Revisions

Revision	Description	Issued by	Date	Approved by
00	Issue for DCO Submission	RG/JB	24/12/20	BUR/LRCH
01	Inclusion of SSSI	JS/RV	16/07/21	BUR/LRCH

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Executive Summary

1.1 For the purposes of this Surface Water Drainage Strategy, the Project Site has been considered as three sites:

1. The Kent Project Site (Main Resort)
2. The Kent Project Site (Access Road)
3. The Essex Project Site.

A sustainable drainage strategy has been identified for each of the three sites.

1.2 Site of Special Scientific Interest Status Update:

1.2.1 Following the initial DCO submission parts of the London Resort project site were designated as a SSSI. The figure below is an extract from Natural England's map of the Swanscombe Peninsula and demonstrates areas of land that holds a SSSI status. This SSSI status was granted after the initial DCO submission.

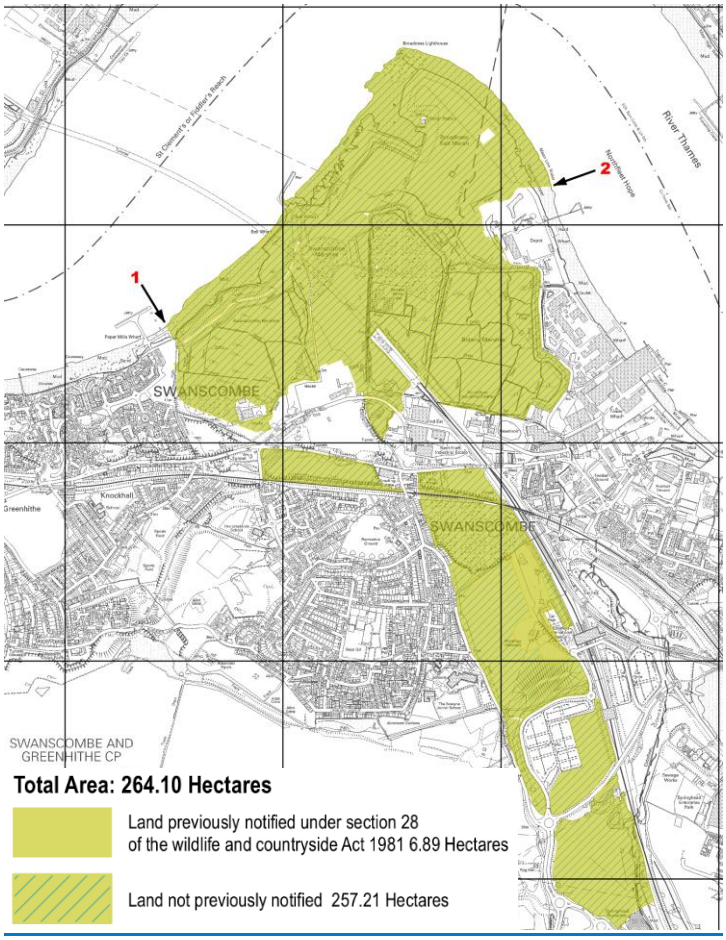

Figure 1 Area classified as Sites of Special Scientific Interest

1.2.2 The following updates shall be incorporated into the proposed drainage strategy for the Kent Project Site (Main Resort) in order to minimise the impact of the drainage strategy and associated earthworks on the SSSI:

1.2.3 The footprint area of the proposed new constructed wetlands shall be reduced in size.

1.2.4 The 250m long channel that runs south to north and connects the new constructed wetlands to the river will be removed from the proposals.

1.2.5 The 290m long outfall culvert from the new constructed wetlands shall be retained and become two large diameter (approx. 1.2m) piped outfalls from the new wetland with non-return valves.

1.2.6 The impact of these changes has been assessed via Microdrainage. A simplified primary drainage run was modelled down the centre of the South Pit Catchment area (catchment shown in Figure 2) from the HS1 pump to the proposed constructed wetlands with a non-return valve at the end. This determined the still water level of the wetlands of approximately 1.5mAOD. The depth above the still water level to which the water can rise was taken to the existing ground level of 4mAOD. An overflow connection from the Botany Marsh area was modelled as a lined swale, the 250m long channel that runs south to north from the new constructed wetlands was omitted and the 290m long outfall that runs east to west from the wetlands to the river was modelled as two large diameter (1.2m) piped outfalls with non-return valves. The initial findings of this high-level model confirmed that the land taken up by the permanent still water level of the wetlands could be reduced to 7,200m^2 with the land rising at a 1 in 3 slope up (whilst maintain it's current shape) to the existing ground level to take up 11,400m^2 of land. This was able to contain 1 in 100-year +40% CC without flooding back into the resort. The model also approximated 3,100m^3 of attenuation would be required upstream within the South Pit catchment for the 1 in 30-year storm event through the pipe and SuDS network (both below and above ground) within the site and 4,900m^3 of attenuation for the 1 in 100-year storm event for prevention of flooding to buildings.

1.2.7 The combined impact of these changes is to reduce the habitat loss within the SSSI which has been documented within ES Chapter 12 Terrestrial Ecology.

1.2.8 With the exception of this addition, the surface water drainage strategy document remains as per the submission version Rev 00. No further changes have been incorporated within the surface water drainage strategy at this time.

Kent Project Site – Main Resort

~~1.2~~1.3 The Kent Project Site is predominantly an undeveloped area and is approximately 387.53 ha. The general topography is variable, with low-lying, undulating land across its central parts and some local mounds due to historical landfilling. The Kent Project Site (Main Resort) area has three managed marsh areas; Black Duck Marsh to the west, Botany Marsh to the east and Broadness Marsh to the north, which are currently drained via a series of manmade drainage ditches and culverts to the River Thames. A partially silted gravity culvert and the High Speed 1 (HS1) pumped culvert currently drain the majority of the Kent Project Site (Main Resort) area.

~~1.3~~1.4 The proposals at the Kent Project Site (Main Resort) include Gates One and Two (Leisure Core), back of house facilities, Related Housing (staff accommodation) and infrastructure. Large areas are changing from permeable to impermeable.

~~1.4~~1.5 The proposed drainage system will be designed for the 1 in 1-year storm event. Above ground flooding can occur only for events higher than the 1 in 30 year with 40% allowance for climate change (CC) in designated areas. Buildings will be protected up to the 1 in 100 year plus 40% CC design flood event and this has been tested against tide-locked conditions. The Proposed Development is designed for no flooding for up to the 1 in 1-year storm event combined with the 1 in 200 year tidal water level 2090 Higher Central allowance, and for up to the 1 in 100 year + 40% CC (up to 2115), combined with the Mean High Water Spring (MHWS). Sustainable Drainage Systems (SuDS) have been incorporated within the drainage network to provide benefit in terms of habitat creation and water quality.

~~1.5~~1.6 Due to the Kent Project Site's (Main Resort) position abutting the River Thames, it is proposed that surface water runoff is discharged directly to the river. Some discrete and isolated areas of the Kent Project Site (Main Resort) to the south, such as the Related Housing (staff accommodation) and infrastructure compounds, are proposed to be drained via infiltration to the ground. These areas are considered to have good infiltration potential, low contamination levels and are the farthest away from the River Thames. As far as practical, a positive drainage system will be utilised within the development area to collect rainfall runoff from roofs and impermeable surfaces. The system will consist of open swales or piped gravity system if required. Pumping will be avoided and restricted to specific areas where the existing ground levels are very low around the HS1 tunnel. The surface water network will discharge to the two marsh areas on east and west of the site and a new constructed wetland proposed at the north of Gate One. Run-off from the access road will be collected via a perimeter swale, treated and discharged to the marshes/wetland. Finally, the surface water runoff will be discharged to River Thames, at unrestricted run-off rates, via new outfalls from the marshes and wetland area. The existing, silted gravity culvert and HS1 pumped culvert are not intended to be used and will be decommissioned, pending agreement with HS1. All outfalls will have second non-return valves. The marsh areas and wetland will act as attenuation areas during tide-locked conditions. The drainage strategy for Kent Project Site (Main Resort) is illustrated in Figure .

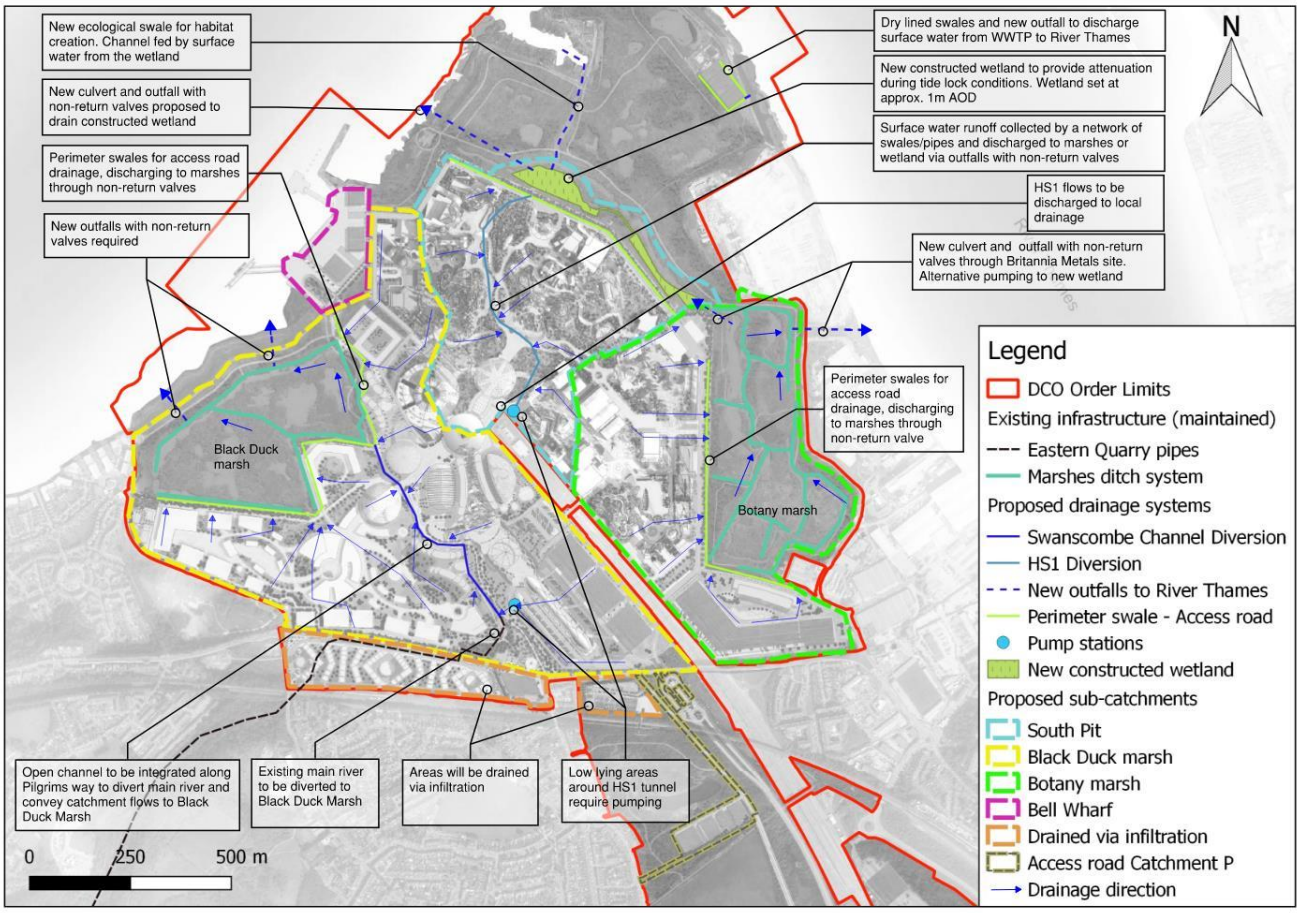

Figure 2: Proposed drainage strategy for Kent Project Site (Main Resort)

~~1.6~~1.7 The additional volume of surface water runoff to the marshes is anticipated to create new habitat and provide ecological improvements under the Ecological Mitigation and Management Framework (Document Reference 6.1, Chapter 12.3). Flexibility will be built into the design of the outfalls from the marshes allowing water levels within the marshes to be adjusted by increasing surface water outflows, as required.

Kent Project Site (Access road)

~~1.7~~1.8 The Kent Project Site (Access Road) area is mainly undeveloped and includes land that were previously used for landfill activities and crosses existing infrastructures such as Ebbsfleet International Station's access road and railway tracks.

~~1.8~~1.9 The general topography is variable, generally falling into north and east directions and some local mounds due to historical landfilling. The area includes ponds and a network of land drains, ditches and culverts. It is anticipated that the existing site ultimately drains to the Ebbsfleet River.

~~1.9~~1.10 The proposals include an upgrade of the multi-roundabouts junction to Watling Road, an upgrade of the south main access to Ebbsfleet International Station (A2260) and the construction of a main and secondary access roads for vehicles and infrastructure buildings.

~~1.10~~1.11 The proposed drainage system will be designed for the 1 in 2-year storm event. Above ground flooding can occur only for events higher than the 1 in 30 year with 40% allowance for climate change in designated areas. The strategy is designed for no increase in flooding outside the development for the respective 1 in 2 year and 1 in 100 year + 40% CC. SuDS have been incorporated within the drainage network to provide benefit in terms of habitat creation, biodiversity and water quality.

~~1.11~~1.12 The drainage strategy for the Kent Project Site (Access Road) is to discharge by gravity through a network of attenuation ponds and underground storage to the Ebbsfleet River at greenfield runoff rates. Infiltration to the ground will be used where proven possible, pending further site investigation. Some sections of highway to the south will include standalone highway soakaways. A pumping station and associated storage will be required to drain the northern part of the proposed access road, where gravity drainage is not feasible.

~~1.12~~1.13 Where existing ponds are impacted by the proposed access road, they are to be relocated on a like-for-like basis, to ensure no net loss of attenuation capacity and biodiversity.

Essex Project Site

~~1.13~~1.14 The Essex Project Site is currently used as parking / storage for new cars and is almost entirely impermeable. It is served by an existing surface water network managed by the Port of Tilbury (PoT). It connects to the main surface water channel (East Dock Sewer) that runs down from Tilbury, which has known issues of siltation and can cause flooding upstream in Tilbury. The channel discharges to River Thames.

~~1.14~~1.15 The development proposals include the construction of a multi-storey car park (MSCP) and changes to the passenger area at Tilbury Cruise terminal. The pipe network is designed for the 1 in 1-year storm event, with no above ground flooding for 1 in 30 + 40% CC. The surface water network is designed such that there is no risk of flooding to buildings for up to the 1 in 100 year +40% CC storm combined with 1 in 20 year (2090 Higher Central) tidal levels, and the 1 in 5 year + CC rainfall event combined with the 1 in 200 year + 40% CC tidal event.

~~1.15~~1.16 The strategy proposes the construction of a new pipe to the River Thames for unrestricted surface water discharge. An existing PoT outfall is currently identified within the passenger area with unknown size, capacity or condition. Following investigations, if the outfall is considered appropriate for use, the new pipe will be connected to it. Alternatively, a new outfall will be constructed. The drainage system of the Essex Project Site will no longer discharge to the East Dock Sewer, which is known to cause flood risk issues, thereby reducing flood risk to other sites. Green/brown roofs at the MSCP and permeable pavement at the visitor plaza are proposed, which will provide further value in terms of habitat, water quality and pollution control. Attenuation will be integrated near the MSCP building and below the permeable pavement to accommodate surface water runoff during the tide-locked scenarios.

~~1.16~~1.17 This document is supported by two sets of Drainage Plans (Drawing series: LR-PL-WSP-DCP-2.15.1 – 2.15.9 and LR-PL-BUR-DCP-2.17.1 – 2.17.9).

~~1.17~~1.18 A number of meetings have been held with key stakeholders, including the Environment Agency (EA), flood risk teams from Kent County Council (KCC) and Essex County Council (ECC) and other utility providers. While Thurrock Council (TC) is the Lead Local Flood Authority for the Essex Project Site, a flood risk officer is not currently appointed. ECC are therefore providing support and technical advice on flood risk matters. The principal points of agreement are summarised below and have all been considered during the development of this drainage strategy:

- Discharge of surface water to the River Thames from the Kent Project Site (Main Resort) and Essex Project Site can be unrestricted;
- Discharge of surface water to Ebbsfleet River from the Kent Project Site (Access Road) is restricted to greenfield rates of runoff;
- The systems shall be assessed against tide lock conditions; and
- Mechanisms shall be put in place to control the water levels within the marsh areas.

~~1.18~~1.19 The drainage proposals provide an overall betterment to the Project Site. The systems have been designed to cope with increased rainfall intensity, runoff and volume due to climate change. At the Kent Project Site, the silted gravity culverts and HS1 pumped culvert are proposed to be replaced by new culverts with longer design life that can discharge under gravity. The marsh habitat will be improved by introducing larger water volumes; flexibility will be built into the system to ensure the most appropriate habitat is created. At the Essex Project Site, the inflows to the East Dock Sewer, which is currently near capacity, will be reduced, further reducing the risk of the system being overwhelmed during a storm event. A new, independent system is proposed to discharge surface water directly to the River Thames.

~~1.19~~1.20 It is considered that, with the proposed surface water drainage design in place, the Proposed Development will not increase the risk of surface water flooding on or off site or have any adverse impacts on the River Thames wate quality. Furthermore, it will have greater resilience than the exiting site, in terms of adaption for climate change, and provide additional value in terms of habitat, water quality, visual amenity and public realm.

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Contents

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Glossary

Term	Definition
BGS	British Geological Survey
CC	Climate Change
DCO	Development Consent Order
DSE	Design Storm Event
EA	Environment Agency
ECC	Essex County Council
FSR	Flood Studies Report
GI	Ground Investigations
HC	Higher Central
KCC	Kent County Council
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LRCH	London Resort Company Holdings Limited
mAOD	metres Above Ordnance Datum
MSCP	Multi-Storey Car Park
NPPF	National Planning Policy Framework
PoT	Port of Tilbury
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TC	Thurrock Council

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Chapter One ◆ Introduction

Report Context

1.1 This report describes the surface water drainage strategy for the Proposed Development. The foul water management strategy is included in the Utilities Statement (document reference 7.6).

1.2 This report has been prepared on behalf of London Resort Company Holdings Limited (LRCH or the applicant) to support the Development Consent Order (DCO) application for the London Resort.

1.3 The London Resort project consists of three principal areas, shown in Figure 1-1:

1. The Kent Project Site (Main Resort)
2. The Kent Project Site (Access Road)
3. The Essex Project Site.

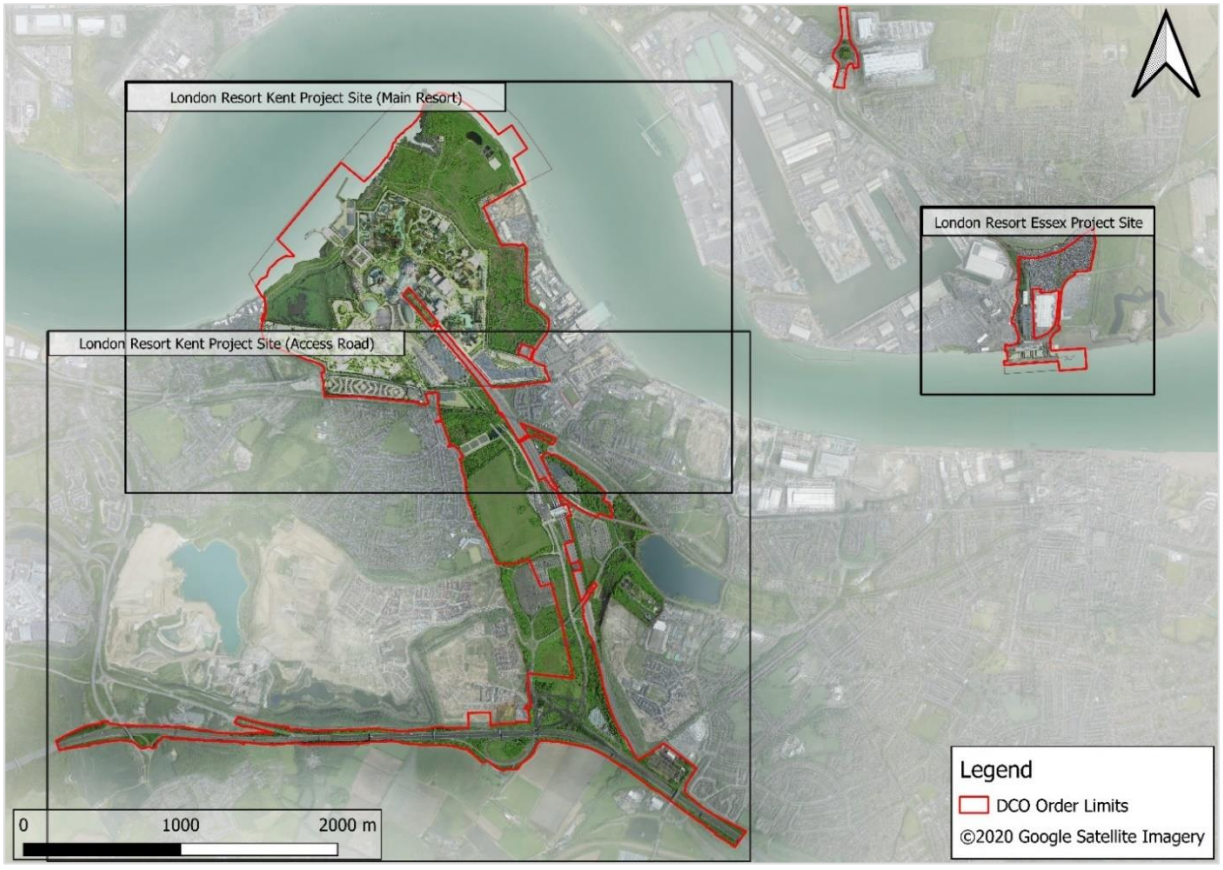

Figure 1-1: London Resort Project Site areas

Report structure

1.4 This report is structured in following manner:

1. Section 1: Introduction and agreements reached with key stakeholders;
2. Section 2: Planning context and design codes;
3. Section 3: Site context; and
4. Section 4: Proposed surface water management strategy.

