Land East of Rayleigh Road, Thundersley

Flood Risk Assessment & Drainage Statement

On behalf of **This Land Development Limited**

A DEVELOPMENT BUSINESS

Project Ref: 47268/4003 | Rev: D | Date: February 2023

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For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
A	July 2021	Draft Report	MD	SK	SCD
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D	November 2022	Final report	YR	SK	SK
E	February 2023	Report for Issue	SK	SK	SCD

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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared by Stantec UK (Stantec) to support an outline planning application with all matters reserved except access for Land East of Rayleigh Road, Thundersley.

In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), the FRA demonstrates that:

(i) The development is safe;

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

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

The Environment Agency (EA) Flood Zone map shows the site lies wholly within Flood Zone 1 'Low Probability' of flooding from the Eastward Brook (as defined in Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change' Table 1) as follows:

Flood Zone 1 'Low Probability' (less than 1 in 1000 (0.1%) annual probability of river or sea flooding)

The proposals for residential development constitute a More Vulnerable land use, which is considered appropriate within Flood Zone 1 (reference NPPF PPG Tables 2 and 3).

The sequential test is considered to be passed on the basis that the site was allocated in the now withdrawn Castle Point Local Plan (2018-2033). Additionally, the sequential test is passed on the basis that the proposed development is classed as 'More Vulnerable' which is acceptable in Flood Zone 1, the surface water flood risk is dealt with through proposed attenuation features and sequential approach of development located outside areas shown to be at potential risk from surface water flooding. There is a low risk from flooding from other sources.

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

The Essex County Council (ECC) Preliminary Flood Risk Assessment (PFRA) does not have any recorded historic incidences of groundwater, sewer or ordinary watercourse flooding with significant consequences within Essex. The South Essex Surface Water Management Plan (SWMP) and Level 1 Strategic Flood Risk Assessment (SFRA) does not identify any recorded historic incidences of groundwater or ordinary watercourse flooding within the site area. The South Essex Catchment Flood Management Plan (CFMP) confirms that there have been no records of groundwater flooding in the South Essex CFMP area. ECC confirm the site is located within a Critical Drainage Area (CDA) 'NRoch_001 Eastwood', falling within the Rochford Surface Water Management Plan (SWMP) Study Area.

Essex County Council as the Lead Local Flood Authority (LLFA) have confirmed four recorded flood incidents, within a 250m buffer of the site, all occurring pre-2011. These occurred on Kingsley Lane, Sandown Road, Hart Road, and Kingshawes. Further details are provided in this report.

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

- Application of the sequential approach has been applied following review of local surface water flood maps and the implementation of the surface water drainage strategy.
- Recommended incorporation of minimum 150mm 'freeboard' in ground floor levels for buildings and appropriate profiling of exterior ground levels away from building entrances;

- Provision of appropriate surface water drainage attenuation systems, including consideration of projected impacts of climate change and exceedance events;

- Plans in place for future management and maintenance of drainage systems.

- Recommended waterproofing in the substructure design and any service trench installations.

- Consideration for the need for dewatering during construction.

- Recommended to line the pipes with leak-tight liner and where appropriate to line the proposed SuDS features to prevent the ingress of ground water into the pipes through leaking joints and into the proposed SuDS features reducing the storage capacity within these features.

- Groundwater monitoring over a 12-month period to confirm seasonal fluctuations in groundwater levels.

The proposed surface water drainage strategy for the development consists of a network of positive drainage consisting of and not limited to Attenuation Basins with localised pond and wetland features, Swales, Wetland areas and Multifunction Attenuation Basins (lower areas used for attenuation and upper levels providing play space but will also store surface water runoff in the climate change scenarios).

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

1 Introduction

1.1 Scope of Report

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec UK (Stantec), on behalf of our Client, This Land Development Limited, to support an outline planning application with all matters reserved except access for a residential development at a site in Land East of Rayleigh Road, Thundersley, Essex.

1.1.2 The report is based on the available flood risk information for the site as detailed in **Section 1.2** and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the FRA is consistent with the 'Site-specific Flood Risk Assessment Checklist' from the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG):

https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section

1.1.3 The required content of the checklist is detailed below along with specific cross-reference to the content in the FRA as follows:

1) **Development site and location –** see Section 2

2) **Development proposals** – see Section 5;

3) **Sequential Test** – see Section 5

4) **Climate change** – see Section 4;

5) **Site-specific flood risk** – see Section 3;

6) **Surface water management** – see Section 7;

7) **Occupants and users of the development** – see Section 5;

8) **Residual Risk** – see Section 9;

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

1.2 Sources of Information

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

- Topographic survey of the site (Drawing reference 26911se-01) undertaken by Survey Solutions in July 2020;
- Development proposals by This Land Development Limited, as follows:

  "*The development of up to 455 new homes, a multi-use community hall, land for the provision of a healthcare facility, land for a stand-alone early years and childcare nursery, new vehicular/pedestrian access points from Stadium Way in the north and Daws Heath Road in the south, new greenways and green links, multi-functional open space, green infrastructure, surface water attenuation, landscaping and associated infrastructure. All matters reserved except access*."

- Environment Agency (EA) published '**Open Data'** datasets available online, reproduced with OS mapping under licence to PBA (contains Ordnance Survey data © Crown copyright and database right [2020], contains Environment Agency information © Environment Agency and database right);

- The **Environment Agency published online flood maps** at https://flood-map-for-planning.service.gov.uk/ and https://flood-warning-information.service.gov.uk/long-term-flood-risk/map;

- **EA Enquiry and Groundwater data** (EA Ref: EAn/2021/206131, dated 09 March 2021);

- **Initial Appraisal of Existing reservoir Technical Note**, prepared by Stantec UK dated 24 February 2021;

- **Castle Point Borough Council Pre-Submission Plan 2018-2033** (December 2019);

- **South Essex Catchment Flood Management Plan** (December 2009);

- **South Essex Level 1 Strategic Flood Risk Assessment** (April 2018);

- **Essex County Council Preliminary Flood Risk Assessment** (January 2011);

- **Essex County Council Green Infrastructure Strategy** (2020); and

- **South Essex Surface Water Management Plan** (April 2012).

1.3 Relevant Planning Policy

1.3.1 This FRA has been prepared in accordance with the relevant national, regional, and local planning policy and statutory authority guidance as follows:

National policy contained within the **National Planning Policy Framework (NPPF)** updated July 2021, issued by Ministry of Housing Communities and Local Government, with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change'; and,

- National policy contained within the National Planning Policy Framework (NPPF) updated July 2021, issued by Ministry of Housing Communities and Local Government, with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change'; and,

- The associated **Planning Practice Guidance (PPG)** was released in March 2014 (with reference to the 'Flood Risk and Coastal Change' section) and last updated August 2022.

- Local planning policy contained within the **Castle Point Borough Council Local Plan** (adopted November 1998) with particular reference to Policy CF13 and Policy CF14, which state as follows:

    - **Policy CF13 - Phasing of Development**

      The council will require, in appropriate cases, the phasing of any large scale development within the borough, in order to ensure satisfactory infrastructure provision.

- **CF14 - Surface Water Disposal**

  In all cases where development would result in significantly increased surface water run-off, the council will require appropriate improvements to watercourse capacity to be undertaken before development commences.

- The **Castle Point Borough Council Pre-Submission Local Plan 2018-2033** (December 2019). Despite the plan being found sound, Members resolved on the 23rd of March 2022, not to adopt the New Local Plan (and the plan was formally withdrawn on 15th June 2022). Nevertheless, the evidence underpinning the New Local Plan and the findings of the Inspector are considered to represent a material consideration which carries substantial weight and therefore the policies promoted for the site in the Local Plan have been given careful consideration where relevant to flood risk and drainage in the development of the masterplan, this flood risk assessment, and the supporting drainage design for the site. Therefore, with reference to the following policies:

  - **Strategic Policy CC1 Responding to Climate Change**

    1. *The Council will seek to mitigate and adapt to climate change and move to reducing the carbon footprint of the borough. This will be achieved by:*

       a. *Identifying development locations with good access by foot, cycling and public transport to services and public transport provision which reduce the need for travel;*

       b. *Providing improvements to the public transport network, and footpaths and cycle paths;*

       c. *Providing opportunities to deliver multi-functional green infrastructure and new habitat creation;*

       d. *Promoting the efficient use of natural resources such as water and energy;*

       e. *Encouraging high-quality sustainable design and construction techniques that contribute to climate change mitigation and adaptation; and*

       f. *Encouraging opportunities for the provision of renewable energy, low carbon technologies and decentralised energy as part of development proposals as appropriate.*

    2. *The Council will seek to minimise the impacts of climate change on its communities through flood risk management that reduces the risk to people and property from extreme weather and flooding events.*

  - **Strategic Policy CC3 Non-Tidal Flood Risk Management**

    1. *The Critical Drainage Areas for the borough are defined by Essex County Council as the Lead Local Flood Authority.*

    2. *New development proposals within Flood Risk Zones for fluvial flooding, or within an area at risk from surface water flooding in a 1 in 1,000-year event, will be considered against the sequential test set out in the NPPF.*

    3. *Built development proposals on sites where the majority of the land is at risk from non-tidal flooding will not normally be permitted unless there is a clear and robust evidence of wider sustainability benefits to the community that outweigh the flood risks.*

    4. *Where a development proposal is located in an area at risk of fluvial or surface water flooding and passes the sequential test and, where appropriate, the exception tests, the design and layout of development must be taken to avoid built development on those parts of the site most at risk of flooding. This*

includes those parts of the site that form natural or pre-existing flow paths for fluvial flood water or surface water.

5. *Where a development proposal is for a site in an area at risk of fluvial or surface water flooding, or is within a Critical Drainage Area, any natural or semi-natural water features such as ditches, dykes and ponds must be retained in their natural or seminatural form in order to maintain existing attenuation provision and existing flow paths.*

6. *All development proposals, including the redevelopment of existing buildings, will be required to manage surface water run-off so that the rate is no greater than the run-off prior to development taking place or if the site is previously developed, development reduces run-off rates and volumes, as far as is reasonably practical. Where possible, SuDS should be incorporated into the landscaping proposals for development schemes in order to achieve additional benefits for the built, natural and historic environment.*

7. *Consideration must be given to whether the capacity of existing flow paths, and the design capacity of any SuDS proposals for a development, could cope with extreme rainfall events. Where appropriate, additional flow paths should be provided to direct excess surface water away from people and property. This must not increase the risk to existing properties nearby.*

8. *In order to protect people and property, any development located in an area at risk from fluvial or surface water flooding should be designed to be flood resistant to a 1 in 1,000 year + climate change level. Fluvial and/or surface water must not be able to enter property, and buildings should be hydrostatically and hydrodynamically resistant to prevent damage to the structure. Regard should be had to the Essex County Council Interactive Flood and Water Management Map, to determine the need for flood resistant design. Where an application relies on guidance from the Map, a precautionary approach will be taken, and upper flood depths for the location of the site will be applied when determining the appropriateness of the resistance proposed. Applications which seek to provide lower levels of resistance must be supported by their own robust, site specific, modelling which demonstrates that the development will be resistant to fluvial and/or surface water inundation and hydrostatic damage.*

- **Strategic Policy NE7 Pollution Control**

  Development proposals should be designed to manage and reduce pollution through energy and water efficient design, the installation of sustainable drainage systems, and the delivery or enhancement of green infrastructure.

- The site was allocated in the now withdrawn Castle Point Borough Local Plan 2018-2033 (December 2019) with **Local Policy HO13 'Land East of Rayleigh Road, Hadleigh'** applicable for the site. The policy confirmed it will be necessary to demonstrate integration of sustainable urban drainage techniques, to ensure that surface water management is managed appropriately to prevent flooding on or nearby the site.

Strategic Flood Risk Assessment

1.3.2 The SFRA is a planning tool, allowing local authorities to assess the location of future development regarding flood risk. Moreover, the document provides an overall understanding of the flood risk within the study area considering all potential sources.

1.3.3 The South Essex Level 1 Strategic Flood Risk Assessment was published in April 2018. Data of specific relevance to the site is as follows:

- Tidal flooding from the Thames Estuary is a potential source of flooding in the Castle Point Borough, however this does not affect the site.
- There are no historic recorded incidences of ordinary watercourse flooding or groundwater flooding within the Castle Point Borough.
- The site is located within the 25-50% risk of groundwater emergence category.

Preliminary Flood Risk Assessment

1.3.4 ECC is defined as the LLFA under the Flood and Water Management Act 2010. The first element of the Flood Risk Regulations (2009) is for LLFAs to produce a PFRA providing a high-level overview of flood risk from all sources within a local area, including consideration of surface water, groundwater and ordinary (minor) watercourses.

1.3.5 ECC Preliminary Flood Risk Assessment (PFRA) was published in January 2011. Data of specific relevance to the site is as follows:

- There are no historic groundwater flooding records within Essex with significant consequences.
- There are no records of properties affected by sewer flooding with significant consequences within Essex.
- There are no records of overtopping events on ordinary watercourses in Essex.

1.4 Caveats and Exclusions

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

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

1.4.3 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and ECC in its role as Lead Local Flood Authority (LLFA).

1.4.4 The findings of this FRA are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals as outlined in **Section 5**.

1.4.5 The EA Product 4 flood data on which the FRA is based is valid under a 12 month licence. As such, the FRA is accurate at time of issue but we would recommend the end user reviews the validity of the flood data on an annual basis with the EA.

1.4.6 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. Stantec does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

2 Site Setting

2.1 Site Description

2.1.1 The 27.89 hectare (ha) site is located in the north of Hadleigh in the Borough of Castle Point (nearest postcode SS7 3NZ, site centre OS grid reference 580,366m E, 189,099m N – see **Figure 2.1**). The site boundary extends to the A129 (Rayleigh Road) to the west, Daws Heath Road to the south, Little Haven Nature Reserve to the east, and Stadium Way and Stadium Trading Estate to the north.

2.1.2 The site consists of agricultural land, divided by established hedge lined fields. There are several agricultural buildings occupied by commercial use, with stables and Claydons Farm located in the southern part of the site. An existing reservoir is situated towards the north-east corner of the site and is used as a community fishing lake through Oak Lodge Fishery, located on the southern boundary.

