



**Environmental Statement:** Volume 6, Annex 2.1 – Onshore Infrastructure Flood Risk Assessments

Date: May 2018



# **Offshore Wind Farm**

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**Environmental Impact Assessment** 

**Environmental Statement** 

Volume 6

Annex 2.1 – Onshore Infrastructure Flood Risk Assessments

Liability

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This report is also downloadable from the Hornsea Project Three offshore wind farm website at: www.hornseaproject3.co.uk

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## Glossary

Term	Definition
Anglian Water	Anglian Water is a water company which supplies drinking water, drainage and sewerage services for the East of England via a network of pipe and pump infrastructure.
Aquifer	A body of permeable rock which can contain or transmit groundwater.
Catchments	An area that serves a watercourse with rainwater. Every part of land where the rainfall drains to a single watercourse is in the same catchment.
Climate change	A long term change in weather patterns, in the context of flood risk, climate change will produce more frequent severe rainfall.
Drainage Board	Drainage Boards are an integral part of water level management in the UK. Each DB is a local public authority established in areas of special drainage need in England and Wales. They have permissive powers to manage water levels within their respective drainage districts. They undertake works to reduce flood risk to people and property and manage water levels to meet local needs.
Exceptions Test	The Exceptions Test ensures that development is permitted in flood risk areas only in exceptional circumstances and when strict qualifying conditions have been met. It is carried out if the Sequential Test demonstrates that a development cannot be located in areas of low flood risk.
Flood Defences	A structure that is used to reduce the probability of floodwater affecting a particular area.
Flood risk assessment	A flood risk assessment is an assessment of the risk of flooding from all flood mechanisms, including the identification of flood mitigation measures, in order to satisfy the requirements of the NPPF and Planning Practice Guidance.
Flood Zone 1	Low Probability Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Flood Zone 2	Medium Probability Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Flood Zone 3a	High Probability Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
Flood Zone 3b	The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.
Geology	The scientific study of the origin, history and structure of the earth.

Term	
Greenfield Runoff Rate	Rates of s (greenfiel
Groundwater	All water v zone and
Hydrology	The study
Lead Local Flood Authority (LLFA)	Lead Loca Local Floo sources o consisten organisati partnersh organisati actions fo
Onshore infrastructure	For the pu includes t station an
Obar	Mean ann event reco measure state to en surface w
Sequential Test	A Sequen lowest pro not alloca the propo flooding.
Strategic Flood Risk Assessment	A Strategi at risk fro
Surface water runoff	Surface w water, me
Sustainable urban drainage systems	A sequen designed to infiltrate slowly at
Tidal (Coastal) flooding	Tidal floor tides and features.
UK Climate Projections 2009	Climate p projection scenarios scenarios observatio



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#### Definition

surface water runoff from a site that is undeveloped eld).

which is below the surface of the ground in the saturated I in direct contact with the ground or subsoil.

ly of the movement, distribution, and quality of water.

cal Flood Authorities have responsibility for developing a ood Risk Management Strategy for their area covering local of flooding. The local strategy produced must be nt with the national strategy. It will set out the local tions with responsibility for flood risk in the area, hip arrangements to ensure co-ordination between these tions, an assessment of the flood risk, and plans and or managing the risk.

purpose of the site-specific Flood Risk Assessment this the Hornsea Three onshore cable corridor, HVAC booster nd HVDC converter/HVAC substation.

nual maximum flow rate is the value of the average flood corded in a river. This flow rate is used to provide a of the greenfield runoff performance of a site in its natural enable flow rate criteria to be set for post development water discharges for various return periods.

ntial Test aims to steer new development to areas with the robability of flooding by recommending that development is ated if there are reasonably available sites appropriate to osed development in areas with a lower probability of

gic Flood Risk Assessment provides information on areas om all sources of flooding.

water runoff is flow of water that occurs when excess storm eltwater, or other sources of water flows over a surface.

nce of management practices and control measures I to mimic natural drainage processes by allowing rainfall te, and by attenuating and conveying surface water runoff peak times.

oding is caused by extreme tidal conditions including high l storm surges, overtopping local flood defences or coastal

projections expressed in terms of absolute values. A on of the response of the climate system to emission s of greenhouse gases and aerosols, or radiative forcing s based upon climate model simulations and past tions.





Term	Definition	
Water Framework Directive	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.	
Water Quality	The physical, chemical and biological characteristics of water.	

## Acronyms

Acronym	Definition
bgl	Below ground level
BGS	British Geology Survey
DCO	Development Consent Order
EA	Environment Agency
FRA	Flood Risk Assessment
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
LDP	Local Development Plan
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPS	National Policy Statement
PPG	Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Urban Drainage System

Unit	De
kg	Kilogram (weight)
km	Kilometre (distance)
kV	Kilovolt (electrical potential)
kW	Kilowatt (power)
l/s	Litres per second (flow rate)
m	Metre (distance)
m <sup>3</sup>	Metres cubed (volume)
mm/year	Millimetres per year (rainfall)
MW	Megawatt (power)

## Units

Unit	Description
g	Gram (weight)
GW	Gigawatt (power)
ha	Hectare (area)



escription	





#### Introduction 1.

#### Background 1.1

- 1.1.1.1 A site-specific Flood Risk Assessment (FRA) has been prepared for the Hornsea Three onshore cable corridor, HVAC booster station and HVDC converter/HVAC substation (hereafter referred to as 'onshore infrastructure').
- 1.1.1.2 The FRA has been produced in accordance with the Overarching National Policy Statement (NPS) for Energy EN-1, the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) ID7 and relevant local planning policies, a summary of each is presented in Section 3. The policies cover the requirements in respect to Nationally Significant Infrastructure Projects.
- 1.1.1.3 The FRA supports the Development Consent Order (DCO) application for Hornsea Three in accordance with the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended). It also forms an annex to Hornsea Three Environmental Statement volume 3, chapter 2: Hydrology and Flood Risk.
- Developments that are designed without regard to flood risk may endanger lives, damage property, cause 1.1.1.4 disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works.
- 1.1.1.5 Current guidance on development and flood risk (PPG: ID7 Flood risk and coastal change) identifies several key aims for a development to ensure that it is sustainable in flood risk terms. These aims are as follows:
  - The development should not be at a significant risk of flooding and should not be susceptible to ٠ damage due to flooding;
  - The development should not be exposed to flood risk such that the health, safety and welfare of the • users of the development, or the population elsewhere, is threatened;
  - Normal operation of the development should not be susceptible to disruption as a result of flooding; •
  - Safe access to and from the development should be possible during flood events; •
  - The development should not increase flood risk elsewhere;
  - The development should not prevent safe maintenance of watercourses or maintenance and • operation of flood defences;
  - The development should not be associated with an onerous or difficult operation and maintenance • regime to manage flood risk. The responsibility for any operation and maintenance required should be clearly defined;
  - Future users of the development should be made aware of any flood risk issues relating to the development;

- or mortgage finance, or in selling all or part of the development, as a result of flood risk issues;
- The development should not lead to degradation of the environment; and
- The development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change.
- The FRA is undertaken with due consideration of these sustainability aims. 1.1.1.6
- The key objectives of the FRA are: 1.1.1.7
  - To assess the flood risk to the proposed development and to demonstrate the feasibility of users would be acceptable;
  - To assess the potential impact of the proposed development on flood risk elsewhere and to would not increase flood risk elsewhere; and
  - as they require FRAs to be submitted in support of DCO applications.

#### 1.2 Methodology

- 1.2.1.1 The proposed study area for each of the FRAs follows the Hornsea Three hydrology and flood risk study area as defined in volume 3, chapter 2: Hydrology and Flood Risk. It includes a 1 km buffer around the onshore HVAC booster station area and onshore HVDC converter/HVAC substation area, and a 250 m buffer around the Hornsea Three onshore cable corridor.
- 1.2.1.2 The buffers applied are considered appropriate for data collection taking into account the nature of Hornsea Three and likely zone of influence on hydrological receptors.
- In order to achieve the objectives outlined within 1.1.1.7, a staged approach was adopted in undertaking 1.2.1.3 the FRA in accordance with NPS (EN-1), the NPPF and PPG. Initially, screening studies have been undertaken utilising publicly available information, records and data to identify whether there are any potential sources of flooding within the proposed onshore HVAC booster station and HVDC converter/HVAC substation areas and elsewhere in the Hornsea Three hydrology and flood risk study area, which may warrant further consideration. Identified potential flooding issues are then assessed further within a specific flood risk section. The aims of the assessment are:
  - HVAC booster station and HVDC converter/HVAC substation areas; and
  - To identify any impact of the Hornsea Three onshore infrastructure on flood risk elsewhere.

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The development design should be such that future users will not have difficulty obtaining insurance

appropriately designing the development such that any residual flood risk to the development and

demonstrate the feasibility of appropriately designing the development, such that the development

To satisfy the requirements of the NPS, the NPPF and PPG and DCO application guidance insofar

To review all available information and provide a qualitative analysis of the flood risk to the onshore





## 1.3 Report structure

- 1.3.1.1 This report has the following structure:
  - Section 2 identifies the sources of information that have been consulted in preparation of the FRA;
  - Section 3 sets out relevant legislation, guidance and local planning policy;
  - Section 4 provides the development specific FRA for the proposed onshore HVAC booster station area;
  - Section 5 provides the development specific FRA for the proposed onshore HVDC converter/HVAC substation area; and
  - Section 6 provides the development specific FRA for the proposed Hornsea Three onshore cable corridor.
- 1.3.1.2 A hydrological review of the onshore HVAC booster station, HVDC converter/HVAC substation areas and Hornsea Three onshore cable corridor; requirements of the NPPF and PPG; a description of the flood risk management measures incorporated into the design of the onshore HVAC booster station and onshore HVDC converter/HVAC substation; and a summary are presented below.









#### 2. **Information Sources**

2.1.1.1 The information used in the preparation of report is set out in Table 2.1.

 Table 2.1:
 Information sources consulted during the preparation of the report.

Source	Data	Information consulted/provided
	OS Mapping 1: 50 000 Sheet 133: North East Norfolk.	Area information, rivers and other
Ordnance Survey (OS).	OS Mapping 1: 50 000 Sheet 134: Norwich & The Broads.	watercourses, general site environments, built environment, catchment information.
British Geological Survey (BGS).	BGS (online) Geology of Britain Viewer. Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html	Site and area geology.
Environment Agency (EA).	EA data holdings, customer service and engagement team.	Current flood risk, local flood defences, flood levels, supplementary geology and groundwater information.
Groundsure.	Enviro Insight and Geo Insight.	Classification of the underlying geology and hydrogeology. Flood risk from groundwater and surface water.
Internal Drainage Board (IDB).	Norfolk Rivers IDB.	Local Drainage Networks.
	Norfolk County Council.	
Local Planning Authorities	Broadland District Council.	Flood Zoning.
(LPA).	North Norfolk District Council.	Local Development Framework.
	South Norfolk District Council	
Sewerage/Water Company.	Anglian Water.	Water and sewerage assets in the vicinity.
	NPPF.	FRA and Planning Guidance.
	PPG.	Flood zoning as used by the EA in England.
Planning Policy.	NPS EN-1 Section 5.7.	NPS EN-1(5.7.6) refers applicants to this Practice Guide.
	The Department for Environment Food and Rural Affairs (Defra) Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems (March 2015).	Surface water runoff standards.
	UK Climate Projections (UKCP09).	Climate change prediction data.

Source	Data	Information consulted/provided
Norfolk County Council.	Norfolk Minerals and Waste Development Framework, Core Strategy and Minerals and Waste Development Management Policies Development Plan Document 2010-2026. Revised Combined Strategic Flood Risk Assessment (SFRA).	
	Norfolk Local Flood Risk Management Strategy, July 2015.	
	Norfolk Lead Local Flood Authority Statutory Consultee Guidance Document, April 2017.	Current Flood Zone/risk including historical flooding locations. Any
Broadland District Council.	Partnership of Broadland District Councils, Strategic FRA, Subsidiary Report A. North Norfolk District Council Area, December 2007.	relevant flood modelling completed.
North Norfolk District Council.	Partnership of Norfolk District Councils, Strategic FRA, Subsidiary Report A. North Norfolk District Council Area, December 2007.	
South Norfolk District Council.	Partnership of Norfolk District Councils, Strategic FRA, Subsidiary Report A. South Norfolk District Council Area, December 2007.	







#### Legislation and Guidance 3.

#### **National Policy Statements** 3.1.1

- 3.1.1.1 Planning policy for Nationally Significant Infrastructure Projects, specifically in relation to hydrology and flood risk is contained in the Overarching National Policy Statement (NPS) for Energy EN-1 (Department of Energy and Climate Change, 2011). Section 5.7 of NPS EN-1 sets out the aims of planning policy on development and flood risk to ensure that flood risk from all sources of flooding is taken into account at all stages in the planning process. Guidance on what to be considered in the application is set out in volume 3, chapter 2: Hydrology and Flood Risk. In terms of mitigation and the management of flood risk, NPS (EN-1) paragraphs 5.7.20 and 5.7.21 state:
  - "Site layout and surface water drainage systems should cope with events that exceed the design capacity of the system, so that excess water can be safely stored on or conveyed from the site without adverse impacts"; and
  - "The surface water drainage arrangements for any project should be such that the volumes and peak • flow rates of surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect".

#### 3.1.2 National Planning Policy Framework (March 2012)

- 3.1.2.1 The NPPF sets out Government planning policies for England and how these are expected to be applied. The framework acts as guidance for LPAs and decision-takers, both in drawing up plans and making decisions about planning applications.
- 3.1.2.2 Paragraphs 99-108 states that new development should take into account climate change and that appropriate mitigation should be provided. It states that inappropriate development should be located away from high risk areas and that a sequential risk-based approach should be applied through the local planning system to the location of development. The guidance is set out below:

"Local Plans should take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure.

Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. Local Plans should be support by Strategic Flood Risk Assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as lead local flood authorities and internal drainage

boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change, by:

- Applying the Sequential Test;
- If necessary, applying the Exception Test;
- Safeguarding land from development that is required for current and future flood management;
- including housing, to more sustainable locations.

If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate. For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the been prepared; and
- A site-specific flood risk assessment must demonstrate that the development will be safe for its where possible, will reduce flood risk overall.

Both elements of the test will have to be passed for development to be allocated or permitted.

Where determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- are overriding reasons to prefer a different location; and
- and it gives priority to the use of sustainable drainage systems.

For individual developments on sites allocated in development plans through the Sequential Test, applicants need not apply the Sequential Test. Applications for minor development and changes of use should not be subject to the Sequential or Exception Tests but should still meet the requirements for site-specific flood risk assessments".



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Using opportunities offered by new development to reduce the causes and impacts of flooding; and Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to facilitate the relocation of development,

community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has

lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and,

Within the site, the most vulnerable development is located in areas of lowest flood risk unless there

Development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning;





- 3.1.2.3 The remaining paragraphs (paragraphs 105 to 108) relate to development in coastal areas, in particular "local authorities should reduce risk from coastal change by avoiding inappropriate development in vulnerable areas by adding to the impacts of physical changes to the coast". Any areas likely to be affected by physical changes to the coast should be identified as a Coastal Change Management Area by the relevant LPA.
- 3.1.2.4 The NPPF requires the application of a sequential risk-based approach to determining the suitability of land for development in flood risk areas. The Sequential Test approach steers new development to areas of land with the lowest probability of flooding (i.e. Flood Zone 1). Where there are no reasonably available sites in Flood Zone 1, LPAs should take into account the flood risk vulnerability of land uses in their decision making and consider reasonably available sites in Flood Zone 2 (i.e. areas with a medium probability of flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 and 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exceptions Test if required. The Exception Test is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

#### 3.1.3 Planning Practice Guidance (online)

- PPG ID7 Flood Risk and Coastal Change provides guidance to ensure the effective implementation of the 3.1.3.1 NPPF planning policy for development in areas at risk of flooding.
- PPG ID7 states that a site-specific FRA is required for all proposals for new development in Flood Zones 3.1.3.2 2 and 3 and for any proposal of 1 ha or greater in Flood Zone 1. Flood Zones are defined as:
  - Flood Zone 1 Land having a less than 1 in 1,000 annual probability of river or sea flooding; •
  - Flood Zone 2 Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding; and
  - Flood Zone 3 Land having a 1 in 100 or greater annual probability of river flooding; or Land having • a 1 in 200 or greater annual probability of sea flooding.
- An FRA should consider vulnerability to flooding from other sources as well as from river and sea flooding, 3.1.3.3 and also the potential for any increased risk of flooding elsewhere resulting from a development. The guidance sets out a checklist of the information that should be included in a site-specific flood risk assessment, including the following key stages:
  - Development site and location including current use of the site;
  - Development proposals;
  - Sequential test for developments in Flood Zones 2 and 3 only. If the development site is wholly within Flood Zone 1 it is not necessary to undertake this stage;
  - Climate change how is the flood risk likely to be affected by climate change; •

- risk measures do not increase the risk of flooding off-site; and
- Surface water management. •

#### 3.1.4 Non-statutory technical standards for sustainable drainage systems (March 2015)

This document sets out non-statutory technical standards for sustainable drainage systems, which should 3.1.4.1 be used in conjunction with the NPPF and PPG. The standards relevant for Hornsea Three are presented below:

### "Peak flow control

S2 - For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

### Volume control

S4 - Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

S6 - Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

### Flood risk within the development

S7 - The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 - The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 - The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property."

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Site-specific flood risk – what are the main sources of flooding, what is the probability of flooding, how will the development be made safe from flooding; ensure that the development and any flood





#### 3.1.5 Climate change

- 3.1.5.1 The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and supporting planning practice guidance on Flood Risk and Coastal Change explain when and how FRAs should be used. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account.
- 3.1.5.2 In February 2016, the EA updated advice on climate change allowances to support the NPPF. The new guidance requires that FRAs and SFRAs assess both the central and upper end allowances of peak rainfall intensity (Table 3.1) to understand the range of impacts. The allowances (upper end and central) are based on emission percentiles. The central allowance is based on the 50th percentile, whilst the upper end allowance is based on the 90<sup>th</sup> percentile. Further information on the climate change allowances can be found at (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

### Table 3.1: Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline).

Allowance Category (Applies across all of England)	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

The peak river flow allowance shows the anticipated changes to peak flow within the river systems in the 3.1.5.3 Anglian district caused by climate change. Table 3.2 presents the anticipated peak river flow change associated with the impacts of climate change.

Table 3.2:	Peak river flow allowances b	y river basin district	(use 1961 to 1990 baseline).
------------	------------------------------	------------------------	------------------------------

River Basin District	Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
	Upper end	25%	35%	65%
Anglian	Higher central	15%	20%	35%
	Central	10%	15%	25%

3.1.5.4 The EA expect sea level rise to increase the rate of coastal erosion. Table 3.3 presents the anticipated sea level rise for given time frames associated with climate change.

### Table 3.3: Sea level allowance for each epoch (mm) per year (use 1990 baseline).

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 (metres)
East, east midlands, London, south east	4mm (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m

- As a Lead Local Flood Authority (LLFA), Norfolk County Council refer all developers to the Flood risk 3.1.5.5 assessment: climate change allowances guidance for all developments.
- 3.1.5.6 In line with the EA's Flood risk assessments: climate change allowance guidance, 20% and 40% has been added to all attenuation/runoff calculations for the Hornsea Three onshore infrastructure to account for climate change (assuming a 1 in 100 year rainfall event).





#### **Onshore HVAC Booster Station Area Flood** 4. Risk Assessment

#### Site setting 4.1

#### 4.1.1 Location

4.1.1.1 The proposed location of the onshore HVAC booster station is National Grid Reference TG 11336 33206 approximately 2.7 km north of the village of Saxthorpe (see Figure 4.1). The area is bounded by woodland to the north and east, with agricultural land to the south and east. Access is gained via Sweetbriar Lane.

#### 4.1.2 Existing use

4.1.2.1 The area has no buildings, structures or development and its topography gently slopes from east to west. It is currently used for agricultural purposes.

#### 4.1.3 **Proposed use**

- It is proposed that a HVAC booster station will be constructed as part of Hornsea Three (as described in 4.1.3.1 volume 1, chapter 3: Project Description). The onshore HVAC booster station and associated permanent infrastructure will occupy a site of up to 3.04 ha, including some land which may be used for landscaping. The onshore HVAC booster station is expected to have an operational life of 35 years. Indicative layouts are presented in volume 1, chapter 3: Project Description. For the purpose of this FRA, the maximum design scenarios are identified in volume 3, chapter 2 Hydrology and Flood Risk and are summarised below:
  - The HVAC booster station site area (including all above ground permanent infrastructure, internal • circulation roads, fencing, buildings and landscaping): 30,407 m<sup>2</sup>, of which:
    - Approximately 10,000 m<sup>2</sup> comprises low permeability hardstanding/surfacing; 0
    - Approximately 20,400 m<sup>2</sup> comprises above ground permanent infrastructure, gravelled areas, 0 landscaping etc.

#### 4.1.4 Flood Risk Assessment

### Hydrological overview

4.1.4.1 The location of EA designated main rivers and ordinary watercourses within the Hornsea Three hydrology and flood risk study area are shown on . Main rivers and ordinary watercourses are defined in annex 2.2: Environment Agency and Internal Drainage Board Watercourses and Flood Zones. There are no main rivers in the Hornsea Three hydrology and flood risk study area at the onshore HVAC booster station area, however there are ordinary watercourses to the east and south.

### Fluvial and tidal flooding



- The EA's flood map (Figure 4.1) indicates that the onshore HVAC booster station area is within Flood 4.1.4.2 Zone 1, defined as land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).
- The Norfolk County Council and Partnership of Norfolk District Council's SFRA Flood Zone Maps replicate 4.1.4.3 the EA's flood mapping indicating that the onshore HVAC booster station area is located within Flood Zone 1.





Figure 4.1: EA fluvial and tidal flood map for the onshore HVAC booster station area.

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### Flooding from rising/high groundwater

- 4.1.4.4 BGS geology online map (accessed March 2017) indicates that the onshore HVAC booster station is underlain by Mid-Pleistocene glaciofluvial (Sand and Gravel) and Mid-Pleistocene diamicton till superficial deposits. The superficial deposits are underlain by bedrock consisting of the undifferentiated chalk formations of the White Chalk Subgroup (white, well-bedded, flint-free chalk with common marl seams). Further information on geology and ground conditions can be found in volume 3, chapter 1: Geology and Ground Conditions.
- The chalks are classified by the EA under the Water Framework Directive as a principal aquifer, defined 4.1.4.5 as "... layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale".
- 4.1.4.6 North Norfolk County Council's (2010) SFRA indicates that no groundwater flooding has been reported at the onshore HVAC booster station area.
- There are no EA-defined categories to assess the potential for groundwater flooding, therefore, the 4.1.4.7 author's professional judgement has been used. Taking into account the geology and hydrogeology of the area and absence of historical groundwater flood events, the potential for groundwater flooding is considered to be low.

### Source Protection Zones

EA mapping shows the onshore HVAC booster station area is not located within a groundwater Source 4.1.4.8 Protection Zone (see annex 1.2: Abstraction Licences and Source Protection Zones).

### Surface water flooding

- Surface water or pluvial flooding is defined as flooding caused by rainfall generated overland flow, before 4.1.4.9 the runoff enters a watercourse or sewer. In such events sewerage and drainage systems and surface watercourses may be overwhelmed.
- As shown in Figure 4.2, the EA's surface water flood mapping indicates that the majority of the onshore 4.1.4.10 HVAC booster station area is at 'very low' risk of surface water flooding. A localised area along the north eastern corner of the onshore HVAC booster station area is defined as being at low risk of surface water flooding.
- Based on the relatively flat lying and primarily agricultural landscape of the onshore HVAC booster station 4.1.4.11 area the majority of surface runoff will either infiltrate into exposed permeable natural surfaces and soils, or be conveyed to the local drainage network.

### Reservoir failure assessment

4.1.4.12 EA mapping shows that the onshore HVAC booster station area is not at risk of reservoir flooding.

### Flood defence measures

EA and SFRA mapping indicates that there are no flood defences within the immediate vicinity of the 4.1.4.13 development site.

### Sewer/water main failure assessment

- 4.1.4.14 As the onshore HVAC booster station area is currently agricultural land, with the surrounding area being a mixture of wooded areas and agricultural fields, it is anticipated that no water assets would be present within the vicinity of the onshore HVAC booster station area.
- However, if any adopted sewers are present in close proximity to the site they are assumed to have been 4.1.4.15 designed to industry standards (e.g. sewers for adoption). The most common causes of flooding from sewers are inadequate flow capacity, blockages, pumping station failures, burst water mains, water inflow from rivers or the sea, tide locking, siltation, fats/greases and sewer collapse. Should any of these events occur there is a risk of flooding in the vicinity of the sewer by surcharge where the flood is in excess of the sewer capacity (usually 1 in 30 year event or greater).
- The DG 5 register is a register of properties that have flooded as a result of hydraulic inadequacy of the 4.1.4.16 public sewer network. The DG 5 register requires all water companies to keep a record of any properties that have been affected by sewer flooding. According to the Norfolk County Council SFRA and Flood Risk Management Strategy, there are no records of historical sewerage flooding on the onshore HVAC booster station area as a consequence of a failure in artificial drainage (e.g. sewers).
- Taking into account the above, the absence of any historical sewer flooding specific to the onshore HVAC 4.1.4.17 booster station area and the author's professional judgement, the overall risk of flooding via artificial drainage system to the onshore HVAC booster station area has been assessed to be low.

### Historic flooding

Norfolk County Council, SFRA and Flood Risk Management Strategy (Norfolk County Council, 2010) 4.1.4.18 mapping indicates that the onshore HVAC booster station area has not been affected by historical flooding.

### Current flood risk

- The onshore HVAC booster station area is located within Flood Zone 1 being within an area considered 4.1.4.19 at low risk of flooding from fluvial or tidal sources.
- 4.1.4.20 It has been determined that the main risk of flooding to the onshore HVAC booster station area is from groundwater.







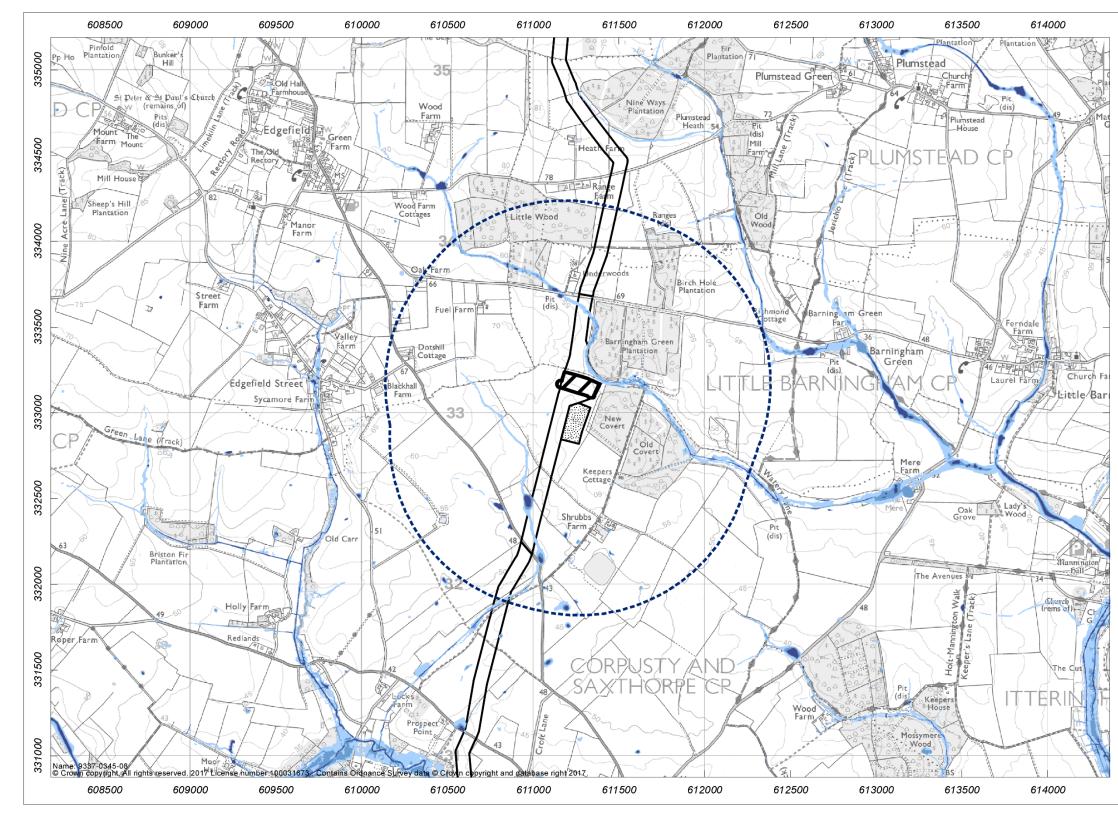


Figure 4.2: Onshore EA surface water flood map for the onshore HVAC booster station area.

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#### 4.2.1 Site vulnerability

- Applying the Flood Risk Vulnerability Classification in Table 2 of the PPG Flood Risk and Coastal Change 4.2.1.1 (Department for Communities and Local Government, 2014), the onshore HVAC booster station is classified as "Essential infrastructure".
- Table 3 of PPG (Table 4.1 of this report) states that "Essential Infrastructure" uses are appropriate within 4.2.1.2 Flood Zone 1 and 2, and also in Flood Zone 3.

Flood Risk Vulnerability classification (see Table 2 of NPPF Technical Guidance)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	Yes	Yes	Yes	Yes	Yes
Zone 2	Yes	Yes	Exception test required	Yes	Yes
Zone 3a	Exception test required	Yes	No	Exception test required	Yes
Zone 3b Functional Floodplain	Exception test required	Yes	No	No	No
Key: Yes: Developmen	t is appropriate, No: Dev	elopment should not be	e permitted.		

### Table 4.1: Flood risk vulnerability and Flood Zone 'compatibility' as identified in table 3 of NPPF technical guidance.

#### Sequential Test 4.2.2

- 4.2.2.1 The Sequential Test is designed to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate for this type of development.
- 4.2.2.2 LPAs allocating land in Local Development Plans (LDPs) for development should apply the Sequential Test to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.

- 4.2.2.3 In areas at risk of river or sea flooding, preference should be given to locating new development in Flood Zone 1. If there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. Within each Flood Zone new development should be directed to sites at the lowest probability of flooding from all sources as indicated by the SFRA.
- 4.2.2.4 The Sequential Test therefore seeks the allocation of land for development in flood areas of least risk where practicable (i.e. preferentially steer towards Zone 1). Developers should also have regard to the Sequential Test when evaluating sites where LDPs have not been subject to SFRA and/or the Sequential Test and where it is necessary to demonstrate that there are no alternative sites with a lower probability of flooding for the given end use.
- 4.2.2.5 Norfolk County Council's SFRA flood mapping shows that the entire development is located within Flood Zone 1 and has therefore passed the Sequential Test requirement of locating development within 'low' flood risk zones.
- 4.2.2.6 As the proposed onshore HVAC booster station area is located within Flood Zone 1 and has passed the Sequential Test there is no need to undertake an Exceptions Test.

