Partners in UK offshore wind

MONA OFFSHORE WIND PROJECT

Preliminary Environmental Information Report

Volume 7, annex 17.1: Flood Consequences Assessment

Image of an offshore wind farm

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Final

Document status

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Acronyms

Acronym	Description
bgl	Below ground level
BGS	British Geological Survey
CCBC	Conwy County Borough Council
DAM	Development Advice Maps
DCC	Denbighshire County Council
DCO	Development Consent Order
FCA	Flood Consequence Assessment
HDD	Horizontal Directional Drilling
LRFMS	Local Flood Risk Management Strategy
LDP	Local Development Plan
NRW	Natural Resources Wales
PEIR	Preliminary Environmental Information Report
PFRA	Preliminary Flood Risk Assessment
PPW	Planning Policy Wales
SAC	Special Area of Conservation
SFCA	Strategic Flood Consequences Assessment
SPA	Special Protection Area
SSSI	Site off Special Scientific Interest
SuDS	Sustainable Drainage System
TAN 15	Technical Advice Note 15

Units

Unit	Description
%	Percentage
g	Gram (weight)
GW	Gigawatt (power)
ha	Hectare (area)
kg	Kilogram (weight)
km	Kilometre
km^2	Square kilometres
kV	Kilovolt (electrical potential)
kW	Kilowatt (power)

Unit	Description
l/s	Litres per second (flow rate)
M	Meters (distance)
m3	Meters cubed (volume)
mm/yr	Millimetres per year (rainfall)
MW	Megawatt (power)

1 FLOOD CONSEQUENCES ASSESSMENT

1.1 Introduction

1.1.1 Background

1.1.1.1 This Flood Consequences Assessment (FCA) has been used to inform the assessment of Mona Offshore Wind Project as reported in volume 3, chapter 17: Hydrology and flood risk of the Preliminary Environmental Information Report (PEIR). A site-specific Flood Consequence Assessment (FCA) has been prepared for the Mona Proposed Onshore Development Area.

1.1.1.2 The FCA supports the Development Consent Order (DCO) application for the Mona Offshore Wind Project in accordance with the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009.

1.1.1.3 Developments that are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works.

1.1.1.1. The key objectives of the FCA are:

- To assess the flood risk to the Mona Offshore Wind Project and to demonstrate the feasibility of appropriate design such that any residual flood risk to the Project and users would be acceptable.
- To assess the potential impact of the Mona Offshore Wind Project on flood risk elsewhere and to demonstrate the feasibility of appropriate design, such that the Project would not increase flood risk elsewhere.
- To satisfy the requirements of the legislative planning guidance set out in section 2 which require FCAs to be submitted in support of DCO applications.

1.1.2 Study area

1.1.2.1 The Mona hydrology and flood risk study area focuses on areas landward of Mean High Water Springs (MHWS). The elements of the hydrology and flood risk study area relevant to this technical report are described below and shown on Figure 1.1:

- The area of land to be temporarily or permanently occupied during the construction, operation and maintenance and decommissioning of the Mona Offshore Wind project (hereafter referred to as the Mona Proposed Onshore Development Area).
- Flood risk receptors located within 1km of the Mona Onshore Substation and 250m of the Mona Proposed Onshore Development Area. The buffers were chosen primarily to identify any existing receptors, assets or infrastructure that have the potential to be affected by flood risk as a result of the Mona Offshore Wind Project.

1.1.2.2 This technical report should be read in conjunction with annex 17.2: Surface watercourses and NRW flood zones of the PEIR.

1.1.3 Methodology

1.1.3.1 The FCA has been produced in accordance with the Overarching National Policy Statement (NPS) for Energy EN-1, Planning Policy Wales Edition 11 (PPW) and Technical Advice Note 15: Development and Flood Risk (TAN 15). Reference has also been made to local flood risk documents and provides an outline of the relevant local planning policies in addition to potential flood risk and hydrological constraints to the Mona Proposed Onshore Development Area and Mona Onshore Substation. The policies cover the requirements in respect to Nationally Significant Infrastructure Projects.

1.1.3.2 In order to achieve the key objectives above, a staged approach was adopted in preparing the FCA in accordance with NPS (EN-1), PPW 11 and TAN 15. Initially, screening studies have been undertaken utilising publicly available information within the 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 outputs of this assessment are:

- A review of all available information and a qualitative analysis of the flood risk to the Mona Onshore Substation and Mona Proposed Onshore Development Area has been produced.
- Identification of any impact of the Mona onshore infrastructure has on flood risk elsewhere.

Information sources

1.1.3.3 The information used in the preparation of this report is set out in Table 1.1.

Table 1.1: Information sources consulted during preparation of the FCA.

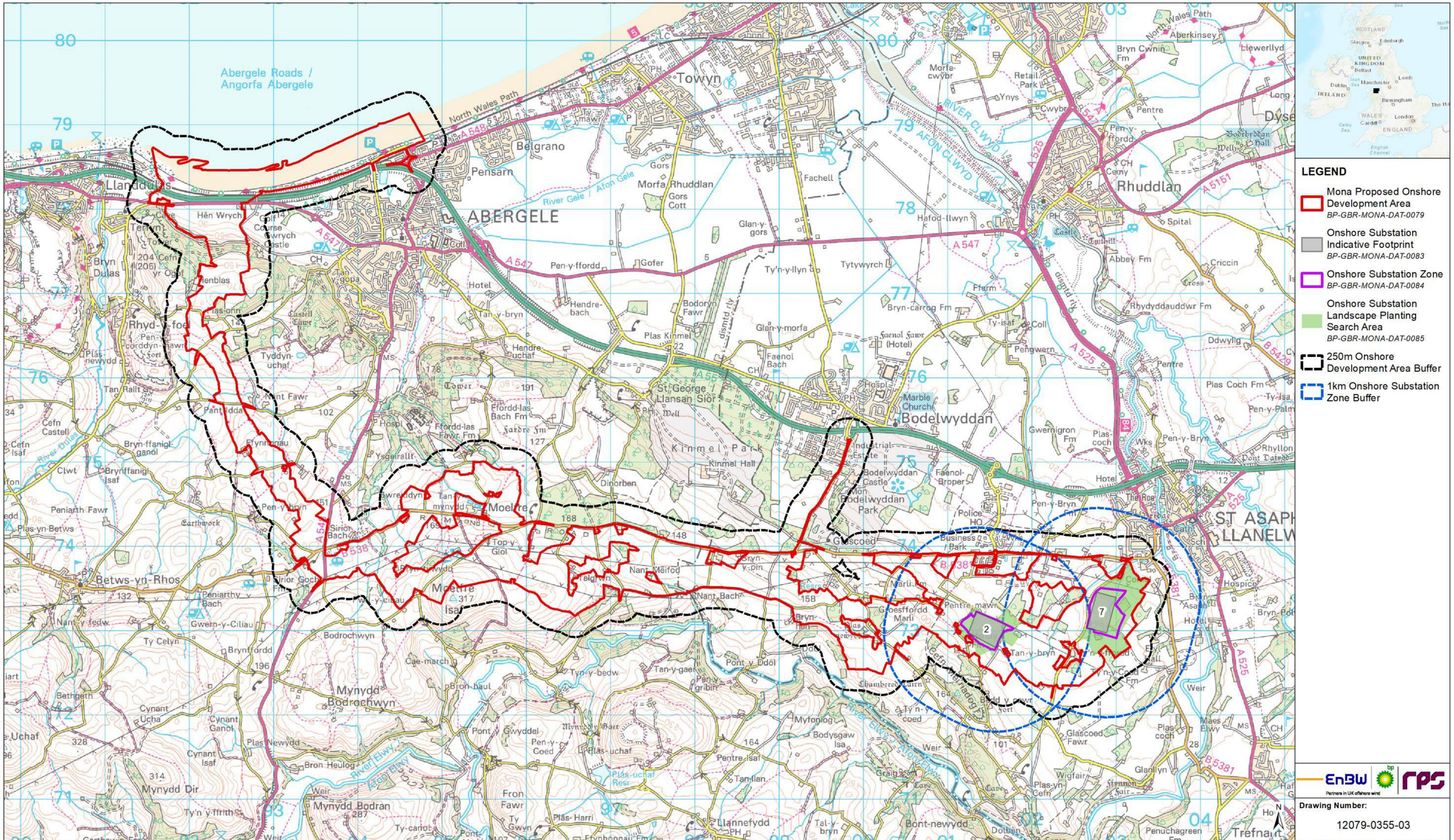
Title	Source	Year	Author
OS mapping 1:25 000	http://bing.com/maps	2023	OS
Interactive map viewer	https://naturalresources.wales/evidence-and-data/maps/browse-map-of-data-about-the-natural-environment/?lang=en	2023	NRW
Geoindex Onshore Mapping.	https://www.bgs.ac.uk/map-viewers/geoindex-onshore/	2023	BGS
Soilscapes viewer	http://www.landis.org.uk/soilscapes/	2023	The National Soils Research Institute
Enviro and Geo Insight digital reports	reference GSIP-2022-12806-10820_A – E and GSIP-2022-12806-10819	2022	Groundsure

Title	Source	Year	Author
Flood Estimation Handbook Web Service	https://fehweb.ceh.ac.uk/GB/map	2023	FEH
Flood Map for Planning	https://flood-map-for-planning.naturalresources.wales/	2023	NRW
Development Advice Map	https://naturalresources.wales/flooding/flood-map-for-planning-development-advice-map/?lang=en	2023	NRW
Flood Risk Assessment Wales Map	https://naturalresources.wales/flooding/flood-map-for-planning-development-advice-map/?lang=en	2023	NRW
National Flood Hazard and Risk Maps	https://naturalresources.wales/flooding/flood-map-for-planning-development-advice-map/?lang=en	2023	NRW
Lle Geo-Portal	http://lle.gov.wales/home	2023	NRW
Flood Consequences Assessments: Climate Change Allowances	https://www.gov.wales/sites/default/files/publications/2021-09/climate-change-allowances-and-flood-consequence-assessments_0.pdf	2021	NRW
Planning Policy Wales Edition 11	https://www.gov.wales/planning-policy-wales	2021	Welsh Government
Technical Advice Note 15	https://www.gov.wales/technical-advice-note-tan-15-development-and-flood-risk-2004	2004	Welsh Government
Overarching National Policy Statement (NPS) for Energy EN-1	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf	2011	Department of Energy and Climate Change
Strategic Flood Consequences Assessment	https://www.conwy.gov.uk/en/Resident/Planning-Building-Control-and-Conservation/Strategic-Planning-Policy/Adopted-Local-Development-Plan-LDP/Evidence-Base/Natural-Environment/BP17-Conwy-Strategic-Flood-Consequences-Assessment.pdf	2012	Conwy County Borough Council
Local Development Plan (2006 – 2021)	https://www.denbighshire.gov.uk/en/planning-and-building-regulations/local-development-plan/adopted-local-development-plan.aspx	2006	Denbighshire County Council
Local Flood Risk Management Strategy	https://www.denbighshire.gov.uk/en/your-council/strategies-plans-and-policies/strategies/local-flood-risk-management-strategy.aspx	2014	Denbighshire County Council
Preliminary Flood Risk Assessment and Addendum	https://www.denbighshire.gov.uk/en/your-council/strategies-plans-and-policies/strategies/local-flood-risk-management-strategy.aspx	2009	Denbighshire County Council
Strategic Flood Consequences Assessment	https://www.denbighshire.gov.uk/en/documents/planning-and-building-regulations/ldp/evidence-monitoring-and-information/strategic-flood-consequence-assessment-final-report-january-2018.pdf	2018	Denbighshire County Council

1.1.3.4 Table 1.2 below lists the reports consulted during preparation of the FCA.

Table 1.2: Reports consulted during preparation of the FCA

Title	Source	Year	Author
Local Development Plan (2007 – 2022) Adopted 2013	https://www.conwy.gov.uk/en/Resident/Planning-Building-Control-and-Conservation/Strategic-Planning-Policy/Adopted-Local-Development-Plan-LDP/Assets-written-proposals-maps/Conwy-Local-Development-Plan-2007-2022.pdf	2013	Conwy County Borough Council
Local Flood Risk Management Strategy	https://www.conwy.gov.uk/en/Resident/Crime-and-emergencies/Preparing-for-Emergencies/Flooding/documents/Conwy-Local-Flood-Risk-Management.pdf	2013	Conwy County Borough Council
Preliminary Flood Risk Assessment	https://www.conwy.gov.uk/en/Resident/Crime-and-emergencies/Preparing-for-Emergencies/Flooding/documents/Conwy-Preliminary-Flood-Risk-Assessment.pdf	2011	Conwy County Borough Council



Project Name:	Drawing Title:	Scale	Geodetic Information:	Data Sources:	Service Layer Credits
MONA OFFSHORE WIND PROJECT	HYDROLOGY AND FLOOD RISK STUDY AREA	0 0.25 0.5 nm; 0 0.5 1 km	Datum: OSGB 1936; Projection: British National Grid; Scale@379mmx231mm: 1:46,000	BP One Map, OS	Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

VER	DATE	DETAILS	BY	CHECK
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Figure 1.1: Mona hydrology and flood risk study area.