2.1.3 Access to the site is proposed via Daws Heath Road and Stadium Way.

2.1.4 The town of Hadleigh lies within the administrative boundary of Castle Point Borough Council (CPBC).

2.1.5 A Site Location Plan with Aerial Photography, reference Figure 01b, is contained in **Appendix A**.

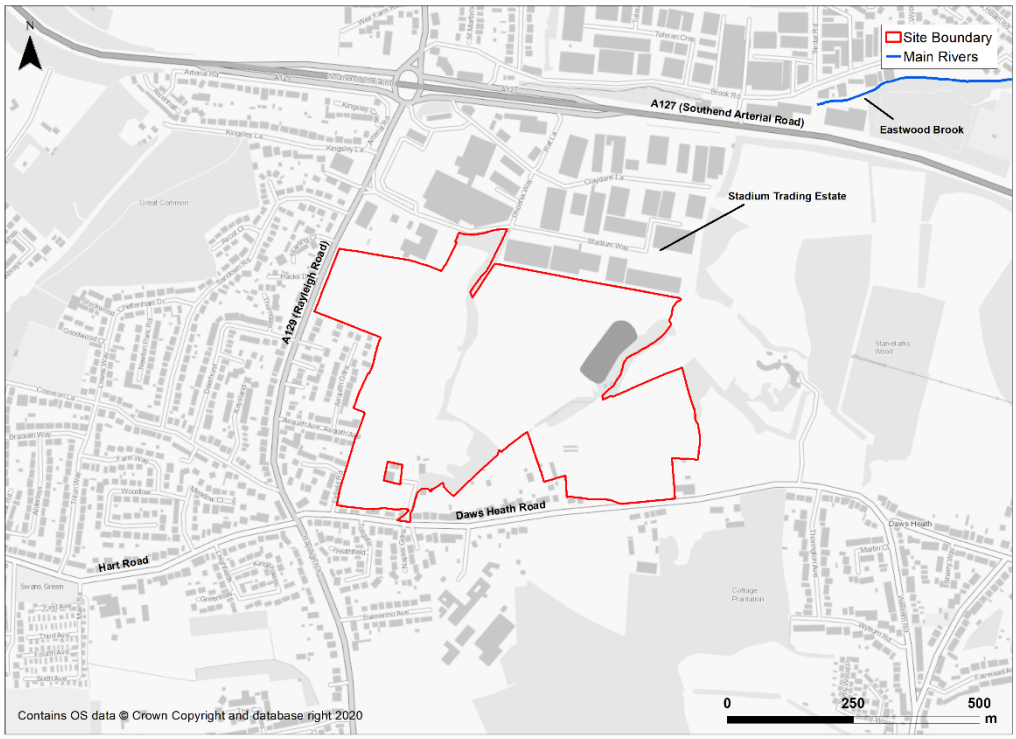


Figure 2.1: Site Location Plan

2.2 Topography

2.2.1 The topographic survey of the site was completed by Survey Solutions in July 2020, a copy of the survey plan is included in **Appendix B**. This indicates levels across the site range from approximately 79.72m AOD, in the south-west corner of the site, to 57.38m AOD, within the north-east corner. The south-western part of the site steeply falls eastward towards an onsite

watercourse (see **Section 2.4** for further details) and northwards towards the Eastwood Brook. The eastern part of the site generally slopes to the north.

2.2.2 OS Mapping agrees with the topographic survey, showing levels range from approximately 80.00m AOD, in the south-west corner of the site, to 57.32m AOD, within the north-east corner.

2.2.3 **Figure 2.2** below and Figure 1 in **Appendix A** shows the topography of the site relative to the immediate surrounding area based on LiDAR data.

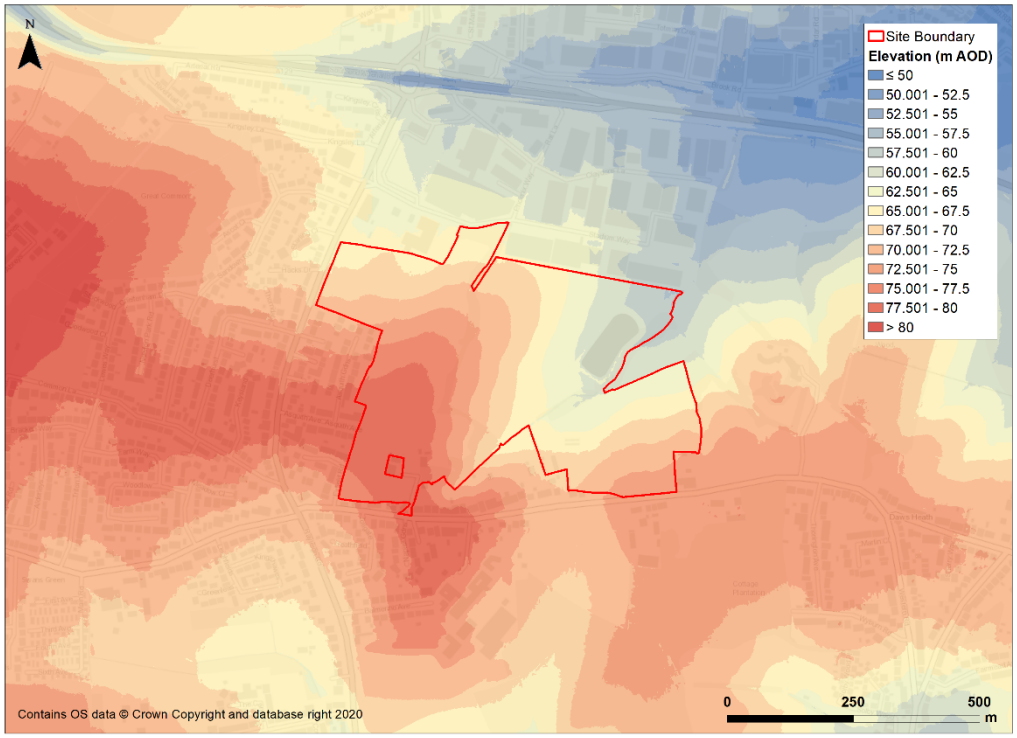


Figure 2.2: Area Topography

2.3 Hydrological Setting

2.3.1 The nearest EA Main River is the Eastwood Brook, located approximately 400m to the north of the site on the opposite side of the A127, which flows eastward relative to the site.

2.3.2 There is an unnamed ordinary watercourse which runs along the southern boundary before bisecting the site and running along the eastern boundary; an ordinary watercourse is defined as a river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. This watercourse conveys flow towards the north-east and becomes culverted after leaving the site and is assumed to discharge into the Eastwood Brook downstream.

2.3.3 The reservoir (fishing lake) is located in the north-east part of the site and is approximately 140m long by 40m wide. It is understood to have been constructed in 1975/76 by impounding water within a raised embankment. The reservoir has a surface water area of 7,800m^2 and maximum depth of 4m, with an estimated volume of ~17,000m^3, all using design water levels. The ordinary watercourse pond flows parallel on its eastern edge. Due to the raised embankment around the reservoir perimeter, surrounding land cannot drain into the reservoir.

2.3.4 An initial appraisal of the reservoir was undertaken by a Reservoir Panel Engineer, to inform on the potential flood risk, the future use and management of this feature. It is proposed to ensure the reservoir remains for future community use as fishing lake. Refer to **Appendix C** for a copy

of the technical note. Future management and safety recommendations are listed with a view for this to be looked at further in the future.

2.3.5 The reservoir is topped up from a 4" plastic pipe at the southwest corner. This inlet supplies water from a diversion structure in the watercourse approximately 90m to the south. The structure incorporates informal stop boards that can be removed or adjusted to control flows as required, although it does not appear that this is actively managed.

2.3.6 It is not known if the watercourse at the diversion structure contains sufficient water to supply the reservoir all year round. Riparian owners can abstract a maximum of 20 cubic meters per day of water for their domestic purposes or for agricultural use, excluding spray irrigation, from a watercourse without a licence. It is therefore assumed in the absence of any information on the management of the fishing lake that any top up of water levels is in accordance with the landowners' Riparian rights. The watercourse had relatively little flow during the Stantec visit for the initial reservoir appraisal, so it is possible that the watercourse may dry up completely in summer conditions. Stantec were advised at their visit that the water level in the reservoir does not significantly drop during summer, although no records were available to confirm this.

2.3.7 Due to the raised embankment around the reservoir perimeter, surrounding land cannot drain into the reservoir. Apart from the inlet pipe supply, the only other water that can enter the reservoir is direct rainfall.

2.3.8 There is a single overflow from the reservoir in the form of a 4" plastic pipe at the south corner. This has an upstream invert level of 61.83m AoD, which determines the normal water level. The pipe runs approximately 15m south to discharge into the watercourse behind a timber fenced area adjoining a small building.

2.3.9 A pond is situated adjacent to the southern boundary of the site, approximately 30m south-east of one of the buildings associated with Claydons Farm.

2.4 Existing Drainage Arrangements

On-Site Drainage

2.4.1 The site consists primarily of open agricultural land, such that surface water would likely drain towards the lowest part of the site (i.e. north-east area) during heavy rainfall events following the natural topography with eventual discharge to the Ordinary Watercourse. Some infiltration could occur during the lower order storm events.

2.4.2 The site has five drainage catchments, **Figure 2.3** below shows an indicative Catchment Plan (included in **Appendix D**). Land in the northern-east and east of the site (Catchments 1 and 2) drain north-westward and northward to the existing industrial estate (Stadium Way) and Rayleigh Road, respectively. Land in the south-west corner (Catchment 3) drains to the south-west, towards Daws Heath Road, with areas in the centre and south-east of the site (Catchments 4 and 5) draining eastward and northward respectively, towards the ordinary watercourse.

2.4.3 Existing impermeable areas within the proposed site are limited to the few agricultural buildings.

Figure 2.3: Catchment Plan

Public Sewers

2.4.4 Anglian Water (AW) has provided copies of its sewerage infrastructure plans for the site and surrounding area. A copy of the sewer asset plans are provided in **Appendix E**.

2.4.5 In the western part of the site, there are two surface water sewers of unspecified diameter that convey surface water runoff north before merging into a 9 inch sewer, then 18 inch sewer as it joins the system under the A129.

2.4.6 There is a 686mm surface water sewer close to the north-east corner of the site within the Trading Estate, flowing northward. A surface water sewer within Stadium Way, 375mm to 450mm, discharges eastwards and outfalls into this 686mm sewer.

2.4.7 There is a nine inch sewer which runs along the south-west boundary of the site adjacent to Firfield Road before discharging offsite into Daws Heath Road. There appears to be a surface water outfall at the end of Asquith Avenue at the south-west boundary of the site.

2.4.8 Foul sewers are present within Stadium Way, the A129, Asquith Avenue and within Daws Heath Road, with varying pipe diameters.

2.4.9 There are no foul sewers within the site itself.

2.5 Geology and Hydrogeology

2.5.1 A Phase 1 Ground Conditions Assessment and Preliminary Ground Investigation report was completed for the site by Stantec (May, 2021). This confirms BGS mapping showing superficial deposits are largely absent from the Site, in the centre, west and south suggesting shallow bedrock.

2.5.2 Infiltration testing undertaken as part of the Preliminary Ground Investigation failed in 11 test locations, only one test undertaken in TP104 yielded infiltration results between 1.79 and $2.96x10^{-6}$. It is noted that a granular sand layer present in trial pit TP104 helped facilitate some infiltration. Refer to **Appendix F** for the infiltration test results.

2.5.3 Site specific data obtained during the investigation works (May and June 2021) confirm the presence of a shallow water table (<1m deep) in half of the monitoring well locations installed on site. The monitoring across six wells recorded groundwater depth between 0.61 and 3.21 m bgl.

2.5.4 The British Geological Survey (BGS) mapping shows the majority of the site has an absence of superficial deposits including the north-west, central and south-east areas. The north-east corner of the site has a band of Head deposits comprising Clay, Silt, Sand and Gravel present. A band of Glaciofluvial deposits comprising Sand and Gravel are present along the south-eastern edge. A small localised area of Sand and Gravel is present within the south-west corner of the site.

2.5.5 With regards to bedrock geology, the site is underlain by the Bagshot Formation across the western, central, and south-east, and Claygate Member in the north-east. Geological information is shown in Figures 8 and 9 enclosed in **Appendix A**.

2.5.6 The Soil Association Map (see Figure 10 in **Appendix A**) shows that the site is mainly underlain wholly by freely draining soil, specifically type 571o (Melford) with type 511e present in the northern part of the site adjacent to Westley Road. There is a thin band adjacent to the eastern boundary where soil type is unknown/undisclosed. The permeability characteristics of soil types 571o and 511e are summarised in **Table 2-1** below.

Table 2-1: Soil Association types found at site

Soil Type	Coverage	Description	BFIHOST
572j (Burlesdon)	100%	Deep fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging associated with deep coarse loamy soils variably affected by groundwater. Some slowly permeable seasonally waterlogged loamy over clayey soils.	0.49

2.5.7 Groundwater monitoring data provided by the EA (see response and data in **Appendix G**) indicates levels within the chalk aquifer are at approximately 0m AOD. This is between 65-70m below ground level at the site. The superficial groundwater is close to the surface at 0-1m below ground level on site. Modelled groundwater flows suggest the groundwater within the chalk is towards the east, partially influenced by a large abstraction approximately 2.3km to the east of the site, with superficial groundwater flows towards the north-east.

2.5.8 The SFRA shows that the site falls within the 25-50% EA Areas Susceptible to Groundwater Flooding Map (AStGWf) category mapping but confirms that there have been no recorded groundwater flooding incidences within the Castle Point Borough.

2.5.9 The site is not within a Groundwater Source Protection Zone (SPZ), see **Figure 2.4** below. The site is entirely underlain by a Secondary A bedrock aquifer, with the northern section of the site underlain by Secondary (undifferentiated) superficial drift aquifer associated with the Head deposits, and Secondary A aquifer in the south-east corner associated with the Glaciofluvial deposits.