#### **Drainage strategy** 4.3

#### 4.3.1 Surface water drainage

- 4.3.1.1 The sustainable management of surface water is an essential element of reducing future flood risk to the onshore HVAC booster station area and its surroundings.
- 4.3.1.2 Undeveloped sites generally rely on natural drainage to convey or absorb rainfall, with the water soaking into the ground or flowing across the surface into watercourses.
- The effect of development is generally to reduce the permeability of at least part of the onshore HVAC 4.3.1.3 booster station area, which markedly changes the site's response to rainfall. Without specific measures to manage surface water, the volume of water and peak flow rate are likely to increase. Inadequate surface water drainage arrangements can increase the risk of flooding to others.
- 4.3.1.4 Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the HVAC booster station area prior to Hornsea Three while reducing the risk of flooding at the onshore HVAC booster station area and elsewhere, taking climate change into account.







#### 4.3.2 Sustainable drainage options

- The NPPF and associated PPG, Sustainable Urban Drainage Systems (SuDS) Manual (CIRIA, 2015) and 4.3.2.1 also the North Norfolk Core Strategy (North Norfolk District Council, 2008) promote sustainable water management through the use of SuDS. A hierarchy of techniques is identified:
  - Prevention the use of good site design and housekeeping measures on individual sites to prevent • runoff and pollution (e.g. minimise areas of hard standing);
  - Source Control control of runoff at or very near its source (such as the use of rainwater harvesting); •
  - Site Control management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site); and
  - Regional Control management of runoff from several sites, typically in a detention pond or wetland. •
- 4.3.2.2 The implementation of SuDS as opposed to conventional drainage systems, provides several benefits by:
  - Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding • downstream;
  - Reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
  - Improving water quality over conventional surface water sewers by removing pollutants from diffuse ٠ pollutant sources;
  - Reducing potable water demand through rainwater harvesting; •
  - Improving amenity through the provision of public open spaces and wildlife habitat; and
  - Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

#### 4.3.3 **Runoff rate calculations**

- 4.3.3.1 An assessment of the current and proposed runoff rates was undertaken to determine the surface water attenuation requirements for the onshore HVAC booster station area in line with The SuDS Manual (2015), which indicates that the flow rate discharged from the onshore HVAC booster station area must not exceed that prior to the proposed development for the:
  - 1 in 1 year event;
  - Greenfield runoff rate (Qbar);
  - 1 in 30 year event; and
  - 1 in 100 year event. •

4.3.3.2 The rates of runoff were determined using the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS (National SuDS Working Group, 2004) and the Non-statutory technical standards for sustainable drainage systems (Defra, 2015). The EA/Defra recommended methodology for sites with an area up to 50 ha, is the Institute of Hydrology Report 124 method (Institute of Hydrology, 1994). The runoff rates were calculated using the MicroDrainage software suite and are present within Table 4.2.

#### 4.3.4 Greenfield runoff rate characteristics

- The proposed land use is an onshore HVAC booster station with an operational life of 35 years. The 4.3.4.1 greenfield runoff has been assessed against a 'greenfield' baseline, assumed to be 100% permeable surfacing.
- The following parameters were incorporated into the greenfield site runoff calculations: 4.3.4.2
  - Catchment Area: 10,000 m<sup>2</sup>;
  - Standard-period Average Annual Rainfall: 605 mm/year;
  - Soil: 0.400 (global soil index); and
  - Region No: 5 (catchment based on Flood Studies Report Figure I.2.4.).

### Table 4.2: Greenfield runoff characteristics.

Annual Probability (Return Period, years)	Current (Greenfield) Runoff (I/s)
100% (1)	2.50
Qbar	2.90
3.33% (30)	6.90
1% (100)	10.20
1% + 20% Climate Change	12.24
1% + 40% Climate Change	14.28







#### 4.3.5 Attenuation requirements

- 4.3.5.1 The attenuation volume required to restrict the surface water runoff rate from low permeable surfacing to 2.50 l/s the existing 1 in 1 year rate for a 1 in 100-year rainfall event plus climate change (40%) has been determined using the industry standard MicroDrainage software suite incorporating the following parameters:
  - Impermeable Area: approximately 10,000 m<sup>2</sup>;
  - Cv (proportion of rainfall forming surface water runoff): assume a factor of 75% for the development in summer, and 84% in winter (weighted average based on proposed land use);
  - Runoff rate: 2.50 l/s; and •
  - Assuming no infiltration losses.
- 4.3.5.2 The system was modelled within MicroDrainage as a tank/pond with controlled discharge via an orifice outflow control. The MicroDrainage calculation sheets are included within section A.7.
- The attenuation volume required to restrict runoff from a 1 in 100-year storm event, plus a 40% allowance 4.3.5.3 for climate change, to 2.50 l/s, is approximately 1,050 m<sup>3</sup> for the onshore HVAC booster station area. Appendix A, section A.10 illustrates the outline drainage strategy for the onshore HVAC booster station and demonstrates that the required attenuation volume can be practicably provided within the onshore HVAC booster station area.

#### Summary and conclusions 4.4

#### 4.4.1 Summary

4.4.1.1 A site-specific FRA in accordance with section 5.7 of the NPS EN-1, the NPPF and associated PPG ID7 has been undertaken for the onshore HVAC booster station area, located 2.7 km north of the village Saxthorpe.

#### 4.4.2 Flood risk

- 4.4.2.1 In accordance with the guidance on development and flood risk (PGG: ID7 Flood risk and coastal change) the FRA provides a response to the aims set out in 1.1.1.5:
  - EA mapping shows that the proposed development is located in Flood Zone 1 at 'low' risk of flooding • (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%)).
  - There is no historical evidence of flooding at the onshore HVAC booster station area. .
  - The onshore HVAC booster station area is located within a flat lying and primarily agricultural landscape, indicating that the potential surface water flood risk to the onshore HVAC booster station area is low. The majority of surface runoff will either infiltrate into exposed permeable natural surfaces soils, or given the flat nature of the surrounding topography pluvial flooding will be localised at the point of origin with low mobility.

- groundwater flooding.
- The risk of flooding from infrastructure failure including adopted sewers is considered to be low.
- The onshore HVAC booster station area is not at risk of flooding from a reservoir failure.
- change.
- The onshore HVAC booster station is located within EA Flood Zone 1 and SFRA Flood Zone 1. Therefore, there is no requirement for either a Sequential or Exceptions Test.
- the 1 in 100 year storm event plus 40% allowance for climate change.

#### 4.4.3 Conclusion

4.4.3.1 This FRA and supporting documentation shows that the onshore HVAC booster station at this location meets the requirements of NPS EN-1 and the NPPF.



Annex 2.1 - Onshore Infrastructure Flood Risk Assessments **Environmental Statement** May 2018

The onshore HVAC booster station area has been assessed to be at low to medium risk of

The onshore HVAC booster station is defined as "Essential Infrastructure" in Table 2 of Planning Practice Guidance ID7 and is suitable for the present Flood Zone and the zone including climate

There will be an increase in low permeability cover; and surface runoff will need to be controlled at an agreed runoff rate. MicroDrainage calculations indicate that the overall attenuation requirement for the 10,000 m<sup>2</sup> impermeable development area assuming no loss via infiltration is 1,019 m<sup>3</sup> for





## **Onshore HVDC Converter/HVAC Substation Area Flood** 5. **Risk Assessment**

#### Site setting 5.1

#### 5.1.1 Location

5.1.1.1 The proposed onshore HVDC converter/HVAC substation area is located at National Grid Reference TG 21000 03541 approximately 5.6 km south west of Norwich City Centre (Figure 5.1). The onshore HVDC converter/HVAC substation area is bounded by the Norwich Southern Bypass (A47) to the north, enclosed agricultural fields to the south and east, and Main Road to the west with agricultural fields beyond. Access to the onshore HVDC converter/HVAC substation area is gained via Main Road (B113).

#### 5.1.2 Existing use

5.1.2.1 The onshore HVDC converter/HVAC substation area contains no buildings, structures or development and its topography slopes from the east to the west. It is currently used for agricultural purposes with enclosed fields separated by hedges.

#### Proposed use 5.1.3

- It is proposed that a HVDC converter/HVAC substation will be constructed as part of Hornsea Three (as 5.1.3.1 described in volume 1, chapter 3: Project Description). It will contain the electrical components for transforming the power supplied by the offshore wind farm to 400 kV. If a HVDC transmission system is used it will also house equipment to convert the power from HVDC to HVAC.
- The onshore HVDC converter/HVAC substation and associated permanent infrastructure will occupy an 5.1.3.2 area up to 14.9 ha. The onshore HVDC converter/HVAC substation is expected to have an operational life of 35 years. For the purpose of this FRA, the maximum design scenarios are identified in volume 3, chapter 2: Hydrology and Flood Risk and are summarised below:
  - The HVDC converter/HVAC substation site area (including all above ground permanent infrastructure, internal circulation roads, fencing, buildings and landscaping): 149,302 m<sup>2</sup>, of which:
    - Approximately 60,000 m<sup>2</sup> comprises above ground permanent infrastructure, internal 0 circulation roads, fencing, buildings; and
    - Approximately 80,900 m<sup>2</sup> comprises permeable surfacing, including ground permanent 0 infrastructure, gravelled areas, landscaping etc.

#### Flood Risk Assessment 5.1.4

### Hydrological Overview

5.1.4.1 The location of EA designated main rivers and ordinary watercourses within the Hornsea Three hydrology and flood risk study area are shown on Figure 5.1. There are no main rivers in the Hornsea Three hydrology and flood risk study area at the onshore HVDC converter/HVAC substation, however there are several ordinary watercourses.

### Fluvial and tidal flooding

- 5.1.4.2 The EA's flood map (Figure 5.1) indicates that the onshore HVDC converter/HVAC substation area is within Flood Zone 1, defined as land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).
- 5.1.4.3 The Norfolk County Council and Partnership of Norfolk District Council's SFRA Flood Zone Maps replicate the EA's flood mapping indicating that the onshore HVDC converter/HVAC substation area is located within Flood Zone 1.



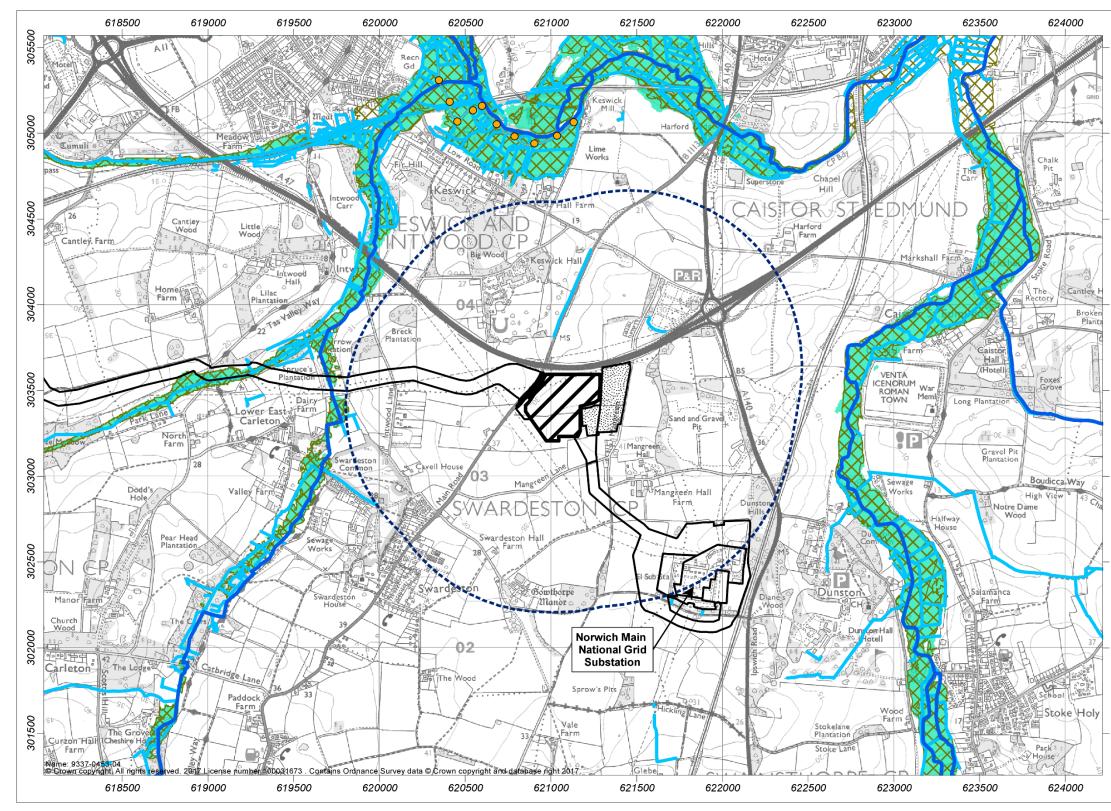


Figure 5.1: EA fluvial and tidal flood map for the onshore HVDC converter/HVAC substation area.

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### Flooding from rising/high groundwater

- 5.1.4.4 BGS geology online map (accessed March 2017) indicates that the onshore HVDC converter/HVAC substation area is underlain by Lowestoft formation superficial deposits consisting sands, gravels, silts, clays and chalky till. The superficial deposits are underlain by bedrock consisting of the undifferentiated chalk formations of the White Chalk Subgroup (white, well-bedded, flint-free chalk with common marl seams).
- The chalks are classified by the EA under the Water Framework Directive as a principal aquifer, defined 5.1.4.5 as "... layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale".
- North Norfolk County Council SFRA indicates that no groundwater flooding has been reported at the site. 5.1.4.6
- Based on the information outlined above the potential for groundwater flooding is considered to be at low 5.1.4.7 to medium. This takes into account underlying granular geological characteristics, and absence of historical groundwater flood events.

### Source Protection Zones

EA mapping shows the onshore HVDC converter/HVAC substation area is not located within a 5.1.4.8 groundwater Source Protection Zone (see annex 1.2: Abstraction Licences and Source Protection Zones)

### Surface water flooding

- Surface water or pluvial flooding is defined as flooding caused by rainfall generated overland flow, before 5.1.4.9 the runoff enters a watercourse or sewer. In such events sewerage and drainage systems and surface watercourses may be overwhelmed.
- Figure 5.2 of the EA's surface water flood mapping indicates that the majority of the site is at 'very low' 5.1.4.10 risk of surface water flooding. A localised area along the north and western extent of the onshore HVDC converter/HVAC substation area is defined at being at low risk of surface water flooding.
- Based on the primarily agricultural landscape of the site, the majority of surface runoff will either infiltrate 5.1.4.11 into exposed permeable natural surfaces and soils, or be conveyed to local drainage network.

### Reservoir failure assessment

5.1.4.12 EA mapping shows that the onshore HVDC converter/HVAC substation area is not at risk of reservoir flooding.

### Flood defence measures

5.1.4.13 EA and SFRA mapping indicates that there are no flood defences within the immediate vicinity of the onshore HVDC converter/HVAC substation area.

### Sewer/water main failure assessment

- 5.1.4.14 As the onshore HVDC converter/HVAC substation area is currently agricultural land it is anticipated that no sewer/water assets are present within the site boundary.
- 5.1.4.15 However, if any adopted sewers in close proximity to the site would be assumed to have been designed to industry standards (e.g. sewers for adoption). However, the most common causes of flooding from sewers are inadequate flow capacity, blockages, pumping station failures, burst water mains, water inflow from rivers or the sea, tide locking, siltation, fats/greases, and sewer collapse. Should any of these events occur there is a risk of flooding within the vicinity of the sewer by surcharge where the flood is in excess of the sewer capacity (usually 1 in 30 year event or greater).
- Under the DG 5 register requirements all water companies are obliged to keep a record of any properties 5.1.4.16 that have been affected by sewer flooding. The Norfolk County Council SFRA and Flood Risk Management Strategy do not provide any records relating to historical flooding on site as a consequence of a failure in artificial drainage (e.g. sewers).
- Taking into account the above and absence of any historical sewer flooding specific to the onshore HVDC 5.1.4.17 converter/HVAC substation area the overall risk of flooding via artificial drainage system to the onshore HVDC converter/HVAC substation area has been assessed to be low.

### Historic flooding

5.1.4.18 Norfolk County Council, SFRA and Flood Risk Management Strategy (Norfolk County Council, 2010) mapping indicates that the onshore HVDC converter/HVAC substation area has not been affected by historical flooding.

### Current flood risk

- The onshore HVDC converter/HVAC substation area is located within Flood Zone 1, an area considered 5.1.4.19 at low risk of flooding from fluvial or tidal sources.
- 5.1.4.20 It has been determined that the main risk of flooding to the onshore HVDC converter/HVAC substation area is from groundwater sources.





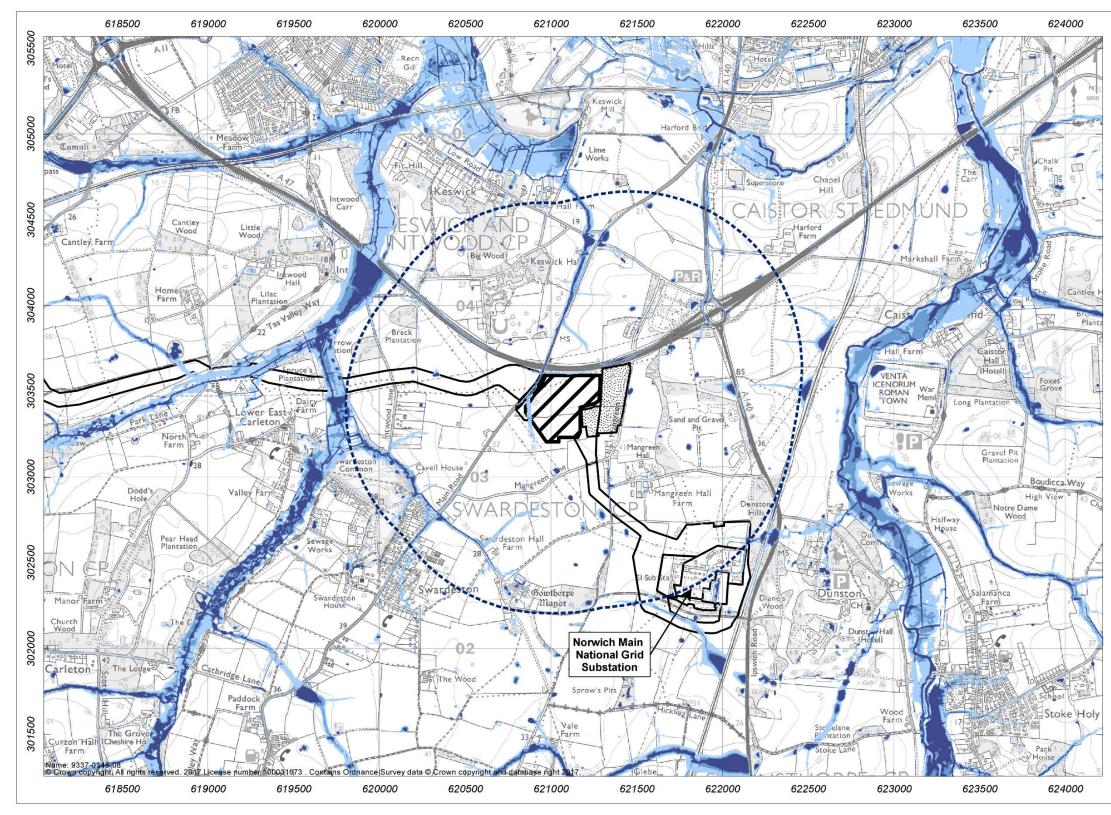


Figure 5.2: Onshore EA surface water flood map for the onshore HVDC converter/HVAC substation area.

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#### Flood risk management 5.2

#### 5.2.1 Site vulnerability

- Applying the Flood Risk Vulnerability Classification in Table 2 of the PPG Flood Risk and Coastal Change 5.2.1.1 (Department for Communities and Local Government, 2014), the onshore HVDC converter/HVAC substation is classified as "Essential infrastructure".
- Table 3 of PPG (Table 5.1 of this report) states that "Essential Infrastructure" uses are appropriate within 5.2.1.2 Flood Zone 1 and 2, and also in Flood Zone 3.

Flood Risk Vulnerability classification (see Table 2 of NPPF Technical Guidance)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	Yes	Yes	Yes	Yes	Yes
Zone 2	Yes	Yes	Exception test required	Yes	Yes
Zone 3a	Exception test required	Yes	No	Exception test required	Yes
Zone 3b Functional Floodplain	Exception test required	Yes	No	No	No
Key: Yes: Developmen	t is appropriate, No: Deve	elopment should not be	permitted.		

### Table 5.1: Flood risk vulnerability and Flood Zone 'compatibility' as identified in table 3 of NPPF technical guidance.

#### 5.2.2 Sequential Test

5.2.2.1 The Sequential Test is designed to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate for this type of development.

- 5.2.2.2 LPAs allocating land in LDPs for development should apply the Sequential Test to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed. In areas at risk of river or sea flooding, preference should be given to locating new development in Flood Zone 1. If there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. Within each Flood Zone new development should be directed to sites at the lowest probability of flooding from all sources as indicated by the SFRA.
- The Sequential Test therefore seeks the allocation of land for development in flood areas of least risk 5.2.2.3 where practicable (i.e. preferentially steer towards Zone 1). Developers should also have regard to the Sequential Test when evaluating sites where LDPs have not been subject to SFRA and/or the Sequential Test and where it is necessary to demonstrate that there are no alternative sites with a lower probability of flooding for the given end use.
- 5.2.2.4 Norfolk County Council SFRA flood mapping shows that the onshore HVDC converter/HVAC substation area is located within Flood Zone 1 and has therefore passed the Sequential Test requirement of locating development within 'low' flood risk zones.
- As the onshore HVDC converter/HVAC substation area is located within Flood Zone 1 and has passed 5.2.2.5 the Sequential Test there is no need to undertake an Exceptions Test.

#### **Drainage strategy** 5.3

#### 5.3.1 Surface water drainage

- The sustainable management of surface water is an essential element of reducing future flood risk to the 5.3.1.1 site and its surroundings.
- 5.3.1.2 Undeveloped sites generally rely on natural drainage to convey or absorb rainfall, the water soaking into the ground or flowing across the surface into watercourses.
- 5.3.1.3 The effect of development is generally to reduce the permeability of at least part of the site, which markedly changes the site's response to rainfall. Without specific measures to manage surface water the volume of water and peak flow rate are likely to increase. Inadequate surface water drainage arrangements can threaten the development itself and increase the risk of flooding to others.
- 5.3.1.4 Surface water arising from a developed site should as far as is practicable be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development while reducing the risk of flooding at the site and elsewhere, taking climate change into account.







#### 5.3.2 Sustainable drainage options

- The NPPF and associated PPG, SuDS Manual (CIRIA, 2015) and also the Joint Core Strategy for 5.3.2.1 Broadland, Norwich and South Norfolk (Broadland District Council et al., 2014) promote sustainable water management through the use of SuDS. A hierarchy of techniques is identified:
  - Prevention the use of good site design and housekeeping measures on individual sites to prevent • runoff and pollution (e.g. minimise areas of hard standing);
  - Source Control control of runoff at or very near its source (such as the use of rainwater harvesting); •
  - Site Control management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site); and
  - Regional Control management of runoff from several sites, typically in a detention pond or wetland. •
- 5.3.2.2 The implementation of SuDS as opposed to conventional drainage systems, provides several benefits by:
  - Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding • downstream;
  - Reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
  - Improving water quality over conventional surface water sewers by removing pollutants from diffuse ٠ pollutant sources;
  - Reducing potable water demand through rainwater harvesting; •
  - Improving amenity through the provision of public open spaces and wildlife habitat; and
  - Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

#### 5.3.3 **Runoff rate calculations**

- 5.3.3.1 An assessment of the current and proposed runoff rates was undertaken to determine the surface water attenuation requirements for the onshore HVDC converter/HVAC substation area in line with The SuDS Manual (2015), which indicates that the flow rate discharged from the onshore HVDC converter/HVAC substation area must not exceed that prior to Hornsea Three for the:
  - 1 in 1 year event;
  - Qbar;
  - 1 in 30 year event; and
  - 1 in 100 year event. •
- The rates of runoff were determined using the current 'industry best practice' guidelines as outlined in the 5.3.3.2 Interim Code of Practice for SuDS (National SuDS Working Group, 2004) and the Non-statutory technical standards for sustainable drainage systems (Defra, 2015). The EA/Defra recommended methodology for sites up to 50 ha, in area is the Institute of Hydrology Report 124 method (Institute of Hydrology, 1994). The runoff rates were calculated using the MicroDrainage software suite and are present within Table 5.2.



#### Greenfield runoff rate characteristics 5.3.4

- 5.3.4.1 The proposed land use (as noted in Section 3.3) is an onshore HVDC converter/HVAC substation with an operational life of 35 years. The greenfield runoff rates are based on the current site baseline, assumed to be 100% permeable surfacing.
- The following parameters were incorporated into the greenfield site runoff calculations: 5.3.4.2
  - Area: 60,000 m<sup>2</sup>;
  - Standard-period Average Annual Rainfall: 605 mm/year;
  - Soil: 0.400; and
  - Region No: 5.

#### Table 5.2: Greenfield runoff characteristics.

Annual Probability (Return Period, years)			
100% (1)			
Qbar			
3.33% (30)			
1% (100)			
1% + 20% Climate Change			
1% + 40% Climate Change			

Greenfield Runoff (I/s)
15.00
17.20
41.30
61.30
73.56
85.82





#### 5.3.5 Attenuation requirements

- 5.3.5.1 The attenuation volume required to restrict the surface water runoff from low permeable surfacing to the existing 1 in 1 year rate for a 1 in 100 year rainfall event plus climate change (40%) has been determined using the industry standard MicroDrainage software suite incorporating the following parameters:
  - Impermeable area: approximately 60,000 m<sup>2</sup> (assumed 100% impermeable area); •
  - Cv (proportion of rainfall forming surface water runoff): assume a factor of 75% for the development • in summer, and 84% in winter (weighted average based on proposed land use);
  - Runoff rate: 15.00 l/s: and
  - Assuming no infiltration losses. •
- The system was modelled within MicroDrainage as a tank/pond with controlled discharge via an orifice 5.3.5.2 outflow control. The MicroDrainage calculation sheets are included within section B.7.
- 5.3.5.3 The attenuation volume required to restrict runoff from a 1 in 100 year storm event, plus a 40% allowance for climate change, to the 1 in 1 year (100% annual probability) current runoff rate of 15.00 l/s, has been determined to be approximately 7,500 m<sup>3</sup> for the onshore HVDC converter/HVAC substation area. Appendix B, section B.11, illustrates the outline drainage strategy for the onshore HVDC converter/HVAC substation and demonstrates that the required attenuation volume can be practicably provided within the HVDC converter/HVAC substation area.

#### Summary and conclusions 5.4

#### 5.4.1 Summary

5.4.1.1 A site-specific FRA in accordance with section 5.7 of the NPS EN-1, the NPPF and associated PPG ID7 has been undertaken for the onshore HVDC converter/HVAC substation area, located approximately 5.6 km south west of Norwich City Centre.

#### 5.4.2 Flood risk

- 5.4.2.1 In accordance with the guidance on development and flood risk (PGG: ID7 Flood risk and coastal change) the FRA provides a response to the aims set out in 1.1.1.5:
  - EA mapping shows that the proposed development is located in Flood Zone 1 at 'low' risk of flooding • (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%)).
  - There is no historical evidence of flooding at the onshore HVDC converter/HVAC substation area. •
  - The onshore HVDC converter/HVAC substation area is located within a primarily agricultural landscape. The majority of surface runoff will either infiltrate into exposed permeable natural surfaces soils, or be conveyed to the local drainage network. The EA surface water flood map indicates that localised areas within the northern and western extent of the onshore HVDC converter/HVAC substation area are at low risk of surface water flooding.

- of groundwater flooding.
- considered to be low.
- climate change.
- Zone 1 therefore there is no requirement for either a Sequential or Exception Test.
- storm event plus a 40% allowance for climate change.

#### 5.4.3 Conclusion

5.4.3.1 This FRA and supporting documentation shows that the HVDC converter/HVAC substation at the proposed locations meets the requirements of NPS EN-1 and the NPPF.



Annex 2.1 - Onshore Infrastructure Flood Risk Assessments **Environmental Statement** May 2018

The onshore HVDC converter/HVAC substation area has been assessed to be at low to medium risk

The risk of flooding from infrastructure failure including flood defences and adopted sewers is

The onshore HVDC converter/HVAC substation area is not at risk of flooding from a reservoir failure. The onshore HVDC converter/HVAC substation is defined as "Essential Infrastructure" in Table 2 of Planning Practice Guidance ID7 and is suitable for the present Flood Zone and the zone including

The onshore HVDC converter/HVAC substation is located within EA Flood Zone 1 and SFRA Flood

There will be an increase in low permeability cover; and surface runoff will need to be controlled at an agreed runoff rate. MicroDrainage calculations indicate that the overall attenuation requirement for the 60,000 m<sup>2</sup> development assuming no loss via infiltration is 7,500 m<sup>3</sup> for the 1 in 100 year





### Hornsea Three Onshore Cable Corridor Flood Risk 6. Assessment

#### Methodology 6.1

The approach to the Hornsea Three onshore cable corridor FRA was discussed and agreed with Norfolk 6.1.1.1 County Council (acting as LLFA for the Hornsea Three hydrology and flood risk study area) during a meeting in November 2017. The FRA focused on areas where the Hornsea Three onshore cable corridor crosses land assessed as Flood Zone 2 and 3, medium to high risk of flooding.

#### Site setting 6.2

#### 6.2.1 Location

6.2.1.1 The proposed Hornsea Three onshore cable corridor runs approximately 55 km from the landfall location to the onshore HVDC converter/HVAC substation south of Norwich City Centre (Figure 6.1). The Hornsea Three onshore cable corridor runs through a predominantly agricultural land uses together with areas of heathland, valley mires and woodland. The landscape is relatively flat lying with elevations reaching 100 m Above Ordinance Datum (AOD) near Sheringham.

#### 6.2.2 Existing use

Hornsea Three onshore cable corridor passes through the EA designated Anglian River Basin District 6.2.2.1 which covers 27,890 km<sup>2</sup> from Lincolnshire in the north to Essex in the south. The landscape ranges from gentle chalk and limestone ridges to the extensive lowlands of the fens and East Anglian coastal estuaries and marshes. The river basin district is predominantly rural, with more than half of its land surface (c. 1.5 million ha) used for agriculture and horticulture.