1.2 Legislation and guidance

1.2.1 National Policy Legislation and Guidance

National Policy Statements

1.2.1.1 Planning policy for Nationally Significant Infrastructure Projects, specifically in relation to hydrology and flood risk is contained in NPS EN-1. It 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 17: Hydrology and flood risk of the PEIR. 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"*.
- *"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"*.

Planning Policy Wales Edition 11

1.2.1.2 Planning Policy Wales Edition 11 (2021) sets out the land use planning policies of the Welsh Government. The objective is to ensure the planning system contributes towards sustainable development and improves the social, economic, environmental land cultural well-being of Wales.

1.2.1.3 Chapter 13 'Minimising and Managing Environmental Risk and Pollution' outlines the Welsh Government's objectives in terms of addressing flood risk.

1.2.1.4 Section 13.4 of PPW 11 states:

1.2.1.5 "*Development proposals in areas designed as being of high flood hazard should only be considered where:*

- *New development can be justified in that location, even though it is likely to be at risk from flooding; and*
- *The development proposal would not result in the intensification of existing development which may itself be at risk; and*
- *New development would not increase the potential adverse impacts of a flood event*."

1.2.1.6 Planning Policy Wales is supplemented by a series of Technical Advice Notes (TAN). TAN15 provides technical guidance on development and flood risk.

Technical Advice Note (TAN) 15: Development and Flood Risk

1.2.1.7 TAN 15 (2004) provides technical guidance to supplement the policy set out within Planning Policy Wales in relation to development and flooding. The guidance relates to sustainability principles and provides a framework to allow risks arising from river flooding, coastal flooding and additional run off from developments to be assessed.

1.2.1.8 In relation to flood risk, TAN 15 indicates that the Assembly has a duty to ensure that development is sustainable and does not create problems for future generations. Managing flooding has an important role to ensure sustainable development by guiding developments to locations with little or no risk from river, tidal or coastal flooding, managing consequences of flooding where developments can be justified and making provision for climate change.

1.2.1.9 TAN 15 confirms that each planning authority in Wales must prepare a development plan for its area. The development plans provide locational guidance for development, detailed site-specific policies, and identification of proposals for development. Catchment Flood Management Plans aim to take a holistic approach to flood management at a catchment scale and can provide guidance on managing risk to future developments. The information provided in local development plans and catchment flood management plans will aid with the application of the Justification Test. This FCA is in line with the guidance of the 2004 edition of TAN 15.

Development Advice Maps

1.2.1.10 The Welsh Assembly Government produces Development Advice Maps (DAM) to accompany TAN 15. These maps show the degree of flood risk which is to be applied to a site for the planning process and thus establish the suitability of a site for development. These maps are based upon the Natural Resource Wales (NRW) flood maps and similarly they can be modified through the presentation of data (i.e. hydraulic modelling) to illustrate that a Site is within a different flood zone. The development advice zones are listed below, alongside their attributed planning actions:

- **Zone A:** Areas considered to be at little or no risk of fluvial or tidal/coastal flooding. Flood risk within this zone does not need to be considered further.
- **Zone B:** Areas known to have been flooded in the past evidenced by sedimentary deposits. Areas within this zone are further checked against the 0.1% flood level.
- **Zone C1:** Based on the NRW 0.1% flood outline and are areas of the floodplain developed served by significant flood defence infrastructure.
- **Zone C2:** Based on the NRW 0.1% flood outline and areas of the floodplain without significant flood defence infrastructure.

Flood Map for Planning

1.2.1.11 A revised edition of TAN 15 is due to be implemented in June 2023 and will be supported by the new Flood Map for Planning to demonstrate how flood risk will be affected by climate change in the next century. Whilst the Flood Map for Planning has no official status for planning purposes until June 2023, NRW may use the Flood Map for Planning as 'best available information' on flood risk to inform planning guidance.

1.2.1.12 The NRW Flood Zones refer to the probability of flooding from rivers and sea in a given year, assuming no defences are in place and including climate change. Flood zone definitions are set out as the following:

- **Flood Zone 1:** land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).
- **Flood Zone 2:** land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.
- **Flood Zone 3**: land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Requirements of TAN15

1.2.1.13 An FCA , to support a development application, should be proportionate to the risk and appropriate to the scale, nature and location of the development. The following will need to be considered:

- The consequences of flooding on the development, the consequences of the development on flood risk elsewhere and if appropriate mitigation measures to be incorporated into the design.
- Mechanisms of flooding, including sources of floodwater, how floodwater enters and flows across a site, height, and speed of floodwaters.
- Uncertainties in estimating flood events including use of historical records and forecasting.
- Security of proposed developments over their lifetime and ensuring those using the development have an awareness of the potential risks from flooding.
- Description of consequences under a range of extreme events including: mechanisms, sources, depths, speed, rate of rise, overland flood routes, velocity, access and egress, impacts on natural heritage, impact on flood risk in surrounding areas.
- Structural adequacy of defences to contain flows and withstand overtopping and if required the suitability of implementing a buffer zone adjacent to defences.
- Measures required to ensure flooding is managed to acceptable levels and ensure that the impact upon flood risk elsewhere in the flood plain is managed.

1.2.2 Local Planning Policy

Conwy Local Development Plan 2007 – 2022

1.2.2.1 The Local Development Plan (LDP) provides a framework for sustainable development within Conwy County Council up to 2022. The LDP was formally adopted in October 2013 and is used for consistent and rational decision-making during the plan period to ensure the most efficient use of land and other limited resources, whilst at the same time promoting the regeneration and stimulation of the local economy for the benefit of the present and future population.

1.2.2.2 The LDP expired in December 2021 and a replacement LDP is currently being developed; the old LDP is considered to be still relevant until the new LDP is issued. It is unknown whether the LPA will save any of the expired LDP policies.

1.2.2.3 The Conwy County Borough Council (CCBC) LDP does not contain any specific policies regarding flood risk; however, the most relevant policies are outlined below:

Strategic Policy DP/1 Sustainable Development Principles

1.2.2.4 Development will only be permitted where it is demonstrated that it is consistent with the principles of sustainable development. All developments are required to:

- Take account of and address the risk of flooding and pollution in the form of noise, lighting, vibration, odour, emissions or dust in line with Policies DP/2 and DP/3 – ‘Promoting Design Quality and Reducing Crime’.

Policy DP/3 Promoting Design and Reducing Crime

1.2.2.5 All new development will be of high quality, sustainable design which provides usable, safe, durable and adaptable places, and protects local character and distinctiveness of the Plan Area’s built historic and natural environment. The Council will require development to:

- Provide sustainable urban drainage systems to limit waste water and water pollution and reduce flood risk in line with national guidance and Policy NTE/8 – ‘Sustainable Drainage Systems’.

Policy NTE/6 Energy Efficiency and Renewable Technologies in New Development

1.2.2.6 The efficient use and conservation of natural resources are essential to the overall quality of life within the Plan Area and to support wider social and economic sustainability objectives. The Council will:

- Ensure that all new developments incorporate the principles of sustainable design such as: appropriate layout, massing, orientation, use of materials, rain water harvesting, energy efficiency, sustainable drainage, and waste recycling areas/storage in line with the Development Principle Policies and NTE/8 – ‘Sustainable Drainage Systems’, NTE/9 – ‘Foul Drainage’ and NTE/10 – Water Conservation’.

Policy NTE/8 Sustainable Drainage Systems

1.2.2.7 The use of Sustainable Drainage Systems will be required wherever reasonably practicable with preference for onsite disposal and where satisfactory arrangements can be put in place for the long-term maintenance of those systems. Where this is not proposed a developer will need to justify that discharge is necessary and is adequately controlled.

1.2.2.8 Subsequent preference for surface water drainage will be for:

a. Drainage to a surface water body (river, lake etc.) subject to appropriate treatment and attenuation
b. Drainage to surface water sewer
c. Drainage to combined sewer.

1.2.2.9 The developer must demonstrate that higher preference drainage options are unfeasible before proposing less sustainable options.

Denbighshire Local Development Plan 2006 – 2021

1.2.2.10 The Local Development Plan (LDP) provides a framework for sustainable development within Denbighshire County up to 2021. The LDP was formally adopted on 4 June 2013 and is used for consistent and rational decision-making during the Plan period to ensure the most efficient use of land and other limited resources, whilst at the same time promoting the regeneration and stimulation of the local economy for the benefit of the present and future population.

1.2.2.11 Whilst the LDP expired in December 2021, a replacement LDP is currently being developed. h However, the Denbighshire Local Development Plan 2018 to 2033: Revised Delivery Agreement December 2022 confirms that the current adopted LDP will remain the statutory development plan until it is replaced by a revised version of the LDP and as such the existing LDP policies remain the basis for determining planning applications

1.2.2.12 Denbighshire County Council (DCC) LDP does not contain any specific policies regarding flood risk; however, the most relevant policies are outlined below:

Policy RD 1 Sustainable Development and Good Standard Design

1.2.2.13 Development proposals will be supported within development boundaries provided that all the following criteria are met:

- Satisfies physical or natural environmental considerations relating to land stability, drainage and liability to flooding, water supply and water abstraction from natural watercourses.

1.2.2.14 Development will only be permitted where it is demonstrated that it is consistent with the principles of sustainable development. All developments are required to:

- Take account of and address the risk of flooding and pollution in the form of noise, lighting, vibration, odour, emissions or dust in line with Policies DP/2 and DP/3 – 'Promoting Design Quality and Reducing Crime'.

Policy VOE 6 Water Management

1.2.2.15 All development will be required to eliminate or reduce surface water run-off from the site, where practicable. The run-off rates from the site should maintain or reduce pre-development rates.

1.2.3 Climate Change

1.2.3.1 TAN15 states that when considering new development proposals, it is necessary to take account of the potential impact of climate change over the lifetime of development. Residential development is assumed to have a lifetime of 100 years while a lifetime of 75 years is assumed for non-residential developments. To ensure future development can provide a safe and secure living and /or working environment throughout its lifetime, national planning policy requires proposals in areas of high flood risk to be accompanied by an assessment of flooding consequences to and from the development, taking into account the impacts of climate change.

1.2.3.2 In line with TAN15 and NRW Climate Change Allowances guidance (September 2021), the climate change allowances have been informed by latest available information on climate change projections and different scenarios of carbon dioxide (CO_2) emissions to the atmosphere. Allowances are provided for different epochs (periods) of time over the next century. This NRW guidance will be reviewed when more up-to-date climate change research is available.

1.2.3.3 Both the central and upper end allowances should be assessed to understand the range of impact. As a minimum, proposals should be assessed against the central allowance to inform design levels. It is recommended that the 2080s changes are used when considering any time beyond 2115. Table 1.3 below presents the anticipated increase in peak river flows for the Western Wales River Basin, and Table 1.4 presents the expected change to Extreme Rainfall Intensity. The climate change allowances are based on UKCP09 and emerging UKCP18 research data.

Table 1.3: Peak river flow allowances by River Basin District (use 1961 to 1990 baseline)

River Basin District	Allowance category	Total potential change anticipated for '2020s' 2015-2039)	Total potential change anticipated for '2050s' (2040-2069)	Total potential change anticipated for the '2080s' (2070-2115)
Western Wales	Upper Estimate	25%	40%	75%
	Central Estimate	15%	25%	30%

Table 1.4: Change to extreme rainfall Intensity compared to a 1961-90 baseline

Changes to extreme rainfall intensity			
Applies across all of Wales	Total potential change anticipated for '2020s' 2015- 2039)	Total potential change anticipated for '2050s' (2040- 2069)	Total potential change anticipated for the '2080s' (2070-2115)
Upper Estimate	10%	20%	40%
Central Estimate	5%	10%	20%

1.2.3.4 The NRW Climate Change Allowances Guidance (September 2021) recommends that the central estimate, or change factor, for the 2080s for the relevant river basin district should be used to assess the potential impact of climate change as part of a flood consequence assessment.

1.2.3.5 The allowances are consistent with the A1B (medium) emissions scenario derived from UKCP09 and emerging UKCP18 research data and converted into regionalised data of climate change on flood flows for the 2020s, 2050s and 2080s time-horizon, and for the B1 (low) and A1F1 (high) emissions scenarios for the 2080s time-horizon.

1.2.3.6 Runoff and attenuation calculation for any development design would have to take into account the above change in climate change policy.

1.3 Onshore substation Area Flood Risk Assessment Option 2

1.3.1 Site setting

Location

1.3.1.1 The proposed location of the Mona Onshore Substation – option 2 is centred on National Grid Reference SJ 01486 73017, approximately 2.8km to the southwest of St Asaph village. The site is bound by pastural agricultural fields and currently access is gained via the B5381, a public highway. The location of the substation is shown on Figure 1.1.

Topography

1.3.1.2 The boundary associated with the Mona Onshore Substation – option 2 falls from 80mAOD within the southwest of the site to approximately 55mAOD within the northeast of the site. The local topography within the 1km buffer of the Mona Onshore Substation – option 2 generally falls towards the northeast.

Existing use

1.3.1.3 The site of the proposed Mona Onshore Substation – option 2 is currently comprised of pastural agricultural fields, with field margins delineated by mature trees and hedgerows. An ordinary watercourse is present within the centre of the site conveying flow to the north and a second runs northwards within the far east of the site from a well.

