Technical Appendix 4: Flood Risk Assessment & Drainage Impact Assessment

Ballydonagh Solar Farm – Amendment Application

05/12/2025

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Neo Environmental Ltd	
Head Office – Glasgow: Wright Business Centre, 1 Lonmay Road, Glasgow, G33 4EL. **T:** 0141 773 6262 E: info@neo-environmental.co.uk	**Bristol Office:** Spaces 8th Floor, The Programme Building, Bristol, BS1 2NB. **T:** 01174 571 610 E: info@neo-environmental.co.uk
Warrington Office: 600 Lakeview, Lakeside Drive, Centre Park Square, Warrington, WA1 1RW. **T:** 01925 984 682 E: info@neo-environmental.co.uk	**Rugby Office:** Valiant Suites, Lumonics House, Valley Drive, Swift Valley, Rugby, Warwickshire, CV21 1TQ. **T:** 01788 297012 E: info@neo-environmental.co.uk
Ireland Office: C/O Origin Enterprises PLC, 4-6 Riverwalk Citywest Business Campus Dublin 24, D24 DCW0 T: 00 353 (1) 5634900 E: info@neo-environmental.ie	**Northern Ireland Office:** 83-85 Bridge Street, Ballymena, Co. Antrim, BT43 5EN. T: 0282 565 04 13 E: info@neo-environmental.co.uk

Prepared For:

Renewable Energy Systems on behalf of Ballydonagh Solar Limited

Prepared By:

Michael McGhee BSc TechIOA

Ollie Henderson BSc (Hons)

Thomas Hughes BSGeog

	Name	Date
Edited By:	Michael McGhee	05/12/2025
Checked By:	Colleen Patterson	05/12/2025
	Name	**Signature**
Approved By	Paul Neary	

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EXECUTIVE SUMMARY

4.1. This Flood Risk and Drainage Impact Assessment has been carried out for the Proposed Amendment consisting of the installation and operation of a solar farm in the townlands of Ballydonagh, Cloonineen, Skecoor, Kiltormer East and Graveshill, Co. Galway.

4.2. The proposed type of development is not specifically mentioned within any of the three land use vulnerability categories outlined in The Planning System and Flood Risk Management Guidelines. Solar Panels can be classed as 'Water Compatible Development' provided that the panels are raised above the flood depths with a suitable freeboard. Access tracks, as long as they are not raised above ground, can also be classed as 'Water Compatible Development', as can the fencing and CCTV. All other electrical infrastructure such as the string inverters and transformer are classed as 'Essential Infrastructure'.

4.3. The PFRA flood map present areas within the Application Site identified as being at risk of fluvial flooding events along the West Kiltormer Stream and where the East Loughturk Watercourse converges with the West Kiltormer Stream. These areas are classed as Flood Zone A and B, however the majority of the Application Site is within Flood Zone C.

4.4. In a recent appeal to An Bord Pleanala (**Ref: ABP-311460-21)** of a solar farm consented by Meath County Council (**Ref: 21/396**), An Bord Pleanala commented on solar panels being located within Flood Zones A and B and that it was appropriate as long as the panel minimum height was raised above the flood level with an appropriate freeboard.

4.5. Only the 'Water Compatible Development' infrastructure has been located in areas that are shown on the PFRA map to be within Flood Zones A and B. The panels will be pile driven and have a minimum height of at least 0.8m above ground level (AGL). It is recommended that hydraulic modelling be undertaken post consent to determine the flood depths, this is to ensure that any panels located within the flood zone will have a sufficient freeboard of 0.3m above the 1 in 1000 year flood event level.

4.6. All infrastructure classed as 'Highly Vulnerable Development' is in Flood Zone C. Using the matrix of vulnerability versus flood zone, the site design is considered appropriate.

4.7. In addition to fluvial and coastal flood risk, the PFRA map also indicates areas of flood risk due to pluvial sources. This indicated a number of locations where surface water flooding was predicted, with panels only located in these areas. However, on examination of the topographical survey, the majority is only minimal ponding of up to approximately 0.3m, however the eastern section of Field 22 that will have ponding up to approximately 1.7m deep. Where pluvial flooding is possible, only solar panels and access tracks have been proposed. The panels will be pile driven and raised above ground level by a minimum height of 0.8m (2.0m in the eastern section of Field 22) and therefore any ponding will occur below the panels with a sufficient freeboard.

