is not within a Drinking Water Safeguard Zone (surface water or groundwater).

The BGS historic borehole record suggests that groundwater is at approximately 5.0mbgl.

4 SOURCES OF FLOOD RISK

4.1 Criteria

In accordance with the NPPF and advice from the EA, an assessment of the risk associated with various flooding sources is required along with consideration of the effects of climate change over the design life of the development (in this case assumed to be 75 years).

The EA's most recent climate change guidance, published in May 2022⁴, should be referenced in order to identify the appropriate peak river flow and rainfall intensity allowances for the scheme. The appropriate allowance for peak river flow is based on the location of the site in the country, the lifetime of development, the relevant flood zone and the vulnerability of the proposed end use.

The flood risk elements that need to be considered for any site are defined in BS 8533 'Assessing and managing flood risk in development Code of practice'⁵ as the "Forms of Flooding" and are listed as:

- Flooding from rivers (fluvial flood risk);
- Flooding from the sea (tidal flood risk);
- Flooding from the land;
- Flooding from groundwater;
- Flooding from sewers (sewer and drain exceedance, pumping station failure etc); and
- Flooding from reservoirs, canals and other artificial structures.

The following section reviews each of these in respect of the subject site.

4.2 Flooding from rivers and sea (fluvial and tidal flood risk)

The EA Flood Zone mapping study for England is available on their website at: <https://flood-map-for-planning.service.gov.uk>.

The latest EA published flood zone map (**Figure 4.1**) shows that the site lies predominantly within Flood Zone 2, representing land having between a 1 in 100 and 1 in 1000 annual probability of fluvial flooding or between a 1 in 200 and 1 in 1,000 annual probability of tidal flooding.

The north-western corner of the site is within Flood Zone 3, representing a 1 in 100 year or greater probability of flooding from fluvial sources or a 1 in 200 year or greater probability of flooding from tidal sources.

⁴ Environment Agency, 'Guidance: Flood Risk Assessments: Climate Change Allowances'.
<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>, last updated May 2022

⁵ BSI, 'BS 8533-2017 Assessing and managing flood risk in development Code of practice', December 2017.

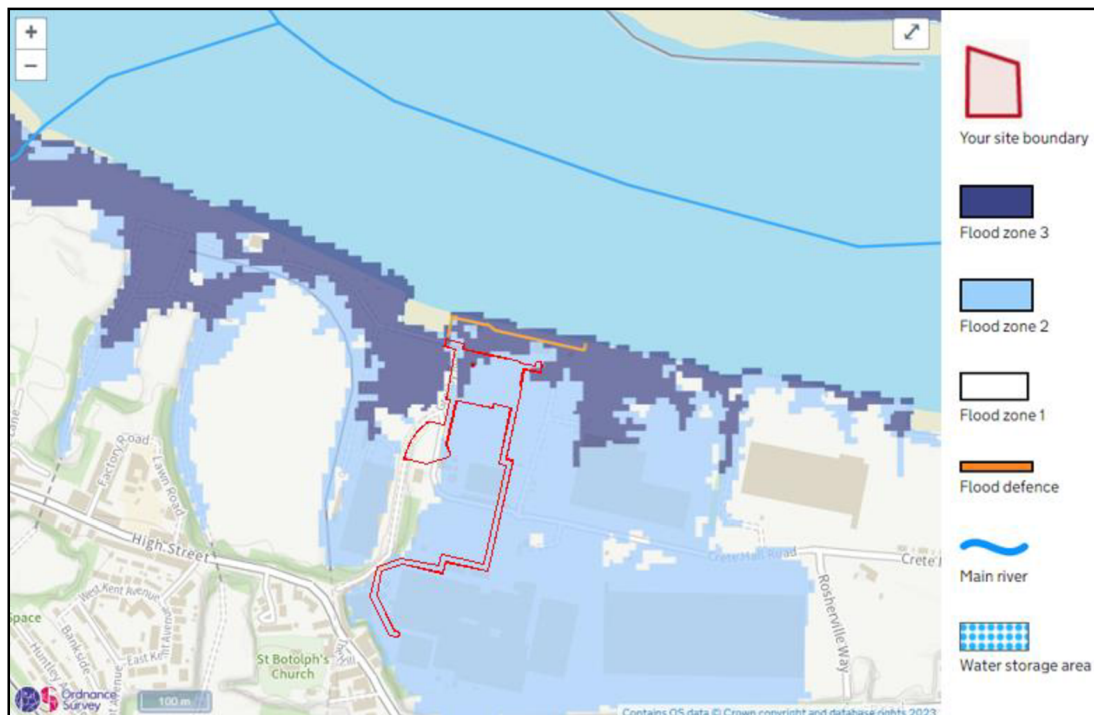


Figure 4.1: Environment Agency 'Flood map for planning'

The flooding is shown to come from the River Thames to the north of the site. The mapping in **Figure 4.1** shows a flood defence outside of the northern boundary of the site.

The EA was formally consulted as part of this assessment, with request for flood related information (including flood levels) included in the consultation. Their full response to the flood data request can be found in **Appendix E**.

River levels have not been supplied by the EA as part of the Product 4 data. The TE2100 in-channel levels and defence crest levels were provided as a downloaded shapefiles from Sharefile. The information for the closest modelled node 3.24 provided by the Thames Estuary 2100 study completed by HR Wallingford (2008) notes the extreme water level for 2100 in a climate change scenario is 6.49mAOD. These levels take account of fluvial flows from the River Thames, the astronomical tide, tide surge and climate change and operation of the Thames Barrier. No further information has been supplied as part of the Product 4 data.

The 'Defence levels downriver of the Thames Barrier (Table 7.1)' document (**Appendix E**) provided as part of the Sharefile provides the existing levels of the defences at each node. At node 3.24 it is noted the defences on the right bank have a crest level of 6.73mAOD.

It is required by 2040 that these defences are increased to a crest level of 6.90mAOD, and by 2070 are increased to 7.40mAOD. The future statutory defence level is 7.40m AOD and will ensure the site is protected from the extreme flood level of 6.49m AOD,

however the onus of delivering these flood defence improvements will be on the private land owner in which the flood defences lie.

If flood defences are not maintained to their current condition and standard of protection then the flood risk to the site will increase as tidal flooding will not be prevented as effectively, the risk of a breach of the defences also increases. If the flood defences are not improved in line with future statutory defence level requirements then the site will be at increased risk of more frequent flooding as sea level rises with climate change.

Topographic information indicates that site levels range from 3.60mAOD to 5.40mAOD. The above ground element of the proposed site compound is theoretically at risk of inundation up to 6.49mAOD only if defences were to be overtopped, breached or fail (see Section 4.2.1). The flood water level is an in-channel level located approximately 50m away from site. In the event of a breach, flood levels are unlikely to be this extreme within the site.

The latest EA 'extent of flooding from rivers or the sea' flood map (**Figure 4.2**) indicates that the site is considered to be at low risk of flooding, based on the presence of the tidal flood defences. Low risk means that this area has a chance of flooding of between 0.1% and 1% each year. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

The main source of flood risk to the site is likely to be tidal flooding associated with overtopping or a breach in the defences on the River Thames and is described below.

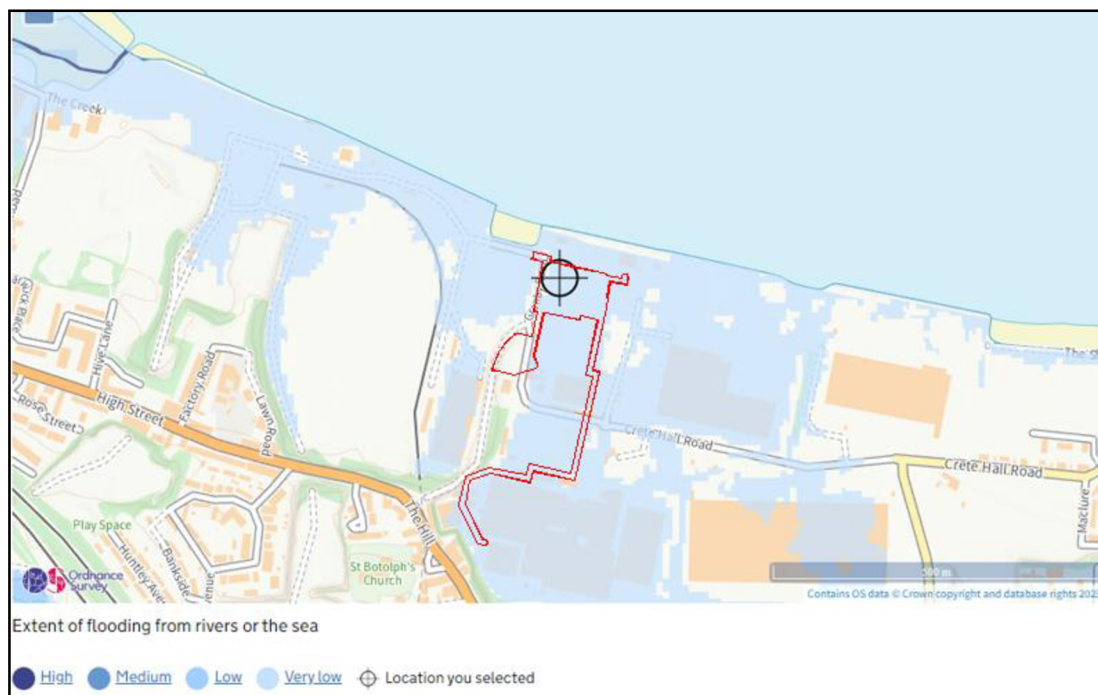


Figure 4.2: Environment Agency 'Extent of flooding from rivers or the sea'

4.2.1 Breach analysis

As noted above, the site is afforded protection from tidal inundation by the presence of raised linear flood defences to the north of the site. Whilst the failure of the defences during an extreme tidal event is considered unlikely, the consequence of a breach or overtopping failure in terms of the rate, depth and extent of inundation will be dictated largely by the landward ground levels within the embayment area behind the defences. The residual risk, in the event of defence failure, should therefore be assessed for the site.

The EA have supplied a Product 4 data package which includes the breach analysis data, the modelling is based on the Downriver Breach Inundation Modelling Study 2018, with an allowance for climate change for epoch 2115. Nodes 1, 3, 12 and 13 are considered most relevant to the above ground compound proposed within the rectangular site boundary at the north of the site. The modelled levels for a breach for the 0.5% AEP and 0.1% AEP scenarios are shown in **Table 4.1**. The EA mapping of the Node location points and modelled levels is contained in **Appendix E**.

The lowest existing ground levels in the area of the compound are approximately 5.30mAOD. For the present day scenario this could mean flooding of up to 0.41m to 0.48m for the 0.5% AEP and 0.1% AEP scenario respectively. For the future scenario this could mean flooding of up to 0.78m to 1.1m for the 0.5% AEP and 0.1% AEP scenario respectively

Table 4.1: Breach inundation modelling node data

Node	Modelled levels in mAODN for 0.5% AEP		Modelled levels in mAODN for 0.1% AEP	
	2014	2115	2014	2115
1	5.71	6.08	5.78	6.37
3	5.24	5.99	5.53	6.40
12	N/A	N/A	N/A	N/A
13	5.47	6.02	5.65	6.40

The breach mapping outputs in the Product 8 data show the breach hazard mapping which are calculated from the maximum flood depths multiplied by the maximum flood velocity and then categorised. Maximum flood depths on site (at the main compound area) are expected to be between 0.25m and 1.0m for a 0.5% AEP flood in the 2115 scenario. Maximum hazard levels are greatest at the north western extent of the site, within the greater than 2.0 category this indicates a danger for all. The site is predominantly within the maximum hazard rating category of 1.25-2.0, indicating a danger for most.

A 0.1% AEP flood in the 2115 scenario shows a greater depth of flooding on site, predominantly within the 1.0-1.5m category. This results in the hazard rating for the site being within the greater than 2.0 category indicating a danger for all on site during this scenario.

Overall, the site is currently defended against a 1 in 1000 year fluvial / tidal flood event and will continue to be afforded this standard of protection on the basis that the relevant riparian owners continue to maintain and raise the existing flood defences in line with their responsibilities as riparian landowners. There is a residual risk of tidal flooding to the site in the event of a defence failure. Flooding could lead to the damage of equipment given the potential maximum flood height of 6.40maOD (0.1% APE 2115 scenario) to 6.49mAOD (Thames Estuary 2100 climate change in channel flood levels). The flooding would be classified as a danger for most in a 0.5% AEP scenario.

Given the high standard of protection afforded to the site under normal circumstances over its lifetime, but potential for significant flood depths in the event of a flood defence failure, the overall tidal flood risk is considered to be **medium**.

4.3 Flooding from the land (surface water flood risk)

If intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or other watercourse.

Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff can occur. Excess surface water runoff from the site will drain to existing drainage infrastructure, evidenced by the several gullies and strip drains across the site.

The EA's surface water flood map (**Figure 4.3**) shows that small sections of the site are at a risk of flooding from surface water sources though these areas are associated within the pipeline route along the linear section of the site boundary. The main compound within the rectangular section of the red line boundary is not shown to be at risk from surface water flooding.