1.3.1.4 The 1km buffer zone associated with the Mona Onshore Substation – option 2 comprises predominantly of agricultural land use in addition to areas of woodland and a sparse density of residential dwellings. An unnamed public highway runs north-south across the western extent of the buffer.

Proposed use

1.3.1.5 The proposed Mona Onshore Substation – option 2 and associated infrastructure will have a maximum footprint of up to 125,000m^2 and will be located within the Onshore Substation zone. This area will include the substation buildings (up to four buildings) and the earthworks to create the platform; up to 57,000m^2 will be impermeable. The temporary working area of the onshore substation is 250,000m^2. The onshore substation is expected to have an operational life of 35 years and indicative layouts are presented within volume 1, chapter 3, Project description of the PEIR.

Hydrological overview

1.3.1.6 A 1km buffer was selected for the Mona Onshore Substation – option 2 to identify any potential receptors that might be affected.

1.3.1.7 The Mona Onshore Substation – option 2 is located within the catchment of the River Elwy, a Main River which conveys flows to the east some 1.5km to the south of the substation site (see annex 17.2: Surface watercourses and NRW flood zones of the PEIR. The river converges with the River Clwyd some 3.9km to the northeast and discharges to the Irish Sea approximately 7.8km to the north of the site at Rhyl.

1.3.1.8 There are two ordinary watercourses present within the site of the proposed Mona Onshore Substation – option 2 site which convey flows to the north, converging with the Nant-y-Faenol some 950m to the north of the site. Nany-y-Faenol is a tributary of the River Clywd and is classified as a Main River to the north of the B5381.

1.3.1.9 There are several additional ordinary watercourses present within the 1km buffer zone which eventually drain to the River Elwy/River River Clwyd. A number of pond features are also present within the buffer zone.

Hydrogeological overview

Geological setting

1.3.1.10 The BGS Geology of Britain mapping (1:50,000 scale) indicates the entirety of the proposed Mona Onshore Substation – option 2 is underlain by glacial till (diamicton) superficial deposits. The 1km buffer zone is also predominantly underlain by glacial till (diamicton).

1.3.1.11 The far western extent of the Mona Onshore Substation – option 2 is underlain by Clwyd Limestone Group (limestone) while the remainder of the site is underlain by Warwickshire Group (mudstone, siltstone and sandstone).

1.3.1.12 The 1km buffer zone is predominantly underlain by Clwyd Limestone Group (limestone) with Warwickshire Group (mudstone, siltstone and sandstone) present within the eastern extent.

Groundwater

1.3.1.13 Several borehole logs undertaken as part of the construction of Glascoed Water Works water works 1.7km to the west of the site extend to maximum depths of 9.45m below ground level (bgl). Boreholes logs recorded glacial till to approximately 9mbgl before encountering limestone. No groundwater strikes were recorded within the borehole logs.

Aquifer designation

1.3.1.14 Bedrock Geology Aquifer Designation Wales mapping indicates Clwyd Limestone Group (limestone) to be a Principal Aquifer; permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers. Warwickshire Group (mudstone, siltstone and sandstone) is classified as a Secondary A Aquifer; i.e. permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers.

1.3.1.15 Superficial Deposits Aquifer Designation Wales mapping indicates glacial till deposits are categorised as a Secondary (undifferentiated) aquifer; this is rock considered to have variable and insignificant contributions to water resources and river base flows.

Source Protection Zones

1.3.1.16 There are no Source Protection Zones within the Mona Onshore Substation – option 2 site and the associated 1km buffer area.

Soils classification

1.3.1.17 The National Soils Research Institute Soilscapes viewer classifies soils underlying the proposed Mona Onshore Substation – option 2 as slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.

1.3.1.18 Soils within the 1km buffer zone are classified as mainly slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils, with an area of freely draining soils within the southwest of the buffer.

Flood risk assessment

Fluvial and tidal flooding

Flood Map for Planning

1.3.1.19 The NRW Flood Map for Planning indicates the Mona Onshore Substation – option 2 site and associated 1km buffer zone is located wholly within fluvial and tidal Flood Zone 1.

Development Advice Maps

1.3.1.20 The Development Advice Map indicates the Mona Onshore Substation – option 2 site and associated 1km buffer zone is wholly located within the DAM Zone A.

Denbighshire County Council data

1.3.1.21 The DCC PFRA, SFCA and LRFMS documents do not hold any records of historic flood event having taken place within the Mona Onshore Substation – option 2 site or within its 1km buffer zone.

Summary

1.3.1.22 The Mona Onshore Substation – option 2 site and surrounding 1km buffer zone are assessed to have a low risk of fluvial flooding. Due to the distance inland from sea, the site and associated buffer zone is also assessed to have a low risk of tidal flooding.

Surface water flooding

1.3.1.23 Surface water flooding occurs when the amount of rainfall exceeds the drainage or infiltration capacity of the surface it falls upon. Surface water runoff can coalesce into surface water flow pathways as it flows towards a drainage system or watercourse. Surface water can also pond within areas of inadequate drainage. Flooding from watercourses not classified as Main Rivers is also included within this category.

1.3.1.24 The NRW Flood Risk from Surface Water and Small Watercourse mapping indicates the Mona Onshore Substation – option 2 site is predominantly located outside the mapped extent at risk of surface water flooding. There is a 'low – high' risk of flooding associated with surface water pathways flowing towards two ordinary watercourses present within the site.

1.3.1.25 Flooding associated with the 30-year event is isolated to the central-northern extent of the site with flood depths less than 150mm.

1.3.1.26 Flow pathways become established by the 1,000-year event and conveys flow towards the ordinary watercourses that flow within the Mona Onshore Substation – option 2 site. While flood depths are predominantly less than 150mm, isolated areas of flooding are up to 900mm but thought to be constrained within watercourse channels. Flood velocities associated with the 1,000-year event are less than 1m/s within both pathways. Flood hazard posed by both flood pathways are largely categorised as 'low' with very limited areas of 'danger for most'.

1.3.1.27 Within the 1 km buffer zone there is a 'low – high' risk of flooding from additional small watercourses and from isolated areas of surface water ponding.

1.3.1.28 It is expected an 8m buffer between the ordinary watercourse and any development will ensure the preservation of the ordinary watercourses. Final proposed levels will be shaped to ensure the flow pathway regime is maintained to ensure surface water can be conveyed towards the watercourses and offsite. The risk of flooding from this source is therefore classified as low.

Flooding from rising/high groundwater

1.3.1.29 Groundwater flood risk mapping included within the Groundsure Enviro and Geo Insight report (2022) shows the Mona Onshore Substation – option 2 site has a 'low' risk of groundwater flooding. The majority of the 1km buffer zone is also shown to have a 'low' risk of flooding with limited areas with a 'negligible' risk of flooding.

1.3.1.30 Due to the type of development proposed, the overall risk of flooding from groundwater has been assessed to be very low.

Reservoir failure assessment

1.3.1.31 The NRW Flood Map for Planning includes flood risk from reservoirs mapping which shows the entirety of the Mona Onshore Substation – option 2 site is located outside the extents of flooding from this source.

1.3.1.32 The overall risk of flooding from reservoir failure has been assessed to be negligible.

Sewer/water main failure assessment

1.3.1.33 Flooding from sewerage failure occurs when a rainfall event exceeds the maximum capacity of the 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).

1.3.1.34 The site is currently in agricultural use and is therefore, unlikely to have sewer assets within the site. Mitigation measures, as identified in Table 17.17 of volume 3, chapter 17: Hydrology and flood risk of the PEIR, limit the potential impact on the surrounding sewer networks from any residual risk from this source. Flood risk from this source is therefore assessed to be very low.

Flood defence measures

1.3.1.35 The NRW Flood Map for Planning shows there are no flood defences present within the Mona Onshore Substation – option 2 site or the 1km buffer zone.

Historic flooding

1.3.1.36 The NRW Flood Map for Planning includes recorded flood extents mapping which shows the entirety of the Mona Onshore Substation – option 2 site is located outside the mapped extent of historical flooding.

Current flood risk

1.3.1.37 The Mona Onshore Substation – option 2 site is located within Flood Zone 1 and is considered at low risk from fluvial and tidal sources.

1.3.1.38 It has been determined that the main risk of flooding to the Mona Onshore Substation – option 2 site is from surface water flooding (small watercourses)

1.3.2 Flood risk management

Site vulnerability

1.3.2.1 In accordance with the Development Vulnerability Categories in Figure 2 of TAN15, wind farm developments are classified as 'Less Vulnerable'.

1.3.2.2 The Mona Onshore Substation – option 2 site, its access/egress and associated 1km buffer zone are located in Zone A.

1.3.2.3 All types of development are considered acceptable within this Zone A and B and the justification test is not applicable to the Mona Onshore Substation.

Mitigation measures

1.3.2.4 The Mona Proposed Onshore Development Area is located wholly within Zone A and as such no fluvial/tidal mitigation measures are proposed.

1.3.2.5 It is expected with development of the site, there will be an 8m buffer between the banks of the watercourse and the proposed Mona Onshore Substation – option 2.

1.3.2.6 Flood risk arising from construction activities during the construction phase is to be mitigated via the implementation of the Code of Construction Practice (CoCP).

1.3.3 Drainage strategy

Surface water drainage

1.3.3.1 The sustainable management of surface water is an essential element of reducing future flood risk to the site and its surroundings.

1.3.3.2 Undeveloped sites generally rely on natural drainage to convey or absorb rainfall, with water infiltrating into the ground or coalescing across the surface towards watercourses. As the Mona Onshore Substation – option 2 site is in agricultural use field drains will be present. The location of field drains will be confirmed with landowners as part of the field drainage strategy. Any field drainage intercepted during the cable installation will either be reinstated following the installation of the cable or diverted to a secondary channel. Any works undertaken will be in agreement with the appropriate stakeholders

1.3.3.3 The effect of development is generally to reduce the permeability of at least part of the site, which markedly changes its 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.

1.3.3.4 Surface water arising from a developed site should as far as is practicable be managed in a sustainable manner to mimic the natural hydrology of the site while reducing the risk of flooding and elsewhere, taking climate change into account.

Sustainable drainage options

1.3.3.5 NPS EN-1, PPW Edition 11, associated TAN 15 technical guidance, SuDS Manual (CIRIA 2015) and the DCC LDP promote sustainable water management through the use of SuDS. A hierarchy of techniques is identified:

- Prevention
- Source control
- Site control
- Regional control

1.3.3.6 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 pollutant sources
- Reducing potable water demand through rainwater harvesting
- Improving amenity through the provision of open spaces and wildlife habitat
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

1.3.3.7 An assessment of the current and proposed runoff rates was undertaken to determine the surface water attenuation requirements for the Mona Onshore Substation – option 2 (see section 0 and Appendix A for the attenuation requirements). In line with The SuDS Manual (2015) the proposed discharge rate from the Onshore Substation - option 2 site must not exceed the greenfield discharge rate prior to development.

Runoff rate calculations

1.3.3.8 Runoff rates have been determined using the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS (National SuDS Working Group, 2004), the Welsh Government Statutory standards for sustainable drainage systems (Welsh Government, 2019) and the non-statutory technical standards for sustainable drainage systems (Defra, 2015). The Defra recommended methodology for sites up to 50ha is the Institute of Hydrology Report 124 method (Institute of Hydrology, 1994).

1.3.3.9 For catchments smaller than 50ha the equivalent runoff from a 50ha site must be calculated using IH124, it is then possible to pro-rata this value to give the runoff for the smaller site. Interim Code of Practice (ICP) SuDS calculation automatically carries out the pro rata conversion reducing the possibility of human error. The runoff rates were calculated using the MicroDrainage software suite and are present within Table 1.5.

Table 1.5: Existing surface water run-off rates for Option 2 site.

Return period (years)	Runoff rate (l/s)
1 in 1	9.9
1 in 2	10.4
QBAR	11.2
1 in 30	19.8
1 in 100	24.5

Greenfield runoff rate characteristics

1.3.3.10 The proposed land use comprises a substation and associated infrastructure will have a maximum footprint of up to 125,000m^2 within which up to 57,000m^2 will be impermeable. The greenfield runoff rates are based on the current site baseline, assumed to be 100% permeable surfacing.

1.3.3.11 The following parameters were incorporated into the greenfield site runoff calculations:

- Area: 57,000m^2
- Standard-period Average Annual Rainfall: 749mm/yr
- Soil: 0.3 (global soils index)
- Region number: 9 (catchment based on Flood Studies Report Figure I.2.4.).

Attenuation requirements

1.3.3.12 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:

1.3.3.13 The system was modelled within MicroDrainage as a tank/pond with restricted discharge rate achieved via an orifice outflow control. The MicroDrainage calculation sheets are included within Appendix A.

1.3.3.14 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 9.9l/s, has been determined to be approximately 5,255m^3 for the Mona Onshore Substation – option 2.

1.3.3.15 As the layout of the Onshore Substation has not been confirmed, the current drainage design is based on a set of maximum design perimeters included in this FCA. The search area for the attenuation pond is shown on Figure 1.2. Following submission of the PEIR, a surface water drainage strategy will be developed in consultation with DCC and included within the DCO application.

