

Appendix: Water Resources, Flood Risk, Drainage and Ground Conditions

Annex 1: Legislation and Planning Policy Context

Annex 2: Phase 1 Contamination Assessment Report

Annex 3: Flood Risk Assessment and Surface Water Drainage Strategy

**FLOOD RISK
ASSESSMENT AND
SURFACE WATER
DRAINAGE STRATEGY**

Northfleet Harbourside,
Gravesham

Prepared for:
Northfleet Central 1 Ltd

28th September 2022

Project Number:
RMA-C2402

THIS PAGE HAS BEEN LEFT BLANK INTENTIONALLY



environmental planning consultancy



RMA Environmental Limited, 1 Emperor Way, Exeter Business Park, Exeter, EX1 3QS
t 01392 576227 e enquiries@rma-environmental.co.uk w www.rma-environmental.co.uk

Registered in England No. 6915388. Registered Office: 2 Chartfield House, Castle Street, Taunton TA1 4AS

Document Production Record:

Report Number: RMA-RC2402

Prepared by: Rosie Tutton

Checked by: Melissa Seymour/Nick Yeo

Approved by: Rob Murdock

Document Revision Record:

Issue Number	Date	Revision Details
1	26 th September 2022	Client Issue
2	28 th September 2022	Final

RMA Environmental Limited has prepared this report in accordance with the instructions of the above named client for their sole and specific use. Any third parties who may use the information contained herein do so at their own risk.

CONTENTS

1	INTRODUCTION	1
	Background	1
	Site Location and Land Use	1
	Proposed Development.....	2
	Requirements for a Flood Risk Assessment.....	3
	Consultation	4
2	BASELINE ENVIRONMENTAL CONDITIONS.....	5
	Topography	5
	Hydrology	5
	Geology and Hydrogeology.....	6
3	EXTERNAL FLOOD RISK.....	8
	Flooding Mechanisms	8
	Historic Flooding.....	8
	River Thames Flood Levels and Defences.....	9
	EA Breach and Inundation Analysis.....	10
	Fluvial Flood Risk.....	11
	Surface Water Flood Risk	12
	Groundwater Flood Risk	13
	Mitigation Measures	13
	Safe Access/Egress	14
	Other Considerations	15
	Land Use Vulnerability	16
4	DRAINAGE ASSESSMENT	17
	Introduction.....	17
	Summary	17
	Water Quality Requirement.....	19
	Designing for Exceedance Events	19
	Long Term Maintenance of SuDS.....	19
5	CONCLUSIONS	20

FIGURES

Figure 1.1:	Site Location Plan
Figure 3.1:	EA's Flood Map for Planning
Figure 3.2:	EA's Surface Water Flood Map
Figure 3.3:	EA's Historic Flood Extent Map
Figure 3.4:	EA's Design Tidal Breach Levels and FFLs
Figure 3.5:	EA's Medium Surface Water Flood Depth Map
Figure 3.6:	Defence Easements and Indicative Realignment

APPENDICES

Appendix A:	Proposed Development Layout
-------------	-----------------------------

Appendix B:	EA Consultation
Appendix C:	LLFA Consultation
Appendix D:	Southern Water Maps
Appendix E:	Topographical Survey
Appendix F:	EA Flood Data
Appendix G:	Surface Water Drainage Strategy
Appendix H:	SuDS Maintenance Schedule

1 INTRODUCTION

Background

- 1.1 RMA Environmental Limited was commissioned by Northfleet Central 1 Ltd to prepare a Flood Risk Assessment (FRA) and surface water drainage strategy in support of the following development on land at Grove Road in Northfleet, Kent, DA11 9AX:
- 1.2 “an outline application with all matters reserved, except for the primary means of access, for a mixed-use redevelopment involving the demolition of existing buildings and structures including site preparation/remediation works, and the development of residential units (Use Class C3), Use Class E floorspace including floorspace for retail, food and beverage, office floorspace and flexible Class E floorspace, floorspace for a new multi-use stadium with associated business and leisure facilities, floorspace for a hotel (Use Class C1), floorspace for community uses (Use Class F2) and other sui generis uses, delivery of open space and the realignment of the A226 Galley Hill Road/Stonebridge Road with hard/soft landscaping, car and cycle parking, highways works, infrastructure works, ancillary and associated works”.
- 1.3 This FRA has been prepared in accordance with the National Planning Policy Framework (NPPF), associated Planning Practice Guidance (PPG) and Environment Agency (EA) standing advice on flood risk for new development.

Site Location and Land Use

- 1.4 The site area contains predominantly a mix of commercial and industrial warehouses and yards, as well as Ebbsfleet football stadium. The site extends to an area of approximately 19 hectares (ha) and is located at National Grid Reference TQ 61539 75079 (refer to Figure 1.1).
- 1.5 The site is located within the Gravesham Borough Council authority area and is bordered by the following land uses:
- Tower Wharf is located to the north of the site;
 - the River Thames and Robins Creek are located to the north-east of the site;
 - woodland and residential dwellings are located to the south-east of the site;
 - railways lines are located to the south of the site;
 - residential dwellings are located to the south-west of the site; and
 - Northfleet Industrial Estate and Swanscombe Marshes are located to the north-west of the site.

- 1.6 Access to the site is currently via Stonebridge Road, Galley Hill Road, Thames Way and Lower Road. Further details on site topography, geology and hydrology are set out in Section 2.

Proposed Development

- 1.7 This application seeks outline planning permission with all matters reserved (except for access) for the following:
- Site clearance including removal of the existing industrial uses on-site and remediation of brownfield land as relevant;
 - Realignment of the A226 Galley Hill Road / Stonebridge Road;
 - Up to 3,500 residential units (Use Class C3);
 - A new multi-use stadium (with associated facilities) with an estimated 8,000 seats and up to 15,000 m² Gross External Area (GEA) (Sui Generis Use);
 - Up to 22,500 m² (GEA) Use Class E(a) retail floorspace;
 - Up to 9,500 m² (GEA) Use Class E(b) food and beverage floorspace;
 - Up to 18,000 m² (GEA) Use Class E(g)(i) and E(g)(ii) office floorspace;
 - Up to 5,000 m² (GEA) 'other' flexible use, comprising:
 - Up to 1,100 m² (GEA) local services (Use Class E(c));
 - Up to 1,200 m² (GEA) indoor sport, recreation and fitness (Use Class E(d));
 - Up to 1,500 m² (GEA) medical or health services (Use Class E(e));
 - Up to 1,200 m² (GEA) crèche or nursery (Use Class E(f));
 - Up to 4,000 m² (GEA) (Use Class F2) local community use;
 - Approximate 300 room hotel (Use Class C1), comprising up to 20,000 m² (GEA) floorspace;
 - Car and cycle parking; and
 - Provision of landscaping, public realm and associated works.
- 1.8 The proposed development plans are included as Appendix A.