#### 6.2.3 Proposed use

- The Hornsea Three onshore cable corridor will extend from the landfall at Weybourne to the onshore 6.2.3.1 HVDC converter/HVAC substation to the south of Norwich. For the purpose of this FRA, the maximum design scenarios are identified in volume 3, chapter 2: Hydrology and Flood Risk and are summarised below:
  - Onshore cable corridor (approximately 80 m wide, comprising 60 m permanent area and 20 m • temporary working area);
  - Up to six cable trenches, each trench is up to 5 m wide at the ground level; •
  - Up to 440 jointing bays and 440 link boxes; •
  - Up to 120 Horizontal Directional Drilling (HDD) locations (per phase) comprising up to 105 minor • HDDs and 15 major HDDs) – some of these will be watercourse crossings;
  - Up to 15 HDD compounds; •



- Up to six crossings of watercourses using open cut techniques;
- HVDC converter/HVAC substation);
- Up to 55 storage areas; and
- Up to 66 km of temporary haul road surfaced with aggregate on geotextile.

6.2.3.2 Location of compounds can be seen on Figure 6.1. The location of the HDDs is shown on the crossing schedule which accompanies the DCO application.

### Annex 2.1 - Onshore Infrastructure Flood Risk Assessments **Environmental Statement** May 2018

Up to five secondary compounds (compounds also at the Hornsea three landfall and at the onshore





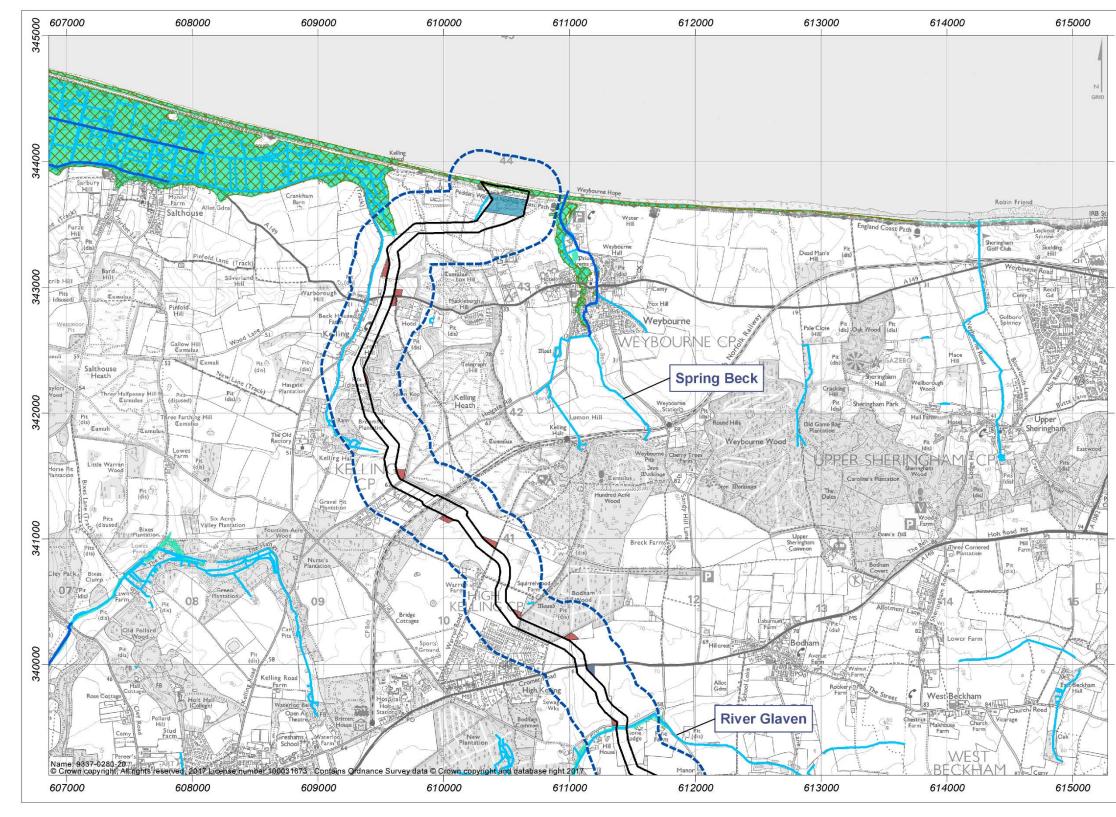


Figure 6.1: Watercourses and Flood Zones.



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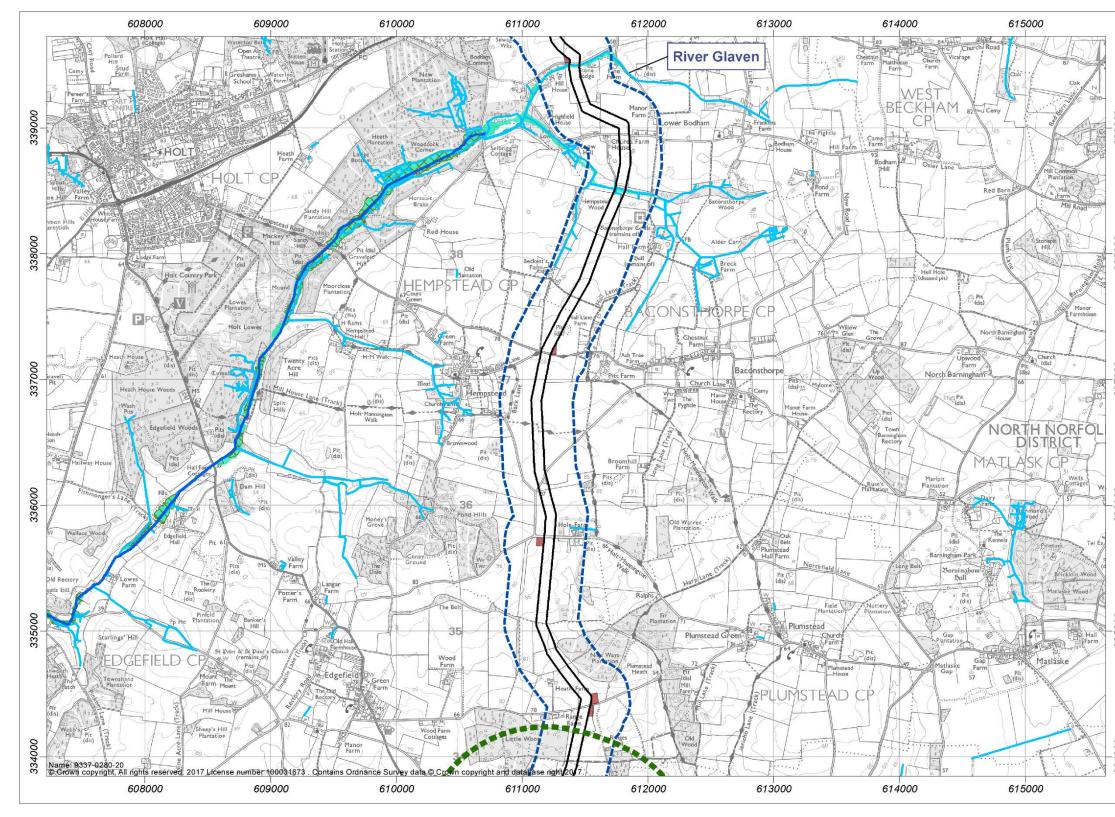


Figure 6.1: Watercourses and Flood Zones.



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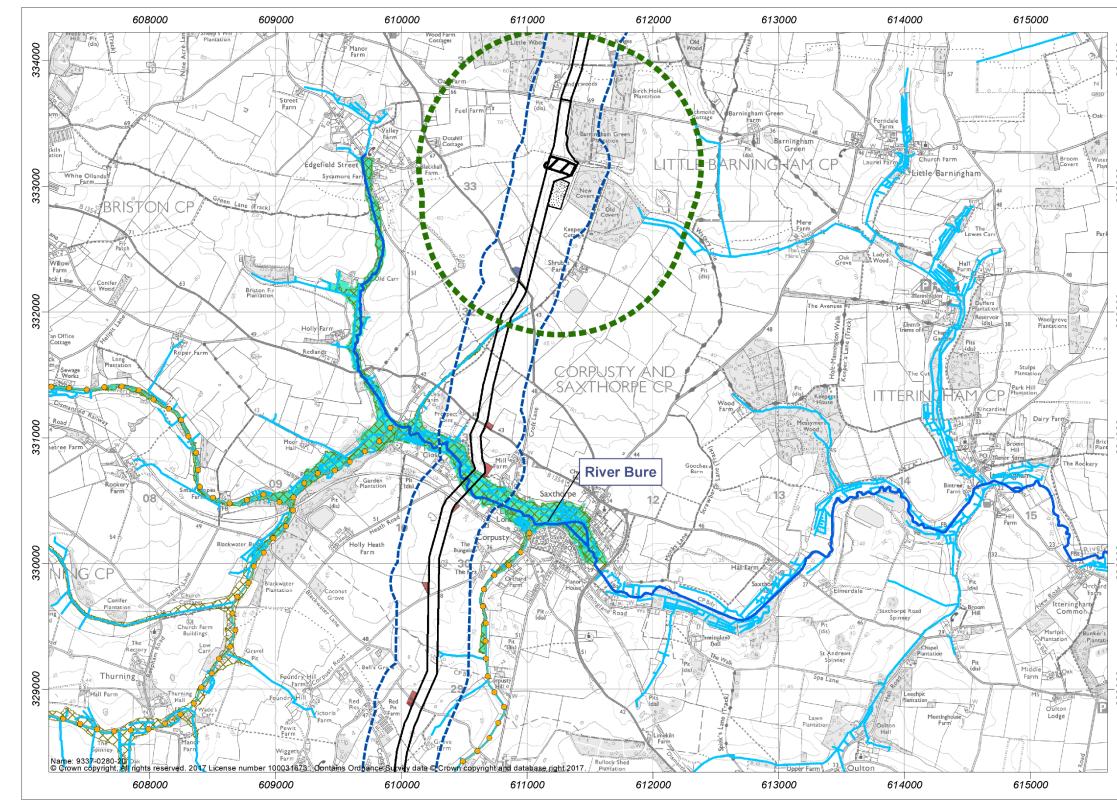


Figure 6.1: Watercourses and Flood Zones.



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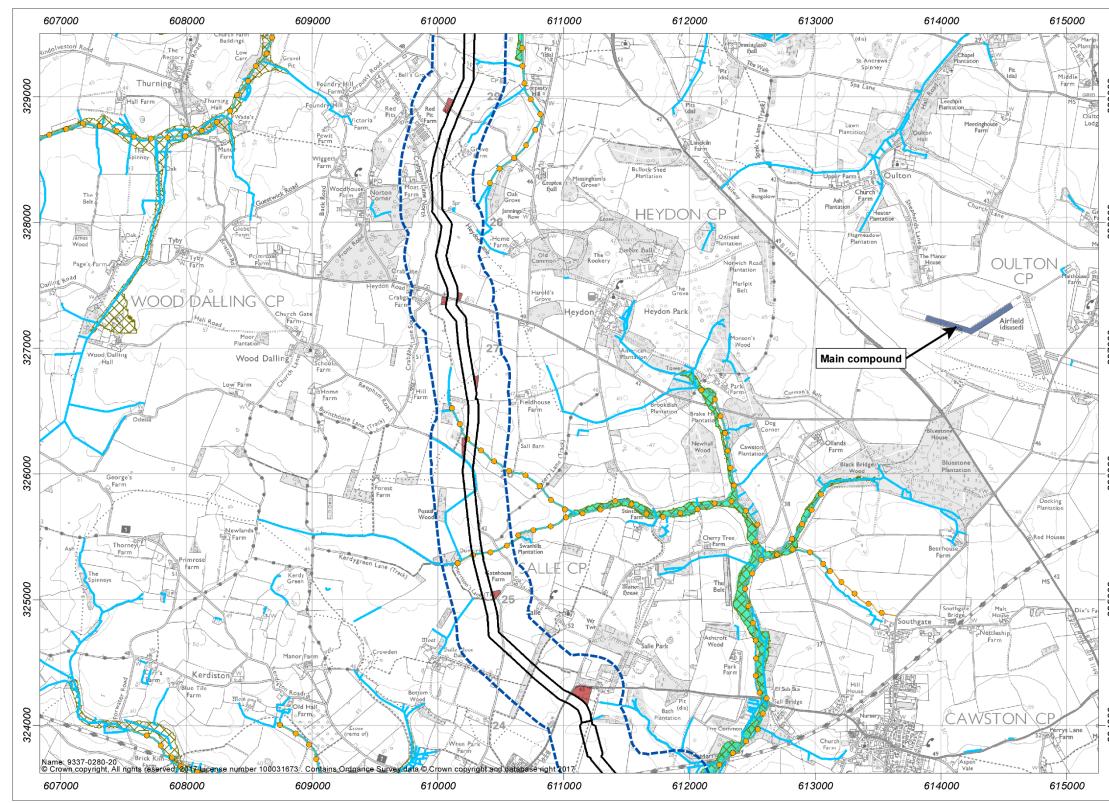


Figure 6.1: Watercourses and Flood Zones.



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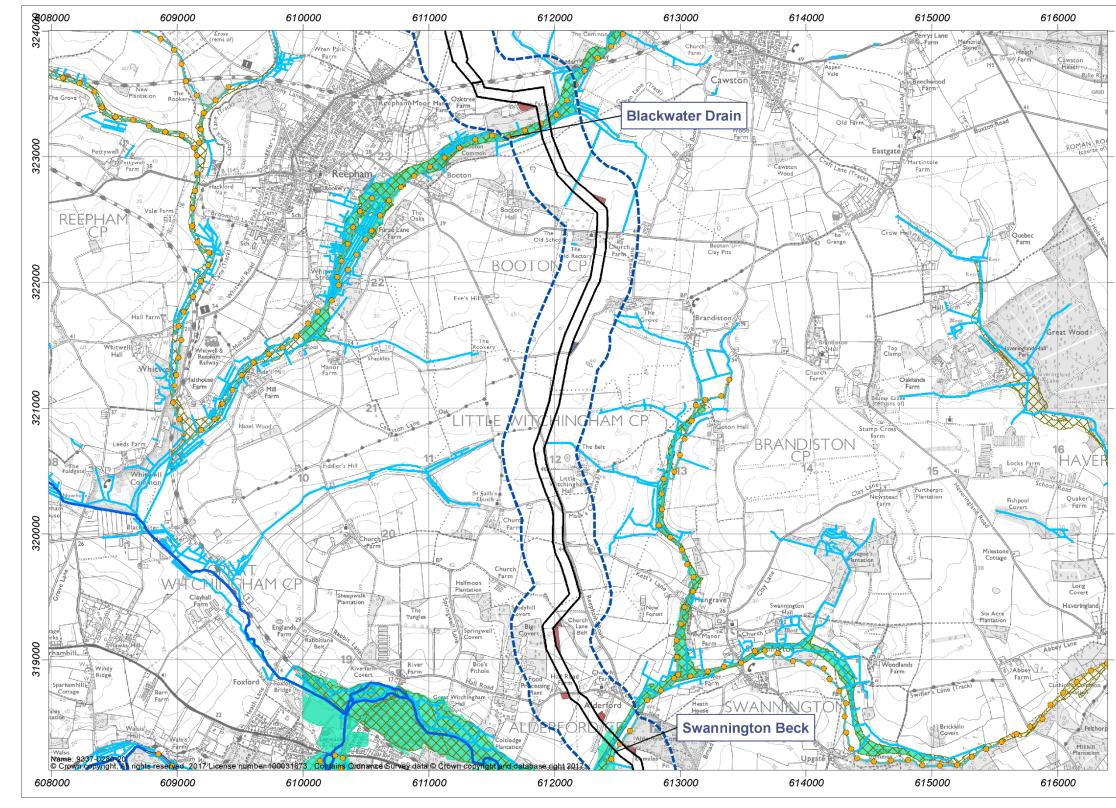


Figure 6.1: Watercourses and Flood Zones.



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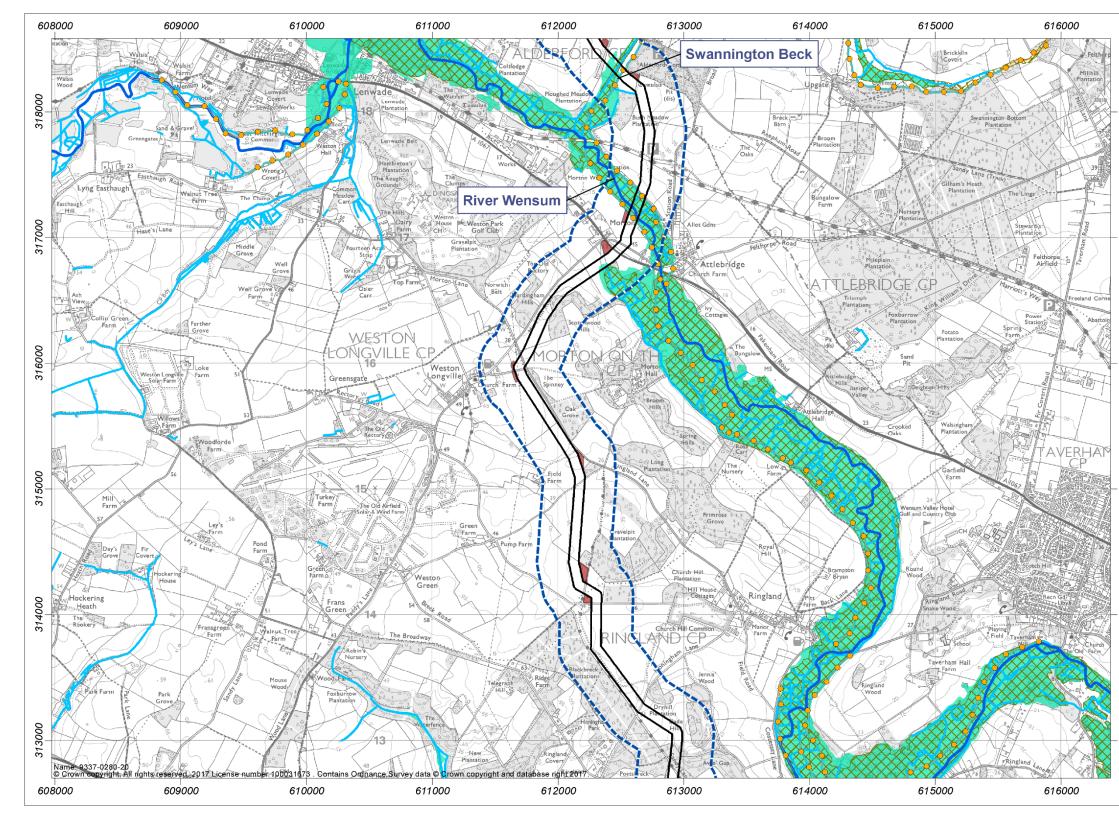


Figure 6.1: Watercourses and Flood Zones.



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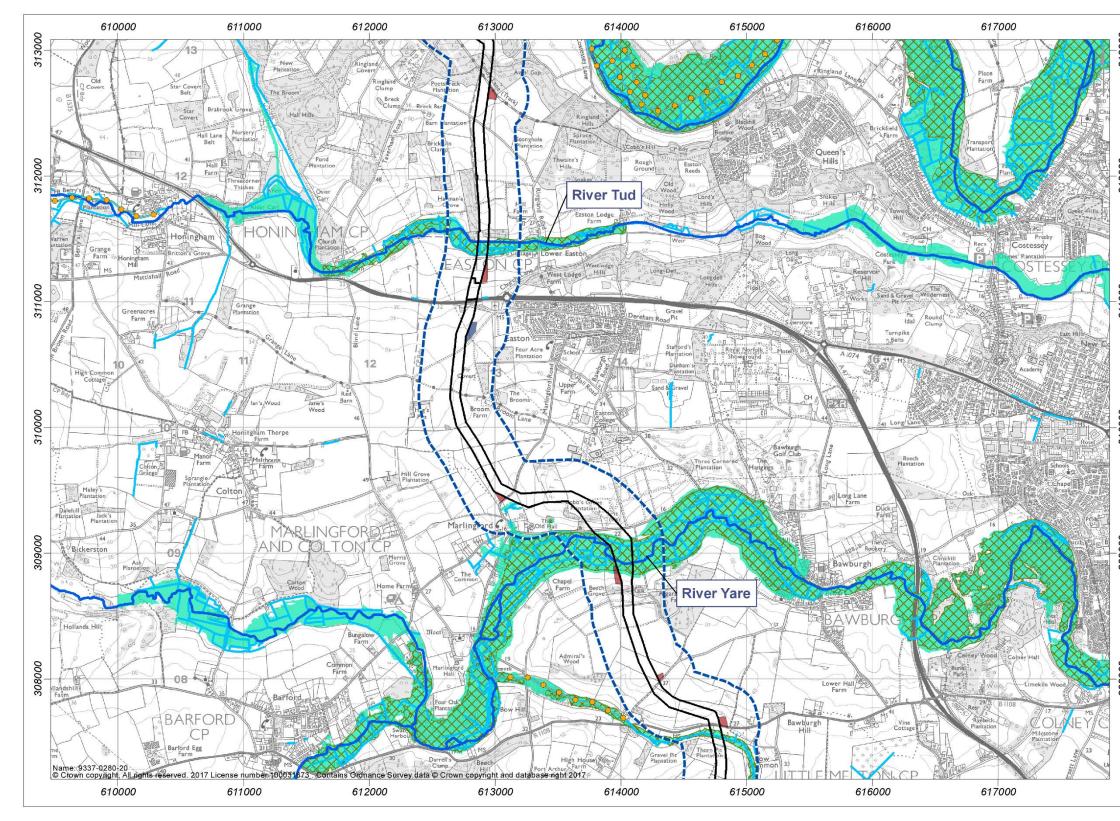


Figure 6.1: Watercourses and Flood Zones.



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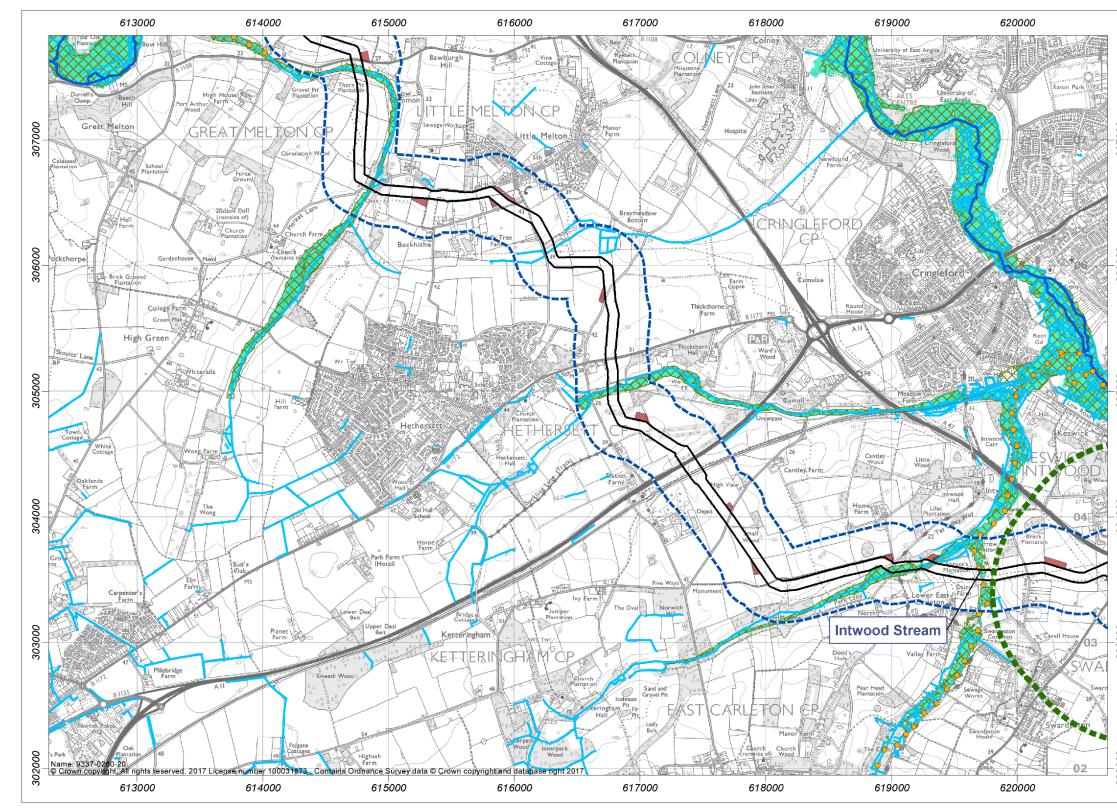


Figure 6.1: Watercourses and Flood Zones.



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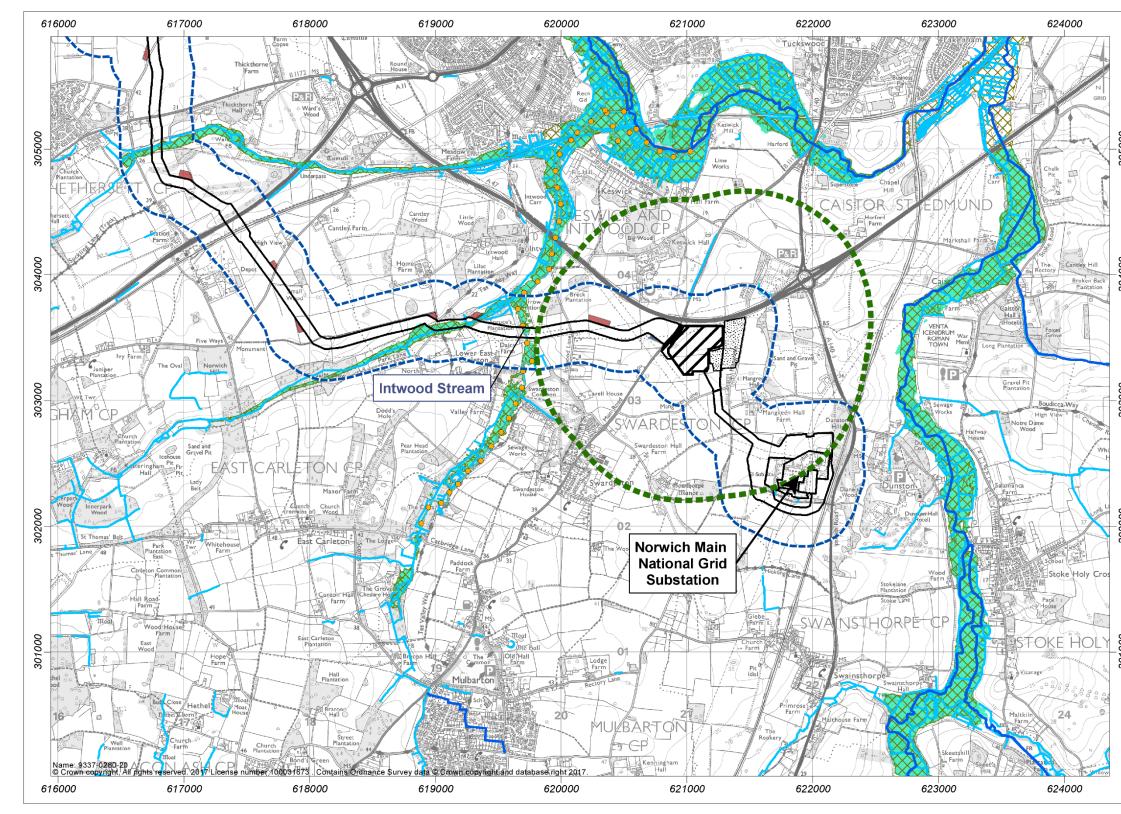


Figure 6.1: Watercourses and Flood Zones.



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#### Flood Risk Assessment 6.2.4

#### Hydrological overview

- 6.2.4.1 This section assesses the baseline hydrological characteristics of the Hornsea Three onshore cable corridor. A 250 m buffer was selected for the Hornsea Three onshore cable corridor to identify any potential receptors that might be affected by the Hornsea Three onshore cable corridor. The 250 m buffer is considered an appropriate buffer to identify changes in flood risk in the surrounding area.
- The Hornsea Three onshore cable corridor crosses a number of catchments associated with EA 6.2.4.2 designated main rivers and ordinary watercourses. The Hornsea Three onshore cable corridor also passes through an IDB area managed by Norfolk Rivers IDB. The Board's drainage and water level management infrastructure consists of a number of watercourses, of varying sizes, which all discharge by gravity into EA designated main rivers. The IDB maintains only the most critical ordinary watercourses (i.e. that are not main rivers), which equates to around 25% of the total length of ordinary watercourses in the IDB district.
- 6.2.4.3 This section will focus on areas where the Hornsea Three onshore cable corridor crosses areas designated within Flood Zone 2 and 3. The areas which are assessed within the sections are outlined below.

#### Fluvial flood risk

The EA Flood Map for Planners indicates that the majority of the Hornsea Three onshore cable corridor 6.2.4.4 is located in areas defined as Flood Zone 1 (land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%)). Localised areas along the Hornsea Three onshore cable corridor associated with main rivers and ordinary watercourses including, the unnamed stream near Salle, Blackwater Drain, Swannington Beck, River Wensum, River Tud, River Yare, unnamed tributary of the River Yare at Little Melton and Intwood Stream are shown to be within Flood Zone 3. Full details of the areas within Flood Zones 2 and 3 associated with each watercourse are outlined below and in Table 6.1.

#### River Glaven (Gunthorpe Stream)

6.2.4.5 An area approximately 1.46 ha either side of Gunthorpe Stream is designated as being within Flood Zone 2, designated as at medium risk of fluvial flooding.

#### **River Bure**

An area equalling approximately 12.29 ha either side of the River Bure is designated as being within Flood 6.2.4.6 Zone 2 and at medium risk of fluvial flooding. A smaller area equalling 10.40 ha, either side of the River Bure is designated being within Flood Zone 3 at high risk of fluvial flooding. Smaller field drains are present north of the River Bure which may contribute to the flood risk within the area.

### Blackwater Drain

6.2.4.7 An area equalling approximately 4.65 ha either side of Black Water Drain is designated as being within Flood Zone 2. A smaller area equalling approximately 3.92 ha is designated as being within Flood Zone 3.

#### Swannington Beck

6.2.4.8 A localised area along the banks of the field drain north of Swannington Beck is designated as being within Flood Zone 2 and 3, at high risk of fluvial flooding. An area approximately 2.96 ha along Swannington Beck is designated as being within Flood Zone 3.

#### **River Wensum**

6.2.4.9 The land immediately adjacent to the River Wensum within the Hornsea Three hydrology and flood risk study area is designated as Flood Zone 3, at high risk of fluvial flooding with the area equalling 11.75 ha. To the south west of the Hornsea Three hydrology and flood risk study area, south of Fakenham Road, outside of the IDB boundary, the area around the drainage dykes is also classified as in Flood Zones 3 and 2.

#### **River Tud**

6.2.4.10 The land to the south of the River Tud is designated as Flood Zone 2 (approximate area 8.15 ha) and 3 (approximate area 6.82 ha), at high risk of fluvial flooding. The area to the north of the site rises steeply which has contributed to the area being designated as Flood Zone 1.