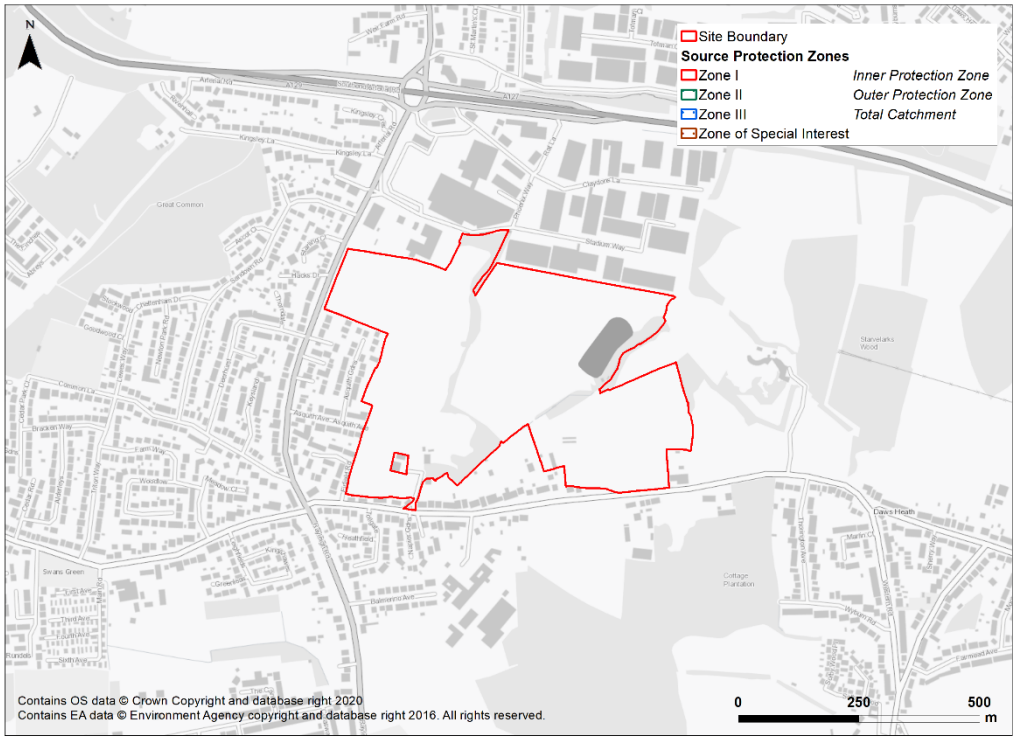


Figure 2.4: EA Source Protection Zones

3 Overview of Flood Risk

3.1 EA Flood Maps

Flood Zone Map

3.1.1 The first phase in identifying whether a site is potentially at risk of flooding is to consult the EA's Flood Zone maps, available on the EA's website. This provides an initial indication of the extent of the Flood Zones, which is more detailed site-specific level survey and modelled flood levels. The Flood Zones are defined in Table 1 of the NPPF Planning Practice Guidance (PPG) ('Flood Risk and Coastal Change' section) as follows:

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

3.1.2 **Figure 3.1** an extract of the Flood Map for Planning, reference Figure 2 enclosed in **Appendix B**, shows the whole of the site lies within **Flood Zone 1 'Low Probability' of river flooding**.

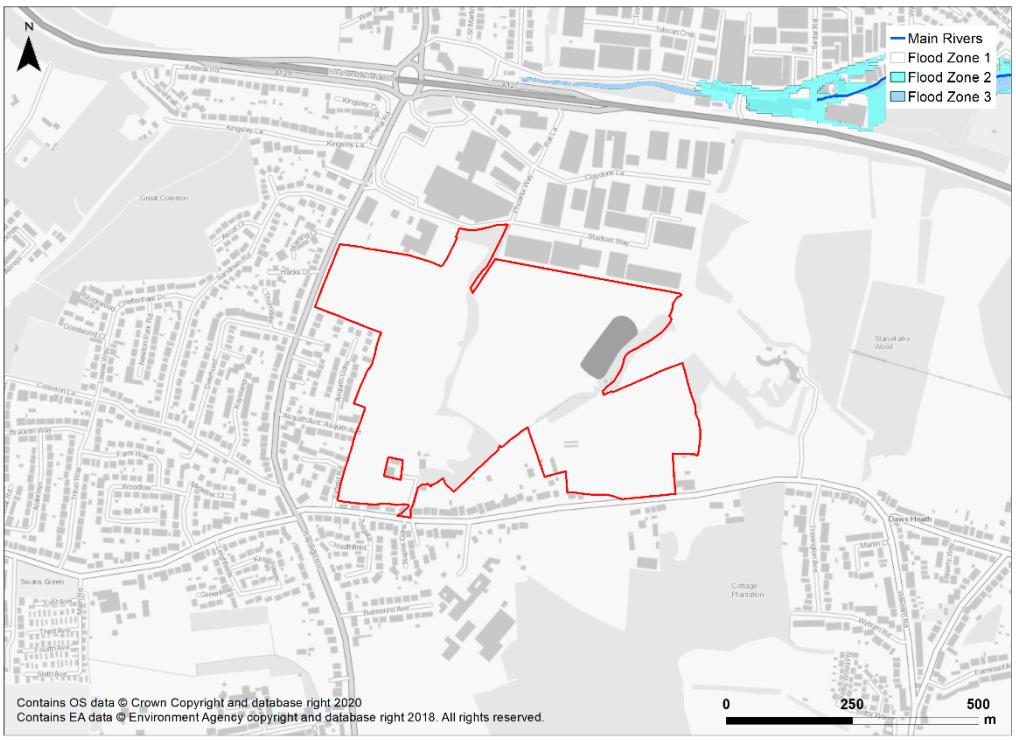


Figure 3.1: EA Flood Zone Map

3.1.3 The Flood Zones for Planning do not map fluvial flood risk from ordinary watercourses. However, the 'Risk of Flooding from Surface Water' (RoFSW) map is considered a reasonable initial indicator of fluvial flood risk from ordinary watercourses, further details on the surface water flood risk are provided within this section.

Flood Risk from Reservoirs Map

3.1.4 The EA provides maps showing the risk of flooding in the event of a reservoir failure. **Figure 3.2** below, and enclosed in **Appendix B**, shows the risk of flooding in the event of a breach from reservoirs, based only on large reservoirs. It shows the site is not at risk of reservoir flooding. The existing reservoir is not large enough to be registered under the Reservoirs Act, and therefore no breach flood mapping is available from the EA for this feature.

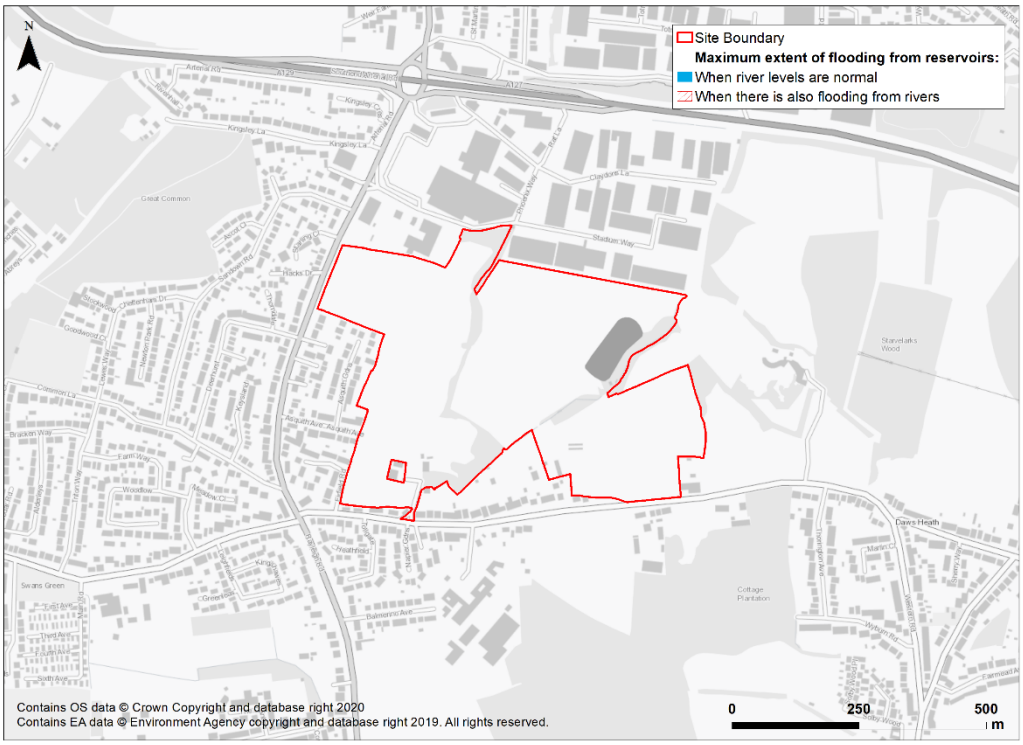


Figure 3.2: EA Risk of Flooding from Reservoirs

3.1.5 It should be emphasised that the risk of flooding from a reservoir breach is very small. The EA are the enforcement authority for the Reservoirs Act (1975) and there is a mandatory requirement for all large raised reservoirs (where greater than 25,000m^3 of water is stored above natural ground level) to be inspected and supervised by reservoir panel engineers. The EA's website states:

> *'Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, we ensure that reservoirs are inspected regularly and essential safety work is carried out'.*

3.1.6 In England, for raised reservoirs which hold less than 25,000m^3 above natural ground level the reservoir owner has a duty of care under the Health and Safety at Work Act 1974 to ensure others are not placed at risk from their assets or actions.

3.1.7 Whilst the consequences of a reservoir breach could be severe, the probability of such an occurrence is therefore considered to be very low.

3.1.8 The estimate volume of the fishing lake is 17,000m^3 and there is insufficient freeboard for the impounded volume to exceed 25,000m^3, therefore this feature does not fall under the ambit of the Act, and consequently not represented on the EA Flood Risk from Reservoir mapping. There is however still a potential flood risk associated with this feature. The existing reservoir is impounded above the lowest surrounding ground levels and therefore could potentially escape

if the dam were to fully breach. If such a dam breach were to occur, the uncontrolled release of water would enter the natural flow route beside the reservoir and flow along the watercourse toward the northeast. If a breach were sudden and significant, the release of water could potentially cause flooding to existing development along the watercourse, especially if it occurred during storm conditions when the watercourse was already experiencing high flows and the catchment was saturated. The flooding could be similar or greater in extent to the areas indicted on the EA surface water flooding map.

Flood Risk from Surface Water

3.1.9 The EA RoFSW map shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event. The latest mapping assesses flooding resulting from severe rainfall events based on the scenarios in **Table 3-1**. Please note that the surface water flood maps show modelled information and not historical records.

Table 3-1: Risk of Surface Water Flooding Scenarios

Risk of flooding	Probability
Very low	< 1 in 1000 (0.1%)
Low	1 in 1000 (0.1%) - 1 in 100 (1%).
Medium	1 in 100 (1%) - 1 in 30 (3.3%)
High	>1 in 30 (3.3%)

3.1.10 **Figure 3.3** below, an extract of the Flood Map for Surface Water, reference Figure 3, enclosed in **Appendix B** shows that the majority of the site is considered as being at a 'Very Low' risk surface water flooding. There is an existing surface water flow path located along the central portion and next to north-eastern boundary of the site which drains north-eastwards. This flow route is associated with runoff from the upper catchment at higher elevations to the south-west and south-east draining into the existing ordinary watercourse causing overtopping on site. This flow route is considered as having a 'Low', 'Medium' and 'High' risk of surface water flooding.

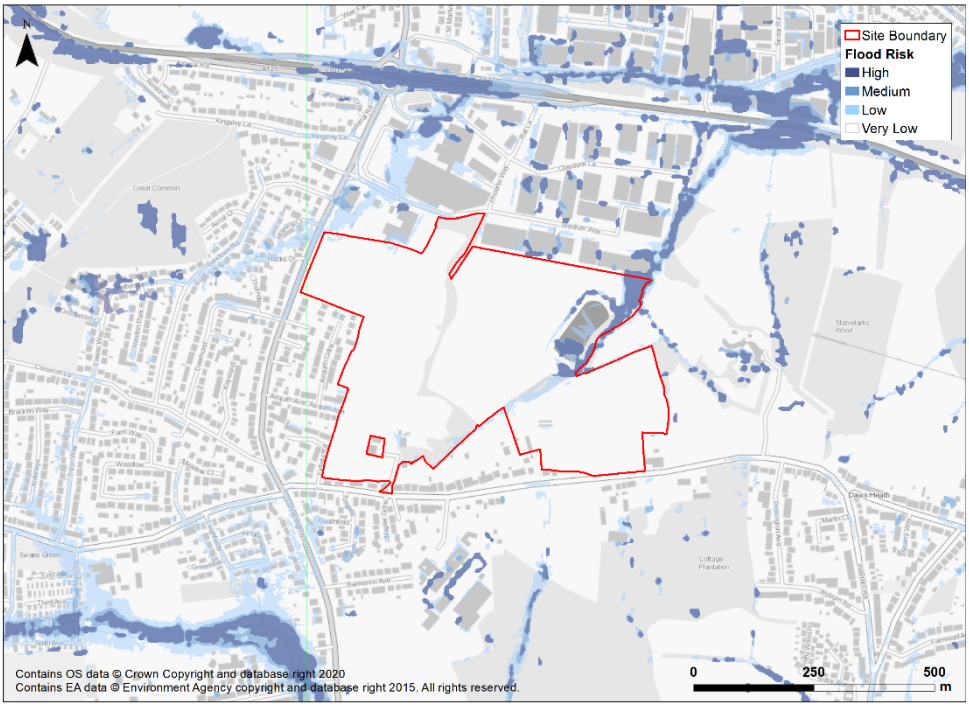


Figure 3.3: EA Flood Map for Surface Water

3.1.11 **Figure 3.4** shows that the aforementioned flow paths could have a flood depth of up to 1200mm in a low risk scenario at the north-eastern boundary of the site near the industrial estate.

Appendix B includes further GIS mapping, reference Figures 3-10, that show further detail of flood extents, flood depths and flow velocities.

3.1.12 The overland flow route requires further consideration, and this is discussed further in the Mitigation Strategy (**Section 6**).