4.8. This soil class within the Application Site has an SPR of 0.1 which suggests it provides excellent opportunity for infiltration drainage. The extent of impermeable area created is due to the buildings associated with the Proposed Amendment and the QBar run off rate was 0.0l/s used to calculate the storage volume requirement. 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.

4.9. It is proposed to construct multiple infiltration drains/soakaways within the Application Site. The locations of the schemes have been chosen on the downward slope or near to impermeable infrastructure or on the external boundary of any field which has a relatively steep gradient. The idea is to capture any overland flow in the Sustainable Urban Drainage Scheme) SuDS device before infiltrating into the surrounding soils.

4.10. The proposed filter drains will have an overall length of approximately 1,337m, with a base width of 0.5m, 0.5m 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 66.9m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (19.0m^3). It is therefore considered that this not only adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area but provides a minor improvement.

4.11. The SuDS features will be implemented during the construction phase of the Proposed Amendment and the swales will be planted with vegetation to protect against soil erosion. They will be maintained throughout the lifespan of the Proposed Amendment, generally in accordance with the recommendations in the appropriate guidance.

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

- Solar Panels: current grass cover is to be retained or reinstated adjacent to and under panels in order to maximise bio-retention;
- Access Tracks: 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; and
- Transformers: the scale of these types of structures is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing should be directed to a percolation area for discharge to ground. Should surface water

accumulate around any of these locations then a simple soakaway can be constructed to allow water soak into the underlying subsoils.

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

INTRODUCTION

Background

4.14. Neo Environmental Ltd has been appointed by Renewable Energy Systems on behalf of Ballydonagh Solar Limited to undertake a Flood Risk Assessment and Drainage Impact Assessment for a proposed amendment to a previously consented solar farm (Planning Reference: 2361049) with associated infrastructure on lands at Ballydonagh, Cloonineen, Skecoor, Kiltormer East and Graveshill, Co. Galway (the "Application Site").

4.15. Please see **Figure 2, Volume 2** for the layout of the Proposed Amendment.

Development Description

4.16. The Proposed Amendment will consist of several minor amendments to the previously consented development under Planning Reference 2361049. The amendments comprise the following; re alignment of the main entrance and access gate; re alignment and widening of internal access tracks; alteration of the boundary fence at the main entrance and at the northeast corner of the site; removal of the consented 38 kV substation in Field 22 to facilitate the Gortnalug Loop in and out 110 kV substation (the 110kV substation and grid connection will form part of a strategic Infrastructure development Application) and associated grid connection; combined central inverters and MV transformers are replaced by separate string inverters and central MV transformers; reduction in the size of related hardstanding areas; updated table layout to accommodate the 110 kV substation and grid cable including a reduction in PV table numbers from 3209 to 3120; new overhead line separation areas to reflect that a section of the existing 110 kV overhead line will be removed to facilitate the substation grid connection; inclusion of an additional badger sett buffer and extension the operational lifetime of the solar farm from 35 years to 40 years.

4.17. These alterations are considered minor in nature and do not alter the overall design intent or scale of the consented solar development.

Site Description

4.18. The Application Site is located in a rural setting, approximately 9.5km south of Ballinasloe, 33km east of Athenry and 21km northeast of Loughrea. The area of the Proposed Amendment lies at an elevation of approximately 71 – 96m AOD and covers a total area of c. 81.9 hectares. It is centred at approximate Irish Grid Reference (ITM) X 583549 Y 720440 and is located c. 7km northeast of the N65 and 8.4km south of the M6.

4.19. Comprising of 26 agricultural fields (31 were surveyed in total, however fields 1, 5, 9, 10 and 11 have since been removed from the Proposed Amendment boundary), the site is currently

being used for pastoral farming. The fields are bound by a mixture of trees, hedgerows and post-and-wire fencing.

4.20. Access to both parcels of land is gained from existing access points off the L4301 which dissects the site.

Scope of Report

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

4.22. The grid cable route proposed as part of this Proposed Amendment will be underground and will not increase flood risk elsewhere or be impacted by any flooding. The report therefore will focus on the solar farm development alone.