### River Yare

The areas north and south of the River Yare are designated as Flood Zone 2 and 3, at high risk of fluvial 6.2.4.11 flooding. The approximate area within Flood Zone 3 equals 20.35 ha. The area at risk of flooding mirrors the area of the IDB boundary but generally extends approximately 30 m further from the river.

#### Intwood Stream

6.2.4.12 The majority of the Hornsea Three hydrology and flood risk study area at the Intwood Stream crossing point is within Flood Zone 1. A small area (3.69 ha) associated with flat lying ground is within Flood Zone 3 at high risk of fluvial flooding. An area associated with the unnamed stream to the west of Intwood Stream is designated as Flood Zone 2 and 3.

### Tidal flood risk

- 6.2.4.13 Flooding from tidal sources occur when water levels from the sea (i.e. tidal surge) raise above ground levels / flood defences within coastal areas.
- 6.2.4.14 By virtue of ground elevation, the onshore landfall site is located within Flood Zone 1. The intertidal zone associated with Weybourne Beach is located within Flood Zone 2 and 3.





6.2.4.15 Due to the land characteristics and topography of the areas associated with the onshore landfall tidal flooding has not be considered further within this assessment. Mitigation measures and management strategies to address onshore and intertidal flood risk are presented in the Outline Code of Construction Practice (CoCP) (document reference A8.5).

Watercourse	Flood Zone 2 (ha)	Flood Zone 3 (ha)
Blackwater Drain	4.65	3.92
Intwood Stream	4.78	3.69
River Bure	12.29	10.40
River Glaven (Gunthorpe Stream)	1.46	0.00
River Tud	8.15	6.82
River Wensum	13.12	11.75
River Yare	23.20	20.35
Swannington Beck	7.31	2.96

# Flooding from rising/high groundwater

- 6.2.4.16 The majority of the Hornsea Three onshore cable corridor is underlain by superficial deposits predominantly made up of different glacial deposits. In the northern part of the Hornsea Three hydrology and flood risk study area, the valley floors are dominated by Alluvium and Head. Peat is also present near Beach Lane at the Hornsea Three intertidal area (refer to volume 3, chapter 1: Geology and Ground Conditions for further details on superficial and bedrock deposits).
- 6.2.4.17 The bedrock underlying the northern and central part of the Hornsea Three onshore cable corridoris split between the Lewes Nodular Chalk of the White Chalk Subgroup (in the west) and the Wroxham Crag Formation (in the east). The rest of the Hornsea Three onshore cable corridor is underlain by Lewes Nodular Chalk of the White Chalk Subgroup.
- In North Norfolk, the chalk aquifer is dominated by groundwater flow via fissures and bedding planes, 6.2.4.1 which tend to be more prevalent in the top 30 to 60 m of the chalk leading to a high flow potential at these depths. Depth to groundwater and groundwater flow direction is heavily influenced by the overlying topography. Seasonal fluctuations in groundwater levels are likely to occur based on the low storage capacity of the chalk with such variation being more prevalent towards the higher topographic areas. The Wroxham Crag Formation is less utilised as a source groundwater due to its unconsolidated nature (i.e. loose material making construction and use of abstraction wells more problematic than the underlying chalk).

- 6.2.4.2 The chalk is designated as a principal aquifer, which is defined by the BGS as "layers of rock or drift deposits that have high intergranular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers as aquifers previously designated as major aquifers".
- 6.2.4.3 Based on the information outlined above the potential for groundwater flooding is considered to be at low to medium. This is based on the author's professional judgement and takes into account underlying geological characteristics and absence of historical groundwater flood events.

# Surface water flooding

- 6.2.4.4 Surface water, or pluvial, flooding is defined as flooding caused by rainfall generated overland flow, before the runoff enters a watercourse or sewer. In such events sewerage and drainage systems and surface watercourses may be overwhelmed.
- 6.2.4.5 Localised areas along the Hornsea Three onshore cable corridor are defined as being at 'low to high' risk of flooding from surface water. However, the Hornsea Three onshore cable corridor following instillation will not be impacted or cause any adverse effect of surface water flooding.

# Reservoir failure assessment

- Localised areas along the Hornsea Three onshore cable corridor are within an area designated as being 6.2.4.6 within the maximum extent of flooding from a reservoir.
- 6.2.4.7 However, the EA stipulate that a reservoir dam failure is an unlikely event. All large reservoirs are inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the EA ensure that reservoirs are inspected regularly and essential safety work is carried out where required.
- 6.2.4.8 Taking into account the above, the overall risk of flooding from a reservoir failure has been assessed to be low.

# Flood defence measures

6.2.4.9 EA Spatial Flood Defence data indicates a number of flood defences are present along the Hornsea Three hydrology and flood risk study area. The main flood defences are associated with river flood defences along the banks outlined in Table 6.2.





## Table 6.2: EA flood defences

Watercourses	Asset Type	Design Standard (Year)	Condition
River Tud	High Ground (River Channel)	5	3
River Yare	High Ground	5	3
River Bure	High Ground (Maintained Channel Bank)	5	3
River Wensum	High Ground (Main River Channel)	10	3
Intwood Stream	High Ground	0	3

The onshore cable corridor will cross main rivers and any ordinary watercourses which incorporate flood 6.2.4.10 defences using HDD. Therefore, the Hornsea Three onshore cable corridor would cause no adverse effects on watercourses, the flood defence function or integrity.

## Sewer/water main failure assessment

- Flooding from sewerage failure occurs when a rainfall event exceeds the maximum capacity of the 6.2.4.11 surrounding network. The most common causes of flooding from sewers are inadequate flow capacity, blockages, pumping station failures, burst water mains, water inflow from rivers or the sea, tide locking, siltation, fats/greases, and sewer collapse. Should any of these events occur there is a risk of flooding within the vicinity of the sewer by surcharge where the flood is in excess of the sewer capacity (usually 1 in 30-year event or greater).
- 6.2.4.12 Sewerage flooding issues may occur along the Hornsea Three onshore cable corridor. However, mitigation measures, as identified in Table 2.17 of volume 3, chapter 2: Hydrology and Flood Risk, limiting the potential impact on the surrounding sewer networks, in turn being at low risk of flooding from this source.

## Historic floodina

EA historic flood records indicate no historical flood events have occurred within the Hornsea Three 6.2.4.13 hydrology and flood risk study area.

### Flood risk management 6.3

### 6.3.1 Site vulnerability

Applying the Flood Risk Vulnerability Classification in Table 2 of the PPG Flood Risk and Coastal Change 6.3.1.1 (Department for Communities and Local Government, 2014), the Hornsea Three onshore cable corridor is classified as "Essential infrastructure".

6.3.1.2 Table 3 of the PPG (Table 6.3 of this report) states that "Essential Infrastructure" uses are appropriate within Flood Zone 1 and 2, and also in Flood Zone 3, but subject to an Exception test.

## Table 6.3: Flood risk vulnerability and Flood Zone 'compatibility' as identified in table 3 of NPPF technical guidance.

Flood Risk Vulnerability classification (see Table 2 of NPPF Technical Guidance)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	Yes	Yes	Yes	Yes	Yes
Zone 2	Yes	Yes	Exception test required	Yes	Yes
Zone 3a	Exception test required	Yes	No	Exception test required	Yes
Zone 3b Functional Floodplain	Exception test required	Yes	No	No	No
Key: Yes: Development is ap	opropriate, No: Develo	pment should not be	e permitted.		

### 6.3.2 Sequential and Exception Tests

- 6.3.2.1 The Sequential Test is designed to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate for this type of development.
- LPAs allocating land in LDPs for development should apply the Sequential Test to demonstrate that there 6.3.2.2 are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed. In areas at risk of river or sea flooding, preference should be given to locating new development in Flood Zone 1. If there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. Within each Flood Zone new development should be directed to sites at the lowest probability of flooding from all sources as indicated by the SFRA.
- The Sequential Test therefore seeks the allocation of land for development in flood areas of least risk 6.3.2.3 where practicable (i.e. preferentially steer towards Zone 1). Developers should also have regard to the Sequential Test when evaluating sites where LDPs have not been subject to SFRA and/or the Sequential Test and where it is necessary to demonstrate that there are no alternative sites with a lower probability of flooding for the given end use.







6.3.2.4 The development is for the installation of below ground HVAC/HVDC export cables, and can be classified as "Essential Infrastructure". Norfolk County Council SFRA flood mapping shows that the majority of the development is located within Flood Zone 1, with a small percentage (59.89 ha or 1.1%) located within Flood Zone 3. The development is to connect the landfall and onshore HVDC converter/HVAC substation, and therefore is unable to be routed without crossing areas within Flood Zone 3, does not increase flood risk to the surrounding area and has negligible risk of flooding to and from the development. On this basis, the Sequential Test and Exception Test are determined to be passed.

### Flood mitigation measures 6.4

- 6.4.1.1 During construction, site workers will be made aware of areas that are located within Flood Zone 2 and 3, and of the evacuation protocol in the event of a flood. Stockpiled material and construction compounds will be located outside of the floodplain (where possible), minimising loss of floodplain storage area and reducing possibility of silt laden runoff into surrounding watercourses. In accordance with Byelaw 10 (Norfolk Rivers Internal Drainage Board, Development Control Byelaws, March 2013), no materials, Heavy Goods Vehicle's or soil stockpiles will be located within 9 m of the edge of drainage, watercourse and flood risk management features. No work will be carried out within 8 m of non-tidal water bodies unless agreed with the relevant drainage authority, EA or LLFA.
- 6.4.1.2 The Hornsea Three onshore cable corridor would encounter main rivers, ordinary watercourses, as well as field drains and ditches. Some of the smaller watercourses are likely to be crossed by open-cut techniques (see the Crossing Schedule which accompanies the DCO application). Mitigation measures to minimise any potential adverse effects on surrounding watercourses, increase in flood risk, degradation of agricultural land / designated sites during construction are set out in volume 3, chapter 2: Hydrology and Flood Risk and the Outline CoCP (document reference A8.5) which accompanies the DCO application.
- 6.4.1.3 HDD will be used to cross main rivers along the Hornsea Three onshore cable corridor. Where required, consent will be sought from local drainage authorities and/or the EA for any works within 8 m of non-tidal water bodies and 9 m from the edge of drainage and flood risk management features.

### Summary and conclusions 6.5

- 6.5.1 Summary
- A FRA in accordance with section 5.7 of the NPS EN-1, the NPPF and associated PPG ID7 has been 6.5.1.1 undertaken for the proposed Hornsea Three onshore cable corridor extending approximately 55 km from the landfall to the onshore HVDC converter/HVAC substation south of Norwich City Centre.

### 6.5.2 Flood risk

In accordance with the guidance on development and flood risk (PGG: ID7 Flood risk and coastal change) 6.5.2.1 the FRA provides a response to the aims set out in 1.1.1.5:



- within Flood Zone 2 and 3.
- area for the onshore cable corridor.
- areas within the along the route are at 'low to high' risk of surface water flooding.
- groundwater flooding.
- considered to be low.
- The Hornsea Three onshore cable corridor is not at risk of flooding from a reservoir failure.
- including climate change, subject to an Exception Test.
- passed.
- hydrology and flood risk to the area and designated sites.
- from all sources.

### 6.5.3 Conclusion

6.5.3.1 This FRA and supporting documentation shows that the Hornsea Three onshore cable corridor meets the requirements of NPS EN-1 and the NPPF.

Annex 2.1 - Onshore Infrastructure Flood Risk Assessments **Environmental Statement** May 2018

EA mapping shows that the majority of the proposed development is located in Flood Zone 1 at 'low' risk of flooding (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%)). Localised areas associated with main rivers and ordinary watercourses are designated as being

There is no historical evidence of flooding within the Hornsea Three hydrology and flood risk study

The Hornsea Three onshore cable corridor is located within a primarily agricultural landscape. The majority of surface runoff will either infiltrate into exposed permeable natural surfaces soils, or be conveyed to the local drainage network. The EA surface water flood map indicates that localised

The Hornsea Three onshore cable corridor has been assessed to be at low to medium risk of

The risk of flooding from infrastructure failure including flood defences and adopted sewers is

The proposed Hornsea Three onshore cable corridor is defined as "Essential Infrastructure" in Table 2 of Planning Practice Guidance ID7 and is suitable for the present Flood Zone and the zone

The Hornsea Three onshore cable corridor is to connect the landfall and onshore HVDC converter/HVAC substation, and therefore is unable to be routed without crossing areas within Flood Zone 3, does not increase flood risk to the surrounding area and has negligible risk of flooding on the development. On this basis, the Sequential Test and Exception Test are determined to be

Proposed mitigation measures will reduce any adverse impacts caused by the installation of the Hornsea Three onshore cable corridor, meaning there will be a negligible impact to the existing

Following the installation of Hornsea Three onshore cable corridor, it is anticipated that it will have no adverse effects/impacts on all sources of flooding and the hydrological characteristics of the area. The Hornsea Three onshore cable corridor has therefore, been designated as at low risk of flooding





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Ordnance Survey 1:10,000 Scale Electronic Data Mapping for assessment area.

Ordnance Survey Mapping (2016) 1: 50 000 Sheet 134: Norwich & The Broads. Landranger Series. Southampton, Ordnance Survey.





# Appendix A Outline Surface Water Drainage Strategy for the **Onshore HVAC Booster Station**

### Introduction A.1

This Outline Surface Water Drainage Strategy was produced to support the FRA for the onshore HVAC A.1.1.1 booster station. The outline strategy is based on an indicative layout of the onshore HVAC booster station and will be developed in detail post consent.

### Site information A.2

- The onshore HVAC booster station area is located 2.5 km east of the village of Edgefield. It is rectangular A.2.1.1 in shape occupying a total area of approximately 3.04 ha. Access to the onshore HVAC booster station area is currently provided via a network of farm tracks, off B1149.
- A.2.1.2 No topographical survey was undertaken for the onshore HVAC booster station area. However, based on available online OS maps, the onshore HVAC booster station area has an average slope of 8% with a steady fall towards the north east. Ground levels south west and north east of the onshore HVAC booster station area are approximately 59.5m AOD and 48.5m AOD respectively.
- A.2.1.3 The onshore HVAC booster station area is currently used for agricultural purposes and fully permeable. The proposed development will create a total impermeable area of 1 ha. The remaining 2.04 ha will be permeable, consisting of free draining surface chippings and landscaping.
- A.2.1.4 The Qbar for the onshore HVAC booster station boundary was calculated using the Interim Code of Practice (ICP) for SuDS method. The results, attached in section A.8, shows that the Obar based on an overall impermeable area of 1 ha is 2.5 l/s.

### A.3 Policy

- The NPPF requires that proposed development should not increase flood risk. Surface water runoff from A.3.1.1 the development site should not exceed that generated from the existing application site.
- The National Planning Practice Guidance (NPPG) meanwhile outlines the hierarchy to be investigated by A.3.1.2 the developer when considering surface water drainage strategy. The following drainage options are to be investigated following order of priority:
  - 1. Discharge rainwater into ground via infiltration;
  - 2. Discharge rainwater direct to a watercourse;
  - 3. Discharge rainwater to a surface water sewer/drain; and
  - 4. Discharge rainwater to the combined sewer.



### Surface water drainage hierarchy A.4

- A.4.1.1 The NPPF requires that proposed development should not increase flood risk. Surface water runoff from the development site should not exceed that generated from the existing application site.
- A.4.1.2 Based on the NPPG, all of the drainage options are examined in detail in order to assess the feasibility of using a combination of SuDS as part of the onshore HVAC booster station.

# Discharge rainwater into ground via infiltration

- A.4.1.3 No soil infiltration testing was undertaken on the onshore HVAC booster station area at the time of writing due to access restrictions. Reference to the BGS online mapping (1:50,000) indicates that the onshore HVAC booster station area is underlain by superficial deposits from Briton's Lane Sand and Gravel Member. The onshore HVAC booster station area is shown to be underlain by bedrock deposits from the Lewes Nodular Chalk Formation which comprised of rock.
- Reference to BGS borehole records indicates a borehole log on site (BGS reference: TG13SW5). The A.4.1.4 borehole scans shows that the onshore HVAC booster station area is underlined by sandy subsoil up to 6m below ground level (bgl) and sand between 6m and 15m bgl and clay between 15m and 24m bgl.
- Due to the presence of clay, the discharge of surface water runoff into the ground via infiltration is A.4.1.5 considered not feasible.

# Discharge rainwater direct to a watercourse

- A.4.1.6 There are two unnamed watercourses located approximately 0.5 km from the onshore HVAC booster station western boundary and 1 km from the eastern boundary.
- Surface terrain models obtained from LiDAR confirmed the presence of a ditch passing through a wooded A.4.1.7 area to the north east of the onshore HVAC booster station. This appears to connect into the unnamed ditch situated east of the onshore HVAC booster station. Figure 7.1 below illustrates the location of the ditch from the onshore HVAC booster station.
- The ditch has a level of approximately 48.7m AOD 47.7m AOD which is reflective of the topography of A.4.1.8 the onshore HVAC booster station area which fall towards the north east.
- On this basis, the possibility to discharge surface water runoff generated from the onshore HVAC booster A.4.1.9 station area to the ditch will be considered.





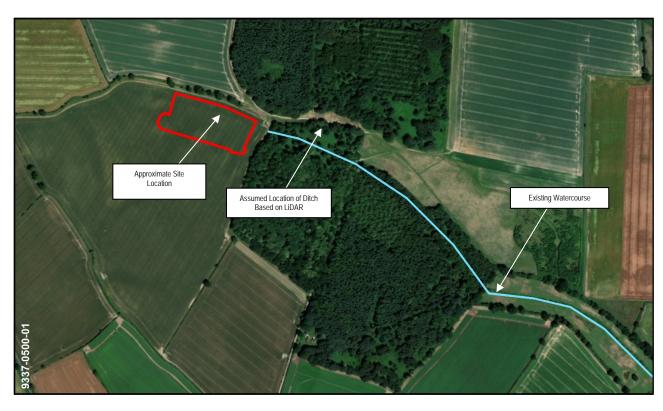


Figure A.1: Indicative Location of Ditch.

# Discharge rainwater to a surface water sewer

- A.4.1.10 No sewer records were made available.
- A.4.1.11 As the onshore HVAC booster station area is currently greenfield and located 1 km north east of the B1149, it is highly likely that there are no public sewers present on the onshore HVAC booster station area. If there are sewers located beyond the onshore HVAC booster station boundary, it is possible that these sewers are used to drain surface water runoff generated from the B1149 and associated highways.

# Discharge rainwater to the combined sewer

A.4.1.12 No sewer records were made available.

### Proposed surface water drainage strategy **A.5**

- The proposed surface water drainage design parameters are as follows: A.5.1.1
  - The proposed drainage system is to be designed so that no flooding will occur during a 1 in 100 year rainfall event + 40% climate change will effect in any part of the onshore HVAC booster station area;
  - Surface water runoff generated by the onshore HVAC booster station area is to discharge into the existing drain running along the onshore HVAC booster station's northern boundary;

- The discharge rate into the existing drain is to be limited to Qbar 1 in 1 year; and
- prior to discharge.
- Surface water runoff within the onshore HVAC booster station area will be generated by the access road, A.5.1.2 the HVAC booster station and its associated concrete plinths.
- A.5.1.3 It is proposed that surface water runoff generated on the access road will flow into the filter drain. The filter drain, to be located directly adjacent to the access road will be wrapped with impermeable geotextile membrane to avoid ingress and egress of water. Surface water runoff within the filter drain will then be conveyed forward, towards underground storage tanks.
- Surface water runoff generated from the roof of the onshore HVAC booster station meanwhile will be A.5.1.4 collected and conveyed towards the Geocellular Storage Crates for attenuation.
- Surface water runoff generated from areas where oil/fuel may be present (i.e. concrete bunds), will be A.5.1.5 passed through an Oil Water Separator prior to attenuation.
- A.5.1.6 Surface water runoff will eventually discharge into the existing ditch, located north east of HVAC booster station area boundary. The discharge rate will be limited to Qbar 1 in 1 year of 2.5 l/s. The rate will be restricted via Hydro-Brake® Optimum® flow control system or other similar approved system.

### Surface water drainage modelling A.6

- The attenuation features for the surface water drainage system has been sized using MicroDrainage® to A.6.1.1 prevent flooding of the onshore HVAC booster station area and surrounding areas. The modelling summary for the onshore HVAC booster station area attached in section A.9, shows that in order to attenuate surface water runoff generated for rainfall event up to 1 in 100 year with 40% climate change effect the Geocellular Storage Crates would need to provide a total of 1,050 m<sup>3</sup> of storage, which could have an area of 700 m<sup>2</sup> and a depth of 1.5 m.
- A.6.1.2 Section A.10 illustrates the outline drainage strategy for the onshore HVAC booster station and demonstrates that the required attenuation volume can be practicably provided within the onshore HVAC booster station area.



Surface water runoff generated on areas where there is a possibility of contaminants will be treated





### MicroDrainage calculations for onshore HVAC booster station **A**.7



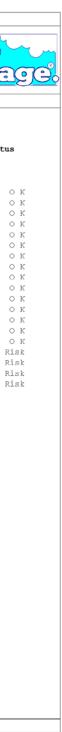




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Date 29/03/2017 17:3		Decian	d By to	nathan.m.		200	
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File 1 in 100 yr plus							
Micro Drainage		Source	Control	W.12.4			
Summary	of Res	ults fo	or 100 y	ear Retur	n Period	(+20%	<u>)</u>
OL	utflow i	s too le	ow. Desig	gn is unsat	isfactory.		
Storm	Мак	Мак	Мак	Маж	Мах	Ман	Status
Event	Level	Depth	Control	Overflow 2		Volume	
	(m)	(m)	(1/s)	(1/s)	(1/s)	(m <sup>3</sup> )	
15	0 400	0 400	0.4	0.0	0.4	0.4.0 1	A 14
15 min Summer 30 min Summer			0.4	0.0	0.4	840.1 970.6	0 K
60 min Summer			0.4	0.0		970.6	ок
120 min Summer			0.5	0.0		1294.4	0 K
180 min Summer			0.5	0.0		1407.6	0 K
240 min Summer			0.6	0.0		1493.5	0 K
360 min Summer			0.6	0.0		1623.0	0 K
480 min Summer			0.6	0.0		1720.9	
600 min Summer			0.6	0.0		1800.5	0 K
720 min Summer			0.6	0.0		1867.7	0 K
960 min Summer			0.6	0.0	0.6	2008.0	0 K
1440 min Summer			0.7	0.0	0.7	2221.0	ΟK
2160 min Summer	9.401	1.401	0.7	0.0		2451.4	0 K
2880 min Summer			0.7	0.0		2624.8	0 K
4320 min Summer			0.8	0.0		2723.7	0 K
5760 min Summer			0.8	0.0		2785.4	0 K
7200 min Summer			0.8	0.0		2826.0	0 K
8640 min Summer	9.630	1.630	0.8	0.0	0.8	2852.8	0 K
	Sto	rm	Rain	Overflow	Time-Peak		
	Eve	nt	(mm/hr)	Volume	(mins)		
				(m³)			
	15 min	Summer	179.305	0.0	27		
			103.599	0.0	42		
		Summer	59.858	0.0	42		
		Summer		0.0	132		
		Summer		0.0	192		
			19.982	0.0	252		
	360 min	Summer	14.497	0.0	372		
	480 min		11.545	0.0	492		
	600 min		9.676	0.0	612		
	720 min		8.376	0.0	732		
	960 min		6.771	0.0	970		
	440 min		5.017	0.0	1450		
	2160 min		3.718	0.0	2168		
	2880 min 1320 min		3.005 2.108	0.0	2888 4328		
	520 min 5760 min		1.639	0.0	4320		
	200 min		1.349	0.0	7208		
	8640 min		1.150	0.0	8648		
	©19	82-201	0 Micro	Drainage	Ltd		
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3rd Floor 34 Lisbon Stree Leeds Date 29/03/201 File 1 in 100 y Micro Drainage Storm Event 10030 min S 15 min W 30 min W 30 min W 120 min W 120 min W 130 min W 240 min W 240 min W 260 min W	LS1 41 7 17:30 yr plus mmary ( inter 1 finter 4 finter 4 finter 4	0 s of Re Max Level (m) 9.640 8.538	Check Source esults Max Depth (m)	ed By e Control for 100 y Max	nathan.m. W.12.4 Tear Retur Max Verflow E	n Perio Max	PC PC	
Leeds Date 29/03/2017 File 1 in 100 y Micro Drainage Storm Event 10080 min S 15 min W 30 min W 120 min W 120 min W 120 min W 240 min W 240 min W 360 min W 240 min W 240 min W 240 min W 240 min W 240 min W 240 min W 360 min W 370 mi	LS1 41 7 17:30 yr plus mmary ( inter 1 finter 4 finter 4 finter 4	0 s of Re Max Level (m) 9.640 8.538	Check Source esults Max Depth (m)	ed By e Control for 100 y Max Control O	W.12.4 Tear Retur	n Perio Max		ÎŊE
Date 29/03/201 File 1 in 100 y Micro Drainage Storm Event 10030 min S 15 min W 30 min W 120 min W 120 min W 120 min W 240 min W 360 min W 240 min W 240 min W 240 min W 240 min W 240 min W 360 min W 370 min W	7 17:30 yr plus mmary ( ummer ) (inter ) funter ( inter )	0 s of Re Max Level (m) 9.640 8.538	Check Source esults Max Depth (m)	ed By e Control for 100 y Max Control O	W.12.4 Wear Retur	n Perio Max		ÎŊE
File 1 in 100 y Micro Drainage Storm Event 10030 min S 15 min W 30 min W 60 min W 120 min W 120 min W 240 min W 240 min W 360 min W 240 min W 240 min W 240 min W 240 min W 240 min W 240 min W 360 min W 370 min W	yr plus mmary ummer Sinter Sinter Sinter Sinter	of Re Max Level (m) 9.640 8.538	Check Source esults Max Depth (m)	ed By e Control for 100 y Max Control O	W.12.4 Wear Retur	n Perio Max		<u>*</u>
Micro Drainage Sum Storm Event 10080 min S 15 min W 30 min W 60 min W 120 min W 120 min W 120 min W 240 min W 360 min W 480 min W 960 min W 1440 min W 2800 min W	nummer Summer Sinter Sinter Sinter	of Re Max Level (m) 9.640 8.538	Check Source esults Max Depth (m)	ed By e Control for 100 y Max Control O	W.12.4 Wear Retur	n Perio Max		18]
Micro Drainage Sum Storm Event 10080 min S 15 min W 30 min W 60 min W 120 min W 120 min W 120 min W 240 min W 360 min W 480 min W 960 min W 1440 min W 2800 min W	nummer Summer Sinter Sinter Sinter	of Re Max Level (m) 9.640 8.538	Source esults Max Depth (m)	for 100 y Max Control O	wear Retur	Max		18]
<u>Sun</u> Storm Event 10030 min S 15 min W 30 min W 00 min W 120 min W 120 min W 240 min W 360 min W 360 min W 480 min W 960 min W 1440 min W 2280 min W 2280 min W 5760 min W 5760 min W	ummer Vinter Vinter Vinter Vinter	Max Level (m) 9.640 8.538	Max Depth (m)	for 100 y Max Control O	wear Retur	Max		18]
Storm Event 10030 min S 15 min W 30 min W 60 min W 120 min W 240 min W 240 min W 360 min W 360 min W 600 min W 960 min W 940 min W 2160 min W 2280 min W 2280 min W	ummer Vinter Vinter Vinter Vinter	Max Level (m) 9.640 8.538	Max Depth (m)	Max Control O	Max	Max		18]
Event 10080 min S 15 min W 30 min W 120 min W 120 min W 120 min W 240 min W 240 min W 360 min W 720 min W 240 min W	ummer Vinter Vinter Vinter	Level (m) 9.640 8.538	Depth (m)	Control O			Max	
10080 min S 15 min W 30 min W 60 min W 120 min W 120 min W 240 min W 360 min W 480 min W 720 min W 960 min W 2460 min W 2400 min W 2400 min W 2400 min W 2400 min W 2400 min W 2700 min W	ummer Vinter Vinter Vinter	(m) 9.640 8.538	(m)		verflow <b>S</b>			Statu
15 min W 30 min W 60 min W 120 min W 120 min W 240 min W 360 min W 480 min W 720 min W 2460 min W 2460 min W 2460 min W 2460 min W 2460 min W 2670 min W 2700 min W	Vinter Vinter Vinter	9.640 8.538		(1/s)				
15 min W 30 min W 60 min W 120 min W 120 min W 240 min W 360 min W 480 min W 600 min W 720 min W 960 min W 2160 min W 2280 min W 3200 min W	Vinter Vinter Vinter	8.538	1.640		(1/s)	( <b>1/</b> s)	(m <sup>3</sup> )	
15 min W 30 min W 60 min W 120 min W 120 min W 240 min W 360 min W 480 min W 600 min W 720 min W 2400 min W 2460 min W 2460 min W 2450 min W 5760 min W	Vinter Vinter Vinter	8.538		0.8	0.0	0.8	2870.0	
30 min W 60 min W 120 min W 240 min W 240 min W 360 min W 480 min W 720 min W 960 min W 2400 min W 2160 min W 2280 min W 4320 min W 5760 min W	Vinter Vinter Vinter			0.4	0.0		940.9	
120 min W 180 min W 240 min W 360 min W 480 min W 600 min W 960 min W 1440 min W 2160 min W 2880 min W 4320 min W 5760 min W	inter a	0.021		0.5	0.0		1087.1	
130 min W 240 min W 360 min W 430 min W 600 min W 720 min W 960 min W 2440 min W 2890 min W 4320 min W 5760 min W		8.718	0.718	0.5	0.0	0.5	1255.7	
240 min W 360 min W 480 min W 600 min W 720 min W 960 min W 2160 min W 2830 min W 4320 min W 5760 min W	inter (	8.829	0.829	0.5	0.0	0.5	1449.9	
360 min W 480 min W 600 min W 720 min W 960 min W 1440 min W 2160 min W 4320 min W 5760 min W		8.901	0.901	0.6	0.0	0.6	1576.7	
480 min W 600 min W 720 min W 960 min W 1440 min W 2160 min W 2830 min W 4320 min W 5760 min W	inter (	8.956	0.956	0.6	0.0	0.6	1673.1	
600 min W 720 min W 960 min W 1440 min W 2160 min W 2880 min W 4320 min W 5760 min W 7200 min W	inter	9.039	1.039	0.6	0.0	0.6	1818.3	
720 min W 960 min W 1440 min W 2160 min W 2830 min W 4320 min W 5760 min W 7200 min W				0.6	0.0	0.6	1928.2	
960 min W 1440 min W 2160 min W 2880 min W 4320 min W 5760 min W 7200 min W	inter	9.153	1.153	0.6	0.0	0.6	2017.5	
1440 min W 2160 min W 2880 min W 4320 min W 5760 min W 7200 min W				0.7	0.0		2093.0	
2160 min W 2880 min W 4320 min W 5760 min W 7200 min W				0.7	0.0	0.7		
2880 min W 4320 min W 5760 min W 7200 min W				0.7	0.0		2489.9	
4320 min W 5760 min W 7200 min W				0.8	0.0		2749.4	
5760 min W 7200 min W				0.8	0.0		2945.1	
7200 min W				0.8	0.0			Flood R
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0000 1111				0.8	0.0			Flood R Flood R
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		s	torm	Rain	Overflow	Time-Pe	ak	
		E	vent	(mm/hr)	(m <sup>3</sup> )	(mins)		
	ΤU		nin Summe			100	88 27	
				er 179.305 er 103.599			42	
				er 59.858			42 72	
				er 34.585			32	
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		720 n	nin Winte	er 8.376	0.0	7	26	
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	á	2160 n	nin Wint€	er 3.718	0.0	21	52	
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Micro Drainage		ce Control	W 12 4		
nicio Diainage	bour	De COMELOL	M.12.4		
Summa	ary of Results	for 100 ye	ear Retur	n Period (+2	0%]
Storm Event	Max Max Level Depth		Max erflow E	Max Max Outflow Volume	Status
Livence	(m) (m)			(1/s) (m <sup>3</sup> )	
10080 min Wint	er 9.849 1.849	0.8	0.0	0.8 3236.0	) Flood Risk
	-				
	Storm Event	Rain (mm/hr)	Volume	Time-Peak (mins)	
			(m³)		
	10080 min Win	ter 1.005	0.0	9888	
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File 1 in 100 yr plus	1	_			
Micro Drainage	Source	Contr	ol W.1	2.4	
	Ra	infall	Detai	ls	
Rain	nfall Mode	-1			FEH
Return Peri					100
Sit			11350 3	33200 TG	11350 33200
	C (1kr D1 (1kr				-0.024 0.319
	D1 (1kr D2 (1kr				0.371
	D3 (1kr				0.236
	E (1kr	a)			0.311
	F (1kr				2.479
	nmer Storr hter Storr				Yes
	iter Storr Cv (Summe:				Yes 0.750
	Cv (Winter				0.840
Shortest St	torm (mina	5)			15
Longest St					10080
Climat	te Change	8			+20
	Time	e / Are	a Diad	gram	
		al Area			
Time		Time	Area		Area
(mins)	) (ha)	(mins)	(ha)	(mins)	(ha)
			1 000		0.500
0	4 1.000	4-8	1.000	8-12	
0-4	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0-	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
0	4 1.000	4-8	1.000	8-12	
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Micro Drain	age	Sou	rce Contr	ol W.12.4			
			Model I	Details			
		Storage is		over Level (n	n) 10.000		
				d Structur			
<b>-</b>	· · · · · · · · · · · · · · · · · · ·			1 (m) 8.000			• · · · · · · · · · · · · · · · · · · ·
Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m) 1	Area (m²)	Depth (m)	Area (m²)
0.000	1750.0	1				1	
0.400	1750.0					1	
0.800							1750.0
1.200 1.600	1750.0 1750.0			6.800	1750.0 1750.0 1750.0	9.600	1750.0
2.000				7.200	1750.0	10.000	1750.0
2.000	1750.0	1	1750.0		1750.0		
2.300	2.00.0	0.200	2,00.0	0.000	2.00.0	I	
		Ori	lfice Out	flow Contro	01		
Diam	eter (m) 0	.017 Disch	arge Coeffi	.cient 0.600	Invert I	Level (m) 8	.000
		We	eir Overfl	low Control	L		
	Discharge	Coef 0.544	Width (m)	1.000 Inve	ort Level	(m) 10.000	
	Discharge	JUEL 0.344	WIGCH (H)	1.000 11146	SIC Devel	(10) 10.000	
		@1000	2010 Mi -	ro Drainage	T+2		
		@1.982-	-2010 MIC	to prainage	а пга		