Key stakeholders

1.5 With regard to development planning and permissions, the following key local stakeholders and/or approving authorities associated with drainage of the Proposed Development have been identified:

- The Environment Agency (EA) is responsible for management of 'Main Rivers' throughout England and advise on flood risk from fluvial and tidal sources.
- The Lead Local Flood Authorities (LLFA) manage local flood risk in their area and are a consultee for planning applications that impact on surface water, including approval of proposed drainage and Sustainable Drainage System (SuDS) strategies. For the purposes of the Proposed Development, these authorities are Kent County Council (KCC) and Thurrock Council (TC). They have powers to maintain and operate local watercourses, 'Ordinary Watercourses' and highways. Consultations were held with the councils on the 4th August 2020 and 10th July 2020 respectively.
- Essex County Council (ECC) are providing technical advice and support to TC in terms of flood risk and drainage. They hold the expertise to support TC in the approval of drainage schemes for new developments. Consultations with ECC flood risk team were held on 25th September 2020.
- Southern Water, Thames Water, Essex and Suffolk Water and Anglian Water are the local sewerage undertakers and potable water suppliers for the Kent and Essex Project Sites, with powers under The Water Industry Act 1991 (the 1991 Act). Consultations have been undertaken with respect to existing sewerage infrastructure and disposal of foul water from the site as well as provision of potable water. More information is included in the Utilities Statement (document reference 7.6).
- Port of Tilbury (PoT) own and manage the existing drainage system on the Essex Project Site. Some information of the existing drainage systems has been provided.
- National Rail owns and operate the HS1 tunnel that is located adjacent to the Kent Project Site. They have provided drainage drawings of the existing surface water drainage for the tunnel.

Agreements reached with stakeholders

Environment Agency

1.6 The EA has provided information on the Main Rivers and their function around the Project Site, as well as modelled information as part of pre-application enquiry. Meetings have been carried out with the EA on the 23rd June 2020 and 4th August 2020 and agreed to the following principles:

- un-restricted discharge to the River Thames;
- drainage strategy to ensure the surface water drainage network, culverts and outfalls are designed for tidelock scenarios;
- outfalls to incorporate scour protection; and
- For Kent Project Site, the marsh outfalls shall incorporate gates to allow surface water to be retained within the marsh or drained from the marsh should it be desirable in the future.

1.7 The meeting minutes from the consultations with the EA have been included in Appendix A.

1.8 A Flood Risk Management Strategy design note (0042936_LR_BUR_DCO_FRM_1004) was issued to the EA to present the proposed flood risk and drainage strategy in more detail. The comments from the EA have been addressed through the proposed strategy. Please refer to section 0 of this document.

Lead Local Flood Authorities

Kent County Council

1.9 During a joint meeting with the EA on 4th August 2020, KCC had the opportunity to review the drainage proposals for the Kent Project Site (Main Resort and Access road). The following were agreed/raised by KCC:

Unrestricted discharge to the River Thames from the Kent Project Site (Main Resort) is acceptable. The following tide-locked scenarios should be considered in the design process:
    - 1 in 1 year storm event combined with the 1 in 200 year 2090 tidal level;
    - 1 in 100 year storm event + climate change combined with current MHWS.
- A mechanism shall be put in place to ensure the level of inundation of the marsh areas is acceptable to the marsh habitats and the impact on ecology;
- Land drainage consents will be required for culverting or infilling of ordinary watercourses and sufficient offset for access and maintenance is required for any retained watercourses; and
- Natural systems of treating surface water runoff (SuDS) will be prioritised.

Thurrock Council

1.10 TC were consulted on 10th July 2020 when they confirmed the following:

- While TC is the LLFA for Tilbury, there is currently no flood risk officer within TC. Essex CC will provide support in terms of technical advice.
- The watercourse to the to the west of the Essex Project Site (East Dock Sewer) is an EA Main River and TC have confirmed that it has known issues of siltation that can cause flooding upstream in Tilbury;
- The operation of the sluice valve within the western watercourse needs to be understood; and
- There is not much capacity in the surface water drainage system in the area.

Essex County Council

1.11 In the consultation on the 25th of September 2020 ECC commented the following on the presented drainage strategy:

- In agreement in principle with the unrestricted discharge and the tidelock scenarios described in the proposal;
- Confirmed that as the area is not residential, a 20% climate change allowance would be acceptable. The 40% allowance should be tested to ensure no flooding of buildings and no flooding outside the Order Limits; and
- Confirmed that green roofs provide adequate pre-treatment for roofs, such as the covered proposed MSCP.

1.12 ECC recommended that at the next stage of design the following are to be developed further:

- Use of additional SuDS and Source Control features such as Rainwater Harvesting, Rain Gardens, Bio retention areas, SuDS Tree Planters etc. to provide additional amenity and biodiversity value;
- Reference should be made to EA guidance on climate change allowances for outfall conditions to the Thames tidal estuary, for consideration as a possible relaxation over current Essex SuDS Design requirements if this is proven not to have a detrimental impact on pluvial flood risk;
- Provisions to be made for the full tide-locked scenario and evidence provided that the drainage system half drains down within 24hrs for the 1 in 30 year return period, to allow capacity for a follow up 1 in 10 year return period storm;
- Any third-party agreements being secured to discharge to the Thames tidal estuary; and
- Reference should be made to the Thurrock Local Flood Risk Management Strategy (2015) within the Flood Risk Assessment (FRA, document reference 6.2.17.1) to identify any Areas of Critical Drainage (AoCD) that might be impacted by the Proposed Development.

1.13 The meeting minutes from the consultation with ECC are included in Appendix A to this document. Responses to the key stakeholder consultees are included in Section 0.

Chapter Two ◆ Planning context and guidance

Document Overview

2.1 This drainage design has been prepared in accordance with the policies and guidance applicable to the proposed development, outlined within the following publications:

- National Planning Policy Framework (February 2019);
- National Planning Policy Framework Planning Practice Guidance website;
- The SuDS Manual, CIRIA (2015);
- Kent and Medway Growth and Infrastructure Framework (GIF) (2018 update);
- Kent County Council Drainage and planning policy statement, Local flood risk management strategy guidance (June 2017);
- Dartford Borough Council, Dartford Core Strategy (September 2011);
- Gravesham Borough Council, Gravesham Local Plan Core Strategy (September 2014);
- Thurrock Council, Core Strategy and Policies for Management of Development, Development Plan Document (2015);
- Essex County Council Sustainable Drainage Systems – Design Guide (2016);
- Department for Environment, Food and Rural Affairs Non-Statutory Technical Standards for Sustainable Drainage Systems (TSSuDS) (March 2015); and
- Ebbsfleet Development Corporation, Ebbsfleet Implementation Framework (2017).

Planning policy

National Planning Policy Framework (February 2019)

2.2 The National Planning Policy Framework[1] (NPPF) provides national policy for dealing with surface water, with a focus on sustainable development. At Paragraph 079, the NPPF requires that developments incorporate sustainable drainage systems (SuDS) unless there is clear evidence that this would be inappropriate and to include mitigation for the anticipated impacts of climate change where necessary.

2.3 The Planning Practice Guidance[2] to the NPPF states that the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

1. Into the ground (infiltration);

[1] Ministry of Housing, Communities and Local Government, (2019). National Planning Policy Framework
[2] Ministry of Housing, Communities and Local Government, (2014). National Planning Policy Framework Planning Practice Guidance. [online] Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change. [Accessed 04 October 2018].

2. To a surface water body;
3. To a surface water sewer, highway drain, or another drainage system; and
4. To a combined sewer.

2.4 The drainage design contained within this report has been developed in accordance with this drainage hierarchy.

2.5 The climate change guidance published by the EA in February 2016 (updated July 2020) to support the NPPF contains sensitivity ranges that are recommended to be applied to peak rainfall intensities, peak river flows, sea level rise, offshore wind speeds and extreme wave heights. The general trend is for each parameter to increase in the future, which in turn increases the risk of flooding to any site. The recommended allowances for peak rainfall intensity are given in Table 2.1.

Table 2.1: Recommended climate change allowances for peak rainfall intensity

Allowance Category	Total potential change anticipated for 2015 to 2039	Total potential change anticipated for 2040 to 2069	Total potential change anticipated for 2070 to 2115
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

2.6 The surface water drainage design contained within this report has made an allowance for 40% increase in peak rainfall intensity due to the design life of the development.

Kent and Medway Growth and Infrastructure Framework (KCC, 2018 update)

2.7 The Kent and Medway Growth and Infrastructure Framework (GIF) provides a strategic framework across the County, for identifying and prioritising investment across a range of infrastructure, for planned growth up to 2031. Under flood protection, the framework recognises that '*Sustainable Drainage Systems (SuDS) offer opportunities to mimic natural drainage that can reduce flood risk and offer other benefits, such as amenity space and habitats*.'

Development Plan Document (Core Strategy) (TC, 2015)

2.8 The Thurrock Local Development Framework *Core Strategy and Policies for Management of Development, Development Plan Document* (Core Strategy) (TC, 2015) is a strategic document providing broad guidance on the scale and distribution of development and the provision of supporting infrastructure. It contains core strategies (CS) for water and policies for management of development (PMD) in relation to flood risk. CSTP27 – *Management and reduction of flood risk* states, amongst others, that the Council will ensure that, where necessary, new development contains space for water including naturalisation and environmental enhancement. Developers will be required to incorporate SuDS as a priority and to contribute towards flood risk management infrastructure where appropriate. In PMD15 – *Flood Risk Assessment* it is further emphasised that developments will be expected to incorporate SuDS to reduce the risk of surface water flooding, both to the site in question and to the surrounding area. Where the potential for surface water flooding has been identified, site specific Flood Risk Assessments should ensure that suitable SuDS techniques are incorporated as part of the redevelopment.

Sustainable Drainage Systems Design Guide (ECC, 2016)

2.9 The Sustainable Drainage Systems – Design Guide (ECC, 2016) provides design criteria based on local principles and local standards detailing the purpose, construction and functioning of SuDS. The local standard requires that one designs for water quantity with requirements for runoff rate, runoff volume and storage volume. For an outfall to a tidal estuary, SuDS should be sized to accommodate storm run-off during times when the outfall is tide-locked. The storage provision should be calculated by modelling a 1 in 100 inclusive of climate change rainfall event and 1 in 20 inclusive of climate change tidal event coinciding. The guidance also requires that SuDS are designed with regard to water quality, based on an appropriate 'train' of SuDS components installed to reduce the risk of pollutants entering watercourses via runoff from developed sites. Interception storage should be used as part of the treatment train to ensure that pollutants are managed at source, which will reduce the risk of them contaminating water bodies.

Chapter Three ◆ Site context

3.1 The Project Site lies approximately 30 km east-south-east of central London on the south and north banks of the River Thames, in the ceremonial counties of Kent and Essex. For clarity, the section of the Project Site to the south of the River Thames is referred to as the 'Kent Project Site' and that to the north of the river is identified as the 'Essex Project Site'. The term 'Project Site' refers to both the Kent and Essex Project Sites collectively. The 'Order Limits' within which the proposed DCO would apply are shown on the Location Plan (document reference 2.1).

Kent Project Site (Main Resort)

Site description and levels

3.2 The Kent Project Site occupies much of the Swanscombe Peninsula, formed by a meander in the River Thames. It consists of the Main Resort and Access Road and is approximately 387.53 ha. The Kent Project Site (Main Resort) is predominantly undeveloped area and has managed marsh areas, namely the Black Duck Marsh on the west, Botany Marsh on the east and Broadness Marsh on the north. It is largely a historic landfill site for Cement Kiln Dust (CKD), a waste product from the previous, local cement industry. The general topography is variable across the Kent Project Site, with low-lying, undulating land across its central parts and some local mounds due to historical landfilling. Broadness Marsh has been used for tipping of CKD and dredged material from River Thames and has been raised from an assumed original height of 2-3 m AOD to approximately 8.8 m AOD. Tipping of CKD has occurred across much of the site in historic clay pits, and some areas are still licenced landfills.

3.3 Land levels across the site can vary between 1mAOD in the marsh areas to 13mAOD at landfill points. Figure 3-1 provides spot elevations of the topography at the Kent Project Site. Flood defences surround the Swanscombe Peninsula at varying levels from 6.04m AOD to 11.02m AOD.

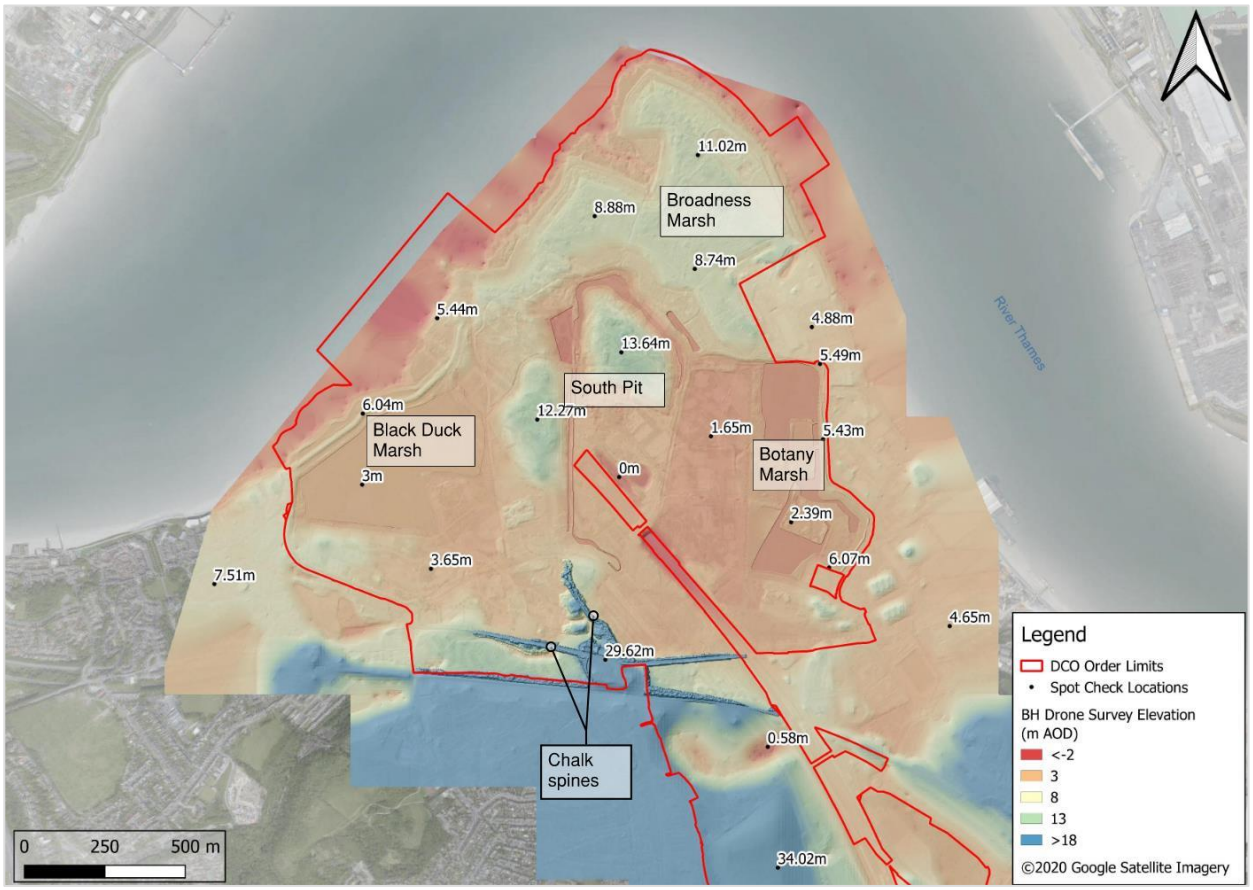

Figure 3-1: Kent Project Site (Main Resort) existing marshes and spot elevations from topographic survey flown July 2020 (Note; the spot elevations within the marsh areas are likely higher than the actual ground due to presence of thick vegetation).

Existing ground conditions

3.4 Large parts of the Kent project Site (Main Resort) have Made Ground at the top layers. Made Ground varies across the Swanscombe Peninsula. Towards the north it comprises predominantly of CKD, whilst towards the south it comprises chalk, clay, sand and gravels which have been used to backfill pits and quarries, together with a mixture of domestic and commercial wastes within landfilled areas. Substantial chalk spines are present in the centre of the Kent Project Site, upon which roads and railway lines run, approximately 16-20m above the surrounding ground. Large parts of the site have Made Ground at the top layers.

3.5 Alluvium covers a large portion of the Swanscombe Peninsula north of Manor Way, and these deposits are predominantly silty clay and clayey silt, with some coarser grained units. Historical borehole records indicate two prominent layers of peat across the Swanscombe Peninsula, at approximately -4 mAOD and -8 mAOD. Head deposits are anticipated across small pockets of the Swanscombe Peninsula, formed from the Chalk bedrock comprising sandy, silty and angular to sub-angular flints. Both the Alluvium and the Head deposits beneath the Swanscombe Peninsula are classified as Secondary 'A' aquifers by the EA, defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

3.6 The direction of groundwater flow on the Swanscombe Peninsula is not well understood. Regionally it is expected to flow northwards, towards the River Thames. Abstractions associated with the HS1 portal and quarries in the vicinity will have an impact on flow direction locally.

3.7 Records from monitoring wells in some areas of the site in June 2020 indicated groundwater levels between 0.8-1.9m AOD where the Principal Development is proposed.

3.8 Due to the contaminated nature of the area and the potential of contamination of the underlying Secondary Aquifer, infiltration has been discounted as an appropriate method for surface water discharge.

Existing sub-catchments

3.9 The Kent Project Site (Main Resort) is currently drained via a series of manmade drainage ditches and culverts to the River Thames. It consists of the following sub-catchments, as shown in Figure 3-2.

- South Pit sub-catchment shown in light blue (discharge points A & B);

- Botany Marsh area shown in light blue with line hatch (part of South Pit sub-catchment, discharge points A & B);
- Black Duck Marsh sub-catchment shown in yellow (discharge point C);
- Bell Wharf sub-catchment shown in purple (direct overland runoff to River Thames);
- Broadness Marsh area at the north comprising of 3 sub-catchments shown in green, red and dark blue (some treatment and direct overland runoff to River Thames).

3.10 The general flow direction is southeast to northwest and is indicated in Figure 3-2 with the black arrows. The existing rates of runoff from each catchment have been estimated using the IH124 method for greenfield areas and the Modified Rational Method (MRM) for brownfield areas and are presented in Table 3.1.

Table 3.1: Existing rates of runoff within the Kent project Site (Main Resort) Order Limits

Site areas	Area (ha)	Existing rates (l/s)
		1 in 100
South Pit*	65.1	4,560
Botany Marsh*	28.1	2,165
Black Duck Marsh	62.3	4,440
Bell Wharf	2.4	53
Broadness Marsh**	41.5	180

** Botany Marsh discharges to South Pit. Here the values shown are separated between the two sub-catchments.*

***Broadness Marsh consists of three sub-catchments: Broadness West (green), Broadness North (~~purple~~dark blue), and Broadness South (red).*

3.11 A CCTV survey of the Kent Project Site (Main Resort) was undertaken in September 2020 and can be found in Appendix B~~**Error! Reference source not found.**~~. The outputs of the CCTV survey have informed the understanding of the existing sub-catchments. The relevant information for each sub-catchment is included in the following sections.