Requirements for a Flood Risk Assessment

- 1.9 The requirements for FRAs are provided in the NPPF¹ and associated PPG². Paragraph 167 of the NPPF (July 2021) requires that a site-specific FRA should be submitted with planning applications for:
- all sites greater than 1 ha in Flood Zone 1;
 - for sites of any size within Flood Zones 2 or 3;
 - in an area within Flood Zone 1 which has critical drainage problems;
 - in an area within Flood Zone 1 which is identified in a strategic flood risk assessment as being at increased flood risk in the future; and/or
 - an area within Flood Zone 1 that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.
- 1.10 The EA's Flood Zones are defined as follows:
- Flood Zone 1 is defined as land with little or no flood risk (an annual exceedance probability [AEP] of flooding of less than 0.1%);
 - Flood Zone 2 is defined as having a medium flood risk (an AEP of between 0.1% and 0.5% for tidal areas or 0.1% and 1.0% for rivers); and
 - Flood Zone 3 is defined as high risk (with an AEP of greater than 0.5% for tidal areas or greater than 1.0% for rivers).
- 1.11 The EA's Surface Water Flood Risk extents are defined as follows:
- Very low surface water flood risk is defined where "each year, this area has a chance of flooding of less than 1 in 1000 (0.1%)."
 - Low surface water flood risk is defined where "each year, the area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)."
 - Medium surface water flood risk is defined where "each year, this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)."
 - High surface water flood risk is defined where "each year, this area has a chance of flooding of greater than 1 in 30 (3.3%)."
- 1.12 FRAs should describe and assess all flood risks (from rivers, the sea, surface water, sewers, reservoirs and groundwater) to and from the development and demonstrate how they will be managed, including an evaluation of climate change effects.

¹ Department for Levelling Up, Housing and Communities. (2021). National Planning Policy Framework.

² Department for Levelling Up, Housing and Communities. (2021). Planning Practice Guidance. Flood Risk and Coastal Change. (Online). Available at: <https://www.gov.uk/guidance/flood-risk-and-coastal-change>.

Relevant Planning Policy

1.13 This FRA has been undertaken with reference to the following key policy and guidance documents:

- Gravesham Local Plan Core Strategy Local Plan (Adopted September 2014)³;
- Gravesham Water and Flood Risk Background Paper (October 2020)⁴;
- Kent County Council's Drainage and Planning Policy Statement (2019)⁵;
- Kent Design Guide Making it Happen – Appendix C2 Drainage Systems⁶; and
- Other relevant planning policy and guidance documents.

Consultation

- 1.14 Consultation has been undertaken with the EA throughout the design of the proposed development (refer to Appendix B). This has included initial pre-application advice with regard to flood levels, flood defences and Finished Floor Levels (FFLs) of the proposed buildings. This report has been updated to address these points where necessary.
- 1.15 Consultation has been undertaken with the Lead Local Flood Authority (LLFA) with regard to the surface water drainage strategy, surface water flooding and groundwater flooding (refer to Appendix C).
- 1.16 Asset location plans have been received from Southern Water which indicate that surface water and foul sewers are located along Stonebridge Road within the site (refer to Appendix D). Foul sewers are located along Grove Road and the unnamed road in the western part of the site and a rising main is located along Lower Road and Stonebridge Road within the site.

³Gravesham Borough Council. (2014). Gravesham Borough Council Core Strategy Local Plan.

⁴Gravesham Borough Council. (2020). Gravesham Water And Flood Risk Background paper.

⁵Kent County Council. (2019). DRAFT Drainage and Planning Policy Statement – Local Flood Risk Management Strategy Guidance.

⁶Kent County Council (2007). The Kent Design Guide – Making It Happen Sustainability (Drainage Systems) – Appendix C2.

2 BASELINE ENVIRONMENTAL CONDITIONS

Topography

- 2.1 According to Light Detection and Ranging (LiDAR) data and the spot levels within the site, the majority of the site slopes in a southerly direction towards the south-eastern corner, although the south-east corner and the northern and western parts of the site slopes in a northerly direction (refer to Appendix E). The highest level is recorded to be at a level of approximately 4.80 metres Above Ordnance Datum (mAOD) in the northern part of the site, falling to approximately 2.52 mAOD in the south-eastern corner of the site (refer to Appendix E).

Hydrology

- 2.2 The closest 'main river'⁷ is the River Ebbfleet which flows through the south-eastern part of the site, within a culvert, in a northerly direction and enters Robins Creek approximately 25 m to the north-east of the site. This ultimately flows into the River Thames via a tidal flap resulting in the discharge from the Robins Creek being restricted by the tidal regime of the River Thames. According to the Flood Estimation Handbook (FEH) web service, this watercourse has a catchment area of 46.1 km² at the site location.
- 2.3 Ebbsfleet is an open watercourse up until 130 m south of the site where it meets Thames Way. The EA's Flood Map Improvements: Ebbsfleet Modelling Report states that the Ebbsfleet enters a 450 m long culvert with a 1.71 m diameter, referred to as the Long Culvert, beneath the A226 Thames Way and outfalls into a small section of open channel to the east of the site. The watercourse then enters a 63 m long culvert with a 0.95 m diameter, referred to as Grove Road Culvert, before discharging into Robins Creek.
- 2.4 Swanscombe Marshes (part of the Swanscombe Peninsula Site of Special Scientific Interest) are located to the north-west of the site which comprise areas of marshland and a number of local land drains.
- 2.5 The River Thames tidal defences are located outside of the application site boundary to the north and the defences along the edge of Robins Creek are located outside of the application site boundary to the east.
- 2.6 There are no other significant watercourses or water bodies within the surrounding area.

⁷ Main river is defined by the EA as any watercourse that contributes significantly to the hydrology of a catchment.