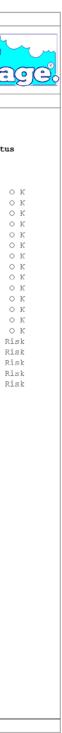




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		2		na chan . m.		<u>re n</u>	<u>ueces</u>
File 1 in 100 yr plus		Checked	-				
Micro Drainage		Source	Control	W.12.4			
Summary	of Res	ults fo	or 100 y	ear Retur	n Period	(+40%	<u>)</u>
00	itflow i	s too lo	w. Desig	gn is unsat	isfactory.		
Storm	Мах	Мак	Мак	Маж	Max	Маж	Status
Event	Level	Depth	Control	Overflow D	Outflow	Volume	
	(m)	(m)	(1/s)	(1/s)	(1/s)	(m <sup>3</sup> )	
15 min Oursen	0 100	0 4 90	0.4	0.0	0.4	000 0	0 14
15 min Summer 30 min Summer			0.4	0.0	0.4	980.2 1132.4	o k o k
60 min Summer			0.5	0.0		132.4	0 K
120 min Summer			0.5	0.0		1510.5	0 K
180 min Summer			0.5	0.0		1642.8	0 K
240 min Summer		0.872	0.6	0.0		1743.2	0 K
360 min Summer			0.6	0.0		1894.7	0 K
480 min Summer		1.005	0.6	0.0		2009.4	0 K
600 min Summer		1.051	0.6	0.0		2102.7	0 K
720 min Summer			0.6	0.0		2181.7	0 K
960 min Summer		1.173	0.7	0.0		2346.3	0 K
1440 min Summer			0.7	0.0		2596.9	0 K
2160 min Summer			0.7	0.0		2869.0	0 K
2880 min Summer		1.537	0.7	0.0		3074.6	0 K
4320 min Summer			0.8	0.0		3196.5	0 K
5760 min Summer			0.8	0.0		3274.9	0 K
7200 min Summer		1.664	0.8	0.0		3328.8	0 K
8640 min Summer		1.683	0.8	0.0		3366.6	0 K
	Sto		Rain				
	Eve	at	(mm/hr)	Volume (m <sup>3</sup> )	(mins)		
				(			
	15 min	Summer	209.189	0.0	27		
	30 min	Summer	120.865	0.0	42		
	60 min	Summer	69.834	0.0	72		
	120 min		40.349	0.0	132		
		Summer		0.0	192		
	240 min		23.313	0.0	252		
	360 min		16.914	0.0	372		
	480 min		13.470	0.0	492		
	600 min		11.289	0.0	612		
	720 min		9.772	0.0	732		
	960 min		7.900	0.0	972		
	440 min		5.853	0.0	1450		
	160 min		4.337	0.0	2172		
		Summer		0.0	2888		
	320 min		2.460	0.0	4328		
	760 min		1.913	0.0	5768		
	200 min		1.574	0.0	7208		
8	640 min	Summer	1.342	0.0	8648		
				Drainage			

3rd Floor 34 Lisbon Street Leeds LS1 Date 29/03/2017 17: File 1 in 100 yr pl Micro Drainage <u>Summary</u> Storm Event	28 us	-	-	onathan	.m	<u>j</u> ie	FO
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Summary Storm	of Re:	SOULCE	Contro	1 1 1 2	4		
Storm	of Rea		, concro.	1 14.12.	4		
		sults i	or 100	year Re	turn Pe	riod (+40	)용]
Event	Max	Max	Max	Max	Max	Max	Statu
	Level (m)	Depth (m)	Control ( (1/s)	Overflow (1/s)	Σ Outflo (1/s)	ow Volume (m <sup>3</sup> )	
10080 min Summer	9.697	1.697	0.8	0.0	0	.8 3393.1	
15 min Winter			0.4	0.0	0	.4 1097.8	
30 min Winter	8.634	0.634	0.5	0.0	0	.5 1268.4	
60 min Winter			0.5	0.0		.5 1465.2	
120 min Winter			0.6	0.0		.6 1692.0	
180 min Winter			0.6	0.0		.6 1840.1	
240 min Winter			0.6	0.0		.6 1952.8	
360 min Winter			0.6	0.0		.6 2122.6	
480 min Winter			0.6	0.0		.6 2251.3	
600 min Winter			0.7	0.0		.7 2356.0 .7 2444.6	
720 min Winter 960 min Winter			0.7	0.0		.7 2444.6 .7 2629.5	
1440 min Winter			0.7	0.0		.7 2029.5	
2160 min Winter			0.8	0.0		.8 3217.1	
2880 min Winter			0.8	0.0		.8 3448.8	Flood I
4320 min Winter			0.8	0.0		.8 3588.4	
5760 min Winter			0.8	0.0		.8 3679.6	
7200 min Winter			0.8	0.0		.8 3743.2	
8640 min Winter		1.894	0.8	0.0		.8 3788.8	
	St	orm	Rain	Overf]	low Time	-Peak	
	Ev	ent	(mm/hr)	) Volum (m <sup>3</sup> )		ns)	
	10000					10000	
	10080 mi		r 1.17: r 209.18		).0 ::	10088 27	
			r 120.86		).0	42	
			r 69.83		).0	72	
			r 40.34		.0	132	
			r 29.27		.0	190	
			r 23.31		.0	250	
			r 16.91		.0	368	
	480 mi	in Winte	r 13.47	0 0	0.0	488	
			r 11.28		.0	606	
		in Winte			0.0	726	
		in Winte			0.0	966	
		in Winte			.0	1444	
		in Winte			0.0	2160	
		in Winte			0.0	2864	
		in Winte				4284 5712	
		in Winte in Winte			).0 ).0	7136	
			r 1.34			8552	
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RPS Planning & Deve	elopmen	t			Pag	je 3		
3rd Floor							<u> </u>	]
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Leeds LS1		Deci	ned Dr	nother				-0
Date 29/03/2017 17:				onathan.m	···/	LC	<u>uc</u> c	<u>130</u>
File 1 in 100 yr pl 4icro Drainage	60.		ea By e Control	1 57 1 2 4				
icio Diallage		Source	e contro.	L W.IZ.4				
Summary	y of Re	sults	for 100 y	year Retu	rn Peri	.od (+40	8]	
Storm Event	Max Level (m)	Max Depth (m)	Max Control ( (1/s)	Max Overflow Σ (l/s)	Max Outflow (1/s)	Max Volume (m <sup>3</sup> )	Status	
10080 min Winter	9.911	1.911	0.8	0.0	0.8	3821.7	Flood Risk	
		orm	Rain (mm/hr)		Time-Pe (mins			
	10080 m	in Winte	er 1.172	2 0.0	9	976		
	(D)1	982-20	10 Micro	Drainage	Ltd			
	0.	202-20	AU HICTO	prainage	пса			

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3rd Floor					
34 Lisbon Street					
Leeds LS1 4LX					<u>Ling</u>
Date 29/03/2017 17:28	Desigr	ned By	jonatha	an.m	Drang
File 1 in 100 yr plus	-	-			2000
Micro Drainage	1	e Contr	ol W.12	2.4	
	Ra	ainfall	Detail	S	
Rain	fall Mod	el			FEH
Return Perio					100
Site			11350 33	3200 TG	-0.024
	C (1k D1 (1k				-0.024 0.319
	D2 (1k				0.371
	D3 (1k				0.236
	E (1k				0.311
	F (1k				2.479
	mer Stori ter Stori				Yes Yes
	v (Summe				0.750
	v (Winte				0.840
Shortest Sto					15
Longest Sto	orm (min e Change				10080 +40
Climate	e Change	8			+40
	Tim	e / Are	ea Diag	ram	
	Tot	al Area	(ha) 2.5	500	
Time	Area	Time	Area	Time	Area
(mins)	(ha)	(mins)	(ha)	(mins)	(ha)
0-4	4 1.000	4-8	1.000	8-12	0.500

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RPS Plannin	ng & Devel	opment			Page	5	
3rd Floor							
34 Lisbon S	Street					78	
Leeds	LS1 4	LX				<u> </u>	
Date 29/03/			igned By	jonathan.r		padr	າອາດາອີ
File 1 in 1				J			
Micro Drain			rce Contr	ol W 12 4			
HICLO DIGIN	lage		ree concr	01 11.12.14			
			Model I	Details			
		Storage is	Online Co	over Level (	(m) 10.000		
		Ta	nk or Pon	d Structu	re		
		:	Invert Leve	l (m) 8.000	)		
Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000							
0.400							
0.800							
1.200				6.800			
1.600				7.200	2000.0	10.000	2000.0
2.000				7.600			
2.400	2000.0	5.200	2000.0	8.000	2000.0		
		Or	ifice Out	Elow Contr	01		
Dian	neter (m) 0	.017 Disch	arge Coeffi	cient 0.60	0 Invert I	Level (m) 8	3.000
		We	eir Overfl	Low Contro	1		
		_			-		
	Discharge	Coef 0.544	Width (m)	1.000 Inv	ert Level	(m) 10.000	
		©1982-	-2010 Mic	ro Drainag	e Ltd		
				g			







### **A.8** Greenfield Obar runoff calculations





RPS Group Limited		Page 1
2420 The Quadrant	RCEF60920	
Aztec West Almondsbury	Hornsea 3 Drainage	4
Bristol BS32 4AQ	Onshore HVAC Booster	Micco
Date 21/02/2018	Designed by ES	
File SITE 1 - ALL.SRCX	Checked by RR	Digitight
Micro Drainage	Source Control 2017.1.2	

## ICP SUDS Mean Annual Flood

Input

Return Period (years) 1 SAAR (mm) 605 Urban 0.000 Area (ha) 1.000 Soil 0.400 Region Number Region 5

### Results 1/s

QBAR Rural QBAR Urban	2.9 2.9
Q1 year	2.5
Q1 year Q30 years Q100 years	

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### Modelling summary **A.9**





RPS Group Limited		Page 1
2420 The Quadrant	60920RCEF	
Aztec West Almondsbury	Hornsea 3 Drainage	L.
Bristol BS32 4AQ	Site 1 - Storage Tank	Micco
Date 21/02/2018 10:34	Designed by ES	
File Site 1 - All.SRCX	Checked by RR	Drainage
Micro Drainage	Source Control 2017.1.2	

Summary of Results for 100 year Return Period (+40%)

	Stor Even		Max Level (m)	Max Depth (m)	Max Control (1/s)	Max Volume (m³)	Status
15	min	Summer	51.900	0.400	2.0	280.2	ОК
30	min	Summer	52.026	0.526	2.0	368.2	ОК
60	min	Summer	52.156	0.656	2.0	459.2	ОК
120	min	Summer	52.318	0.818	2.0	572.3	ОК
180	min	Summer	52.424	0.924	2.0	647.1	ОК
240	min	Summer	52.502	1.002	2.1	701.6	ОК
360	min	Summer	52.607	1.107	2.2	774.7	ОК
480	min	Summer	52.670	1.170	2.2	819.2	ОК
600	min	Summer	52.712	1.212	2.3	848.1	ОК
720	min	Summer	52.739	1.239	2.3	867.4	ОК
960	min	Summer	52.769	1.269	2.3	888.4	ОК
1440	min	Summer	52.778	1.278	2.3	894.8	ОК
2160	min	Summer	52.745	1.245	2.3	871.5	ОК
2880	min	Summer	52.695	1.195	2.3	836.4	ОК
4320	min	Summer	52.609	1.109	2.2	776.3	ОК
5760	min	Summer	52.545	1.045	2.1	731.4	ОК
7200	min	Summer	52.499	0.999	2.1	699.5	ОК
8640	min	Summer	52.464	0.964	2.0	675.0	ОК
10080	min	Summer	52.437	0.937	2.0	656.1	ОК
15	min	Winter	51.949	0.449	2.0	314.1	ОК
30	min	Winter	52.090	0.590	2.0	412.9	0 K

	Stor Even		Rain (mm/hr)	Vol		Discharge Volume (m³)	Time-Peak (mins)
15	min	Summer	150.640		0.0	173.6	27
30	min	Summer	99.120		0.0	171.2	42
60	min	Summer	62.020		0.0	330.7	72
120	min	Summer	38.938		0.0	314.9	132
180	min	Summer	29.560		0.0	312.7	190
240	min	Summer	24.201		0.0	317.8	250
360	min	Summer	18.056		0.0	333.3	370
480	min	Summer	14.508		0.0	342.3	490
600	min	Summer	12.172		0.0	347.5	608
720	min	Summer	10.508		0.0	350.5	728
960	min	Summer	8.281		0.0	352.4	966
1440	min	Summer	5.852		0.0	347.9	1444
2160	min	Summer	4.103		0.0	666.0	2160
2880	min	Summer	3.187		0.0	658.2	2796
4320	min	Summer	2.237		0.0	627.7	3420
5760	min	Summer	1.749		0.0	1224.6	4168
7200	min	Summer	1.457		0.0	1196.5	4984
8640	min	Summer	1.263		0.0	1140.5	5872
10080	min	Summer	1.125		0.0	1082.0	6664
15	min	Winter	150.640		0.0	174.4	27
30	min	Winter	99.120		0.0	165.5	41
		©19	82-2017	XP	Sol	utions	

Attec West Almondsbury       Hornsea 3 Drainage         Site 1 - Storage Tank         ate 21/02/2018 10:34       Designed by ES         Lle Site 1 - All.SRCX       Checked by RR         Erro Drainage       Source Control 2017.1.2         Summary of Results for 100 year Return Period (+         Storm       Max       Max       Max         Event       Depth Control Volume       (m)       (n)         60 min Winter 52.236 0.736       2.0       514.9       0 K         120 min Winter 52.626 1.126       2.2       788.1       0 K         120 min Winter 52.626 1.126       2.2       788.1       0 K         360 min Winter 52.745       1.245       2.3       871.5       0 K         360 min Winter 52.745       1.245       2.3       871.5       0 K         360 min Winter 52.839       1.339       2.4       979.5       0 K         360 min Winter 52.930       1.430       2.4       100.9       0 K         2160 min Winter 52.930       1.430       2.4       100.9       0 K         220 min Winter 52.706       1.226       2.3       844.3       0 K         2160 min Winter 52.706       1.226       2.3       844.3       0 K         2	PS Group Limited						
Site 1 - Storage Tank         ate 21/02/2018 10:34       Designed by ES         ile Site 1 - All.SRCX       Checked by RR         icro Drainage       Source Control 2017.1.2         Summary of Results for 100 year Return Period (+         Storm       Max       Max       Max       Max       Status         Event       Level Depth Control Volume (m)       (m)       (1/s)       (m <sup>3</sup> )         60 min Winter 52.236       0.736       2.0       514.9       0 K         120 min Winter 52.236       0.038       2.1       726.5       0 K         120 min Winter 52.626       1.26       2.2       788.1       0 K         360 min Winter 52.626       1.26       2.4       956.5       0 K         360 min Winter 52.818       1.318       2.4       922.8       0 K         600 min Winter 52.930       1.437       2.4       1005.9       0 K         1400 min Winter 52.930       1.437       2.4       1005.9       0 K         1400 min Winter 52.930       1.430       2.4       969.7       0 K         1400 min Winter 52.706       1.20       2.3       844.3       0 K         1200 min Winter 52.706       1.20       0.3       2.4       969.7	420 The Quadrant						
Atte 21/02/2018 10:34         Designed by ES           ile Site 1 - All.SRCX         Checked by RR           icro Drainage         Source Control 2017.1.2           Summary of Results for 100 year Return Period (+           Storm         Max         Max         Max         Max         Status           Event         Level Depth Control Volume (m)         (m)         (1/s)         (m³)           60 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.236         0.736         2.0         514.9         0 K           180 min Winter         52.538         1.038         2.1         726.5         0 K           360 min Winter         52.626         1.126         2.2         788.1         0 K           360 min Winter         52.899         1.399         2.4         979.5         0 K           360 min Winter         52.930         1.430         2.4         1005.9         0 K           360 min Winter         52.930         1.430         2.4         1005.9         0 K           360 min Winter         52.930         1	ztec West Almondsburg	У	Horr	nsea 3	Draina	age	
Lile Site 1 - All.SRCX       Checked by RR         Loro Drainage       Source Control 2017.1.2         Summary of Results for 100 year Return Period (+         Event       Level Depth Control Volume (m) (m) (1/s) (m³)         60 min Winter 52.236 0.736       2.0 514.9 0 K         120 min Winter 52.417 0.917       2.0 642.1 0 K         180 min Winter 52.626 1.126       2.2 788.1 0 K         240 min Winter 52.626 1.126       2.2 788.1 0 K         360 min Winter 52.818 1.318       2.4 926.5 0 K         720 min Winter 52.861 1.326       2.4 976.5 0 K         600 min Winter 52.930 1.430       2.4 1005.9 0 K         1440 min Winter 52.931 1.437       2.4 1005.9 0 K         960 min Winter 52.931 1.430       2.4 1005.9 0 K         1440 min Winter 52.931 1.430       2.4 1005.9 0 K         1420 min Winter 52.931 1.430       2.4 1005.9 0 K         2160 min Winter 52.932 1.430       2.4 1005.9 0 K         1420 min Winter 52.931 1.433       2.4 969.7 0 K         4320 min Winter 52.781 1.282       2.3 897.2 0 K         5760 min Winter 52.781 1.282       2.3 844.3 0 K         7200 min Winter 52.796 1.206       2.3 844.3 0 K         7200 min Winter 52.554 1.054       2.1 738.0 0 K         10080 min Winter 38.938       0.0 313.7 130         100 min Wi	ristol BS32 4AQ		Site	e 1 -	Storage	e Tanl	< c
Icro Drainage         Source Control 2017.1.2           Summary of Results for 100 year Return Period (+           Storm         Max         Max         Max         Max         Status           Event         Level         Depth         Control         Volume         (m³)           60 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.238         1.038         2.1         726.5         0 K           240 min Winter         52.626         1.26         2.2         788.1         0 K           360 min Winter         52.839         1.338         2.4         922.8         0 K           480 min Winter         52.930         1.430         2.4         1005.9         0 K           1440 min Winter         52.937         1.437         2.4         1005.9         0 K           2160 min Winter         52.930         1.430         2.4         1001.9         0 K           2800 min Winter         52.706         1.26	ate 21/02/2018 10:34		Desi	lgned	by ES		
Summary of Results for 100 year Return Period (+           Storm         Max         Max         Max         Max         Max         Max         Status           Event         Level         Depth         Control         Volume         (m)         (1/s)         (m)           60 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.238         1.038         2.1         726.5         0 K           180 min Winter         52.626         1.126         2.2         788.1         0 K           360 min Winter         52.745         1.245         2.3         871.5         0 K           360 min Winter         52.899         1.399         2.4         979.5         0 K           480 min Winter         52.937         1.437         2.4         1005.9         0 K           1440 min Winter         52.937         1.435         2.4         966.7         0 K           2160 min Winter         52.937         1.437         2.4         1005.9         0 K           2160 min Winter         52.937         1.435         2.5         1010.9         K           2160 min Winter         52.765         1.430	le Site 1 - All.SRC	Х	Chec	cked b	y RR		
Storm Event         Max Level         Max Depth (m)         Max (l/s)         Max (m <sup>3</sup> )         Max Max Max         Max Max         Max Max         Max Max         Max Max         Max Status           60         min Winter 120         min Winter 52.236         0.736         2.0         514.9         0         K           120         min Winter 52.236         0.736         2.0         514.9         0         K           120         min Winter 52.236         0.136         2.1         726.5         0         K           180         min Winter 52.626         1.126         2.2         788.1         0         K           240         min Winter 52.626         1.366         2.4         956.5         K         K           360         min Winter 52.818         1.318         2.4         922.8         0         K           960         min Winter 52.955         1.435         2.4         1005.9         0         K           1440         min Winter 52.955         1.435         2.4         100.9         0         K           280         min Winter 52.086         1.385         2.4         969.7         0         K           2160         min Winter 52.066	icro Drainage		Sour	cce Co	ntrol 2	2017.1	1.2
Storm         Max         Max         Max         Max         Max         Max         Max         Max         Status           Event         Level         Depth         Control         Volume         (m <sup>3</sup> )           60         min Winter         52.236         0.736         2.0         514.9         0         K           120         min Winter         52.236         0.736         2.0         514.9         0         K           120         min Winter         52.236         0.736         2.0         514.9         0         K           120         min Winter         52.236         1.303         2.1         726.5         0         K           240         min Winter         52.626         1.245         2.3         871.5         0         K           360         min Winter         52.818         1.318         2.4         922.8         0         K           600         min Winter         52.955         1.435         2.4         1005.9         0         K           1440         min Winter         52.955         1.435         2.4         969.7         0         K           2800         min Winter         5	Summary o	f Results	for 1(	00 vea	r Retu	rn Pe	riod (+40
Event         Level         Depth         Control         Volume (m)           60         min Winter         52.236         0.736         2.0         514.9         0 K           120         min Winter         52.417         0.917         2.0         642.1         0 K           180         min Winter         52.538         1.038         2.1         726.5         0 K           240         min Winter         52.626         1.126         2.2         788.1         0 K           360         min Winter         52.818         1.318         2.4         922.8         0 K           480         min Winter         52.818         1.318         2.4         922.8         0 K           600         min Winter         52.930         1.430         2.4         1005.9         0 K           960         min Winter         52.930         1.430         2.4         1000.9         0 K           2160         min Winter         52.706         1.206         2.3         844.3         0 K           7200         min Winter         52.706         1.206         2.2         767.2         0 K           700         min Winter         52.554         1.054<	<u>-</u>						
(m)         (m)         (1/s)         (m³)           60 min Winter         52.236         0.736         2.0         514.9         0 K           120 min Winter         52.417         0.917         2.0         642.1         0 K           180 min Winter         52.538         1.038         2.1         726.5         0 K           240 min Winter         52.626         1.126         2.2         788.1         0 K           360 min Winter         52.818         1.318         2.4         922.8         0 K           480 min Winter         52.818         1.318         2.4         979.5         0 K           720 min Winter         52.937         1.437         2.4         1005.9         0 K           1440 min Winter         52.930         1.455         2.5         1018.7         0 K           2160 min Winter         52.930         1.435         2.4         969.7         0 K           2380 min Winter         52.782         1.282         2.3         897.2         0 K           7200 min Winter         52.782         1.282         2.3         897.2         0 K           7200 min Winter         52.554         1.054         2.1         738.0							
60 min Winter       52.236       0.736       2.0       514.9       0 K         120 min Winter       52.417       0.917       2.0       642.1       0 K         180 min Winter       52.538       1.038       2.1       726.5       0 K         240 min Winter       52.626       1.126       2.2       788.1       0 K         360 min Winter       52.818       1.318       2.4       922.8       0 K         480 min Winter       52.818       1.318       2.4       922.8       0 K         600 min Winter       52.899       1.399       2.4       979.5       0 K         960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.930       1.430       2.4       1000.9       0 K         2160 min Winter       52.930       1.435       2.4       969.7       0 K         2160 min Winter       52.706       1.206       2.3       844.3       0 K         7000 min Winter       52.706       1.206       2.3       844.3       0 K         7000 min Winter       52.705       1.054       2.1       738.0       0 K         10080 min Winter       52.554	I	lvent		-			9
120 min Winter       52.417       0.917       2.0       642.1       0 K         180 min Winter       52.538       1.038       2.1       726.5       0 K         240 min Winter       52.626       1.126       2.2       788.1       0 K         360 min Winter       52.818       1.318       2.4       922.8       0 K         600 min Winter       52.816       1.366       2.4       956.5       0 K         720 min Winter       52.899       1.399       2.4       979.5       0 K         960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.930       1.430       2.4       969.7       0 K         2160 min Winter       52.937       1.282       2.3       897.2       0 K         2200 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       38.938			(m)	(m)	(1/S)	(m <sup>3</sup> )	
180 min Winter       52.538       1.038       2.1       726.5       0 K         240 min Winter       52.626       1.126       2.2       788.1       0 K         360 min Winter       52.745       1.245       2.3       871.5       0 K         480 min Winter       52.818       1.318       2.4       922.8       0 K         600 min Winter       52.866       1.366       2.4       956.5       0 K         720 min Winter       52.937       1.437       2.4       1005.9       0 K         960 min Winter       52.930       1.430       2.4       1005.9       0 K         1440 min Winter       52.937       1.437       2.4       1005.9       0 K         2160 min Winter       52.930       1.430       2.4       1005.9       0 K         2160 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       38.938 <td>60</td> <td>min Winter</td> <td>52.236</td> <td>0.736</td> <td>2.0</td> <td>514.9</td> <td>9 ОК</td>	60	min Winter	52.236	0.736	2.0	514.9	9 ОК
240 min Winter       52.626       1.126       2.2       788.1       0 K         360 min Winter       52.745       1.245       2.3       871.5       0 K         480 min Winter       52.818       1.318       2.4       922.8       0 K         600 min Winter       52.816       1.366       2.4       956.5       0 K         720 min Winter       52.939       1.437       2.4       1005.9       0 K         960 min Winter       52.930       1.437       2.4       1005.9       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         280 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.796       1.206       2.3       844.3       0 K         7200 min Winter       52.596       1.096       2.2       767.2       0 K         60 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       62.020       0.0       322.6       70         120 min Winter       29.560       0.0       322.6       <	120	min Winter	52.417	0.917	2.0	642.2	1 ОК
360 min Winter       52.745       1.245       2.3       871.5       0 K         480 min Winter       52.818       1.318       2.4       922.8       0 K         600 min Winter       52.866       1.366       2.4       956.5       0 K         720 min Winter       52.899       1.399       2.4       979.5       0 K         960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.937       1.430       2.4       1005.9       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2800 min Winter       52.782       1.282       2.3       897.2       0 K         4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.796       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       10.54       0.0       313.7       130         180 min Winter       18.938       0.0       313.7							
480 min Winter       52.818       1.318       2.4       922.8       0 K         600 min Winter       52.818       1.366       2.4       956.5       0 K         720 min Winter       52.899       1.399       2.4       979.5       0 K         960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.937       1.437       2.4       1000.9       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2880 min Winter       52.885       1.385       2.4       969.7       0 K         4320 min Winter       52.762       1.206       2.3       844.3       0 K         7200 min Winter       52.764       1.146       2.2       802.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       89.38       0.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
600 min Winter       52.866       1.366       2.4       956.5       0 K         720 min Winter       52.899       1.399       2.4       979.5       0 K         960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.937       1.437       2.4       1000.9       0 K         1440 min Winter       52.930       1.430       2.4       1000.9       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2880 min Winter       52.930       1.430       2.4       969.7       0 K         4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       38.938       0.0       313.7       130         180 min Winter       28.056       0.0       322.6       188         240 min Winter       24.201       0.0       336.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
720 min Winter       52.899       1.399       2.4       979.5       0 K         960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.955       1.455       2.5       1018.7       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2880 min Winter       52.930       1.430       2.4       969.7       0 K         4320 min Winter       52.885       1.385       2.4       969.7       0 K         4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       62.020       0.0       322.6       70         120 min Winter       18.938       0.0       313.7       130         180 min Winter       29.560       0.0       322.6       188							
960 min Winter       52.937       1.437       2.4       1005.9       0 K         1440 min Winter       52.955       1.455       2.5       1018.7       0 K         2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2880 min Winter       52.885       1.385       2.4       969.7       0 K         4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.596       1.096       2.2       767.2       0 K         8640 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       24.201       0.0       336.0       246         360 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508       0.0       361.9       482							
1440 min Winter       52.955       1.455       2.5       1018.7       0         2160 min Winter       52.930       1.430       2.4       1000.9       0       K         2880 min Winter       52.885       1.385       2.4       969.7       0       K         4320 min Winter       52.782       1.282       2.3       897.2       0       K         5760 min Winter       52.706       1.206       2.3       844.3       0       K         7200 min Winter       52.646       1.146       2.2       802.2       0       K         8640 min Winter       52.596       1.096       2.2       767.2       0       K         10080 min Winter       52.554       1.054       2.1       738.0       0       K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       29.560       0.0       322.6       188         240 min Winter       18.056       0.0       352.8       364         480 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508							
2160 min Winter       52.930       1.430       2.4       1000.9       0 K         2880 min Winter       52.885       1.385       2.4       969.7       0 K         4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.646       1.146       2.2       802.2       0 K         8640 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       29.560       0.0       322.6       188         240 min Winter       24.201       0.0       336.0       246         360 min Winter       18.056       0.0       352.8       364         480 min Winter       18.056       0.0       352.8       364         480 min Winter       12.172       0.0       361.9       482         600 min Winter       12.172 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
2880 min Winter       52.885       1.385       2.4       969.7       0 K         4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.646       1.146       2.2       802.2       0 K         8640 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         10080 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       29.560       0.0       322.6       188         240 min Winter       24.201       0.0       36.0       246         360 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508       0.0       361.9       482         600 min Winter       12.172       0.0       367.0       600         720 min Winter       10.508       0.0       369.8       718							
4320 min Winter       52.782       1.282       2.3       897.2       0 K         5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.646       1.146       2.2       802.2       0 K         8640 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         Kevent       (mm/hr)       Volume       Volume       (mins)         (m³)       (m³)       (m³)       0       322.6       70         120 min Winter       62.020       0.0       322.6       70         120 min Winter       29.560       0.0       313.7       130         180 min Winter       24.201       0.0       336.0       246         360 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508       0.0       361.9       482         600 min Winter       12.172       0.0       367.0       600         720 min Winter       10.508       0.0       369.8       718							
5760 min Winter       52.706       1.206       2.3       844.3       0 K         7200 min Winter       52.646       1.146       2.2       802.2       0 K         8640 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         Kern (mm/hr)       Flooded Discharge Time-Peak (mins)         Event       (m³)       (m³)       (mins)         60 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       24.201       0.0       322.6       188         240 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508       0.0       361.9       482         600 min Winter       12.172       0.0       367.0       600         720 min Winter       10.508       0.0       369.8       718							
7200 min Winter       52.646       1.146       2.2       802.2       0 K         8640 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         Event       (mm/hr)       Volume       Volume       (mins)         60 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       29.560       0.0       322.6       188         240 min Winter       24.201       0.0       336.0       246         360 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508       0.0       361.9       482         600 min Winter       12.172       0.0       367.0       600         720 min Winter       10.508       0.0       369.8       718							
8640 min Winter       52.596       1.096       2.2       767.2       0 K         10080 min Winter       52.554       1.054       2.1       738.0       0 K         Storm Event (mm/hr) Volume Volume (mins) (m³)         60 min Winter       62.020       0.0       322.6       70         120 min Winter       38.938       0.0       313.7       130         180 min Winter       24.201       0.0       322.6       188         240 min Winter       24.201       0.0       322.8       364         360 min Winter       18.056       0.0       352.8       364         480 min Winter       14.508       0.0       361.9       482         600 min Winter       12.172       0.0       367.0       600         720 min Winter       10.508       0.0       369.8       718							
Storm         Rain         Flooded         Discharge         Time-Peak           Event         (mm/hr)         Volume         Volume         (mins)           60 min         Winter         62.020         0.0         322.6         70           120 min         Winter         38.938         0.0         313.7         130           180 min         Winter         29.560         0.0         322.6         188           240 min         Winter         24.201         0.0         336.0         246           360 min         Winter         18.056         0.0         352.8         364           480 min         Winter         14.508         0.0         361.9         482           600 min         Winter         12.172         0.0         367.0         600           720 min         Winter         10.508         0.0         369.8         718							
Event(mm/hr)Volume (m³)Volume (m³)(mins) (m³)60 min Winter62.0200.0322.670120 min Winter38.9380.0313.7130180 min Winter29.5600.0322.6188240 min Winter24.2010.0336.0246360 min Winter18.0560.0352.8364480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718	10080	min Winter	52.554	1.054	2.1	738.0	о к
(m <sup>3</sup> ) (m <sup>3</sup> ) 60 min Winter 62.020 0.0 322.6 70 120 min Winter 38.938 0.0 313.7 130 180 min Winter 29.560 0.0 322.6 188 240 min Winter 24.201 0.0 336.0 246 360 min Winter 18.056 0.0 352.8 364 480 min Winter 14.508 0.0 361.9 482 600 min Winter 12.172 0.0 367.0 600 720 min Winter 10.508 0.0 369.8 718						-	
60 min Winter62.0200.0322.670120 min Winter38.9380.0313.7130180 min Winter29.5600.0322.6188240 min Winter24.2010.0336.0246360 min Winter18.0560.0352.8364480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718	E	vent	(mm/hr)				(mins)
120 min Winter38.9380.0313.7130180 min Winter29.5600.0322.6188240 min Winter24.2010.0336.0246360 min Winter18.0560.0352.8364480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718				(m³)	(m	3)	
180 min Winter29.5600.0322.6188240 min Winter24.2010.0336.0246360 min Winter18.0560.0352.8364480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718							70
240 min Winter24.2010.0336.0246360 min Winter18.0560.0352.8364480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718							130
360 min Winter18.0560.0352.8364480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718							188
480 min Winter14.5080.0361.9482600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718							246
600 min Winter12.1720.0367.0600720 min Winter10.5080.0369.8718							
720 min Winter 10.508 0.0 369.8 718							482
						871.2	952
	960 r	nin Winter					1416 2100
	960 r 1440 r		⊿ 1∩⊃	υ.			2100
	960 r 1440 r 2160 r	min Winter		$\cap$			2748 3640
	960 r 1440 r 2160 r 2880 r	nin Winter nin Winter	3.187			63 0	1040
	960 r 1440 r 2160 r 2880 r 4320 r	nin Winter nin Winter nin Winter	3.187 2.237	0.	0 6	63.0 88 1	
8640 min Winter 1.263 0.0 1194.6 6312	960 r 1440 r 2160 r 2880 r 4320 r 5760 r	nin Winter nin Winter nin Winter nin Winter	3.187 2.237 1.749	0. 0.	0 6 0 12	88.1	4440
10080 min Winter 1.125 0.0 1154.5 7256	960 r 1440 r 2160 r 2880 r 4320 r 5760 r 7200 r	nin Winter nin Winter nin Winter nin Winter nin Winter	3.187 2.237 1.749 1.457	0. 0. 0.	0 6 0 12 0 12	88.1 42.8	4440 5344