3.12 The drainage sub-catchment areas are illustrated in Figure 3-2.

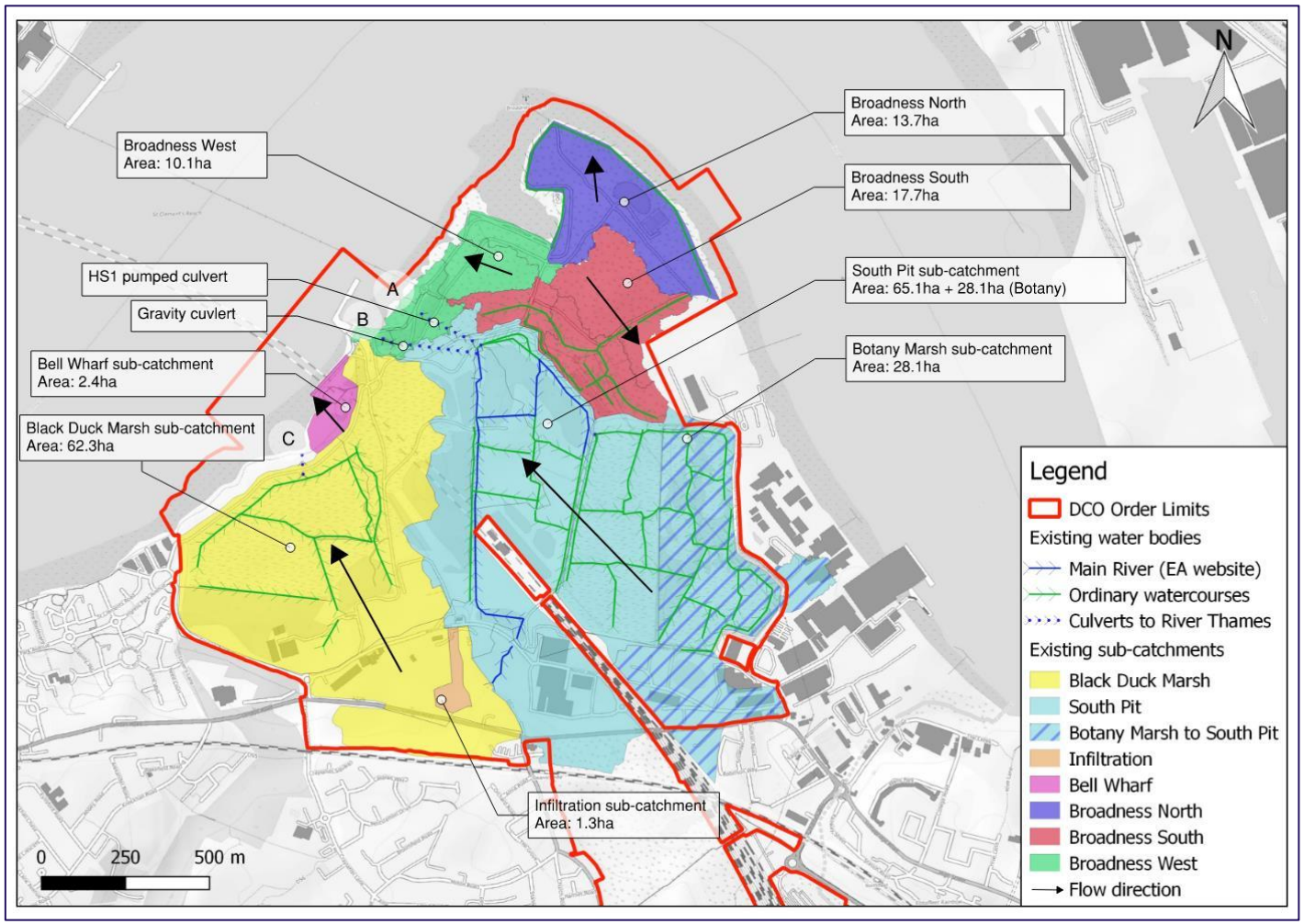

Figure 3-2: Existing surface water drainage catchments and manmade drainage ditch system Kent Project Site (Main Resort), © 2020 Open Street Map imagery

South Pit sub-catchment

3.13 The South Pit sub-catchment (light blue shade) consists of the central and east parts of the Kent Project Site (Main Resort). An EA designated *Main River* (referred to hereafter as Swanscombe channel) crosses the catchment from south to north, as shown by the blue arrow line. Flows to the Swanscombe channel are understood to be mainly from Eastern Quarry abstraction discharge (230 l/s), dewatering of the HS1 tunnel (approximately 31 l/s) and runoff from the surrounding catchment. Camland Group is developing the Eastern Quarry site (known as Whitecliff development). A planning application (reference 20/00197/FUL) was submitted in February 2020 to Dartford Borough Council to divert the flows from the development away from the Swanscombe channel and discharge directly to the River Thames via a new outfall. Following conversations with Camland Group, it is understood that if the planning permission is granted, the flows will be diverted by April 2021.

3.14 The flows from the Swanscombe channel and South Pit sub-catchment (shown in blue) are currently discharged to the river via a 320m long, 1.6m diameter gravity culvert (outfall B) within the western area of the Swanscombe Peninsula. The recent CCTV survey and older CCTV information from the EA have indicated that the culvert is partly silted. Emergency discharge is also achieved via a pumped system operated by HS1 (outfall A), located north of the gravity culvert (300mm diameter pipe).

Botany Marsh area

3.15 The area shown with blue shade and a diagonal hatch indicates the catchment area draining into Botany Marsh. Observations during site visits and a CCTV survey indicate that this area drains towards the northwest and is part of the South Pit sub-catchment. Investigations are ongoing as to whether there is an outfall to the river from Botany Marsh, and to understand whether surface water run-off from the Britannia Metals site is directed onto the marsh.

Black Duck Marsh sub-catchment

3.16 The Black Duck Marsh sub-catchment (yellow shade) drains a large area of the west part of the Swanscombe Peninsula. The CCTV surveys were inconclusive in determining the discharge location from Black Duck Marsh to the River Thames . An outfall has been identified within Black Duck Marsh that could potentially connect to outfall C. This will be investigated further during subsequent CCTV surveys.

Other sub-catchments

3.17 Historic Southern Water Authority drawings indicate that a pipe has historically connected the Black Duck Marsh to the 1.6m diameter gravity pipe (outfall B). It is not currently known if this is still the case.

3.18 One catchment area is believed to drain via infiltration (orange shade). The catchment near Bell Wharf (magenta shade) drains directly to River Thames.

Broadness Marsh sub-catchments and leachate management

3.19 Areas to the north of the Swanscombe Peninsula have been historically used for disposal of CKD. A surface water collection and treatment system has been put in place to treat any leachate before discharge to the River Thames. The leachate collection system and sumps, treatment and outfall location are shown in Figure 3-3.

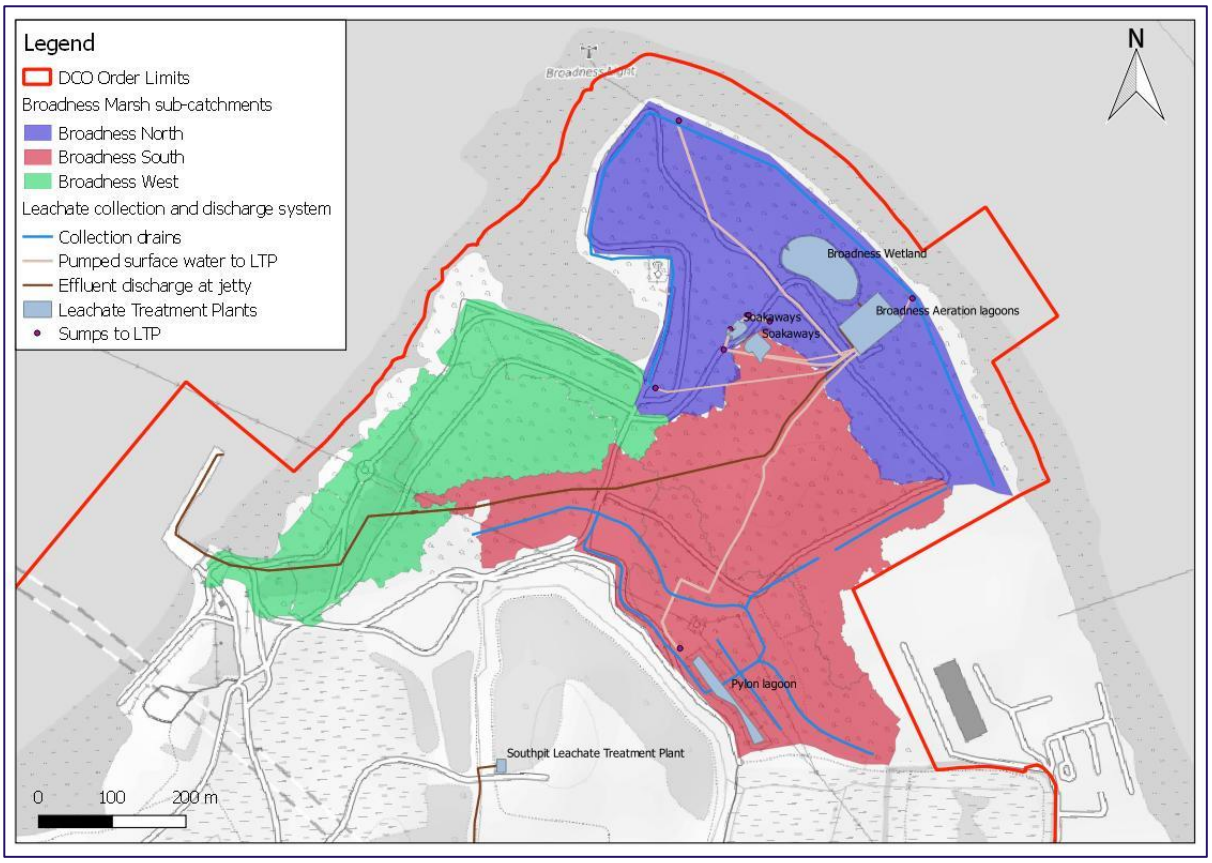

Figure 3-3: Existing drainage sub-catchments in north of Swanscombe Peninsula, Kent Project Site (Main Resort) © 2020 Open Street Map imagery

3.20 CMS-Enviro is currently managing the surface water and leachate treatment of the Kent Project Site (Main Resort). The following baseline conditions have been confirmed:

- Broadness South sub-catchment (red) naturally slopes south-easterly. A series of drainage ditches have been put in place to collect the runoff and convey to the Pylon lagoon. The water from the Pylon lagoon is then pumped to a Leachate Treatment Plant (LTP) at the northeast tip of the Swanscombe Peninsula consisting of aeriation lagoons, soakaways and wetlands. However, as the area is largely flat, high rainfall events overtop the ditches and discharge directly to the River Thames. In any event, the LTP can only discharge 75m^3/day max (27,375m^{3}pa). Only a small volume is therefore treated for discharge;
- Broadness North sub-catchment runoff enters minor collection drains (french drains) around the perimeter of the area. Three sumps used to pump water to the LTP. Due to the low discharge ability of the LTP, runoff is generally uncontrolled and discharged directly to the river;
- Surface water runoff across the Broadness West sub-catchment flows directly to the River Thames.

3.21 Following treatment of surface water runoff at the LTP, the effluent is discharged to River Thames at White's Jetty, at the west area of the Swanscombe Peninsula below water level (shown in brown line).

South Pit leachate management

3.22 A separate leachate collection and treatment system is in place to serve the areas at the south. A leachate collection drain is installed around the perimeter of the South Pit landfill mound. Once leachate is intercepted by the collection drain, the leachate flows under gravity to seven collection sumps spaced around the length of the drain. Leachate is pumped to the treatment compound for treatment and disposal. The South Pit treatment and disposal compound treats the pumped leachate and stores the effluent in tanks, before pumping it to the Southern Water sewer pumping station located to the south of the Kent Project Site (Main Resort) area, as shown in Figure 3-4. ~~**Error! Reference source not found.**~~ If leachate disposal to sewer is not permitted for any reason leachate can be removed from the storage tanks via road going tanker for disposal off site at a suitably licensed disposal facility.

Existing drainage infrastructure

3.23 The following utilities are present within the Kent Project Site (Main Resort) area:

- A leachate system collects leachate from South Pit area, treats and discharges to the Southern Water foul system.

- A separate leachate system serves Broadness Marsh at the north. Treated leachate is discharged at White's Jetty.
- Southern Water foul system serves the south area of the Kent Project Site (Main Resort). A pump station and rising main are located within the Order Limits. There is a decommissioned Southern Water Swanscombe wastewater treatment works at the centre of the area.
- Eastern Quarry flows discharge to the River Thames through the site. Flows are conveyed via the Swanscombe channel (EA Main River). Subject to planning (reference 20/00197/FUL), the flows will be diverted around the Kent Project Site (Main Resort) by April 2021.
- HS1 ground water (tunnel dewatering) is pumped to the Swanscombe channel. A pipe and pump discharge water to the River Thames.
- Manor Way and surrounding roads are served by a KCC surface water system. This drains to the Swanscombe channel.

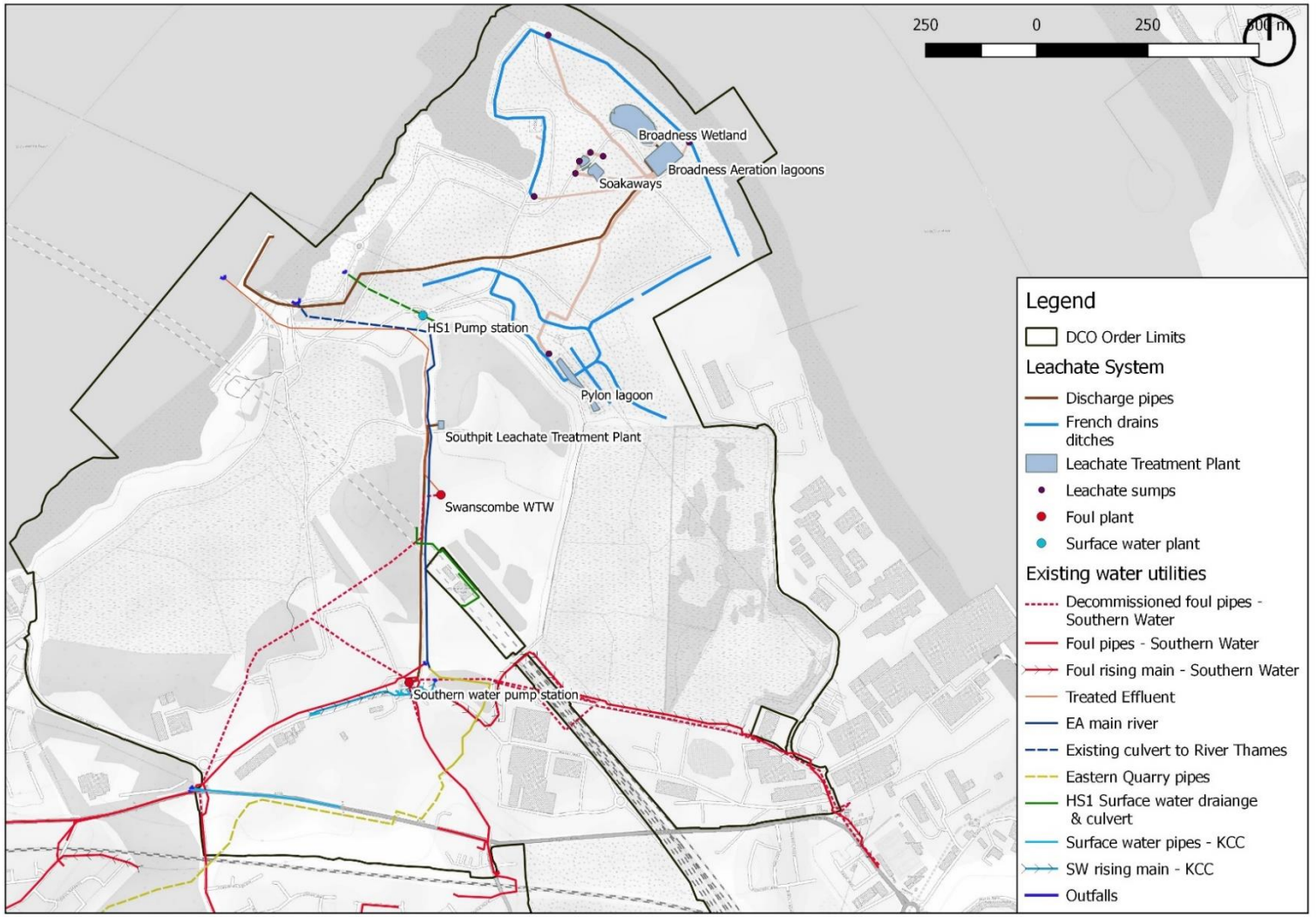

Figure 3-4: Existing utilities Kent Project Site (Main Resort) © 2020 Open Street Map imagery

3.24 Conversations are currently being undertaken with Southern Water with regard to their future plans and potential diversion of their utilities to enable the development. More information can be found in the Utilities Statement (document reference 7.6).

Kent Project Site (Access Road) *(prepared by WSP)*

Site description and levels

3.25 The Kent Project Site Access Road is proposed to link Watling Street to the London Resort Park and facilities north of Galley Hill Road (A226). The proposal includes for an upgrade of the multi-roundabout junctions to Watling Road and the south main access to Ebbsfleet International Station (A2260). A new road link is proposed between the Ebbsfleet River and the HS1A railway tracks to the east, and Southfleet Road and Stanhope Road (B259) to the west.

3.26 The Proposed Development also includes tunnels under Galley Hill Road (A226) and the Swanscombe and Northfleet railway tracks.

3.27 Based on the LiDAR survey available, the Kent Project Site (Access Road) area generally slopes from west to east with the highest point at 19.60m AOD adjacent to the junction of Watling Road and the A2260 and the lowest point at approximately 3.00m AOD in areas adjacent to Galley Hill Road (A226).

3.28 The area covering former landfill sites (located west of the proposed access, north of the access road to Ebbsfleet International Station and south of the Swanscombe and Northfleet railway tracks), includes local steep hills with levels of between 34.0m and 40.0m AOD, respectively.

Existing ground conditions

3.29 The 1:10,000 BGS geological map sheet TQ67SW (Northfleet), Solid and Drift Edition (1996) shows the geological build-up to be Made Ground underlain by the White Chalk Group.

3.30 In December 2014, Atkins undertook a Phase 1 Geo-Environmental and Geotechnical Risk Assessment reviewing the existing geology and contamination history of the former landfill areas. The report includes a review of the existing available borehole records. These former landfill sites are currently overgrown open lands that were historically used as chalk pits and have been used for licenced and un-licenced landfill.

3.31 The geology is characterised by a typical thickness of Made Ground (8.5m) Overhead Deposits (2.5m), River Terrace Deposits (2m), Boyn Hill Gravel (unknown) and White Chalk Group (>6m).

3.32 Groundwater was observed at some locations between 8.0m and 10.0m AOD. The report highlights that the depth of groundwater is variable, and groundwater was not present in most of the boreholes.

Existing sub-catchments

3.33 The Kent Project Site (Access Road) consists of the sub-catchments as shown in Figure 3-5.

3.34 The black arrows indicate the general flow directions in Figure 3-5. The existing rates of runoff from each catchment have been estimated using the IH124 method for greenfield areas.