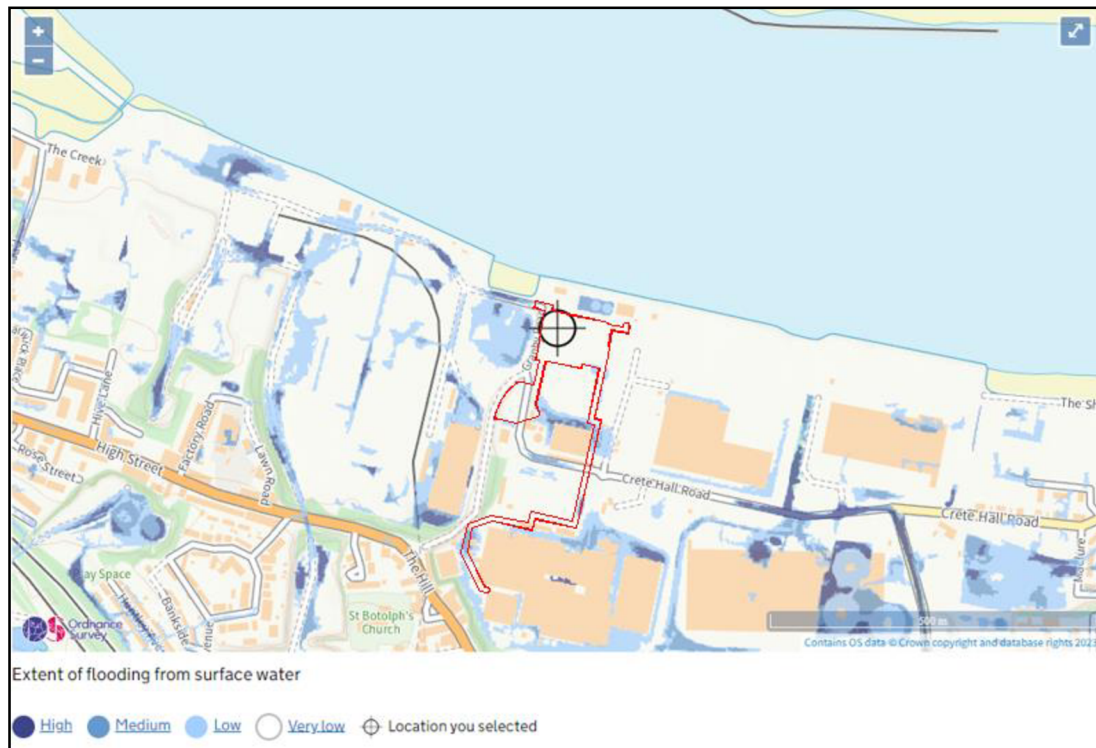


Figure 4.2: Environment Agency ‘Flood risk from surface water’ map

Surface water flooding is likely to increase as a result of climate change in a similar ratio to fluvial flooding. Increased intensity and frequency of precipitation is likely to lead to reduced infiltration and increased overland flow. Climate change guidance was updated by the EA in May 2022. Revised allowances for climate change will be included in the drainage strategy.

The overall risk of surface water flooding at the site is considered to be **very low**.

4.4 Flooding from groundwater

Groundwater flooding tends to occur after long periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. In low-lying areas the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.

The strategic flood risk assessment (SFRA) for the area⁶ notes groundwater flooding is most likely to occur in the lowest lying areas, as the water table is likely to be closest to the ground surface in these areas. The report goes on to note that Chalk is highly permeable and given the right conditions (very wet winter for example) can give rise to groundwater flooding issues. The SFRA does not specifically mention the site or the

⁶ Strategic Flood Risk Assessment of Kent Thameside, Kent Thameside Delivery board, December 2005

surrounding area, however it does note if active dewatering at East Quarry (located at Ebbsfleet, 1.0km south of the site) were to stop then groundwater levels could potentially recover to 5-8mAOD. It is noted these levels are given for East Quarry, approximately 1km south from the site and not likely to be representative on site groundwater flood levels.

There is no ground investigation data available for the site to confirm the geology and groundwater levels on the site. Information from historic borehole logs to the east of the site would suggest the groundwater is approximately 5.0mbgl, however this does not consider seasonal variance in the levels, and actual levels may be higher.

Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. This is less likely to cause a significant change to flood risk than from other sources, since groundwater flow is not as confined. It is probable that any locally perched aquifers may be more affected, but these are likely to be isolated. The change in flood risk as a result of climate change is likely to be low.

The overall groundwater flood risk is considered to be **low**.

4.5 Flooding from sewers

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. When exceeded, the surcharged pipe work could lead to flooding from backed up manholes and gully connections.

Sewer details have been referenced from sewer record plans obtained from Thames Water. The plans indicate there is a 900mm diameter public surface water sewer on the site, the historic FRA report (2010) noted the invert level of the outfall of the 900mm pipe to the River Thames is -3.05mAOD, with no indication of tidal flaps to prevent backflow.

Based on the manhole levels obtained for manhole MH030 (**Appendix B**), there is a cover level of 5.34mAOD. This manhole level is lower than the expected tidal heights indicated by levels in Table 4.1, and the extreme tidal level of 6.49mAOD. If there is no tidal flap on the sewer any surcharged water would most likely back up the pipe and there is a possibility of exceedance from manhole MH030.

No information on historic flooding has been provided by Thames Water and the SFRA does not make mention of site specific sewer flooding. There is uncertainty on the design of the 900mm diameter pipe based on incomplete sewer records and survey information which does not note the outfall structure.

Climate change is likely to result in an increase in flooding from sewers. Increased rainfall and more frequent flooding put existing sewer and drainage systems under additional pressure resulting in the potential for more frequent surcharging and potential flooding. This would increase the frequency of local sewer flooding but would not be significant in terms of the proposed development.

Based on the uncertainty of the pipe design, and possible connection to the tidal flood waters which could be a cause of exceedance onto the site, the overall sewer flood risk to the site is considered to be **medium**.

4.6 Flooding from reservoirs

Flood events can occur from a sudden release of large volumes of water from reservoirs.

The EA reservoir flood map (reproduced as **Figure 4.4**) shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a worst-case scenario, it is unlikely that any actual flood would be this large.



Figure 4.3: Environment Agency 'Flood risk from reservoirs' map

The EA mapping was updated in 2021 to demonstrate the potential maximum extent of flooding for two scenarios - a "dry day scenario" in which river levels are "normal", and a "wet day scenario" where the flooding from the reservoir coincides with flooding from rivers.

The map shows that the site is not in a location at risk of reservoir flooding. The resultant flood risk is considered to be **very low**.

4.7 Other sources of flooding

4.7.1 Canals

There are no Canal & River Trust owned canals within the area.

4.7.2 Other artificial features

No other artificial features with the potential to result in a flood risk to the site have been identified.

4.7.3 Tide locking

Tide locking occurs when a high rainfall event coincides with a high tide rather than a fluvial flood. Tide locking can be a regular occurrence. However, the period of tide lock is confined to the peak of the tide and therefore its duration is generally limited.

The tide levels for the previous 5 days (from 16.08.2023) at the Tilbury water level monitoring station located 600m north from the site on the left bank of the River Thames suggest that 'normal' sea levels range between -2.00m (for low tide) and 3.19m (for high tide). The highest recorded level at the station is 4.78m⁷.

There has been no evidence to suggest that the site floods frequently as a result of rainfall coinciding with high tide, though water levels at Tilbury monitoring station do suggest frequent surcharging of the 900mm diameter public sewer outfall which may impede drainage.

The site is shown to discharge from 375mm diameter private surface water sewer directly into the 900mm diameter public sewer network at Manhole MH030 (as shown on **Appendix B**). Details of the design of the sewer are currently unknown and flood risk from tide locking is considered as a potential risk.

The risk from tide locking causing flooding to the site is greatest when a high intensity rainfall event would coincide with hightide. Tide locking would impede drainage and will result in backlogging of the drainage into the site, therefore resulting in a heightened risk of ponding on site until tidal levels recede. The flood risk is therefore considered medium.

The effect of tide locking could be exacerbated by climate change as a result of more frequent higher tides and increased surface runoff.

⁷ Sea level at Tilbury, <https://check-for-flooding.service.gov.uk/station/7394>, accessed August 2023

5 MITIGATION MEASURES AND RESIDUAL RISK

5.1 Sequential approach within application boundary

The site is considered at low risk from flooding when defences are considered (Figure 4.2) and the breach mapping shows a relatively equal level of breach hazard flood risk through the site owing to the level ground levels on site.

From the information described above and the breach mapping extents as provided in the Product 4 data, there is relatively little difference in flood risk within the application boundary. Therefore, the position of the proposed development is considered to be best placed at the proposed location within the existing yard.

5.2 Overland flood flow

Tidal flooding caused by a breach of the flood defences will enter the site from the north and flood southwards towards the proposed development. It is not proposed to bund the site, and flooding will be permitted to occur in the unlikely event of a breach, ensuring no disruption to existing flow routes.

There is uncertainty regarding the likelihood of exceedance flows from the surface water manholes during a tidal event. The topography of the site would suggest exceedance flows from surcharged manholes within the yard will flow westwards towards the lower ground at approximately 5.25mAOD.

No overland flow routes have been identified across the site from surface water flooding.

5.3 Finished floor levels

A pre-application enquiry response from provided by the EA (**Appendix F**) details what is expected of the proposed development to address the flood risk posed to the site. The response noted that: *“The proposal should consider how the site will be protected from tidal flood risk. This will likely require flood defence raising and/or land raising. Raising options should be considered in line with the Thames Estuary 2100 (TE2100) plan.*

Land raising may be required to protect the site from inundation during a tidal flood defence breach event. This may be of particular importance if the site is considered to be essential infrastructure.”

Whilst it is acknowledged the site is at risk from flooding during the unlikely scenario of a breach of the defences, it is not proposed to raise equipment above the flood levels to maintain operation through a flooding scenario. The design of the proposed development will place emphasis on an automatic safe system shut down in the event of a flood.

The primary process safety risk posed by site flooding are loss of electrical supply and loss of process cooling. Both are considered to be Global Design Scenarios and will be considered in the project HAZID (Hazard Identification) and HAZOP (Hazard and Operability) studies. These scenarios will also be considered in the specification of equipment design pressure and temperatures, pressure relief facilities, and emergency shutdown systems. Throughout development, the concepts of both inherent safety and ALARP (As Low As Reasonably Practicable) will be applied, ensuring that the mitigations applied against the risks associated with site flooding follow the hierarchy of controls. These mitigations will be outlined during the Pre-FEED (Front End Engineering Design) process, and fully specified by the end of FEED.

The finished ground level is to be retained from the existing yard levels. Finished floor levels / slab levels are to be specified in the detailed design of the proposed development dependent on the sensitivity of the equipment.

In the event of a breach of the tidal flood defences, the paper mill to which hydrogen will be provided by the facility will be inundated. During such an event, there will be no requirement for the hydrogen facility to continue to operate. Therefore the benefits of raising equipment are considered to be limited, and outweighed by the commercial difficulties associated with raising the equipment, particularly given the low likelihood of a breach event occurring. The ability to safely shut down the equipment in the event of flooding, and the unmanned nature of the facility, means the facility will remain safe in the event of flooding. The operator acknowledges the residual risk of flooding and accepts that any damage to equipment would need to be repaired prior to the facility being brought back into use following a flood.

In terms of the construction of the development, reference should be made to “Preparing for Floods” a DEFRA publication⁸, CIRIA guidance C624 “Development and flood risk”⁹ and the CLG document “Improving the flood performance of new buildings”¹⁰.

5.4 Easements and consents

There are flood defences north of the site. The proposed developed is approximately 50m south from the flood defences. The distance between the flood defences and proposed development is not considered to impede flood defence works in the future including the potential for new defences to be built 16m inland from the existing defences (as outlined by the EA in **Appendix G**).

The current layout is greater than 16m south from the flood defences, as shown in **Appendix D**.

⁸ DTLR, ‘Preparing for Floods Interim guidance for improving the flood resistance of domestic and small business properties’, October 2003.

⁹ CIRIA, ‘Development and Flood Risk guidance for the construction industry’ C624, 2004.

¹⁰ Communities and Local Government, ‘Improving the flood performance of new buildings – flood resilient construction’, May 2007.

Any consent works usually take place post planning, prior to construction, however, the principals of any development within the appropriate easements should be agreed at the planning stage.

5.5 Flood compensation

The site is shown to be at risk from tidal flooding, rather than fluvial flooding, so floodplain compensatory measures are not deemed necessary.

5.6 Safe access/egress

The site is shown to be within flood extents, especially in a tidal breach scenario during which inundation mapping shows flooding across the site. The most direct access to Flood Zone 1 and outside of the breach extents is via Granby Road which slopes steeply upwards away from the River Thames. Granby Road will be accessible from the site via a proposed ramped access road for vehicular access. Granby Road provides safe refuge more than 600mm above the expected flood depth

It is noted that the proposed facility will not need to be manned, and requires maintenance visits roughly once each month. These visits will take account of any flood warnings in operation for the site and will not take place should conditions mean an increased risk of a breach of the existing defences.

5.7 Flood management plan

The site is partially located within Flood Zone 3. Given that the site could be impacted in the event of a breach of the Thames Tidal defences during a 1 in 200 year event, a Flood Management Plan should be prepared to support the development.

Forecasting of tidal flooding on the River Thames is well developed through 24 hour monitored telemetry and flood forecasting models allowing around 36 hours notice of an impending storm surge.

The site is located within the EA Flood warning area classified as 'Gravesend and Northfleet'. The EA charter is to provide a minimum 2 hours advance warning, which would provide sufficient time for site users to be evacuated to an area of safe refuge (such as exiting the site to Granby Road). Generally the site will be unmanned besides monthly scheduled maintenance visits, thereby decreasing risk to life further.

However, it is recommended that future users of the site ensure they are registered with the EA's Flood Warning system (Floodline Warning Direct) to provide adequate forewarning in the event of a predicted flood in the neighbourhood in order to decrease the overall risk to a 'safe' level.

6 PLANNING POLICY CONTEXT

6.1 National planning policy

Section 14 of the NPPF details the overarching requirements relating to flood risk for any development. The key message is that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

In areas at risk of flooding, the NPPF requires that the following criteria are met:

- a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;
- c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- d) any residual risk can be safely managed; and
- e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

The PPG supports the NPPF and provides further advice regarding the assessment of flood risk and the application of the Sequential and Exception Tests.

6.1.1 Land use vulnerability

Table 2 of the PPG indicates the compatibility of various land uses in each flood zone, dependent on their vulnerability to flooding. Table 6.1 below is reproduced from Table 2 of PPG.

Table 6.1: Flood risk vulnerability and flood zone ‘compatibility’

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

With reference to Annex 3 of the NPPF, the proposed development is classed as ‘less vulnerable’. This classification of development is appropriate for areas within Flood Zone 3a and therefore appropriate for the subject site.

6.1.2 Sequential Test

The Sequential Test aims to direct new development to areas with the lowest probability of flooding. A full analysis of the availability of alternative sites is beyond the scope of this assessment. However, it is noted that the proposed facility needs to be located within close proximity to the paper mill and specifically the dual-fuel boiler that it will be providing hydrogen to. The specific location of the facility within the existing paper mill site has been dictated by the requirement to direct the infrastructure to an area away from the general public for safety reasons. It is therefore not practicable to locate the facility in another location.

6.1.3 Exception Test

In accordance with Table 6.1, there is no requirement to apply the Exception Test for a ‘less vulnerable’ development within Flood Zone 3.

7 CONCLUSIONS AND RECOMMENDATIONS

This FRA complies with the NPPF and Planning Practice Guidance and demonstrates that flood risk from all sources has been considered in the proposed development. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

The proposed development site lies in an area designated by the EA as Flood Zone 2 and Flood Zone 3, the site is protected by flood defences and is therefore considered at low risk of flood according to the 'Extent of flooding from rivers or the sea'. The risk of fluvial or tidal flooding is residual only, associated with a breach of the existing flood defences.