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RPS Group Limited		Page 4
2420 The Quadrant	60920RCEF	
Aztec West Almondsbury	Hornsea 3 Drainage	L.
Bristol BS32 4AQ	Site 1 - Storage Tank	Micco
Date 21/02/2018 10:34	Designed by ES	
File Site 1 - All.SRCX	Checked by RR	Digitigh
Micro Drainage	Source Control 2017.1.2	

### Model Details

Storage is Online Cover Level (m) 53.700

Tank or Pond Structure

Invert Level (m) 51.500

## Depth (m) Area (m<sup>2</sup>) Depth (m) Area (m<sup>2</sup>) Dept

0.000	700.0	1.500	700.0	
0.200	700.0	1.501	0.0	
0.400	700.0	1.800	0.0	
0.600	700.0	2.000	0.0	
0.800	700.0	2.001	0.0	
1.000	700.0	2.400	0.0	
1.001	700.0	2.600	0.0	

## Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0068-2500-1500-2500 Design Head (m) Design Flow (l/s) Flush-Flo™ Application Sump Available Diameter (mm) Invert Level (m) Minimum Outlet Pipe Diameter (mm) Suggested Manhole Diameter (mm)

## Control Points

Design Point (Calculated) Flush-Flo™ Kick-Flo® Mean Flow over Head Range

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m) Flo	ow (1/s)	Depth (m) Flow	/ (1/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	1.200	2.3	3.000	3.4	7.000	5.1
0.200	2.0	1.400	2.4	3.500	3.7	7.500	5.3
0.300	2.0	1.600	2.6	4.000	3.9	8.000	5.4
0.400	2.0	1.800	2.7	4.500	4.2	8.500	5.6
0.500	1.9	2.000	2.9	5.000	4.4	9.000	5.8
0.600	1.7	2.200	3.0	5.500	4.6	9.500	5.9
0.800	1.9	2.400	3.1	6.000	4.8		
1.000	2.1	2.600	3.2	6.500	4.9		
		01000	0010 1				

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2420 The Quadrant	60920RCEF	
Aztec West Almondsbury	Hornsea 3 Drainage	L.
Bristol BS32 4AQ	Site 1 - Storage Tank	Micco
Date 21/02/2018 10:34	Designed by ES	
File Site 1 - All.SRCX	Checked by RR	Dialinaye
Micro Drainage	Source Control 2017.1.2	1

## Rainfall Details

Rainfall Model		FEH	Winter Storms	Yes
Return Period (years)		100	Cv (Summer)	0.750
FEH Rainfall Version		2013	Cv (Winter)	0.840
Site Location	GB 609251	333774	Shortest Storm (mins)	15
Data Type		Point	Longest Storm (mins)	10080
Summer Storms		Yes	Climate Change %	+40

### Time Area Diagram

Total Area (ha) 1.000

Time	(mins)	Area	Time	(mins)	Area	Time	(mins)	Area
From:	To:	(ha)	From:	To:	(ha)	From:	To:	(ha)
0	4	0.333	4	8	0.333	8	12	0.333

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oth	(m)	Area	(m²)	Depth	(m)	Area	(m²)	
2	800		0.0	Д	.200		0.0	
	000		0.0		400		0.0	
З.	001		0.0	4.	.600		0.0	
З.	400		0.0	4.	.800		0.0	
	600		0.0	5.	.000		0.0	
	800		0.0					
4.	000		0.0					

1.500 2.5 Calculated Objective Minimise upstream storage Surface Yes 68 51.500 100 1200

### Head (m) Flow (l/s)

1.500	2.5
0.300	2.0
0.609	1.7
-	2.0



### Onshore HVAC booster station – proposed drainage layout A.10

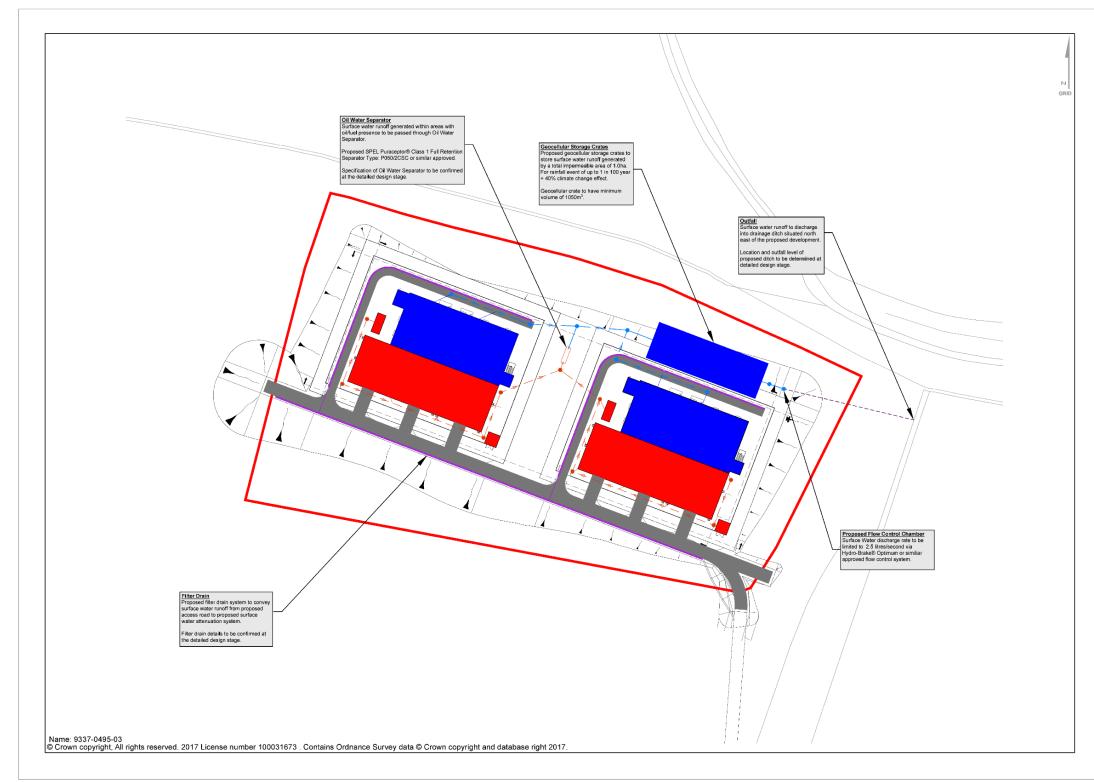


Figure A.2: Onshore HVAC Booster Station – Proposed Drainage Layout.



	Site Extent	
	Bund Area	
	Roof Cover	
	Access Road	
Breakdown of A	) reas	
Total Imperme Total Permeab	able Area = 1.000 hectares	
	Proposed Surface Water Network	
	Proposed Surface Water Network (A	area with Oil/Fuel)
	Proposed Surface Water Pipe     Proposed Surface Water Pipe (Area	with Oil/Fuel)
(° °	Proposed Filter Drain Proposed SPEL Puraceptor® Class	1 Full Retention
<u> </u>	Separator Type P050/2CSC or simil	iar approved
Reference S Projection : I	System : OSGB36 Scale@A BNG Vertical re	.3: eference: Newlyn
REV	REMARK	DATE
00	Initial Issue	28/02/2018
	Hornsea Project Three Onshore HVAC Booster Stat	ion
	Proposed Drainage Layou	t
Doc no: RPS-9 Created by: CF		<b>.</b>
Checked by: R Approved by:C	R RPS	Ursted





# Appendix B Outline Surface Water Drainage Strategy for the **Onshore HVDC Converter/HVAC Substation**

### **B**.1 Introduction

This Outline Surface Water Drainage Strategy was produced to support the FRA for the onshore HVDC B.1.1.1 converter/HVAC substation. The strategy is based on an indicative layout for the HDVC converter/HVAC substation and will be developed in detail post consent.

### Site information **B**.2

- The onshore HVDC converter/HVAC substation area is located 1 km north west of the existing National B.2.1.1 Grid Electricity Transmission 400 kV Norwich Main substation. It is irregular in shape occupying a total area of 14.9 ha. Access to the onshore HVDC converter/HVAC substation area is currently provided in the western section of the site via B1113.
- B.2.1.2 No topographical survey was undertaken for the onshore HVDC converter/HVAC substation area. However, based on available online OS maps, the onshore HVDC converter/HVAC substation area has an average slope of 4% with a steady fall from south east to the north west. The highest point of the site is approximately 40 m AOD, located in the south east corner.
- The onshore HVDC converter/HVAC substation area is currently greenfield and fully permeable. The B.2.1.3 onshore HVDC converter/HVAC substation will create a total impermeable area of 6 ha. The remaining 8.9 ha will be permeable, consisting of free draining surface chippings.
- The Qbar for the site boundary was calculated using the ICP SuDS method. The results, attached in B.2.1.4 section B.8, shows that the Obar based on an overall impermeable area of 5.687 ha is 16.3 l/s.

### Policy **B**.3

- The NPPF requires that proposed development should not increase flood risk. Surface water runoff from B.3.1.1 the development site should not exceed that generated from the existing application site.
- B.3.1.2 The NPPG meanwhile outlines the hierarchy to be investigated by the developer when considering surface water drainage strategy. The following drainage options are to be investigated following order of priority:
  - 1. Discharge rainwater into ground via infiltration;
  - 2. Discharge rainwater direct to a watercourse;
  - 3. Discharge rainwater to a surface water sewer/drain; and
  - 4. Discharge rainwater to the combined sewer.

### Surface water drainage hierarchy **B.4**

B.4.1.1 Based on the NPPG, all of the drainage options are examined in detail in order to assess the feasibility of using a combination of SuDS as part of the onshore HVDC converter/HVAC substation area.

# Discharge rainwater into ground via infiltration

- B.4.1.2 No soil infiltration testing was undertaken on the onshore HVDC converter/HVAC substation area at the time of writing due to access restrictions. Reference to BGS online mapping (1:50,000) indicates that the onshore HVDC converter/HVAC substation area is underlain by superficial deposits from Lowestoft Formation. This particular deposit forms an extensive sheet of chalky till together with outwash sands and gravels, silts and clays. The onshore HVDC converter/HVAC substation area is shown to be underlain by bedrock deposits from the Lewes Nodular Chalk Formation which is comprised of rock.
- Reference to BGS borehole records indicates a borehole log on site (BGS reference: TG20SW14). The B.4.1.3 borehole scans shows that the onshore HVDC converter/HVAC substation area is underlined by boulder clay.
- Based on the information above, discharge of surface water runoff into ground via infiltration is considered B.4.1.4 not feasible.

# Discharge rainwater direct to a watercourse

- The River Tas is located approximately 1.25 km away from the onshore HVDC converter/HVAC substation B.4.1.5 area eastern boundary. The River Yare meanwhile, is approximately 1.5 km from the onshore HVDC converter/HVAC substation area northern boundary.
- B.4.1.6 Based on information provided from onshore HVDC converter/HVAC substation area, there are local ditches at the edges of the proposed onshore HVDC converter/HVAC substation area. A deep drain, with depth of up to 1 m, runs along the northern boundary of the development area, separating the onshore HVDC converter/HVAC substation area from the A47 dual carriageway. It is believed that the drain is used to intercept overland surface water runoff generated on onshore HVDC converter/HVAC substation area from overflowing offsite, into the A47.
- On this basis, the possibility to discharge surface water runoff generated from the onshore HVDC B.4.1.7 converter/HVAC substation area to the deep drain will be considered.





## Discharge rainwater to a surface water sewer

- B.4.1.8 No sewer records were made available.
- As the onshore HVDC converter/HVAC substation area is currently greenfield and located along the A47, B.4.1.9 it is highly likely that there are no public sewers presence on site. If there are sewers located beyond the onshore HVDC converter/HVAC substation area boundary, it is possible that these sewers are used to drain surface water runoff generated from the A47 and associated highways.

## Discharge rainwater to the combined sewer

B.4.1.10 No sewer records were made available.

### Proposed surface water drainage strategy **B**.5

- B.5.1.1 The proposed surface water drainage design parameters are as follows:
  - The proposed drainage system is to be designed so that no flooding will occur during a 1 in 100 year • rainfall event + 40% climate change will effect in any part of the onshore HVDC converter/HVAC substation area:
  - Surface water runoff generated by the proposed development is to discharge into the existing drain running along the onshore HVDC converter/HVAC substation area's northern boundary;
  - The discharge rate into the existing drain to be limited to Qbar; and ٠
  - Surface water runoff generated on areas where there is a possibility of contaminants will be treated prior to discharge.
- Surface water runoff within the proposed development will be generated by three different areas the B.5.1.2 access road, the roof of the substations and the associated substations concrete bunds.
- As the onshore HVDC converter/HVAC substation area is extensive, the proposed drainage strategy will B.5.1.3 look to divide the site into two - the southern and northern catchment. The southern catchment will have a total impermeable area of 3 ha and the northern catchment 3 ha.
- B.5.1.4 Surface water runoff generated will be collected and conveyed towards Geocellular Storage Crates for attenuation. Surface water runoff generated from areas where oil/fuel may be present (i.e. concrete bunds), will be passed through an Oil Water Separator prior to attenuation.
- Surface water runoff will eventually discharge into the deep drain running through the onshore HVDC B.5.1.5 converter/HVAC substation area's northern boundary. The discharge rate will be limited to Qbar 1 in 1 year of 15 l/s. In order to achieve this, discharge rate from the southern and northern catchment will be limited to 7.5 l/s each. Due to the depth of the proposed Geocellular Storage Crates, pumps would be utilised to limit the discharge rates.

### Surface water drainage modelling **B.6**

- B.6.1.1 The attenuation features for the surface water drainage system has been sized using MicroDrainage® to prevent flooding of the site and surrounding areas. The modelling summary for both catchment areas in sections B.9 and B.10, shows that in order for the proposed attenuation systems to attenuate surface water runoff generated for rainfall event up to 1 in 100 year with 40% climate change effect the Geocellular Storage Crates would need to provide a total 7,500 m<sup>3</sup> of storage for both catchments which could have an area of 1,500 m<sup>2</sup> and a depth of 2.5 m.
- B.6.1.2 Section B.11 illustrates the outline drainage strategy for the onshore HVDC converter/HVAC substation and demonstrates that the required attenuation volume can be practicably provided within the onshore HVDC converter/HVAC substation area.