Geology and Hydrogeology

- 2.7 According to the British Geological Survey (BGS) online viewer⁸, the majority of the site is underlain by the superficial deposits of Alluvium comprising clay, silt, sand and gravel. Areas along the eastern and western boundaries are underlain by the superficial deposits of Head comprising clay, silt, sand and gravel. A few areas along the eastern boundary and north-western corner are not underlain by any superficial geology.
- 2.8 According to Defras online Magic Map⁹, the EA classify the Alluvium and Head deposits as undifferentiated Secondary Aquifer; these are defined as areas where *“it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.”*
- 2.9 According to the BGS Geology of Britain Viewer, the site is entirely underlain by the bedrock geology of the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation comprising chalk.
- 2.10 The Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation is classified by the EA as a Principal Aquifer; these are defined as *“layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer”*.
- 2.11 From reviewing the BGS 1:50,000 map series England and Wales Sheet 271 for Dartford, it shows that the site is located in an area of previously worked ground. The BGS map also shows that Kempton Park Gravels are located beneath the Alluvium deposits underlying the site.
- 2.12 The EA classify the Kempton Park Gravels as Secondary A Aquifer; these are defined as *“permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.”*
- 2.13 From reviewing BGS mapping, there is an available borehole record located in the centre of the site (TQ67SW791), which was drilled to a depth of 21.34 m and had the following geological sequence:
- Drift deposits (4.28 m thick); and
 - Chalk and flints (at least 17.06 m thick).

⁸ British Geological Survey. (2019). Geology of Britain 3D (Beta version)

⁹ DEFRA. Magic Map. <https://magic.defra.gov.uk/MagicMap.aspx>

- 2.14 The Groundsure Reports within the Phase 1 Land Contamination Assessment Report (included within ES Volume 3, Appendix Ground Conditions: Annex 2) confirms that the site is underlain by artificial deposits of made ground and worked ground specifically in the northern extent of the site. The Groundsure report confirms that there is a mix of artificial ground permeability on site with a maximum permeability of 'very high'.
- 2.15 The majority of the site is located within the Zone II (Outer Protection Zone) groundwater Source Protection Zone and a limited area in the western boundary is located within the Zone 3 (Total Catchment) groundwater Source Protection Zone.
- 2.16 Zone II (Outer Protection Zone) groundwater Source Protection Zone is defined as *‘by the 400-day travel time from a point below the water table. Additionally, this zone has a minimum radius of 250 or 500 metres, depending on the size of the abstraction. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants’*.
- 2.17 Zone 3 (Total Catchment) groundwater Source Protection Zone is defined as *‘the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is less than 0.75’*.

3 EXTERNAL FLOOD RISK

Flooding Mechanisms

- 3.1 The EA's flood map for planning¹⁰ (refer to Figure 3.1) indicates that the majority of the site lies within Flood Zone 3 (high risk) and there are small areas of Flood Zone 2 (medium risk) throughout the site. However, the site is shown to lie within an area benefitting from flood defences along the River Thames which is discussed further below.
- 3.2 The EA's surface water flood risk map¹¹ identifies that the majority of the site has a very low risk from surface water flooding with areas of low, medium and high flood risk of surface water flooding throughout the site (refer to Figure 3.2).
- 3.3 A review of Kent County Council's Local Flood Risk Management Strategy¹² concludes that groundwater flooding in the area is known to occur in areas underlain by major aquifers and is localised with floodplain sands and gravels. This is discussed further below.
- 3.4 The Thameside Stage 1 Surface Water Management Plan¹³ (SWMP; JBA Consulting, 2013) includes a record of a hydraulic overload of the foul system on Thames Way in 1994 where flooding affected a cellar, garage and building. No further details are given on the location of these records or if upgrades were conducted since 1994. Subject to consultation with Southern Water, mitigation against sewer flooding could be achieved through the provision of non-return valves which prevent water entering the property from drains and sewers. Non-return valves can be installed with gravity sewers or drains, within the property's private sewer system. Further information is provided in the CIRIA publication 'Low cost options for prevention of flooding from sewers'. Therefore, with the proposed mitigation measures within the site, the risk from sewer flooding is deemed to be low.
- 3.5 A review of the Local Flood Risk Management Strategy, SWMP and EA flood maps, has identified that there are no other significant sources of flooding at the site, i.e. from reservoirs.

Historic Flooding

- 3.6 The Thameside Stage 1 Surface Water Management Plan (SWMP; JBA Consulting, 2013) has been reviewed to establish any records of flooding at or in close proximity to the application site. This identifies that a record of flooding within the site during a breach of the Thames defences. Stonebridge Road within the site is recorded to have flooded in 2009 due to surface water to a depth of 1 ft and in 2010 due to a burst water main.

¹⁰ Environment Agency. (2019). Flood Map for Planning [Online]. [Accessed September 2022]. Available from: <https://flood-map-for-planning.service.gov.uk/>

¹¹ Environment Agency. (2019). Long term flood risk assessment for locations in England [Online]. [Accessed September 2022]. Available from: <https://flood-warning-information.service.gov.uk/long-term-flood-risk>

¹² Kent County Council. Kent Local Flood Risk Management Strategy. 2017.2023

¹³ Kent County Council, JBA Consulting. Thameside Surface Water Management Plan

- 3.7 Consultation undertaken with the LLFA has identified a number of flood records along Thames Way, Stonebridge Road, Eagle Way, Grove Road and Lower Road due to heavy rainfall and blocked drains/gullies causing surface water flooding (refer to Appendix C).
- 3.8 The EA's historic flood map indicates that a record of historic flooding in February 1953 affected the site due to the tidal defences being overtopped (refer to Figure 3.3). However, since this flood event occurred, the River Thames defences have been upgraded reducing the risk of tidal flooding.

River Thames Flood Levels and Defences

- 3.9 The detailed flood level and flood defence data provided by the EA is included as Appendix F. The data presented has been extracted from the Thames Estuary 2100 Study produced by HR Wallingford (2008). In-channel flood levels for the closest modelled nodes to the site have been provided and these represent the highest levels permitted by the Thames Barrier. The closest modelled node to the proposed development is Node 3.23. Table 3.1 below contains the extreme water levels and defence levels that are applicable to the site.

Table 3.1 – Thames Estuary 2100 Extreme Water Levels for Node 3.23

	THAMES ESTUARY 2100 WATER LEVELS	
	PRESENT DAY	2100
Extreme Water Level (mAOD)	5.85	6.52
Defence Level (mAOD)	6.75	8.00

- 3.10 The site lies at an elevation between 2.52 mAOD and 4.80 mAOD and, therefore, is 3.33 m below the present-day extreme flood level and 4.00 m below the 2100 extreme flood level based on the extreme water levels downstream of the Thames Barrier.
- 3.11 However, the flood defence crest heights downstream of the Thames Barrier are significantly higher than the extreme water levels and, therefore, the site is provided protection for all scenarios.
- 3.12 The River Thames defences provide a standard of protection up to the 0.1% annual exceedance probability (AEP) combined tidal and fluvial event. This remains true up to the year 2070, after which the standard of protection will decrease with time. However, the Thames Estuary 2100 project¹⁴ has studied options to manage flood risk in the Thames Estuary up to the year 2100, with the aim of implementing flood protection measures for the future.