3.35 A review of the existing elevation information available (LiDAR data) and existing land uses have identified the following existing catchments:

Table 3.2: Existing Rates of Runoff within the Access Road Site Boundary

Catchment references	Area (ha)	Existing rates (l/s)
		1 in 100
Catchment I	15.85	74.49
Catchment J	6.69	31.44
Catchment K	8.03	Site Specific
Catchment L	10.50	49.35
Catchment M	19.17	90.10
Catchment N	11.68	54.90

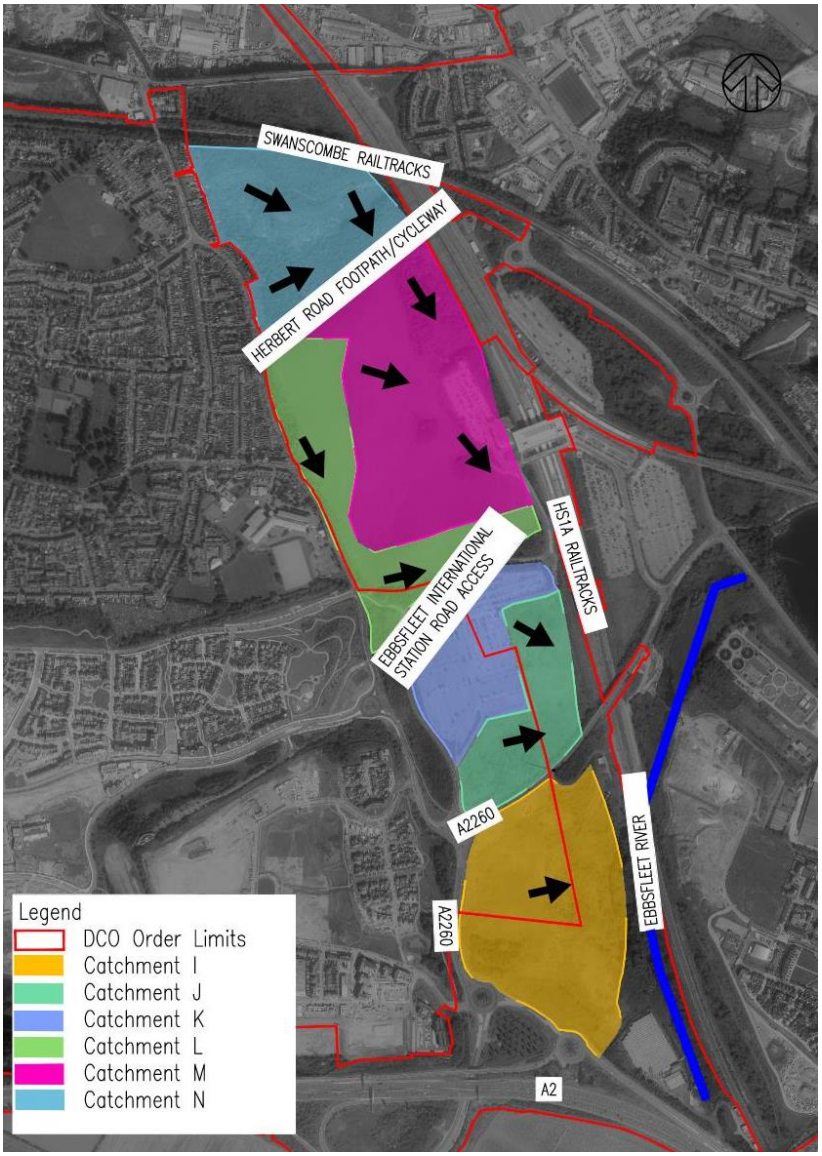

Figure 3-5: Kent Project Site (Access Road) existing catchments

Catchment 'I'

3.36 Catchment 'I' covers an area of 15.85ha and includes the area south and east of Ebbsfleet Gateway (A2260), north of Watling Street (A2) and west of Ebbsfleet River. The entire catchment is greenfield and slopes towards the Ebbsfleet River. An existing pond discharges via a culvert and headwalls to the Ebbsfleet River.

3.37 The survey information available for this catchment shows a headwall in the embankment of Ebbsfleet Gateway (A2260). This headwall appears to be associated with a recent residential development located west of Ebbsfleet Gateway (A2260). The upstream drainage connections of this catchment and the existing drainage regime of the existing pond are to be investigated and confirmed. The drainage strategy assumes that the headwall is an overflow, which is present to ensure the continuity of a potential overland flow route to Ebbsfleet River.

Catchments 'J' & 'K'

3.38 Catchments 'J' & 'K' cover the area located in between, the access road to Ebbsfleet International Station, the A2260 Ebbsfleet Gateway and HS1a rail tracks.

3.39 Catchment 'J' covers an area of 6.69ha and includes greenfield areas. The catchment is entirely greenfield and slopes towards the east. The upstream and downstream drainage connections of this catchment are still to be confirmed. Existing ditches and a culvert within the catchment are shown, but it is undetermined whether they discharge to a wider catchment downstream to the east.

3.40 Catchment 'K' covers an area of 8.03ha and includes the Ebbsfleet International Station's main car park. This catchment is brownfield and it is proposed to remain unchanged, except for its eastern part which is to receive a portion of the proposed road access. Details of the existing drainage arrangements and point of discharge for this catchment area are to be investigated further. The drainage strategy assumes that the car park drainage is attenuated on site prior to being discharged via an existing culvert under the HS1A rail tracks to Ebbsfleet River further to the east.

Catchments 'L' and 'M'

3.41 Catchments 'L' and 'M' cover the former landfill site located south of Herbert Road's footpath/cycleway and north of the access road to Ebbsfleet International Station. Both catchments are greenfield.

3.42 The landfill site is divided into two catchments separated by a crest line joining the two hills located north and south.

3.43 Catchment 'L' covers an area of 10.50ha and includes the western and southern part of the landfill site. A ditch runs along the western boundary and southern boundary of the catchment towards a low point where water is collected at an existing culvert. The details and outfall of the culvert needs to be investigated further, to confirm its existing capacity. Until this is confirmed, the drainage strategy assumes that the culvert runs under HS1A railway tracks and discharges to Ebbsfleet River further to the east.

3.44 Catchment 'M' covers an area of 19.17ha and includes the eastern part of the landfill site. Ditches run along the northern and eastern boundary of the catchment towards a low point where water is collected via twin 900mm culverts. The details and outfalls of the culverts are to be investigated. Until this is confirmed, the drainage strategy assumes that the culvert runs under HS1A railway tracks and discharges to Ebbsfleet River further to the east.

Catchment 'N'

3.45 Catchment 'N' covers the "Bamber Pit" site of 15.85ha and includes areas located south of Swanscombe/Northfleet railway tracks and north of Herbert Road's footpath/cycleway. The catchment is entirely greenfield and slopes towards Swanscombe Pond and the HS1A railway tracks to the east.

3.46 The upstream and downstream drainage connections (if any) of this catchment are to be confirmed.

3.47 It is unclear whether the pond entirely infiltrates surface water into the ground or whether an outfall connection allows the pond to discharge to a wider downstream catchment. No outfall has currently been identified, but the survey information is limited.

Existing drainage infrastructure

3.48 A review of the information available for the site confirms the presence of two ponds close to the HS1A railway tracks within the north and south part of the access road:

- Swanscombe Pond to the north located south of Swanscombe/Northfleet railway tracks and north of Herbert Road's footpath/cycleway
- An unnamed pond to the south located west of the Ebbsfleet River

3.49 A network of ditches and land drains appear to connect some sections of the existing greenfield areas which discharge towards existing culverts.

3.50 Records collected for the site confirm that part of the Ebbsfleet Gateway (A2260) crossing the site is served by a traditional highway gravity drainage system including road gullies, drains and catchpits. The outlets of the highway drainage system are to be investigated and confirmed.Highways records for most of the site including Ebbsfleet International Station are to be obtained and reviewed.

3.51 HS1A drainage infrastructure records for the section of rail tracks abutting the eastern boundary of the site are to be obtained and reviewed.

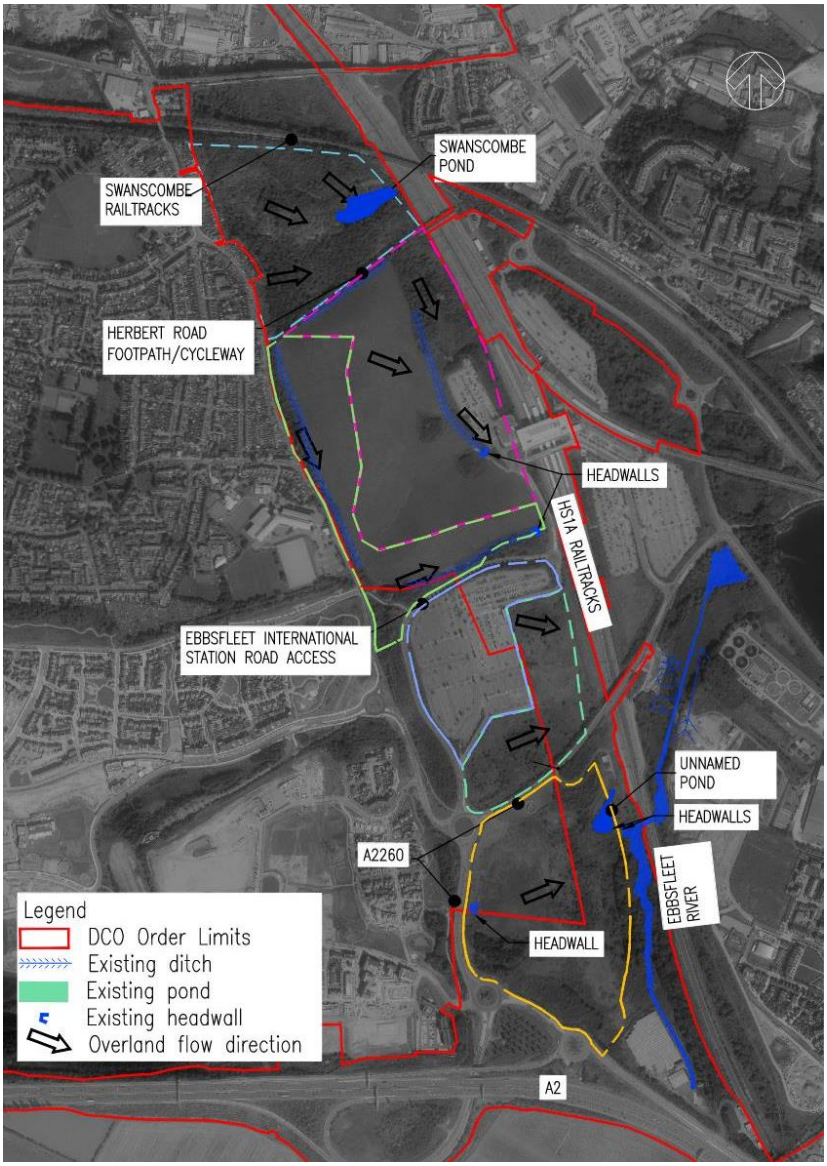

Figure 3.6: Kent Project Site (Access Road) existing drainage structures

Essex Project Site

Site description and area

3.52 The Essex Project Site is approximately 25.54 ha. It is located in Tilbury (and is a part of the Port of Tilbury), in the administrative area of Thurrock. The majority of the area is currently used as parking / storage for new cars and with a Cruise Terminal, Ferry Terminal and Passenger Landing Stage on the southern boundary adjacent to the River Thames. Along the northern boundary runs a newly constructed road linking the Port of Tilbury with the new port of Tilbury2. There is a large light industrial warehouse (Unit 1) in the approximate centre of the Essex Project Site which is excluded from the DCO Order Limits. The Essex Project Site constitutes previously developed (brownfield) land, currently all hardstanding.

Figure 3-6: Essex Project Site with DCO Order Limit (Google Maps data)

Site topography

3.53 The levels for the Tilbury Cruise Terminal pedestrian area varies between 4.3-4.7m AOD, the car parking area at the centre varies between 2-3m AOD and the new vehicles storage surface at the north varies between 1.5m-2m AOD. Flood defences along the River Thames frontage protect the area from flooding for a current day 1 in 1000 year tidal flood event. Figure 3-7 below provides spot elevations of the topography at the site, as well as the alignment of the existing flood defences.

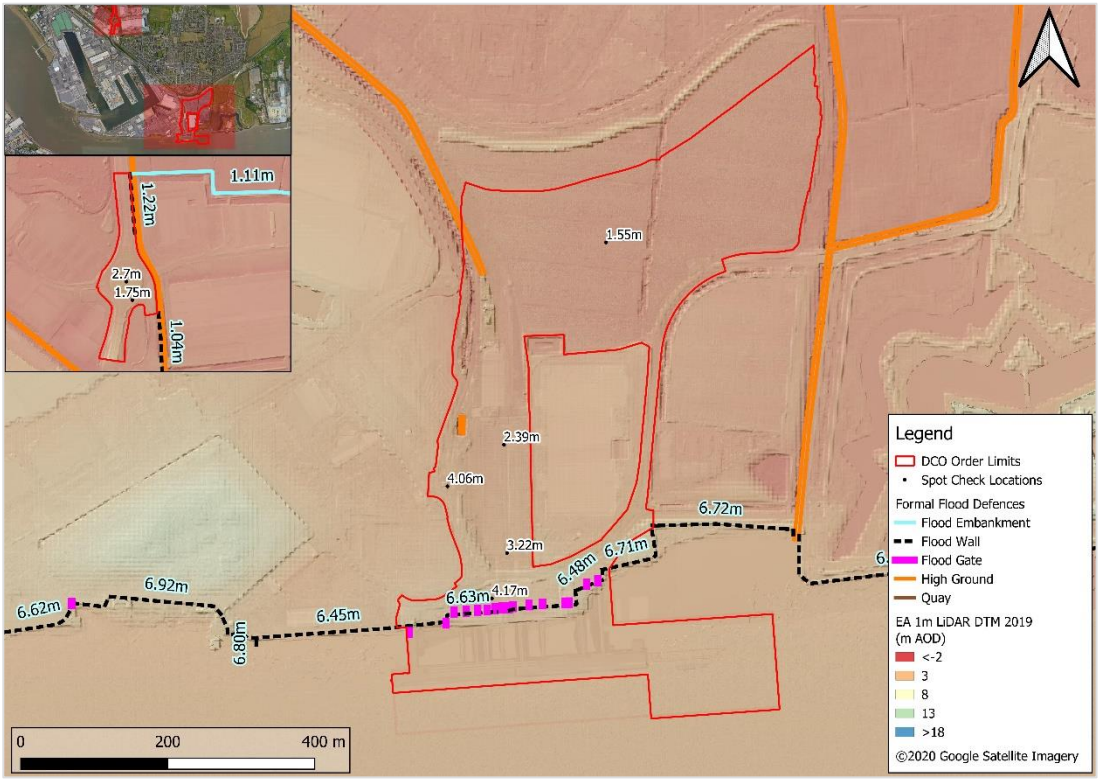

Figure 3-7 Existing flood defence alignment and crest levels taken from EA data and spot elevations of existing land levels taken from LiDAR 2019 for the Essex Project Site.

Existing ground conditions

3.54 The anticipated geology is a heterogeneous composition of Made Ground (including ash, concrete, brick, timber, flint), typically between about 1 and 3m, underlain by a natural geological sequence comprising about 15m of Alluvium (very soft to firm clays, peats and sands) over a relatively limited thickness (approximately 2 to 5m) of River Terrace Gravels. Beneath these is the Upper Chalk at about 18 to 24m bgl.

3.55 There are limited records of groundwater strikes on BGS borehole records. However, where recorded / encountered shallow groundwater ingress was generally at approximately 1 to 2m bgl in Made Ground or Alluvium. A deeper groundwater body was recorded at the top of River Terrace Deposits at approximately 16 to 17m bgl, rising to between 8 and 9m bgl, indicating sub-artesian pressures due to confinement by the overlying Alluvium. This deeper body is likely to be in continuity with the Chalk.

3.56 No infiltration tests have been carried out. Infiltration of stormwater has not been considered for the Proposed Development, due to the Essex Project Site's location next to the River Thames. As the Essex Project constitutes a brownfield site, there is potential for contaminated ground conditions.

Existing drainage infrastructure and waterbodies

3.57 An EA designated Main River crosses the Essex Project Site along the west as shown in Figure 3-8. It is the main surface water channel (East Dock Sewer) that runs down from Tilbury, along St Andrew's Road. There are known issues in respect of siltation, which can cause flooding upstream in Tilbury (information from meeting with TC, 10/07/2020). The EA have worked with ECC and Anglian Water (Partnership & Strategic Overview East Anglia: Essex, Norfolk & Suffolk) to develop the Tilbury Integrated Flood Strategy (2015) through modelling of different sources of flooding except tidal. These include surface water flooding for the 1 in 20, 100 and 1000 chance of flooding in any given year. Flood flow and level information from the above modelling have been provided as part of the EA Flood Risk Product 4 data, the model notes can be seen in Figure 3-8.

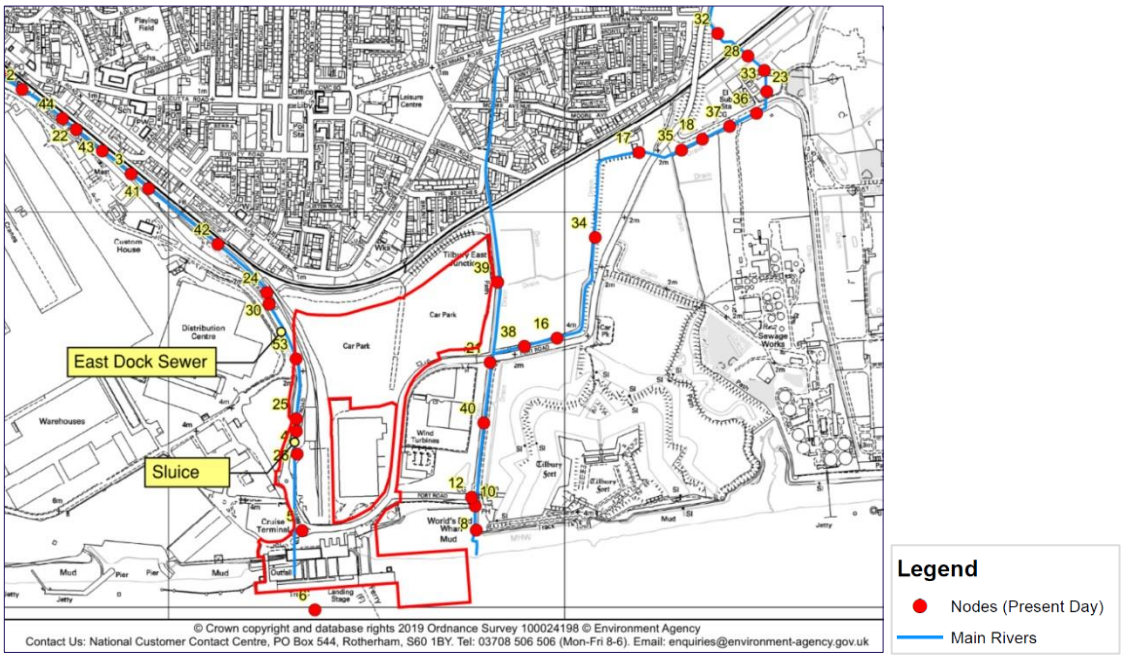

Figure 3-8: Essex Project Site - Tilbury Integrated Flood Strategy model nodes (EA Product 4, 28/07/2020)

Table 3.2: Flood levels near the development (mAOD)

Node	1 in 20 yr	1 in 100 yr	1 in 100 yr +CC	1 in 1000 yr
4	1.14	1.44	1.63	1.92

3.58 The resulting flood risk depths are shown in Figure 3-9. It is noted that the Essex Project Site is at some risk of flooding during the 1 in 100 year flood event when climate change is taken into account. The areas at flood risk are mainly around the main rivers and a swale located within the new car storage area at the north.

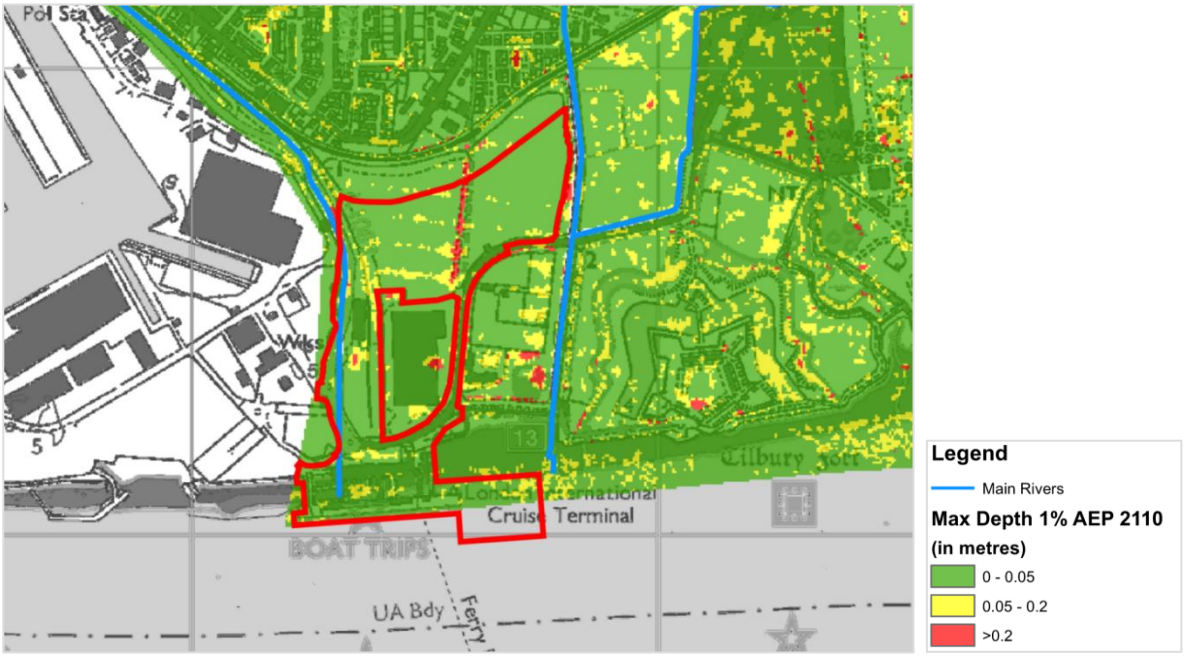

Figure 3-9: Essex Project Site - Tilbury Integrated Flood Strategy flood extents for the 1 in 100 year + Climate change (2110) (EA Product 4, 28/07/2020)

3.59 The Essex Project Site is currently served by a PoT surface water network. The network is understood to connect to the East Dock Sewer at a gravity outfall sluice. At this point the EA main river becomes culverted. The EA have indicated that due to its condition, the sluice will be sensitive to construction works in the area. The main river outfalls to the River Thames to the west of the cruise terminal (information from meeting with the EA, 23/06/2020 – refer to Meeting minutes in Appendix A~~Error! Reference source not found.~~ to this document). Figure 3-9 shows the approximate alignment of the EA Main River according to the EA asset data. The actual alignment has been confirmed to be as shown by the PoT data in Figure 3-10.