The proposed development is classified as 'less vulnerable' and therefore considered appropriate within the Flood Zone.

This FRA has considered multiple sources of flooding and concluded the following:

Table 7.1: Flood risk summary

Source	Level of risk	Mitigation
Tidal	Medium	Breach of the flood defences in the event of a tidal flood could lead to high hazard risks within the site boundary. It is proposed to safely shut down the site in the event of flooding, the site will be unmanned. Safe access away from the hazard extents is achievable from Granby Road.
Surface water	Very Low	Where possible, any sensitive equipment should be raised to limit the impact of any ponded surface water. The development will incorporate a surface water drainage strategy to accommodate surface water generated on site.
Groundwater	Low	There is limited risk from groundwater flooding given comments in the SFRA made on the geology. Groundwater flooding has a tendency to be shallow and where possible raising of sensitive equipment will mitigate limited flood risk from groundwater.
Sewers	Medium	The design of the 900mm diameter surface water sewer is unknown and tidal flood levels compared to manhole levels on site suggest exceedance flows could be a possibility. The topography of the site would

Source	Level of risk	Mitigation
		suggest exceedance flows would drain westwards away from the compound area. A drainage strategy can include non-return valves to prevent exceedance flows from manholes within the compound.
Reservoir	Very Low	None required
Other sources	Medium	There is potential risk from a tidal locked outfall which can prevent surface water leaving the site if coincided with a rainfall event. The design of the surface water drainage from the compound should consider a tidally locked outfall for a higher return period.

Overall, taking into account the above points, the development of the site should not be precluded on flood risk grounds.

APPENDIX A

RSK GROUP SERVICE CONSTRAINTS

1. This report and the drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for Hyro Energy Ltd (the "client") in accordance with the terms of a contract between RSK and the "client" dated April 2023. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable civil engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are

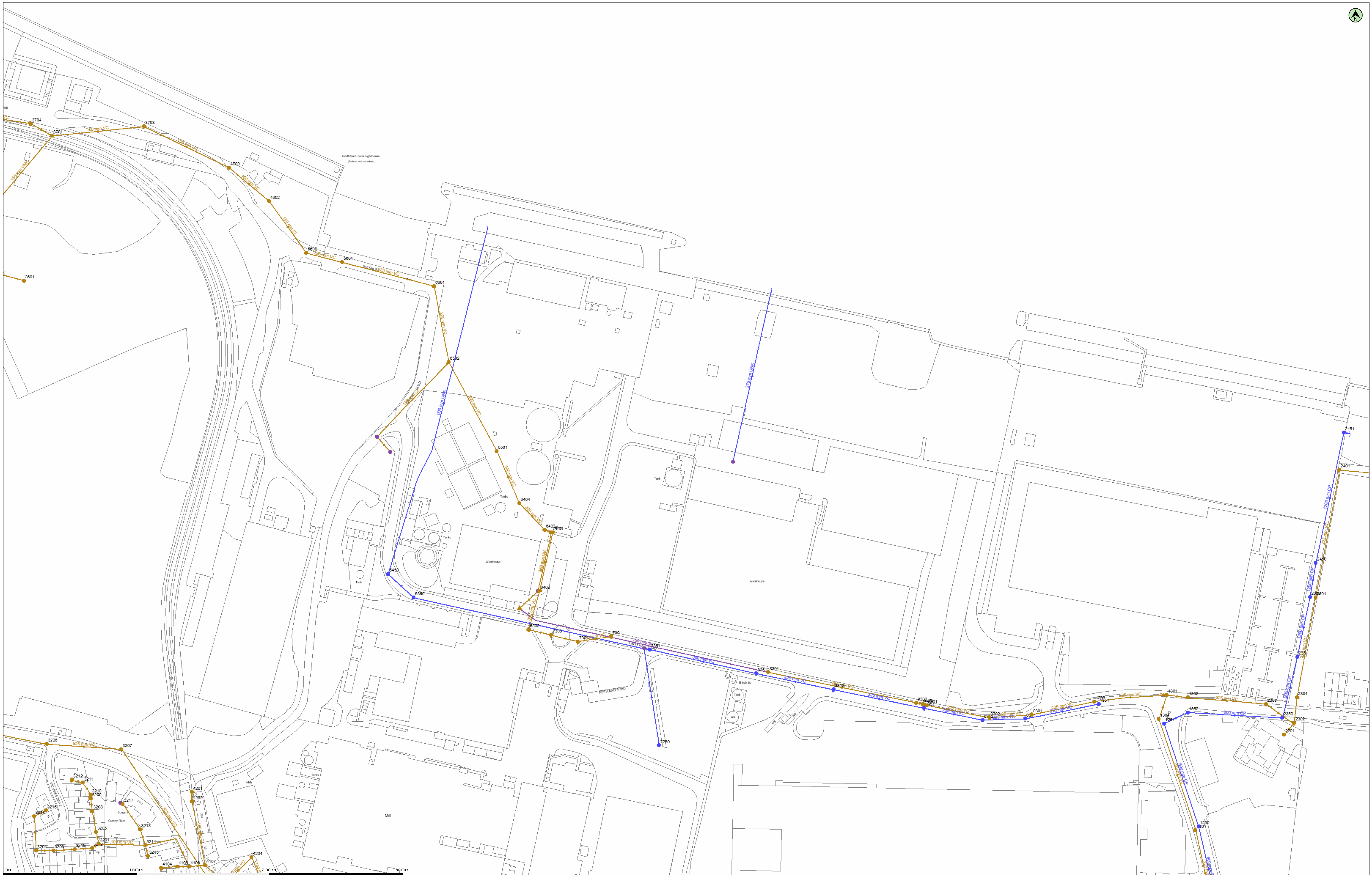
not drawn to scale but are centred over the appropriate location. Such features should not be used for setting out and should be considered indicative only.

APPENDIX B

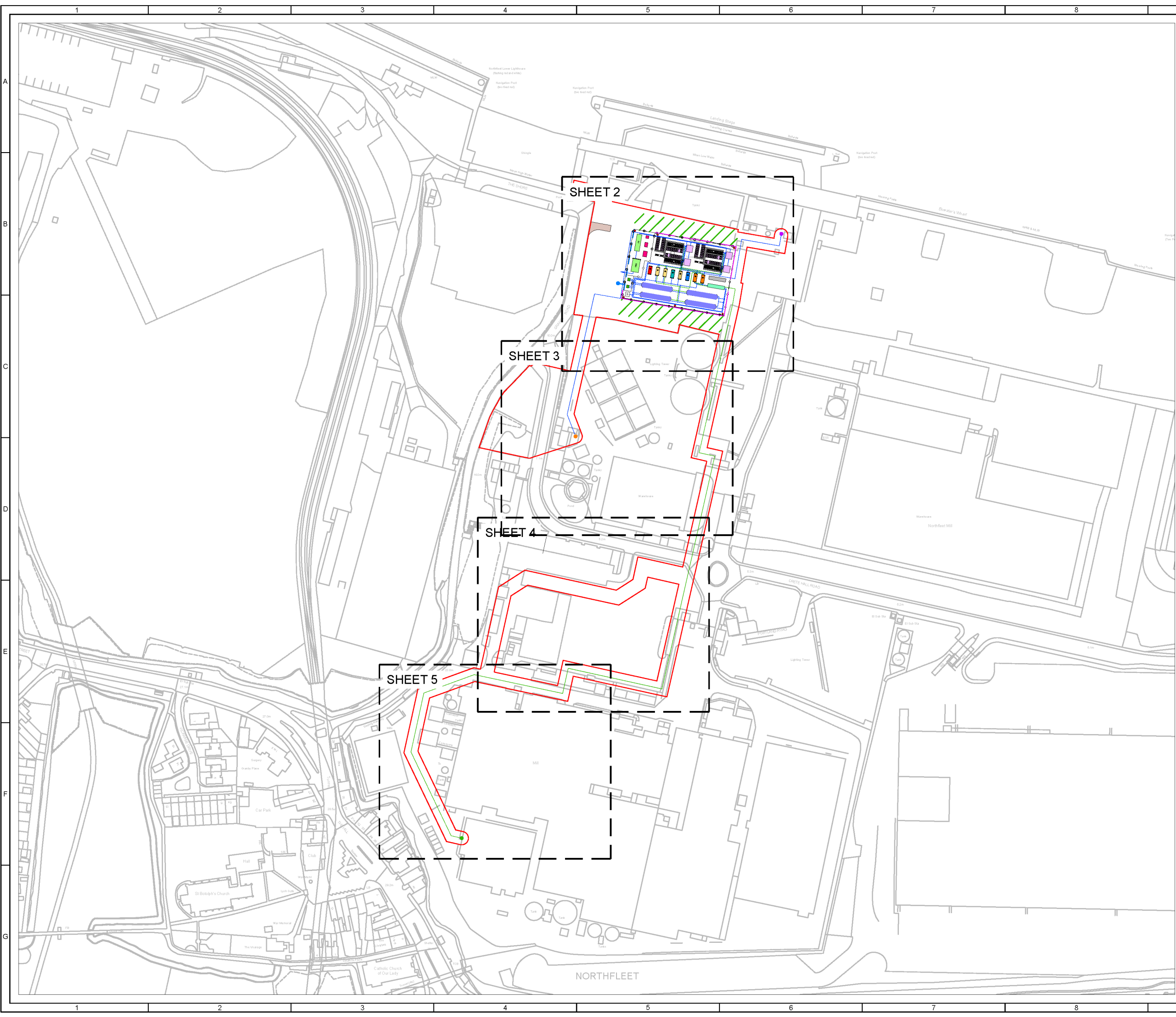
TOPOGRAPHIC SURVEY

APPENDIX C

THAMES WATER SEWER RECORDS



APPENDIX D SITE LAYOUT PLANS



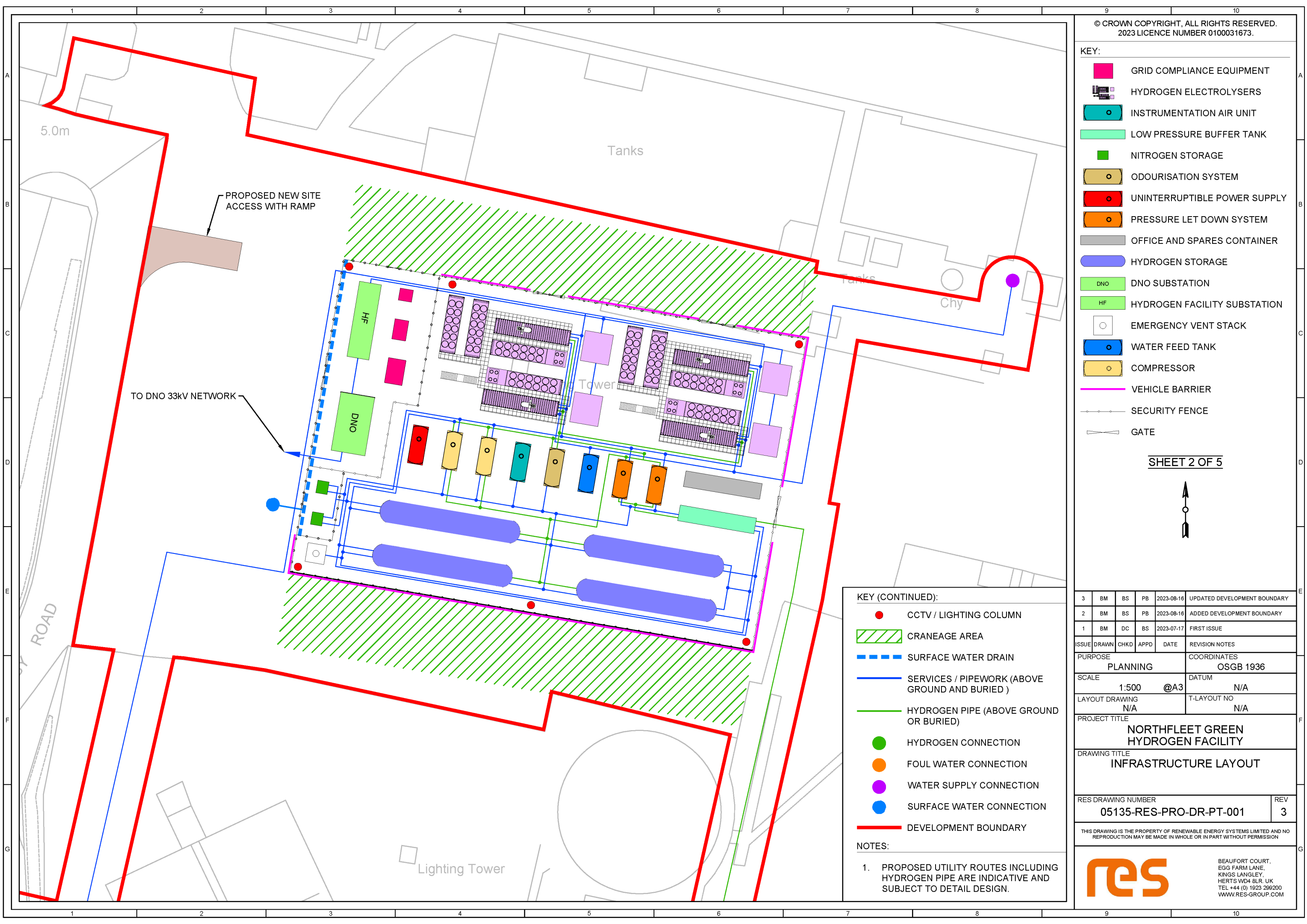
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KEY:

1. FOR KEY, REFER TO SHEETS 2-5.

SHEET 1 OF 5

3	BM	BS	PB	2023-08-16	UPDATED DEVELOPMENT BOUNDARY		
2	BM	BS	PB	2023-08-16	ADDED DEVELOPMENT BOUNDARY		
1	BM	DC	BS	2023-07-17	FIRST ISSUE		
ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES		
PURPOSE				COORDINATES			
PLANNING				OSGB 1936			
SCALE				DATUM			
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PROJECT TITLE							
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DRAWING TITLE							
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- KEY:
- GRID COMPLIANCE EQUIPMENT
 - HYDROGEN ELECTROLYSERS
 - INSTRUMENTATION AIR UNIT
 - LOW PRESSURE BUFFER TANK
 - NITROGEN STORAGE
 - ODOURISATION SYSTEM
 - UNINTERRUPTIBLE POWER SUPPLY
 - PRESSURE LET DOWN SYSTEM
 - OFFICE AND SPARES CONTAINER
 - HYDROGEN STORAGE
 - DNO DNO SUBSTATION
 - HF HYDROGEN FACILITY SUBSTATION
 - EMERGENCY VENT STACK
 - WATER FEED TANK
 - COMPRESSOR
 - VEHICLE BARRIER
 - SECURITY FENCE
 - GATE

SHEET 2 OF 5



- KEY (CONTINUED):
- CCTV / LIGHTING COLUMN
 - CRANEAGE AREA
 - SURFACE WATER DRAIN
 - SERVICES / PIPEWORK (ABOVE GROUND AND BURIED)
 - HYDROGEN PIPE (ABOVE GROUND OR BURIED)
 - HYDROGEN CONNECTION
 - FOUL WATER CONNECTION
 - WATER SUPPLY CONNECTION
 - SURFACE WATER CONNECTION
 - DEVELOPMENT BOUNDARY
- NOTES:
1. PROPOSED UTILITY ROUTES INCLUDING HYDROGEN PIPE ARE INDICATIVE AND SUBJECT TO DETAIL DESIGN.