¹⁴ TE2100, available on the Gov.uk website: <https://www.gov.uk/government/publications/thames-estuary-2100-te2100>

- 3.13 The River Thames defences were originally designed with an allowance for sea level rise due to climate change to the year 2030. However, these defences were constructed with a predicted sea level rise of 8 mm/yr, whereas the actual rate of sea level rise has been measured at approximately 3 mm/yr. Therefore, the River Thames flood defences are providing a greater flood defence capability than expected and will not need any major changes until 2070.
- 3.14 It is recommended for the Swanscombe and Northfleet Policy Unit (which includes the site area) that the defences will need to be raised to 8.00 mAOD by 2070. However, the actual dates of defence raising are yet to be decided due to the uncertainty in climate change predictions and the associated increase in sea level.
- 3.15 The River Thames tidal flood wall is located outside of the Northfleet's developments red line boundary and, therefore, these defences are not located within the applicant's control and any future upgrades to the defences are not included within the proposed development outline application. However, futureproofing of the site and the flood defences has been duly considered in the development design, with the inclusion of a 19 m set back (standard being 16 m) that is free from any built development in the northern extent of the site. There is commitment within this application to provide new flood defences within the 19 m set back to meet the TE2100 standards that is required. Given the outline nature of the proposal, details with regards to the design, existing condition of the current defences and structure will be provided at reserved matters stage.
- 3.16 It is therefore concluded that with the reserved matters considered as outline within 3.15, the proposed development will benefit from the improved River Thames flood defences for the duration of its operational lifetime (assumed to be 100 years).

EA Breach and Inundation Analysis

- 3.17 Whilst the site is anticipated to benefit from the River Thames flood defences for its operational lifetime, it is necessary to consider if the proposed development could be affected by a breach in the flood defences.
- 3.18 Detailed flood data has been extracted from the Thames Tidal Downriver Breach Inundation Modelling Study 2018 completed by Atkins Ltd. The downstream inundation modelling is a representation of 'at risk' areas assuming no defences. The modelling is based on the 2008 TE2100 in-channel levels for the 0.5% AEP and the 0.1% AEP events. The modelling represents all downstream tidal breach locations based on low floodplain topography.
- 3.19 The results of the Thames Tidal Downriver Breach Inundation Modelling Study (2018) identify that the site is located within the modelled breach zone for the 0.5% AEP events (refer to Appendix F). Figure 6 within Appendix F shows the flood nodes throughout the site and the corresponding 0.5% AEP flood levels for the year 2115 for these nodes. Table 3.4 sets out the 0.5% AEP flood levels for the nodes throughout the site (Nodes, 2, 10, 13, 16, 30).

Table 3.2: 0.5% AEP Flood Levels

MODELLED FLOOD LEVELS (mAOD)	
2005	2115
<i>Tidal Breach Inundation Scenario (Node 2)</i>	
4.58	5.11
<i>Tidal Breach Inundation Scenario (Node 10)</i>	
4.66	5.56
<i>Tidal Breach Inundation Scenario (Node 13)</i>	
5.35	6.02
<i>Tidal Breach Inundation Scenario (Node 16)</i>	
4.84	5.41
<i>Tidal Breach Inundation Scenario (Node 26)</i>	
4.32	5.27

- 3.20 The site could flood to a maximum depth of 2.08 m in the vicinity of node 26 during a breach event in the 2014 epoch. A few areas along the eastern and western boundaries are located outside of the breach extent in the 2014 epoch as this part of the site is at a higher elevation.
- 3.21 With an allowance for climate change, the 0.5% breach flood level varies from 5.11 mAOD in the western corner to a level of 6.02 mAOD in the north along the bank of the River Thames and, therefore, the flood levels vary significantly across the site (refer to Appendix F). Based on a review of LiDAR, the flood depths during the 0.5% breach event in the year 2115 vary between 0.004 m located along Stonebridge Road and the eastern boundary and 3.19 m in the south-eastern corner (refer to Appendix F).

Fluvial Flood Risk

- 3.22 The River Ebbsfleet Model (Capita URS, 2015) received from the EA indicates that the site is located within fluvial Flood Zone 1 as it is not affected by the 1% or 0.1% AEP flood events (refer to Appendix F).
- 3.23 The latest guidance on climate change for the Medway Management Catchment states that a central climate change allowance of 27% should be used for 'more vulnerable' development. The 1% AEP plus 27% climate change flood level was not provided by the EA; however, the 1% plus 35% climate change scenario is available. This indicates that the site is located outside of this flood extent and, therefore, the site is not located within future Flood Zone 3 (refer to Appendix F).
- 3.24 A 75% blockage scenario during the 50% and 20% AEP events were undertaken for the Long Culvert and Grove Road Culvert and this indicates that the site would remain unaffected during these blockage scenarios (refer to Appendix F).

- 3.25 Consultation with the EA indicates that this model is *'inaccurate and the model should not be used as the only assessment of fluvial flood risk at this site'* (refer to Appendix B). The River Ebbsfleet Flood model (2015) was provided by the EA in July 2022 when the product 4 data for the FRA was requested. It was not stipulated at the time that this was inappropriate to use for this site and should have been highlighted.
- 3.26 The 2015 model is an update to the previous 2005 model and is understood to have been updated to include the culvert within the model. Given the outline nature of the proposed scheme, a detailed culvert survey will be undertaken at reserved matters stage (controlled by a suitably worded planning condition), and on receipt of this, the model can be updated to validate the 2015 model with the culvert survey.
- 3.27 The current 2015 model includes both the 1% AEP plus 35% climate change allowance and the 1% AEP event plus 70% climate change allowance and for both of these scenarios, the site is not affected by flooding. When reviewing the EA's most recent climate change allowances guidance that were updated in July 2021, for a 'more vulnerable' development at this site it is required to use a climate change allowance of just 27% for the 1% AEP scenario. This suggests that the current model assesses a worst-case scenario and shows the site would not be affected by flooding for a much higher climate change allowance (i.e. 35% and 70%).
- 3.28 The proposed mitigation measures discussed below, following the undertaking of a detailed culvert survey to inform design options, including the indicative realignment of the culvert and opportunities to increase the capacity of the culvert to provide a betterment in flood risk terms, therefore, will not create an increase in fluvial flood risk at the site shown within the 2015 model.

