



# Technical Appendix 4: Flood Risk Assessment and Drainage Impact Assessment

GORTNALUG 110KV SUBSTATION AND GRID CONNECTION

20/03/2026



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## EXECUTIVE SUMMARY

The FRA and DIA requirements are set out by the Department of Environment, Heritage and Local Government in 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' document.

4.1 The Guidance aims to avoid inappropriate development in flood zones and instead direct it to areas of low risk by adopting a sequential approach.

4.2 The PFRA, NIFM and CFRAM flood maps present no areas within the Application Site identified as being at risk of flooding from fluvial or coastal events and therefore the Application Site is situated in 'Flood Zone C'.

4.3 The proposed type of development is specified as Highly Vulnerable Development category outlined in The Planning System and Flood Risk Management Guidelines. The access track can be classed as 'Water Compatible Development', whilst the substation has been classed as 'Highly Vulnerable Development'. Both are appropriate for Flood Zone C.

4.4 In addition to fluvial and coastal flood risk, the PFRA map also indicates areas of flood risk due to pluvial sources. The topographical survey and the PFRA map indicated a number of locations where surface water flooding was predicted. Where the PFRA map has indicated areas within the Application Site at risk of pluvial flooding, there will only be 'Water Compatible Development' located within those areas, such as access tracks.

4.5 It is proposed to construct a network of rainwater harvesting tanks and two soakaway pit/infiltration drain within the Application Site. The idea is to capture any overland flow in the SuDS device before infiltrating into the surrounding soils.

4.6 The proposed soakaway pits/infiltration drains will have an overall length of approximately 93m, with a base width of 2.0m, a 2.0m design depth and a 0.15m freeboard. It will be filled with crushed rock with a void ratio of 20% and will provide a total storage volume of approximately 74.4m<sup>3</sup>.

4.7 The underground piped system will separately connect the Eirgrid Control building and Customer Control Building to separate rainwater harvesting tanks, which discharge into soakaway pits. As the transformer will hold a volume of oil, the system will include a class 1 full retention separator. The soakaway pit and rainwater harvesting tanks will be designed to hold a total volume of 177m<sup>3</sup> with the detailed design of the structure being submitted to the council for review prior to the construction period.

4.8 A permanent toilet is proposed within the Eirgrid Control building and Customer Control Building and will be utilised by maintenance staff of substation. Each toilet will be off grid toilet with a foul holding tank which will be emptied when required by an approved contractor.

Additional drainage measures to be implemented on-site include the following:

- Access Tracks and laydown areas: access tracks are to be unpaved and constructed from local stone. Temporary swales or similar shall be utilised to collect runoff from access tracks with discharge to ground through percolation areas. Where swales are utilised, frequent checks of dams formed from gravels and other excavated material should be undertaken.

4.10

The FRA and DIA have therefore demonstrated that the Proposed Development will **not increase flood risk** away from the Application Site during the construction and operation phases. The Proposed Development is therefore considered to be acceptable in planning policy terms.

4.11

## INTRODUCTION

### Background

4.12 Neo Environmental Ltd has been appointed by Renewable Energy Systems on behalf of Ballydonagh Solar Limited (the “Applicant”) to undertake a Natura Impact Statement (NIS) and Appropriate Assessment (AA) for a new 110k V Air insulated substation (AIS) and grid connection with associated infrastructure( the “Development”) on lands at Ballydonagh, Kiltormer, Co. Galway, Ireland (the “Application Site”).

4.13 The method of connection to the national grid will be a new 110 kV AIS Loop-in station (Gortnalug) with a ‘Loop-in/Loop out’ connection into the existing Ennis -Agannygal-Shannonbridge 110kV circuit. Ballydonagh Solar Limited accepted the Eirgrid Connection Offer (P602-CA-OL) in December 2025.

4.14 The Proposed Development comprises a 110kV AIS and associated grid connection infrastructure to facilitate the connection of the permitted Ballydonagh Solar Farm under Ref 2361049, as amended under Ref 25/61903 and Ballydonagh Solar Farm Extension under Ref 2461749, as amended under 26/60009, to the national grid. The applicant is seeking a ten-year permission from the date of consent of the 110kV Substation.

4.15 Please see **Figure 300101338-DR-100 Overall Site Layout , Volume 2** for the layout of the proposed Development.

### Development Description

#### 4.16 Site Description

4.17 The area of the proposed Development (the “Application Site”) lies at an elevation of approximately 76.51– 96.56m AOD and covers a total area of c. 34.8 hectares. It is centred at approximate Irish National Grid Reference (NGR) E 183907 N 220547 and is located on lands north of the L4301.

4.18 Comprising of a 13 field parcels of agricultural land, the site is currently being used for pastoral farming. The field itself is bound by a mixture of trees, hedgerows and post-and-wire fencing. Access will be gained from the south gate entrance from a private lane to an unnamed local road off the L4301 to the southeast of the site.

The surrounding context is predominately agriculture with pockets of forestry and peatland and punctuated by individual properties, farmsteads and ribbon development associated with the minor and regional road network. Fields are typically small to medium in scale and similar in character to the Application Site lands.

## Scope of Report

The aim of this assessment is to identify the baseline geological and hydrological conditions of the Application Site and surrounding area, to assess the potential impacts of the Proposed Development during the construction operation and decommissioning phases (if required), to identify the risk of flooding at the Application Site and to recommend mitigation measures where appropriate.

4.19

This Flood Risk Assessment has been prepared in accordance with 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities'<sup>1</sup> document, prepared by the Department of Environment, Heritage and Local Government (DoEHLG).