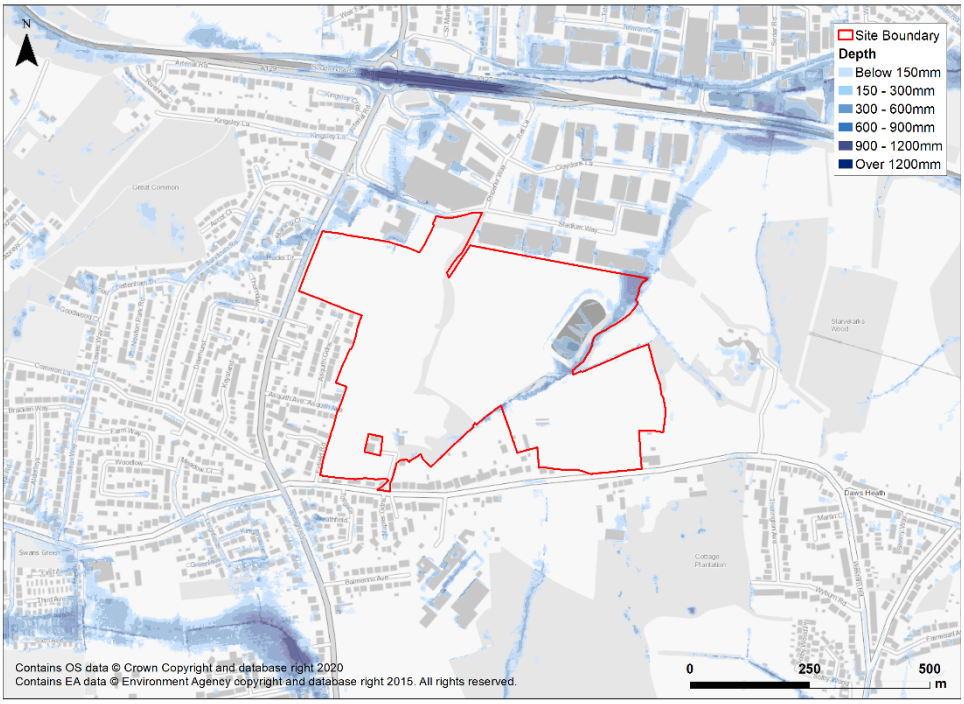


Figure 3.4: EA Flood Map for Surface Water (Low Risk Scenario)

3.1.13 It should be noted that these maps are generated using a relatively coarse methodology whereby rainfall is routed over a ground surface model (LiDAR). As such, the analysis does not fully take account of any below-ground drainage infrastructure, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently, the mapping highlights low lying areas of topography and preferential flow paths that may be more susceptible to surface water flooding in the event of extreme rainfall. Given the relatively low risk identified it is not deemed necessary to undertake detailed modelling to quantify these risks further in the application. The current mapping gives an appreciation of the worst case risk areas where mitigation can be deployed to manage such residual risk.

3.2 Groundwater Flooding

3.2.1 The SFRA states that there are no records of groundwater flooding. However, groundwater within superficial deposits (Head deposits) are generally at levels at or just below the ground surface; therefore, the SFRA indicates in these areas, surrounding the Eastwood Brook, to the north, and extending into the north-east corner of the site, groundwater risk may be higher.

3.2.2 The intrusive ground investigation for the site encountered the presence of a shallow water table (<1m deep) in half of the monitoring well locations installed on site. Groundwater level monitoring in May and June 2021 records the groundwater depth between 0.61 and 3.21 m bgl.

3.2.3 For the site overall, the risk of flooding from groundwater is considered to be medium.

3.3 Sewer and Water Mains Flooding

3.3.1 The SWMP does not contain any specific information with regards to sewer and water mains flooding in the vicinity of the site. AW confirmed they have no records of sewer flooding for the site (see response in **Appendix E**).

3.4 Canals, Ponds and Other Artificial Watercourses

3.4.1 The existing flood risk associated with the fishing lake is discussed in **Section 3.1**, within the Reservoir Map section.

3.4.2 There are no canals or other artificial watercourses located within the vicinity of the site, and therefore it is assessed that the risk of flooding from canals, ponds and other artificial watercourses is low.

3.5 Historic Flood Map and Flood Records

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

3.5.2 This map, see **Figure 3.5** below an extract of the Historic flood extents map, reference Figure 6, enclosed in **Appendix B**, indicates that there have been no recorded floods at the site or within surrounding areas.

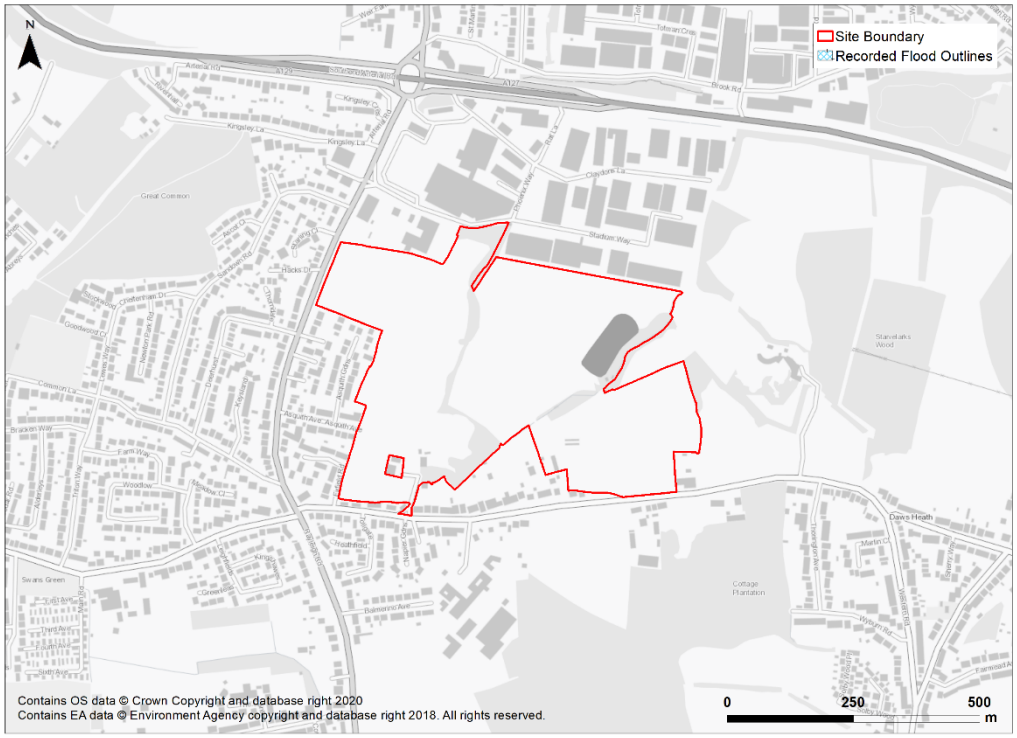


Figure 3.5: EA Recorded Flood Outlines

3.5.3 This is supported by the EA who state they hold no records of flooding on site or within proximity (see responses in **Appendix G**).

3.5.4 The LLFA have confirmed four recorded flood incidents, within a 250m buffer of the site, all occurring pre-2011. These occurred on Kingsley Lane, Sandown Road, Hart Road, and Kingshawes (see response in **Appendix H**).

3.6 Summary of Flood Risk

3.6.1 The following table provides an overview of the flood risk to the site, based on the information obtained and detailed in **Section 3**.

Table 3-2: Summary of Sources of Flood Risk

Source of Flooding	Risk of Flooding to Site	Comment/Justification	Source of data	Mitigation requirements for new development (see Section 5)	Risk of Flooding to Site after mitigation
Tidal		The site is not close to a tidal influenced watercourse and in Flood Zone 1.	EA Data (see Section 3.1)	N/A	
Fluvial		The site is located in Flood Zone 1 on the Flood Map. There are no historic records of fluvial flooding at the site.	EA Data (see Section 3.1)	N/A	
Land Drainage (i.e. Surface Water/ Pluvial)		Most of the Site is at very low risk of surface water flooding. An existing surface water flow path along the central and north eastern boundary draining north east has a low, medium and high risk.	EA surface water flood maps (see Section 3.1) SFRA	Areas shown to be at risk from SW flooding will remain free from development. Minimum 150mm 'freeboard' in ground floor levels and profiling of exterior ground levels away from building entrances . Liaise with the LLFA in development of SW strategy	
Ground water		The site is considered to have a low to medium risk of groundwater flooding	Infiltration Testing Geo investigations BGS Viewer Soilscapes website	Allow for waterproofing in substructure design and service trench installations, and for the lining of pipes and SuDS features. Further groundwater monitoring.	
Reservoir, Canals, Ponds and Other Artificial Sources		The online reservoir flood map shows the site is at low risk of reservoir flooding; However, the existing reservoir is not registered under the Act and therefore not modelled. If a breach was to occur this would impact downstream areas outside of the redline boundary to the north of the site, especially during storm conditions. There are no canals or other artificial watercourses located within the vicinity of the site.	Reservoir Appraisal (see Section 3.4) EA Data (see Section 3.1)	Management Plan for the Reservoir in accordance with the Panel Engineer recommendations.	
Sewers		AW have confirmed they hold no historical records of flooding at, or within the vicinity of, the site.	AW Response (see Section 3.3)	N/A	
Key:		**Low/Negligible Risk** – No noticeable impact to site and not considered to be a constraint to development			
		Medium Risk – Issue requires consideration but not a significant constraint to development			
		High Risk – Major constraint to development requiring active consideration in mitigation proposals			

4 Impact of Climate Change

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

4.1.2 In May 2022 the EA updated guidance on the application of climate change allowances in flood risk assessments:

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

4.1.3 This guidance provides contingency allowances for potential increases in peak river flow in Table 1, and for potential increases in rainfall intensity in Table 2. The latter requires consideration in any surface water drainage strategy for new development and is discussed in **Section 7**.

Peak River Flow

4.1.4 The peak river flow allowances table provides a range of allowances based on percentile (i.e. the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The provided allowances are subject to the sub-catchments of river basin district (known as management catchments) and the vulnerability classification of the proposed use of the site.

4.1.5 The climate change allowances have since been updated in May 2022. The latest climate change allowances are included in **Table 4-1** below.

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

River Basin District	Management Catchment	Flood Risk Vulnerability Classification	Climate Change Allowances requiring consideration (2080s)	
			Central	Higher Central
Anglian	*Combined Essex*	*More Vulnerable*	***+25%***	***+38%***

4.1.6 As the site is located entirely in Flood Zone 1, as illustrated on the online Flood Map for Planning, it is considered reasonable to assume that the site is not impacted by fluvial flooding when climate change is taken into consideration.

Peak Rainfall

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

4.1.8 The impact of climate change, for a residential development should be considered for the lifetime of the development and hence should be considered for a minimum of 100 years, therefore the change in rainfall intensity anticipated for the '2070s' (2061 to 2125) is applicable.

4.1.9 ECC require a 20% increase in rainfall intensities to be used for design purposes to assess the impact on the surface water drainage network. A 40% increase in rainfall intensities should be used to assess the potential flood risk implications including whether there is any increased flood risk to third parties because of the development.

4.1.10 The climate change impact from the EA on rainfall intensity over time to be considered as part of the FRA is as detailed in **Table 4-2**.

Table 4-2: Climate Change – Rainfall Intensities

Applies across all of England	Total potential change anticipated for the '2050s' (upto 2060)	Total potential change anticipated for the '2070s' (2061 to 2125)
Upper end	45%	40%
Central	20%	25%

4.1.11 The masterplan for the site has been undertaken over a lengthy period and in consultation with stakeholders prior to the changes to national climate change were known in May 2022. The new values in climate change for the 2070s', applicable to residential development, show an increase in the central allowance from 20% to 25%, with no changes to the upper values. It is noted that whilst ECC latest guidance stipulates a 20% increase for design purposes and the higher allowance of 40%, we have also undertaken further modelling and sensitivity testing to allow for the slightly higher value of 25% within the provided freeboard, to ensure the attenuation provided at the site confirms to both National and Regional design policy.

5 Proposed Development and Sequential Test

5.1 Proposed Development

5.1.1 This FRA accompanies an outline planning application with all matters reserved except access for:

"*The development of up to 455 new homes, a multi-use community hall, land for the provision of a healthcare facility, land for a stand-alone early years and childcare nursery, new vehicular/pedestrian access points from Stadium Way in the north and Daws Heath Road in the south, new greenways and green links, multi-functional open space, green infrastructure, surface water attenuation, landscaping and associated infrastructure. All matters reserved except access*."

5.1.2 Details of the parameter plans by This Land Development Limited are included in **Appendix J**.

5.1.3 The proposed residential development has an assumed design life of 100 years. The proposed mitigation is therefore based on a design life for the development of 100 years, and the climate change allowances to the '2080s' (2070 to 2115) scenario as outlined in **Section 4** are also based on this assumption.

5.2 Flood Risk Vulnerability

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

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

5.2.2 The proposed residential development is classed as 'More Vulnerable' development.

5.2.3 The location of the proposed development is in Flood Zone 1.

5.3 NPPF Sequential Test

5.3.1 The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. In addition to this the PPG gives further clarity on the how the Sequential Test should be applied to developments.

5.3.2 The site is located within Flood Zone 1, however there is a localised area of high risk of surface water flooding in the north-east corner associated with low topography. The flood map for surface water flooding shows areas to the north east, associated with the existing ordinary watercourse, to potentially be susceptible to surface water flooding. The sequential approach has therefore been applied whereby areas shown to be at potential risk will remain free from development. This has been further considered with the built development located in areas of low or no surface water flooding, the incorporation of a minimum 150mm 'freeboard' in ground floor levels for buildings, profiling of exterior ground levels away from building entrances and the implementation of a surface water drainage strategy.

5.3.3 The sequential test is considered to be passed on the basis that the site is considered a low risk from flooding (Flood Zone 1). Additionally, the proposed development is classed as 'More Vulnerable' which is acceptable in Flood Zone 1, and the risk of surface water flooding will be dealt with through the sequential approach by avoiding development in areas highlighted as being at potential risk from surface water flooding, the raising of ground levels for buildings and the proposed attenuation features, eliminating the need to find alternative sites.

5.4 NPPF Exception Test

5.4.1 With reference to Table 3 of the NPPF and PPG the site is classed as ‘More Vulnerable’ development located in Flood Zone 1 and at low risk from other sources of flooding, now and in the future, therefore there is no requirement to apply the Exception Test.

6 Flood Mitigation Strategy

6.1 Sequential Approach

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

6.1.2 The whole of the development is located in Flood Zone 1, the lowest probability of flooding. The sequential approach is therefore not required with respect to fluvial flood risk.

6.1.3 Parts of the site are shown to be at potential risk from surface water flooding, these are areas likely associated with the low-lying topography in proximity to the ordinary watercourse and the potential presence of a culvert at the downstream location prior to entering the industrial estate. Therefore, it is proposed to apply the sequential approach and leave these areas free from development.

6.1.4 The proposed development layout has considered surface water flood risk on site by locating built development in areas of low to no risk of surface water flooding and the inclusion of a surface water drainage attenuation system. This system will involve a series of SuDS features designed to ECC requirements that will manage the flood risk by collecting and storing surface water runoff from within the site and the upstream catchment area. These features will be located to parts of the site with lowest topography, and discharge at greenfield runoff rates.