Surface Water Flood Risk

- 3.29 The majority of the site has a very low surface water flood risk; however, areas of low, medium and high surface water flood risk are located throughout the site particularly in the southern part of the site (refer to Figure 3.3).
- 3.30 The EA's surface water flood risk mapping shows what *"happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead."* It is noted that this type of flooding is difficult to predict and is based on the best information available to the EA regarding ground levels and drainage.
- 3.31 The low surface water flood risk is beyond the 1% AEP design event and, therefore, no mitigation is required for this surface water flood event.
- 3.32 There are areas of localised ponding throughout the site which have between a medium and high surface water flood risk. However, with the adoption of the drainage strategy outlined in Section 4, it is considered that surface water flooding would not adversely affect the proposed development and the surface water flood risk is considered to be less significant than the tidal risk. As such, the mitigation discussed below for tidal flooding is also relevant to this source.

Groundwater Flood Risk

- 3.33 A review of Kent County Council's Local Flood Risk Management Strategy (LFRMS) concludes that groundwater flooding in the area is known to occur in areas underlain by major aquifers and is localised with floodplain sands and gravels. According to BGS groundwater flooding susceptibility, the site has up to a *'high risk of groundwater flooding'*.
- 3.34 From reviewing BGS mapping, a borehole record located in the centre of the site (BGS reference: TQ67SW791) was drilled to a depth of 21.34 m and groundwater was not encountered. A review has been undertaken of other nearby boreholes and a borehole located approximately 200 m south-west of the site along the railway line (BGS reference: TQ67SW865) was dug to a depth of 10 m and this encountered groundwater at 5.70 metres below ground level (mbgl) within the upper chalk. Two adjacent borehole records (TQ67SW580 and TQ67SW599) encountered groundwater at 4.60 mbgl and 5.10 mbgl.
- 3.35 Pre-application consultation has been undertaken with Gravesham Borough Council (GBC; refer to Appendix C). This states that the *"site conditions identified from mapping show the underlying geology as Upper Chalk with groundwater likely to be seated at less than 3m below the ground surface, which may be subject to seasonal variation"*.
- 3.36 There are no specific records of groundwater flooding in the vicinity of the site and no basements are proposed. Given the chalk aquifer underlying the site as well as gravels and the proximity of the site to the River Thames, it should be considered, as a worst case scenario, that groundwater levels are relatively shallow on site. With this in mind, it is considered that any risk of groundwater flooding can be mitigated alongside the measures proposed to protect the site from tidal flooding.

Mitigation Measures

Finished Floor Levels

- 3.37 The EA recommends that the *'finished floor level of more vulnerable units should be set no lower than 600mm above the design flood level for the site'* (refer to Appendix B).
- 3.38 All FFLs of 'more vulnerable' development will be raised 600 mm above the tidal breach 2100 flood level for each building (refer to Figure 3.4). There will be some areas where reception areas and entrances will be required to be located at ground level, below the flood level, however the most vulnerable uses in these areas will be raised above the flood levels where appropriate (i.e. bedrooms and habitable rooms). The areas below the design flood level will include internal safe access/egress to an area above the flood level should a breach flood event occur.
- 3.39 It is proposed to incorporate flood resilient techniques on the ground floor where FFLs cannot be raised above the design flood level.

Flood Resilience

- 3.40 Flood resilience measures aim to construct the building in a way that flood water may enter a building but its impact is reduced. Flood resilience measures are proposed for the ground floors of the proposed buildings which are not raised 600 mm above the breach levels with the aim of providing additional protection.

- 3.41 The Department of the Communities and Local Government (DCLG) published a report entitled '*Improving the flood performance of new buildings: flood resilient construction*'¹⁵ in 2007. This document provides guidance on building materials, floors, walls, doors and windows, fittings and services. It is recommended that the detailed design of the ground floor elements of the development to consider the advice and guidance set out in this report.
- 3.42 Simple measures such as setting electrical sockets and vulnerable infrastructure 300 mm above the design flood level (where possible) would ensure that these buildings would remain operational during a flood event.
- 3.43 Furthermore, the ground floor levels of these buildings would be designed to allow water to drain away after flooding and access to all spaces would be provided to allow drying and cleaning.

Flood Warnings

- 3.44 As the proposed development is at risk of tidal flooding, the occupants of the residential units and the managers of the other land uses would register to the EA's flood warning service for the local area, to ensure as far as possible that sufficient warning is provided in the event of an extreme flood. This will ensure that, should the EA issue a flood warning for the area, all occupants would have sufficient time to safely leave the site.
- 3.45 The site users will be responsible for acting on flood warnings and the procedures to be followed in the event of a flood. These measures will be set in a Flood Evacuation Plan, which would be submitted to the EA and Council for approval prior to commencement of the proposed development.

Safe Access/Egress

Tidal Flooding

- 3.46 It has been demonstrated that the site is protected from the current and future extreme water levels due to the presence of the Thames defences. However, the site is at risk of flooding during the breach events for the present and climate change scenarios.
- 3.47 The EA's Thames Tidal Breach Hazard Mapping indicates that the safe access/egress route along High Street to the east has a 'very low hazard' rating, the route along Galley Hill Road has a maximum hazard rating of a 'danger for most' and the route along Thames Way has a maximum hazard rating of a 'danger for all' (refer to Appendix F).
- 3.48 A 'very low hazard' is defined as a caution for access/egress. A 'danger for most' is defined as a danger for the general public. A 'danger for all' is defined as a danger for the general public including the emergency services.

¹⁵ Improving the Flood Performance of New Buildings [Online]. [Accessed December 2020]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

- 3.49 Should sufficient flood warning be given, it would be possible to evacuate occupants of the site to land located outside of the breach zone, which is situated adjacent to the eastern boundary along Stonebridge Road, approximately 35 m to the west of the site along Galley Hill Road and approximately 150 m to the south-east of the site along High Street. Tidal flooding is more predictable than fluvial flooding and it is anticipated that a flood warning could be issued several hours in advance providing sufficient time to evacuate the site.
- 3.50 Should sufficient flood warning not be possible, then an internal safe refuge would be available within each unit with a floor level at least 600 mm above the 0.5% breach flood levels in the year 2115. Additionally, safe refuge areas would be available on the podium levels for example around the football stadium. The occupants within the podium tunnel could evacuate via the entrances or through the emergency accesses to the podium level. On this basis, it is concluded that future occupants of the development would be safe in the event of a tidal breach flood event for the operational lifetime of the development.