4.20

This report is supported by the following figures and appendices:

4.21

- Appendix 4A Figures:
  - Figure 4.1: Watercourses and Photo Locations
  - Figure 4.2: Topographical Survey
  - Figure 4.3: PFRA Map
  - Figure 4.4: Outline SuDS Design
- Appendix 4B: FRA Photo Appendix
- Appendix 4C: Flow Output
- Appendix 4D: Rainfall Return Period

### 4.22 Statement of Authority

This Flood Risk Assessment (FRA) has been produced by Michael McGhee, Tom Saddington and Ollie Henderson of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has worked on over 1GW of renewable development flood risk and drainage impact assessments across the UK and Ireland whilst working towards becoming a Chartered Engineer. Michael has over 10 years of environmental consultancy experience, mainly producing technical assessments for energy projects. Tom has an undergraduate degree in Bioengineering and graduated with an MSc in Environmental and Energy Engineering in January 2020. He has been working on various technical assessments including flood risk

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<sup>1</sup> Department of Environment, Heritage and Local Government (2009) *The Planning System and Flood Risk Management: Guidelines for Planning Authorities*. Available at: <https://www.gov.ie/en/publication/7db50-the-planning-system-and-flood-risk-management-guidelines-for-planning-authorities-nov-09/>

assessment reports for numerous renewable developments in Ireland and the UK. Ollie graduated with an undergraduate honours degree in Geography in September 2024.

## LEGISLATION

A review of relevant legislation has been conducted to ensure the Proposed Development complies with the following:

- EU Directive on the Assessment and Management of Flood Risks [2007/60/EC];
- 4.23 • The Water Framework Directive [2000/60/EC] (as amended);
- Planning and Development Act 2000 (as amended);
- The Water Policy Regulations (S.I. No. 722 of 2003);
- Surface Waters Regulations (S.I. No. 272 of 2009);
- Groundwater Regulations (S.I. No. 9 of 2010); and
- Environmental Protection Agency Acts, 1992 (as amended).

### Review of Development Plan Policy

#### Galway County Development Plan (CDP)

- 4.24 The Galway County Development Plan 2022 - 2028<sup>2</sup> (“the CDP”) came into effect on the 20<sup>th</sup> June 2022 and presents an extensive list of policies regarding development management within the County. Of these policies and objectives, the following are considered to be relevant to this assessment.

**Table 4 - 1: Galway CDP Flood Management Policies/Objectives**

Planning Policy/Objective	Assess	Comment
<p><b>WW7</b></p> <p><i>“To require the use of Sustainable Drainage Systems to minimise and limit the extent of hard surfacing and paving and require the use of SuDS measures be incorporated in all new development (including extensions to existing developments). All development proposals shall be accompanied by a comprehensive SuDS assessment including run-off quantity, run off</i></p>	<p><b>Yes</b></p>	<p>The Drainage Impact Assessment will implement SuDS.</p>

<sup>2</sup> Galway County Council. *County Development Plan 2022 – 2028*.

<p><i>quality and impacts on habitat and water quality.”</i></p>		
<p><b>WW8</b> <i>“To support the improvement of storm water infrastructure and to increase the use of sustainable drainage and reduce the risk of flooding in urban environments.”</i></p>	<p>Yes</p>	<p>Drainage Impact Assessment takes into account this policy.</p>
<p><b>WW10</b> <i>“To require all new developments to provide a separate foul and surface water drainage system and to incorporate sustainable urban drainage systems where appropriate in new development and the public realm.”</i></p>	<p>Yes</p>	<p>A Drainage Impact Assessment has been undertaken in order to design a SuDS scheme.</p>
<p><b>FL 3</b> <i>“(b) Development proposals in areas where there is an identified or potential risk of flooding or that could give rise to a risk of flooding elsewhere will be required to carry out a Site Specific Flood Risk Assessment, and justification test where appropriate, in accordance with the provisions of The Planning System and Flood Risk Management Guidelines 2009 (or any superseding document); Any flood risk assessment should include an assessment of the potential impacts of climate change, such as an increase in the extent or probability of flooding, and any associated measures necessary to address these impacts”</i></p>	<p>Yes</p>	<p>A Flood Risk Assessment has been undertaken in accordance with the Planning System and Flood Risk Management Guidelines.</p>
<p><b>FL 6</b> <i>“Maintain and enhance, as appropriate, the existing surface water drainage system in the County. Ensure that new developments are adequately serviced with surface water drainage infrastructure and promote the use of Sustainable Drainage Systems in all new developments. Surface water run-off from development sites will be limited to predevelopment levels and planning applications for new developments will be required to provide</i></p>	<p>Yes</p>	<p>A Drainage Impact Assessment has been undertaken in order to design a SuDS scheme.</p>

<p><i>details of surface water drainage and sustainable drainage systems proposals.”</i></p>		
<p><b>FL7</b>  <i>“Protect waterbodies and watercourses within the County from inappropriate development, including rivers, streams, associated undeveloped riparian strips, wetlands and natural floodplains. This will include protection buffers in riverine, wetland and coastal areas as appropriate..”</i></p>	<p><b>Yes</b></p>	<p>Suitable buffer zones to watercourses have been applied in the design of the project.</p>
<p><b>FL8</b>  <i>“Site-specific Flood Risk Assessment (FRA) is required for all planning applications in areas at elevated risk of flooding, even for developments appropriate to the particular flood zone. The detail of these site-specific FRAs will depend on the level of risk and scale of development. A detailed site-specific FRA should quantify the risks, the effects of selected mitigation and the management of any residual risks. The Planning Authority shall have regard to the results of any CFRAM Studies in the assessment of planning applications.”</i></p>	<p><b>Yes</b></p>	<p>A Flood Risk Assessment has been undertaken in accordance with the Planning System and Flood Risk Management Guidelines.</p>

4.25 **Strategic Flood Risk Assessment for County Galway**

4.26 The Strategic Flood Risk Assessment (SFRA) for County Galway<sup>3</sup> is contained as a separate Environmental Report of the adopted CDP.

4.27 The SFRA has reviewed flood risk from river, costal and surface water flooding. It also provides recommendations to manage flood-prone areas, flood risk mitigation and land zoning, furthermore it also provides information regarding sustainable drainage developments for new projects. However, the focus of the study is on risk from fluvial and tidal flooding.

The SFRA did not identify the Application Site of being at risk to any flooding. Therefore, the PFRA maps have been used to determine the fluvial flood risk to the Application Site.