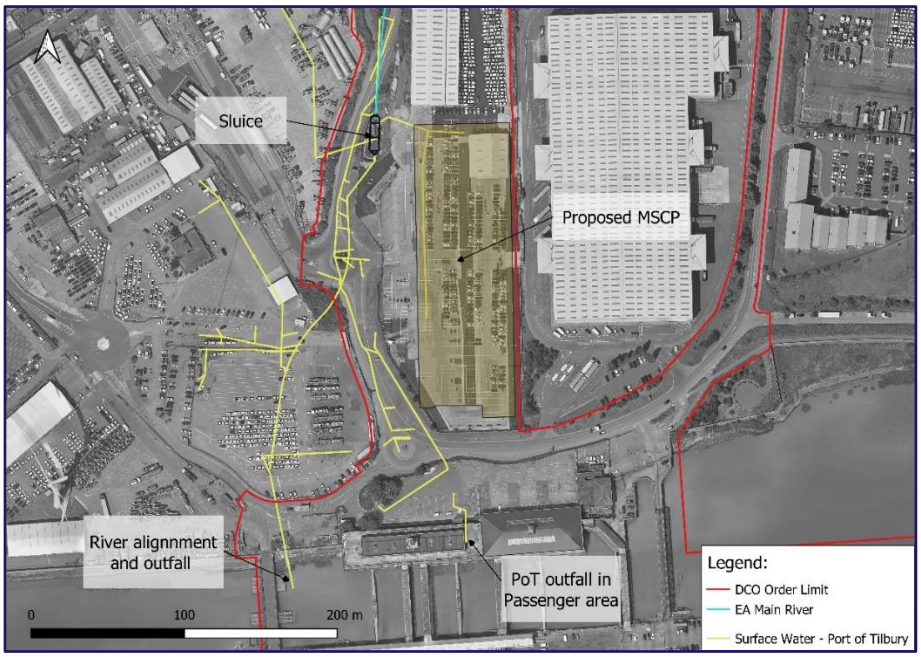

Figure 3-10: Existing drainage pipes and EA main rivers around the Essex Project Site

3.60 An existing PoT outfall is understood to be located underneath the Tilbury Cruise Terminal. Information on the size and catchment area of the outfall is not currently available.

Proposed development

3.61 The Resort will be a nationally significant visitor attraction and leisure resort, built largely on brownfield land at Swanscombe Peninsula in Kent on the south bank of the River Thames and with supporting transport and visitor reception facilities on the northern side of the river in Essex.

3.62 A detailed description of the Proposed Development is provided in chapter three of the Project ES. The focus of the Resort will be a 'Leisure Core' containing a range of events spaces, themed rides and attractions, entertainment venues, theatres and cinemas, developed in landscaped settings in two phases known as Gate One and Gate Two ('the Gates'). Outside the Gates will be a range of ancillary retail, dining and entertainment facilities in an area known as the Market.

3.63 The Resort will also include hotels, a water park connected to one of the hotels, a conference and convention centre known as a 'conferention centre', a Coliseum (capable of hosting e-Sports events), creative spaces, a transport interchange including car parking, 'back of house' service buildings, an energy centre, a wastewater treatment works and utilities required to operate the Resort. Related housing is also proposed to accommodate some of the Resort's employees.

3.64 Substantial improvements are proposed to transport infrastructure. This will include a new direct road connection from the A2(T) and a dedicated transport link between Ebbsfleet International Station, the Resort and a passenger ferry terminal beyond. The ferry terminal would serve visitors arriving by ferry on the River Thames from central London and Tilbury. A coach station is also proposed. On the northern side of the Thames to the east of the Port of Tilbury, additional coach and car parking and a passenger ferry terminal are proposed to serve the Resort.

3.65 The Proposed Development would involve an extensive restoration of land used in the past for mineral extraction, waste disposal and industrial activities including cement and paper production, with a comprehensive landscape strategy proposed incorporating the retention and enhancement of wildlife habitats.

Chapter Four ◆ Proposed Strategy

Overview

4.1 The proposed surface water drainage design has been prepared in accordance with the drainage hierarchy identified in the NPPF Planning Practice Guidance, the guidance in the C753 SuDS Manual (CIRIA, 2015), the guidance in the KCC Drainage and Planning Policy (KCC, Deceber 2019), the Sustainable Drainage Systems – Design Guide (ECC, 2016) and advice provided during consultations with the key consultees.

Strategic objectives

4.2 The proposed surface water drainage strategy for the Project Site will be designed to:

- Protect against flooding on the Project Site for the critical storm events, as agreed with the EA and the LLFA;
- Collect and convey surface water away from developed areas in a safe and controlled manner;
- Provide measures to improve the quality of run-off, where contamination could occur, prior to discharge;
- Be sustainable and maintainable;
- Be appropriate for and compliment a developed, landmark urban space; and
- Ensure structural integrity over the duration of the development design life.

Sustainable Drainage Systems

4.3 In order to protect the receiving waters and the local ecology, SuDS will be incorporated across the Project Site to minimise the risk of pollution to the water environment and create habitat. SuDS are used to mimic more natural processes to convey surface water away from a development. They can beneficially:

- manage runoff flow rates;
- protect or enhance water quality;
- be sympathetic to the environmental setting;
- provide a habitat for wildlife; and
- encourage natural groundwater recharge, where appropriate.

4.4 Surface water runoff will be captured from roads, pavements, car parks and roofs. An assessment of the land uses and associated hazard classification with regard to contamination will be carried out, in line with the CIRIA C753 SuDS Manual and other international best practice. Silt, sediment, hydrocarbons and other contaminants from runoff will be reduced through SuDS Systems. Surface water will be treated through an appropriate treatment train, depending on the hazard classification of the surface water runoff and the sensitivity of the receiving water. The surface water strategy for the Project Site will also include opportunities for biodiversity enhancements and increased amenity. The SuDS options proposed for each the Kent Project Site (Main Resort), Kent Project Site (Access Road) and Essex Project Site are presented under each sub-section.

4.5 Rainwater can be filtered and reused for irrigation or other non-potable uses within the Proposed Development. The collection and storage of rainwater for later use within the buildings will be developed during the detailed design stage for each of the individual buildings. For the purpose of this surface water drainage design, it has been assumed that no rainfall is reused within the Proposed Development, to represent the most conservative scenario in terms of managing flows off site.

Kent Project Site (Main Resort)

Drainage hierarchy

4.6 The design of the proposed surface water drainage strategy for the application site will follow the hierarchy for surface water drainage discharge as follows:

1. Discharge to a watercourse or the sea – The Kent Project Site (Main Resort) is adjacent to the tidally influenced River Thames. As such, discharge directly to the river is the preferred option. Following discussion with the EA, it has been agreed that the surface water can be discharged, unrestricted, to the River Thames. This is common practice for developments adjacent to tidally influenced rivers, especially when located at the downstream end of the river catchment. The majority of the surface water runoff from the Kent Project Site is therefore proposed to be discharged directly to the River Thames.
2. Discharge to the ground via infiltration – The majority of the Kent Project Site (Main Resort) has been historically used as landfill and is contaminated with CKD. Infiltration of the surface water could mobilise pollutants to the groundwater table and cause contamination of the underlying aquifers. Infiltration techniques will be restricted to areas of low groundwater contamination risk and good infiltration potential, such as the Related Housing (staff accommodation) and infrastructure compounds to the south of the Kent Project Site (Main Resort).
3. Discharge to existing drainage infrastructure – Currently there is very limited drainage infrastructure within the Kent Project Site (Main Resort). The nature and location of the site allows for discharge to a watercourse to be utilised. Discharge of surface water to any existing infrastructure has been discounted.

Basis of design and assumptions

4.7 The surface water management strategy will incorporate the following design criteria. Agreement to these criteria with key stakeholders has been reached during previous consultations, refer to Section 0:

- The surface water runoff will be discharged to the River Thames at an unrestricted rate;
- Local drainage system such as the network pipes/swales will be designed for the 1 in 1-year rainfall event;
- No above ground flooding of the system for the 1 in 30 year with 40% allowance for climate change;
- No flooding of buildings for up to the 1 in 100 year with 40% CC. Above ground flooding in controlled areas is acceptable;
- Measures to improve the quality of run-off prior to discharge will by incorporated through SuDS where possible;
- An operation and maintenance strategy will be provided during design development;
- The impact of the tide lock scenarios presented in the matrix below as agreed with KCC (11/08/2020), will be considered to ensure flood risk to the Kent Project Site (Main Resort) is not increased for the different scenarios.

Table 4.1: Tide-locked scenarios assessed

Rainfall Event	**River Water Levels**		
	No restriction (low tide)	MHWS	1:200 year water level 2090 Higher Central (HC) allowance
1 in 1 year	Yes	Yes	Yes
1 in 30 year	Yes	Yes	No
1 in 100 year + climate change	Yes	Yes	No

4.8 Therefore, in addition to the above, the system will be tested for the following:

- No flooding of buildings for up to the 1 in 1-year storm event combined with the 1 in 200 year tidal water level 2090 Higher Central (HC) allowance.
- No flooding of buildings for up to the 1 in 100 year with 40% allowance for climate change (up to 2115), combined with MHWS.

Proposed Surface Water Management Strategy

4.9 The Proposed Development will include a considerable proportion of the Kent Project Site (Main Resort) area becoming impermeable surface, to avoid infiltration and mobilisation of contaminants within the existing ground. This could increase the flood risk from overland flow to the Kent Project Site (Main Resort) and offsite areas compared to existing if not appropriately designed. The risk may also increase in the future due to projected increase in rainfall intensity and sea level rise causing more tide-locked scenarios than currently experienced.

4.10 The key principles of the surface water management strategy for the Kent Project Site (Main Resort) are summarised as follows:

- A surface water gravity network (pipes or dry lined swales where possible) collects rainfall runoff from the buildings and impermeable surfaces;
- Runoff is discharged to the two existing marsh areas (Botany Marsh and Black Duck Marsh) and a new constructed wetland proposed at the north of Gate One, via outfalls with non-return valves where required;
- A perimeter dry lined swale will collect, treat and convey water from the perimeter access road to the marsh areas and constructed wetland via outfalls with non-return valves;
- The two marshes and new constructed wetland will act as attenuation areas of surface water during tide-locked conditions. New outfalls from the marsh areas and wetland to River Thames will discharge surface water runoff unrestricted when the tide is low;
- Ecological monitoring of the wetlands pre and post development will be put in place to ensure the water levels within the marsh areas support the intended habitats. Discharge outfalls from the marshes to the Thames will include manual flow/level controls to adjust water levels within the marshes as required;
- The new constructed wetland at the north has been sized for the tide lock scenario. A new 280m culvert is proposed from the constructed wetland to the River Thames northwest of the Principal Development to allow discharge of the flows from Gate One and the wetland;
- The Related Housing (staff accommodation) and infrastructure compounds are located on areas with good infiltration potential and low levels of contamination. These areas are proposed to drain via infiltration; and
- Flows to the existing Swanscombe channel (Main River) are anticipated to be reduced significantly due to the Eastern Quarry diversion of flows. The channel will be diverted to Black Duck Marsh along Pilgrims Way and will collect flows from adjacent catchments as well as any flows from outside the Kent Project Site.

4.11 The proposed catchments and above principles are demonstrated in Figure 4-1. The strategy is described in more detail in the following sections. The drainage strategy for the Kent Project Site (Main Resort) is also illustrated in the Drainage Strategy Plans (document reference 2.17).

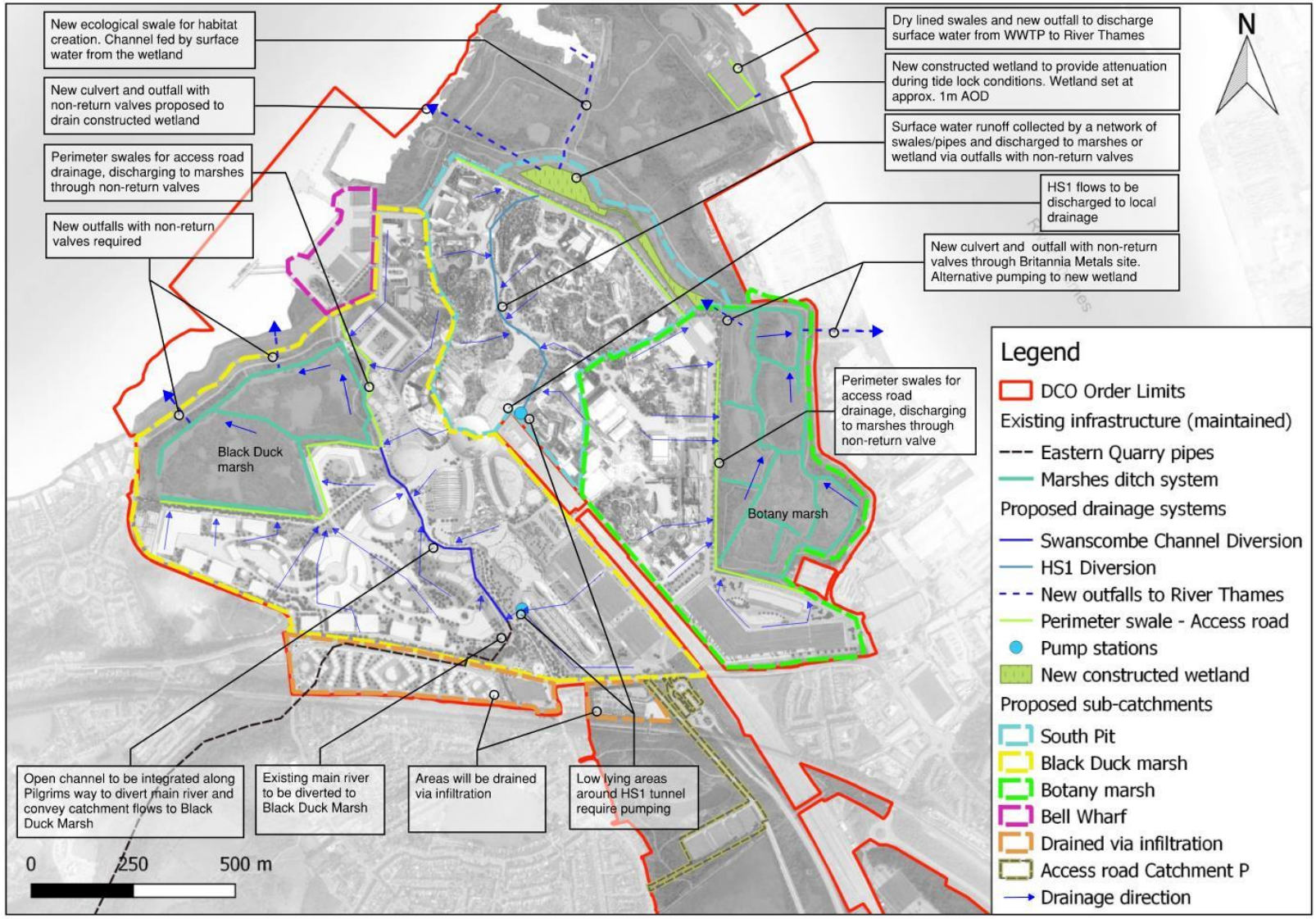

Figure 4-1: Proposed drainage strategy for Kent Project Site (Main Resort)

Local drainage

4.12 As far as practicable, a positive drainage system will be utilised to collect rainfall runoff through a network of open lined swales and piped system if required, reducing maintenance requirements. Underground tanks and pumped systems are avoided where possible.

4.13 The drainage network will be designed for the 1 in 1-year event, with no above ground flooding for up to the 1 in 30 year event +40%CC. It will collect the surface water runoff from roofs and impermeable areas and discharge to swales/pipes. The swales/pipes will outfall to dedicated areas within the three marsh areas: the existing Black Duck and Botany Marshes and the constructed wetland at the north part of Gate One. A perimeter swale will collect, treat and convey surface water runoff from the perimeter access road before discharging to the marshes. All swales will be lined to avoid transmission of contaminants to the ground.

4.14 Areas around the HS1 box tunnel are currently at relatively lower levels than the surrounding areas and marshes. They are also farthest away from the existing marshes. As such, positive drainage from these areas to the marshes is not possible and underground attenuation and pumping are proposed, as indicated in Figure 4-1.

4.15 For events greater than the 1 in 30 year +40%CC, landscaping of the development and dedicated areas for overground temporary ponding will ensure that buildings and users of the Resort are safe during such events.

Operation of marshes

4.16 It is understood that the marsh habitats have changed over the years due to changes in land management practices. Salinity levels within the marshes have been reported as increasing. As such, the current habitat conditions are not necessarily considered the optimum conditions for the existing flora and fauna and an increase in water in the marshes may provide a preferred condition. Certain protected species exist within the marshes that will need to be protected when the Resort is in place.

4.17 The existing overland/known discharge regimes to the Botany and Black Duck Marshes will be preserved where possible. The discharge rates and volumes of surface water runoff from the Proposed Development to the marshes will increase compared to existing due to changes to the sub-catchments and increase in impermeable areas. Table 4.2 lists the existing and proposed sub-catchment areas and resulting surface water runoff from each for the 1 in 100 year flood event. It should be noted that both existing and proposed conditions comprise of a combination of greenfield and brownfield areas. As agreed with the EA and KCC, runoff from the Proposed Development will discharge to the River Thames unrestricted.

Table 4.2: Existing and proposed runoff rates to River Thames from sub-catchment areas (excludes flows from Swanscombe channel)

Sub-Catchment	Catchment area (ha)			Unrestricted runoff rates for the 1 in 100 year flood event (l/s)		Proposed location of discharge
	Existing	Proposed	Increase (%)	Existing	Proposed	
South Pit	65.1	32.4	-32.7 (-50%)	4,560	10,065	River Thames via new constructed wetland
Botany Marsh	28.1	43.0	14.9 (53%)	2,165	9,210	River Thames via Botany Marsh
Black Duck Marsh	62.3	76.5	14.3(23%)	4,440	21,390	River Thames via Black Duck Marsh
Bell Wharf	2.4	4.2	1.8 (75%)	53	1,510	Directly to River Thames
Infiltration areas (Related Housing and infrastructure compound)	1.3	8.5	N/A	50	N/A	Infiltration
Broadness Marsh	41.5	36.4	5.1 (12%)	180	160	River Thames via leachate treatment as appropriate

4.18 In order to ensure that the Kent Project Site (Main Resort) is not at increased risk from flooding, tide-locked conditions will be considered as part of design development. The marshes will be used to act as temporary storage areas during tide-locked conditions and are the preferred option over attenuation tanks, as long as this remains ecologically appropriate.

4.19 The outfalls to the River Thames from the marsh areas and the new constructed wetland are proposed to have their invert levels sitting between 1.5m AOD and 2m AOD. The cover level of the culvert depends on the size of each culvert and vary at each location. Based on approximate invert levels of the outfalls, the marshes will therefore be at tide-locked condition for approximately 4hrs as shown in Figure 4-2.