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2	BM	BS	PB	2023-08-16	ADDED DEVELOPMENT BOUNDARY
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PLANNING				OSGB 1936	
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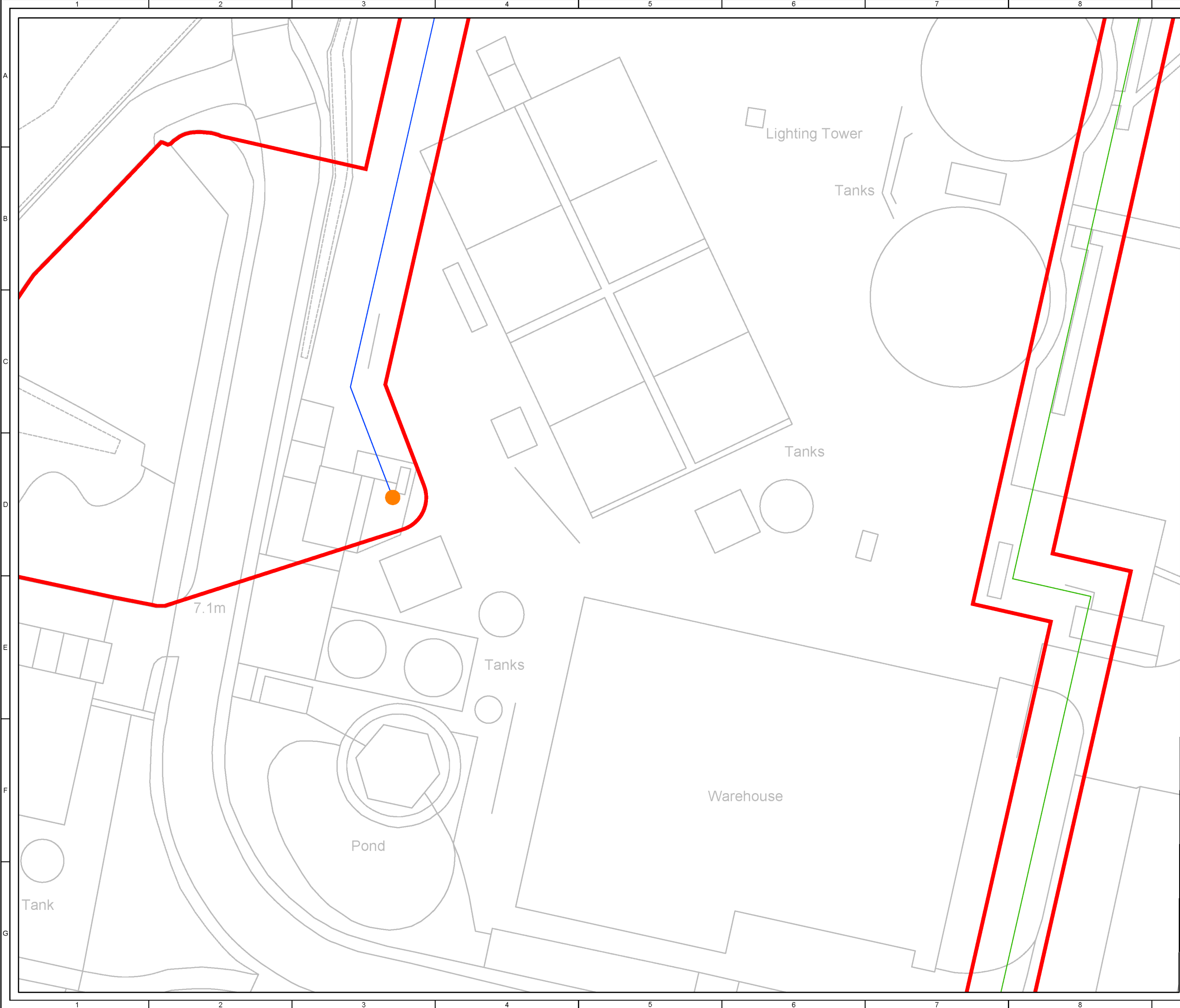
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**NORTHFLEET GREEN
HYDROGEN FACILITY**

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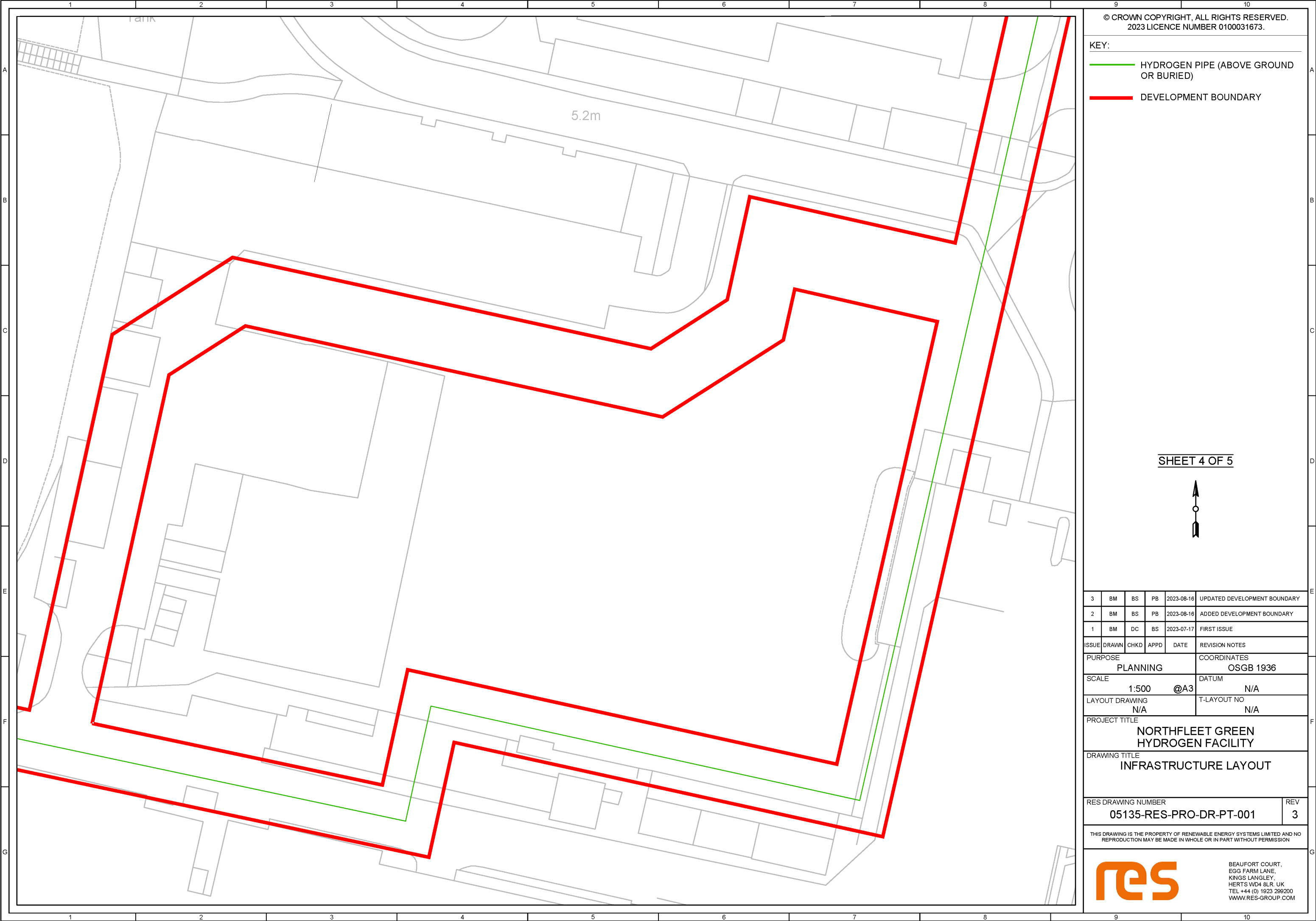
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KEY:

- SERVICES / PIPEWORK (ABOVE GROUND AND BURIED)
- HYDROGEN PIPE (ABOVE GROUND OR BURIED)
- FOUL WATER CONNECTION
- DEVELOPMENT BOUNDARY

SHEET 3 OF 5

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2	BM	BS	PB	2023-08-16	ADDED DEVELOPMENT BOUNDARY				
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ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES				
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NORTHFLEET GREEN HYDROGEN FACILITY									
DRAWING TITLE									
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SHEET 4 OF 5



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ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
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PURPOSE	COORDINATES
PLANNING	OSGB 1936

SCALE	DATUM
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PROJECT TITLE
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HYDROGEN FACILITY

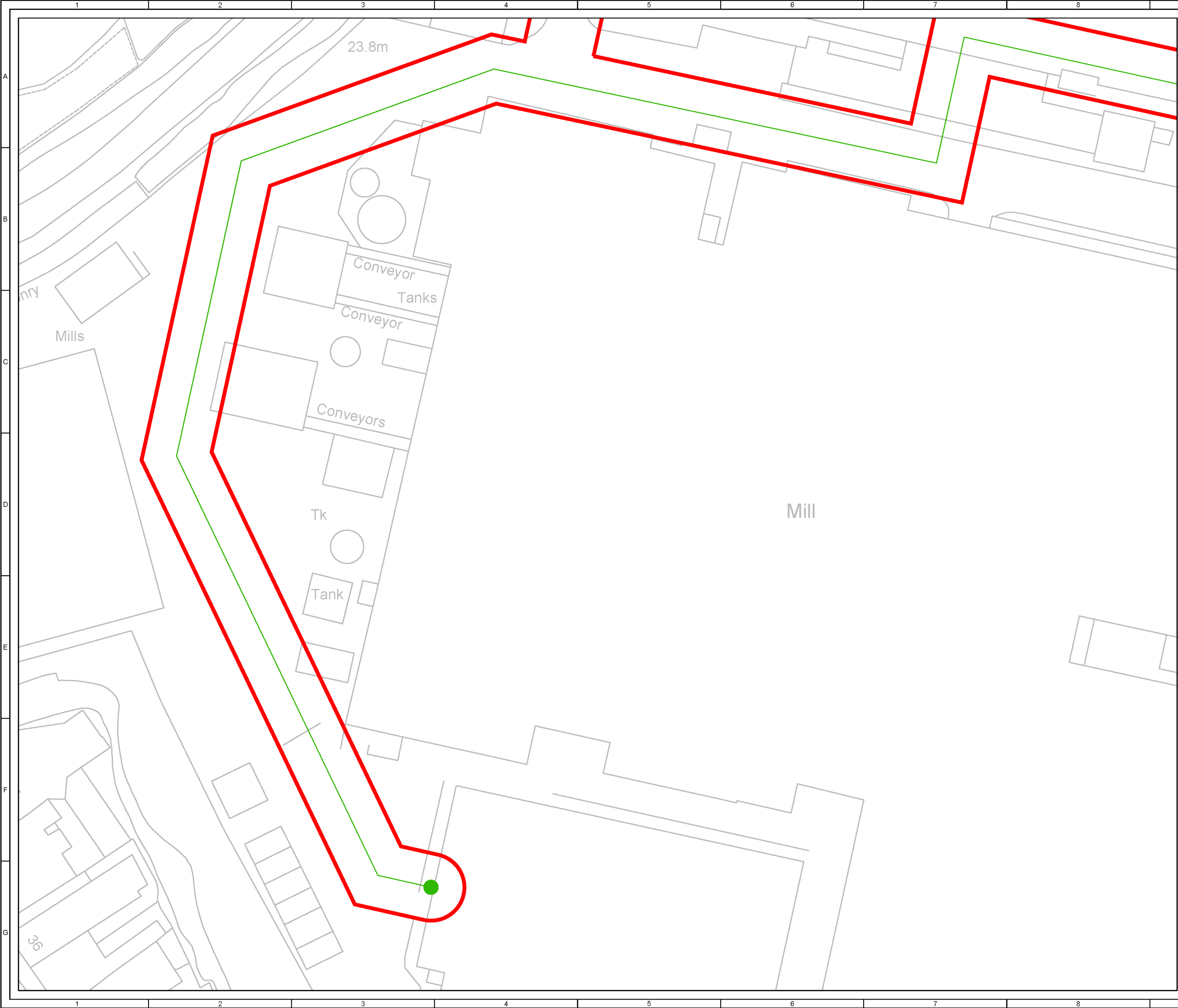
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SHEET 5 OF 5

3	BM	BS	PB	2023-08-16	UPDATED DEVELOPMENT BOUNDARY
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APPENDIX E

ENVIRONMENT AGENCY CORRESPONDENCE

Product 4 (Detailed Flood Risk) for: Kimberly-Clark Industrial Estate, Crete Hall Road, Northfleet,
Gravesend, DA11 9AD

Requested by: Alison Cadge

Reference: KSL 305544 RL

Date: 12th May 2023

Contents

- Flood Map for Planning (Rivers and Sea)
- Flood Map Extract
- Thames Estuary 2100 (TE2100)
- Thames Tidal Downriver Breach Inundation Modelling 2018
- Thames Tidal Downriver Breach Inundation Modelling Map
- Site Node Locations Map
- Defence Details
- Recorded Flood Events Data
- Recorded Flood Events Outlines Map
- Additional Information

The information provided is based on the best data available as of the date of this letter.

You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements to the data for this location have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

Please refer to the [Open Government Licence](#) which explains the permitted use of this information.

Flood Map for Planning (Rivers and Sea)

The Flood Map:

Our Flood Map shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences (including any tidal barriers). Although flood defences reduce the risk of flooding they cannot completely remove that risk as they may be over topped or breached during a flood event.