Surface Water Flooding

- 3.51 When reviewing the EA's surface water flood map, it has been identified that the access/egress route for the site via Thames Way has up to a high surface water flood risk and High Street has up to a medium surface water flood risk.
- 3.52 During the medium risk scenario, it is identified that High Street has maximum estimated flood depth of less than 150 mm and Thames Way has a maximum estimated flood depth of between 150 mm and 300 mm (refer to Figure 3.5).
- 3.53 As the estimated flood depths are less than 300 mm, it is considered that safe access/egress from the site would still be possible. On this basis, it is concluded that future occupants of the development would be safe in the event of a surface water flood event for the operational lifetime of the development.

Other Considerations

Maintenance Buffers

- 3.54 The proposed buildings including the structural support of any buildings/structures along the northern boundary will be set back more than 16 m (up to a maximum of 19 m) from the River Thames defences and structural supports for buildings and structures will be completely separate of any river wall supports (refer to Figure 3.6). This therefore, provides an appropriate easement to allow for access and maintenance of the flood defences and the potential future upgrade of the defences. There is a commitment within this application to provide new flood defences within the 19 m set back to meet the TE2100 standards that are required.
- 3.55 Presently, due to the lack of information and documentation, including specific and clear as-built survey information of the culvert, coupled with the inaccessibility of the area in question, the exact alignment of the Ebbsfleet culvert is currently unknown. The current alignment shown on Figure 3.6 is taken from EA main river spatial data and this shows buildings overlaying part of the culvert. Given the outline nature of the proposed scheme, a detailed culvert survey will be undertaken at reserved matters stage (controlled by a suitably worded planning condition). This is considered a reasonable, proportionate approach given the flexibility within the design.

- 3.56 However, an indicative resolution is proposed which includes the diversion of the culvert along the road to the west of the site (refer to Figure 3.6). The realignment details would be confirmed following a detailed survey of the culvert to understand its depth, width and condition and this would stipulate any realignment route. This approach would provide a betterment when compared to the existing scenario as there will be opportunities to widen the culvert, increasing its capacity thereby reducing flood risk. This approach would also ensure that there is a suitable 8 m easement predominantly free of built development to allow for access and maintenance. Opportunities for de-culverting and partial decelerating will also be considered following the culvert survey that will be undertaken at reserved matters stage.

Flood Risk Activity Permit

- 3.57 The proposed diversion of the River Ebbsfleet would be subject to a Flood Risk Activity Permit (FRAP) or registration of the appropriate exemption with the EA.

Land Use Vulnerability

- 3.58 Annex 3 of the NPPF sets out a schedule of land uses based on their vulnerability or sensitivity to flooding. As set out in Table 2, the residential, hotel, non-residential including education, nursery and health services development are classified as land uses that are 'more vulnerable' to flooding. Office, business, retail, restaurants, cafes, leisure (i.e. football stadium) and community uses are classified as land uses that are 'less vulnerable' to flooding.
- 3.59 Referring to Table 3 of the NPPF PPG, 'more vulnerable' land uses are considered appropriate within Flood Zone 3a subject to passing the Sequential and Exception Tests. 'More vulnerable' land uses are considered appropriate within Flood Zone 2 subject to passing the Sequential Test. 'Less vulnerable' land uses are considered appropriate within Flood Zones 2 and 3 subject to passing the Sequential Test.
- 3.60 The Gravesham Local Plan identifies that the site is located within the Northfleet Embankment and Swanscombe Peninsula East Opportunity Area and within the Grove Road and Lower Ebbsfleet Area (sub-area 1.3) which '*has the potential for residentially-led regeneration*'. The site proposes a residential-led development in line with the Opportunity Area requirements. Therefore, it is considered that the Sequential Test is passed.
- 3.61 Therefore, on the basis of land use vulnerability, the development should be deemed appropriate in planning policy terms in its proposed location.

4 DRAINAGE ASSESSMENT

Introduction

- 4.1 A drainage strategy has been prepared in accordance with Defra's "*Non-statutory technical standards for sustainable drainage systems*" (March 2015) to ensure that the proposed development does not increase flood risk to the site or elsewhere and where practicable reduces flood risk over the lifetime of the development.
- 4.2 Peak rainfall intensity is expected to increase as a result of climate change and, as such, storage calculations have included a 40% increase in rainfall depths in accordance with current climate change guidance.
- 4.3 The outline surface water drainage strategy has been prepared by Pitman Associates in collaboration with RMA Environmental Ltd and is provided in Appendix G.

Summary

- 4.4 The site is brownfield comprising a mix of commercial and industrial warehouses and yards, as well as Ebbsfleet football stadium. Currently, any surface water runoff generated within the majority of the site flows in a southerly direction and runoff from the south-eastern corner flows in a northerly direction and is assumed to flow into the existing drainage system and the public surface water sewer along Stonebridge Road. Surface water runoff from the northern part of the site flows in a northerly direction and is assumed to flow into the River Thames and the runoff from the western part of the site is assumed to flow in a northerly direction into the Swanscombe Marshes.
- 4.5 The feasibility of infiltration-based SuDS will be confirmed via infiltration testing which was not completed at this stage of the development given that the planning application is for outline permission and other reasons detailed below.
- 4.6 It has not been possible to undertake any intrusive site investigation at this stage at the site; this is not only because of the active and busy operational nature of the site (as an established and highly active industrial area) but also the associated access restrictions with vehicle traffic, ownership and localised operations.
- 4.7 Additionally, the site is located within a Zone 2 outer protection zone groundwater SPZ. A Phase 1 Land Contamination Assessment (LCA) has been undertaken for the site which shows that the land uses on site have included (but are not limited to) cement works, a windmill, football ground, tramway and railway tracks, ponds, depots, industrial estates, electrical substations and garages. Given the extensive industrial land uses present on site, the likelihood of contaminants such as metals, asbestos, Polycyclic Aromatic Hydrocarbons (PAHs) and other hydrocarbons cannot be ruled out.
- 4.8 Consultation with the LLFA has identified that '*the BGS information also shows that for this area there is a very significant potential for one or more geohazards associated with infiltration. The underlying geology of Upper Chalk can present a significant soluble rock hazard*' (refer to Appendix C).