1.3.4 Summary and conclusions

Summary

1.3.4.1 A site-specific FCA in accordance with Section 5.7 of the NPS EN-1, PPW and TAN 15 has been undertaken for the Mona Onshore Substation – option 2 located 2.8km to the southwest of St Asaph village.

Flood risk

1.3.4.2 The Mona Onshore Substation – option 2 site is located within Flood Zone 1 and Zone A and is considered at low risk from fluvial and tidal sources.

1.3.4.3 The site is assessed to have a low risk of surface water flooding from ordinary watercourses and a very low and negligible risk of flooding from all other sources. An 8m easement between the on-site watercourse and the Mona Onshore Substation – option 2 is proposed.

1.3.4.4 There are no historical records of flooding within the site held by either the NRW or DCC.

1.3.4.5 In accordance with the Development Vulnerability Categories in Figure 2 of TAN15, wind farm developments are classified as ‘Less Vulnerable’.

1.3.4.6 All types of development are considered acceptable within this zone and the justification test is not applicable to the Mona Onshore Substation – option 2.

Surface Water Drainage

1.3.4.7 The proposed land use comprises an onshore substation and associated infrastructure will have an impermeable area of up to 57,000m^2.

1.3.4.8 The site is currently agricultural and as such, the proposed discharge rate will be set at 9.9l/s, the greenfield runoff rate. Approximately 5,255m^3 of attenuation storage will be required to accommodate these flows for the 1 in 100-year + 40% climate change event.

Conclusion

1.3.4.9 The FCA and supporting documentation demonstrates the Mona Onshore Substation – option 2 meets the requirements of the NPS EN-1, PPW and TAN 15.

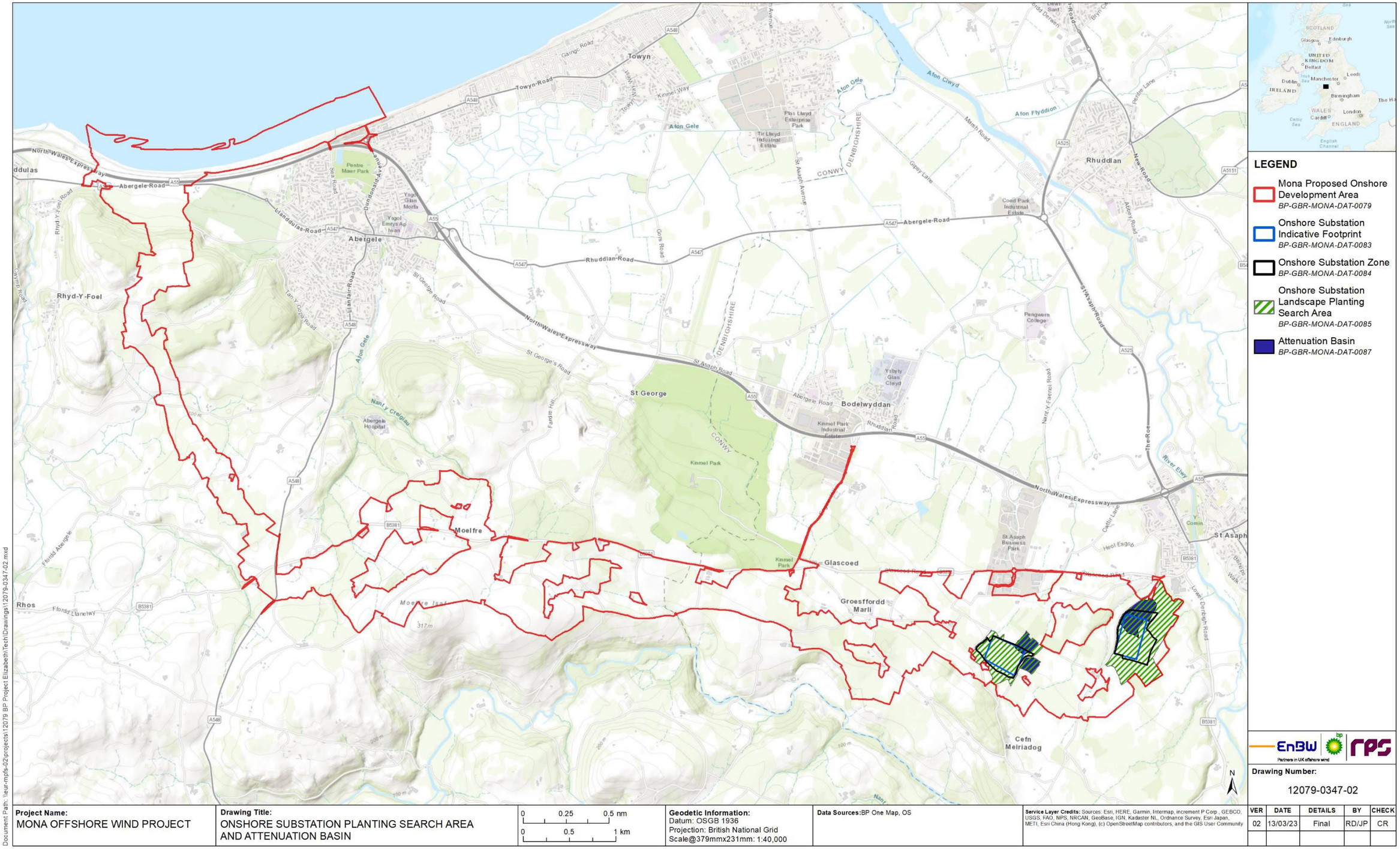

Figure 1.2: Attenuation basin search area for Onshore Substation Options 2 and 7

1.4 Onshore substation Area Flood Risk Assessment Option 7

1.4.1 Site setting

Location

1.4.1.1 The proposed location of the Mona Onshore Substation – option 7 centred on National Grid Reference SJ 02883 73357, approximately 1.3km to the south of St Asaph village. The site is bound by agricultural fields and access is gained via B5381, a public highway. The location of the substation is shown on Figure 1.1.

Topography

1.4.1.2 The proposed site boundary associated with the Mona Onshore Substation – option 7 falls from 80mAOD within the southwest of the site to approximately 55mAOD within the northeast of the site. The local topography within the 1km buffer of the Mona Onshore Substation – option 7 generally falls towards the northeast.

Existing use

1.4.1.3 The Mona Onshore Substation – option 7 site currently comprises agricultural fields, with field margins delineated by mature trees and hedgerows. A track bisects the southern extent of the site, running from east to west. An ordinary watercourse also bisects the site, running from south to north.

1.4.1.4 The 1km buffer zone associated with the Mona Onshore Substation – option 7 comprises predominantly agricultural land use in addition to areas of woodland and a sparse density of residential dwellings. A public highway and second ordinary watercourse running south-north is located within the western extent of the buffer zone. Several additional ponds and agricultural reservoirs are also present within the buffer zone.

Proposed use

1.4.1.5 The proposed Mona Onshore Substation – option 7 and associated infrastructure will have a maximum footprint of up to 125,000m^2 and will be located within the Onshore Substation zone. This area will include the substation buildings (up to four buildings) and the earthworks to create the platform; up to 57,000m^2 will be impermeable. The temporary working area of the Mona Onshore Substation – option 7 is 250,000m^2. The onshore substation is expected to have an operational life of 35 years and indicative layouts are presented within volume 1, chapter 3: Project description of the PEIR.

Hydrological overview

1.4.1.6 A 1km buffer was selected for the Mona Onshore Substation – option 7 to identify any potential receptors that might be affected by the Mona Onshore Substation – option 7.

1.4.1.7 The Mona Onshore Substation – option 7 is located within the catchment of the River Elwy, a Main River which conveys flows to the east some 650m to the east of the site. The river converges with the River Clwyd some 3.2km to the north and discharges to the Irish Sea some 8.3km to the north of the site at Rhyl.

1.4.1.8 An ordinary watercourse flows northwards across the centre of the site and discharges into the River Elwy some 650m to the northeast of the site. A second ordinary watercourse is present within the 1km buffer zone of the Onshore Substation – option 7 and also flows to the north, converging with the on-site watercourse some 275m to the north of the site to the south of the B5381.

1.4.1.9 Several pond features and agricultural reservoirs are present within the 1km buffer zone.

1.4.2 Hydrogeological overview

Geological setting

1.4.2.1 The BGS Geology of Britain mapping (1:50,000 scale) indicates the entirety of the Mona Onshore Substation – option 7 site and associated 1km buffer is underlain by glacial till (diamicton) superficial deposits.

1.4.2.2 The entirety of the Mona Onshore Substation – option 7 and associated 1km buffer is underlain by Warwickshire Group (mudstone, siltstone and sandstone).

Groundwater

1.4.2.3 The BGS Geology of Britain mapping shows there are no non-classified borehole log datasets available within proximity of the Mona Onshore Substation – option 7 site and its associated 1km buffer zone.

Aquifer designation

1.4.2.4 Bedrock Geology Aquifer Designation Wales mapping indicates Warwickshire Group (mudstone, siltstone and sandstone) is a Secondary A Aquifer; i.e. permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers.

1.4.2.5 Superficial Deposits Aquifer Designation Wales mapping indicates glacial till deposits are categorised as a Secondary (undifferentiated) aquifer; i.e. rock considered to have variable and insignificant contributions to water resources and river base flows.

Source Protection Zones

1.4.2.6 There are no Source Protection Zones within the Mona Onshore Substation – option 7 and the associated 1km buffer area.

Soils classification

1.4.2.7 The National Soils Research Institute Soilscapes viewer classifies soils underlying the Mona Onshore Substation – option 7 and associated 1km buffer zone to be classified as slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils

1.4.3 Flood risk assessment

Fluvial and tidal flooding

Flood Map for Planning

1.4.3.1 The NRW Flood Map for Planning indicates the Mona Onshore Substation – option 7 is located wholly within fluvial and tidal Flood Zone 1. The 1km buffer zone is predominantly located within Flood Zone 1, with eastern extents of the buffer zone located within Flood Zone 2 and 3, associated with fluvial flooding from the River Elwy.

Development Advice Maps

1.4.3.2 The Development Advice Map indicates the Mona Onshore Substation – option 7 is located wholly within DAM Zone A. The 1km buffer zone is predominantly located within DAM Zone A, with eastern extents of the buffer zone located within DAM Zone B, C1 and C2, associated with fluvial flooding from the River Elwy.

Denbighshire County Borough Council data

1.4.3.3 The DCC PFRA, SFRA and LRFMS documents do not hold any records of historic flood event having taken place within the Mona Onshore Substation – option 7 or within its 1km buffer zone.

Summary

1.4.3.4 The Mona Onshore Substation – option 7 site and its associated access/egress is assessed to have a low risk of fluvial flooding. Due to the distance inland from sea, the site is also assessed to have a low risk of tidal flooding.

Surface water flooding

1.4.3.5 Surface water flooding occurs when the amount of rainfall exceeds the drainage or infiltration capacity of the surface it falls upon. Surface water runoff can coalesce into surface water flow pathways as it flows towards a drainage system or watercourse. Surface water can also pond within areas of inadequate drainage. Flooding from watercourses not classified as Main Rivers is also included within this category.

1.4.3.6 The NRW Flood Risk from Surface Water and Small Watercourse mapping indicates the Mona Onshore Substation – option 7 has a 'low – high' risk of flooding from an ordinary watercourse traversing across the site. Flood depths associated with the 30-year, 100-year and 1,000-year events are greater than 900mm, with flood extents marginally expanding with high return period events. Flood velocities are predominantly less than 1m/s, with limited areas up to 2m/s.

1.4.3.7 Within the Mona Onshore Substation – option 7 1km buffer zone there is a 'low – high' risk of flooding from an ordinary watercourse to the west of the site and from isolated areas of surface water ponding.

1.4.3.8 On-site flooding from this source will largely be conveyed within the watercourse channel for all return periods, with marginal out-of-bank flooding for the worst-case event. With development, it is anticipated localised watercourse realignment will be required within the site. It is expected that watercourse realignment design will ensure existing watercourse capacity is maintained as to not increase flood risk. It is further expected an 8m buffer between the ordinary watercourse and any development will ensure that the development is located outside the mapped extent of flooding from this source. As such, the overall risk of flooding from this source is classified as low.

Flooding from rising/high groundwater

1.4.3.9 Groundwater flood risk mapping included within the Groundsure Enviro and Geo Insight report shows the Mona Onshore Substation – option 7 site has a 'low' risk of groundwater flooding. The majority of the 1km buffer zone is also shown to have a 'low' risk of flooding with limited areas with a 'negligible' risk of flooding.

1.4.3.10 Due to the type of development proposed, the overall risk of flooding from groundwater has been assessed to be very low.

Reservoir failure assessment

1.4.3.11 The NRW Flood Map for Planning includes flood risk from reservoirs mapping which shows the entirety of the Mona Onshore Substation – option 7 site is located outside the extents of flooding from this source. The closest location of flooding from this source is some 560m to the east of the site, associated with flooding from Dolwen Reservoir.

1.4.3.12 OS Mapping shows the presence of several agricultural reservoirs within the Mona Onshore Substation – option 7 1km buffer zone. Due to the distance between the site and reservoirs and local topography of the area, it is assessed there is a negligible risk of flooding on-site from a breach or overtopping of agricultural reservoirs present within the buffer zone.