The Flood Map indicates areas with a 1% (0.5% in tidal areas), Annual Exceedance Probability (AEP) - the probability of a flood of a particular magnitude, or greater, occurring in any given year, and a 0.1% AEP of flooding from rivers and/or the sea in any given year. In addition, the map also shows the location of some flood defences.

The Flood Map is intended to act as a guide to indicate the potential risk of flooding. When producing it we use the best data available to us at the time and also take into account historic flooding and local knowledge. The Flood Map is updated on a quarterly basis to account for any amendments required. These amendments are then displayed on the internet at <https://www.gov.uk/check-flood-risk>

At this Site:

The Flood Map shows that this site lies within the outline of Flood Zone 3. This zone comprises land assessed as having a 0.5% (1 in 200) or greater annual probability of tidal flooding.

Enclosed is an extract of our Flood Map which shows this information for your area.

Method of production

The Flood Map at this location has been derived using detailed modelling of the tidal River Thames through the North Kent Coastal Modelling study completed in 2018 by JBA Consulting.

Flood Map for Planning centred on DA11 9AD created 12th May 2023 [Ref: KSL 305544 RL]



Scale 1: 10,000



Legend

-  Site Location
-  TE2100 Model Nodes
-  Main Rivers
-  Flood Zone 3
-  Flood Zone 2
-  Flood Defences

Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 0.5% or greater chance of occurring each year
- or from a river with a 1% or greater chance of occurring each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 0.1% chance of occurring each year.

Thames Estuary 2100 (TE2100)

You have requested in-channel flood levels for the tidal river Thames. These have been taken from the Thames Estuary 2100 study completed by HR Wallingford in 2008. The modelled node closest to your site is **3.24**; the locations of nearby nodes are also shown on the enclosed map.

Details about the TE2100 plan

The Plan sets out how the Environment Agency and our partners can work together to manage tidal flood risk, from now until the end of the century. The Plan covers the Thames Estuary from Teddington in the west to the mouth of the estuary at Shoeburyness (north bank) and Sheerness (south bank) in the east. It is an adaptive plan for managing the estuary, including the tidal defence system, until 2100 so that current standards of flood protection are maintained or improved taking into account climate change effects e.g. sea level rise. The Plan has 3 phases of activity:

- Until 2035 – maintain and improve current defences, safeguard areas required for future improvements, and monitor climate change indicators.
- 2035-2050 – raise existing walls, defences & smaller barriers whilst reshaping the riverside environment.
- 2050-2100 – determine and implement an option for the future of the Thames Barrier, and adapt other defences as required to work alongside this to protect the estuary.

The Thames Estuary 2100 Plan can be found at: <https://www.gov.uk/government/publications/thamesestuary-2100-te2100>

Details about the TE2100 in-channel levels

The TE2100 in-channel levels take into account operation of the Thames Barrier when considering future levels. The Thames Barrier requires regular maintenance and with additional closures the opportunity for maintenance will be reduced. When this happens, river levels – for which the Barrier would normally shut for the 2008 epoch – will have to be allowed through to ensure that the barrier is not shut too often. For this reason, levels upriver of the barrier will increase and the tidal walls will need to be raised to match.

Where to find the in-channel levels and defence crest level data from the 2008 TE2100 study

The TE2100 in-channel levels and defence crest levels documents can be downloaded from ShareFile at the following link:

<https://ea.sharefile.com/d-s5e564014724448219331e780c91c4ac2>

- Downriver of the Thames Barrier is detailed within Table 7.1 (page 56) of the document titled '*Thames Estuary 2100, Improvements to Flood Risk Management System, Design Water Levels and Future Defence Crest Levels, May 2015*'. Defence raising for other barrier options can also be found in the document titled '*Thames Estuary 2100, Phase 3 Studies, Topic 1.5, Phase 3 Set 2 Estuary Wide Options Hydraulic modelling, December 2008*'

Thames Tidal Downriver Breach Inundation Modelling - 2018

The table below displays site-specific modelled flood levels at your site. These have been taken from the Downriver Breach Inundation Modelling Study 2018 completed by Atkins Ltd. in May 2018.

We have developed a modelling approach where all downriver breach locations along the Thames are equitably modelled, to ensure a consistent approach across London. This modelling simulates continuous tidal breaches along the entire extent of the Thames between the Thames Barrier and east of Gravesend on the south bank and east of Tilbury on the north bank. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width.

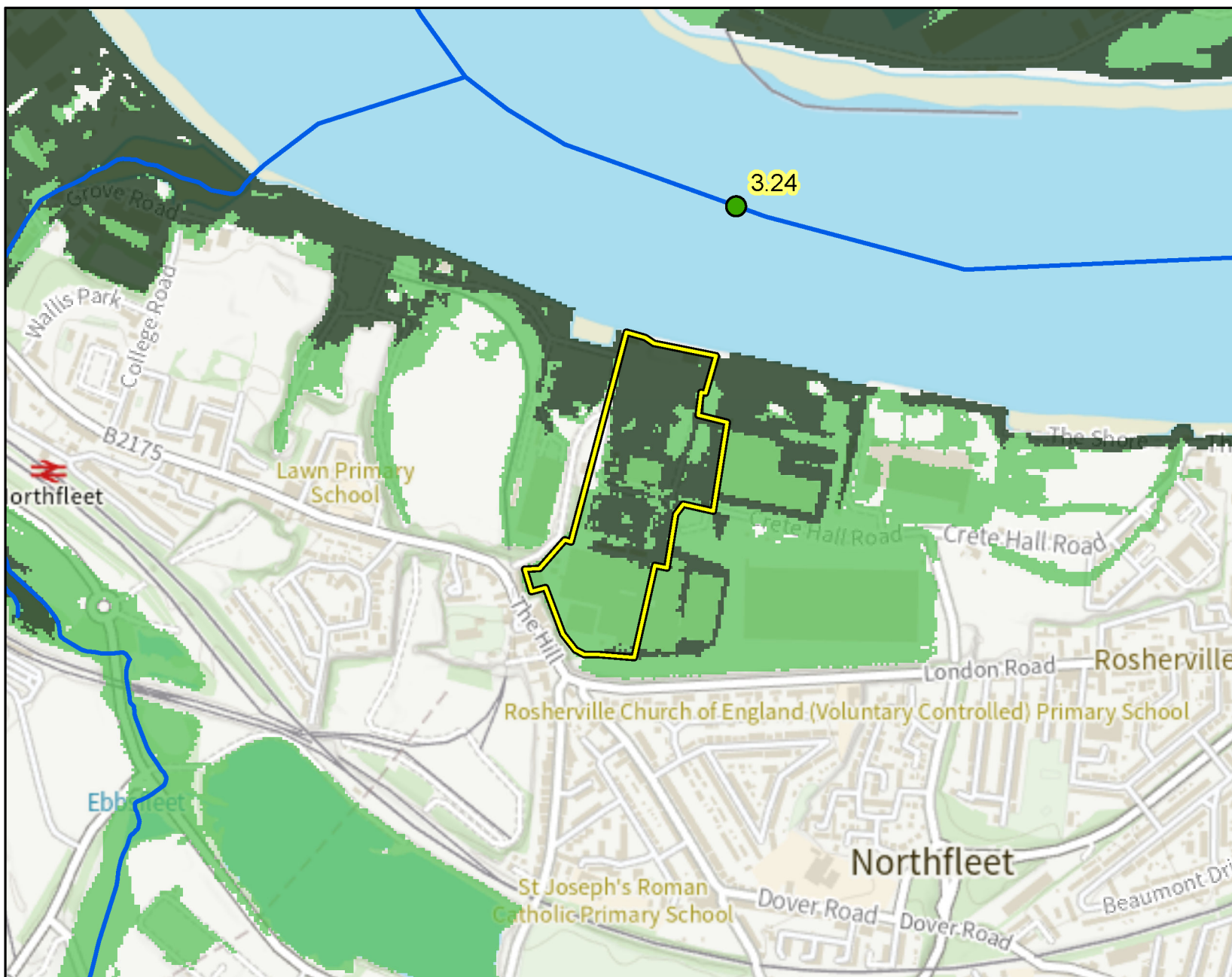
Based on the 2008 TE2100 in-channel levels, the 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) annual probability of exceedance tidal events were modelled for all breach locations downriver of the Thames Barrier. These were modelled for the 2014 year epoch (current year), as well as 2115 epoch which include allowances for climate change.

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within London.

Node	National Grid Reference		Modelled levels in mAODN for 0.5% AEP		Modelled levels in mAODN for 0.1% AEP	
	Easting	Northing	2014	2115	2014	2115
1	562638	174658	5.71	6.08	5.78	6.37
2	562773	174622	5.40	5.99	5.58	6.40
3	562748	174516	5.24	5.99	5.53	6.40
4	562792	174503	5.21	5.99	5.53	6.40
5	562771	174375	5.21	5.99	5.46	6.40
6	562715	174381	5.28	5.99	5.48	6.40
7	562688	174273	3.59	5.99	4.32	6.40
8	562635	174113	Nil return	5.98	4.32	6.40
9	562550	174119	Nil return	5.99	4.32	6.40
10	562494	174248	Nil return	5.99	4.32	6.40
11	562547	174302	Nil return	5.99	4.32	6.40

12	562593	174476	Nil return	Nil return	Nil return	Nil return
13	562674	174549	5.47	6.02	5.65	6.40
14	562631	174345	Nil return	5.99	5.30	6.40

Downriver Breach Modelling Map centred on DA11 9AD created 12th May 2023 [Ref: KSL 305544 RL]



Scale 1: 10,000



Legend

- Site Location
- TE2100 Model Nodes
- Main Rivers

Downriver 0.5% AEP Outlines

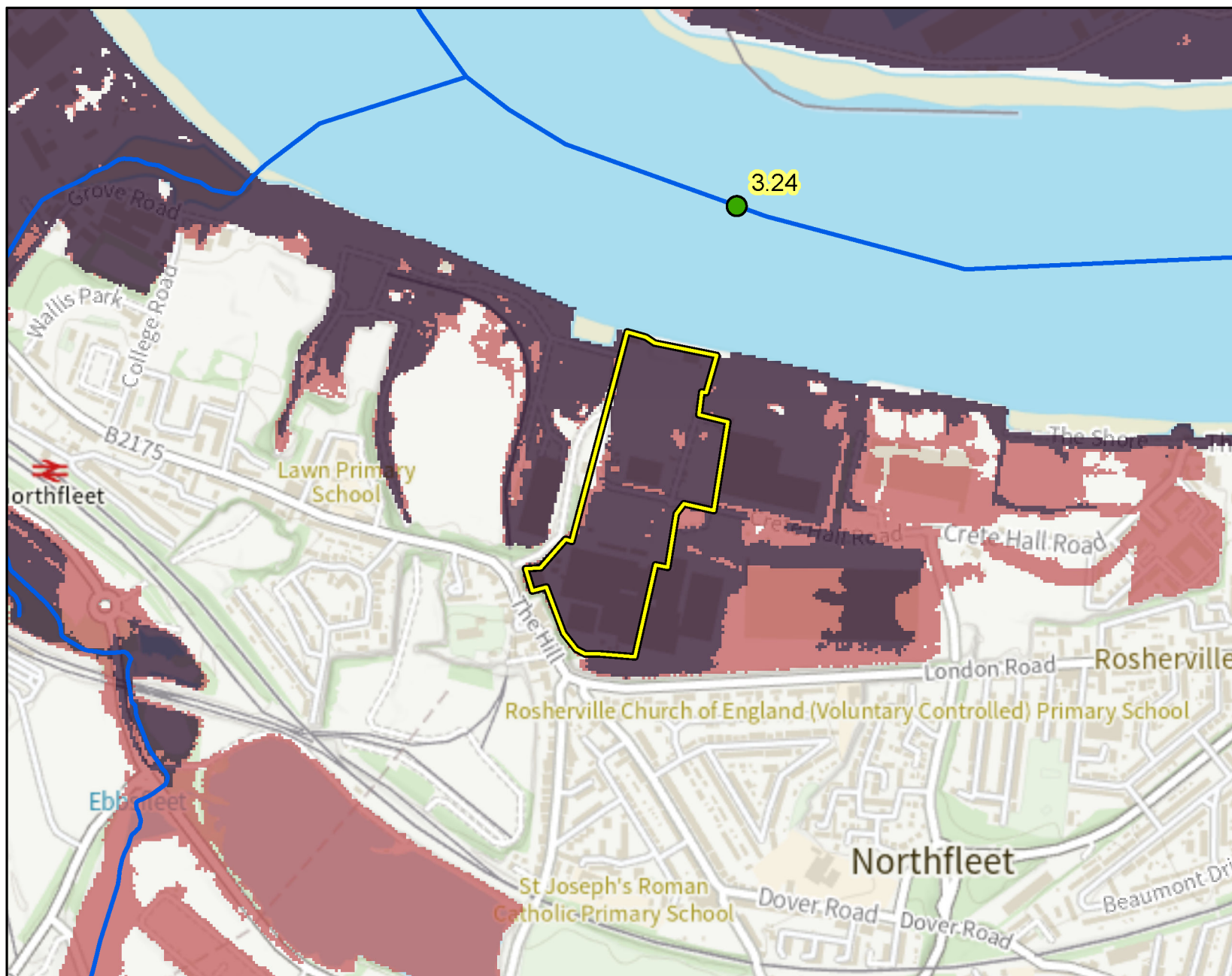
Epoch

- 2014 (Current year)
- 2115

Thames Tidal Downriver Breach Inundation Modelling 2018

A modelled representation of all tidal breach locations along the Thames from the Thames Barrier to Gravesend, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2115.

Downriver Breach Modelling Map centred on DA11 9AD created 12th May 2023 [Ref: KSL 305544 RL]



Scale 1: 10,000



Legend

- Site Location
- TE2100 Model Nodes
- Main Rivers

Downriver 0.1% AEP Outlines

Epoch

- 2014 (Current year)
- 2115

Thames Tidal Downriver Breach Inundation Modelling 2018

A modelled representation of all tidal breach locations along the Thames from the Thames Barrier to Gravesend, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2115.

Node Location Map centred on DA11 9AD created 12th May 2023 [Ref: KSL 305544 RL]



Scale 1: 5,000



Legend

-  Node Point Locations
 Site Location
 Main Rivers

Defence Details

Asset type / Description – Wall

Location – Kimberly-Clark Industrial Estate, Crete Hall Road, Northfleet,

Maintainer – Environment Agency

Standard of protection – 1000

Asset protection type – Tidal

Condition – 3

Build date – 11/10/2012

Date of next inspection – 20/07/2023

Plans for improvement / future schemes – Unknown

For more information on your rights and responsibilities as a riparian owner, please see our document ‘Living on the edge’ found on our website at:

<https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities>

Areas Benefiting from Flood Defences

The Environment Agency has taken the decision to retire this dataset and remove it from the Flood Map for Planning portal. This is because we have determined that it no longer meets the customer needs and creates a false sense of security for users.