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<sup>3</sup> CAAS Ltd (2022) *Strategic Flood Risk Assessment for County Galway*. Available at: <https://www.galway.ie/en/media/Strategic%20Flood%20Risk%20Assessment%20Galway%20%20CDP%202022-2028.pdf>

### Shannon Upper and Lower Catchment (River Basin 25 and 26) - Flood Risk Management Plan<sup>4</sup>

The purpose of this plan is to set out the strategy, including a set of proposed measures, for the cost-effective and sustainable, long-term management of flood risk in the River Basin, including the areas where the flood risk has been determined as being potentially significant.

4.28 The plan identifies a number of communities in the catchment with potentially significant flood risk, however there are no schemes in the vicinity of the Application Site.

4.29

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<sup>4</sup> Office for Public Works (2018), Flood Risk Management Plan – Shannon Upper and Lower Catchment (River Basin 25 and 26), Available at: [https://s3-eu-west-1.amazonaws.com/docs.floodinfo.opw/floodinfo\\_docs/Final\\_FRMPs\\_For\\_Publication/FRMP\\_Final2018\\_RiverBasin\\_25\\_26.pdf](https://s3-eu-west-1.amazonaws.com/docs.floodinfo.opw/floodinfo_docs/Final_FRMPs_For_Publication/FRMP_Final2018_RiverBasin_25_26.pdf)

## METHODOLOGY

4.31 Flood planning guidance for Ireland has been produced by the Department of Environment, Heritage and Local Government (now the Department of Housing, Planning, Community and Local Government) in 'The Planning System and Flood Risk Management Guidelines for Planning Authorities'<sup>5</sup> (the "FRM Guidelines") document. This FRA and DIA has been undertaken in accordance with these guidelines.

4.32 Flood planning policy aims to avoid inappropriate development in flood zones and instead direct it to areas of low risk by adopting a *sequential approach*. A developments vulnerability classification will define which flood zone it is permitted within, with only flood compatible development permitted in areas with a high probability of flooding, unless the development passes a justification test. This is to ensure that residual risks can be successfully managed and that there are no unacceptable impacts on adjacent land. The following indicators are typically used in assessing flood risk and are appropriate for site FRAs:

- Flood probability;
- Flood depth;
- Flood velocity;
- Rate and onset of flooding; and
- Development vulnerability.

4.33 Flood Risk Assessments are required to *"assess all types of flood risk for a new development. FRAs identify the sources of flood risk, the effects of climate change on this, the impact of the development, the effectiveness of flood mitigation and management measures and the residual risks that remain after those measures are put in place. Must be carried out in all areas where flood risk have been identified but level of detail will differ if SFRA at development plan level has been carried out."*<sup>6</sup>

4.34 An assessment of how surface water runoff will be managed should also be addressed within any FRA. Drainage is a material consideration at the planning stage of a development and due consideration must be given to the impact of the Proposed Development on the catchment

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<sup>5</sup> Department of Environment, Heritage and Local Government (2009) *The Planning System and Flood Risk Management*. Available at: <https://www.gov.ie/en/publication/7db50-the-planning-system-and-flood-risk-management-guidelines-for-planning-authorities-nov-09/>

<sup>6</sup> Department of Environment, Heritage and Local Government (2009) *The Planning System and Flood Risk Management*. Available at: <https://www.gov.ie/en/publication/7db50-the-planning-system-and-flood-risk-management-guidelines-for-planning-authorities-nov-09/>

area. This includes an assessment of potential for both flood risk and pollution. Surface water runoff may need to be assessed in all flood zones. The FRA should demonstrate that the surface water drainage system takes account of Sustainable Drainage Systems (SuDS) principles.

In the FRM Guidelines, the likelihood of a flood occurring is established through the identification of Flood Zones which indicate a high, moderate or low risk of flooding from fluvial or tidal sources, as defined as follows:

4.35

- *Flood Zone A* - Where the probability of flooding is highest (greater than 1% Annual Exceedance Probability (AEP) or 1 in 100 for river flooding and 0.5% AEP or 1 in 200 for coastal flooding) and where a wide range of receptors would be vulnerable;
- *Flood Zone B* - Where the probability of flooding is moderate (between 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 for coastal flooding); and
- *Flood Zone C* - Where the probability of flooding is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding).

4.36

The FRM Guidelines provide three land-use vulnerability categories, based on the type of proposed development, which are detailed as follow:

- Highly vulnerable development, which include:
  - Garda, ambulance and fire stations and command centres required to be operational during flooding;
  - Hospitals;
  - Emergency access and egress points;
  - Schools;
  - Dwelling houses, student halls of residence and hostels;
  - Residential institutions such as residential care homes, children's homes and social services homes;
  - Caravans and mobile home parks;
  - Dwelling houses designed, constructed or adapted for the elderly or other people with impaired mobility; and

- Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.), in the event of flooding.
- Less vulnerable development, which include:
  - Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions;
  - Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans;
  - Land and buildings used for agriculture and forestry;
  - Waste treatment (except landfill and hazardous waste);
  - Mineral working and processing; and
  - Local transport infrastructure.
- Water compatible development, which include:
  - Flood control infrastructure;
  - Docks, marinas and wharves;
  - Navigation facilities;
  - Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location;
  - Water-based recreation and tourism (excluding sleeping accommodation);
  - Lifeguard and coastguard stations;
  - Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and
  - Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).

**Table 4 - 2: Matrix of Vulnerability versus Flood Zone**

Zone	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (Including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Where proposed development requires a Justification Test, this must be undertaken to determine if the development can be justified.

4.37

The Justification Test has been designed to assess the appropriateness of such developments. The test is comprised of two processes: The Plan-making Justification Test and the Development Management Justification Test. The latter is used at the planning application stage where it is intended to develop land that is at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be considered inappropriate for that land.