6.2 Building Design

Ground Floor Levels

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

6.2.2 The above standard requirement is not applicable as the site is in Flood Zone 1 and once developed not close to any watercourses at risk of flooding.

6.2.3 It is recommended that ground floor levels are set a suitable freeboard above surrounding ground (minimum 150mm) to mitigate the residual flood risk associated with excess surface water runoff in an extreme rainfall event. Similarly, exterior ground levels across the site should also be appropriately contoured to direct surface water away from dwellings in such a scenario.

Groundwater Emergence Mitigation

6.2.4 There is a potential risk of groundwater emergence based on groundwater monitoring results, see **Section 3.2**. Taking this into consideration, appropriate waterproofing will be required to be included in the substructure design and any service trench installations. The developer should consider the need for localised dewatering and / or cut off drains during construction, with recharge back to the groundwater, so as to not have an environmental impact. It is recommended to line the pipes with leak-tight liner and where appropriate to line the proposed SuDS features, with where required, anti-flotation measures. This mitigation measure will prevent the ingress of ground water into the pipes through leaking joints and into the proposed SuDS features reducing the storage capacity within these features. We propose groundwater monitoring is undertaken over a 12-month period to confirm seasonal fluctuations in groundwater levels prior to detail design.

6.3 Ordinary Watercourse Consent

6.3.1 There is an ordinary watercourse within the site (see **Section 2.4**)

6.3.2 Proposed works in, over, under or near an ordinary watercourse require a 'Ordinary Watercourse land drainage consent application' under the Land Drainage Act 1991 to be made to ECC. This includes any proposed diversion works. This is required to demonstrate any new development does not have a detrimental impact on flood risk.

6.3.3 No diversion works are likely to be required for this site, but it is proposed for areas of the site to positively drain to the watercourse with proposed outfall structures. Therefore, consent will be required at the detail design stage for the outfall structures.

6.3.4 A crossing of the ordinary watercourse is proposed for highways. These features are to be clear span to not impede flow of the watercourse.

7 Surface Water Management Strategy

7.1 Overview

7.1.1 This Section outlines how surface water run-off from the development is to be managed in accordance with national and regional policy requirements, and best practice guidance. The design aims to mitigate the risk of surface water flooding on the site as discussed in the previous Sections.

7.1.2 This Section of the report should be read in conjunction with the surface water management strategy drawings contained within **Appendix K**.

7.1.3 The surface water drainage strategy has been informed through pre-planning consultations with AW and ECC, as documented in **Appendix E** and **Appendix H** respectively, and best practise guidance documents including the 'CIRIA SuDS Manual 2015 (C753)'.

7.1.4 The proposed drainage design will provide a reduction in runoff rates from the site, hence there will be no increased flood risk to external receptors as part of the development proposals.

7.2 Design Principles

7.2.1 As of April 2015, the LLFA has become a statutory consultee on planning applications for surface water management. As the LLFA, ECC is therefore responsible for the approval of surface water drainage systems for new major development. Major Development consists of any of the following:

- the provision of dwelling houses where residential development of 10 or more units; or where the development is to be carried out on a site having an area of 0.5 hectares or more and the number of units is not known;
- the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or
- development carried out on a site having an area of 1 hectare or more.

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

7.2.3 The Non-Statutory Technical Standards for SuDS set out general recommendations for control of development runoff, including the requirement to ensure that runoff from the site is not increased by development, and the requirement to manage surface water runoff for events up to the 1 in 100 (1%) Annual Probability event (including an additional allowance for the projected impacts of climate change).

7.2.4 PPG advises that climate change allowances should be determined with reference to the guidance provided in the EA document 'Flood Risk Assessments: Climate Change Allowances (Published February 2016 and updated May 2022). As most of the site is proposed for residential purposes, with an assumed design life of 100 years, an additional allowance on rainfall intensity has been incorporated into the surface water management strategy.

7.2.5 In accordance with the NPPF guidance document, for developments with a design life extending beyond the year 2070, climate change allowances of 20% to 40% should be considered against design rainfall intensities.

7.2.6 It is proposed that the drainage strategy will be based on provision of surface water attenuation on site which will accommodate the 1 in 100 (1%) Annual Probability plus 40% climate change event.

7.3 Surface Water Drainage Hierarchy

7.3.1 Regional and national planning policy will be taken into account going forward within the surface water drainage strategy for the site.

7.3.2 Part H of the Building Regulations states that options for the disposal of surface water runoff should be considered in the following hierarchical order:

i. Into the ground (infiltration);
ii. To a surface water body (e.g. watercourse);
iii. To a surface water sewer, highway drain or other drainage system;
iv. To a combined sewer.

7.3.3 Based on the underlying geology and infiltration test results, the site is unlikely to support the use of infiltration features.

i) Infiltration

7.3.4 As discussed in **Section 2.5** there is only one area of the site which showed potential to infiltrate, this is located towards north central margins of the site based on the initial soakaway testing, reference TP104. Refer to **Appendix F** for the infiltration test results.

7.3.5 Groundwater strikes were recorded as part of the infiltration investigations that were undertaken. The results showed presence of a shallow water table (<1m deep) in half of the monitoring well locations installed on site. Groundwater level monitoring in May and June 2021 records the groundwater depth between 0.61 and 3.21 m bgl. The CIRIA SuDS Manual (C753) states that there should be a minimum depth of 1m of unsaturated aquifer material between the base of any infiltration system and the maximum likely groundwater level (taking account of potential shifts in groundwater level resulting from extended periods of wet weather).

7.3.6 The one location where infiltration test was completed (only one test location drained down in accordance with BRE 365 for the test to complete), was in an area where a ground water strike was also not encountered. Therefore, there is a potential scope to utilise some shallow at source infiltration techniques within this location, where feasible subject to a suitable saturation zone of a minimum of 1m. It is therefore proposed at this outline stage to use infiltrating porous paving for parking, driveways and where possible and acceptable within some of the private highway areas. This will be investigated further as part of future detailed design and supported with groundwater monitoring.

ii) Watercourse

7.3.7 With infiltration not being a viable option across the site it is therefore proposed to attenuate surface water runoff and discharge at a controlled rate to the existing ordinary watercourse at the site. This will utilise existing catchments extents, dictated by the site topography, which has the central and southern areas of the site falling towards the watercourse.

iii) Surface Water Sewer or Highway Drain

7.3.8 Where topography and other constraints associated with the site, such as retaining features like the central woodland belt, prevent discharge to the watercourse. It is proposed to discharge surface water drainage to the existing sewers located adjacent to the site.

7.3.9 A pre-planning enquiry was submitted to AW to establish whether there is capacity in the sewer network to accept a greenfield runoff rate, should infiltration into the ground or discharge to a

watercourse not be deemed feasible. AW confirmed acceptability of surface water runoff based on 1.6l/s/ha rate.

7.3.10 It is noted that ECC require discharge to the 1 year rate and therefore the attenuation features are designed as such.

7.4 Correspondence with Essex County Council as LLFA

7.4.1 A series of discussions and emails with the LLFA have been undertaken, the correspondence is provided **Appendix H**.

7.4.2 Stantec discussed the surface water drainage proposals with the ECC/LLFA Development and Flood Risk Officers in a pre-application meeting on the 30th July 2021. A copy of the discussions is provided in **Appendix H**, and a summary of the key discussion points is provided below:

- Multifunctional spaces and SuDS storage areas were discussed, the LLFA recommended the multiuse basins should be well designed to manage water in addition to providing amenity and biodiversity benefits.

- Concerns regarding the fishing lake and a long-term management plan was discussed. It was discussed that the fishing lake will receive runoff from the watercourse and implications caused by the inflow and outflow is considered.

- The LLFA agreed that additional SuDS features at the catchment or plot scale would be delivered at the detailed design stage. The LLFA recommended these features would be open features and integrated into the Landscape Strategy as multi-functional space, where practical.

- The LLFA stated that the onsite sewer network design should demonstrate that there is no surcharging for the 1 in 1 year return period event, no flooding for the 1 in 30 year return period event, and if not contained within the system details of overland flood flow routes should be provided for the 1 in 100 year plus climate change return period event, which should demonstrate no internal flooding to properties.

- The LLFA advised that interactions between the existing flood risk and the proposed development and associated drainage should be considered.

- The LLFA advised that rainwater re-use should be considered as part of the development, and if not proposed, a clear explanation should be provided.

- Infiltration testing results were provided by Stantec and it was explained that ground conditions onsite were unlikely to be suitable for infiltration. It was agreed with the LLFA that infiltration was not an option. However, the LLFA stated that future information regarding groundwater levels and depth of infiltration features would be required to understand whether infiltration is viable.

- Stantec explained that discharge would be to an Anglian Water Sewer and to the watercourse from the adjacent catchments. It was discussed that discharge from the site would be limited to the greenfield 1 in 1 year rate. The LLFA recommended that the runoff rate should be calculated using the developable area for the redline plan, and the combined discharge from the catchments should not be in excess of the 1 year greenfield rate calculated from the entire developable area for the redline plan.

- The LLFA stated that "*where discharge is to a watercourse, the outfall should be above the 1 in 100 plus climate change level or alternatively the effect of surcharging of the outfall should be modelled and appropriate measures put in place*". It was agreed with the LLFA that due to unavailability of watercourse data, outfall surcharge sensitivity was not required for outline planning application and can be discussed later in the planning process.

- The LLFA require a 10% allowance for urban creep.

- The LLFA require details on half-drain times, stating that "*If half drain time is in excess of 24 hours a follow up 1 in 10 year storm event can be modelled to evidence sufficient capacity*". The LLFA also confirmed that it is preferred to maintain a 300mm freeboard.

- The overland flow routes were discussed with the LLFA, and it was agreed that if storage is placed in a surface water flow path that originated offsite, it should be demonstrated that any storage feature will be sized appropriately to accommodate offsite flows that may enter.

7.4.3 Following the pre-application meeting and further modelling, the LLFA have agreed that sufficient information on the SuDS strategy had been provided, email correspondence with ECC in April 2022 provided in **Appendix H**.

7.5 Existing Site Drainage Catchments

7.5.1 As outlined in **Section 2.4**, The site has five drainage catchments (included in **Appendix D**), the Land in the northern-east and east of the site (Catchments 1 and 2) drain north-westward and northward to the existing industrial estate (Stadium Way) and Rayleigh Road, respectively. Land in the south-west corner (Catchment 3) drains to the south-west, towards Daws Heath Road, with areas in the centre and south-east of the site (Catchments 4 and 5) draining eastward and northward respectively, towards the ordinary watercourse.

7.5.2 The site is has been confirmed to have poor infiltration potential based on the identified soil association type and confirmed through infiltration testing records (**Section 2.5 and 7.3.**).

7.6 Greenfield Runoff Rates

7.6.1 For this assessment, the site has been considered as 100% greenfield with poor infiltration based on the supporting infiltration tests.

7.6.2 The greenfield runoff rate was estimated using the FEH Statistical method based on catchment descriptors for the site. BFIHOST values were checked using soil association plans. This method resulted in a QBAR (1 in 2.33 annual probability event) greenfield runoff rate of 1.6l/s/ha and 1 year annual probability event rate of 1.4 l/s/ha, as detailed in **Appendix L**.

7.6.3 It should be noted that limiting discharge rates to the 1-year greenfield rate, could impact the water into the fishing lake therefore ongoing monitoring of the impact to the fishing lake following development of the site will be undertaken to ensure the fishing lake can still function. The need for monitoring of this feature will form part of the management and maintenance plan for the fishing lake which will be provided as part of the future detail design.

7.6.4 Following consultation with AW on maintenance and adoption of the future SuDS features, concerns were raised on limiting discharge rates to the lower value of 1.4l/s/ha in some areas of the site, where it results in considerable small controls which could become prone to blockages. An agreement has therefore been reached on limiting discharge rates to a rate of 2.0 l/s/ha in future and where this is the case.

7.6.5 The discharge rate from the site to any outfall has been designed so that it can be limited to the worst-case rate of the 1 in 1-year greenfield runoff rate of 1.4 l/s/ha, as summarised in **Table 7-1** below with supporting calculations included in **Appendix M.**

7.6.6 The LLFA recommended that the combined discharge from the catchments should aim to not be in excess of the 1 in 1-year greenfield rate calculated for the entire developable area for the redline plan and even though an agreement has been reached with AW for an increase of this.

7.6.7 The site developable area is 13.62 ha, resulting in a discharge rate for this developable area to be 19.1 l/s in total (1 in 1 year greenfield runoff rate = 1.4 l/s/ha. 13.62ha x 1.4 l/s/ha = 19.1 l/s).

7.6.8 **Table 7-1** below indicates the proposed combined discharge rate is 13.4 l/s demonstrating the combined discharge rate is not in excess of the 1 in 1-year greenfield rate calculated for the developable area (19.1 l/s).

Table 7-1: Proposed Discharge Rates (1:1-Year) and Discharge Locations, as agreed with AW where applicable

Catchment	Discharge Location	Proposed Discharge Rate (l/s)
1	Public Sewer	2.7
2	Public Sewer	2.0
3	Public Sewer	2.0
4A	Watercourse	2.4
4B	Watercourse	1.9
5A	Watercourse	1.0
5B	Watercourse	1.4
	TOTAL	***13.4***

7.6.9 Where existing topography allows, surface water will be discharged at the controlled discharge rate to the existing watercourse. Other areas of the site, which are directed by the existing topography and surface water catchments of the site will discharge to the AW Surface Water Sewers located in Rayleigh Road, Stadium Way and Daws Heath Road.

7.7 Proposed Drainage Catchments and Impermeable Areas

7.7.1 The site has been divided into five sub-catchment areas which are informed by the natural topography of the site and the proposed outfalls, as indicated on the surface water management drawing provided in **Appendix K.**

7.7.2 Comparing the sub-catchment areas set out in the surface water management drawing against the existing catchments plan, contained in **Appendix D**, the existing distribution of runoff to the receiving watercourses shall be mimicked post-development. As discussed in **Section 7.5**, the runoff rates will also be closely mimicked.

7.7.3 As shown on the surface water management strategy drawing, the following is proposed:

- Catchments 4a, 4b, 5a and 5b is served by attenuation basins with controlled discharge to the Ordinary watercourse which runs through the site, through to the industrial estate in the north.
- Catchments 1 and 2 shall drain to attenuation basins to the north which shall discharge at the controlled greenfield runoff rates to the existing surface water sewers in Rayleigh Road to the east and Simpson Way to the north respectively.
- Catchment 3 shall drain to an attenuation basin in the south with controlled discharge to the public surface water sewer within Daws Heath Road in the South.