### MicroDrainage calculations for onshore HVDC converter/HVAC substation **B**.7





RPS Group PLC

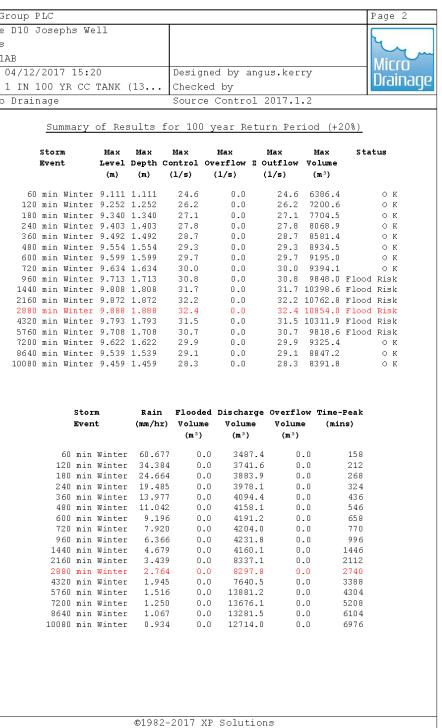
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Micro Drain	nage			Source	e Control	2017.1	• 2
	Summarv	of Res	sults f	or 100	year Reti	ırn Per	rio
	<u> </u>						
	Storm	Max	Max	Max	Max	Max	I
	Event		-		Overflow Σ		۷o
		(m)	(m)	(l/s)	(l/s)	(l/s)	(
60	min Winter	g 111	1 111	24.6	0.0	24.6	6
	min Winter			26.2	0.0	24.0	
	min Winter			27.1	0.0	27.1	
	min Winter			27.8	0.0	27.8	
	min Winter			28.7	0.0	28.7	
	min Winter			29.3	0.0	29.3	
	min Winter			29.7	0.0	29.7	
	min Winter				0.0	30.0	
960	min Winter	9.713	1.713	30.0 30.8	0.0	30.8	
1440	min Winter	9.808	1.808	31.7	0.0	31.7	
2160	min Winter	9.872	1.872	32.2	0.0	32.2	
2880	min Winter	9.888	1.888	32.2 <mark>32.4</mark>	0.0	32.4	108
4320	min Winter	9.793		31.5	0.0	31.5	103
5760	min Winter	9.708	1.708	30.7	0.0	30.7	98
7200	min Winter	9.622	1.622	30.7 29.9	0.0	29.9	93
8640	min Winter	9.539	1.539	29.1	0.0	29.1	88
10080	min Winter	9.459	1.459	28.3	0.0	28.3	83
	Stor	m	Rain	Floode	d Discharge	e Overfl	.0₩
	Even		(mm/hr)		-	Volum	
			,,,	(m <sup>3</sup> )	(m <sup>3</sup> )	(m <sup>3</sup> )	
	60 min	Winter	60.67	70.	0 3487.4	1 0	.0
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	180 min	Winter	24.66	40.	0 3883.9		.0
	240 min	Winter	19.48	50.	0 3978.3	L 0	.0
	360 min	Winter	13.97	70.	0 4094.4	£ 0	.0
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	1440 min						.0
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LB3         LB3         LB4         Designed by angus.kerry Checked by         Micro           Micro         Drainage         Source         Control         2017.1.2           Storn         Max         Max <th< th=""><th></th><th></th><th>1 m</th></th<>			1 m	
File 1 IN 100 YR CC TANK (13         Checked by           Micro Drainage         Source Control 2017.1.2           Summary of Results for 100 year Return Period (+208)           Storn         Max         Max         Max         Max         Max         Status           (n)         (n)         (1/2)         (1/2)         (1/2)         (n)         0.1           15         min Summer 8.774         0.774         20.3         0.0         20.3         4447.7         0 K           30         min Summer 8.976         0.876         2.1.7         0.0         2.1.7         5531.0         0 K           120         min Summer 9.194         1.16         2.4.6         0.0         2.4.6         6418.2         0 K           120         min Summer 9.194         1.94         2.5.5         0.0         2.7.5         7941.0         0 K           600         min Summer 9.328         1.328         2.7.0         0.0         2.7.9         7941.0         0 K           1400         min Summer 9.517         1.559         0.0         2.8.9         9333.6         0 K           200         min Summer 9.521         1.521         2.9.0         0.0         2.8.9         9333.6         0 K	LS3 1AB		Mirro	
Micro Drainage         Source Control 2017.1.2	Date 04/12/2017 15:20	Designed by angus.kerry	Desinado	
Micro Drainage         Source Control 2017.1.2           Storm         Max         Max <thman< th=""> <thman< th=""> <th< td=""><td>File 1 IN 100 YR CC TANK (13</td><td>Checked by</td><td>Diamaye</td></th<></thman<></thman<>	File 1 IN 100 YR CC TANK (13	Checked by	Diamaye	
Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208)           Summary of Results for 100 year Return Period (+208) <th col<="" td=""><td></td><td></td><td></td></th>	<td></td> <td></td> <td></td>			
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Storn         Hax         Max         Max         Max         Max         Max         Max         Max         Max         Max         Statur           15         min         Summer         9.774         0.775         0.7	Gummente of Desciltor f	100 D-toon D-ni1 (100%)		
Frent         Los         Day L (n)         Control (1/2)         Display (1/2)         Display (1/2)         Display (1/2)         Display (1/2)           15 min         Summer         8.070         0.700         20.33         0.00         22.03         20.700         0.70           10 min         Summer         0.090         0.700         22.01         0.000         22.01         509.01         0.70           100 min         Summer         0.201         1.000         22.01         509.01         0.70         70.00         22.01         509.01         0.70           100 min         Summer         9.201         1.202         2.700         0.00         2.201         708.00         0.70           300 min         Summer         9.201         1.202         2.000         2.201         704.00         0.70           300 min         Summer         9.201         1.402         2.000         2.201         9.201.00         0.70           200 min         Summer         9.201         1.501         2.201         0.001         2.201.00         0.70         2.201.00         0.70           200 min         Summer         9.201         1.501         2.001         2.001.00         2.201.	Summary of Results f	or IUU year Return Period (+20%)		
Frent         Los         Dop-tr         Control         Vortical         Vortical         Vortical         Vortical           15 min         Summer         0.77         0.78         20.3         0.00         20.33         444.7         0.8           15 min         Summer         0.800         0.990         23.1         0.00         22.01         543.0         0.8           100 min         Summer         9.104         1.146         24.0         0.00         22.00         543.0         0.8           100 min         Summer         9.201         1.250         26.0         22.00         743.0         0.8           300 min         Summer         9.201         1.250         26.0         22.05         744.0         0.8           300 min         Summer         9.201         1.517         28.0         0.00         22.05         744.0         0.8           300 min         Summer         9.517         1.517         28.0         0.00         22.05         744.0         0.8           300 min         Summer         9.517         1.517         28.0         0.00         22.05         743.0         0.8           2000 min         Summer         9.52<				
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30       min Summer 8.876       0.876       21.7       0.0       21.7       5037.0       0.8         120       min Summer 9.194       1.194       25.5       0.0       22.4.6       6418.2       0.8         120       min Summer 9.194       1.194       25.5       0.0       25.5       6664.2       0.8         30       min Summer 9.328       1.232       27.0       0.0       27.0       7634.5       0.8         300       min Summer 9.328       1.321       27.5       0.0       27.5       7941.0       0.8         600       min Summer 9.420       1.420       27.9       0.0       28.2       833.6       0.8         960       min Summer 9.555       1.555       29.7       0.0       28.9       872.0       0.8         2100       min Summer 9.555       1.556       30.3       0.0       30.3       9522.6       0.6         2100       min Summer 9.551       1.556       2.5       0.0       29.6       9119.5       0.5         2100       min Summer 9.521       1.521       2.9.0       0.0       28.3       0.0       28.3       0.0       28.3       0.0       28.4       0.5       0.5	(m) (m)	(1/s) (1/s) (1/s) (m <sup>3</sup> )		
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60 min Summer 9.116       1.116       23.1       0.0       23.1       565.1       0 K         120 min Summer 9.116       1.116       24.6       0.0       24.6       6418.2       0 K         240 min Summer 9.250       1.250       26.1       0.0       25.5       6864.2       0 K         240 min Summer 9.251       1.328       27.5       0.0       27.5       7941.0       0 K         600 min Summer 9.331       1.331       27.5       0.0       27.5       7941.0       0 K         600 min Summer 9.449       1.449       28.2       0.0       28.2       833.6       0 K         720 min Summer 9.515       1.595       2.97       0.0       27.7       9173.2       0 K         2160 min Summer 9.561       1.566       0.3       0.0       30.1       948.8       0 K         2160 min Summer 9.561       1.566       29.6       0.0       29.6       911.5       0 K         7200 min Summer 9.561       1.551       28.3       0.0       28.3       8387.0       0 K         7200 min Summer 9.391       1.391       27.1       0.0       27.1       77.841.1       0 K         100min Summer 107.076       0.0       1651.1       0				
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360 min Summer       9.328       1.328       27.5       0.0       27.0       734.5       0 K         460 min Summer       9.420       1.420       27.5       0.0       27.5       7941.0       0 K         720 min Summer       9.449       1.449       28.2       0.0       28.2       833.6       0 K         960 min Summer       9.571       1.517       28.9       0.0       28.9       8720.0       0 K         2160 min Summer       9.662       1.656       0.56       0.0       29.7       9173.2       0 K         2160 min Summer       9.656       1.556       29.6       0.0       29.6       9179.5       0 K         4220 min Summer       9.459       1.459       28.3       0.0       28.3       3887.0       0 K         10080 min Summer       9.391       1.391       27.7       0.0       27.1       712.6       0 K         1080 min Summer       9.391       1.341       27.1       0.0       27.1       712.6       0 K         1080 min Summer       9.391       1.341       27.1       0.0       27.1       712.6       0 K         1080 min Summer       9.391       1.341       27.1       0.0				
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				
600 min Summer 9.420 1.420       27.9       0.0       27.9       8164.7       0 K         720 min Summer 9.517 1.517       28.9       0.0       28.9       8720.0       0 K         1440 min Summer 9.555       1.595       29.7       0.0       28.9       8720.0       0 K         280 min Summer 9.656       1.656       30.3       0.0       30.3       9522.6       0 K         2880 min Summer 9.521       1.521       29.0       0.0       29.0       8747.9       0 K         7200 min Summer 9.521       1.521       29.0       0.0       29.0       8747.9       0 K         7200 min Summer 9.321       1.521       28.3       0.0       28.3       8387.0       0 K         10080 min Summer 9.398       1.398       27.7       0.0       27.6       9041.1       0 K         10080 min Summer 9.392       0.982       23.0       0.0       23.0       5647.1       0 K         30 min Winter 8.967       0.867       21.6       0.0       21.6       4985.9       0 K         30 min Summer 107.076       0.0       1539.9       0.0       117         30 min Summer 127.0       0.0       3244.0       0.0       158         120 min Su			0 К	
960 min Summer 9.517 1.517       28.9       0.0       28.9       9720.0       0 K         1440 min Summer 9.558       1.595       29.7       0.0       29.7       913.2       0 K         2800 min Summer 9.566       1.656       30.3       0.0       30.3       9522.6       0 K         2800 min Summer 9.521       1.551       29.0       0.0       29.0       8747.9       0 K         5760 min Summer 9.521       1.551       29.0       0.0       29.0       8747.9       0 K         7200 min Summer 9.521       1.521       29.0       0.0       27.7       8041.1       0 K         10080 min Summer 9.521       1.341       27.7       0.0       27.7       8041.1       0 K         10080 min Summer 9.341       1.341       27.1       0.0       23.0       5647.1       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         30 min Summer       107.076       0.0       1559.9       0       117         30 min Summer       107.076       0.0       3244.0       0.0       139         120 min Summer       14.664       0.0       3620.6       0.0       214			ОК	
1440 min Summer 9.595       1.595       29.7       0.0       29.7 9173.2       0 K         2160 min Summer 9.656       1.642       30.1       0.0       30.1       9438.8       0 K         2800 min Summer 9.586       1.586       29.6       0.0       29.6       9119.5       0 K         4320 min Summer 9.595       1.521       29.0       0.0       29.0       8747.9       0 K         7200 min Summer 9.459       1.459       28.3       0.0       28.8       8387.0       0 K         10080 min Summer 9.459       1.459       28.3       0.0       27.7       8041.1       0 K         10080 min Summer 9.398       1.398       27.7       0.0       27.7       8041.1       0 K         30 min Winter 8.867       0.867       21.6       0.0       21.6       4985.9       0 K         30 min Winter 8.982       0.962       23.0       0.0       23.0       5647.1       0 K         30 min Summer 107.076       0.0       1539.9       0.0       117         30 min Summer 34.384       0.0       3485.5       0.0       214         180 min Summer 19.485       0.0       3620.6       0.0       270         240 min Summer 13.977 <t< td=""><td></td><td></td><td>O K</td></t<>			O K	
2160 min Summer 9.642 1.642       30.1       0.0       30.1 9438.8       0 K         2800 min Summer 9.656 1.656       30.3       0.0       30.3 9522.6       0 K         4320 min Summer 9.521 1.521       29.0       0.0       29.0       8747.9       0 K         7200 min Summer 9.459 1.459       28.3       0.0       27.7       8041.1       0 K         8640 min Summer 9.341       1.341       27.1       0.0       27.7       8041.1       0 K         10080 min Summer 9.341       1.341       27.1       0.0       27.1       77.7       0 K         30 min Winter 8.962       0.982       23.0       0.0       23.0       5647.1       0 K         Storm Rain (mm/hr)       Flooded Discharge Volume Volume (mis)         30 min Winter 8.982       0.982       23.0       0.0       117         30 min Summer 107.076       0.0       1551.1       0.0       130         60 min Summer 124.664       0.0       3620.6       0.0       270         240 min Summer 13.977       0.0       3821.1       0.0       328         360 min Summer 13.977       0.0       3821.1       0.0       328         360 min Summer 110.42       0.0       3822.0	960 min Summer 9.517 1.51	28.9 0.0 28.9 8720.0	о к	
2880 min Summer 9.656 1.656       30.3       0.0       30.3 9522.6       0 K         4320 min Summer 9.586 1.586       29.6       0.0       29.0       9119.5       0 K         5760 min Summer 9.459       1.459       28.3       0.0       28.3       8387.0       0 K         8640 min Summer 9.459       1.459       28.3       0.0       27.7       8041.1       0 K         10080 min Summer 9.398       1.398       27.7       0.0       27.1       712.6       0 K         15 min Summer 9.341       1.341       27.1       0.0       27.1       712.6       0 K         30 min Winter 8.867       0.867       21.6       0.0       23.0       5647.1       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         Storm (mm/hr) Volume (m/h)       Volume (m <sup>3</sup> )       Volume (mins)         15 min Summer 188.954       0.0       1539.9       0.0       117         30 min Summer 19.465       0.0       3485.5       0.0       214         180 min Summer 19.465       0.0       3620.6       0.0       228         360 min Summer 13.977       0.0       3821.1       0.0       480 <td></td> <td></td> <td>О К</td>			О К	
4320 min Summer 9.586 1.586       29.6       0.0       29.6       9119.5       0 K         5760 min Summer 9.521       1.521       29.0       0.0       28.3       0.0       28.3       0.0       0 K         7200 min Summer 9.398       1.398       27.7       0.0       27.7       8041.1       0 K         10080 min Summer 9.341       1.341       27.1       0.0       27.1       712.6       0 K         15 min Winter 8.867       0.867       21.6       0.0       21.6       495.9       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         30 min Summer 107.076       0.0       155.1       0.0       130       117         30 min Summer 107.076       0.0       3244.0       0.0       158         120 min Summer 134.384       0.0       3465.5       0.0       210         240 min Summer 19.465       0.0       3710.3       0.0       328         360 min Summer 19.465       0.0       3821.1       0.0       554         600 min Summer 19.465       0.0       3913.9       0.0       668         720 min Summer 19.196       0.0       3913.9       0.0       668	2160 min Summer 9.642 1.643	30.1 0.0 30.1 9438.8	O K	
5760 min Summer 9.521 1.521       29.0       0.0       29.0       8747.9       0 K         7200 min Summer 9.459       1.459       28.3       0.0       27.7       8041.1       0 K         8640 min Summer 9.341       1.341       27.1       0.0       27.7       8041.1       0 K         10080 min Summer 9.341       1.341       27.1       0.0       27.7       8041.1       0 K         30 min Winter 8.867       0.867       21.6       0.0       21.6       4985.9       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         Kern (mm/hr) Volume Volume Volume (m³)         15       min Summer 107.076       0.0       1651.1       0.0       130         60       min Summer 107.076       0.0       3485.5       0.0       214         180       min Summer 104.664       0.0       3620.6       0.0       270         240       min Summer 13.977       0.0       382.1       0.0       440         480       min Summer 13.977       0.0       382.1       0.0       440         480       min Summer 13.977       0.0       382.1       0.0       440 <tr< td=""><td>2880 min Summer 9.656 1.65</td><td>i 30.3 0.0 30.3 9522.6</td><td>O K</td></tr<>	2880 min Summer 9.656 1.65	i 30.3 0.0 30.3 9522.6	O K	
7200 min Summer 9.459       1.459       28.3       0.0       28.3       8387.0       0 K         8640 min Summer 9.398       1.398       27.7       0.0       27.7       8041.1       0 K         10080 min Summer 9.341       1.341       27.1       0.0       27.7       7041.1       0 K         30 min Winter 8.867       0.867       21.6       0.0       21.6       4985.9       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         Storm Event (mm/h)       Flooded Discharge Volume (m <sup>2</sup> )       Volume (mins)         15       min Summer 107.076       0.0       1551.1       0.0       130         60       min Summer 107.076       0.0       3620.6       0.0       270         240       min Summer 19.485       0.0       3710.3       0.0       328         360       min Summer 13.977       0.0       382.0       0.0       554         600       min Summer 19.465       0.0       3933.7       0.0       1010         1440       min Summer 3.439       0.0       7744.9       0.0       2464         420       min Summer 1.945       0.0       3953.7 <td< td=""><td>4320 min Summer 9.586 1.58</td><td>i 29.6 0.0 29.6 9119.5</td><td>O K</td></td<>	4320 min Summer 9.586 1.58	i 29.6 0.0 29.6 9119.5	O K	
8640 min Summer 9.341 1.341       27.7       0.0       27.7       8041.1       0 K         10080 min Summer 9.341 1.341       27.1       0.0       27.1       7712.6       0 K         15 min Winter 8.967       0.67       21.6       0.0       21.6       4985.9       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         Event       Yolume Yolume Yolume Yolume (mins)         15       min Summer 188.954       0.0       1539.9       0.0       117         30       min Summer 107.076       0.0       1651.1       0.0       138         120       min Summer 107.076       0.3244.0       0.0       158         120       min Summer 24.664       0.0       3620.6       0.0       270         240       min Summer 13.977       0.0       3821.1       0.0       440         480       min Summer 11.042       0.0       382.0       0.0       554         600       min Summer 34.389       0.0       393.7       0.0       1010         1440       min Summer 13.977       0.0       3824.5       0.0       782         960       min Summer 4.679			O K	
8640 min Summer 9.398 1.398       27.7       0.0       27.7       8041.1       0 K         10080 min Summer 9.341 1.341       27.1       0.0       27.1       7712.6       0 K         15 min Winter 8.967       0.667       21.6       0.0       21.6       4985.9       0 K         30 min Winter 8.982       0.982       23.0       0.0       23.0       5647.1       0 K         Event       Flooded Discharge Overflow Time-Peak (mins)         15 min Summer 188.954       0.0       1539.9       0.0       117         30 min Summer 107.076       0.0       1651.1       0.0       158         120 min Summer 34.384       0.0       3485.5       0.0       214         180 min Summer 19.465       0.3710.3       0.0       328         360 min Summer 11.042       0.0       3821.1       0.0       440         440 min Summer 7.920       0.3826.5       0.0       782         960 min Summer 7.920       0.3886.9       0.0       1470         1440 min Summer 1.042       0.0       3886.9       0.0       1470         140 min Summer 1.1.042       0.0       3826.5       0.0       782         960 min Summer 1.1.042       0.		28.3 0.0 28.3 8387.0		
15 min Winter 8.867 0.867       21.6       0.0       21.6       4985.9       0 K         30 min Winter 8.982 0.982       23.0       0.0       23.0       5647.1       0 K         Storm Event       Flooded Discharge Volume Volume (mins) (m²)         Storm 188.954       0.0       1539.9       0.0       117         30 min Summer 188.954       0.0       1539.9       0.0       117         30 min Summer 107.076       0.0       1651.1       0.0       130         60 min Sunmer 107.076       0.0       3244.0       0.0       158         120 min Sunmer 34.384       0.0       3244.0       0.0       228         360 min Sunmer 19.465       0.0       3226.5       0.0       214         180 min Sunmer 13.977       0.0       3821.1       0.0       440         480 min Sunmer 11.042       0.0       3822.5       0.0       554         600 min Sunmer 13.977       0.0       3821.1       0.0       440         480 min Sunmer 1.9465       0.0       393.9       0.0       668         720 min Sunmer 1.920       0.0       3866.9       0.0       1470         1440 min Sunmer 1.920       0.0       3866.9		27.7 0.0 27.7 8041.1		
30 min Winter 8.982 0.982       23.0       0.0       23.0 5647.1       0 K         Storm       Rain       Flooded       Discharg       Overflow       Time-Feak         Event       Yolum				
Storn EventRain (mn/rx)Floodel Volume (m°)Discharg Volume (m°)Overflov Volume (m°)Time-Peak (min)15minsumer 1000189.950.011730minsumer sumer107.0760.01539.90.011730minsumer sumer60.6770.03244.00.0158120minsumer sumer24.6640.03243.50.00214180minsumer sumer13.9770.03821.10.0440600minsumer sumer11.0420.03913.90.0668720minsumer sumer19.960.03913.70.010101440minsumer sumer3.4390.03710.30.010101440minsumer sumer7.9200.03953.70.010101440minsumer3.4390.07734.90.021602800minsumer1.5160.03886.90.014702160minsumer1.5160.01267.90.020443200minsumer1.5160.01267.90.024603201minsumer1.5160.012667.90.044023202minsumer1.5160.012667.90.044023203minsumer1.5160.0126				
Event         (nm/hz)         Volume (n°)         Volume (n°)         Volume (n°)         (mins)           15         nin         Sumer         188.954         0.0         1539.9         0.0         117           30         nin         Sumer         107.076         0.0         1651.1         0.0         130           60         nin         Sumer         34.384         0.0         3244.0         0.0         158           120         nin         Sumer         34.384         0.0         3485.5         0.0         270           240         nin         Sumer         13.977         0.0         3821.1         0.0         440           480         nin         Sumer         11.042         0.0         3912.5         0.0         554           600         nin         Sumer         19.485         0.0         3913.7         0.0         1010           440         nin         Sumer         11.042         0.0         3953.7         0.0         1010           1440         nin         Sumer         3.439         0.0         7734.9         0.0         2464           120         nin         Sumer         3.439	30 min Winter 8.982 0.98;	23.0 0.0 23.0 5647.1	o k	
Event         (nm/hz)         Volume (n°)         Volume (n°)         Volume (n°)         (mins)           15         nin         sumer         188.954         0.0         1539.9         0.0         117           30         nin         sumer         107.076         0.0         1651.1         0.0         130           60         nin         sumer         34.384         0.0         3244.0         0.0         158           120         nin         sumer         34.384         0.0         3485.5         0.0         270           240         nin         sumer         19.485         0.0         3710.3         0.0         328           360         nin         sumer         11.042         0.0         3882.0         0.0         554           600         nin         sumer         7.920         0.0         3953.7         0.0         1010           1440         nin         sumer         3.439         0.0         7734.9         0.0         2464           200         nin         sumer         3.439         0.0         744.9         0.0         1470           1440         nin         sumer         3.439         0.				
Event(mn/hr.)Volume (m³)Volume (m³)Volume (m³)(mins)15minSumer188.9540.01539.90.011730minSumer107.0760.01651.10.013060minSumer34.3840.03244.00.0158120minSumer34.3840.03485.50.0214180minSumer24.6640.03710.30.03228360minSumer13.9770.03821.10.0440480minSumer11.0420.03926.50.0782960minSumer7.9200.03953.70.010101440minSumer3.4390.07734.90.024844320minSumer3.4390.07097.20.032045760minSumer1.5160.012667.90.040087200minSumer1.5200.01268.80.048328640minSumer1.6570.0120848328640minSumer1.6570.0646415minWinter1000minSumer1.6570.012667.90.0646415minSumer1.6570.012667.90.064641000minSumer1.6570.01400117 <td></td> <td></td> <td></td>				
(m <sup>3</sup> )         (m <sup>3</sup> )         (m <sup>3</sup> )         (m <sup>3</sup> )           15 min Summer 108.954         0.0         1539.9         0.0         117           30 min Summer 107.076         0.0         1651.1         0.0         130           60 min Summer 60.677         0.0         3244.0         0.0         158           120 min Summer 34.384         0.0         3485.5         0.0         214           180 min Summer 24.664         0.0         362.6         0.0         270           240 min Summer 19.485         0.0         3710.3         0.0         328           360 min Summer 13.977         0.0         382.1         0.0         440           480 min Summer 11.042         0.0         3882.0         0.0         554           600 min Summer 9.196         0.0         3913.9         0.0         668           720 min Summer 6.366         0.0         3953.7         0.0         1010           1440 min Summer 1.4679         0.0         782         960         1470           2160 min Summer 1.945         0.0         7734.9         0.0         2484           4320 min Summer 1.945         0.0         7065         0.0         3204           5760 min Summer 1.516		-		
15 min Summer188.9540.01539.90.011730 min Summer107.0760.01651.10.013060 min Summer60.6770.03244.00.0158120 min Summer34.3840.03485.50.0214180 min Summer19.4850.03620.60.0270240 min Summer19.4850.03710.30.0328360 min Summer13.9770.03821.10.0440480 min Summer11.0420.03882.00.0554600 min Summer9.1960.03913.90.0668720 min Summer7.9200.03866.90.014701440 min Summer3.4390.07734.90.021602800 min Summer1.9450.07097.20.032245760 min Summer1.5160.012667.90.040087200 min Summer1.5160.012667.90.048328640 min Summer1.0670.01267.90.0646410080 min Summer0.9340.011678.90.0646415 min Winter108540.01647.40.011730 min Winter107.0760.01764.50.0130	Event (mm/hr)			
30 min Summer       107.076       0.0       1651.1       0.0       130         60 min Summer       60.677       0.0       3244.0       0.0       158         120 min Summer       34.384       0.0       3465.5       0.0       214         180 min Summer       24.664       0.0       360.6       0.0       270         240 min Summer       19.485       0.0       3710.3       0.0       328         360 min Summer       13.977       0.0       3821.1       0.0       440         400 min Summer       11.042       0.0       3882.0       0.0       554         600 min Summer       7920       0.0       3913.9       0.0       668         720 min Summer       7.920       0.0       3953.7       0.0       1010         1440 min Summer       3.439       0.0       7734.9       0.0       2484         4320 min Summer       2.764       0.0       70075.5       0.0       2484         4320 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.525       0.0       1267.9       0.0       4832         8640 min Summer       1.516       0.0		(m~) (m~)		
60 min Summer       60.677       0.0       3244.0       0.0       158         120 min Summer       34.384       0.0       3485.5       0.0       214         180 min Summer       24.664       0.0       3620.6       0.0       270         240 min Summer       19.485       0.0       3710.3       0.0       328         360 min Summer       13.977       0.0       3821.1       0.0       440         480 min Summer       11.042       0.0       3822.0       0.0       554         600 min Summer       7.920       0.0       3913.9       0.0       668         720 min Summer       6.366       0.0       3953.7       0.0       1010         1440 min Summer       3.439       0.0       7734.9       0.0       2460         2160 min Summer       3.439       0.0       7704.5       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4832         8640 min Summer       1.516       0.0       1267.9       0.0       4832         8640 min Summer       1.677       0.0	15 min Summer 188.95	0.0 1539.9 0.0 117		
120 min Summer       34.384       0.0       3485.5       0.0       214         180 min Summer       24.664       0.0       3620.6       0.0       270         240 min Summer       19.485       0.0       3710.3       0.0       328         360 min Summer       19.485       0.0       3710.3       0.0       440         480 min Summer       11.042       0.0       3821.1       0.0       440         480 min Summer       9.196       0.0       3913.9       0.0       668         720 min Summer       7.920       0.0       3926.5       0.0       1010         1440 min Summer       6.366       0.0       3953.7       0.0       1010         1440 min Summer       3.439       0.0       7734.9       0.0       2160         2800 min Summer       1.945       0.0       7097.2       0.0       3204         4320 min Summer       1.516       0.0       1267.9       0.0       4028         640 min Summer       1.516       0.0       1267.9       0.0       4028         7200 min Summer       1.677       0.1       12184.3       0.0       4832         8640 min Summer       1.967       0.0	30 min Summer 107.07	5 0.0 1651.1 0.0 130		
180 min Summer       24.664       0.0       3620.6       0.0       270         240 min Summer       19.485       0.0       3710.3       0.0       328         360 min Summer       13.977       0.0       3821.1       0.0       440         480 min Summer       11.042       0.0       3821.1       0.0       450         600 min Summer       9.196       0.0       3913.9       0.0       668         720 min Summer       7.920       0.0       3926.5       0.0       782         960 min Summer       6.366       0.0       3953.7       0.0       1010         1440 min Summer       3.439       0.0       774.9       0.0       2160         2880 min Summer       3.439       0.0       7706.5       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       1267.9       0.0       4008         7200 min Summer       1.267       0.0       1264.3       0.0       5640         10080 min Summer       1.067       0.0	60 min Summer 60.67	0.0 3244.0 0.0 158		
240 min Summer       19.485       0.0       3710.3       0.0       328         360 min Summer       13.977       0.0       3821.1       0.0       440         480 min Summer       11.042       0.0       3892.0       0.0       554         600 min Summer       9.196       0.0       3926.5       0.0       782         920 min Summer       7.920       0.0       3953.7       0.0       1010         1440 min Summer       4.679       0.0       3886.9       0.0       1470         2160 min Summer       3.439       0.0       7734.9       0.0       2160         2880 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4832         640 min Summer       1.516       0.0       12667.9       0.0       4832         8640 min Summer       1.667       0.0       12161.8       0.0       4832         8640 min Summer       1.667       0.0       12184.3       0.0       5640         10080 min Summer       1.8954       0.0       1674.4       0.0       117         30 min Winter       107.076       0.				
360 min Summer       13.977       0.0       3821.1       0.0       440         480 min Summer       11.042       0.0       3882.0       0.0       554         600 min Summer       9.196       0.0       3913.9       0.0       668         720 min Summer       7.920       0.0       3953.7       0.0       1010         1440 min Summer       6.366       0.0       3953.7       0.0       1470         2160 min Summer       3.439       0.0       7734.9       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.520       0.0       1267.9       0.0       4832         640 min Summer       1.667       0.0       1267.9       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       1.88954       0.0       1678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.				
480 min Summer       11.042       0.0       3882.0       0.0       554         600 min Summer       9.196       0.0       3913.9       0.0       668         720 min Summer       7.920       0.0       3926.5       0.0       782         960 min Summer       6.366       0.0       3953.7       0.0       1010         1440 min Summer       4.679       0.0       3886.9       0.0       1470         2160 min Summer       3.439       0.0       7734.9       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4032         7200 min Summer       1.516       0.0       1267.9       0.0       4832         8640 min Summer       1.667       0.0       12764.3       0.0       5640         10080 min Summer       0.934       0.0       11678.9       0.0       6464         15 min Winter       108.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
600 min Summer9.1960.03913.90.0668720 min Summer7.9200.03926.50.0782960 min Summer6.3660.03953.70.010101440 min Summer4.6790.03886.90.014702160 min Summer3.4390.07734.90.021602880 min Summer1.9450.07706.50.024844320 min Summer1.5160.012667.90.040087200 min Summer1.5160.012518.80.048328640 min Summer1.0670.012184.30.0564010080 min Summer0.9340.01678.90.0646415 min Winter188.9540.01647.40.011730 min Winter107.0760.01764.50.0130				
720 min Summer       7.920       0.0       3926.5       0.0       782         960 min Summer       6.366       0.0       3953.7       0.0       1010         1440 min Summer       4.679       0.0       3866.9       0.0       1470         2160 min Summer       3.439       0.0       7704.5       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       11678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
960 min Summer       6.366       0.0       3953.7       0.0       1010         1440 min Summer       4.679       0.0       3886.9       0.0       1470         2160 min Summer       3.439       0.0       7734.9       0.0       2484         4320 min Summer       2.764       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       11678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
1440 min Summer       4.679       0.0       3886.9       0.0       1470         2160 min Summer       3.439       0.0       7734.9       0.0       2160         2800 min Summer       2.764       0.0       7706.5       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       11678.9       0.0       6464         15 min Winter       108.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
2160 min Summer       3.439       0.0       7734.9       0.0       2160         2880 min Summer       2.764       0.0       7706.5       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       1678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
2880 min Summer       2.764       0.0       7706.5       0.0       2484         4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       1678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
4320 min Summer       1.945       0.0       7097.2       0.0       3204         5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       1678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
5760 min Summer       1.516       0.0       12667.9       0.0       4008         7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       11678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
7200 min Summer       1.250       0.0       12518.8       0.0       4832         8640 min Summer       1.067       0.0       12184.3       0.0       5640         10080 min Summer       0.934       0.0       11678.9       0.0       6464         15 min Winter       188.954       0.0       1647.4       0.0       117         30 min Winter       107.076       0.0       1764.5       0.0       130				
8640 min Summer 1.067 0.0 12184.3 0.0 5640 10080 min Summer 0.934 0.0 11678.9 0.0 6464 15 min Winter 188.954 0.0 1647.4 0.0 117 30 min Winter 107.076 0.0 1764.5 0.0 130				
10080 min Summer 0.934 0.0 11678.9 0.0 6464 15 min Winter 188.954 0.0 1647.4 0.0 117 30 min Winter 107.076 0.0 1764.5 0.0 130				
15 min Winter 188.954 0.0 1647.4 0.0 117 30 min Winter 107.076 0.0 1764.5 0.0 130				
30 min Winter 107.076 0.0 1764.5 0.0 130				
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Page 1









Suite D10 Josephs Well Leeds LS3 1AB Date 04/12/2017 15:20 File 1 IN 100 YR CC TANK (13 Micro Drainage Source Control 2017.1.2 Rainfall Model Rainfall Model FEH Return Period (years) Site Location GB 621150 304100 TG 21150 04100 c (1km) -0.024 D1 (1km) 0.351 D3 (1km) 0.244	3
LS3 1AB Date 04/12/2017 15:20 File 1 IN 100 YR CC TANK (13 Checked by Micro Drainage Source Control 2017.1.2 Rainfall Details Rainfall Model FEH Return Period (years) 100 FEH Rainfall Version 1999 Site Location GB 621150 304100 TG 21150 04100 C (1km) -0.024 D1 (1km) 0.291 D2 (1km) 0.351	
Date 04/12/2017 15:20 File 1 IN 100 YR CC TANK (13 Checked by Micro Drainage Source Control 2017.1.2 Rainfall Details Rainfall Model FEH Return Period (years) 100 FEH Rainfall Version C (1km) 0.291 D2 (1km) 0.351	
File 1 IN 100 YR CC TANK (13       Checked by         Micro Drainage       Source Control 2017.1.2         Rainfall Details       Rainfall Details         Rainfall Model       FEH         Return Period (years)       100         FEH Rainfall Version       1999         Site Location GB 621150 304100 TG 21150 04100       C (1km)         0.291       D2 (1km)       0.351	
Micro Drainage       Source Control 2017.1.2         Rainfall Details         Rainfall Model       FEH         Return Period (years)       100         FEH Rainfall Version       1999         Site Location GB 621150 304100 TG 21150 04100       c (1km)         0.291       D2 (1km)       0.351	ם חהו
Rainfall Details           Rainfall Model         FEH           Return Period (years)         100           FEH Rainfall Version         1999           Site Location GB 621150 304100 TG 21150 04100         C (1km)           C (1km)         -0.024           D1 (1km)         0.291           D2 (1km)         0.351	uye
Rainfall Model         FEH           Return Period (years)         100           FEH Rainfall Version         1999           Site Location GB 621150 304100 TG 21150 04100         C (1km)           C (1km)         -0.024           D1 (1km)         0.291           D2 (1km)         0.351	
E (1km)       0.312         F (1km)       2.488         Summer Storms       Yes         Winter Storms       Yes         Cv (Summer)       0.750         Cv (Winter)       0.840         Shortest Storm (mins)       15         Longest Storm (mins)       10080         Climate Change %       +20         Time Area Diagram	
Total Area (ha) 12.800 Time (mins) Area Time (mins) Area Time (mins) Area Time (mins) Area From: To: (ha) From: To: (ha) From: To: (ha) From: To: (ha)	
0 4 0.500 28 32 0.500 56 60 0.500 84 88 0.500 4 8 0.500 32 36 0.500 60 64 0.500 88 92 0.500	
8 12 0.500 36 40 0.500 64 68 0.500 92 96 0.500	
12 16 0.500 40 44 0.500 68 72 0.500 96 100 0.500	
16 20 0.500 44 48 0.500 72 76 0.500 100 104 0.300 20 24 0.500 48 52 0.500 76 80 0.500	
24 28 0.500 52 56 0.500 80 84 0.500	
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RPS Group PLC		Pag
Suite D10 Josephs Well		
Leeds		4
LS3 1AB		Mi
Date 04/12/2017 15:20	Designed by angus.kerry	
File 1 IN 100 YR CC TANK (13	Checked by	DIG
Micro Drainage	Source Control 2017.1.2	•

Model Details

Storage is Online Cover Level (m) 10.000

### Tank or Pond Structure

Invert Level (m) 8.000

### Depth (m) Area (m<sup>2</sup>) Depth (m) Area (m<sup>2</sup>) Depth (m) Area (m<sup>2</sup>)

0.000 5750.0 0.400 5750.0 0.800 5750.0 1.200 5750.0 1.600 5750.0 2.000 5750.0

### Orifice Outflow Control

Diameter (m) 0.107 Discharge Coefficient 0.600 Invert Level (m) 8.000

### Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 10.000

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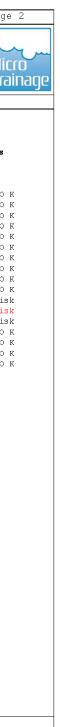


RPS Group PLC							Page 1
Suite D10 Josephs	s Well						I ago I
Leeds							4
LS3 1AB							1 mm
Date 04/12/2017 1	15.21		Designe	d by angu	is korry		Micro
File 1 IN 100 YR		13	Checked		.o. KCLLY		Drainage
Micro Drainage	00 111111 (	10		Control 2	017 1 2		
nioro Brainage			DOULOC	CONCLOT 2	.0111112		
Summa	ary of Res	ults fo	or 100 y	vear Retui	n Perio	d (+40%)	
Storm		Max	Max	Max	Max		tatus
Event		-		Overflow E			
	(m)	(m)	(1/s)	(1/s)	(1/s)	(m 3)	
	Summer 8.69		19.1	0.0	19.1	5208.9	0 К
	Summer 8.78		20.5	0.0	20.5	5899.6	ОК
	Summer 8.890 Summer 9.004		21.9 23.3	0.0 0.0	21.9 23.3	6673.1 7528.4	o k o k
	Summer 9.07		23.3	0.0	23.3	7J20.4 8060.7	O K
	Summer 9.12		24.8	0.0	24.8	8447.9	ок
	Summer 9.20		25.6	0.0	25.6	8997.6	0 К
	Summer 9.25		26.1	0.0	26.1	9381.5	ОК
	Summer 9.28! Summer 9.31!		26.6 26.9	0.0 0.0	26.6 26.9	9669.1 9892.9	o k o k
	Summer 9.38		20.9	0.0		10399.6	0 K
	Summer 9.472		28.5	0.0		11041.0	0 K
2160 min :	Summer 9.53	6 1.536	29.1	0.0	29.1	11517.4	О К
2880 min :	Summer 9.55	9 1.559	29.3	0.0	29.3	11690.8	O K
	Summer 9.502		28.8	0.0		11266.9	ОК
	Summer 9.453		28.3	0.0		10897.4	O K
	Summer 9.40) Summer 9.36		27.8 27.3	0.0 0.0		10545.0 10199.6	ок ок
	Summer 9.31		26.8	0.0	26.8	9864.5	0 K
	Winter 8.77		20.3	0.0	20.3	5838.1	O K
30 min 1	Winter 8.882	2 0.882	21.7	0.0	21.7	6612.9	0 К
	Storm	Rain	Flooded	Discharge	Overflow	Time-Peak	
	Event	(mm/hr)		Volume	Volume	(mins)	
			(m³)	(m³)	(m³)		
15	min Summer	220 114	0.0	1479.9	0.0	117	
	min Summer			1585.3	0.0	131	
	min Summer	70.790		3181.9	0.0	158	
	min Summer	40.115		3408.6	0.0	216	
	min Summer	28.775		3534.3	0.0	272	
	min Summer min Summer	22.732		3617.0 3717.6	0.0	330 444	
	min Summer min Summer	12.882		3717.6 3770.9	0.0	444 558	
	min Summer	10.729		3796.9	0.0	674	
	min Summer	9.240		3804.8	0.0	788	
	min Summer	7.427		3822.8	0.0	1020	
	min Summer	5.459		3745.6	0.0	1482	
	min Summer min Summer	4.012		7671.6 7603.9	0.0 0.0	2176	
	min Summer min Summer	3.225 2.269		7603.9 6957.8	0.0	2812 3448	
	min Summer	1.769		13276.9	0.0	4192	
	min Summer	1.458	0.0	12973.2	0.0	4992	
	min Summer	1.245		12511.5	0.0	5816	
	min Summer min Winter	1.089		11908.9 1582.1	0.0	6640	
	min Winter min Winter			1582.1	0.0	117 131	
			2017 XP				
L		21202		20100101	-		