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

4.24. This report is supported by the following figures and 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
  - Figure 4.5: Arterial Drainage Schemes
- Appendix 4B: Photo Appendix
- Appendix 4C: Flow Report

[1] Department of Environment, Heritage and Local Government (2009) *The Planning System and Flood Risk Management: Guidelines for Planning Authorities.* Available at: http://www.opw.ie/media/Planning%20System%20and%20Flood%20Risk%20Management%20Guidelines.pdf

Statement of Authority

4.25. This Flood Risk Assessment (FRA) has been produced by Michael McGhee, Ollie Henderson and Thomas Hughes 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. Thomas graduated from the University of Salford in 2022 with a Bachelor of Science degree in Geography. He has been with Neo Environmental for over a year and is now an Assistant Environmental Engineer with experience in technical assessments including Flood Risk Assessments and Drainage across the UK and Ireland. Ollie graduated with an undergraduate honours degree in Geography in September 2024.

LEGISLATION

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

- EU Directive on the Assessment and Management of Flood Risks [2007/60/EC];
- 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 County Development Plan Policy

Galway County Development Plan (CDP)

4.27. The Galway County Development Plan (CDP) 2022 - 2028[2] came into effect in June 2022 and presents an extensive list of policies regarding development management within the County.

4.28. Of these policies, the following are considered relevant to this assessment.

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

Planning Policy/Objective	Comment
FL2 *"Comply with the requirements of the DoEHLG/OPW The Planning System and Flood Risk Management Guidelines for Planning Authorities and its accompanying Technical Appendices Document 2009 (including any updated/superseding documents).* *This will include the following:*	A Flood Risk Assessment has been undertaken in accordance with the Planning System and Flood Risk Management Guidelines.

[2] The Galway County Development Plan 2022. County Development Plan 2022 - 2028 . Available at: https://consult.galway.ie/en/consultation/adopted-galway-county-development-plan-2022-2028

(a) Avoid, reduce and/or mitigate, as appropriate in accordance with the Guidelines; *(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;* *(c) Development that would be subject to an inappropriate risk of flooding or that would cause or exacerbate such a risk at other locations shall not normally be permitted;* *(d) Galway County Council shall work with other bodies and organisations, as appropriate, to help protect critical infrastructure, including water and wastewater, within the County, from risk of flooding..”*	
FL6 *“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 pre-development levels and planning applications for new developments will be required to provide details of surface water drainage and sustainable drainage systems proposals..”*	Sustainable Urban Drainage Systems will be implemented as part of the Drainage Impact Assessment.
FL7 *“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..”	Suitable buffer zones to watercourses have been applied in the design of the project.
FL8 *“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.”*	A Flood Risk Assessment has been undertaken in accordance with the Planning System and Flood Risk Management Guidelines.

Strategic Flood Risk Assessment for Galway County Council

4.29. The Strategic Flood Risk Assessment for various Local Area Plan (SFRA) is contained in the supporting documents section[3] of the adopted CDP. The aim of the SFRA is to assess flood impacts that may arise from amendments to the plans for each of these settlements and to inform the Strategic Environmental Assessment (SEA).

4.30. The SFRA, in accordance with Flood Risk Management guidelines, sets out a stage 1 flood risk assessment (Identification) for the individual settlements based on best datasets available to the Council. The SFRA documents considers flooding from drainage systems, reservoirs and canals and other artificial or man-made systems, however, it contains no assessment of the Application site or surrounding area.

[3]Galway County Council, Supporting Documents in relation to Variation No.1 to Galway County Development Plan 2015-2021. Available at: http://www.galway.ie/en/services/planning/developmentplansandpolicy/galwaycountydevelopmentplan2015-2021/supportingdocumentsno1/

Shannon Upper and Lower Catchment (River Basin 25 and 26) - Flood Risk Management Plan[4]

4.31. 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.

4.32. 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] 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

METHODOLOGY

4.33. 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[5]' (the "FRM Guidelines") document. This FRA and DIA has been undertaken in accordance with these guidelines.

4.34. 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.

4.35. 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."*[6]

4.36. 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 Amendment on the catchment area. This includes an assessment of potential for both flood risk and pollution. Surface water

[5] Department of Environment, Heritage and Local Government (2009) *The Planning System and Flood Risk Management.* Available at: http://www.opw.ie/media/Planning%20System%20and%20Flood%20Risk%20Management%20Guidelines.pdf

[6] Department of Environment, Heritage and Local Government (2009) The Planning System and Flood Risk Management. Available at: http://www.opw.ie/media/Planning%20System%20and%20Flood%20Risk%20Management%20Guidelines.pdf

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.

4.37. 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:

- *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).

4.38. The FRM Guidelines provide three land-use vulnerability categories, based on the type of Proposed Amendment, 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 recreationand 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

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

4.40. 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.

4.41. 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 Amendment 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 Amendment 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."

4.42. 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:

- 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;
- 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.