7.7.4 Discharge to the surface water sewers has been agreed with AW. Refer to **Table 7.2** for further details.

7.7.5 In consultation with ECC and at this outline stage an allowance for urban creep has been applied within the impermeable area calculations of 10%.

7.8 Attenuation Storage

7.8.1 The drainage strategy for the site has been designed in accordance with the Sustainable Drainage Systems Design Guide for Essex website, which advises that allowable discharge flow rates is applicable to the Greenfield 1 in 1 year rate, and in consultation with both ECC and AW, refer to **Section 7.5**.

7.8.2 The total storage required has been modelled using MicroDrainage 'Source Control', refer to **Appendix M**, assuming the following design criteria:

- Design for 1 in 100 annual probability event with 40% allowance for climate change;
- Design of the 1 in 100 annual probability event with 20% allowance for climate change and 300mm freeboard;
- Sensitivity check of the 1 in 100 annual probability event with 25% allowance for climate change;
- FEH rainfall data used;
- 1 in 1 year rate of 1.4 l/s ha which is pro-rata based on the proposed impermeable area (excluding Urban Creep);
- 10% Urban Creep applied to the proposed impermeable area; and
- 50% storage drain down during the 1 in 30 year, if not achievable to run with a following 1 in 10 year event + 300mm freeboard;

7.8.3 The ECC SuDS Proforma has been completed and applied to site, Refer to **Appendix N**.

7.8.4 The estimated storage provided does not include potential storage provided in upstream SuDS features such as swales, filter drains, permeable pavement etc. This is therefore considered a robust approach at the outline design stage which should be refined at the detailed design stage. A breakdown on the storage provided and outfall locations are listed below.

Table 7-2: Surface Water Management Summary

Catch-ment	Impermeable Area (ha)	Max permitted discharge rate (l/s)‡	Attenuation Storage Required (m³)†	Discharge Point	Half Drain Downtime (hours)
1	1.93	2.7	2539	Public SW Sewer (Ref 0.345 – Rayleigh Road))	79.8
2	0.85	2.0	1038	Public SW Sewer (Ref 2351 – Simpson Rd)	42.3
3	0.48	2.0	543	Public SW Sewer (Ref 0851 – Daws Heath Rd)	21.7
4a	1.71	2.4	2257	Watercourse	80.5
4b	1.38	1.9	1831	Watercourse	81.9
5a	0.74	1.0	999	Watercourse	83.4
5b	0.98	1.4	1294	Watercourse	81.4

† storage volume required is estimated as 1062 to 1076m³/impermeable ha

‡ greenfield runoff rate is estimated as 1.4l/s/ha

7.8.5 The half drain downtime of the features have been reviewed. This shows the structure does drain down, but exceeds a typical 24hour requirement which would be applicable if utilising infiltration. Refer to **Appendix M** for the supporting calculations associated with this.

7.8.6 The LLFA confirmed that details on half-drain time for storage structures should be submitted for review, outlining that should half-drain time be in excess of 24 hours for the 1 in 30 AEP plus climate change, then it must be demonstrated that storage features are capable of storing the 1 in 30 AEP followed by a subsequent 1 in 10 AEP.

7.8.7 As the half drain down time for the 1 in 30 AEP plus 20% climate change exceeds the 24-hour requirement, **Table 7-3** below demonstrates there is sufficient storage available for the 1 in 30 AEP plus 20% climate change followed by a subsequent 1 in 10 AEP.

Table 7-3: Storage Volumes for the 1 in 10 AEP, and 1 in 30 AEP plus 20% climate change

Catchment	Storage Provided (m^3)	Storage Volume (m^3)		
		1 in 10 AEP	1 in 30 AEP plus 20% climate change	1 in 10 AEP + 1 in 30 AP plus 20% climate change
1	2670	915	1552	2467
2	1225	370	609	979
3	840	118	312	430
4A	2390	814	1390	2204
4B	1945	692	1139	1831
5A	1020	382	626	1008
5B	1390	486	800	1286

7.8.8 The LLFA advise a 300mm freeboard is to be maintained for storage features for the 1 in 30 AEP plus climate change followed by a 1 in 10 AEP. The calculations provided in **Appendix M** show there is sufficient space to allow for a 300mm freeboard in the masterplan and exact sizing is to be considered at the detailed design stage.

7.8.9 A sensitivity check of the attenuation basins has also been undertaken discharging to the watercourse, these show should the basins have a surcharged outfall with the watercourse at 75% capacity, the basins are still able to operate without flooding in the 1 in 100 year plus climate change event. Refer to **Appendix M** for further details and supporting technical note. A non return flap valve will also be employed at the outfall of all attenuation features discharge to the watercourse.

7.9 Exceedance

7.9.1 To demonstrate that in an exceedance event any flooding does not negatively affect the development, flows up to the 1 in 100 (1%) annual probability plus climate change rainfall event will be managed onsite. This may be achieved by ensuring that site levels are designed to direct flows away from the buildings and towards areas such as car parking or formal landscaping where temporarily shallow flooding can be safely captured to enhance the flood risk mitigation. Furthermore, the attenuation will be designed to accommodate surface water runoff with no flooding for all storms up to and including the 1 in 100 (1%) annual probability plus 40% climate change event.

7.10 Sustainable Drainage Systems (SuDS)

7.10.1 It is a requirement of the NPPF that SuDS are used in all major developments, if feasible. The LLFA also advocates the use of appropriate SuDS in new development as detailed in The Sustainable Drainage Systems Design Guide for Essex website.

7.10.2 CIRIA report C753 'The SuDS Manual' outlines the various types of SuDS, their benefits and limitations, and design considerations associated with each. Not all SuDS components/methods are feasible or appropriate for all developments, factors such as available space, ground conditions and site gradient will influence the feasibility of different methods for a development.

7.10.3 The use of SuDS techniques within the proposed development has been informed by the SuDS hierarchy.

7.10.4 The use of SuDS techniques within the proposed development has been informed by the SuDS hierarchy, as detailed in **Table 7-4**.

Table 7-4: SuDS Hierarchy

SuDS Technique	Can they be incorporated into the site?	Reason
Green Roofs	✓/**X**	Green roofs will be assessed as part of the detailed design of the community and early years at the site.
Basins, Wetlands, Bio-retention areas and Ponds	✓	Attenuation basins are proposed at the site, The proposed basins have been designed in locations to operate as multi functional areas with wet grassland mix for bio-diversity and ecological enhancement. Bio-retention areas to be considered at detailed design stage.
Filter Strips & Swales	✓	Swales are proposed along some of the main highway's trough the site. Swales are also proposed within areas of the site to convey, where feasible and required, development generated runoff from development parcels to the attenuation features.
Infiltration techniques	✓/**X**	Infiltration may be feasible in a localised area of the site, based on initial soakaway testing. It is hoped to maximise these areas with permeable paving operating at source control. This is subject to further groundwater monitoring.
Permeable surfaces and filter drains	✓	Permeable paving is proposed within the private driveways and parking areas, where possible.
Rainwater Harvesting	✓/**X**	Rainwater harvesting is not considered appropriate at a strategic level. However, rainwater butts could be provided at all residential properties. An assessment on the viability of rainwater harvesting at the community buildings and early learning centre can be assessed as part of the detail design review.
Tanked Systems	✓/**X**	Below ground storage has not been considered as part of the outline design stages. Although these could potentially be utilised as part of a rainwater harvesting system located at the community and early learning centre.

7.10.5 The design and the integration of the proposed SuDS features within the wider landscape strategy and proposals have been carefully considered as part of the masterplan development process and will themselves provide an element of Public Open Space (POS) use. The SuDS proposals have therefore been designed to ensure they enhance and support the landscape proposals going forward. This conforms to the Essex Green Infrastructure Strategy, dated 2020,

which requires *"All development proposal should incorporate SuDS and natural flood management techniques. This should demonstrate multifunctional green infrastructure solutions to flood management. Development should include biodiversity and open space provision, which will enhance biodiversity, natural capital and provide aesthetic and amenity value; and safe public access. These designs should draw on national and local best practice guidance and must comply with requirements set out in the Essex SuDS Guide and national policy."*

7.10.6 At this outline stage, the drainage strategy has been designed with all drainage elements as open features and no below ground storage included within the drainage strategy. Typical details for the proposed attenuation features are included in **Appendix K**, for reference.

7.10.7 The drainage modelling (**Appendix M**) indicates that the surface water volume for the 1 in 100 (1%) Annual Probability plus 40% climate change event can be accommodated entirely within these features. This is in accordance with the CIRIA SuDS Manual.

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

7.10.9 The prevailing surface water strategy, included in **Appendix L** for each catchment on site, which will be offered for adoption is a network of positive drainage consisting of and not limited to:

- Attenuation Basins planted with wet grassland mix,
- Swales and;
- Some of the Proposed Attenuation Basins have been modelled as multifunction Attenuation Basins, with lower areas used for attenuation and upper levels providing natural play space but will also store surface water runoff in the climate change scenarios. The natural play areas are vegetated locations which are dry for most of the time and only in an extreme case will it contain shallow water, until it is able to drain back into the basins. This will be for a period of less than 24 hours.

7.10.10 Upstream on plot drainage solutions such as bio-retention planters, rainwater gardens, green roofs (where feasible) and permeable paving will also provide pre-treatment for runoff from hard standing surfaces such a parking areas. Roof runoff where feasible will either drop directly into a piped drainage network before discharging to the strategic attenuation areas.

7.10.11 Piped networks may still be utilised in areas based on the LLFA, Highways and Sewerage undertaker adoption requirements.

7.10.12 The current draft surface water drainage proposals for the site shown are for strategic attenuation features located in natural low lying areas of the site, the drainage strategy drawing excludes on plot solutions at this time. These strategic areas are where surface water runoff will be controlled to the existing Greenfield runoff rate, equivalent to the 1 year rate.

7.10.13 The surface water flow will be restricted using attenuation and flow control such as Hydro-Brake or Hydro-slide prior to discharging into the watercourses and surface water sewers.

7.11 Pollution Control

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

7.11.2 The proposed surface water sewer arrangement will incorporate suitable pollution and silt control measures such as catchpit manholes upstream of any proposed permeable paving, and rain gardens to help manage sediment control and water quality. The planting within the proposed swales will also provide an element of water quality treatment.

7.11.3 The drainage system will be designed to comply with the requirements of the SuDS treatment train as laid out in CIRIA C753 'The SuDS Manual', described as the 'Simple Index' Approach. This approach is anticipated at this stage to mitigate any negative impact because of the development to the local waterbodies and conforms to the WFD, subject to stakeholder consultation during the pre-application works.

7.11.4 The final strategy for pollution control including provision of a SuDS design code will be confirmed as part of the detailed design, however at this stage of the assessment, an appropriate upstream SuDS treatment train has been incorporated into the design prior to the final discharge to the watercourses.

7.11.5 In accordance with Table 26.2 of the SuDS Manual Simple Index Approach, the proposed development will have the pollution hazard indices as shown in **Table 7-5**.

Table 7-5: Summary of Pollution Indices for Residential Development

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roof	Very Low	0.2	0.2	0.05
Other Roof (typically commercial/industrial roof)	Low	0.3	0.2 (up to 0.8 where there is the potential for metals to leach from the roof)	0.05
Individual property highways, car parks, low traffic roads.	Low	0.5	0.4	0.4

7.11.6 **Table 7-6** presents the mitigation indices provided by each SuDS method proposed as part of the drainage strategy.

Table 7-6: SuDS Mitigation Indices for Discharge to Surface Waters

SuDS Measure	TSS	Metals	Hydrocarbons
Swale (will be higher if planted)	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable Paving	0.7	0.6	0.7
Detention Basin (considered to be higher than shown with wetland grass mix)	0.5	0.5	0.6

7.11.7 Surface water runoff from highways, where potential pollution is expected to be greatest require a minimum of two levels of treatment and on this basis, the upstream SuDS treatment train will provide adequate stages of treatment prior to discharge to the receiving watercourse. It is noted

that where two stages of treatment have been provided, the mitigation indices for the second stage are assumed to be half of the original value.

7.11.8 The surface water management drawing demonstrates that all highways shall be served by at least two stages of treatment, using a combination of roadside swales, bio-retention features or a downstream defender where these open features are not feasible, and the proposed attenuation basins.

7.12 Adoption and Maintenance

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

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

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

7.12.4 As part of the future management, monitoring of the water levels to the fishing lake will be included to ensure any changes made to the drainage regime will not have long term implications to the reservoir and its on going use.

8 Foul Water Drainage

8.1.1 Foul water discharge rates are expected to increase as a consequence of the proposed development. Estimated wastewater volumes arising as a result of the proposed development (in a fully operational event day scenario) have been consulted with AW, included in **Appendix E**.

8.1.2 A provisional foul water drainage strategy for the site has been developed to allow for future phasing of the scheme. This has been produced in consultation with AW and is provided in **Appendix O**.

8.1.3 The proposed development will include water efficiency measures to try and reduce the volume of foul water discharged to the network and so reduce the overall magnitude of the impact of the proposed development on the foul drainage and sewer network.

8.1.4 Reinforcement works for proposed foul drainage flows could be required and addressed at detail design stages and if so, will form part of the inherent mitigation of the project, although at this outline stage the principle of the development and subsequent flows have been accepted by AW.

8.2 Proposed Foul Water Drainage Strategy

8.2.1 In accordance with infrastructure connection charging rules introduced in April 2018 developers have the right to connect to the local public sewer network at the closest point of connection, to a pipe of equivalent size or greater. If any reinforcement to the public sewer network is required to enable the connections, this will be carried out by the sewerage undertaker through the infrastructure charge mechanism.

8.2.2 The site lies within the Rayleigh-East Water Recycling Centre (WRC) catchment area. A pre-development enquiry issued to Anglian Water confirms that Rayleigh-East WRC does have sufficient capacity to treat all additional wastewater flows from the proposed development and level of growth within their catchment (see **Appendix E** for Anglian Water pre-development enquiry response).

8.2.3 The main principles of the foul water drainage strategy is that all FW catchments generally follows the existing surface water catchments based on existing topography. This identifies that Areas A to D can drain via gravity with a positive outfall into the public sewer. The foul water Area B catchment differs slightly to the corresponding surface water catchment as it was concluded that utilising the proposed main highway corridor for conveyance was the most suitable option.

8.2.4 A pumping station is proposed to serve the Area E foul water catchment as initial assessment has concluded that a positive outfall into the public sewer is not achievable.