To understand the long-term risk of flooding to an area, you can use the [Check Your Long Term Flood Risk portal](#); this will provide an understanding of flood risk from rivers and sea, taking into account the presence and condition of defences, and other sources of flood risk such as from surface water and reservoirs.

Recorded Flood Events Data

We hold records of historic flood events from rivers and the sea. Information on the floods that may have affected the area local to your site is provided below and in the enclosed map (if relevant).

Flood Event Data

1953 – The site was within approximately 700m of the tidal flooding, due to a storm surge in the North Sea, on the night of the 31st January into the morning of 1st February. An approximate level in the Thames at the time was 4.90 m AODN.

Due to the fact that our records are not comprehensive, we would advise that you make further enquiries locally with specific reference to flooding at this location. You should consider contacting the relevant Local Planning Authority and/or water/sewerage undertaker for the area.

We map flooding to land, not individual properties. Our historic flood event record outlines are an indication of the geographical extent of an observed flood event. Our historic flood event outlines do not give any indication of flood levels for individual properties. They also do not imply that any property within the outline has flooded internally.

Please be aware that flooding can come from different sources. Examples of these are:

- from rivers or the sea;
- surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system);
- overflowing or backing up of sewer or drainage systems which have been overwhelmed,
- groundwater rising up from underground aquifers

Currently the Environment Agency can only supply flood risk data relating to the chance of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding and drainage systems that have been overwhelmed.

Historic Flood Map centred on DA11 9AD created 12th May 2023 [Ref: KSL 305544 RL]



Scale 1: 10,000



Legend

- Site Location
- TE2100 Model Nodes
- Main Rivers
- Jan 1953 Flood Outline

Additional Information

Information Warning - OS background mapping

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Environment Agency planning guidance and pre application service

- Planning Practice Guidance_- provides information about planning considerations in areas at risk of flooding. <https://www.gov.uk/guidance/flood-risk-and-coastal-change>
- Planning applications: assessing flood risk - information about completing Flood Risk Assessments. <https://www.gov.uk/planning-applications-assessing-flood-risk>
- Site specific flood risk assessment: Checklist_- a checklist to help ensure you have considered all the relevant factors in your flood risk assessment. <http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/site-specific-flood-risk-assessment-checklist/>
- Climate change allowance guidance <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

We recommend that you discuss your proposals with the Local Planning Authority at the earliest opportunity. They will be able to advise you on a wide range of planning matters in addition to flood risk.

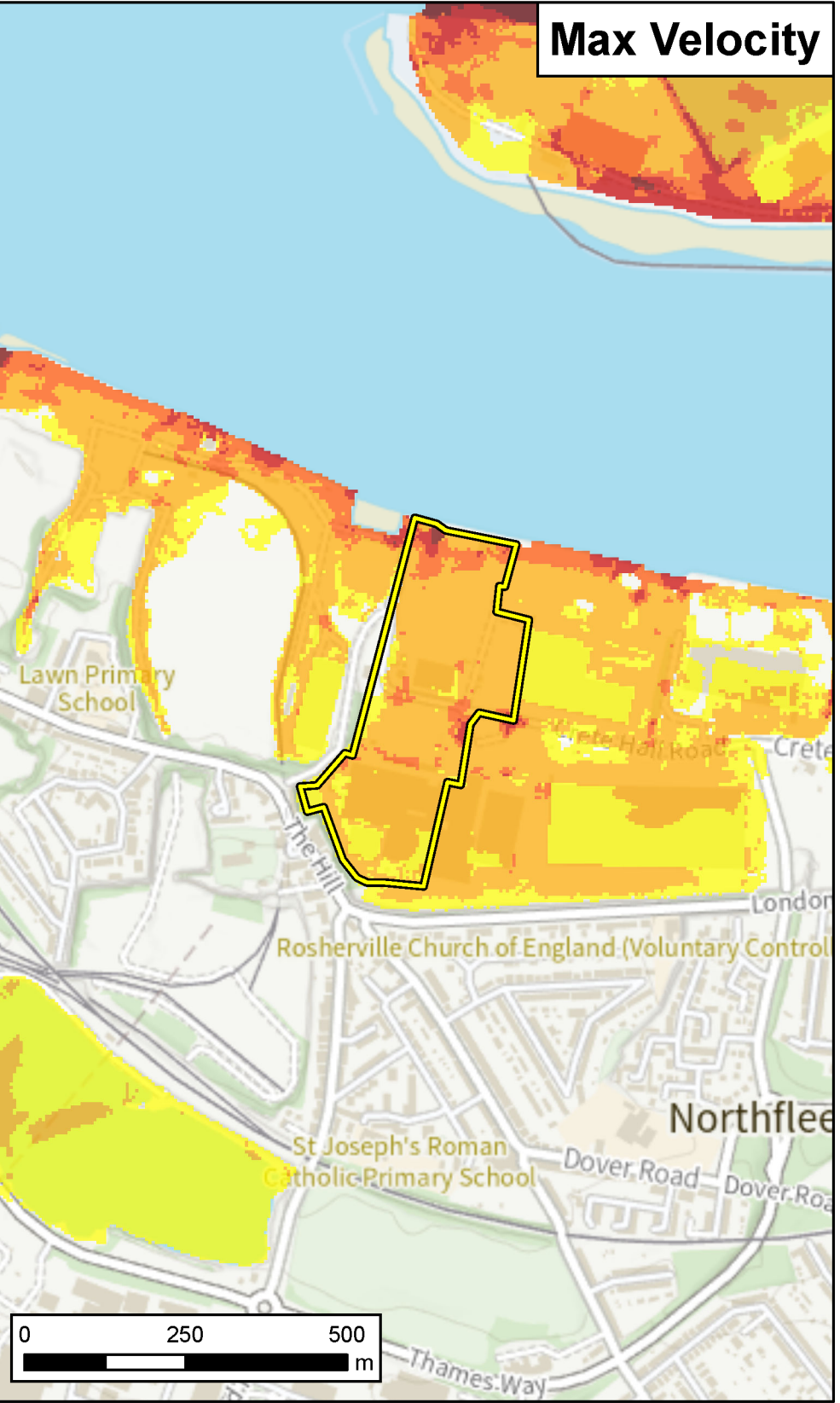
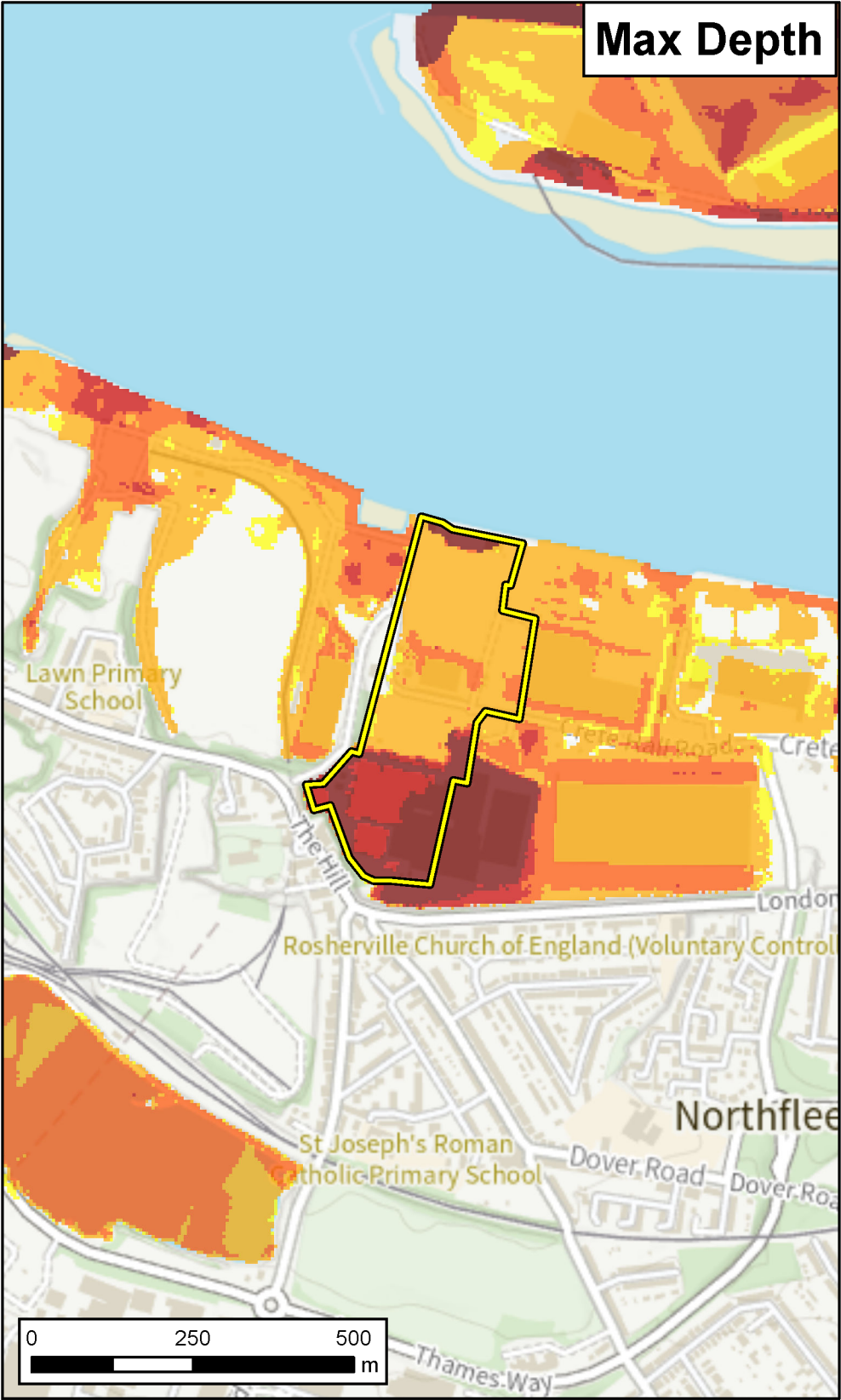
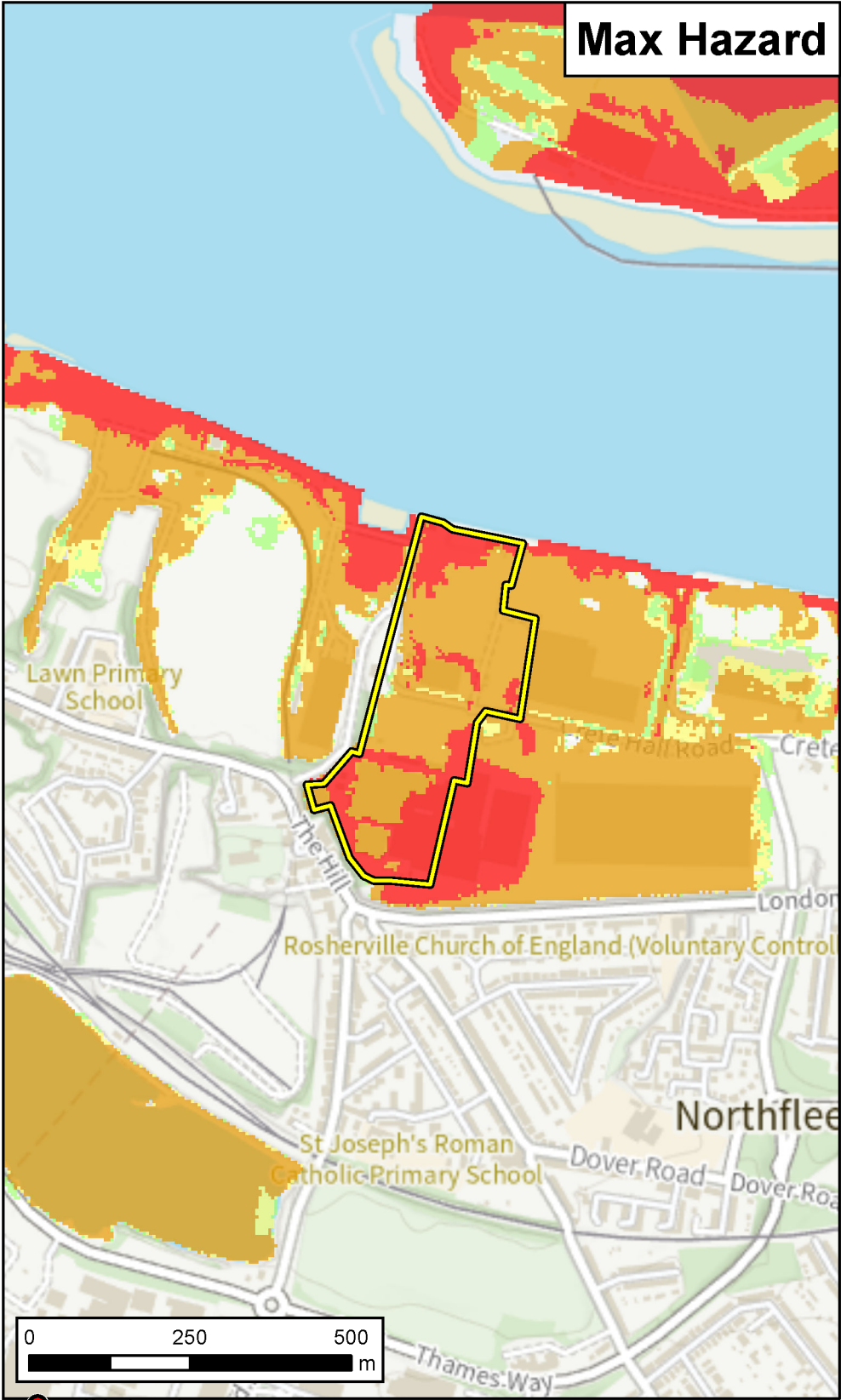
Please see our website for details on how to get planning advice, including charged-for discretionary advice, from the Environment Agency <https://www.gov.uk/guidance/developers-get-environmental-advice-on-your-planning-proposals#when-to-consult>. Our planning team can be contacted at kslplanning@environment-agency.gov.uk

You should also consult the Strategic Flood Risk Assessment and flood risk local plan policies produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment where one is required, but does not constitute such an assessment on its own.