4.38

4.39

The FRM Guidelines recommend a staged approach to flood risk assessment. The stages of appraisal and assessment are as follows:

- Stage 1 Flood Risk Identification:** *“to identify whether there may be any flooding or surface water management issues related to a plan area or proposed development site that may warrant further investigation.”*
- Stage 2 Initial Flood Risk Assessment:** *“to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. The extent of the risk of flooding should be assessed which may involve preparing indicative flood zone maps. Where existing river or coastal models exist, these should be used broadly to assess the extent of the risk of flooding and potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures”;* and
- Stage 3 Detailed Flood Risk Assessment:** *“to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing*

*development, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model of the river or coastal cell across a wide enough area to appreciate the catchment wide impacts and hydrological processes involved.”*

This report contains the first stage of the flood risk assessment, ‘Stage 1 – Flood Risk Identification’, in accordance with the FRM Guidelines. The basic requirements for a FRA are outlined within the FRM Guidelines as follows:

- 4.40
- An examination of the current and historical drainage patterns;
  - A concept drawing of the development proposal;
  - A brief summary of how the drainage design provides SuDS techniques or complies with any drainage strategy for the area identified in the SFRA;
  - Summary of SuDS to be incorporated;
  - The soil classification for the site; and
  - Calculations showing the pre-development peak runoff flow rate for the critical rainfall event and the storage volumes to restrict the runoff to greenfield levels.
- 4.41
- A site walkover survey was also undertaken in order to identify hydrological, geological, flood risk and drainage features within the Application Site. A photographic record of drainage features is contained within **Appendix 4B**, and the photo locations can be seen in **Figure 4.1 of Appendix 4A**.

## BASELINE CONDITIONS

This section presents the information gathered on the existing topographical, geological, hydrological, and hydrogeological conditions of the Application Site and its immediate surroundings.

For all field numbers refer to **Figure 3: Volume 2**.

4.42

### Topography

4.43

A topographical survey was undertaken at the Application Site (see **Figure 4.2 Appendix 4A**). The topography and flow paths vary across the Application Site in that all the fields slope

4.44

towards the nearest drains. The highest elevation point of 96.56m AOD in the northeast of the Application Site, whilst the low point of 76.51m AOD in the south of the Application Site.

### Geology & Soil

4.45

The geological conditions of the Application Site were identified utilising the Geological Survey of Ireland (“GSI”) Spatial Resources online geological mapping<sup>7</sup> system. The Application Site is underlain by Lucan Formation. Lucan Formation consists of dark limestone & shale (‘calp’), with a thickness ranging between 300m to 800m.

4.46

Analysis of the GSI borehole database shows no boreholes within the vicinity of the Application Site.

### 4.47 Geo-Hazards

According to the GSI on-line mapping, the classification for landslide susceptibility for the Application Site is **Low** (D). There are presently no records of geo-hazards such as landslides within or in close proximity to the Application Site.

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<sup>7</sup> GSI Spatial Resources Online Map., Available at <http://dcenr.maps.arcgis.com/apps/MapSeries/?appid=a30af518e87a4c0ab2fbde2aaac3c228>

## Geological Heritage

The GSI on-line mapping was reviewed to identify sites of geological heritage within the Application Site and surrounding area. No geological heritage sites are located within the immediate vicinity of the Application Site.

## Soil

4.48

Different soil types have different capabilities for absorbing water, the efficiency of which is dependent upon their structure and infiltration capacity. The GSI interactive map has been utilised to obtain Teagasc soil data. The Application Site is underlain mostly of till derived chiefly from limestone, with an area of calcareous bedrock at the surface. These are classed as:

4.49

- TLs - BminPD – Mineral poorly drained mineral (Mainly basic)
- TLs - BminDW – Deep well drained mineral (Mainly basic)
- TLs - BminPDPT – Peaty poorly drained mineral (Mainly basic)
- RckCa – BminSW - Shallow well drained mineral (Mainly basic)

4.50

According to the Wallingford Procedure ‘Winter Rain Acceptance Potential’ (WRAP) map<sup>8</sup>, the soil classification for the site is Class 1. This soil class has a Standard Percentage Runoff (SPR) of 0.10 and is likely to provide good infiltration opportunities. Infiltration testing will be conducted post consent to confirm whether infiltration drainage is suitable on this site as the WRAP maps aren’t site specific and relate to the wider area, although are usually a good guide at this stage in the project. This will inform the detailed drainage design which will also be undertaken post consent and should dealt with by means of a suitably worded condition.

4.51

## Hydrology

4.52

According to the Environmental Protection Agency (EPA) Map<sup>9</sup> the proposed Application Site and the surrounding area lies within Hydrometric Area No.25, Lower Shannon (Water Framework Directive) Catchment Area. The Application Site lies within the Kilcrow sub catchment ‘SC\_010’.

The Application Site is contained within the Kilcrow\_020 river sub basin.

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<sup>8</sup> UK Sustainable Drainage and Guidance Tools. Greenfield Runoff Estimation for the Sites. Available at: <https://www.uksuds.com/tools/greenfield-runoff-rate-estimation>

<sup>9</sup>Environmental Protection Agency. EPA Map Viewer. Available at: <https://gis.epa.ie/EPAMaps/>

## Local River Network

4.53 The East Loughturk Watercourse is approximately 0.2km west of the Application Site and flows in a southern and then western direction before joining the West Kiltormer Watercourse, approximately 0.4km to the west of the Application Site. This watercourse then connects with the Mountain Stream approximately 2.6km west of the Application Site, flowing in a southern direction before it eventually converges with the Kilcrow River approximately 2.9km southwest of the Application Site.

**Figure 4.1: Appendix 4A** shows the watercourses in relation to the Application Site.

## Internal Watercourses

4.54 The fields are bound by field drains which will convey all the surface water through the local drainage network to the watercourses outlined above. These drains vary in depth and width with **Appendix 4B** showing a variety which were noted during the site visit.

4.56 Prior to construction of the bridge/ crossing across the C85/470/200 arterial drain, a Section 50 of the Arterial Drainage Act will be agreed with the Office for Public Works (OPW). The bridge/ crossing will be designed so it's capable of passing the fluvial flood flow with a 1% annual exceedance probability (AEP) or 1 in 100 year flow without significantly changing the hydraulic characteristics of the drain. The bridge / crossing will be capable of this flow passing underneath with a minimum freeboard of 300mm. It should be noted this crossing was part of the adjacent Ballydonagh Solar Farm consent (**Planning Ref: 23/61049**).