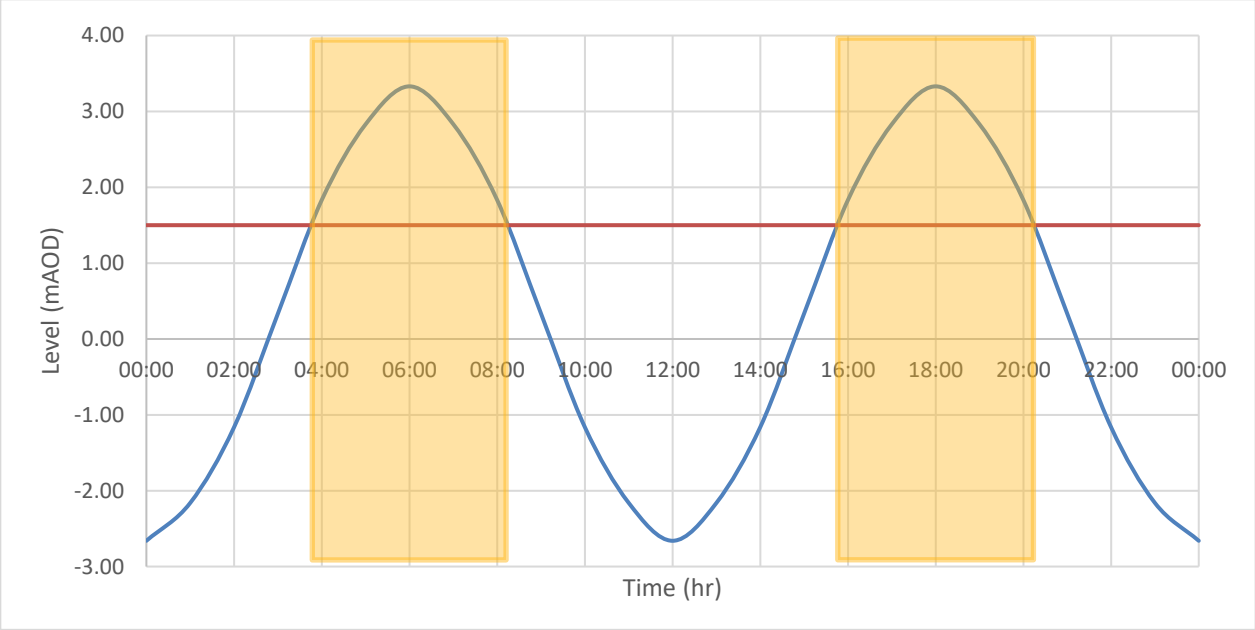

Figure 4-2: Predicted spring tides at Kent Project Site (Main Resort). Times when outfalls are predicted to be at tide-locked condition shown in orange shade.

4.20 An assessment of the approximate volume generated by the sub-catchments during the tide-locked scenario has been undertaken. This assessment is done for both the existing and proposed sub-catchments for comparison during a 1 in 100 year 4-hour storm duration with 40% allowance for climate change. The volumes in each marsh area are shown in Table 4.3. These have been estimated using an adjusted version of the long-term storage volume calculation method provided in Kellagher (2013), described below:

- Volumes from greenfield areas: Vol = RD*area*10*SPR
- Volumes from brownfield areas: Vol = RD*area*10*(PIMP/100)

4.21 Where RD is the rainfall depth for the 4-hr storm event, SPR is the index for the SOIL (proportion of runoff from pervious areas) and PIMP is the impermeable areas as a percentage of the total area. A value of 0.8 is usually applied to the PIMP factor; as the majority of the site is proposed to be lined to prevent any infiltration and contaminant transport, a conservative assumption of 100% runoff has been taken (PIMP value of 1.0).

4.22 The calculations assume no discharge of surface water to the River Thames during the 4-hr storm. The depth calculated below is the average depth of surface water ponding across the entire marsh areas. This will respond to the topography of the marshes, with higher water depths at depressions and low or no water at other locations.

Table 4.3: Surface water volumes to the marsh areas during a 4-hr storm event (1 in 2 and 1 in 30 year events)

Marsh areas	**Catchment area (ha)**		**Volume of runoff – 1 in 2 year event (m3)**			**Volume of runoff – 1 in 30 year event (m3)**		
	Existing	Proposed	Existing	Proposed	Maximum depth (m)	Existing	Proposed	Maximum Depth (m)
South Pit (new constructed wetland)	65.1	32.4	6,175	6,455	0.25	15,310	12,800	0.5
Botany Marsh	28.1	43.0	2,725	6,750	0.05	6,755	16,730	0.1
Black Duck Marsh	62.3	76.5	5,940	14,220	0.1	14,720	35,240	0.2

Table 4.4: Surface water volumes to the marsh areas during a 4-hr storm event (1 in 100 and 1 in 100 + 40%CC year events)

Marsh areas	**Catchment area (ha)**		**Volume of runoff – 1 in 100 year event (m3)**			**Volume of runoff – 1 in 100 year event +40% CC (m3)**		
	Existing	Proposed	Existing	Proposed	Maximum depth (m)	Existing	Proposed	Maximum Depth (m)
South Pit (new constructed wetland)	65.1	32.4	20,820	21,760	0.8	29,145	30,465	1.2
Botany marsh	28.1	43.0	9,190	22,760	0.15	12,860	31,860	0.2
Black Duck Marsh	62.3	76.5	20,025	47,930	0.3	28,035	67,105	0.4

4.23 The outfalls from the development site to the marshes and from the marshes/constructed wetland to the River Thames will incorporate measures to prevent scour of marshes/river such as concrete aprons, gabion matts or other solutions that suit each setting and discharge conditions. The water levels within the marshes are proposed to be managed to ensure no deterioration of habitat. Discharge outfalls from Black Duck Marsh and Botany Marsh to the Thames will include manual flow/level controls (such as a sluice gates) to adjust water levels within the marshes as required as part of the Ecological Mitigation and Management Framework (document reference 6.2.12.3) for the marshes. The outfalls will have non-return valves to protect the Kent Project Site (Main Resort) from tidal flooding.

4.24 The groundwater/permanent water levels within the marsh areas are not known at this stage. It is considered that there is enough capacity within the areas above any permanent water levels to accommodate the additional volumes during tide-locked conditions. Water level monitoring will be undertaken at the next stage of design.

South Pit sub-catchment

4.25 Surface water from the Gate One area will be collected through a positive swale/piped network where possible. The swales will convey the flows to a new proposed constructed wetland to the north of Gate One via outfalls with non-return valves. A perimeter swale adjacent to the access road will collect, treat and convey surface water runoff from the road to the wetland. Areas adjacent to HS1 tunnel are currently proposed at lower levels to tie in with the levels of the existing tunnel. As such, a piped collection system and pump station are required at this area to collect and pump surface water to the local swale network.

4.26 The new constructed wetland is proposed at the north of the South Pit catchment. The primary purpose of the wetland is to deliver ecological benefits to the Proposed Development, as well as water treatment and stormwater attenuation for the South Pit catchment during a tide-locked scenario. The wetland is proposed to be excavated from 5m AOD down to a level of approximately 0.5-1.5m AOD (levels to be confirmed during design development).

4.27 The existing gravity and HS1 pumped culverts are proposed to be decommissioned subject to agreement with HS1, as they are reaching the end of their design life and have known siltation issues. Flows from HS1 are proposed to be diverted to the local drainage system and discharged to the constructed wetland.

4.28 A new, 290m long outfall will discharge surface water from the new constructed wetland to the River Thames. The culvert will be located from east to west, as shown in Figure 4-3. The invert level of the outfall is currently set at approximately 2m AOD and the size of it is approximately of 1m diameter. The outfall will have a non-return valve to protect the Proposed Development from high tidal levels. A long section of the new pipe is shown in Figure 4-4. During design development, the culvert will be designed to ensure the drain down time of the wetland is within the window between two tide-locked conditions (approximately 8hrs).

4.29 There is an aspiration to enhance the ecological benefits within Broadness Marsh. As such, a new 250m long ecological channel is proposed between the wetland and the River Thames (Bay area) on a south to north direction. The purpose of the channel is to provide additional opportunities for habitat and amenity, as well as act as an overflow from the constructed wetland to the Bay. The channel will be mainly fed by surface water from the wetland via gravity or pumping and is proposed to be lined to avoid contamination. The function of the channel as a main discharge point from the wetland to the river (and in place of the culvert) or as a back-up overflow will be decided during design development, in light of additional topographic survey data at the Bay location. The design of the channel will include 2 sets of non-return valves to protect the site from high tides and will ensure that the flood defences along Broadness marsh are not compromised.

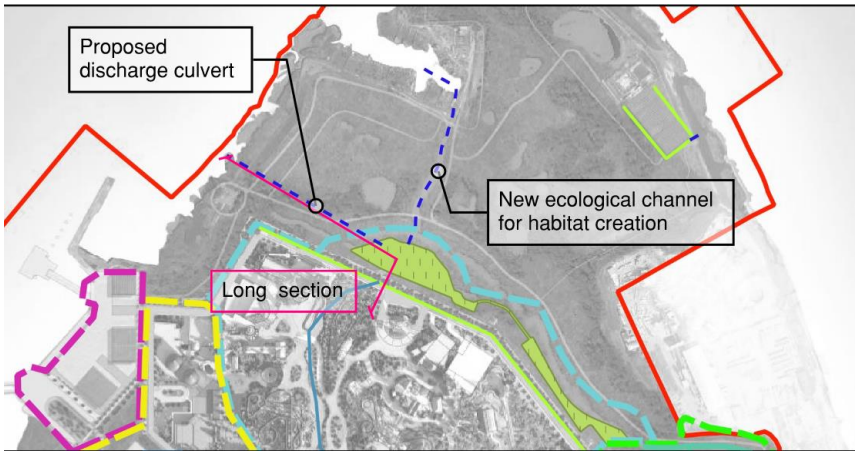

Figure 4-3: Location of long section Kent Project Site (Main Resort)

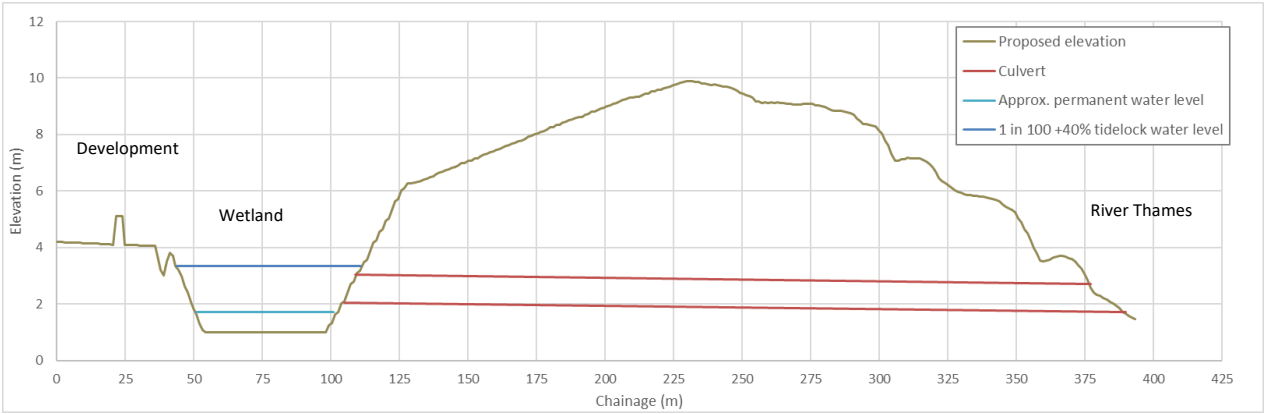

Figure 4-4: Long section through edge of development, new constructed wetland and new culvert and outfall

Botany Marsh area

4.30 Surface water from the Gate One area and back-of-house facilities will be collected through a positive swale/piped network where possible. The swales will convey the flows to the marsh via outfalls with non-return valves. A perimeter swale adjacent to the access road will collect, treat and convey surface water runoff to the marsh.

4.31 During an extreme tidal event, the flood defences along River Thames east of Botany Marsh will be overtopped (please refer to the Flood Risk Assessment, document reference 6.2.17.1). Due to the Proposed Development, the extents and depths of flooding within Botany Marsh during such an event will increase. The design will ensure that there is enough capacity within the marsh to accommodate the increased flood depths during the extreme tidal overtopping event without imposing risk of flooding to the Proposed Development or other properties, as well as providing attenuation volumes to accommodate a stormwater flood event (approximate depths from stormwater are shown in Table 4.3). Discharge from offsite areas to Botany Marsh (specifically from Britannia Metals) will be maintained to ensure no flood risk impact on third parties.

4.32 It is proposed that a ditch network and lowered areas for ponding are created within the Botany Marsh to provide habitat enhancement and create water vole mitigation areas. Parts of the marsh will therefore be excavated to create this habitat. Surface water will be stored in these depressions during tide-locked conditions. It is therefore important to ensure the right amount of water is discharged and maintained in Botany Marsh to enable this habitat creation. Ecological monitoring will be undertaken pre- and post-construction and water levels adjusted in response to ecological requirements. An illustrative cross section between Gate One and Botany Marsh is shown in Figure 4-5.

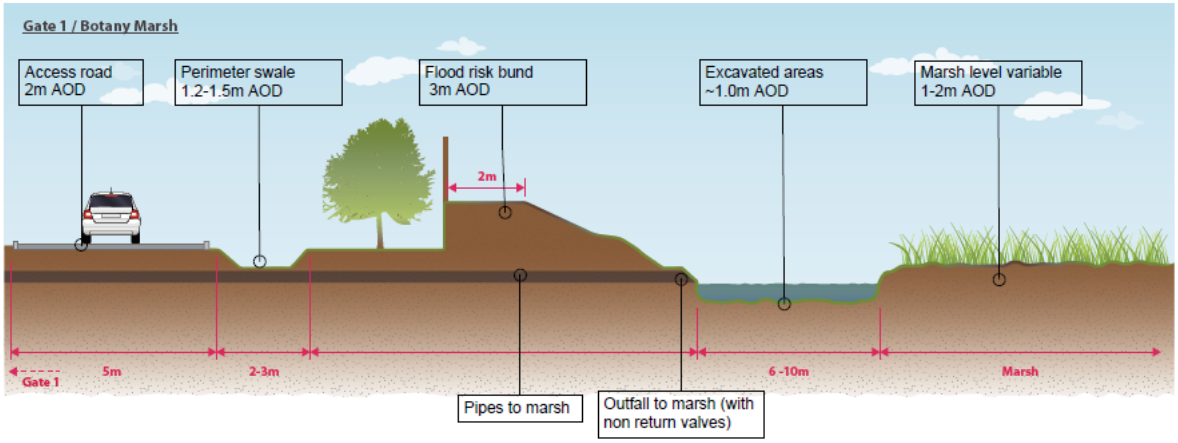

Figure 4-5: Illustrative section through Botany Marsh

4.33 Ecological connectivity with the constructed wetland to the north is proposed via a perimeter ditch proposed within Botany Marsh. Two options are being considered for the discharge of surface and tidal water from Botany Marsh. The first is for a gravity outfall with a non-return valve to be laid from Botany Marsh to the River Thames through Britannia Metals land (located east of the marsh, see Figure 4-1). The outfall will allow discharge of water following tidal or surface water flooding at a controlled level to achieve the ecological objectives. Alternatively, if agreement with Britannia Metals is not achieves, the attenuated water within Botany Marsh can be discharged either via gravity or pumped to the constructed wetland at the north of Gate One. If water from Botany Marsh is discharged to the new constructed wetland, the design of the wetland and outfall from the wetland to the River Thames will be adjusted in size to allow for additional flows.

Black Duck Marsh sub-catchment

4.34 Similar to the system in the Gate One area, the surface water from the Gate Two area will be collected through a positive piped network or swales where possible. As there is no flood risk bund proposed within the Gate Two area, the opportunity to use swales instead of pipes to convey flows to the marshes will be maximised. The swales will discharge surface water runoff to the marsh via outfalls with non-return valves. A perimeter swale adjacent to the access road will collect, treat and convey surface water runoff to the marsh. The swale will be designed to allow water to weir over its banks to the marsh during exceedance events without imposing risk of flooding to the Gate Two development.

4.35 The London Resort Passenger Terminal consists of podium levels and lower formation levels currently proposed at 3m AOD to tie in with the existing HS1 tunnel levels. The area is located adjacent to the HS1 tunnel and further away from Black Duck Marsh. As such, a piped collection system and pump station are required to collect and pump surface water from the low-lying area to the diverted Swanscombe channel (see Section on the diversion of Swanscombe channel below).

4.36 A section of the proposed access road included in the Kent Project Site (Access Road) area falls towards the Black Duck Marsh sub-catchment within the Kent Project Site (Main Resort). This area has been separated out as catchment ‘P’ and also includes the proposed infrastructure buildings and associated car park and vehicular access located adjacent to the Swanscombe pond. Runoff to the Kent Project Site (Main Resort) will be attenuated/treated via the use of a wetland, underground crates and restricted with a flow control system discharging at a total discharge runoff of 10 l/s. The surface water runoff will eventually discharge to Black Duck Marsh via the new Swanscombe Channel diversion. Please refer to section 0 for more information on catchment ‘P’.

4.37 Due to the large size of the Black Duck Marsh, the water levels are not expected to increase significantly following development, despite the increase in water volumes discharged to the marsh. Similar to Botany Marsh, ecological monitoring will be undertaken pre- and post-construction and water levels adjusted in response to ecological requirements. Two new gravity outfalls with non-return valves are proposed to allow discharge of water from the marsh to the river; flexibility will be designed into the system to allow adjustment of the water levels of the marshes post-construction and operation.

4.38 The design of the outfalls will be in accordance to the principles described under Section 0 (Basis of design and assumptions) and will be progressed further during design development.

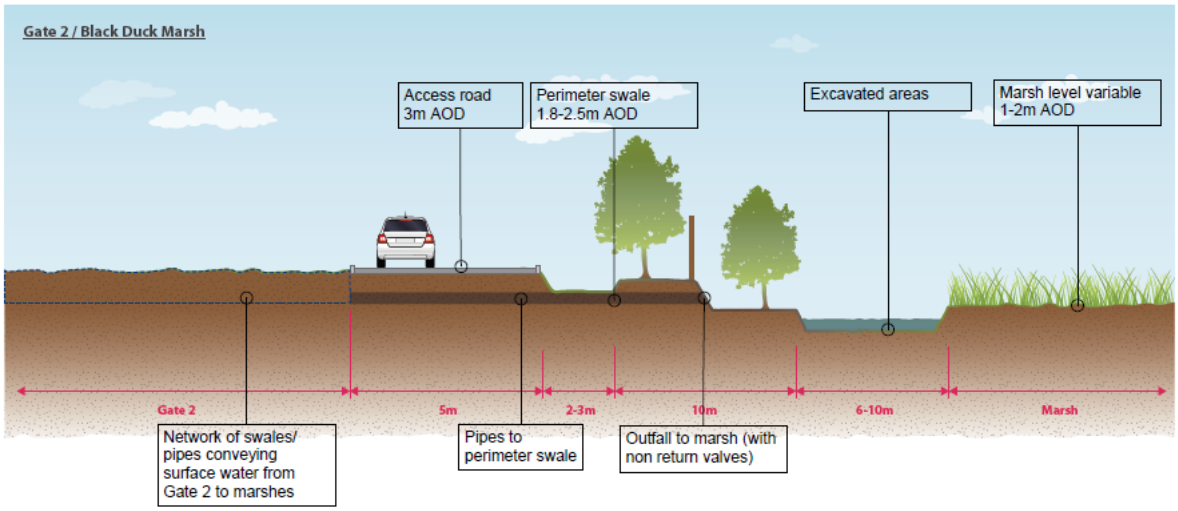

Figure 4-6: Illustrative section through Black Duck Marsh

Diversion of Swanscombe channel

4.39 The Swanscombe channel (*EA Main River*) is a man-made channel that currently conveys flows from the Eastern Quarry dewatering, HS1 tunnel drainage, surface water from Manor Way and local surface water catchments. When the Eastern Quarry flows are diverted around the Kent Project Site (Main Resort), the flows to the channel will be significantly reduced. Attempts have been made to determine other discharge operations to the site and potential inflows to the Swanscombe channel through the latest CCTV surveys. However, the survey had to be abandoned due to restricted access.

4.40 The channel is proposed to be diverted to Black Duck Marsh, as shown in Figure 4-1, with the existing channel infilled. The new proposed channel will be created as an open water body, with minimum pumping and culverted sections. The alignment of the channel will follow Pilgrims Way, allowing access for maintenance to the channel.

4.41 The channel is proposed to take the form of a two stage channel, with a low flow channel to convey the dewatering flows from Eastern Quarry and a higher flow channel to convey surface water flows from surrounding areas within the Black Duck Marsh sub-catchment during high intensity rainfall events. A 5m clear strip for maintenance access will be provided from at least one side.

4.42 Preliminary sizing of the diversion channel is shown in Table 4.5. The shape and size of the channel will be reviewed again against other design considerations during design development.

Table 4.5: Swanscombe channel diversion preliminary sizing

Channel stages	Carrying capacity	Flows	Preliminary sizing
Low flow channel	Daily flows (Eastern Quarry)	260 l/s	Base/Top width: 0.6m / 0.75m Side slope: 1:1.5 Depth: 0.5
High flow channel	1 in 100 year + 40% CC	12,000 l/s	Base/Top width: 3m / 9m Side slope: 1:3 Depth: 1m

4.43 Flows from the HS1 tunnel and any other existing discharge operations that would normally discharge via the Swanscombe channel are proposed to be diverted to the local drainage system and discharged to the new constructed wetland or Botany Marsh, subject to detailed design of the ground levels. Provisions will be put in place to ensure no flood risk impact on third parties.

Broadness Marsh sub-catchment

4.44 The proposals within the Broadness marsh area include a new Wastewater Treatment Plant at the northeast of the area, upgrade of the Leachate Treatment Plant (LTP) facility and creation of ponds for attenuation of surface water and leachate (see further information below) and landscaping (new drainage channel and new constructed wetland).