2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. You should discuss surface water management with your Lead Local Flood Authority.
3. Where a planning application requires a FRA and this is not submitted or deficient, the Environment Agency may well raise an objection due to insufficient information



Site Location		Site Location	
Max Hazard		Max Depth (m)	
	Less than 0.75 (Low Hazard)		0 - 0.25
	Between 0.75 and 1.25 (Danger for Some)		0.25 - 1.00
	Between 1.25 and 2.00 (Danger for Most)		1.00 - 1.50
	Greater than 2.00 (Danger for All)		1.50 - 2.00
			> 2.00
Max Velocity (m/s)			
	0 - 0.3		0 - 0.3
	0.3 - 1.0		0.3 - 1.0
	1.0 - 1.5		1.0 - 1.5
	1.5 - 2.5		1.5 - 2.5
	> 2.5		> 2.5
Date Printed	12/05/2023	Scenario year	2115
		Scenario Annual Chance	0.5% (1 in 200)

This map shows the combined flood hazard to people (called a hazard rating) if our flood defences are breached at any given single location, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches covering the entire extent between the Thames Barrier and Gravesend. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.

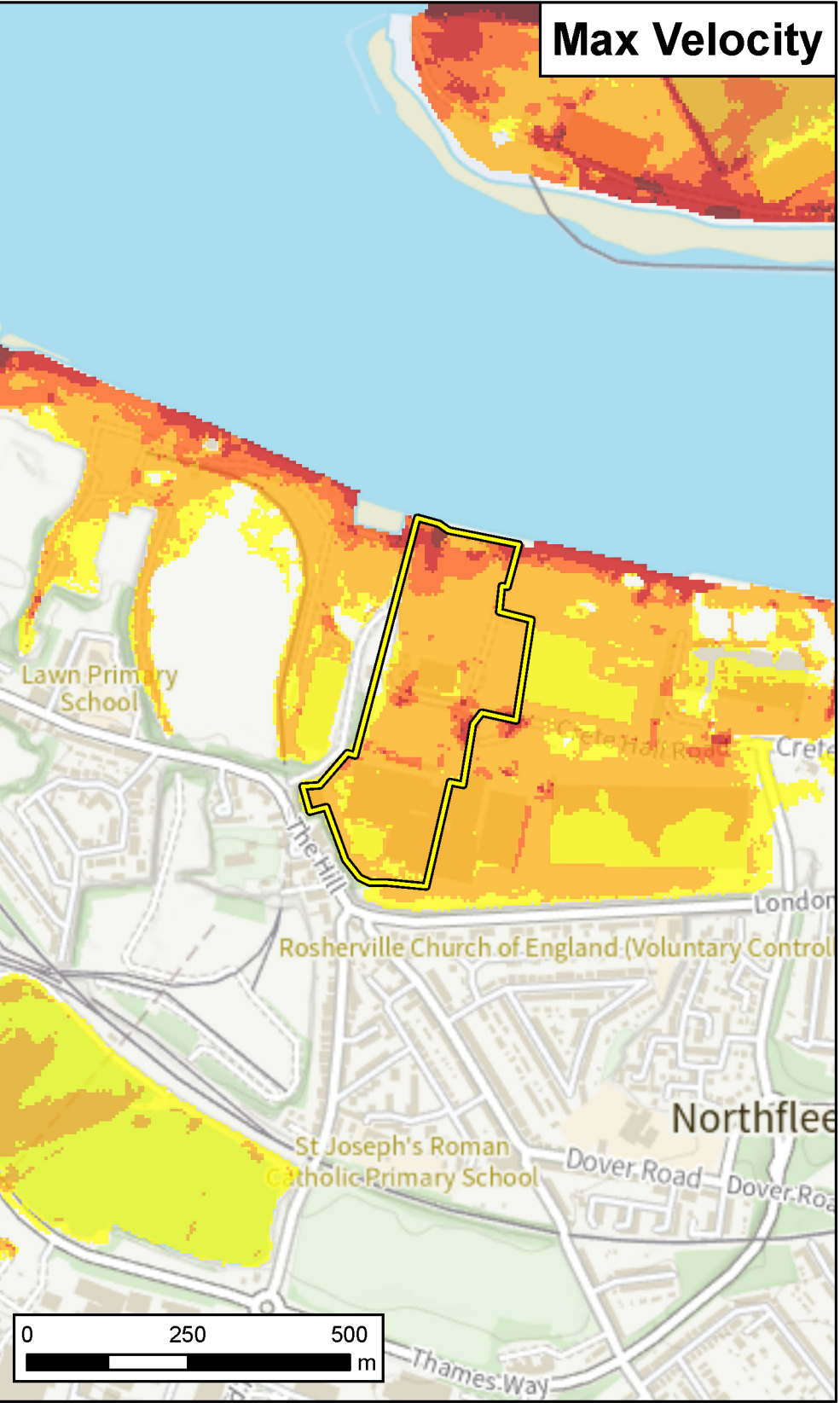
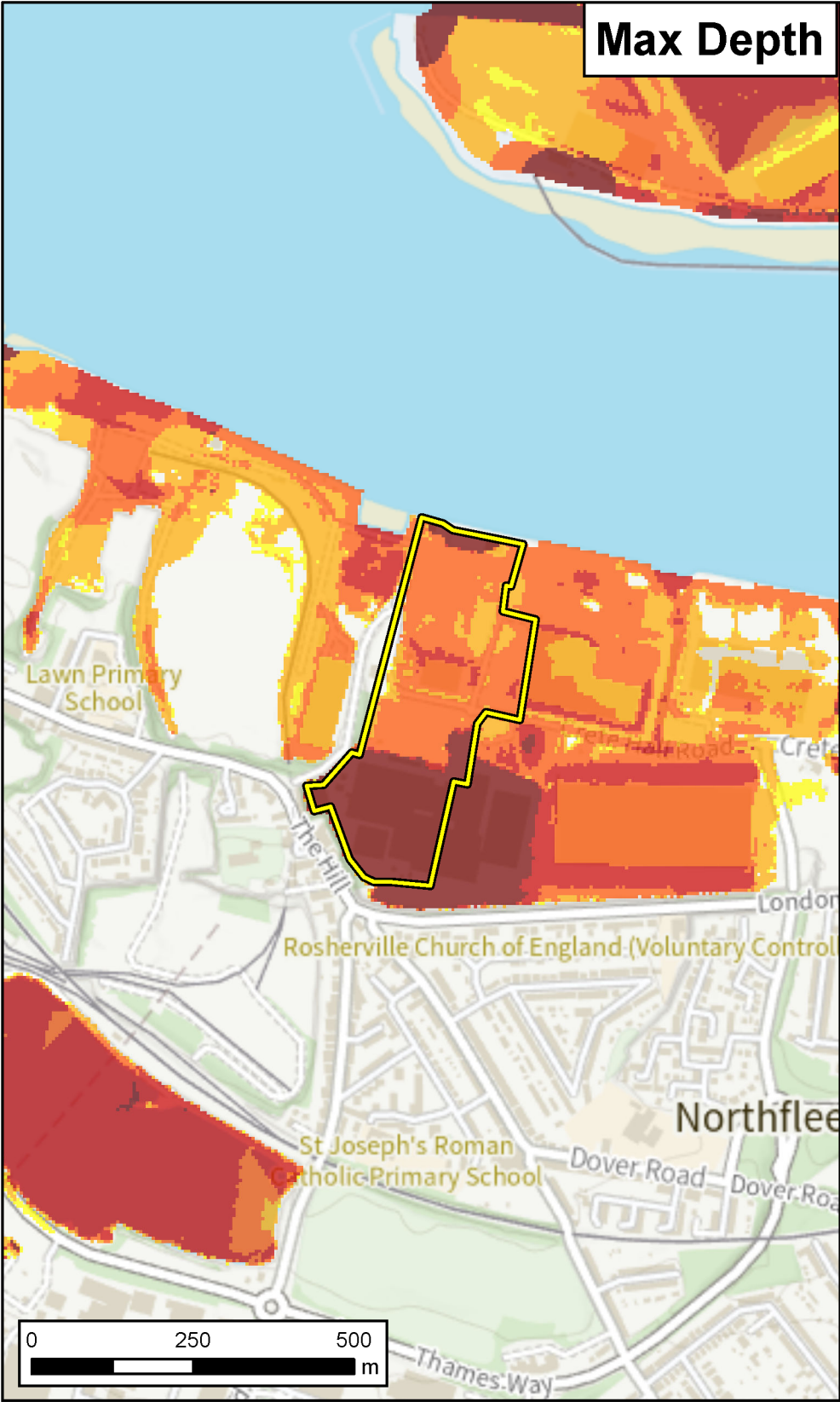
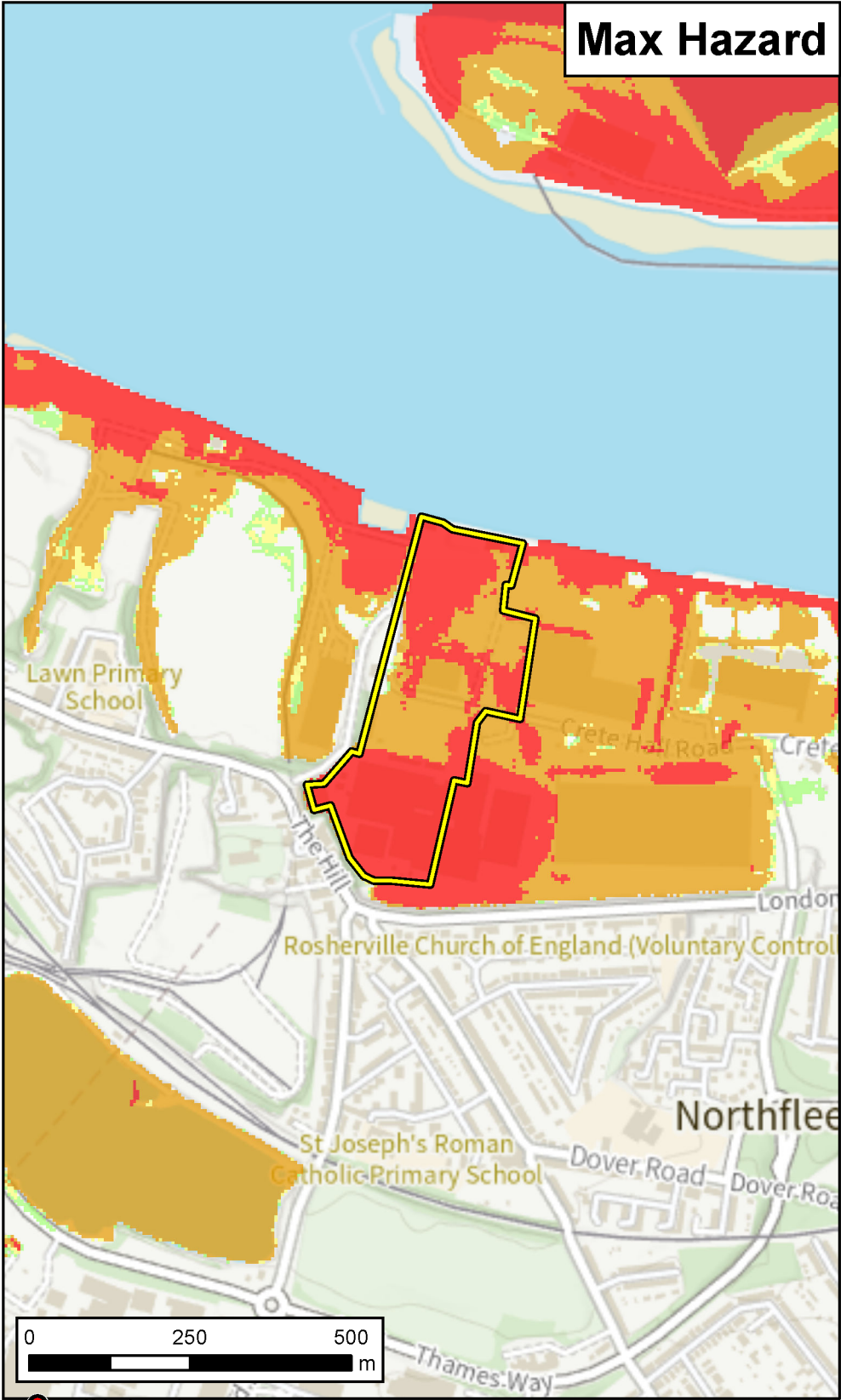
General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary



Thames Tidal Downriver
Breach Hazard Mapping

Map Centred on DA11 9AD
KSL 305544 RL

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Max Hazard		Max Depth (m)		Max Velocity (m/s)	
	Less than 0.75 (Low Hazard)		0 - 0.25		0 - 0.3
	Between 0.75 and 1.25 (Danger for Some)		0.25 - 1.00		0.3 - 1.0
	Between 1.25 and 2.00 (Danger for Most)		1.00 - 1.50		1.0 - 1.5
	Greater than 2.00 (Danger for All)		1.50 - 2.00		1.5 - 2.5
			> 2.00		> 2.5
Date Printed	12/05/2023	Scenario year	2115	Scenario Annual Chance	0.1% (1 in 1000)

This map shows the combined flood hazard to people (called a hazard rating) if our flood defences are breached at any given single location, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches covering the entire extent between the Thames Barrier and Gravesend. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.