8.2.5 The principle of this strategy has been confirmed with AW in a meeting on the 25th January 2022. Refer to for **Appendix E** meeting minutes). AW Sewer records are attached to this document as **Appendix E**.

8.3 Foul Water Pumping Stations

8.3.1 A pumping station is proposed to serve the Area E foul water catchment.

8.3.2 Area E comprises of approximately 100 residential units. Pumped flows is proposed to discharge to the public sewer within Daws Heath Road. Variations to this strategy such as discharging into the head of a proposed foul network within another Area of the proposed development was assessed and discounted due to feasibility and site constraints such as crossings of existing watercourse, length of rising main etc. This was demonstrated to Anglian Water at a recent meeting (see **Appendix E**.) The pump station location is shown indicatively.

8.3.3 Preliminary calculations have been undertaken to estimate the Dry Weather Flow (DWF), Peak inflow, pump rate and storage requirements for each of the foul networks served by a pumping station. These calculations have been based on AW's Adoptable Pumping Station Design Criteria, Revision V2 dated 08/01/2021 and is summarised below in **Table 8-1** below.

Table 8-1: Pumping Station Design Criteria.

	DWF (l/s)	Peak Inflow (l/s)	Pump Rate (l/s)	Emergency Storage (m^3)
Area E Pumping Station (South)	0.4	0.9	1.7	6

8.4 Design and Adoption

8.4.1 The foul water sewers will be offered for adoption and shall be designed in accordance with Sewers Sector Guidance (SSG) design standards which requires the following key hydraulic design parameters to be used:

- Sewers designed to run at 75% pipe full conditions at peak design flow;
- Minimum self-cleansing velocity of 0.75m/s at one-third design flow;
- A roughness value (K_s) of 1.5mm.
- Minimum 1.2m cover depth to all sewers unless reductions in the depth of cover are locally agreed with the sewerage undertaker.

8.4.2 The foul water pumping stations shall be offered to AW for adoption and will be designed in accordance with SSG (Anglian Water-Local practice on sewage pumping stations). Access to foul water pumping station will be provided off an internal development road to facilitate maintenance. The masterplan has allowed space for an appropriate cordon sanitaire to each pumping station.

8.4.3 Any private foul water drains will be designed in accordance with Building Regulations Part H. Furthermore, it is anticipated that any foul water drainage outside the red line boundary shown shall be covered via an easement.

8.5 Reserved Matters Planning Applications and Technical Approvals

8.5.1 Individual reserved matters planning applications will be required to demonstrate compliance with this foul water drainage strategy, and will need to include the following:

- Layout of foul water drainage network and pumping stations;
- Design flows;
- Outfall locations.

8.5.2 An illustrative foul water pipe network has been included within the Foul Water Strategy drawing attached to this document as **Appendix O** and the principles of this strategy have been agreed with AW (see meeting minutes in **Appendix E**). The pumping station location serving Area E is shown indicatively and is to be agreed at detail design stage and appropriately incorporated into the final masterplan.

8.6 Development Phasing

8.6.1 A further assessment has been undertaken to determine how the proposed phasing of the site-wide development corresponds with the foul water drainage strategy.

8.6.2 An outline foul water phasing strategy drawing is attached to this document as **Appendix O**. which indicates the following:

- Area A – Entire area developed in Phase 1
- Area B – Developed in Phase 1 and Phase 3. The main infrastructure drainage along the proposed highway corridor shall be installed as part of the phase 1 works. It is proposed connection points are to be provided in Phase 1 (denoted as Area B1) for the future Phase 3 development within the Area B catchment to connect into. The future development in Area B is denoted as Area B2 and B3 within the outline foul water phasing strategy drawing attached to this document as **Appendix O**.
- Area C – Entire area developed in Phase 3
- Area D – Developed in Phase 2 and Phase 4. A main infrastructure drain is to be installed as part of the Phase 2 works associated with the Area D (denoted as Area D1). It is proposed connection points are provided for the remaining development within Area D in Phase 4. This is denoted as Area D2 within the outline foul water phasing strategy drawing attached to this document as **Appendix O**.
- Area E - Entire area developed in Phase 2

9 Residual Risk

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

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

- Recommended incorporation of minimum 150mm 'freeboard' in ground floor levels for buildings and appropriate profiling of exterior ground levels away from building entrances;
- Provision of appropriate surface water drainage attenuation systems, including consideration of projected impacts of climate change and exceedance events;
- Plans in place for future management and maintenance of drainage systems;
- Management and maintenance of the watercourse that bisects the site from the south-east, along the eastern boundary, to the north-east corner.
- Management Plan, which include as a minimum the ongoing maintenance of the embankments and water level controls to the existing on-site reservoir, in accordance with the Panel Engineer recommendations listed in **Appendix C**.

9.1.3 As such, the residual risk is considered to be acceptable for the lifetime of the development. Some betterment will be provided with a defined management programme for the existing fishing lake and this will reduce the risk of flooding from breach of this feature to downstream areas of the site.

10 Conclusions

10.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec on behalf of our client, This Land Development Limited, to support an outline planning application with all matters reserved except access for a residential development at a site located at Land East of Rayleigh Road, Thundersley.

10.1.2 This FRA concludes that:

- The site is located in Flood Zone 1: Low Probability of flooding;
- There is surface water flood risk in the north-eastern and south-eastern areas of the site which coincide with areas of low topography and existing drainage features and hence considered to be at low risk of flooding;
- There is a medium groundwater flood risk across the site;
- Existing Reservoir at the site which if breached could have an impact to downstream areas located offsite to the North East;
- The site is considered to be at low risk from other forms of flooding; and
- The proposed mitigation strategy demonstrates the development is safe through a number of measures as follows:
    - Application of the sequential approach has been applied following the implementation of the surface water drainage strategy.
    - Recommended incorporation of minimum 150mm ‘freeboard’ in ground floor levels for buildings and appropriate profiling of exterior ground levels away from building entrances;
    - Provision of appropriate surface water drainage attenuation systems, including consideration of projected impacts of climate change and exceedance events;
    - Plans in place for future management and maintenance of drainage systems and reservoir (fishing lake);
    - Recommended waterproofing in the substructure design and any service trench installations;
    - Consideration for the need for localised dewatering and / or cut off drains during construction, with recharge back to the groundwater, to reduce any potential environmental impact
    - Recommended to line the pipes with leak-tight liner and where appropriate to line the proposed SuDS features, with anti-floatation devices, to prevent the ingress of ground water into the pipes through leaking joints and into the proposed SuDS features reducing the storage capacity within these features; and
    - Groundwater monitoring over a period as agreed with approving authorities to confirm seasonal fluctuations in groundwater levels.

10.1.3 The proposed surface water drainage strategy for the development consists of a network of positive drainage consisting of and not limited to Attenuation Basins with, Swales, and some operate as Multifunction Attenuation Basins (lower areas used for attenuation and upper levels providing play space but will also store surface water runoff in the climate change scenarios).

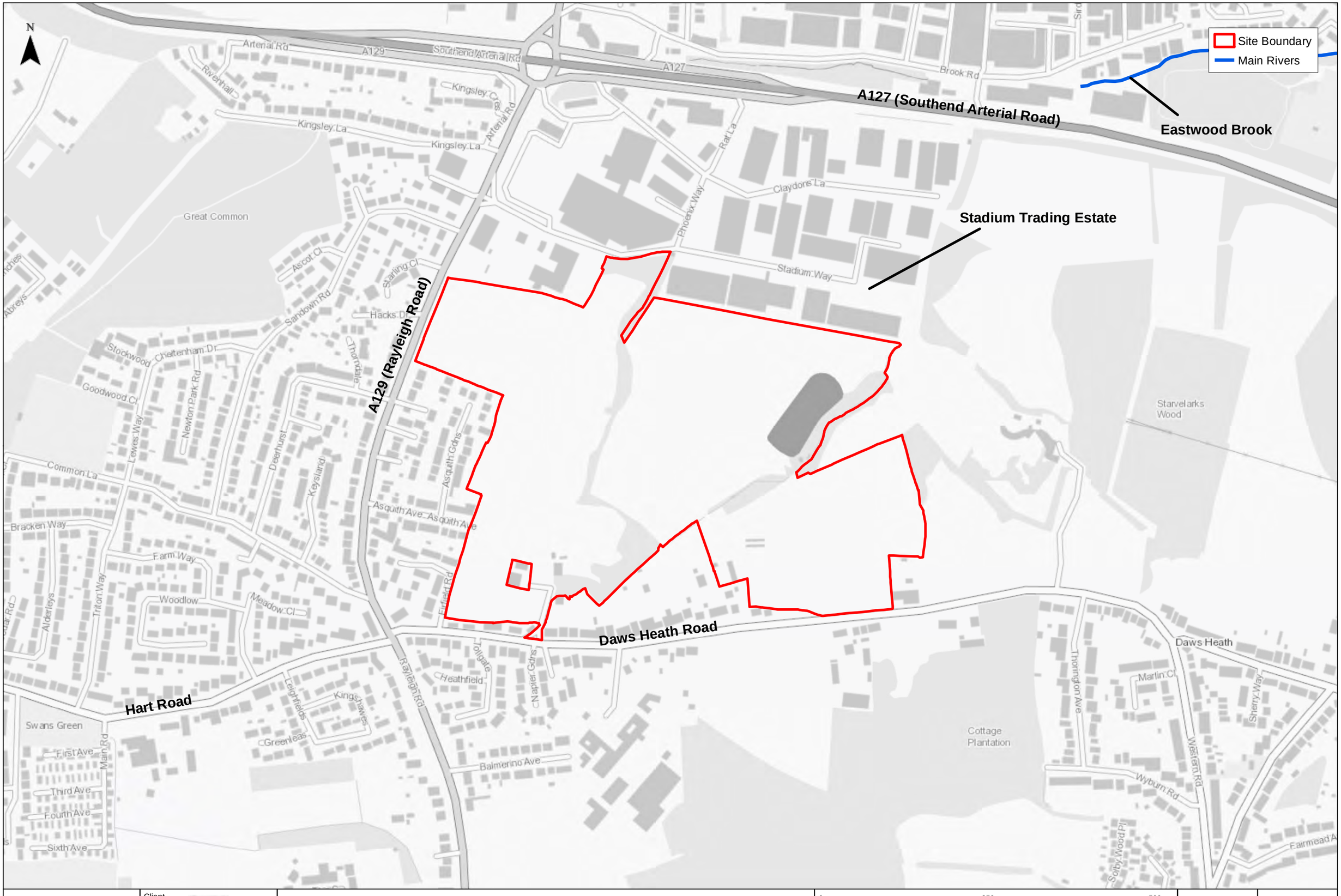
10.1.4 The sequential test is passed on the basis that the site is in Flood Zone 1, the surface water flood risk is dealt with through proposed attenuation features, the low to medium groundwater flood risk is mitigated for, and there is a low risk from flooding from other sources.

10.1.5 Foul Water drainage can be accommodated for the site and is deliverable.

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

Appendix A Site Location Plans and Open Data Maps

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



Stantec

Client: this Land. A DEVELOPMENT BUSINESS

LAND EAST OF RAYLEIGH ROAD

Site Location

0 250 500 m

1:5,000 @ A3	Date: 29/11/2022
Drawn: YR	Checked: SK
Figure 47268/4003/GIS001a	Rev D

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Site Boundary
Main Rivers

A127 (Southend Arterial Road)

Eastwood Brook

Stadium Trading Estate

A129 (Rayleigh Road)

Daws Heath Road

Hart Road

Stantec

Client

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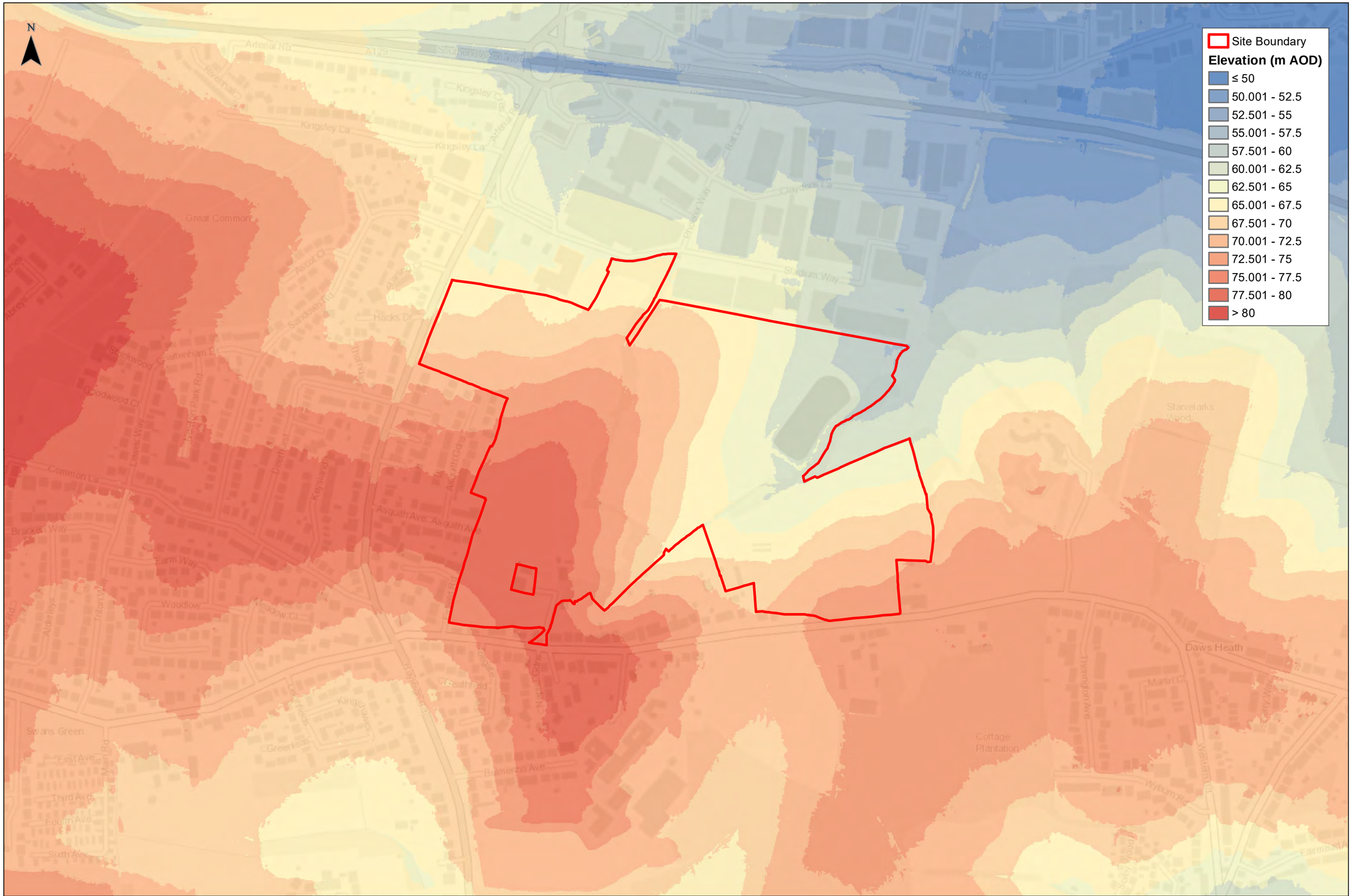
LAND EAST OF RAYLEIGH ROAD