## Flood Zone Classification

4.57 In 2011, the OPW developed Preliminary Flood Risk Assessment (PFRA) maps as part of the National Catchment Flood Risk Assessment and Management (CFRAM) Programme to illustrate areas affected by flooding from pluvial and fluvial sources, as well as groundwater flood extents and identified areas that required further investigation. The Application Site was not chosen as an area which required further investigation and therefore the PFRA maps are the source which should define the flood zone.

4.58

According to PFRA map (**Figure 4.3: Appendix 4A**), there is no risk of fluvial or coastal flooding, within the Application Site. Therefore, the Application Site is wholly within Flood Zone C.

## Historic Flooding

The National Flood Hazard Mapping<sup>10</sup> does not past flood events within the vicinity of the Application Site.

The SFRA document has not identified any historic flood events within close proximity to the Application Site.

4.59

## Hydrogeology

4.60

According to the GSI map, the Application Site lies within the Tynagh Groundwater Body (GWB)<sup>11</sup>. This GWB is shaped roughly like an upside-down triangle, with the long axis oriented N-S. Elevation within the GWB ranges from 30 mAOD along the shore of Lough Derg (along the SE boundary) to 378 mAOD at Cappaghbaun Mountain in the southwest of the GWB. The topography ranges from mountainous in areas underlain by the resistant sandstones and mudstones of the Devonian Old Red Sandstones and Silurian rocks, where elevations are generally >80 mAOD, to flat-lying in areas underlain by impure limestones, where elevations are typically 40-60 mAOD. Overall, elevation decreases eastwards. River flows are predominantly southwards and eastwards, to Lough Derg and the River Shannon.

4.61

4.62

According to the GSI the recharge mechanisms of this GWB are as follows:

*“Diffuse recharge will occur via rainfall percolating through the subsoil. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope. In general, due to the generally low permeability of the aquifers within this GWB, a proportion of the recharge will discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the aquifer. Where permeable gravelly subsoils cover parts of the GWB, however, they will act as a ‘store’ of groundwater and somewhat mitigate this rapid through-flow. A swallow hole in Upper Impure Limestones accept point recharge from surface waters, as do the turloughs in low water table conditions.”*

4.63

4.64

The underlying bedrock aquifer at the Application Site is considered by GSI to be locally important, moderately productive and covers an area of 766km<sup>2</sup>.

There are no groundwater wells and springs within close proximity of the Application Site, and none were noted on the site visit within the site boundary. The sensitivity of this area from impacts of contamination will be high. During the operational stage of the Proposed Development, there will be a **negligible risk of contamination** due to the nature of a

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<sup>10</sup> OPW National Flood Hazard Mapping. Available at: <https://www.floodinfo.ie/map/floodmaps/>

<sup>11</sup> GSI. Tynagh GWB: Summary of Initial characterisation. Available at: <https://gsi.geodata.gov.ie/downloads/Groundwater/Reports/GWB/TynaghGWB.pdf>

substation/grid development. Any risks will come from the construction stage and an outline Construction and Environmental Management Plan (OCEMP) has been submitted alongside this application in order to reduce any potential impact on the environment during the construction and decommissioning (if required) phase of the Proposed Development (see **Technical Appendix 8: Volume 3**).

### Groundwater Vulnerability

4.65 Groundwater Vulnerability refers to the intrinsic geological and hydrogeological characteristics that determine the ease at which groundwater may be contaminated by human activities. The more vulnerable the groundwater is, the more easily it can be contaminated by surface water. The GSI Groundwater Vulnerability maps are based upon the type and thickness of subsoils, and the presence of karst features.

4.66 According to the GSI map, the groundwater vulnerability across the Application Site is predominantly considered to be ‘High’.

4.67 The subsoil permeability across the entire Application Site is predominantly classed as ‘Medium’. This indicates that subsoil thickness for the Application site is between 3.0 – 10.0m.

**Table 4 - 3: GSI Vulnerability Rating (Groundwater Protection Schemes, DELG/GSI/EPA, 1999<sup>12</sup>)**

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type and Thickness)			Unsaturated Zone	Karst Features
	High Permeability (sand/gravel)	Medium Permeability (sandy subsoil)	Low Permeability (Clayey subsoil, slay, peat)	(Sand/gravel aquifers only)	(<30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High (H)	>3.0m	3.0 – 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

12 DELG. EPA/GSI (1999) Protection Schemes Guidelines. Available at: <https://www.gsi.ie/Programmes/Groundwater/Projects/Protection+Schemes+Guidelines.html>

## FLOOD RISK ASSESSMENT

### Flooding Mechanisms

The FRM Guidelines state that the sequential approach is a key tool *“in ensuring that development, particularly new development, is first and foremost directed towards land that is at low risk of flooding.”*

#### 4.68 Fluvial and Coastal Flood Risk

The PFRA (**Figure 4.3: Appendix 4A**), NIFM and CFRAM flood maps present no areas within the Application Site identified as being at risk of flooding from fluvial or coastal events and therefore the Application Site is **wholly** situated in 'Flood Zone C'.

4.69

The proposed type of development is specified as Highly Vulnerable Development category outlined in The Planning System and Flood Risk Management Guidelines. The access track can be classed as 'Water Compatible Development', the substation has been classed as 'Highly Vulnerable Development' and the grid connection infrastructure can be classed as 'Essential Infrastructure'. Using the matrix of vulnerability versus flood zone in **Table 4-2**, this type of development in this location is deemed appropriate.

4.70

#### Pluvial Flood Risk

4.71

The FRA Guidelines further state the planning implications of development in each flood zone. For Flood Zone C, it states:

*“Development in this zone is appropriate from a flood risk perspective (subject to assessment of flood hazard from sources other than rivers and the coast) but would need to meet the normal range of other proper planning and sustainable development considerations”.*

4.72

In addition to fluvial and coastal flood risk, the PFRA map (**Figure 4.3: Appendix 4A**) also indicates areas of flood risk due to pluvial sources, the topographical survey (**Figure 4.2: Appendix 4A**) has also been used to determine pluvial flood risk depth. The topographical survey and the PFRA map indicated a number of locations where surface water flooding was predicted. Where the PFRA map has indicated areas within the Application Site at risk of pluvial flooding, there will only be 'Water Compatible Development' located within those areas, such as access tracks.