4.43. 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

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

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

Topography

4.46. A topography survey was undertaken at the Application Site (see **Figure 4.2 Appendix 4A).** The topography and flow paths within the Application Site, show that the elevation has a high point of 96.56m AOD in the northwest of Field 16, whilst the low point of 71.19m AOD is in Field 31. The Application Site generally slopes downs to the southeast, with exception to localised slopes down to the nearest drain/watercourse.

Geology & Soil

4.47. The geological conditions of the Application Site were identified utilising the Geological Survey of Ireland ("GSI") Spatial Resources online geological mapping[7] 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.

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

Geo-Hazards

4.49. 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.

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

Geological Heritage

4.50. 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

4.51. 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 a small area of Cut Peat. These are classed as:

- TLs - BminPD – Mineral poorly drained (Mainly basic)
- TLs - BminPDPT - Peaty poorly drained mineral (Mainly basic)
- Peat – Cut Peat

4.52. According to the Wallingford Procedure 'Winter Rain Acceptance Potential' (WRAP) map[8], 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 excellent 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.

Hydrology

4.53. According to the Environmental Protection Agency (EPA) Map[9] 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'.

4.54. The Application Site is contained within the Kilcrow_020 river sub basin.

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

[9]Environmental Protection Agency. EPA Map Viewer. Available at: https://gis.epa.ie/EPAMaps/

Local River Network

4.55. The East Loughturk Watercourse flows south along the eastern boundary of Field 4, dissecting Field 4 and 6 before converging with the West Kiltormer Stream. The West Kiltormer Stream which runs along the western boundaries of Fields 6,7 and 8, before converging with the Mountain watercourse approximately 2km west of the Application Site. The Mountain Stream flows in a southern direction before it eventually converges with the Kilcrow River approximately 2km from the Application Site.

4.56. The Ardultagh Watercourse is located adjacent to southwest of Field 31. This flows in a southwestern direction before it converges with the Kilcrow River approximately 3.52Km from the Application Site.

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

Internal Watercourses

4.58. The Fields are mostly bounded by field drains, which vary in depth and width with **Appendix 4B** showing a variety which were noted during the site visit. These drains will mostly convey surface water from the Application Site to the watercourses outlined above.

Flood Zone Classification

4.59. 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.

4.60. The PFRA Map can be viewed in **Appendix 4A: Figure 4.3** and according to this map, the majority of the Application Site is located within Flood Zone C, however there is a risk of fluvial flooding within Field 3 – 4 and 6 - 8 due to potential out of bank flooding of the West Kiltormer Stream. West Kiltormer Stream is a designated Arterial Drainage Scheme (ADS) (**Scheme Ref: C1/33/1**) as part of the Arterial Drainage Act (ADA). The purpose of the schemes was to improve land for agriculture by lowering water levels during the growing season, to reduce waterlogging on the land beside watercourses know as callows. The PFRA mapping did not account for flood defences, channel structures or channel works and therefore it is likely that the flooding shown on the PFRA mapping will be overestimated and waters will likely be contained within the banks of the watercourse, whilst the previously flooded area is known as 'benefitted land'. To further back up this argument, there is only a small catchment area of circa 7.5km^2 for the West Kiltormer Stream at the point where the flooding occurs. All ADS watercourses will have a buffer of at least 10m from any development. However, as not all the

of the out of bank flooding is located within the benefitted land areas, those areas will be classed as flood zone A and B.

Historic Flooding

4.61. The National Flood Hazard Mapping[10] does not identify any past flood evens within the close vicinity of the Application Site.

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

Hydrogeology

4.63. According to the GSI map, the Application Site lies within the Tynagh Groundwater Body (GWB)[11]. 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.

4.64. 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."

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

[10] *OPW National Flood Hazard Mapping*. Available at: https://www.floodinfo.ie/map/floodmaps/

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

4.66. 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 Amendment, there will be a **negligible risk of contamination** due to the nature of a solar farm. 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 phases of the Proposed Amendment (see **Technical Appendix 8: Volume 3**).

Groundwater Vulnerability

4.67. 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.

4.68. According to the GSI map, the groundwater vulnerability across the Application Site is classed as 'High', with an area of 'Extreme' and 'Karst' in Field 30.

4.69. The subsoil permeability across the entire Application Site is predominantly classed as 'Medium'. This indicates that subsoil thickness for whole of the Application site with a groundwater vulnerability as 'High' is between 3.0 – 10.0m.