Site Location (Aerial)

0 250 500 m

1:5,000 @ A3	Date: 29/11/2022
Drawn: YR	Checked: SK
Figure 47268/4003/GIS001b	Rev D

Document Path: \\cam-vfps-001\cam\Projects\47268 - Hadleigh Site Castle Point\GIS\Workspaces\47268 GIS001b Site Location (Aerial).mxd



Stantec

Client: this Land. A DEVELOPMENT BUSINESS

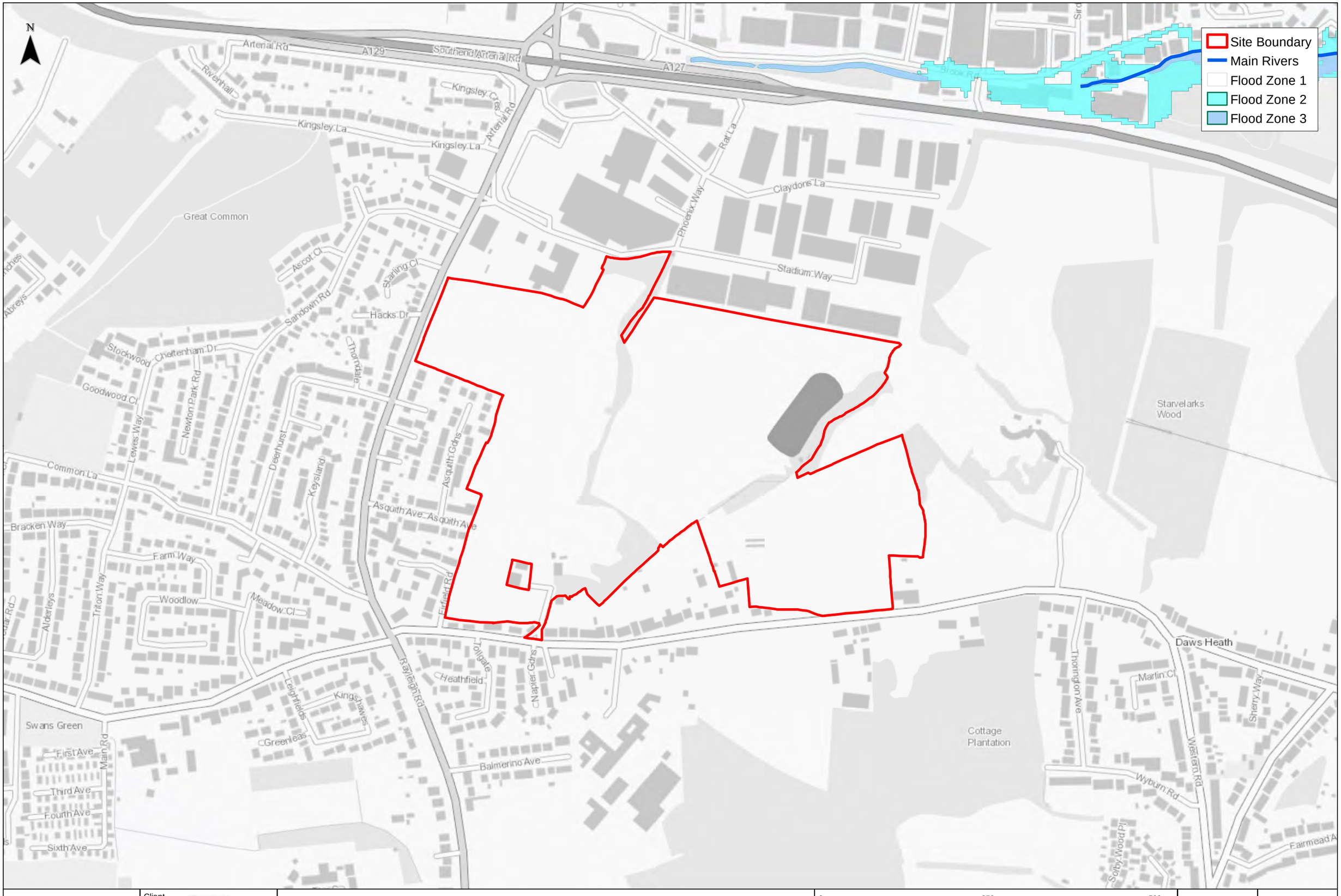
LAND EAST OF RAYLEIGH ROAD

Site Topography (1m LiDAR)

0 250 500 m

1:5,000 @ A3	Date: 29/11/2022
Drawn: YR	Checked: SK
Figure 47268/4003/GIS002	Rev D

Document Path: \\cam-vfps-001\cam\Projects\47268 - Hadleigh Site Castle Point\GIS\Workspaces\47268 GIS002 Topography.mxd



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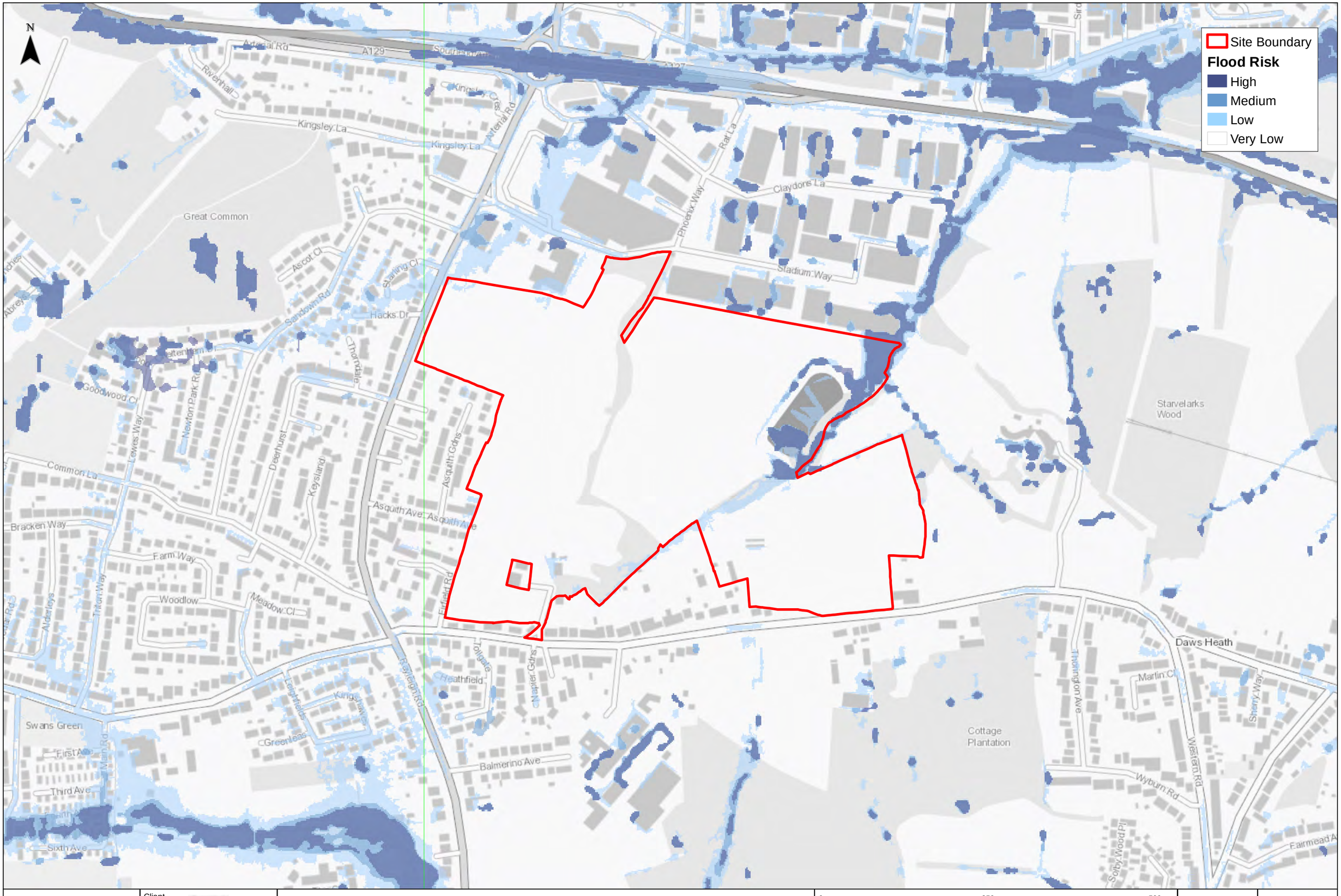
LAND EAST OF RAYLEIGH ROAD

Environment Agency Flood Zones for Planning

0 250 500 m

1:5,000 @ A3	Date: 29/11/2022
Drawn: YR	Checked: SK
Figure 47268/4003/GIS003	Rev D

Document Path: \\cam-vfps-001\cam\Projects\47268 - Hadleigh Site Castle Point\GIS\Workspaces\47268 GIS003 Flood Zones.mxd



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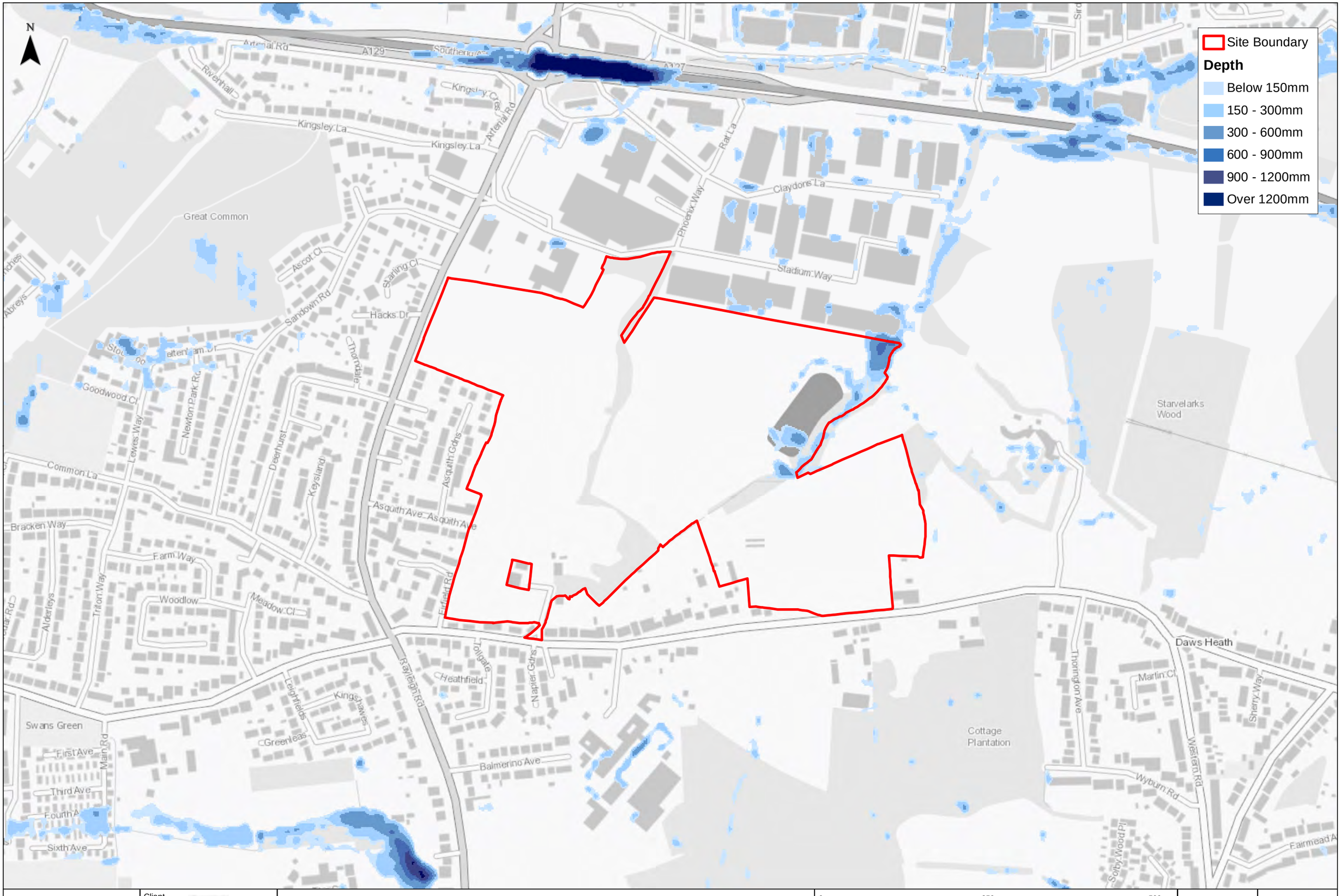
LAND EAST OF RAYLEIGH ROAD

Flood Risk from Surface Water (Flood Extents)

0 250 500 m

1:5,000 @ A3	Date: 29/11/2022
Drawn: YR	Checked: SK
Figure 47268/4003/GIS004	Rev D

Document Path: \\cam-vfps-001\cam\Projects\47268 - Hadleigh Site Castle Point\GIS\Workspaces\47268 GIS004 Flood Risk from Surface Water (Flood Extents).mxd



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LAND EAST OF RAYLEIGH ROAD

Flood Risk from Surface Water
(High Risk Depth)

0 250 500 m

1:5,000 @ A3	Date: 29/11/2022
Drawn: YR	Checked: SK
Figure 47268/4003/GIS005	Rev D

Document Path: \\cam-vfps-001\cam\Projects\47268 - Hadleigh Site Castle Point\GIS\Workspaces\47268 GIS005 Flood Risk from Surface Water (High Risk Depth).mxd