1.4.3.13 The overall risk of flooding from reservoir failure has been assessed to be negligible.

Sewer/water main failure assessment

1.4.3.14 Flooding from sewerage failure occurs when a rainfall event exceeds the maximum capacity of the 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).

1.4.3.15 The site is currently used for agricultural purposes and is therefore unlikely to have drainage assets within the site. Mitigation measures, as identified in volume 3, chapter 17: Hydrology and flood risk of the PEIR, limit the potential impact on the surrounding sewer networks from any residual risk from this source. Flood risk from this source is therefore assessed to be very low.

Flood defence measures

1.4.3.16 The NRW Flood Map for Planning shows there are no flood defences present within the Mona Onshore Substation – option 7 site or the 1km buffer zone.

Historic flooding

1.4.3.17 The NRW Flood Map for Planning includes recorded flood extents mapping which shows the entirety of the Mona Onshore Substation – option 7 site is located outside the mapped extent of historical flooding.

Current flood risk

1.4.3.18 The Mona Onshore Substation – option 7 site is located within Flood Zone 1 and is considered at low risk from fluvial and tidal sources.

1.4.3.19 It has been determined that the main risk of flooding to the Mona Onshore Substation – option 7 site is from surface water flooding (small watercourses)

1.4.4 Flood risk management

Site vulnerability

1.4.4.1 In accordance with the Development Vulnerability Categories in Figure 2 of TAN15, wind farm developments are classified as 'Less Vulnerable'.

1.4.4.2 The Mona Onshore Substation – option 7 site, its access/egress and associated 1km buffer zone are located in Zone A, with the eastern extents of the buffer zone within DAM Zone B, C1 and C2.

1.4.4.3 All types of development are considered acceptable within this zone A and B and the justification test is not applicable to the Mona Onshore Substation.

Mitigation measures

1.4.4.4 The Mona Onshore Substation – option 7 site is located wholly within Zone A and Zone B and as such no fluvial/tidal mitigation measures are proposed.

1.4.4.5 It is expected with development of the site, watercourse realignment will be designed to ensure watercourse capacity is maintained as well as an 8m easement between the banks of the watercourse and any proposed development.

1.4.4.6 Whilst the eastern extent of the 1km buffer zone is located within Flood Zones 2 and 3, due to the distance from flood risk sources to the development, no mitigation measures are proposed.

1.4.4.7 Flood risk arising from construction activities during the construction phase is to be mitigated via the implementation of the Code of Construction Practice (CoCP).

1.4.5 Drainage strategy

Surface water drainage

1.4.5.1 The sustainable management of surface water is an essential element of reducing future flood risk to the site and its surroundings.

1.4.5.2 Undeveloped sites generally rely on natural drainage to convey or absorb rainfall, with water infiltrating into the ground or coalescing across the surface towards watercourses. As the Mona Onshore Substation – option 7 site is currently in agricultural use field drains may also be present.

1.4.5.3 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.

1.4.5.4 Surface water arising from a developed site should as far as is practicable be managed in a sustainable manner to mimic the natural hydrology of the site prior to the proposed development while reducing the risk of flooding at the site and elsewhere, taking climate change into account.

Sustainable drainage options

1.4.5.5 NPS EN-1, PPW Edition 11, associated TAN 15 technical guidance, SuDS Manual (CIRIA 2015) and the DCC LDP promote sustainable water management through the use of SuDS. A hierarchy of techniques is identified:

- Prevention
- Source control
- Site control
- Regional control

1.4.5.6 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 pollutant sources
- Reducing potable water demand through rainwater harvesting
- Improving amenity through the provision of open spaces and wildlife habitat
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

1.4.5.7 An assessment of the current and proposed runoff rates was undertaken to determine the surface water attenuation requirements for the Mona Onshore Substation – option 7 site. In line with The SuDS Manual (2015) the proposed discharge rate from the Onshore Substation area must not exceed the greenfield discharge rate prior to development.

Runoff rate calculations

1.4.5.8 Runoff rates have been determined using the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS (National SuDS Working Group, 2004), the Welsh Government Statutory standards for sustainable drainage systems (Welsh Government, 2019) and the non-statutory technical standards for sustainable drainage systems (Defra, 2015). The Defra recommended

methodology for sites up to 50 ha, in area is the Institute of Hydrology Report 124 method (Institute of Hydrology, 1994).

1.4.5.9 For catchments smaller than 50 ha the equivalent runoff from a 50ha site must be calculated using IH124, it is then possible to pro-rata this value to give the runoff for the smaller site. Interim Code of Practice (ICP) SuDS calculation automatically carries out the pro rata conversion reducing the possibility of human error. The runoff rates were calculated using the MicroDrainage software suite and are presented in Table 1.6

Table 1.6: Existing surface water run-off rates for Option 7 site

Return period (years)	Runoff rate (l/s)
1 in 1	9.7
1 in 2	10.3
QBAR	11.1
1 in 30	19.5
1 in 100	24.1

Greenfield runoff rate characteristics

1.4.5.10 The proposed land use comprises of an onshore substation and infrastructure will have a maximum footprint of up to 125,000m^2 which up to 57,000m^2 will be impermeable and have an operational life of 35 years. The greenfield runoff rates are based on the current site baseline, assumed to be 100% permeable surfacing.

1.4.5.11 The following parameters were incorporated into the greenfield site runoff calculations:

- Area: 57,000ha
- Standard-period Average Annual Rainfall: 738mm/yr
- Soil: 0.3 (global soils index)
- Region no.: 9 (catchment based on Flood Studies Report Figure I.2.4.).

Attenuation requirements

1.4.5.12 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:

1.4.5.13 The system was modelled within MicroDrainage as a tank/pond with restricted discharge rate achieved via an orifice outflow control. The MicroDrainage calculation sheets are included within Appendix B.

1.4.5.14 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 9.7l/s, has been determined to be approximately 5,262m^3 for the Mona Onshore Substation – option 7.

1.4.5.15 As the layout of the Onshore Substation has not been confirmed, the current drainage design is based on a set of maximum design perimeters included in this FCA. The search area for the attenuation pond once it is appropriately sized is shown on Figure 1.2. Following submission of the PEIR, a drainage strategy will be developed in consultation with DCC and included within the DCO application.

1.4.6 Summary and conclusions

Summary

1.4.6.1 A site-specific FCA in accordance with Section 5.7 of the NPS EN-1, PPW and TAN 15 has been undertaken for the Mona Onshore Substation – option 7 site located 1.3km to the south of St Asaph village.

Flood risk

1.4.6.2 The Mona Onshore Substation – option 7 site is located within Flood Zone 1 and Zone A and is considered at low risk from fluvial and tidal sources.

1.4.6.3 The site is assessed to have a low risk of surface water flooding from ordinary watercourses and a very low and negligible risk of flooding from all other sources. An 8m easement between the on-site watercourse and development is proposed.

1.4.6.4 There are no historical records of flooding within the site held by either the NRW or DCC.

1.4.6.5 In accordance with the Development Vulnerability Categories in Figure 2 of TAN15, wind farm developments are classified as ‘Less Vulnerable’.

1.4.6.6 All types of development are considered acceptable within this zone and the justification test is not applicable to the Mona Onshore Substation – option 7.

Surface Water Drainage

1.4.6.7 The proposed land use comprises of an onshore substation and infrastructure will have an impermeable area up to 57,000m$^{2.}$

1.4.6.8 The site is currently undeveloped and as such, the proposed discharge rate will be set at 9.7l/s, the greenfield runoff rate. Approximately 5,262m^3 of attenuation storage will be required to accommodate these flows for the 1 in 100-year + 40% climate change event.

Conclusion

1.4.6.9 The FCA and supporting documentation demonstrates the onshore substation meets the requirements of the NPS EN-1, PPW and TAN 15.

1.5 Mona Proposed Onshore Development Area flood risk assessment

1.5.1 Site setting

Location

1.5.1.1 The Mona Proposed Onshore Development Area extending approximately 18km from the landfall location to the west of Abergele to the Mona Onshore Substation located to the southwest of St.Asaph and a further 3km to the National Grid Substation at Bodelwyddan. The location of the Mona Proposed Onshore Development Area is shown on Figure 17.1 of volume 3, chapter 17: Hydrology and flood risk of the PEIR.

Existing use

1.5.1.2 The Mona Proposed Onshore Development Area runs predominantly through agricultural land uses and woodland. Residential settlements are sparse; with development mainly limited to farmhouses peppered within the landscape. Limestone hills are present along the coastline and hinterland, with land steeply rising inland from the heavily modified coastline. Inland areas of the Mona Proposed Onshore Development Area generally consist of rolling hills and valleys.

1.5.1.3 The Mona Proposed Onshore Development Area traverses across Llanddulas Limestone and Gwrych Castle Wood, classified as Site of Special Scientific Interest (SSSI) and also borders Coed y Gopa SSSI. The Liverpool Bay / Bae Lerpwl is also classified as a Special Protection Area (SPA).

1.5.1.4 It is noted the red line boundary includes Traeth Pensarn SSSI however no installation of below ground cables are proposed within the designated site.

Proposed use

1.5.1.5 For the purpose of this FCA, the maximum design scenarios are identified within volume 3, chapter 17: Hydrology and flood risk of the PEIR and are summarised below:

- Onshore Cable Corridor (approximately 100m wide (including temporary area) and 18km in length; once installed the cables will occupy a permanent corridor of approximately 30m wide).
  - Up to four cable trenches, each trench up to 2.5m wide at ground level
- 400kV grid connection corridor (approximately 60m wide (including temporary area) and 3km in length; once installed the cables will occupy a permanent corridor of approximately 16m wide).
  - Up to two cable trenches, each trench up to 2.5m wide at ground level
- Up to 72 HDD locations on the Onshore Cable Corridor and up to 12 HDD locations on the 400kV Grid Connection Corridor. Each primary HDD location will have a compound measuring up to 150m x 100m (15,000m^2) in size. Secondary HDDs will have a compound measuring 30m x 20m (600 m^2) located to the side of haul road within the easement.
- Up to two primary compounds each measuring 150m x 150m and up to 10 secondary compounds each measuring 150m x 100m.
- Temporary 6m wide haul road constructed using imported engineering granular fill with geotextile style layers and a nominal thickness of 400mm and maximum thickness of up to 1000mm.

Hydrological overview

1.5.1.6 A 250m search area buffer was selected for the Mona Proposed Onshore Development Area to identify any potential receptors that might be affected by the cable corridor. The 250m buffer is considered an appropriate buffer to identify changes in flood risk in the surrounding area.

1.5.1.7 The Mona Proposed Onshore Development Area is predominantly located within upland catchments of the Welsh Western Rivers Basin District and crosses a number of hydrological catchments associated with ordinary watercourses which form tributaries to the River Elwy and River Gele. Numerous pond features are also located within the Mona Proposed Onshore Development Area.

Main Rivers

1.5.1.8 There are no Main Rivers located within the Mona Proposed Onshore Development Area.

Ordinary Watercourses

1.5.1.9 The Mona Proposed Onshore Development Area is shown to cross several ordinary watercourses (see annex 17.2: Surface watercourses and NRW flood zones of the PEIR):

- two tributaries of the River Gele
- Nant y Bryniau
- Nant y Cregiau
- Nant Luke
- A tributary of the River Clywd
- A tributary of the River Elwy

Sea

1.5.1.10 The Mona Proposed Onshore Development Area makes landfall to the north of the intertidal zone at Traeth Pensarn/Pensarn Beach.

Shoreline Management Plan

1.5.1.11 The Landfall area falls under the Shoreline Management Plan 2: 22 - Great Ormes Head to Scotland sub cell 11a PU2.3 which has a Hold the Line policy. The 20, 50 and 100-year Shoreline Management Policies are ‘Hold the Line’. Groynes are present along the coastline of the western extent of the Landfall area.

WFD Classification

1.5.1.12 Coastal areas to the north of Landfall are located within the Wales GB641011650000 WFD coastal waterbody which is classified as Moderately exposed, Macrotidal, heavily modified coastal. Overall classification and overall objective classifications are both good.

Flood Defences

1.5.1.13 The NRW Flood Map for Planning shows a coastal flood defence wall is present along the onshore margin of the intertidal zone within the eastern extent of the Landfall area (see Figure 1.3). The structure provides a 200-year standard of protection and is maintained by CCBC.

1.5.1.14 No additional flood defence structures are shown on NRW mapping to be present within the Mona Proposed Onshore Development Area.

Flood Alert and Flood Warnings

1.5.1.15 Abergele Sea Road Flood Warning reference 101FWTWN415. incorporates the far eastern extent of the landfall area.

1.5.1.16 The North Wales coast Flood Alert area reference 101WATNE10 incorporates the far western extent of the landfall area as well as a similar footprint to the Abergele Sea Road Flood Warning Area.