4.73

Additionally, the substation compound portion of the Proposed Development is to be levelled out to 84.76m AOD. Naturally, the levelling across the substation compound will not be perfect, so there will be some minor deviations across this re-laid surface, but it is expected that there will not be larger deviations than +/- 0.1m. The pluvial flood risk to the substation

compound will be mitigated through the drainage strategy which is highlighted within the Drainage Impact Assessment below.

### Groundwater Flood Risk

Groundwater flooding is a “hidden” risk that is often difficult to distinguish from other types of flooding. For example, rising groundwater often forms in low-lying areas which are also susceptible to the accumulation of surface water.

4.74 The PFRA maps consider groundwater flooding and GSI developed groundwater flood maps for Ireland as part of the 2016-2019 GWFlood project<sup>13</sup>. This mapping does not show any groundwater flooding close to or within the Application Site.

4.75 Based on the above, the risk of flooding from groundwater for the part of the Application Site outside the predicted floodplain is likely to be **low**.

4.76

### Sequential Approach Summary

4.77 The FRM Guidelines state that the sequential approach is a key tool *“in ensuring that development, particularly new development, is first and foremost directed towards land that is at low risk of flooding.”*

4.78 All essential infrastructure lies outside the flood extent, i.e. within the Flood Zone C area and therefore, the Proposed Development does not require a justification test. A Drainage Impact Assessment has been undertaken to propose a surface water management plan as per the sequential approach.

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<sup>13</sup> GSI Groundwater Flood maps. Available at: <https://www.floodinfo.ie/map/floodmaps/#>

## DRAINAGE IMPACT ASSESSMENT

### Introduction

The Planning System and Flood Risk Management Guidelines<sup>14</sup> recognise that surface water arising from a developed site should, as far as is practicable, be managed to mimic the surface water flows arising from the site prior to the Proposed Development, while reducing the flood risk to the Application Site itself and elsewhere.

4.79

### Methodology

#### Catchment Characteristics

Catchment characteristics were obtained from HR Wallingford UK Sustainable Drainage Greenfield Runoff Estimation Tool and Surface Water storage tool.<sup>15</sup> Catchment sizes were measured using ArcGIS and catchment boundaries were produced based on the site-specific contours.

4.80

#### Greenfield Runoff and Stormwater Storage

4.81 Greenfield runoff rates and stormwater storage requirements have been obtained using the following tools:

- HR Wallingford UK Sustainable Drainage Greenfield Runoff Estimation Tool (using IH124<sup>16</sup> methodology due to the small-scale nature of the catchment).
- Flow – Causeway Drainage design software (using IH124<sup>17</sup> methodology due to the small-scale nature of the catchment).
- The areas of permeable and impermeable surfaces have been estimated and are based upon the Proposed Development layout (**Figure 300101338-DR-100 of Volume 2: Planning Application Drawings** for the layout of the Proposed Development).

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<sup>14</sup> Department of the Environment, Heritage and Local Government (2009) *The Planning System and Flood Risk Management Guidelines for Planning Authorities*. Available at: <http://www.environ.ie/sites/default/files/migrated-files/en/Publications/DevelopmentandHousing/Planning/FileDownload%2C21709%2Cen.pdf>

<sup>15</sup> HR Wallingford. Available at: <http://www.uksuds.com/drainage-calculation-tools/surface-water-storage>

<sup>16</sup> Institute of Hydrology (1994). *Flood estimation for small catchments. Report No IH124*, Wallingford.

<sup>17</sup> Institute of Hydrology (1994). *Flood estimation for small catchments. Report No IH124*, Wallingford.

- Met Éireann<sup>18</sup> data has been used to obtain the M5-60 and Ratio R (Appendix 4D).

Where applicable, the surface water drainage criteria from the Greater Dublin Strategic Drainage Study (GSDSDS)<sup>19</sup> was applied.

### Greenfield Runoff rates

4.82 The IH124 methodology is used for calculating the Greenfield runoff rates. This is recommended by the Institute of Hydrology for catchments below 200ha.<sup>20</sup>

The IH124 equation estimates Qbar with the following equation:

4.83

$$4.84 \quad Qbar - rural = 0.00108 \times (0.01 \times AREA)^{0.89} \times SAAR^{1.17} \times SPR^{2.17}, m^3/s$$

where:

- Qbar-rural is the mean annual flood flow from a rural catchment (approximately 2-3-year return period).
- AREA is the area of the catchment in ha.
- SAAR is the standard average annual rainfall for the period 1961 to 1990, available from the Flood Studies Report.
- SPR is Standard Percentage Runoff coefficient for the SOIL category.

4.85

The GSDSDS<sup>21</sup> states that the IH124 method is an accepted method used for determining peak flow rates for small catchments.

### 4.86 Calculating storage estimates

The storage estimates are calculated using the inputs below:

- Return Period

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<sup>18</sup> Met Éireann. Rainfall Return Period Table. Available at: <https://www.met.ie/climate/services>

<sup>19</sup> Greater Dublin Strategic Drainage Study (2005). Accessed at <http://www.dublincity.ie/main-menu-services-water-waste-and-environment-drainage-services/new-development-policy>

<sup>20</sup> Institute of Hydrology (1994). *Flood estimation for small catchments. Report No IH124*, Wallingford.

<sup>21</sup> Greater Dublin Strategic Drainage Study (2005). *Volume 2 Chapter 6 – Storm water Drainage Design*. Available at: <http://www.dublincity.ie/sites/default/files/content//WaterWasteEnvironment/WasteWater/Drainage/GreaterDublinStrategicDrainageStudy/Documents/Vol%20-%20-%20Chapter%206%20-%20Stormwater%20Drainage%20Design.pdf>

- Climate Change
- Impermeable Area
- Peak Discharge

The return period and climate change are combined with the Flood Studies Report (FSR) parameters and storm durations to generate the rainfall used. The result from these calculations is that attenuation storage is required for the Application Site due to the additional runoff generated by the Proposed Development.