4.45 The WWTP has an approximate area of 0.55ha (currently sized as 50mx110m). It is proposed that surface water runoff from the WWTP is collected and conveyed to River Thames via an open dry swale (lined). The surface water will be discharged to the river unrestricted. Vertical scour protection is proposed at the outfall location to create a cascading discharge to the River Thames. Alternatively, discharge can be done via a manhole and outfall at lower level.

Leachate treatment

4.46 There are two existing leachate treatment plants (LTP) that serve the Broadness and South Pit areas. Further investigations of the existing system are planned and these (together with consideration of the planned development) will inform the detailed design of the new and improved leachate collection, management and treatment system. Currently it is anticipated that the LTP at the Broadness Marsh area will be adapted and upgraded to increase its treatment capacity. The conveyance channels around the Broadness area are proposed to be formalised and enlarged to capture the leachate and surface water runoff. The flows will be conveyed to open lined detention ponds within and pumped to the upgraded LTP. The existing leachate effluent discharge pipe discharging to White's Jetty can be maintained but diverted across the new proposed channel (under crossings).

4.47 The LTP currently located within the South Pit area will be relocated to enable the Proposed Development. The most appropriate location for the plant and the required treatment levels will be considered during design development, including the option of pumping the leachate from the South Pit area to the upgraded Broadness Marsh LTP.

Infiltration areas

4.48 The proposed Related Housing (staff accommodation), staff training facility and infrastructure compounds are located over areas with good infiltration potential (chalk quarry) and low contamination levels. It is therefore proposed that these areas are drained via infiltration. This can take the form of soakaways, infiltration basins, permeable pavements and raingardens.

4.49 A hydrogeological risk assessment carried out in January 2011 was reviewed to evaluate the infiltration potential of the site. Data from boreholes at nearby locations have been used (PBGW1 is approximately 500m from the Related Housing (staff accommodation) and 85m from infrastructure compound). A 10m depth of grey discoloured chalk was found (between 1m and 10m) at the level where a soakaway/infiltration basin would sit. This is considered to provide adequate surrounding infiltration. The average in-situ permeability test results for PBGW1 are recorded to be $2.47x10^{4}$ m/s.

4.50 As part of the site investigations, permeability tests should be undertaken at the locations where infiltration measures are proposed. This should be done as per recommendations included in BRE Digest 365 for Soakaway design. The infiltration rates should be used to size the infiltration basins, soakaways or other infiltration feature during design development. Groundwater measurements and, if possible, long-term monitoring shall be undertaken to establish the level of the groundwater table.

4.51 The soakaways shall be designed in accordance with BRE Digest 365. As good practice, soakaways shall be placed 5m away from building foundation or the boundary (as a conservative approach, set 10m from building foundations when located over chalk strata) and 1m above the water table.

4.52 Figure 4-7 demonstrates the generic structure of a crate soakaway and clearance required from a building edge.

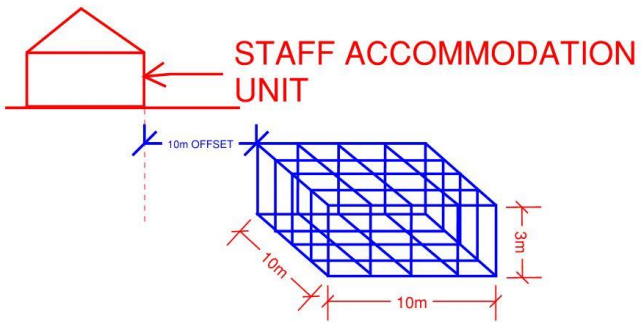

Figure 4-7: Sketch of crate soakaway structure

4.53 The staff training facility is proposed on the chalk spine, at an elevation of 30m AOD. This is 20m higher than the adjacent Related Housing area, which is proposed within the chalk pit at approximately 10m AOD). If the chalk is fractured, there is a risk that the water infiltrating at the chalk spine could seep out to the pit from the vertical face and impose risk of flooding to the Related Housing. Borehole investigations within the chalk spine area shall be undertaken to assess this risk.

Pollution control

4.54 In order to prevent the mobilisation of existing contaminants to groundwater, infiltration measures will not be incorporated in the design where contaminated land is recorded. Open drainage systems such as swales will be appropriately lined. Surface water runoff from the Proposed Development will be treated before discharge to the River Thames. The new constructed wetland area will be designed to treat surface water runoff before discharge to the River Thames.

4.55 An assessment of the proposed land uses and associated hazard classifications with regard to contamination has been carried out. Solutions have been proposed based on an assessment using the guidance outlined in the CIRIA C753 SuDS Manual.

4.56 The hazards associated with each land use have been classified in accordance with Table 26.2 of the CIRIA SuDS Manual. The hazard classifications and allocations identified are listed in Table 4.6.

Table 4.6: Summary of pollution hazards and proposed treatment for Kent Project Site (Main Resort)

Catchments within Kent Project Site (Main Resort)	Land Use Type	Pollution Hazard	Proposed Treatment
South Pit Catchment	Other Non-residential Roof	Low	Green roofs where possible Dry swale network (lined) if levels permit Wetland (New Constructed Wetland)
	Low Traffic Access Road	Low	Dry perimeter swale (lined) Wetland (New Constructed Wetland)
Botany Marsh catchment	Other Non-residential Roof	Low	Green roofs where possible

			Dry swale network (lined) if levels permit Wetland (Botany Marsh)
	Low Traffic Road	Low	Dry perimeter swale (lined) Wetland (Botany Marsh)
Black Duck Marsh catchment	Residential Roofs	Very Low	Green roofs where possible Dry swale network (lined) if levels permit Wetland (Black Duck Marsh)
	Other Non-residential Roofs	Low	Green roofs where possible Dry swale network (lined) if levels permit Wetland (Black Duck Marsh)
	Low Traffic Road	Low	Dry perimeter swale (lined) Wetland (Black Duck Marsh)
	Multi-Storey Car Park (with roof)	Low	Green roofs where possible Dry swale network (lined) if levels permit Wetland (Black Duck Marsh)
	Vehicle washing facilities (roofed)	Low	Rainwater: Dry swale network (lined) if levels permit Wetland (Black Duck Marsh) Wash-bays: Foul system
Broadness marsh	WWTP Roof	Low	Dry swale (lined)
Infiltration catchment	Residential Roof (Related Housing)	Very Low	Green roofs where possible Infiltration via soakaways or infiltration basins if space allows
	Low Traffic Car Park	Low	Permeable paving Infiltration via soakaways or infiltration basins if space allows
	Low Traffic Access Road	Low	• Permeable paving • Infiltration via soakaways or infiltration basins if space allows
Bell Wharf	Other Non-residential Roof	Low	• Dry swale network (lined) if levels permit

	Low Traffic Access Road	Low	• Permeable paving

Further considerations for design development

4.57 During the next stage of design, the viability and use of additional SuDS, such as bioretention areas or tree pits and potential reuse of water through rainwater harvesting will be investigated. Ecological monitoring of the marshes and monitoring of the water levels will inform the drainage design. A topographic survey of the marshes will provide more accurate information and allow a detailed assessment and modelling of the tide-locked conditions. Further CCTV surveys might be undertaken to resolve outstanding unknowns as required, in areas where permission was restricted. Finally, the proposed network, marsh attenuation systems and outfalls to the River Thames will be included in an integrated model to refine the surface water drainage design.

Kent Project Site (Access Road) *(prepared by WSP)*

Drainage hierarchy

4.58 The design of the proposed surface water drainage strategy for the application site will follow the principles described in the CIRIA SuDS manual, particularly the hierarchy for surface water drainage discharge. The hierarchy is as follows:

1. Infiltration to ground via an adequate soakaway or soil infiltration system - Preliminary information reviewed for the southern part of the Kent Project Site (Access Road) suggests the presence of a chalk substrata likely to be suitable for infiltration to the ground. This will need to be checked via soakaway tests at detailed design. For the purpose of this drainage strategy, infiltration has been used as the primary means to dispose of surface water from the site. A robust infiltration rate of 1.10^{-5} m/s has been used for soakaways structures and ponds.
2. Discharge to a watercourse - Ebbsfleet River is located along the south east boundary of the Kent Project Site (Access Road). It is proposed that attenuated flows and overflows exceeding the capacity of the proposed highway drainage system discharge to this watercourse via the use of a new headwall.
3. Discharge to a sewer - There is evidence of headwalls and culverts being used as outfalls to the existing ponds and land drainage located along the HS1A rail tracks. The routing and details of those structures are still to be investigated. The drainage strategy has been developed assuming that the purpose of these land drainage connections can be maintained. Until further information becomes available, the existing culverts will not be used to connect the proposed highway drainage.

Basis of design and assumptions

4.59 The design principles listed below have been followed in regard to the hydraulic performance of the project's drainage system:

- Local drainage system such as network pipes will be designed not to surcharge for the 1 in 2-year rainfall event;
- No above ground flooding of the system for the 1 in 30 year event;
- Proposed run-off rates not to exceed existing for the respective 1 in 2 year and 1 in 100 year events plus 40% climate change;
- The Government's Flood Risk Assessments: climate change allowances guidance states that for peak rainfall intensity, which has been applied in the surface water drainage design for the Proposed Development, both the central and upper end allowances should be considered in order to understand the range of impacts that may occur as a result of climate change. Over 25 years, these allowances are 10% and 20% respectively. Over 100 years, they are 20% and 40% respectively. Refer to https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. This drainage strategy allows for a climate change allowance of 40%; and
- The Kent Project Site (Access Road) will discharge at greenfield runoff rates to Ebbsfleet River (subject to confirmation from the EA).

Proposed surface water management strategy

4.60 The main elements of the proposed drainage strategy for the Kent Project Site (Access Road) are shown on a set of Highways Drainage Plans (document reference 2.15) and summarised below. It should be noted that the letter referencing for existing and proposed catchments is different as the catchments change. Existing catchments described in Section 0 include catchment I, J, K, L, M & N. The proposed catchments described below include catchments A, B, C, D, E, F, G, H and P.

Catchments 'E', 'F' & 'G':

4.61 It has been identified that some sections of the new highway junction are likely to be too low to connect to the rest of the site access drainage by gravity, and so will be dealt with in isolation from the main access road drainage network.

4.62 Surface water flows from catchments 'E', 'F' & 'G' are to be collected via traditional gullies and catchpits that outfall into dedicated highway soakaways.

4.63 The soakaways shall be designed in accordance with BRE Digest 365 or CIRIA156, as applicable.

Table 4.6: MicroDrainage Results and Proposed Sizing

Catchment Reference	Area	Size for 1 in 100 Year Flood Event (+40% CC)
E	0.146ha	Six 2.4mdia x 3 m deep, 2.1 pit multiplier
F	0.079ha	Four 2.4mdia x 3 m deep, 2.1 pit multiplier
G	0.166ha	Two 2.4mdia x 3 m deep, 2.1 pit multiplier

Catchments 'A', 'B', 'C'.

4.64 It is proposed that the highway drainage associated with these catchments discharge to infiltration ponds that will be interconnected via drainage connections acting as overflow systems. The ultimate point of discharge of the overflow system is the proposed attenuation system of Catchment 'D'.

Table 4.7: MicroDrainage Results and Proposed Sizing

Catchment Reference	Area	Maximum Discharge for 1 in 100 Year (+40% CC)	Volume Required (*)
A	0.657ha	0 l/s	795m^3
B & C	0.805ha & 0.355ha	0 l/s	1,400m^3

* The volumes include an allowance of 10% to allow for land drainage and verges draining to highway.

Catchment 'D'.

4.65 The land available for Catchment 'D' is limited to the extent of the proposed highway and road embankments only. This reduces the SuDS options that are available to attenuate and treat the highway runoff. In addition, this catchment is to receive overflow connections from Catchments 'A', 'B' and 'C', and flows coming from Catchment 'H' pumping station.

4.66 It is proposed that flows are attenuated via concrete box culverts under the proposed highway and flow controls prior to discharging at greenfield runoff rates to Ebbsfleet River (running along the south east boundary of the site). Where possible, additional water quality improvement systems will be introduced at detailed design.

4.67 Ebbsfleet River is a main river, and approval from the Environment Agency will be required to obtain a discharge consent.

Table 4.8: MicroDrainage Results and Proposed Sizing

Catchment Reference	Area	Maximum Discharge for 1 in 100 Year (+40% CC)	Volume Required (*)
D	1.723ha(catch D) +5.627ha(catch H)	74.49 l/s	6,635m^3

** The volumes include an allowance of 10% to allow for land drainage and verges draining to highway.*

4.68 The proposed access road is crossing an existing pond, which is proposed to be relocated "like-for-like "adjacent to its current location. The drainage regime and connections associated with this pond are to be investigated and reviewed at detailed design.

Catchments 'H'

4.69 Review of the available information and levels for the proposed highway do not identify a point of discharge by gravity to the northern section of the highway access. It is proposed that surface water flows are pumped via a rising main to infiltration pond 'D', located just upstream of the proposed outfall to Ebbsfleet River. Storage is required to attenuate the flows that are limited by the pump in extreme events.

4.70 The catchment includes the redevelopment of Ebbsfleet International Car Park F which is served by an existing drainage system. These existing connections will be investigated at detailed design stage, and if opportunities arise for a gravity connection then the pumping station may be replaced/reduced by adding a traditional gravity flow control and attenuation drainage system.

4.71 The proposed highway access is crossing Swanscombe pond which is proposed to be relocated "like-for-like" adjacent to its current location. There is no record available for any pond outfalls. The drainage regime and connections associated with the pond are to be investigated and reviewed at detailed design.

Table 4.8: MicroDrainage Results and Proposed Sizing

Catchment Reference	Area	Nominal Pump Discharge & Full Discharge Regime	Volume Required (*)
H	5.627ha	50 l/s & 150 l/s	4,590m^3

** The volumes include an allowance of 10% to allow for land drainage and verges draining to highway.*

Catchment 'P'

4.72 A section of the proposed access road and people mover route falls toward the Kent Project Site (Main Resort). This catchment also includes the proposed infrastructure buildings and associated car park and vehicular access located adjacent to the Swanscombe pond.

4.73 Surface water from the new buildings is to be attenuated onsite via underground storage (such as the use of a porous sub-base) and discharged at 5 l/s to the catchment 'P' highway drainage system. Flows are to be restricted to 5 l/s which is the minimum practical minimum discharge that can be achieved via a vortex flow control without risk of blockage.

4.74 Catchment 'P' highway drainage will include traditional road gullies, catchpits and carrier drain system. Runoff to the Kent Project Site (Main Resort) will be attenuated/treated via the use of a wetland, underground crates and restricted with a flow control system discharging at a total discharge runoff of 10 l/s. The surface water runoff will eventually discharge to Black Duck Marsh via the new Swanscombe Channel diversion. Please refer to section 0 above.

4.75 Due to the history of this part of the Kent Project Site (Access Road) being used for landfill activities, it is proposed to tank the attenuation storage rather than infiltrate. Should future investigations prove infiltration to be feasible at this location without risking mobilisation of contaminants, then this will be included as preferable, in accordance with the drainage hierarchy.

Table 4.9: MicroDrainage Results and Proposed Sizing

Catchment Reference	Area	Maximum Discharge for 1 in 100 year (+40% CC)	Volume Required (*)
P	2.619ha	10.0 l/s	2,205m3 (Infra building) 1,089m^3 (Highway)

** The volumes include an allowance of 10% to allow for land drainage and verges draining to highway.*

Pollution control

4.76 The stormwater draining from the Kent Project Site (Access Road) must also be assessed and improved with regard to water quality, biodiversity and amenity. In accordance with CIRIA SuDS Manual (C753) Simple Index Approach, surface water from the Kent Project Site (Access Road) should be treated based on the pollution hazard level associated with the land use. See the table below for suggested SuDS. Highway drainage systems will require the use of bypass separators (or similar) to be located at strategic locations prior to flows infiltrating to the ground and/or discharging to Ebbsfleet River. It is proposed that the ponds are landscaped to include shallow vegetation such as reedbeds (wetland) to treat potential pollution from the highway. It is also proposed that shallow highway swales combined with tanked filter drains are incorporated into the drainage system where possible, to provide further treatment stages. The overflow connections interlinking the ponds will include pollution control valves to ensure that extreme pollution incidents can be contained with minimal risk to the wider drainage network.

Table 4.9: Suggested SuDS for Kent Project Site (Access Road) based on land use

Location	Land Use Type	Pollution Hazard	Proposed Treatment
Main Road Access Site	All roads except low flow traffic roads and trunk roads/motorways	Medium	• Pond & shallow swales/tanked filter drains • Bypass separators, such as the Downstream Defender or Conder System

Essex Project Site

Drainage hierarchy

4.77 The design of the proposed surface water drainage strategy for the Essex Project Site will follow the principles described in the CIRIA SuDS manual, particularly the hierarchy for surface water drainage discharge. The hierarchy is as follows:

1. Discharge to a watercourse or the sea – due to close proximity to the River Thames, discharge to a watercourse has been chosen as the most appropriate solution.
2. Discharge to the ground via infiltration – The Essex Project Site is currently brownfield with industrial history, and could potentially be contaminated. At this stage, infiltration has been discarded as a potential drainage solution.
3. Discharge to existing drainage infrastructure – The site currently drains to the East Dock Sewer, known to have siltation issues and cause flooding to Tilbury. The Essex Project Site is proposed to be disconnected from the existing drainage system and discharge to the River Thames via a separate outfall.

Basis of design and assumptions

4.78 The following design principles have been discussed and agreed with the EA and ECC, in regard to the hydraulic performance of the Proposed Development's drainage system.

- Local drainage system such as the network pipes will be designed for the 1 in 1 year rainfall event;
- No above ground flooding of the system for the 1 in 30 year with 40% allowance for climate change;
- No flooding of buildings for up to the 1 in 100 year with 40% CC. Above ground flooding in controlled areas is acceptable;
- The Essex Project Site will discharge unrestricted to the River Thames, based on consultation with the EA and ECC;
- Connection of the drainage system to the East Dock Sewer to be avoided as it currently causes flood risk issues in Tilbury;
- No flooding of buildings for the tide-locked scenario for the more critical of the two following combined evets:
    - 1 in 5 year +40% CC rainfall event with the 1 in 200 year tidal event (2090 HC allowance); and
    - 1 in 100 year +40% CC rainfall event coinciding with 1 in 20 year (2090 HC allowance) tidal levels.
- The above criterion is in line with the ECC Sustainable Drainage System Design Guide (ECC, April 2016); and
- The network is modelled to demonstrate that the proposed surface water drainage strategy does not increase flooding to the Essex Project Site or other sites due to the increase in impermeable areas.

Proposed surface water management strategy

4.79 The type of drainage systems considered suitable for the Essex Project Site are driven by the physical characteristics of the area, the density of development and site-specific constraints, allowable discharge rates and outfall invert levels. The site area available for development is limited and opportunities for open water bodies are not considered applicable to the Proposed Development. The infiltration potential of the location and the contamination levels are currently unknown; infiltration systems have therefore been discarded at this stage.

4.80 It is proposed that the drainage pipes serving the area of the proposed MSCP and connecting to the EA Main River are made redundant to reduce the existing fluvial flood issues at Tilbury.

4.81 A new pipe will be constructed to convey flows from the MSCP building and the visitor plaza to the River Thames. If the existing PoT outfall is considered appropriate for use, the new pipe will be connected to it. Alternatively, a new outfall will be required.

4.82 Green/brown roofs at the MSCP and permeable pavement at the visitor plaza are proposed for pollution control (see following sections). Attenuation will be integrated near the MSCP building and underneath the permeable pavement to accommodate surface water runoff during the tide-locked scenarios.

4.83 No changes are anticipated to the vehicle storage surface at the north part of the area within the Order Limits.

4.84 See Figure 4-9 for plan of proposed surface water management strategy.

Tide-lock scenario modelling

4.85 A MicroDrainage model has been built to assess the effectiveness of the proposed strategy against the tide-locked scenarios. Both scenarios have been tested:

- 1 in 5 year +40% rainfall event with the 1 in 200 year (2090 HC) tidal event; and
- 1 in 100 year +40% rainfall event coinciding with 1 in 20 year (2090 HC) tidal levels.

4.86 The 1 in 100 year +40% rainfall event coinciding with 1 in 20 year (2090) tidal levels has been used as the tide-locked scenario to design attenuation being the design storm event (DSE), as it represents the more critical scenario. The estimated volume of attenuation required for the water from the MSCP roof for the DSE tide-locked condition is **675m^3**, in addition to **430m^3** attenuation through permeable pavement underneath the visitor plaza. These values will be updated as the proposals develop further. Infiltration has not been allowed; further verification of any infiltration potential will follow at the next stage of design.