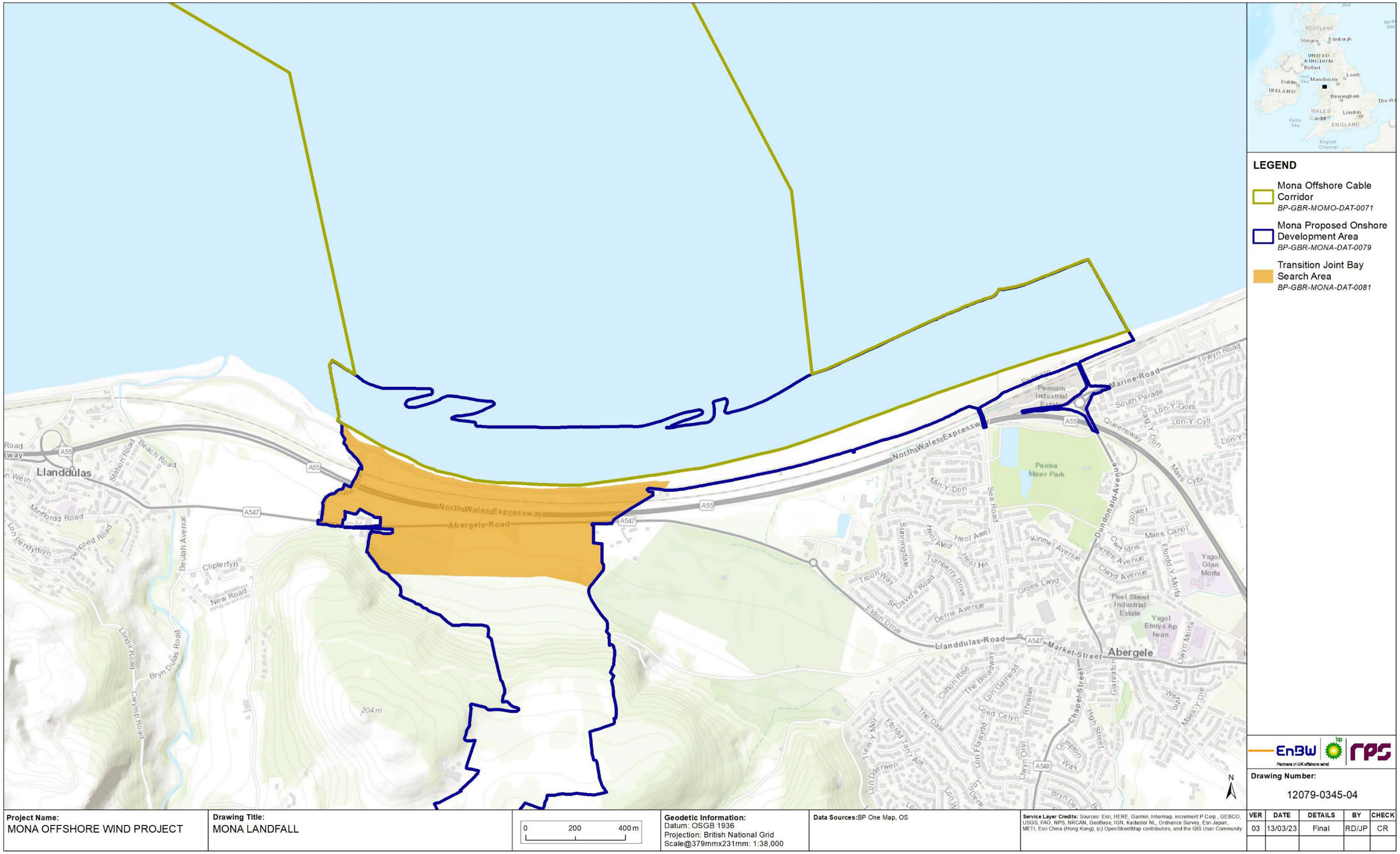

Figure 1.3: Location of flood defences at Landfall (NRW Flood Map for Planning)

1.5.2 Hydrogeological overview

Superficial deposits

1.5.2.1 BGS Geology of Britain mapping (1:50,000 scale) indicates the majority of the lower elevations within the Mona Proposed Onshore Development Area is underlain predominantly by glacial till (diamicton) superficial deposits, with limited isolated areas of glaciofluvial (sand and gravel) and alluvium (clay,silt sand and gravel) superficial deposits near pond features. The intertidal area is underlain by storm beach deposits (gravel) (refer to volume 3, chapter 16: Geology, hydrogeology and ground conditions of the PEIR).

Solid Geology

1.5.2.2 The bedrock underlying the northern and eastern part of the Mona Proposed Onshore Development Area is the Clwyd Limestone Group (limestone). A band of Ffernant Formation (mudstone, siltstone and sandstone) is present north of the central area, whilst the remainder of the Mona Proposed Onshore Development Area is underlain by Elwy Formation (mudstone, siltstone and sandstone). The bedrock within the Mona Proposed Onshore Development Area is shown in annex 16.1: Aquifers, groundwater abstractions and ground conditions of the PEIR.

Aquifer Designation

1.5.2.3 Clwyd Limestone Group (limestone) is categorised as a Principal Aquifer; it is permeable geology able to provide a high level of water storage and able to support water supply and/or river base flow on a strategic scale. Ffernant Formation (mudstone, siltstone and sandstone is classified as a Secondary A aquifer; it includes permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers. Elwy Formation (mudstone, siltstone and sandstone) is classified as a Secondary B aquifer; predominantly lower permeability layers which may store and yield limited amounts of groundwater.

Source Protection Zones

1.5.2.4 There are no SPZs within the Mona Proposed Onshore Development Area or the 250m buffer.

1.5.3 Flood risk assessment

Fluvial flooding

Flood Map for Planning

1.5.3.1 The NRW Flood Map for Planning indicates that Mona Proposed Onshore Development Area, including all temporary construction compound search areas are located entirely within fluvial Flood Zone 1 (as shown in volume 1, chapter 3: Project description of the PEIR).

Development Advice Maps

1.5.3.2 The Development Advice Map indicates the majority of the Mona Proposed Onshore Development Area is located within Zone A; there are isolated areas located within Zone B. Temporary construction compound search areas are predominantly located within Zone A; a small number are located within Zone B (as shown in volume 1, chapter 3: Project description of the PEIR).

Summary

1.5.3.3 The Mona Proposed Onshore Development Area is assessed to have a low risk of fluvial flooding.

Tidal flooding

1.5.3.4 Flooding from tidal sources occur when water levels from the sea (ie. tidal surges) rise above ground levels/flood defences within coastal areas.

Flood Map for Planning

1.5.3.5 The NRW Flood Map for Planning indicates the landfall area and its associated access/egress is partially located within Flood Zone 2 and 3. Due to the beach profile, land southwards of the mean high water line is located within Flood Zone 1. Land to the north of the mean high-water line is located within Flood Zone 2 and 3. Extents of Flood Zone 2 within the landfall area are generally marginal due to the beach profile limiting the extent of tidal flooding.

Development Advice Maps

1.5.3.6 The Development Advice Mapping broadly corresponds to the Flood Map for Planning and indicates land benefitting from the coastal wall flood defence within the eastern extent of the Landfall area is located within Zone C1. The remainder of the Landfall area corresponding with Flood Zone 2 and 3 is located within Zone C2.

1.5.3.7 Land within Zones C1 and C2 within the eastern extent of the Landfall area is located within the Abergele Sea Road Flood Warning and North Wales coast Flood Alert area reference ‘Abergele Sea Road’ Flood Warning Area reference 101FWTWN415.

1.5.3.8 A marginal area within Zone C2 located within the Landfall area is also located within the North Wales coast (from the Dee estuary to the east coast of Anglesey) flood alert, reference 101WATNE10.

1.5.3.9 Areas of the Landfall area located within Flood Zone 1 are located within Zone A.

Flood Model Information

1.5.3.10 Product 5 and 6 data of the Point of Ayr to Pensarn 2017 coastal flood model was obtained from NRW and provides flood extents and depths within the eastern extent of the landfall area a result of coastal defence overtopping and breach. The modelling additional assessed how flood depths and extents will evolve with climate change; with flood model outputs for the present-day and 2117 scenarios.

1.5.3.11 A further consultation request was made to the NRW to obtain the Llanddulas 2016 flood model to capture flood extents and depths within the far western extent of the

landfall area. However model information does not extend into Mona Proposed Onshore Development Area and thus land within the western extent of the landfall area classified within Flood Zone 2 and 3 is unable to be further assessed within the report.

Overtopping in flood defences

1.5.3.12 Flood model data from the Point of Ayr to Pensarn 2017 coastal flood model indicates the eastern extent of the Landfall area within the onshore cable corridor is at risk of flooding from an overtopping of flood defences during the present-day 1 in 200 and 1,000-year events and the 2117 1 in 200-year event.

1.5.3.13 During the present-day 1 in 200 and 1,000-year event that accounts for overtopping of existing flood defences, flooding is restricted to marginal areas of Pensarn Beach with flood depths predominantly below 0.25m for both events.

1.5.3.14 Flooding becomes more extensive during the 2117 1 in 200-year event, with flooding inundating the entirety of Pensarn Beach and partially inundating access/egress taken from Sea Road. Sea Road is inundated by flood depths up to 0.95m while Pensarn Beach is predominantly inundated by flood depths up to 1.50m.

1.5.3.15 It is expected this area of the Mona Proposed Onshore Development Area is to be used as a temporary access to the construction area within the Landfall area. A limited number of site personnel are expected to be on-site using the access during construction Furthermore, due to the nature of temporary works associated with construction, site occupants are not expected to become at risk from the impacts of climate change associated with the 2117 1 in 200-year flood defence overtopping event.

Breach in flood defences

1.5.3.16 The Landfall area within the Mona Proposed Onshore Development Area is at risk of flooding from a breach in flood defences that offer protection to the eastern extent of the Landfall area. The closest breach in flood defences modelled within Point of Ayr to Pensarn 2017 coastal flood model that inundates the site is located some 2.6km to the east of the Landfall.

1.5.3.17 A breach in flood defences under the present-day 1 in 200-year event would result in flooding within the far eastern extent of the Landfall area with flood depths up to 0.42m. The Landfall area site access/egress on Sea Road would also be inundated with flood depths up to 0.43m.

1.5.3.18 During the 2117 1 in 200-year breach event, flood extents cover the eastern extent of the beach within the Landfall area with maximum flood depths of up to 1.73m. The site access/egress on Sea Road would also be inundated with flood depths up to 1.24m.

1.5.3.19 Defences are routinely inspected by CCBC and are recorded to be in ‘good’ condition and offer up to a 200-year standard of protection. As such, a breach event is considered to be extremely unlikely

1.5.3.20 It is expected this area of the Mona Proposed Onshore Development Area is to be used as a temporary access to the construction area within the Landfall area. A limited number of site personnel are expected to be on-site using the access during operational times with sign in/out procedures utilised to monitor site numbers. Furthermore, due to the nature of temporary works associated with construction, site occupants are not expected to become at risk from the impacts of climate change associated with the 2117 breach in flood defences event.

Proposed mitigation

1.5.3.21 The majority of land located within Zone C2 in the Landfall area is covered by a Flood Alert or a Flood Warning. the eastern extent of the Landfall area is located within Zone C1 benefits from a coastal defence wall designed to offer protection up to at least the 0.5% AEP tidal flood event.

1.5.3.22 Within areas at risk of flooding and not benefitting from flood defences it is anticipated work windows will be scheduled against tide times, with site occupants notified of working times at least two weeks in advance. Site personnel will be briefed prior to commencement of works regarding weather conditions, tide times and heights. It is further anticipated works will be halted three hours prior to high time times. It is additionally anticipated that if a Flood Warning / Flood Alert is issued for the Abergele Sea Road’ Flood Warning Area reference 101FWTWN415 and the North Wales Coast Flood Alert area reference 101WATNE10. works within the Landfall area would also be stopped whilst the Flood Warning / Flood Alert is active.

1.5.3.23 Finally, it is anticipated that storage of fuels and chemicals will be within areas benefitting from flood defences, or within areas at low risk of flooding. Refuelling of plant and equipment will only be permitted in designated refuelling areas located above the mean high water level or within areas at low risk of flooding. No refuelling is to be undertaken within the beach area and all refuelling will be undertaken using pumps to reduce spillage.

Summary

1.5.3.24 Due to the beach profile, land southwards of the mean high water line is located within Flood Zone 1 and is classified to have a low risk of tidal flooding. Land to the north of the mean high-water line and the landfall access/egress is located within Flood Zone 2 and 3, corresponding to Zones C1 and C2 are assessed to have a medium – high risk of tidal flooding. Areas benefitting from flood defences are assessed to have a low risk of flooding, with a residual risk of flooding from a breach in flood defences.

1.5.3.25 The majority of land located within Zone C1 and C2 in the Landfall area is covered by a Flood Alert or a Flood Warning.

Surface water flooding

1.5.3.26 Surface water flooding occurs when the amount of rainfall exceeds the drainage or infiltration capacity of the surface it falls upon. Surface water runoff can coalesce into surface water flow pathways as it flows towards a drainage system or watercourse. Surface water can also pond within areas of inadequate drainage.

NRW Mapping

1.5.3.27 The NRW Flood Risk from Surface Water and Small Watercourses mapping shows localised areas along the Mona Proposed Onshore Development Area as having ‘low to high’ risk of flooding from surface water and small watercourses. Flooding is predominantly associated with out-of-bank flows from ordinary watercourses which form tributaries to Main Rivers.