4.87

### Site and Project Descriptions

4.88

The area of the substation compound is approximately 130.0m x 120.0m. The majority of the compound will be made up of crushed aggregate which will be compacted to create a surface, however, will still have permeable properties and rainwater will soak into the ground beneath at the same rate that it presently does.

4.89

As the access tracks will be made up of crushed aggregate, except the areas outlined as being concrete, they will still have permeable properties and rainwater will soak into the ground beneath at the same rate that it presently does.

4.90

The main areas of impermeable development are outlined within **Table 4-4**, however there are other small areas of impermeable development which are much smaller areas and wouldn't require being included in the formal drainage regime. To cater for these areas, a betterment factor of 20% has been included in the calculations.

**Table 4 - 4: Extent of less permeable areas created by the Proposed Development**

Building	Total Area (m <sup>2</sup> )
1 x Transformer Station (Abnormal Shape)	118.1
1 x Eirgrid Control Building 25.0m x 18.0m	450.0
Eirgrid Substation Concrete Access Tracks	949.3
1 x Customer Control Building 23.1m x 10.8m	247.2
1 x Busbar Infrastructure Foundations	373.1
8x Lighting Mast (2.5m (L) x 2.5m (W) x 18.0m (H))	50.0

Capacitor Bank (6.9m (L) x 3.3m (W))	22.8
Reactor Bank (5.6m (L) x 3.3m (W))	18.5
Harmonic Filter (6.3m (L) x 3.3m (W))	20.8
Resistor (2.7m (L) x 2.5m (W))	6.8
Standby Generator (2.7m (L) x 1.3m (W))	3.5
Rural Supply Kiosk (2.6m (L) x 2.2m (W))	5.7
House TX (2.6m (L) x 2.2m (W))	5.7
Total Impermeable Area	2,271.5
Site Area (m <sup>2</sup> )	348,036.5

4.91 In its current greenfield state, the Application Site is considered to be 100% undeveloped. As a result of the Proposed Development, the extent of hardstanding introduced will be approximately 2,271.5m<sup>2</sup> or 0.65% of the total site area.

## Existing Drainage Arrangements

### 4.92 Existing Runoff Rates

The existing runoff rates and hydrological characteristics of the Proposed Development are detailed in **Table 4-5** below (there are no hardstanding areas on the site at present).

**Table 4 - 5: Pre-Development Greenfield runoff rates.**

Site Make Up	Green Field
Greenfield Method	IH124
Positively Drained Area (ha)	0.227
SAAR (mm)	1039
Soil Index	1
Standard Percentage Runoff	0.1

Region	Ireland
	<b>Runoff rate (l/s)</b>
QBar	0.1
1 year	0.0
1 in 30 year	0.1
1 in 100 year	0.1

4.93 The limiting discharge rate will be the QBar greenfield rate, as detailed in **Table 4-5**. The proposal is for infiltration drainage with no discharge; however, this will be confirmed post consent once infiltration testing has been undertaken.

### Post Development Runoff Rate

4.94 The surface water runoff rate resulting from the Proposed Development has been based on the areas of hardstanding introduced, which will have a lower permeability than the existing greenfield composition.

4.95 Surface water runoff was derived using the Modified Rational Method as outlined within the methodology.

4.96 Using this approach, the runoff rate for the 1-in-100-year, 360-minute storm event, inclusive of the 20% climate change allowance would be a combined **16m<sup>3</sup>**, across the three site areas, if left unmanaged.

### 4.97 Proposed Drainage Arrangements

The SuDS Manual<sup>22</sup> is the current best practice guidance on the use of SuDS. It promotes the use of a hierarchical approach to managing runoff. This approach is outlined below:

- 1. Prevention - Preventing runoff by reducing impermeable areas.
- 2. Source Control - Effective control of runoff at or very near its source.
- 3. Site Control- Planned management of water in a local area or site.

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22 CIRIA (2015). Report C753, The SuDS Manual

- 4. Regional Control - Designing a system that can efficiently manage the runoff from a site, or several sites.

The use of SuDS is generally accepted to have greater benefits than conventional drainage systems and these include:<sup>23</sup>

4.98

- Manage runoff volumes and flow rates from hard surfaces, reducing the impact of urbanisation on flooding
- Provide opportunities for using runoff where it falls
- Protect or enhance water quality (reducing pollution from runoff)
- Protect natural flow regimes in watercourses
- Are sympathetic to the environment and the needs of the local community
- Provide an attractive habitat for wildlife in urban watercourses
- Provide opportunities for evapotranspiration from vegetation and surface water
- Encourage natural groundwater/aquifer recharge (where appropriate)

4.99

The surface water drainage strategy for the Proposed Development seeks to provide a sustainable and integrated surface water management scheme for the whole Application Site and aims to ensure no increase in downstream flood risk by managing discharges from the Proposed Development to the local water environment in a controlled manner.

4.100

To comply with current policies, guidance and best practice, the volume and quality of surface water runoff discharged off-site from the Proposed Development at this Application Site will need to be controlled using SuDS.

4.101

In compliance with the above, the drainage strategy has been developed to meet the following key principles;

- Mimic existing (greenfield) drainage arrangements as far as possible;
- Avoid increases in the greenfield rate, volume and frequency of offsite discharge;
- Avoid significant deterioration in water quality of discharges and no detrimental impact in downstream water quality;

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<sup>23</sup> Susdrain. Sustainable drainage. Accessed <http://www.susdrain.org/delivering-suds/using-suds/background/sustainable-drainage.html>

- Achieve the above criteria for all storms up to and including the 100-year event; and
- Incorporate an allowance for climate change (20%).

### Indicative Surface Water Storage Requirements

4.102

Indicative storm water storage volumes have been estimated using Causeway’s Drainage Design Flow software. The storage calculations include up to the critical storm 100-year return period event (including a 20% allowance for climate change) and the design limits discharge rates back to greenfield runoff rates. The results are enclosed in **Appendix 4C**. These are estimated from the new surfaces added to the Proposed Development.