General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary



Thames Tidal Downriver Breach Hazard Mapping

Map Centred on DA11 9AD
KSL 305544 RL

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Table 7.1 Defence levels downriver of the Thames Barrier

DEFENCE LEVELS downriver of Barrier		Existing defence levels (2009)		OPTIONS 1.4 & 3.2 Defence levels required in 2040 (for period 2040 to 2070)		OPTION 1.4 Defence levels required in 2070 (for period 2070 to 2120)		OPTION 1.4 Defence levels required in 2120 (for period 2120 to 2170)		OPTION 3.2 Defence levels required in 2070 (for period 2070 to 2170)	
Location	Node	LB	RB	LB	RB	LB	RB	LB	RB	LB	RB
Barrier	a3.1	7.20	7.20	7.20	7.20	8.30	8.30	8.80	8.80	6.20	6.20
	3.2	7.20	7.20	7.20	7.20	8.30	8.30	8.80	8.80	6.20	6.20
	3.3	7.20	7.20	7.20	7.20	8.30	8.30	8.80	8.80	6.20	6.20
	3.4	7.20	7.20	7.20	7.20	8.30	7.70	8.80	8.20	6.20	6.20
Roding	a3.5u	7.20	7.10	7.20	7.20	8.30	7.70	8.80	8.20	6.20	6.20
	a3.5d	7.20	7.10	7.20	7.20	7.70	7.70	8.20	8.20	6.20	6.20
	River Roding	R5.80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3.6	7.30	7.10	7.20	7.20	7.70	7.70	8.20	8.20	6.10	6.10
	3.7	7.30	7.10	7.20	7.20	7.70	7.70	8.20	8.20	6.10	6.10
	3.8	7.30	7.10	7.20	7.20	7.70	7.70	8.20	8.20	6.10	6.10
Beam	3.9	7.20	7.10	7.10	7.10	7.70	7.70	8.20	8.20	6.10	6.10
	3.10	7.10	7.10	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.11	7.05	7.10	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.12	6.90	7.00	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.13	7.00	7.00	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.14	7.00	6.90	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.15u	7.05	6.90	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.15d	7.05	6.90	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	River Darent	N/A	R5.30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3.16	7.15	6.70	7.10	7.10	7.60	7.60	8.10	8.10	6.10	6.10
	3.17	6.85	6.74	7.00	7.00	7.60	7.60	8.00	8.00	8.50	8.50
	3.18	6.90	6.35	7.00	7.00	7.50	7.50	8.00	8.00	8.50	8.50
	3.19	6.85	6.75	7.00	7.00	7.50	7.50	8.00	8.00	8.50	8.50
	3.20	6.85	6.28	7.00	7.00	7.50	7.50	8.00	8.00	8.50	8.00
	3.21	6.90	7.05	7.00	7.00	7.50	7.50	8.00	8.00	8.50	8.00
	3.22	6.85	7.05	7.00	7.00	7.50	7.50	7.90	7.90	8.00	8.00
	3.23	6.85	6.75	7.00	7.00	7.50	7.50	7.90	7.90	8.00	8.00
	3.24	6.50	6.73	6.90	6.90	7.40	7.40	7.90	7.90	8.00	8.00
	3.25	6.95	6.87	6.90	6.90	7.40	7.40	7.90	7.90	8.00	8.00
	3.26	6.65	6.75	6.90	6.90	7.40	7.40	7.90	7.90	8.00	8.00
	3.27	7.00	6.35	6.90	6.35	7.40	6.35	7.90	6.35	8.00	6.35
	3.28	7.00	6.57	7.00	6.57	7.00	6.57	7.00	6.57	7.00	6.57
	3.29	6.48	6.12	6.48	6.12	6.48	6.12	6.48	6.12	6.48	6.12
	3.30	6.75	5.91	6.75	5.91	6.75	5.91	6.75	5.91	6.75	5.91
Mucking	3.31	6.90	6.10	6.90	6.10	7.50	6.10	8.10	6.10	8.10	6.10
	3.32	6.50	5.90	6.90	5.90	7.50	5.90	8.10	5.90	8.10	5.90
	3.33	6.60	5.80	6.80	5.80	7.50	5.80	8.10	5.80	8.10	5.80
	Vange Creek	R4.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Canvey	3.34	6.80	5.75	6.70	5.75	7.40	5.75	8.10	5.75	8.10	5.75
	3.35	6.75	5.82	6.70	5.82	7.40	5.82	8.10	5.82	8.10	5.82
	3.36	6.65	Cliff	6.70		7.40		8.10		8.10	
	EH Creek	R4.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Hadleigh Marsh	R6.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3.37	4.75	5.30	6.00	5.30	6.70	5.30	7.40	5.30	7.40	5.30
Southend	3.38	5.70	5.50	6.00	5.50	6.70	5.50	7.40	5.50	7.40	5.50
	Grain east	N/A	5.70	N/A	6.30	N/A	7.00	N/A	7.70	N/A	7.70
Key		Notes									
		P5 (1:10,000) Defence levels are shown at ISIS model nodes. Policy Units are not indicated.									
		P4 (1:1,000) Representative levels are shown using the prefix 'R' for defences									
		P4 (1:200) not represented by ISIS nodes.									
		P3									

If staff are requested to provide data to developers in P3 areas downriver of the Barrier, including at Hadleigh Marshes, North Kent Marshes and Isle of Grain, they must contact the TE2100 implementation team as early as possible, to ensure they use the best available data on design levels. The TE2100 Plan assumed that the existing defence crest levels would be maintained in P3 areas downriver of the Barrier but did not calculate the specific design levels required for such sites. These may need to be calculated to support such a data request.

Source: Reference 29 (*Phase 3 Set 2 Estuary Wide Options – Hydraulic Modelling*). Some minor adjustments were subsequently made to simplify the level information.

Table 7.2 Defence levels for Policy Units downriver of the Thames Barrier

Recommendations are given in the right hand column for the allowances for future raising that should be included in new defence designs when defences are replaced.

Policy Unit	Bank	Defence levels (m AOD)				Comment and Recommendations
		Existing (2009 data)	2070 Implement in 2040	2170	2170	
				See Table 7.1 for implementation dates		
				Option 1.4	Option 3.2	
Greenwich, Royal Docks	R L	7.2	7.2	8.8	6.2	Downriver Thames Barrier. Allow future raising to 8.8m AOD
Barking & Dagenham	L	7.2	7.2	8.2	6.1	Allow future raising to 8.2m AOD
Rainham	L	6.9 – 7.1	7.1	8.1	6.1	Allow future raising to 8.1m AOD
Thamesmead	R	7.0 – 7.1	7.1 – 7.2	8.1 – 8.2	6.1	Allow future raising to 8.2m AOD
Dartford & Erith:						
- U/R new barrier	R	6.7 – 7.0	7.1	8.1	6.1	Allow future raising to 8.1m AOD
- D/R new barrier	R	6.7	7.0	8.0	8.5	Allow future raising to 8.5m AOD
Swanscombe & Northfleet	R	6.3 – 7.1	6.9 – 7.0	7.9 – 8.0	8.0	Allow future raising to 8.0m AOD
Purfleet, Grays & Tilbury:						
- U/R new barrier	L	7.1	7.0 - 7.1	8.0 - 8.1	6.1	Allow future raising to 8.1m AOD
- D/R new barrier to Grays	L	6.8 – 6.9	7.0	8.0	8.5	Allow future raising to 8.5m AOD
- D/R Grays	L	6.5 – 6.9	6.9 – 7.0	7.9	8.0	Allow future raising to 8.0m AOD
East Tilbury	L	6.4 – 6.9	6.4 – 6.9	6.4 – 6.9	6.4 – 6.9	APF will be 5% by 2100. Consider secondary defence for East Tilbury.
Shellhaven & Fobbing	L	6.5	6.8 – 6.9	8.1	8.1	Allow for future raising of existing tidal defences to 8.1m AOD in the southern half of the policy unit (i.e. from Mucking Sluice to Fobbing Barrier) to protect critical infrastructure, including London Gateway Port.
Bowers	L	6.5	6.7	8.1	8.1	Allow future raising to 8.1m AOD for primary defence on Holehaven Creek.
Canvey	L	6.6 – 6.8	6.7	8.1	8.1	Allow future raising to 8.1m AOD
Hadleigh	L	6.0	6.0	6.0	6.0	
Southend	L	4.7 – 5.7	6.0	7.4	7.4	Allow future raising to 7.4m AOD
North Kent west	R	6.1 - 6.5	6.1 - 6.5	6.1 - 6.5	6.1 - 6.5	
North Kent east	R	5.8 – 6.1	5.8 – 6.1	5.8 – 6.1	5.8 – 6.1	
Grain west	R	5.5	5.5	5.5	5.5	No defence raising proposed for Allhallows and Grain Marshes. Protection needed for access routes to Grain east.
Grain east	R	5.7	6.0 – 6.3	7.4 – 7.7	7.4 – 7.7	Industrial areas. Allow future raising to 7.4m or 7.7m AOD depending on location.

Notes:

Green shading:

Policy P3 - No change in levels

Orange shading:

Increase in defence levels

D/R: Downriver

U/R: Upriver

If staff are requested to provide data to developers in P3 areas downriver of the Barrier, including at Hadleigh Marshes, North Kent Marshes and Isle of Grain, they must contact the TE2100 implementation team as early as possible, to ensure they use the best available data on design levels. The TE2100 Plan assumed that the existing defence crest levels would be maintained in P3 areas downriver of the Barrier but did not calculate the specific design levels required for such sites. These may need to be calculated to support such a data request.

APPENDIX F

ENVIRONMENT AGENCY PRE-DEVELOPMENT CORRESPONDENCE

Daniel Cole
HYRO Energy Ltd
Beaufort Court Egg Farm Lane
Kings Langley
Hertfordshire
WD4 8LR

Our ref: KT/2023/130807/01-L01
Your ref: 680775
Date: 19 July 2023

Dear Daniel,

Development of hydrogen electrolysis facility within the grounds of the existing Kimberly-Clark Industrial Estate.

Kimberly-Clark Industrial Estate, Crete Hall Road, Northfleet, Gravesend, DA11 9AD

Thank you for consulting us on the above planning application.

Flood Risk:

We have reviewed the submitted information and, we would be unlikely to object to the proposal in principle. However, we are not able to determine if the development would meet the requirements of the National Planning Policy Framework (NPPF, 2021). In particular, it is not clear if the proposal would be made safe for its lifetime without increasing flood risk elsewhere.

As noted, the site is mostly within Flood Zone 2 with a small section in Flood Zone 3. However, the site would be flooded were the neighbouring tidal Thames flood defence to breach. This would result in significant site flooding in the 0.5% Annual Exceedance Probability (AEP) current day breach scenario. The resulting flood depths would worsen with the impacts of climate change.

The client has stated that the proposal's design life would be 25 years. It should be noted that the Planning Practice Guidance (PPG), paragraph 006, states that non-residential development should be considered to have a design life of at least 75 years. We understand elements of the hydrogen electrolysis facility may have a lesser design life, but we would consider 75 years as the baseline for the proposal in its entirety. The tidal Thames downstream model does not include 2050 flood outputs which would rarely be appropriate for development when considering the PPG.

The site benefits from the Tidal Thames flood defences, which should provide a

minimum protection up to the 1 in 1000 year event. However, the condition of the neighbouring flood defences varies and it is likely that significant works would need to be undertaken to maintain this standard of protection and enable such development.

From the submitted documents, it is not clear what the blue line boundary is for the development. Please can this be provided.

The PPG also states that, where flood risk management infrastructure such as flood defences form part of the strategy for addressing flood risk, Flood Risk Assessments (FRAs) should identify how this infrastructure will be operated, funded and maintained in addition to ensuring that there is space for future maintenance or new flood risk management infrastructure.

The proposal should consider how the site will be protected from tidal flood risk. This will likely require flood defence raising and/or land raising. Raising options should be considered in line with the Thames Estuary 2100 (TE2100) plan.

Land raising may be required to protect the site from inundation during a tidal flood defence breach event. This may be of particular importance if the site is considered to be essential infrastructure.

Groundwater and Contaminated Land:

We note that no new buildings are proposed and that the equipment would be housed within portacabin style containers on existing or new hardstanding.

A preliminary risk assessment would be required for any breaking of ground and this may necessitate further investigations should suspected or identified contamination be discovered.

Environmental permits may be required for any effluent with detailed designs submitted for associated infrastructure relating to drainage.

Any facilities for the storage of oils, fuels or chemicals shall be provided with secondary containment that is impermeable to both the oil, fuel or chemical and water, for example a bund, details of which shall be submitted to the local planning authority for approval. The minimum volume of the secondary containment should be at least equivalent to the capacity of the tank plus 10%. If there is more than one tank in the secondary containment the capacity of the containment should be at least the capacity of the largest tank plus 10% or 25% of the total tank capacity, whichever is greatest.

Environmental Permitting Regulations Installations

The papermill is a permitted activity and a change to the boiler arrangement will require a permit variation, however this will depend on specifics of the changes/additions etc, a stand-alone permit could be required in some circumstances, without further information it's difficult to say.

Should you require any additional information, or wish to discuss these matters further, please do not hesitate to contact us via the email below.

Yours sincerely,

pp. Kimberley Wadsworth

George Goodby
Planning Specialist

KSLPLANNING@environment-agency.gov.uk

APPENDIX G

ENVIRONMENT AGENCY CORRESPONDENCE

FOLLOW UP

Alison Cadge
RSK Land and Development Engineering

Our ref: KT/2023/130807/02-L01

Charged Agreement ref:
ENVPAC/1/KSL/00653

Your ref: 680775

Date: 16 August 2023

Dear Alison,

02- Review of further flood risk queries

Kimberly-Clark Industrial Estate, Crete Hall Road, Northfleet, Gravesend, DA11 9AD

Following our initial response dated 19 July 2023 (KT/2023/130807/01-L01), we received further flood risk queries from yourself via email on 25 July 2023. Please see our response to these queries below.

Flood risk vulnerability classification

Thank you for confirming the purpose of the proposed hydrogen facility and that this will not be 'essential infrastructure' but form a part of the wider, less vulnerable site.

Defence raising and setback

Assuming the red line boundary does not include any tidal flood defence, then we accept that defence raising could not be delivered as part of this development. We would require any submitted site specific Flood Risk Assessment (FRA) to consider the spatial requirements for a future tidal flood defence were it to be retreated inland e.g. away from the river wall. It should be clearly demonstrated that the proposed development would not restrict options for future defence raising in line with the Thames Estuary 2100 (TE2100) Plan.

It may be that the current river wall would not form the raised tidal flood defence due to space limitations along the quayside. The revised FRA should show minimum offsets between the riverward boundary of the site and the sunken tanks which border the river frontage. It should be demonstrated that there would be sufficient space to construct a retreated tidal flood defence. Ideally this would be at least 16 metres.

Lifetime of development

As previously stated, the development should be assumed to have a minimum design life of 75 years in line with the Paragraph 6 of the "[Flood Risk and Coastal Change](#)" section of the Planning Practice Guidance (PPG).

At the formal planning consultation stage, we would assume a design life of 75 years, unless the Local Planning Authority advised us to consider a different value

design life.

Safe refuge

Where people are expected to work from the proposed development, we would expect the facility to include safe refuge which must be raised to at least the site breach level for the 0.5% Annual Exceedance Probability (AEP) breach event plus 0.6 metres freeboard.

Closing comments

Please note that the view expressed in this letter is a response to a pre application enquiry and does not represent our final view in relation to any future planning application made in relation to this site. We reserve the right to change our position in relation to any such application. You should seek your own expert advice in relation to technical matters relevant to any planning application before submission.

Should you have any queries regarding this response, please contact me.

Yours sincerely,

George Goodby
Sustainable Places Planning Specialist

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