Conwy County Borough Council data

1.5.3.28 The CCBC LFRMS shows no historic surface water flooding event has taken place within the Mona Proposed Onshore Development Area. Forty properties or more have been recorded to have been inundated by flooding from ordinary watercourses within proximity to Abergele.

1.5.3.29 Due to the type of development proposed, the Mona Proposed Onshore Development Area following installation will not be impacted or cause any adverse effect of surface water flooding.

Groundwater flooding assessment

1.5.3.30 Groundwater flood risk mapping included within the Groundsure Enviro and Geo Insight report shows the majority of the Mona Proposed Onshore Development Area has a low to negligible risk of groundwater flooding. The intertidal zone has a low to medium risk of groundwater flooding. There are isolated areas within centre and east with a moderate risk of flooding.

1.5.3.31 Due to the type of development proposed, the overall risk of flooding from groundwater has been assessed to be very low.

Reservoir failure assessment

1.5.3.32 The NRW Flood Map for Planning includes flood risk from reservoirs mapping which shows the entirety of the Mona Proposed Onshore Development Area is located outside the extents of flooding from this source.

1.5.3.33 The overall risk of flooding from reservoir failure has been assessed to be negligible.

Flood defence measures

1.5.3.34 The NRW Flood Map for Planning provides details of a 1,282m coastal flood defence wall present along the onshore margin of the intertidal zone of the Mona Proposed Onshore Development Area which is maintained by CCBC.

Sewer/water main failure assessment

1.5.3.35 Flooding from sewerage failure occurs when a rainfall event exceeds the maximum capacity of the 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).

1.5.3.36 Sewerage flooding issues may occur along the Mona Proposed Onshore Development Area. However, mitigation measures, as identified in volume 3, chapter 17: Hydrology and flood risk of the PEIR, limit the potential impact on the surrounding sewer networks. Flood risk from this source is therefore assessed to be very low.

Historic flooding

1.5.3.37 The NRW Flood Map for Planning includes recorded flood extents mapping which shows the entirety of the Mona Proposed Onshore Development Area is located outside the mapped extent of historical flooding.

Current flood risk

1.5.3.38 The majority of the Mona Proposed Onshore Development Area is located within Flood Zone 1 and Zones A and B. The intertidal zone is located within Flood Zone 2 and Flood Zone 3 and Zones C1 and C2.

1.5.3.39 It has been determined that the main risk of flooding to the Mona Proposed Onshore Development Area is from tidal flooding sources.

1.5.4 Flood risk management

Site vulnerability

1.5.4.1 In accordance with the Development Vulnerability Categories in Figure 15 of TAN15, wind farm developments are classified as ‘Less Vulnerable’.

1.5.4.2 Aside from the landfall area, the Mona Proposed Onshore Development Area is located entirely within Flood Zone 1 and predominantly located within DAM Zone A, with marginal areas located within DAM Zone B.

1.5.4.3 Due to the beach profile, land to the north of the mean high-water line and the landfall access/egress is located within Flood Zone 2 and 3. The DAM zones further split areas of Flood Zone 2 and 3 into Zones C1 and C2, with land within the Mona Proposed Onshore Development Area not benefitting from flood defences shown to be located within Zone C2. Land benefitting from flood defences (which includes areas of the beach within the eastern extent of the Landfall area and the Landfall area access/egress on Sea Road) is located within Zone C1.

1.5.4.4 All types of development are considered acceptable within Zone A and B. Whilst less vulnerable development can be considered within Zone C1 and C2, the justification test will be applicable to the Mona Offshore Wind Project.

Justification test

1.5.4.5 TAN 15 technical guidance states a requirement for any proposed development within Zone C1 and Zone C2 to be subject to the Justification Test, including acceptability of consequences. The following must be demonstrated in order to justify development within Zone C:

i. “*Development within zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement; or,*

ii. *Development within zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;*

And

iii. Development concurs with the aims of PPW and meets the definition of previously developed land; and,

iv. *The potential consequences of a flooding event for the particular type of development have been considered, and in terms of the criteria contained in sections 5 and 7 and appendix 1 found to be acceptable*."

1.5.4.6 The Mona Offshore Wind Project is classified as a NSIP and will contribute towards meeting the UK Government's targets for generating energy from a renewable energy source; it will generate employment during its construction and operation. Part ii of the justification test is therefore considered to be satisfied. Further details regarding employment is contained within volume 4; chapter 29: Socio-economics of the PEIR.

1.5.4.7 The Mona Proposed Onshore Development Area includes the installation of below ground export cables and can be classified as 'Less Vulnerable'. DAM mapping shows the majority of the Mona Proposed Onshore Development Area is located within Zone A and B, with a small percentage located within Zone C1 and C2 (93.12ha or 9.24% and 3.03ha or 0.3% respectively). The Mona Proposed Onshore Development Area will connect the Landfall to the Mona Onshore Substation and therefore, is unable to be routed without crossing areas within Zones C1 and C2. Part iii of the justification test is therefore considered to be satisfied.

1.5.4.8 In regard to part iv of the justification test, potential consequences of a flood event have been undertaken regarding development taking place within C1 and C2 in line with Appendix 1 of TAN 15.

1.5.4.9 The intertidal section of the Mona Proposed Onshore Development Area located within Zone C2 and is associated with the beach profile. The southern extent of the beach within the eastern extent of the Landfall area is located within Zone C1 benefits from a coastal defence wall designed to offer protection up to at least the 0.5% AEP tidal flood event. The remainder of the Landfall area is located within Zone A.

1.5.4.10 The majority of the Mona Proposed Onshore Development Area located within Zone C2 is covered by the Abergele Sea Road Flood Warning or the North Wales Coast Flood Alert area. The Abergele Sea Road Flood Warning Area additionally covers the area of Zone C1 within the eastern extent of the Landfall area.

1.5.4.11 During the construction phase the site manager will sign up to the Flood Warning Service and will be alerted by a phone call or text when a Flood Warning becomes active. The flood warning will be applied to the entire Mona Proposed Onshore Development Area located within Zone C1 and C2 to enable site personnel to be evacuated from the site in a timely manner prior to a flood event occurring.

1.5.4.12 The installation of below ground cables will be temporary in nature with no permanent above ground structures proposed. The majority of the construction works are not within previously developed land however, there will be no changes to existing land use. The Mona Onshore Cable Corridor does not increase flood risk to the surrounding area and has negligible risk of flooding to and from the development.

1.5.4.13 Any buildings to be located within Zones C1 and C2 during construction are expected to be limited to temporary office units and welfare facilities. Given the temporary nature of the buildings, flood resistant design is not considered to be appropriate.

1.5.4.14 Any alterations in the existing surface water drainage regime associated with the installation of the below ground cables are expected to be only during the construction stage and thus temporary in nature. Any increase in run-off from the Mona Onshore Cable Corridor during construction will be managed through control principals set out in the Outline CoCP of the PEIR that will be revised and submitted to CCBC for approval with consultation with NRW prior to the commencement of works.

1.5.4.15 On this basis, the Justification Test is determined to be passed.

Flood mitigation measures

1.5.4.16 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 Land Drainage (Wales) Byelaws, no persons shall without the consent of the authority, deposit or store objects or matters within 8m 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, NRW or LLFA.

1.5.4.17 The Mona Proposed Onshore Development Area encounters ordinary watercourses, some of which are likely to be crossed by open-cut techniques. A crossing schedule will be prepared and accompany the DCO application. Mitigation measures to minimise any potential adverse effects on surrounding watercourses, increase in flood risk, degradation of agricultural land or during construction are set out in volume 3, chapter 17: Hydrology and flood risk and the Outline CoCP of the PEIR.

1.5.4.18 HDD will be used to cross a selected number of ordinary watercourses within the Mona Proposed Onshore Development Area. The DCO will include protective provisions for securing the consent from local drainage authorities and/or the NRW for any works within 8 m of non-tidal water bodies and 9 m from the edge of drainage and flood risk management features.

1.5.5 Summary and conclusions

Summary

1.5.5.1 A site-specific FCA in accordance with Section 5.7 of the NPS EN-1, PPW and TAN 15 has been undertaken for the Mona Proposed Onshore Development Area which extends approximately 18km from the Landfall location west of Abergele to the Mona Onshore Substation located to the southwest of St. Asaph and a further 3km from the Mona Onshore Substation to the National Grid Substation at Bodelwyddan.

Flood Risk

1.5.5.2 In accordance with the guidance on development and flood risk the FCA demonstrates that:

- NRW mapping shows the majority of the Mona Proposed Onshore Development Area is located within Flood Zone 1, at low risk of flooding. Land to the north of the mean high-water line and the landfall access/egress is located within the Flood Map for Planning Flood Zone 2 and 3 and is assessed to have a medium – high risk of tidal flooding. Areas benefitting from flood defences are assessed to have a low risk of flooding, with a residual risk of

flooding from a breach in flood defences. The DAM zones further split areas of Flood Zone 2 and 3 into Zones C1 and C2.

- The justification test has been applied to the portion of the Mona Proposed Onshore Development Area located within the intertidal zone. Proposals are considered to meet policy requirements and potential consequences of a flood event have been considered. In terms of the criteria within TAN 15, the development proposals are considered to meet requirements and satisfy the justification test.
- The remainder of the Mona Proposed Onshore Development Area; is not subject to the justification test.
- There is no historical evidence of flooding within the 250m buffer around the Mona Proposed Onshore Development Area.
- The Mona Proposed Onshore Development Area has a low to high risk of surface water flooding, associated with out-of-bank flows from ordinary watercourses
- The Mona Proposed Onshore Development Area has been assessed to have a very low risk of groundwater flooding
- The Mona Proposed Onshore Development Area has been assessed to have a very low risk of sewer flooding
- The Mona Proposed Onshore Development Area has been assessed to have a negligible risk of reservoir flooding

Conclusion

1.5.5.3 The FCA and supporting documentation shows that the Mona Proposed Onshore Development Area meets the requirements of the NPS EN-1, PPW and TAN 15.

1.6 Next Steps

1.6.1.1 Following the confirmation of the Onshore Substation layout and the refinement of the design to the Mona Proposed Onshore Development Area, a drainage strategy for the Onshore Substation will be developed in consultation with DCC and included within the DCO application. The drainage strategy will consider the following drainage options in order of priority:

- Discharge rainwater into ground via infiltration
- Discharge rainwater direct to a watercourse
- Discharge rainwater to a surface water sewer/drain
- Discharge rainwater to the combined sewer.

1.6.1.2 The FCA will also be reviewed against TAN 15 (2023) and any new requirements will be incorporated as appropriate. The drainage strategy and updated FCA will be presented in the Environmental Statement.

1.7 References

British Geological Survey (2023) Geoindex Onshore Mapping. Available at: https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ accessed January 2023

CIRIA (2015) The SuDS Manual

Conwy County Borough Council (2013) Local Development Plan. Available at: https://www.conwy.gov.uk/en/Resident/Planning-Building-Control-and-Conservation/Strategic-Planning-Policy/Adopted-Local-Development-Plan-LDP/Assets-written-proposals-maps/Conwy-Local-Development-Plan-2007-2022.pdf accessed January 2023

Conwy County Borough Council (2013) Local Flood Risk Management Strategy. Available at: https://www.conwy.gov.uk/en/Resident/Crime-and-emergencies/Preparing-for-Emergencies/Flooding/documents/Conwy-Local-Flood-Risk-Management.pdf accessed January 2023

Conwy County Borough Council (2011) Preliminary Flood Risk Assessment. Available at: https://www.conwy.gov.uk/en/Resident/Crime-and-emergencies/Preparing-for-Emergencies/Flooding/documents/Conwy-Preliminary-Flood-Risk-Assessment.pdf accessed January 2023

Conwy County Borough Council (2012) Strategic Flood Consequences Assessment. Available at: https://www.conwy.gov.uk/en/Resident/Planning-Building-Control-and-Conservation/Strategic-Planning-Policy/Adopted-Local-Development-Plan-LDP/Evidence-Base/Natural-Environment/BP17-Conwy-Strategic-Flood-Consequences-Assessment.pdf accessed January 2023

Denbighshire County Council (2006) Local Development Plan. Available at: https://www.denbighshire.gov.uk/en/documents/planning-and-building-regulations/ldp/adopted-ldp/adopted-local-development-plan-2006-2021.pdf accessed January 2023

Denbighshire County Council (2014) Local Flood Risk Management Strategy. Available at: https://www.denbighshire.gov.uk/en/documents/your-council/strategies-plans-and-policies/strategies/community-and-living/local-flood-risk-management-strategy/local-flood-risk-management-strategy.pdf accessed January 2023

Denbighshire County Council (2009) Preliminary Flood Risk Assessment Available at: https://www.denbighshire.gov.uk/en/documents/your-council/strategies-plans-and-policies/strategies/community-and-living/local-flood-risk-management-strategy/preliminary-flood-risk-assessment-flood-risk-regulations-2009.pdf accessed January 2023

Denbighshire County Council (2018) Strategic Flood Consequences Assessment. Available at: https://www.denbighshire.gov.uk/en/documents/planning-and-building-regulations/ldp/evidence-monitoring-and-information/strategic-flood-consequence-assessment-final-report-january-2018.pdf accessed January 2023.