- Attenuation storage limits the rate of surface runoff discharge from the Proposed Development to match the pre-development greenfield runoff rates;
- All storage calculations have been given a climate change allowance factor of 20% that has been added to the rain depths.
- A betterment allowance of 20% has been included.

**Table 4 - 6: Storage Estimates**

Storage Estimates	
Return Period (years)	100 years
Climate Change (%)	20
Impermeable Area (ha)	0.227
Peak Discharge (l/s)	0.1
<b>Total storage Requirement (m<sup>3</sup>)</b>	<b>177m<sup>3</sup></b>

4.103

### Proposed Drainage Strategy

4.104

It is proposed to construct a network of rainwater harvesting tanks and two soakaway pits/infiltration drains within the Application Site. The idea is to capture any overland flow in the SuDS device before infiltrating into the surrounding soils.

The proposed soakaway pits/infiltration drains will have an overall length of approximately 93m, with a base width of 2.0m, a 2.0m design depth and a 0.15m freeboard. It will be filled with crushed rock with a void ratio of 20% and will provide a total storage volume of approximately 74.4m<sup>3</sup>.

4.105 The underground piped system will separately connect the Eirgrid Control building and Customer Control Building to separate rainwater harvesting tanks, which discharge into soakaway pits. As the transformer will hold a volume of oil, the system will include a class 1 full retention separator. The soakaway pit and rainwater harvesting tanks will be designed to hold a total volume of 177m<sup>3</sup> with the detailed design of the structure being submitted to the council for review prior to the construction period.

4.106 A permanent toilet is proposed within the Eirgrid Control building and Customer Control Building and will be utilised by maintenance staff of substation. Each toilet will be off grid toilet with a foul holding tank which will be emptied when required by an approved contractor.

Additional drainage measures to be implemented on-site include the following:

- 4.107
- Access Tracks and laydown areas: access tracks are to be unpaved and constructed from local stone. Temporary swales or similar shall be utilised to collect runoff from access tracks with discharge to ground through percolation areas. Where swales are utilised, frequent checks of dams formed from gravels and other excavated material should be undertaken.

## Designing for Exceedance Events

4.108 Overland flow routes will not be altered by the construction of the Proposed Development as it is not proposed to significantly vary ground levels. The outline drainage design has been designed so that flooding will not occur for up to and including the 1-in-100-year storm event (including 20% climate change consideration).

4.109 Should an exceedance of this 1 in 100-year critical storm event occur, surface water will flow the same way as at present, into the surrounding fields. There are no sensitive receptors near to the SuDS schemes and therefore it is unlikely that any would be affected in an exceedance event.

4.110

## Long Term Maintenance of SuDS

The long-term management and maintenance of the proposed SuDS will be the responsibility of the site owner and/or operators. These responsibilities include:

### Soakaway Pit

- Litter/debris removal
- Grass cutting and removal of cuttings
- Clearing of inlets, culverts and outlets from debris and sediment

- Repair of eroded or damaged areas.

## SUMMARY & CONCLUSIONS

The FRA and DIA requirements are set out by the Department of Environment, Heritage and Local Government in 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' document.

4.111 The Guidance aims to avoid inappropriate development in flood zones and instead direct it to areas of low risk by adopting a sequential approach.

4.112 The PFRA, NIFM and CFRAM flood maps present no areas within the Application Site identified as being at risk of flooding from fluvial or coastal events and therefore the Application Site is situated in 'Flood Zone C'.

4.113 The proposed type of development is specified as Highly Vulnerable Development category outlined in The Planning System and Flood Risk Management Guidelines. The access track can be classed as 'Water Compatible Development', whilst the substation has been classed as 'Highly Vulnerable Development'. Both are appropriate for Flood Zone C.

4.115 In addition to fluvial and coastal flood risk, the PFRA map also indicates areas of flood risk due to pluvial sources. The topographical survey and the PFRA map indicated a number of locations where surface water flooding was predicted. Where the PFRA map has indicated areas within the Application Site at risk of pluvial flooding, there will only be 'Water Compatible Development' located within those areas, such as access tracks.

4.116 It is proposed to construct a network of rainwater harvesting tanks and two soakaway pits/infiltration drains within the Application Site. The idea is to capture any overland flow in the SuDS device before infiltrating into the surrounding soils.

4.118 The proposed soakaway pits/infiltration drains will have an overall length of approximately 93m, with a base width of 2.0m, a 2.0m design depth and a 0.15m freeboard. It will be filled with crushed rock with a void ratio of 20% and will provide a total storage volume of approximately 74.4m<sup>3</sup>.

4.119 The underground piped system will separately connect the Eirgrid Control building and Customer Control Building to separate rainwater harvesting tanks, which discharge into soakaway pits. As the transformer will hold a volume of oil, the system will include a class 1 full retention separator. The soakaway pit and rainwater harvesting tanks will be designed to hold a total volume of 177m<sup>3</sup> with the detailed design of the structure being submitted to the council for review prior to the construction period.

A permanent toilet is proposed within the Eirgrid Control building and Customer Control Building and will be utilised by maintenance staff of substation. Each toilet will be off grid toilet with a foul holding tank which will be emptied when required by an approved contractor.

Additional drainage measures to be implemented on-site include the following:

- Access Tracks and laydown areas: access tracks are to be unpaved and constructed from local stone. Temporary swales or similar shall be utilised to collect runoff from access tracks with discharge to ground through percolation areas. Where swales are utilised, frequent checks of dams formed from gravels and other excavated material should be undertaken.

4.120

The FRA and DIA have therefore demonstrated that the Proposed Development will **not increase flood risk** away from the Application Site during the construction operation and decommissioning phases. The Proposed Development is therefore considered to be acceptable in planning policy terms.

4.121

## APPENDICES

### Appendix 4A: Figures

- Figure 4.1: Watercourses and Photo Locations
- Figure 4.2: Topographical Survey
- Figure 4.3: Preliminary Flood Risk Assessment (PFRA) Map
- Figure 4.4: Outline SuDS Design

### Appendix 4B: FRA Photo Appendix

### Appendix 4C: Flow Output

### Appendix 4D: Rainfall Return Period



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