4.87 As any connection from the MSCP building site to the River Thames must be capable of adapting to climate change, a non-return valve type structure will be installed. This will be constructed to take a full tidal loading head, with at least two lines of defence. This will take the form of a flap-valve at the outlet and a non-return valve upstream in the system.

4.88 The MicroDrainage input parameters are listed below:

- FSR rainfall data
- Storm return period: 1 in 100 year + 40% climate change
- Tide-locked scenario: 1 in 20 year 2090 HC
- Total drained/impermeable area: 1.58ha
- Peak surface water discharge rate: Unrestricted to the River Thames

4.89 Figure 4-8 shows the tidal curve used for the MicroDrainage model with a duration of 2015 minutes, a timestep of 5 minutes and an offset of 100 minutes to ensure a tide-locked scenario coinciding with the peak of the design rainfall event.

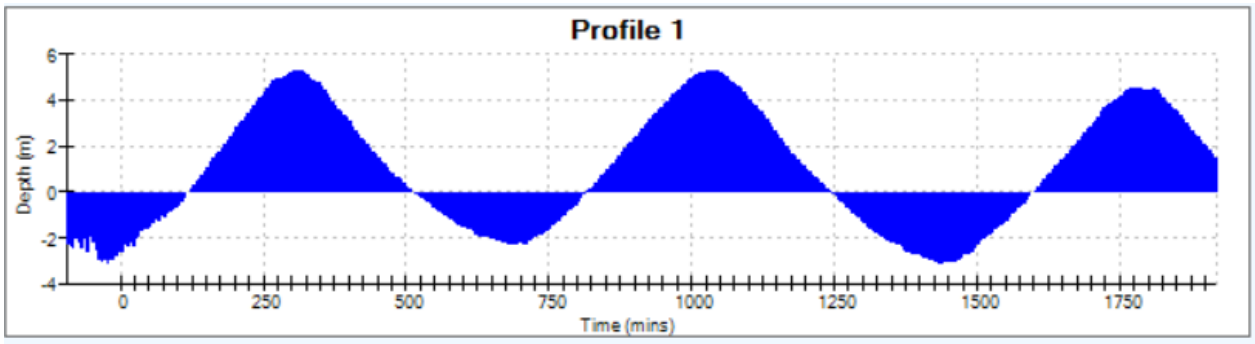

Figure 4-8: Tidal curve used for MicroDrainge model

4.90 An outfall shall be constructed underneath the Tilbury Cruise Terminal. This can be a new outfall or can be incorporated with the existing PoT outfall. The required outfall is approximately 675mm diameter. The size of the pipes, attenuation and outfall will be finalised during design development.

Pollution control

4.91 The stormwater draining from the Essex Project Site must also be assessed and improved upon in regard to water quality. In accordance with CIRIA SuDS Manual (C753) Simple Index Approach, surface water from the Essex Project Site should be treated based on the pollution hazard level associated with the land use. See the below table for suggested SuDS.

Table 4.7: Suggested SuDS based on land use

Catchments within Essex Project Site	Land Use Type	Pollution Hazard	Proposed Treatment
Roof of MSCP	Other Non-residential Roof	Low	• Green/brown roof
Pedestrian Plaza	Pedestrian area	Low	• Permeable Pavement
Internal roads	Delivery areas and commercial yard	Medium	• Permeable Pavement • Mechanical separators (bypass separator or full retention separator), for example the Downstream Defender produced by Hydro International

4.92 The detailed design will consider the potential viability and use of additional SuDS, such as bioretention.

4.93 See Figure 4-9 for a plan showing the location of the proposed SuDS for the Essex Project Site.

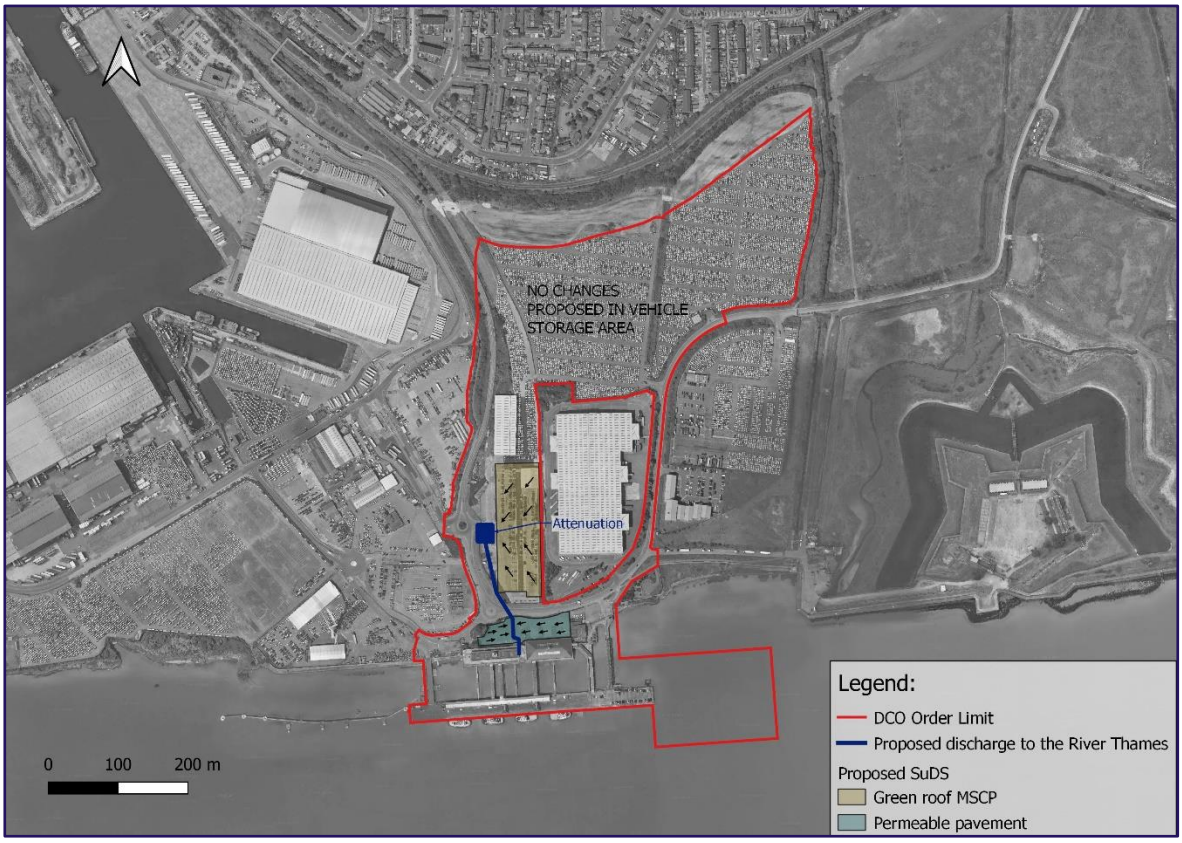

Figure 4-9: Plan showing proposed location of SuDS for the Essex Project Site

4.94 Examples of relevant SuDS proposed for the Essex Project Site are shown below:

Figure 4-10: Geo-cellular attenuation tank/soakaway

Figure 4-11: Green/blue roofs

Figure 4-12: Permeable paving

Further consideration for design development

4.95 The detailed design will consider the potential viability and use of SuDS measures shown in Figure 4-10, Figure 4-11, and Figure 4-12, and additional potential measures such as bioretention areas or tree pits and potential reuse of water through rainwater harvesting. If it can be proven not to have a detrimental impact on pluvial flood risk for the Essex Project Site and surrounding areas, reference will be made to EA guidance on climate change allowances for outfall conditions to the Thames tidal estuary, for consideration of a possible relaxation over current Essex SuDS Design requirements. Provisions will be made for the full tide-locked scenario and evidence provided that the drainage system half drains down within 24 hours for the 1 in 30 year return period, to allow capacity for a follow up 1 in 10 year return period storm. Any relevant third-party agreements must be secured to discharge to the Thames tidal estuary.

Responses to stakeholder comments

Consultations have been undertaken with key stakeholders as described in Section 3. Their comments and how they have been addressed are shown in

4.96 Table 4.8.

Table 4.8: Comments from the relevant Local Authority stakeholders

Stakeholder	Comment	Design response
KCC	Unrestricted discharge to the river is acceptable. The following tidelock scenarios should be considered in the design process: 1 in 1 year storm event combined with the 1 in 200 year 2090 tidal level; 1 in 100 year storm event + climate change combined with current MHWS.	Scenarios have been considered during the design process and will form the basis of design of the strategy.
	A mechanism shall be put in place to ensure the level of inundation of the marsh areas is acceptable to the marsh habitats and the impact on ecology.	Ecological monitoring will be put in place to ensure the water levels in the marshes are not damaging to the marsh habitat.
	Land drainage consents will be required for culverting or infilling of ordinary watercourses and sufficient offset for access and maintenance is required for any retained watercourses	Noted.
	Natural systems of treating surface water runoff (SuDS) will be prioritised.	Open swales, wetlands and green/brown roofs are being proposed.
ECC	For next stage of design: Use of additional SuDS and Source Control features such as Rainwater Harvesting, Rain Gardens, Bio retention areas, SuDS Tree Planters etc. to provide additional amenity and bio-diversity value.	Noted - efforts will be made throughout the design process.
	For next stage of design: Provisions to be made for the full tide-lock scenario and evidence provided that the drainage system half drains down within 24hrs for the 1 in 30 year return period, to allow capacity for a follow up 1 in 10 year return period storm.	Noted
	For next stage of design: Any third-party agreements being secured to discharge to the Thames tidal estuary.	Noted
TC	Reference should be made to the Thurrock Local Flood Risk Management Strategy (2015) within the	Nearest AoCD is Tilbury. Site will

	FRA to identify any Areas of Critical Drainage (AoCD) that might be impacted by the proposed development.	disconnect from the drainage system and shall alleviate some of the risk.

4.97 A preliminary drainage strategy for the Project Site was issued to the EA for their comments as part of pre-application consultations (Flood Risk Management Strategy design note - 0042936_LR_BUR_DCO_FRM_1004). This document has now been superseded by this Surface Water Drainage Strategy. The EA comments and how they have been addressed through this drainage strategy are included in Table 4.9.

Table 4.9: EA comments on the preliminary drainage strategy and responses

Area	EA comments	Design response
Kent Project Site (Main Resort) – Existing Conditions	There is acknowledgement that there is likely to be silt present in the culverts draining the main river into the Thames Estuary, however, there is only reference to a CCTV survey of this culvert. Based on recent experience (which we can share), the CCTV had to be abandoned after a short distance and although there are two manholes, they are very difficult to use due to their size. Therefore we need to understand if any provision is being made to assess the silt volume in the structure before a CCTV inspection is carried out.	CCTV survey undertaken from both sides of the culverts. Both these culverts will be abandoned as part of the proposed drainage strategy.
	Tide locked conditions: there is no information on what the plan is for gravity outfalls that will become submerged in the future as a result of sea level rise.	Tide-locked scenarios are considered for the design of the new constructed wetland and will be considered as part of the detailed drainage design for the sizing of the outfalls. The scenarios have been agreed with the EA and KCC as described under Basis of design and include allowances for climate change.
	We do not believe the illustration of the 'Ordinary watercourse-culverted' is a formal culvert, unless the Developer could provide some	Noted, the connection between Black Duck Marsh and River Thames is still an unknown. The drainage strategy proposes the

	further information to support this. We think it is possible that this has been mistaken for drainage discharge points which are sumps within the valley of the two embankments which drain through the revetment and are flapped.	construction of new outfalls to the River Thames from Black Duck Marsh, unless existing outfalls are identified and considered suitable for use.
Kent Project Site (Main Resort) - Proposed surface water management strategy	Free flowing fluvial channels with naturalised margins and vegetated buffer strips should be incorporated.	Open lined swales will be incorporated as part of the local collection system and perimeter swale, where possible.
	The discharge culverts to the River Thames need to be proven to have a lifetime no less than that of the development (100-years), and to have sufficient discharge capacity and how sediment build up and trash will be managed.	See note above about tide-locked scenario assessment. Management of the sediment built up at the outfalls will be considered during design development, see section 0.
	This mentions the construction of new outfalls. It is not clear whether the existing culverts are to continue to be maintained or whether the drainage assessment is excluding these and the new outfalls will then be responsible for the drainage of the site into the estuary. If the existing culverts are not required as part of the development, there will be a requirement to decommission these assets. If they are to remain, we will need to understand what works will be undertaken to them, as there are known siltation issues and they are nearing end of life.	Preferably, the existing culverts will be decommissioned, as they are reaching the end of their design life. This is subject to agreement with HS1. The new outfalls will discharge the surface water runoff from the new constructed wetland, incorporating second non-return valves.
	Increased rainfall intensities due to climate change should be considered in the drainage strategy as well as consideration of impact of groundwater.	Allowance for a 40% increase in climate change has been made.
	Pollution control measures to ensure water quality in receiving water bodies is not reduced but ideally improved is welcomed int the storm water drainage strategy.	Pollution control measures such as lined swales, wetland areas and green roofs have been incorporated in the design.

	Scour at the foreshore or undermining of structures should be considered for any new or existing stormwater outfall structures.	Scour protection measures will be put in place at outfalls locations in the marshes or River Thames as necessary.
	Remedial works to the existing culvert linking the open channels to the River Thames would be required if remaining within the strategy.	The existing culverts between South Pit and River Thames are towards the end of their design life. They are not intended to be used and will be decommissioned, subject to agreement with HS1.
	Secondary non-return valves would be required for any outfall greater than 300mm diameter to reduce the risk of secondary flooding. The volume and criteria for tide lock conditions needs to be considered.	Secondary non-return valves are proposed for outfalls.
Essex Project Site – Proposed surface water drainage strategy	Any connection from the MSCP building site to the River Thames must be capable of adapting to climate change, and must not impact any future realignment of the tidal defences at Tilbury Cruise Terminal along the proposed alignment. This would require a NRV type structure, constructed to take a full tidal loading head, with at least 2 lines of defence. It is also noted that no mention is made of the surface water drainage from the remainder of the Essex Project Site to the North of the MSCP building.	A non-return valve and flap-valve will be applied at the outfall to River Thames. The attenuation volumes described herein have been calculated assuming a tide-locked scenario (with climate change). This will be updated as the proposals develop. There are no changes proposed at the area north of the MSCP building and subsequently no changes to the existing drainage regime.
	Given that section 1.3 states “there is no confirmed decommission date for the resort”, the FRA will need to consider the operational life that a gravity outfall will have in relation to rising sea levels. This section states that “If the existing PoT outfall is considered appropriate for use, the new pipe will be connected to it. Alternatively, a new outfall will be required”, and such proposals need to be considered vs. the ever decreasing low-tide window	Information is required on the capacity, size, level and condition of the existing outfall. The capacity of the outfall to be used to discharge the surface water runoff from the MSCP and the pedestrian plaza will be assessed under the tide-locked scenarios described herein (with allowance for climate change) during design development.

	duration allowing gravity drainage as time progresses.	
	PoT data is generally correct as to the alignment of the Environment Agency Main River Outfall. This main river is known at East Dock Sewer (not Botany Channel as stated in section 12.1)	Noted.

Chapter Five ◆ Monitoring, Management, Operation and Maintenance

Monitoring and operation

5.1 The ecological enhancement of Black Duck Marsh and Botany Marsh and the creation of new habitat within the new constructed wetland will benefit from the additional surface water volumes entering the marshes and wetland. Ecological monitoring is however required and will be undertaken pre- and post-construction of the Proposed Development to ensure the marshes and new wetland respond to the new hydrological regime as desired.

5.2 The water levels within the marsh areas will be controlled at the outfall locations. These outfalls will be designed to enable adjustment of water levels within the marshes as required.

5.3 The responsibility for the monitoring and operation of the marsh and wetland areas will lie with the London Resort Management. The monitoring of the wetlands and management of the water levels will be part of the Ecological Mitigation and Management Framework (document reference 6.2.12.3).

Maintenance

5.4 Accumulation of litter and debris can lead to water contamination, creating a hazard associated with the spread of disease and illness. This applies to all SuDS features across the Project Site, which must be maintained according to a SuDS maintenance schedule. The maintenance strategy for specific SuDS structures proposed at the Project Site will be dependent upon the products used within the installation of the structures and therefore subject to manufacturer's guidance. Maintenance of the SuDS features will be the responsibility of the London Resort Management along with the maintenance of the buildings, landscaped areas and other site infrastructure.

5.5 The maintenance regime of SuDS features present across the Project Site will consist of regular maintenance, occasional tasks and remedial works. The frequency of regular maintenance will usually be monthly, the occasional tasks and remedial works should be conducted as required.

5.6 As part of their normal function many SuDS features, including porous paving, green roofs and swales, are intended to act as a repository for potential pollutants such as sediment, hydrocarbons and heavy metals, thus improving the water quality of run-off. Certain pollutants, such as hydrocarbons, can be broken down via biodegradation. However, other pollutants, namely the particulate or sediment type, such as metals, remain trapped within elements of the sustainable drainage feature. At end-life, all SuDS shall therefore be disposed of in accordance with the relevant rules, regulations and available guidance at the time. If required, at redevelopment stage, consultation with the EA should be sought and testing of materials and ground should be carried out.

5.7 New outfalls with flap valves are being proposed to discharge surface water runoff to River Thames, while ensuring the Project Site is safe during high tides. Sediment can accumulate downstream and prevent opening of the valve and debris arising from the discharging can also block top-hinged flap gates in the open or closed position. Blockage can occur at any time but it is more likely to occur during storm events. The risk of blockage of the outfalls will be considered in detailed during design development and appropriate monitoring and maintenance to remove the silt will be included in the SuDS maintenance schedule. Options that have reduced risk of blockage such as elastomeric check valves will be considered during detailed design.

Chapter Six ◆ Conclusion

6.1 The drainage design has met the principal design criterion of having no impact on flood risk on the Project Site, while allowing discharge of flows to River Thames unrestricted.

6.2 A network of open lined swales or gravity pipes and perimeter swales are proposed to drain Kent Project Site (Main Resort). The swales will convey surface water flows from the Proposed Development to the Botany and Black Duck marshes and constructed wetland for attenuation, treatment and discharge to River Thames through new outfalls with non-return valves. The marsh areas and wetland will act as attenuation areas during tide-locked conditions. Some discrete and isolated areas of the Kent Project Site (Main Resort) to the south, such as the Related Housing (staff accommodation) and infrastructure compounds, are proposed to be drained via infiltration to the ground. Pumping will be avoided and restricted to specific areas where the existing ground levels are very low around the HS1 tunnel. The existing, silted gravity culvert and HS1 pumped culvert are not intended to be used and will be decommissioned, pending agreement with HS1.

6.3 The Kent Project Site (Access Road) will require several drainage networks. The proposed junction to the A2 and the central part of the Access Road will collect surface water flows via traditional gravity drainage systems, a series of interconnected infiltration basins and underground storage, to provide both treatment and attenuation. These systems will primarily discharge to the ground, with an overflow via a new headwall to Ebbsfleet River for extreme events. The northern section of the Access Road is to discharge to a pumping station (with associated storage), that will convey controlled flows to the southern catchments to infiltrate or overflowing to Ebbsfleet River. A short section of the northern part of the access road (including additional proposed buildings) will discharge to the Kent Project Site (Main Resort) drainage system at a restricted rate. Flows are to be attenuated via the combined use of flow controls, tanked porous sub-base, pond/wetland and underground crates. Shallow swales combined with tanked filter drains will be incorporated into all highway drainage where possible, to complement the treatment provided elsewhere in the system. Some isolated sections of the A2 junction which cannot connect by gravity will discharge to independent highway soakaways.

6.4 Underground attenuation tanks are proposed next to the MSCP and under the pedestrian plaza in the Essex Project Site. The attenuation will ensure that the Essex Project Site is not flooding during a tide-locked scenario.

6.5 SuDS treatment methods have been identified to improve the water quality of runoff prior to discharge to River Thames. The implementation of the proposed open SuDS features including swales, green/brown roofs, permeable pavement and wetland areas to further enhance the amenity and biodiversity of the Project Site and drainage systems.

6.6 The drainage proposals provide an overall betterment to the Project Site. The systems have been designed to cope with increases in storm intensity and therefore runoff and volume due to climate change. At the Kent Project Site (Main Resort), the silted gravity culverts and HS1 pumped culvert are proposed to be replaced by new culverts with longer design life that can discharge under gravity. The marsh habitat will be improved by introducing large water volumes; flexibility will be built into the system to ensure the most appropriate habitat is created. At the Essex Project Site, the inflows to the East Dock Sewer which is currently near capacity will be reduced, reducing the risk of the system being overwhelmed during a storm event. A new independent system is proposed to discharge surface water directly to the River Thames. It is considered that with the surface water drainage design in place, the Proposed Development will not increase the risk of surface water flooding on or off site or have any adverse impacts on the River Thames water quality.

Appendices

Appendix A – Meeting Minutes

Appendix B – CCTV Survey