Department for Environment, Farming & Rural Affairs (2015) Non-statutory Technical Standards for Sustainable drainage Systems

Department for Energy and Climate (2011) Overarching National Policy Statement (NPS) for Energy EN-1. London, The Stationery Office.

FEH Webservice (2023) Catchment mapping. Available at: https://fehweb.ceh.ac.uk/GB/map accessed January 2023

Groundsure (2022) Enviro-Geo Insight reports. Brighton, Nile House.Institute of Hydrology (1994) Hydrology Report 124

National SuDS Working Group (2004) Interim Code of Practice for SuDS.

Natural Resources Wales (2023) Flood Risk Map Viewer. Available at: https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Default&layerTheme=0 accessed January 2023.

Natural Resources Wales (2023) Flood Map for Planning. Available at: https://flood-map-for-planning.naturalresources.wales/ accessed January 2023

Natural Resources Wales (2023). Interactive map. Available at: https://naturalresources.wales/evidence-and-data/maps/browse-map-of-data-about-the-natural-environment/?lang=en accessed January 2023

Natural Resources Wales (2023) Lle Geo-Portal. Available at: http://lle.gov.wales/home accessed January 2023

Natural Resources Wales (2021) Climate change allowances and flood consequence assessments. Available at: https://www.gov.wales/sites/default/files/publications/2021-09/climate-change-allowances-and-flood-consequence-assessments_0.pdf accessed January 2023

The National Soils Research Institute (2023) Soilscapes viewer. Available at: http://www.landis.org.uk/soilscapes/ accessed January 2023

Ordnance Survey (2023) 1:25 000 mapping. Available at: http://bing.com/maps accessed January 2023

Welsh Government (2021) Planning Policy Wales. Cardiff, Publications Centre.

Welsh Government (2019) Statutory Standards for Sustainable Drainage Systems.

Welsh Government (2004) Technical Advice Note 15. Cardiff, Publications Centre.

Appendix A: Microdrainage calculations for Onshore Substation Option 2

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.429	0.729	9.9	1527.8	O K
30 min Summer	7.674	0.974	9.9	2042.0	O K
60 min Summer	7.943	1.243	9.9	2607.5	O K
120 min Summer	8.206	1.506	9.9	3157.5	O K
180 min Summer	8.361	1.661	9.9	3483.3	O K
240 min Summer	8.468	1.768	10.1	3707.2	O K
360 min Summer	8.605	1.905	10.4	3996.0	O K
480 min Summer	8.695	1.995	10.7	4184.7	O K
600 min Summer	8.758	2.058	10.8	4316.1	O K
720 min Summer	8.803	2.103	10.9	4410.7	O K
960 min Summer	8.859	2.159	11.1	4528.5	O K
1440 min Summer	8.899	2.199	11.2	4612.4	O K
2160 min Summer	8.874	2.174	11.1	4558.1	O K
2880 min Summer	8.808	2.108	10.9	4420.8	O K
4320 min Summer	8.665	1.965	10.6	4121.7	O K
5760 min Summer	8.560	1.860	10.3	3900.1	O K
7200 min Summer	8.493	1.793	10.1	3760.9	O K
8640 min Summer	8.450	1.750	10.0	3669.4	O K
10080 min Summer	8.424	1.724	10.0	3616.1	O K
15 min Winter	7.517	0.817	9.9	1712.3	O K
30 min Winter	7.792	1.092	9.9	2289.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.300	0.0	841.8	27
30 min Summer	104.552	0.0	801.3	42
60 min Summer	66.950	0.0	1533.9	72
120 min Summer	40.825	0.0	1482.1	132
180 min Summer	30.230	0.0	1502.1	190
240 min Summer	24.289	0.0	1546.4	250
360 min Summer	17.681	0.0	1606.4	370
480 min Summer	14.062	0.0	1642.1	490
600 min Summer	11.747	0.0	1664.3	608
720 min Summer	10.126	0.0	1678.0	728
960 min Summer	7.987	0.0	1688.7	968
1440 min Summer	5.686	0.0	1673.8	1446
2160 min Summer	4.020	0.0	3236.5	2164
2880 min Summer	3.138	0.0	3206.4	2880
4320 min Summer	2.204	0.0	3061.8	3540
5760 min Summer	1.725	0.0	6021.8	4272
7200 min Summer	1.443	0.0	5796.4	5056
8640 min Summer	1.257	0.0	5548.1	5888
10080 min Summer	1.128	0.0	5340.7	6760
15 min Winter	156.300	0.0	837.3	27
30 min Winter	104.552	0.0	751.3	41

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.094	1.394	9.9	2922.6	O K
120 min Winter	8.389	1.689	9.9	3541.8	O K
180 min Winter	8.564	1.864	10.3	3909.9	O K
240 min Winter	8.685	1.985	10.6	4163.6	O K
360 min Winter	8.843	2.143	11.0	4493.6	O K
480 min Winter	8.947	2.247	11.3	4711.7	O K
600 min Winter	9.020	2.320	11.5	4865.5	O K
720 min Winter	9.074	2.374	11.6	4978.0	O K
960 min Winter	9.143	2.443	11.7	5123.4	O K
1440 min Winter	9.621	2.921	12.8	5243.9	O K
2160 min Winter	9.191	2.491	11.8	5224.1	O K
2880 min Winter	9.137	2.437	11.7	5111.3	O K
4320 min Winter	8.977	2.277	11.4	4774.9	O K
5760 min Winter	8.849	2.149	11.0	4506.9	O K
7200 min Winter	8.764	2.064	10.8	4327.8	O K
8640 min Winter	8.699	1.999	10.7	4192.9	O K
10080 min Winter	8.655	1.955	10.6	4099.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	66.950	0.0	1497.8	72
120 min Winter	40.825	0.0	1512.8	130
180 min Winter	30.230	0.0	1589.0	188
240 min Winter	24.289	0.0	1640.6	248
360 min Winter	17.681	0.0	1702.4	364
480 min Winter	14.062	0.0	1738.4	482
600 min Winter	11.747	0.0	1760.2	600
720 min Winter	10.126	0.0	1772.8	718
960 min Winter	7.987	0.0	1780.7	952
1440 min Winter	5.686	0.0	1758.7	1414
2160 min Winter	4.020	0.0	3433.7	2100
2880 min Winter	3.138	0.0	3394.0	2768
4320 min Winter	2.204	0.0	3231.7	3980
5760 min Winter	1.725	0.0	6225.8	4496
7200 min Winter	1.443	0.0	6027.9	5408
8640 min Winter	1.257	0.0	5864.9	6392
10080 min Winter	1.128	0.0	5748.2	7272

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 302049 373327 SJ 02049 73327
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 5.250

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.750	4	8	1.750	8	12	1.750

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 6.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2097.1	2.500	2097.1	2.501	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0135-9900-1700-9900
Design Head (m)	1.700
Design Flow (l/s)	9.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	135
Invert Level (m)	6.700
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	9.9
Flush-Flo™	0.501	9.9
Kick-Flo®	1.042	7.9
Mean Flow over Head Range	-	8.7

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)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.8	1.200	8.4	3.000	12.9	7.000	19.4
0.200	8.6	1.400	9.0	3.500	13.9	7.500	20.0
0.300	9.5	1.600	9.6	4.000	14.8	8.000	20.7
0.400	9.8	1.800	10.2	4.500	15.7	8.500	21.3
0.500	9.9	2.000	10.7	5.000	16.5	9.000	21.9
0.600	9.8	2.200	11.2	5.500	17.3	9.500	22.5
0.800	9.4	2.400	11.6	6.000	18.0		
1.000	8.3	2.600	12.1	6.500	18.7		

Appendix B: Microdrainage calculations for Onshore Substation Option 7

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.426	0.726	9.6	1528.0	O K
30 min Summer	7.671	0.971	9.6	2042.4	O K
60 min Summer	7.939	1.239	9.6	2608.1	O K
120 min Summer	8.201	1.501	9.6	3158.8	O K
180 min Summer	8.356	1.656	9.6	3485.4	O K
240 min Summer	8.463	1.763	9.8	3710.0	O K
360 min Summer	8.601	1.901	10.2	4000.3	O K
480 min Summer	8.691	1.991	10.4	4190.5	O K
600 min Summer	8.755	2.055	10.6	4323.3	O K
720 min Summer	8.800	2.100	10.7	4419.4	O K
960 min Summer	8.858	2.158	10.8	4540.3	O K
1440 min Summer	8.900	2.200	10.9	4629.9	O K
2160 min Summer	8.878	2.178	10.9	4583.7	O K
2880 min Summer	8.817	2.117	10.7	4453.7	O K
4320 min Summer	8.676	1.976	10.4	4157.3	O K
5760 min Summer	8.571	1.871	10.1	3937.9	O K
7200 min Summer	8.506	1.806	9.9	3800.9	O K
8640 min Summer	8.464	1.764	9.8	3711.4	O K
10080 min Summer	8.440	1.740	9.8	3660.8	O K
15 min Winter	7.514	0.814	9.6	1712.5	O K
30 min Winter	7.788	1.088	9.6	2289.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.300	0.0	821.8	27
30 min Summer	104.552	0.0	782.5	42
60 min Summer	66.950	0.0	1495.2	72
120 min Summer	40.825	0.0	1445.3	132
180 min Summer	30.230	0.0	1468.2	190
240 min Summer	24.289	0.0	1513.2	250
360 min Summer	17.681	0.0	1571.6	370
480 min Summer	14.062	0.0	1606.4	490
600 min Summer	11.747	0.0	1628.0	608
720 min Summer	10.126	0.0	1641.2	728
960 min Summer	7.987	0.0	1651.6	968
1440 min Summer	5.686	0.0	1636.8	1446
2160 min Summer	4.020	0.0	3173.2	2164
2880 min Summer	3.138	0.0	3143.2	2880
4320 min Summer	2.204	0.0	3001.3	3556
5760 min Summer	1.725	0.0	5895.9	4320
7200 min Summer	1.443	0.0	5672.9	5112
8640 min Summer	1.257	0.0	5439.9	5960
10080 min Summer	1.128	0.0	5257.2	6768
15 min Winter	156.300	0.0	817.2	27
30 min Winter	104.552	0.0	733.6	41

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.089	1.389	9.6	2923.3	O K
120 min Winter	8.384	1.684	9.6	3543.2	O K
180 min Winter	8.559	1.859	10.1	3912.0	O K
240 min Winter	8.680	1.980	10.4	4166.5	O K
360 min Winter	8.838	2.138	10.8	4497.9	O K
480 min Winter	8.942	2.242	11.0	4717.5	O K
600 min Winter	9.016	2.316	11.2	4872.9	O K
720 min Winter	9.070	2.370	11.3	4986.9	O K
960 min Winter	9.141	2.441	11.5	5135.3	O K
1440 min Winter	9.617	2.917	12.5	5261.6	O K
2160 min Winter	9.195	2.495	11.6	5249.9	O K
2880 min Winter	9.145	2.445	11.5	5144.5	O K
4320 min Winter	8.990	2.290	11.1	4819.5	O K
5760 min Winter	8.863	2.163	10.8	4551.7	O K
7200 min Winter	8.780	2.080	10.6	4377.4	O K
8640 min Winter	8.719	2.019	10.5	4247.5	O K
10080 min Winter	8.676	1.976	10.4	4157.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	66.950	0.0	1459.8	72
120 min Winter	40.825	0.0	1479.0	130
180 min Winter	30.230	0.0	1554.8	188
240 min Winter	24.289	0.0	1605.1	248
360 min Winter	17.681	0.0	1665.2	364
480 min Winter	14.062	0.0	1700.3	482
600 min Winter	11.747	0.0	1721.4	600
720 min Winter	10.126	0.0	1733.7	718
960 min Winter	7.987	0.0	1741.2	952
1440 min Winter	5.686	0.0	1719.5	1416
2160 min Winter	4.020	0.0	3365.1	2100
2880 min Winter	3.138	0.0	3325.5	2772
4320 min Winter	2.204	0.0	3165.9	4020
5760 min Winter	1.725	0.0	6090.3	4504
7200 min Winter	1.443	0.0	5907.1	5472
8640 min Winter	1.257	0.0	5769.2	6400
10080 min Winter	1.128	0.0	5654.5	7352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 302049 373327 SJ 02049 73327
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 5.250

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.750	4	8	1.750	8	12	1.750

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 6.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2104.2	2.500	2104.2	2.501	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0133-9700-1700-9700
Design Head (m)	1.700
Design Flow (l/s)	9.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	133
Invert Level (m)	6.700
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	9.7
Flush-Flo™	0.503	9.6
Kick-Flo®	1.042	7.7
Mean Flow over Head Range	-	8.5

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)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.8	1.200	8.2	3.000	12.6	7.000	18.9
0.200	8.4	1.400	8.8	3.500	13.6	7.500	19.6
0.300	9.2	1.600	9.4	4.000	14.5	8.000	20.2
0.400	9.6	1.800	9.9	4.500	15.3	8.500	20.8
0.500	9.6	2.000	10.4	5.000	16.1	9.000	21.4
0.600	9.6	2.200	10.9	5.500	16.9	9.500	21.9
0.800	9.2	2.400	11.4	6.000	17.6		
1.000	8.1	2.600	11.8	6.500	18.3		