RPS Group H				-				]	Page
Suite D10 3	Josephs We	211							
Leeds									y
LS3 1AB									Mic
Date 04/12,	/2017 15:2	21		Desigr	ned by an	gus.ker	ry		
File 1 IN 1	100 YR CC	TANK	(13	Checke	ed by				UIC
Micro Drain	nage			Source	e Control	2017.1	.2		
	Summary	of Re:	sults f	or 100	year Ret	urn Per	iod (+4	0%)	
	Storm	Max	Max	Max	Max	Max	Max	Sta	tus
	Event	Level	Depth C	ontrol (	Overflow Σ	Outflow	Volume		
		(m)	(m)	(l/s)	(1/s)	(l/s)	(m³)		
60	min Winter	8.998	0.998	23.2	0.0	23.2	7481.5		0
	min Winter			24.7	0.0	24.7	8443.4		0
180	min Winter	9.206	1.206	25.7	0.0	25.7	9043.8		0
2 40	min Winter	9.264	1.264	26.3	0.0	26.3	9481.7		0
360	min Winter	9.348	1.348	27.2	0.0	27.2	10106.3		0
480	min Winter	9.406	1.406	27.8	0.0	27.8	10545.5		0
600	min Winter	9.450	1.450	28.2	0.0	28.2	10877.0		0
720	min Winter	9.485	1.485	28.6	0.0	28.6	11137.1		0
	min Winter			29.4	0.0		11724.9		0
1440	min Winter	9.665	1.665	30.3	0.0	30.3	12484.4		0
	min Winter			31.1	0.0		13081.0		
	min Winter			31.4	0.0		13342.3		
	min Winter			30.7	0.0		12765.3	Flood	
	min Winter			30.1	0.0		12303.7		0
	min Winter			29.5	0.0		11831.7		0
	min Winter			28.9	0.0		11359.3		0
10080	min Winter	9.453	1.453	28.3	0.0	28.3	10896.6		0
	Stor		Rain		d Discharg				
	Even	t	(mm/hr)	Volum∉ (m³)	e Volume (m³)	Volum (m³)	e (min	ns)	
		Winter					.0	158	
	120 min						.0	214	
	180 min						.0	270	
	240 min						.0	326	
	360 min						.0	438	
	480 min						.0	550	
	600 min						.0	664	
	720 min						.0	776	
	960 min 1440 min						.0	1002	
	1440 min						.0	1456	
	2160 min						.0	2136	
	2880 min 4320 min						.0 .0	2796 3616	
	4320 min 5760 min						.0	3010 4456	
	7200 min						.0	44J0 5368	
	8640 min						.0	6280	
	10080 min						.0	7176	
						- 0			

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RPS Group	PLC									:	Page 3	
Suite D10	Joseph	s Wel	1									
Leeds											L	
LS3 1AB											Micro	Jun
Date 04/12					Desig	ned b	y angu:	s.kern	сy		Drain	
File 1 IN		CC T	ANK (1	13	Check	-					Dialiti	uye
Micro Drai	nage				Sourc	e Con	trol 20	017.1.	2			
			Period infall Site	ll Mode (years Versio Locatio C (1km D1 (1km D2 (1km D3 (1km	) n GB 63 ) ) ) )		<u>ils</u> 304100 T	G 2115	-0.02 0.29 0.35 0.24	0 9 4 1 1 4		
		Longes	Winte Cv Cv t Storn t Storn	E (1km F (1km r Storm r Storm (Summer (Winter m (mins m (mins Change	) 5 5 ) ) )				0.31 2.48 Ye 0.75 0.84 1 1008 +4	8 5 0 0 5 0		
					le Are l Area							
Time From:	(mins) To:		Time From:	(mins) To:		Time From:			Time From:		Area (ha)	
0 4 8 12 16 20 24	8 12 16 20 24	0.500 0.500 0.500 0.500 0.500 0.500	32 36 40 44 48	36 40 44 48 52	0.500 0.500 0.500 0.500 0.500 0.500	60 64 68 72 76	64 68 72 76 80	0.500 0.500 0.500 0.500 0.500 0.500	88 92 96 100	92 96 100	0.500 0.500 0.500 0.300	
				©1982-	2017 :	XP Sol	lutions	3				

RPS Group PLC		Pa
Suite D10 Josephs Well		
Leeds		4
LS3 1AB		N
Date 04/12/2017 15:21	Designed by angus.kerry	
File 1 IN 100 YR CC TANK (13	Checked by	D
Micro Drainage	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m) Area (m²) Depth (m) Area (m²) Depth (m) Area (m²)

0.000 7500.0 0.400 7500.0 0.800 7500.0 1.200 7500.0 1.600 2.000 7500.0 7500.0

Orifice Outflow Control

Diameter (m) 0.107 Discharge Coefficient 0.600 Invert Level (m) 8.000

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 10.000

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### **B.8 Greenfield Obar Runoff Calculations**





RPS Group Limited		Page 1
2420 The Quadrant	HVDC Converter	
Aztec West Almondsbury	QBAR	4
Bristol BS32 4AQ		Micco
Date 21/02/2018	Designed by ES	
File	Checked by RR	Drainage
Micro Drainage	Source Control 2017.1.2	

## ICP SUDS Mean Annual Flood

Input

Return Period (years) 1 Soil 0.400 Area (ha) 6.000 Urban 0.000 SAAR (mm) 605 Region Number Region 5

Results 1/s

QBAR Rural 17.2 QBAR Urban 17.2

Q1 year 15.0

Q1 year 15.0 Q30 years 41.3 Q100 years 61.3

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Modelling summary for onshore HVDC converter/HVAC substation southside **B.9** 





RPS Group Limited						Page 1
2420 The Quadrant		RCEF	60920			
Aztec West Almondsbury	7	-	Conver	rter		<b>L</b>
Bristol BS32 4AQ		-		ha Impe	rmeable	1 mm
Date 21/02/2018			qned by	-		Micro
File HVDC Southern.src	v		ked by			Drainage
Micro Drainage	.21			rol 2017	1 2	
The starnaye		5001				
Summary of	of Result	s for 10	)0 year	Return 1	Period (+40%)	-
	Half	Drain Tin	ne : 5283	8 minutes.		
Storm			lax	Max	Max Max	Status
Event		-	tration ( ./s)	Control Σ (1/s)	Outflow Volume (1/s) (m <sup>3</sup> )	
	(111) (1	) (1	./3/	(1/3)	(1/3) (m)	
15 min Summer			0.0	1.9	1.9 899.1	O K
30 min Summer 60 min Summer			0.0	2.5 3.1	2.5 1176.1 3.1 1459.2	ок ок
120 min Summer			0.0	3.7	3.7 1759.1	O K
180 min Summer			0.0	4.2	4.2 1978.5	O K
240 min Summer			0.0	4.5	4.5 2152.8	O K
360 min Summer	33.195 1.	695	0.0	5.1	5.1 2415.1	O K
480 min Summer			0.0	5.5	5.5 2599.9	O K
600 min Summer			0.0	5.8	5.8 2733.5	O K
720 min Summer			0.0	6.0	6.0 2833.3	O K
960 min Summer			0.0	6.2	6.2 2963.8	OK
1440 min Summer 2160 min Summer			0.0	6.5 6.6	6.5 3089.5 6.6 3134.9	ок ок
2160 min Summer 2880 min Summer			0.0	6.6	6.6 3134.9 6.6 3119.7	O K
4320 min Summer			0.0	6.4	6.4 3056.6	0 K
5760 min Summer			0.0	6.3	6.3 3014.4	
7200 min Summer	33.596 2.	096	0.0	6.3	6.3 2986.3	O K
8640 min Summer			0.0	6.2	6.2 2962.3	O K
10080 min Summer			0.0	6.2	6.2 2939.9	O K
15 min Winter			0.0	2.1	2.1 1006.9	O K
30 min Winter 60 min Winter			0.0	2.8	2.8 1317.2	OK
60 min Winter 120 min Winter			0.0	3.4 4.1	3.4 1634.3 4.1 1970.5	O K O K
180 min Winter			0.0	4.7	4.7 2216.5	O K
240 min Winter			0.0	5.1	5.1 2411.9	0 K
360 min Winter			0.0	5.7	5.7 2706.1	O K
480 min Winter	33.545 2.	045	0.0	6.1	6.1 2913.6	O K
600 min Winter	33.650 2.	150	0.0	6.5	6.5 3063.9	0 K
	Storm	Rain	Flooded	Discharco	Time-Peak	
	Event	(mm/hr)		Volume (m <sup>3</sup> )	(mins)	
15	min Summe:	r 160.105	0.0	148.5	27	
	min Summe:					
	min Summe					
	min Summe			530.8	132	
	min Summe					
	min Summe					
	min Summe					
	min Summe: min Summe:					
	min Summe:					
	min Summe:					
	min Summe					
2160	min Summe	r 4.431	0.0			
	min Summe					
	min Summe					
	min Summe					
	min Summe: min Summe:					
	min Summe:					
	min Winte					
	min Winte					
	min Winte					
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	min Winte					
	min Winte					
	min Winte					
	min Winte min Winte					
	©1	982-2017	XP Sol	utions		

RPS Group Limited				1-					Page 2
2420 The Quadrant	_				60920				
Aztec West Almonds	bury			HVDC Converter Southside 3 ha Impermeable					
Bristol BS32 4AQ							rmeable	e	Mirro
Date 21/02/2018					gned by				Drainage
File HVDC Southern.srcx					ked by				brainage
Micro Drainage				Sour	ce Cont	rol 2017	.1.2		
Summa	iry of	E Resi	ults	for 10	0 year	Return 1	Period	(+40%)	
Storm		Max	Max	M	lax	Max	Max	Max	Status
Event	:			Infil	tration (	Control E			
		(m)	(m)	(1	/s)	(1/s)	(1/s)	(m³)	
720 min Win	nter 3	33 729	2 229		0.0	6.7	67	3176.3	ОК
960 min Win					0.0	7.0		3323.7	0 K
1440 min Win					0.0	7.3		3467.7	O K
2160 min Win					0.0	7.4		3525.8	O K
2880 min Win 4320 min Win					0.0	7.4 7.2		3518.8 3437.1	ок ок
5760 min Win					0.0	7.1		3374.9	
7200 min Win					0.0	7.0		3327.6	
8640 min Win						6.9		3280.8	
10080 min Win	nter 3	33.770	2.270		0.0	6.8	6.8	3235.0	O K
				D	-	Die 1			
		torm vent	,		Flooded Volume	Discharge Volume	e Time-Pe (mins		
	E	venc	(		(m <sup>3</sup> )	(m <sup>3</sup> )	(mins	)	
	700	nin T-T-	at ~ ~	10 007				710	
				10.987 8.749				718 952	
				6.265				418	
	2160 n	nin Wir	nter	4.431	0.0			L00	
				3.457				768	
				2.435				980	
				1.904 1.580				188 108	
				1.360				312	
				1.201				256	
			©1982	2-2017	XP Sol	utions			

		1
RPS Group Limited		Page 3
2420 The Quadrant	RCEF60920	
Aztec West Almondsbury	HVDC Converter	M m
Bristol BS32 4AQ Date 21/02/2018	Southside 3 ha Impermeable Designed by ES	Micro
File HVDC Southern.srcx	Checked by RR	Drainage
Micro Drainage	Source Control 2017.1.2	
niero brainage	Source concrot 2017.1.2	
Ra	ainfall Details	
Rainfall Model Return Period (years)	FEH Winter Storms Yes 100 Cv (Summer) 0.750	
FEH Rainfall Version	2013 Cv (Winter) 0.840	)
	621399 303590 Shortest Storm (mins) 15	
Data Type Summer Storms	Point Longest Storm (mins) 10080 Yes Climate Change % +40	
	me Area Diagram	
	al Area (ha) 3.000 ime (mins) Area   Time (mins) Area	
	rom: To: (ha) From: To: (ha)	
0 4 1.000	4 8 1.000 8 12 1.000	

RPS Group Limited		Page 4
2420 The Quadrant	RCEF60920	
Aztec West Almondsbury	HVDC Converter	L.
Bristol BS32 4AQ	Southside 3 ha Impermeable	Micco
Date 21/02/2018	Designed by ES	Drainarre
File HVDC Southern.srcx	Checked by RR	Diamaye
Micro Drainage	Source Control 2017.1.2	

## Model Details

Storage is Online Cover Level (m) 35.000

## Cellular Storage Structure

Invert Level (m) 31.500 Safety Factor 2.0 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Side (m/hr) 0.00000

### Depth (m) Area (m<sup>2</sup>) Inf. Area (m<sup>2</sup>) Depth (m) Area (m<sup>2</sup>) Inf. Area (m<sup>2</sup>)

0.000 1500.0 2.500 1500.0 1500.0 1500.0

### Pump Outflow Control

Invert Level (m) 31.500

### Depth (m) Flow (l/s)

2.500 7.5000

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2.501 0.0 1500.0



Modelling summary HVDC converter/HVAC substation northside **B.10** 





RPS Group Limited		Page 1
2420 The Quadrant	RCEF60920	
Aztec West Almondsbury	HVDC Converter	L.
Bristol BS32 4AQ	Northside 3 ha Impermeable	Micco
Date 21/02/2018	Designed by ES	
File HVDC Northern.srcx	Checked by RR	Dialiaye
Micro Drainage	Source Control 2017.1.2	

Summary of Results for 100 year Return Period (+40%)

### Half Drain Time : 5283 minutes.

	Storm Event		Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15	min	Summer	32.131	0.631	0.0	1.9	1.9	899.1	ΟK
30	min :	Summer	32.325	0.825	0.0	2.5	2.5	1176.1	ΟK
60	min :	Summer	32.524	1.024	0.0	3.1	3.1	1459.2	ΟK
120	min :	Summer	32.734	1.234	0.0	3.7	3.7	1759.1	ΟK
180	min	Summer	32.888	1.388	0.0	4.2	4.2	1978.5	ОК
240	min :	Summer	33.011	1.511	0.0	4.5	4.5	2152.8	ΟK
360	min :	Summer	33.195	1.695	0.0	5.1	5.1	2415.1	ΟK
480	min	Summer	33.324	1.824	0.0	5.5	5.5	2599.9	ОК
600	min :	Summer	33.418	1.918	0.0	5.8	5.8	2733.5	ΟK
720	min :	Summer	33.488	1.988	0.0	6.0	6.0	2833.3	ΟK
960	min :	Summer	33.580	2.080	0.0	6.2	6.2	2963.8	ΟK
1440	min :	Summer	33.668	2.168	0.0	6.5	6.5	3089.5	ΟK
2160	min :	Summer	33.700	2.200	0.0	6.6	6.6	3134.9	ΟK
2880	min :	Summer	33.689	2.189	0.0	6.6	6.6	3119.7	ΟK
4320	min :	Summer	33.645	2.145	0.0	6.4	6.4	3056.6	ΟK
5760	min :	Summer	33.615	2.115	0.0	6.3	6.3	3014.4	ΟK
7200	min a	Summer	33.596	2.096	0.0	6.3	6.3	2986.3	ОК
8640	min a	Summer	33.579	2.079	0.0	6.2	6.2	2962.3	ОК
10080	min	Summer	33.563	2.063	0.0	6.2	6.2	2939.9	ОК
15	min M	Winter	32.207	0.707	0.0	2.1	2.1	1006.9	0 K

	Stor Even		Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15	min	Summer	160.105	0.0	148.5	27
30	min	Summer	104.820	0.0	193.6	42
60	min	Summer	65.150	0.0	442.5	72
120	min	Summer	39.418	0.0	530.8	132
180	min	Summer	29.668	0.0	593.9	192
240	min	Summer	24.302	0.0	642.8	250
360	min	Summer	18.312	0.0	713.2	370
480	min	Summer	14.897	0.0	759.0	490
600	min	Summer	12.624	0.0	788.5	610
720	min	Summer	10.987	0.0	807.0	728
960	min	Summer	8.749	0.0	821.6	968
1440	min	Summer	6.265	0.0	804.6	1446
2160	min	Summer	4.431	0.0	1598.1	2164
2880	min	Summer	3.457	0.0	1563.7	2880
4320	min	Summer	2.435	0.0	1426.5	3596
5760	min	Summer	1.904	0.0	2717.6	4320
7200	min	Summer	1.580	0.0	2672.4	5112
8640	min	Summer	1.360	0.0	2592.6	5888
10080	min	Summer	1.201	0.0	2477.5	6752
15	min	Winter	160.105	0.0	166.4	27
		©198	82-2017	XP Sol	utions	

RPS Group Limited			Dane	60000				Page 2
2420 The Quadrant				60920				1.
Aztec West Almondsb	ury		HVDC	Conve				
Bristol BS32 4AQ			Nort	hside	3 ha Impe	ermeabl	е	Micco
Date 21/02/2018			Desi	gned b	y ES			Desipar
File HVDC Northern.	srcx	Chec	ked by	RR			Drainag	
Micro Drainage		Sour	ce Con	trol 2017	7.1.2			
						. –		
Summary	of Res	ults f	for 10	00 year	Return 1	Period	(+40%)	-
Storm	Max	Max	м	ax	Max	Max	Max	Status
Event					Control S			Status
	(m)	(m)		/s)	(1/s)	(1/s)	(m <sup>3</sup> )	
30 min Winte				0.0	2.8		1317.2	O K
60 min Winte				0.0	3.4		1634.3	
120 min Winte 180 min Winte				0.0	4.1 4.7		1970.5 2216.5	
240 min Winte				0.0 0.0	4./ 5.1		2411.9	
360 min Winte				0.0	5.7		2706.1	
480 min Winte				0.0	6.1		2913.6	
600 min Winte				0.0	6.5		3063.9	
720 min Winte				0.0	6.7		3176.3	
960 min Winte				0.0	7.0		3323.7	
1440 min Winte				0.0	7.3		3467.7	
2160 min Winte				0.0	7.4		3525.8	
2880 min Winte				0.0	7.4		3518.8	O K
4320 min Winte	r 33.912	2.412		0.0	7.2	7.2	3437.1	O K
5760 min Winte	r 33.868	2.368		0.0	7.1	7.1	3374.9	O K
7200 min Winte	r 33.835	2.335		0.0	7.0	7.0	3327.6	O K
8640 min Winte				0.0	6.9		3280.8	O K
10080 min Winte	r 33.770	2.270		0.0	6.8	6.8	3235.0	0 K
	Storm Event		Rain m/hr)	Flooded Volume (m <sup>3</sup> )	l Discharge Volume (m³)	e Time-Pe (mins		
				• •				
-							4.0	
	0 min Wi				216.8		42	
6	0 min Wi	nter (	55.150	0.0	216.8 495.6	5	72	
6 12	0 min Wi 0 min Wi	nter 6 nter 3	55.150 89.418	0.0	216.8 495.6 594.5		72 L30	
6 12 18	0 min Wi 0 min Wi 0 min Wi	nter 6 nter 3 nter 2	55.150 89.418 29.668	0.0 0.0	216.8 495.6 594.5 665.2		72 130 188	
6 12 18 24 36	0 min Wi 0 min Wi 0 min Wi 0 min Wi 0 min Wi	nter 6 nter 3 nter 2 nter 2 nter 1	55.150 39.418 29.668 24.302 8.312	0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9		72 L30	
6 12 18 24 36	0 min Wi 0 min Wi 0 min Wi 0 min Wi 0 min Wi	nter 6 nter 3 nter 2 nter 2 nter 1	55.150 39.418 29.668 24.302 8.312	0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9 798.8		72 130 188 248	
6 12 18 24 36 48	0 min Wi 0 min Wi 0 min Wi 0 min Wi	nter 6 nter 3 nter 2 nter 2 nter 1 nter 1	55.150 39.418 29.668 24.302 .8.312 .4.897	0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9 798.8		72 L30 L88 248 366	
24 12 24 36 48 60 72	0 min Wi 0 min Wi	nter 6 nter 3 nter 2 nter 1 nter 1 nter 1 nter 1 nter 1	55.150 39.418 29.668 24.302 .8.312 .4.897 .2.624 .0.987	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1		72 130 188 248 366 184	
24 12 24 36 48 60 72	0 min Wi 0 min Wi 0 min Wi 0 min Wi 0 min Wi 0 min Wi 0 min Wi	nter 6 nter 3 nter 2 nter 1 nter 1 nter 1 nter 1 nter 1	55.150 39.418 29.668 24.302 .8.312 .4.897 .2.624 .0.987	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9		72 130 188 248 366 184 500	
6 12 18 24 36 48 60 72 96 144	0 min Wi. 0 min Wi.	nter 6 nter 3 nter 2 nter 1 nter 1 nter 1 nter 1 nter 1 nter 1 nter 1 nter 1	55.150 39.418 29.668 24.302 .8.312 .4.897 .2.624 0.987 8.749 6.265		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1		72 130 188 248 366 484 500 718 952 418	
24 12 24 36 48 60 72 96 144 216	0 min Wi. 0 min Wi.	nter 3 nter 3 nter 2 nter 1 nter 1 nter 1 nter 1 nter 1 nter 1 nter 1 nter 1	5.150 39.418 29.668 24.302 8.312 4.897 2.624 0.987 8.749 6.265 4.431	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b>		72 130 188 248 366 484 500 718 952 418 100	
6 12 18 24 36 48 60 72 96 144 216 288	0 min Wi. 0 min Wi.	nter 6 nter 3 nter 2 nter 1 nter 1	55.150 89.418 29.668 24.302 8.312 4.897 2.624 0.987 8.749 6.265 4.431 3.457	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2		72 130 188 248 366 484 500 718 952 418 100 768	
6 12 18 24 36 48 60 72 96 144 216 288 432	0 min Wi. 0 min Wi.	nter 6 nter 3 nter 2 nter 1 nter 1	55.150 89.418 29.668 24.302 2.624 0.987 8.749 6.265 4.431 3.457 2.435		216.8 495.6 594.5 665.2 719.9 798.8 850.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0		72 130 188 248 366 484 500 718 952 418 100 768 980	
24 12 18 24 36 48 60 72 96 144 216 288 432 576	0 min Wi. 0 min Wi.	nter 6 nter 3 nter 2 nter 1 nter 1 nt	55.150 89.418 29.668 24.302 8.312 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1		72 130 188 248 366 484 500 718 952 418 100 768 980 488	
24 12 18 24 36 48 60 72 96 144 216 288 432 576 720	0 min Wi: 0 min Wi:	nter 6 nter 2 nter 2 nter 2 nter 1 nter 1 nt	55.150 89.418 29.668 24.302 4.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1		72 130 188 248 366 484 500 718 952 418 100 768 980 488 408	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi. 0 min Wi.	anter 6 anter 3 anter 2 anter 1 anter	55.150 39.418 29.668 24.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580 1.360		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi: 0 min Wi:	anter 6 anter 3 anter 2 anter 1 anter	55.150 39.418 29.668 24.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580 1.360		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi. 0 min Wi.	anter 6 anter 3 anter 2 anter 1 anter	55.150 39.418 29.668 24.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580 1.360		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi. 0 min Wi.	anter 6 anter 3 anter 2 anter 1 anter	55.150 39.418 29.668 24.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580 1.360		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi. 0 min Wi.	anter 6 anter 3 anter 2 anter 1 anter	55.150 39.418 29.668 24.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580 1.360		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi. 0 min Wi.	anter 6 anter 3 anter 2 anter 1 anter	55.150 39.418 29.668 24.302 4.897 2.624 0.987 8.749 6.265 4.431 3.457 2.435 1.904 1.580 1.360		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	
24 12 24 36 48 60 72 96 144 216 288 432 576 720 864	0 min Wi. 0 min Wi: 0 min Wi:	nter 6 nter 2 nter 2 nter 1 nter 1 nt	55.150 89.418 29.668 24.302 2.624 2.624 2.624 2.624 2.624 2.625 4.431 3.457 2.435 1.904 1.580 1.360 1.201		216.8 495.6 594.5 665.2 719.9 798.8 850.1 883.1 903.9 920.2 901.1 <b>1789.8</b> 1751.2 1597.0 3043.1 2992.1 2902.0		72 130 188 248 366 484 500 718 352 418 100 768 380 488 408 312	

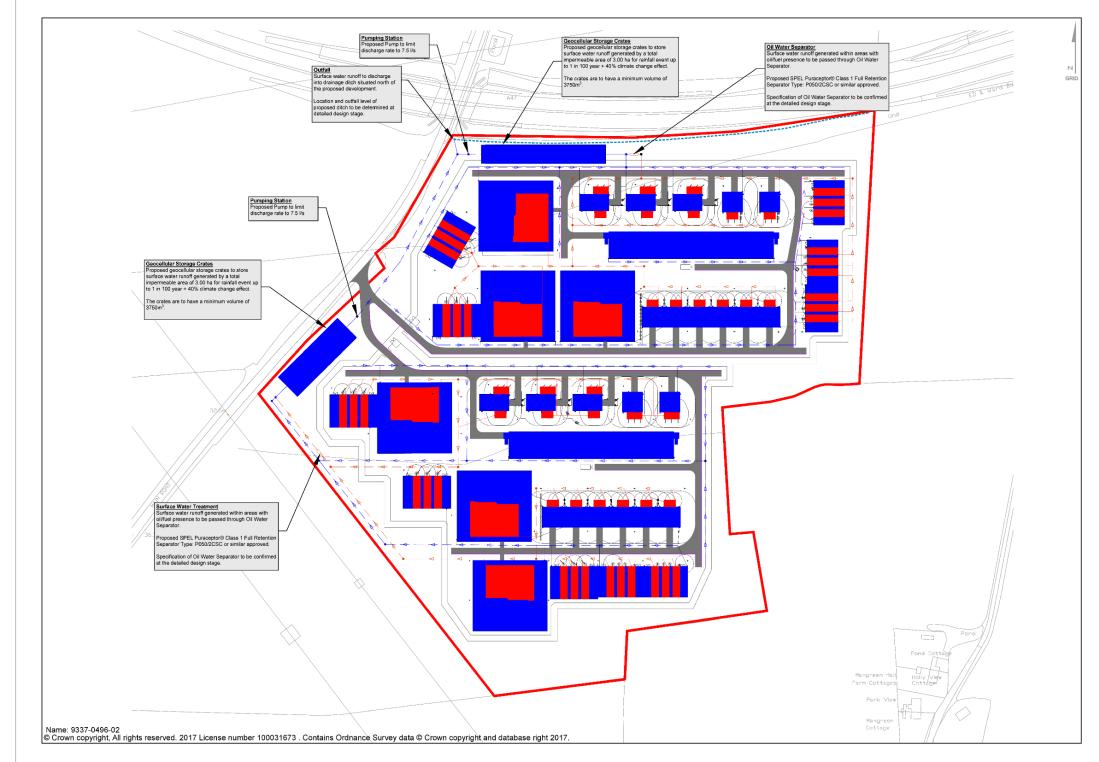
up Limited		Page 3	1	RPS Group Limited					Page 4
e Quadrant	RCEF60920		1	2420 The Quadrant		RCEF60920	0		
est Almondsbury	HVDC Converter	4		Aztec West Almonds	shurv	HVDC Conv			4
BS32 4AQ	Northside 3 ha Impermeable	1 mm		Bristol BS32 4AQ	ar j		e 3 ha Imp	ermeable	1 mm
/02/2018	Designed by ES	— Micro		Date 21/02/2018		Designed		CTUICADIE	— Micro
DC Northern.srcx	Checked by RR	Drainage		File HVDC Northern	srcy	Checked k			Drainago
	Source Control 2017.1.2	J	]	Micro Drainage	I.SICX		ontrol 201	7 1 0	
rainage	Source control 2017.1.2			MICIO DIAINAGE		Source co		1.1.2	
	<u>Rainfall Details</u>					<u>Model Deta</u>	<u>ails</u>		
Rainfall Model Return Period (years)	FEH Winter Storms 100 Cv (Summer) 0.	Yes 750			Storage i	s Online Cover	Level (m) 3	5.000	
		15			<u>Cel</u>	lular Storage	Structure	<u>.</u>	
Data Type	Point Longest Storm (mins) 10					Invert Level (m)	) 31.500 Sa	fety Factor	2.0
Summer Storms	Yes Climate Change %	+40				ient Base (m/hr) ient Side (m/hr)		Porosity	0.95
	-			Depth (m) A	Area (m²) Inf	. Area (m²) Dep	th (m) Area	(m <sup>2</sup> ) Inf. A	rea (m²)
Τ	Cotal Area (ha) 3.000			0.000	1500.0	1500.0	2.501	0.0	1500.0
	Time (mins) Area Time (mins) Area From: To: (ha) From: To: (ha)			2.500	1500.0	1500.0	2.001		100010
0 4 1.000					<u>]</u>	Pump Outflow	<u>Control</u>		
						Invert Level (m)	) 31.500		
						Depth (m) Flow	/s (1/s)		
						2.500	7.5000		
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RPS Group Limited 2420 The Quadrant Aztec West Almondsbury Bristol BS32 4AQ Date 21/02/2018

Micro Drainage

File HVDC Northern.srcx





### Onshore HVDC converter/HVAC substation – proposed drainage layout **B**.11

Figure B.1: Onshore HVDC converter/HVAC substation – Proposed Drainage Layout.



	Site Extent
	Bund Area
	Roof Cover
	Access Road
Breakdown Total Impe Total Perm	meable Area = 6.000 hectares
	Proposed Surface Water Network Proposed Surface Water Network (Area with Oil/Fuel) Proposed Surface Water Pipe Proposed Surface Water Pipe (Area with Oil/Fuel) Proposed Oil Water Separator
Referenci Projectior	e System : OSGB36 Scale@A3: : BNG Vertical reference: Newlyn
REV	REMARK DATE
00	Initial Issue 28/02/2018
ŀ	Hornsea Project Three VAC Onshore Substation Location B Proposed Drainage Layout
Doc no: RP Created by: Checked by Approved b	