- 4.9 Therefore, it is considered that infiltration-based SuDS features would not be appropriate for this site. It is proposed to conduct infiltration testing in accordance with BRE365 at the detailed design stage.
- 4.10 As infiltration techniques are considered to be unfeasible, an attenuation-based strategy has been provided for the 1 in 100 year storm including a 40% allowance for climate change.
- 4.11 A survey of the existing drainage network within the site was not undertaken at this stage due to the active industrial uses on-site resulting in areas being inaccessible for surveys. The drainage network and the invert levels of the existing discharge points are proposed to be established at the pre-commencement stage through a detailed drainage survey. Therefore, a connection into the existing drainage network has not been proposed.
- 4.12 The discharge point for the site is in the vicinity of the confluence of the River Thames and the Ebbsfleet and, therefore, the effect of the high tides on the outflows from the site have been considered (refer to Appendix G). This is in line with the guidance from the LPA provided in consultation which stated that *“subject to it being demonstrated that infiltration is not feasible we accept an unrestricted outflow to the river Ebbsfleet dependent on it being demonstrated that tidal lock is not a concern”*.
- 4.13 As the majority of the site is below the highest astronomical tide, a pumped discharge has been proposed as a precautionary approach. The drainage strategy includes three sub-catchments and sub-catchments A and B will have a pumped discharge into Robins Creek and sub-catchment C will drain via gravity into Robins Creek via a swale.
- 4.14 The proposed SuDS features within the site are as follows (refer to DR-001 in Appendix G):
- roof runoff from the residential buildings will be harvested and re-used which will reduce the discharge to sewers;
 - runoff from podium areas will be attenuated in low-profile attenuation tanks;
 - roof runoff from the football stadium will be captured for re-use (i.e. irrigation) in a low-profile tank located beneath the pitch;
 - green roofs with low-profile attenuation tanks are proposed on the other buildings;
 - park areas will be profiled to provide attenuation for rainfall events in excess of the 30 year return period rainfall event;
 - parking spaces will be constructed of permeable paving;
 - low-traffic roads will be constructed of permeable paving or drain to tree pits or swales; and
 - other roads will drain to tree pits or swales.

Water Quality Requirement

- 4.15 One of the guiding principles of SuDS is the appropriate management of water quality and the use of pollution prevention techniques to improve the quality of runoff from developed sites. The SuDS Manual recommends the use of a management train whereby a series of consecutive treatment stages are employed to remove pollutants from runoff.
- 4.16 The recommended number of treatment stages is dependent on the type of development and sensitivity of the discharge receptor and the mitigation indices of proposed SuDS features. Surface water requiring treatment will come from the roofs, access road, driveways and parking areas. In this instance, mitigation with an index or combined indices of more than 0.7 for Total Suspended Solids (TSS), 0.6 for metals and 0.7 for hydrocarbons is acceptable (refer to Appendix G).
- 4.17 The permeable paving, tree pits and swales will meet the water quality requirements required for the proposed development.

Designing for Exceedance Events

- 4.18 If the proposed drainage system was to become blocked or an event above the design event occur, it is considered likely that some additional storage would be provided in the form of shallow flooding of hard-paved areas. Any water leaving the site would be routed along the road network towards the River Ebbsfleet, River Thames and Swanscombe Marshes. This would mimic what would occur naturally on the site in its existing condition and would ensure that the proposed development is safe during an exceedance event.

Long Term Maintenance of SuDS

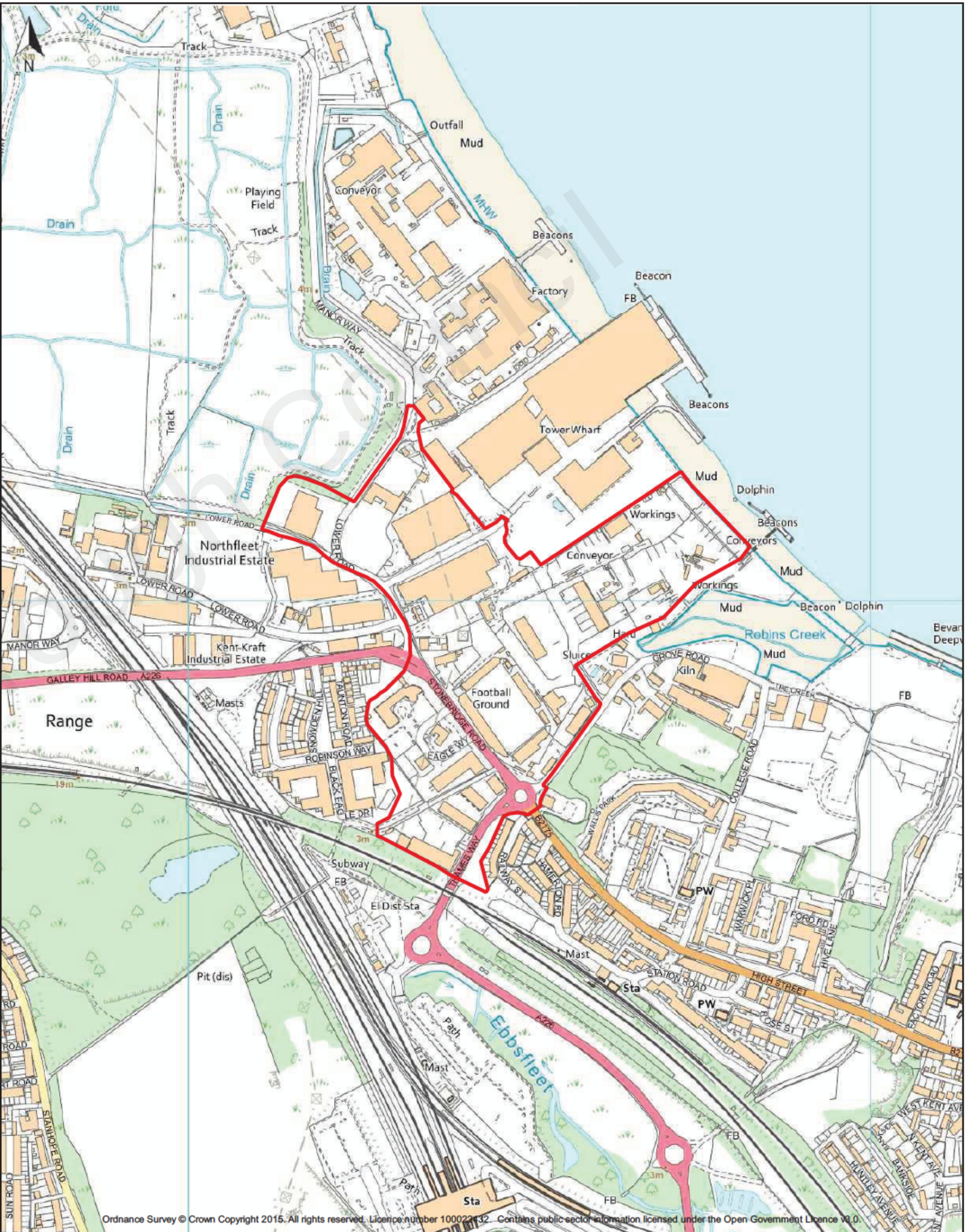
- 4.19 It would be the responsibility of the developer to either maintain the SuDS features themselves or to negotiate with and secure the agreement of a third party to maintain the sustainable drainage system.
- 4.20 The maintenance requirements of the proposed SuDS features for use in the drainage strategy are detailed in the SuDS Manual and would be carried out accordingly (refer to Appendix H).

5 CONCLUSIONS

- 5.1 The requirements for Flood Risk Assessment are provided in the National Planning Policy Framework and its associated Planning Practice Guidance, together with the Environment Agency's Guidance Notes. This policy and associated guidance have been followed in the preparation of this FRA.
- 5.2 The EA's flood map for planning indicates that the majority of the site lies within Flood Zone 3 (high risk) and there are small areas of Flood Zone 2 (medium risk) throughout the site. However, the site is shown to lie within an area benefitting from flood defences.
- 5.3 The majority of the site has a very low risk from surface water flooding with a low, medium and high flood risk of surface water flooding throughout the site. The low surface water flood risk is beyond the 1% AEP design event; therefore, no mitigation is required for this surface water flood event. With the adoption of the drainage strategy, it is considered that medium and high surface water flood risk would not adversely affect the proposed development and the surface water flood risk is considered to be less significant than the tidal risk.
- 5.4 According to BGS Groundwater flooding susceptibility, the site has up to a '*high risk of groundwater flooding*'. Given the chalk aquifer underlying the site as well as gravels and the proximity of the site to the River Thames, it should be considered, as a worst case scenario, that groundwater levels are relatively shallow on site. With this in mind, it is considered that any risk of groundwater flooding can be mitigated alongside the measures proposed to protect the site from tidal flooding.
- 5.5 The site is at risk of sewer flooding; however, the risk from these sources is considered to be low.
- 5.6 The site will benefit from the River Thames flood defences for its operational lifetime, based on the proposed increases to defence levels. However, during a breach event the site could flood to a maximum depth of 3.19 m in the 2100 epoch.
- 5.7 The site is not affected by the 1%, 0.1% or 1% plus 35% climate change AEP fluvial flood events and, therefore, the site is located not within future Flood Zone 3.
- 5.8 All FFLs of 'more vulnerable' development will be raised 600 mm above the tidal breach 2100 flood level for each building. There will be some areas where reception areas and entrances will be required to be located at ground level, below the flood level, however the most vulnerable uses in these areas will be raised above the flood levels where appropriate (i.e. bedrooms and habitable rooms). The areas below the design flood level will include internal safe access/egress to an area above the flood level should a breach flood event occur. Flood resilience measures are proposed for the 'less vulnerable' uses and other ground floor areas, with the aim of providing additional protection.

- 5.9 During the design breach flood event, the access route has a maximum hazard rating of a 'danger for all'. However, should sufficient flood warning be given, it would be possible to evacuate occupants of the property to land located outside the breach zone, which is situated adjacent to the eastern boundary along Stonebridge Road, approximately 35 m to the west of the site along Galley Hill Road and approximately 150 m to the south-east of the site along High Street.
- 5.10 Should sufficient flood warning not be possible, then an internal safe refuge would be available within each unit with a floor level at least 600 mm above the 0.5% breach flood levels in the year 2115. Additionally, safe refuge areas would be available on the podium levels for example around the football stadium. The occupants within the podium tunnel could evacuate via the entrances or through the emergency accesses to the podium level. On this basis, it is concluded that future occupants of the development would be safe in the event of a tidal breach flood event for the operational lifetime of the development.
- 5.11 During the medium risk scenario, the estimated surface water flood depths along High Street and Thames Way are less than 300 mm so it is considered that safe access/egress from the site would still be possible.
- 5.12 A 19 m maintenance buffer has been provided from the River Thames flood defences. This provides an appropriate easement (3 m in excess of the minimum standard) to allow for access and maintenance of the flood defences and a commitment for future upgrade of the defences within the site in line with TE2100.
- 5.13 Presently, due to the lack of information and documentation, including the as-built survey information of the culvert, coupled with the inaccessibility of the area in question, the exact alignment of the culvert is currently unknown. Given the outline nature of the proposed scheme, a detailed culvert survey will be undertaken at reserved matters stage.
- 5.14 However, an indicative resolution is proposed which includes the diversion of the culvert along the road to the west of the site, this approach would provide a betterment when compared to the existing scenario as there will be opportunities to widen the culvert, increasing its capacity thereby reducing flood risk. This approach would also ensure that there is a suitable 8 m easement predominantly free of built development to allow for access and maintenance. Opportunities for de-culverting and partial decelerating will also be considered following the culvert survey that will be undertaken at reserved matters stage.
- 5.15 It is considered that infiltration-based SuDS features would not be appropriate for this site and this would be determined through testing at the detailed design stage. The surface water drainage strategy proposes sub-catchments A and B will have a pumped discharge into Robins Creek and sub-catchment C will drain via gravity into Robins Creek via a swale. The proposed SuDS features will include rainwater harvesting, low-profile attenuation tanks, green roofs and profiled park areas.
- 5.16 This FRA has therefore demonstrated that the proposed development will be safe and that it would not increase flood risk elsewhere. The proposed land uses are classified as 'more vulnerable' and 'less vulnerable' development and are considered appropriate in relation to the flood risk vulnerability classifications set out in Table 3 of the NPPF subject to passing the Sequential and Exception Tests.

Figures



Key Red Line Boundary	Figure 1.1: Site Location Plan		RMA ENVIRONMENTAL			
	Client: Northfleet Central 1 Ltd					
	Project: Northfleet Harbourside, Gravesham					
	Project No.: C2402		Drawn RT	Checked RM	Date 2 /09/2022	Scale 1 5,000@A3