Table 4 - 3: GSI Vulnerability Rating (Groundwater Protection Schemes, DELG/GSI/EPA, 1999[12])

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

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

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

FLOOD RISK ASSESSMENT

Flooding Mechanisms

4.70. 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.*"

Fluvial and Coastal Flood Risk

4.71. The PRFA flood map presents areas within the Application Site identified as being at risk of flooding from fluvial flooding events.

4.72. The proposed type of development is not specifically mentioned within any of the three land use vulnerability categories outlined in The Planning System and Flood Risk Management Guidelines. Solar Panels can be classed as 'Water Compatible Development' provided that the panels are raised above the flood depths with a suitable freeboard. Access tracks, as long as they are not raised above ground, can also be classed as 'Water Compatible Development', as can the fencing and CCTV. All other electrical infrastructure such as the string inverters and central transformers are classed as 'Essential Infrastructure'.

4.73. A recent appeal to An Bord Pleanala (**Ref: ABP-311460-21)** of a solar farm consented by Meath County Councils decision (**Ref: 21/396**) made the following comments in relation to solar panels in the Flood Zone A and B:

"Having regard to the documentation submitted with the application, the fact that only solar panels are located within Flood Zone B, that solar panels are constructed for external use and to withstand weather events, the limited depth of any anticipated flood extent, the freeboard to solar panels to be provided, the thin framework which means there would be no loss of flood storage within the flood zone, the absence of a rationale from the planning authority to support its position, and previous Board decisions which permitted solar panels in flood zones, I do not consider a flooding related condition to be necessary for this permission. For clarity, there is no concern with solar panels in Flood Zone B".

4.74. This statement supports the classification of solar panels as water compatible.

4.75. Only the 'Water Compatible Development' infrastructure has been located in areas that are shown on the PFRA map to be within Flood Zones A and B. The panels will be pile driven and have a minimum height of at least 0.8m above ground level (AGL). It is recommended that hydraulic modelling be undertaken post consent to determine the flood depths, this is to ensure that any panels located within the flood zone will have a sufficient freeboard of 0.3m above the 1 in 1000 year flood event level.

4.76. All infrastructure classed as 'Highly Vulnerable Development' is in Flood Zone C. Using the matrix of vulnerability versus flood zone in Table 4-2, the site design is considered appropriate.

Pluvial Flood Risk

4.77. 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".*

4.78. In addition to fluvial and coastal flood risk, the PFRA map also indicates areas of flood risk due to pluvial sources. This indicates that there are multiple small areas of surface water flooding within the Application Site. Following a review of 'floodmaps.ie', it can be seen that, in Field 2 and 3, there was surface water flooding during the 2015/16 winter according to the GSI 2016-2019 GWFlood project.

4.79. **Figures 4.2 and 4.3: Appendix 4A** show the topographical survey and PFRA map of the Application Site, respectively. Where the PFRA map demonstrates areas of surface water risk, the topographical survey, as well as aerial maps, were studied to determine if there will indeed be surface water flooding. This indicated some minor temporary ponding within the Application Site. However, an investigation with the aid of the topographical survey showed the majority if only minimal ponding of up to approximately 0.3m, however the eastern section of Field 22 that will have ponding up to approximately 1.7m deep. Where pluvial flooding is possible, only solar panels and access tracks have been proposed. The panels will be pile driven and raised above ground level by a minimum height of 0.8m (2.0m in the eastern section of Field 22) and therefore any ponding will occur below the panels with a sufficient freeboard.

Groundwater Flood Risk

4.80. 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.

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

4.82. Local groundwater levels often respond to water levels within nearby watercourses. As there is little pluvial flood risk to the Application Site, with pluvial flooding due to slight ponding at minor depressions on the ground, groundwater flooding is unlikely to be a significant risk.

[13] GSI Groundwater Flood maps. Available at: https://www.floodinfo.ie/map/floodmaps/#

4.83. 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.

Sequential Approach Summary

4.84. 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.*"

4.85. All essential infrastructure lies outside the flood extent, i.e. within the Flood Zone C area and therefore, the Proposed Amendment 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.

Site Access Point

4.86. Existing access points will be used to access the site and should any work be required to reinstate these surface water will be diverted into the site, rather than onto the public road.

DRAINAGE IMPACT ASSESSMENT

Introduction

4.87. The Planning System and Flood Risk Management Guidelines[14] 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 Amendment, while reducing the flood risk to the Application Site itself and elsewhere.

Methodology

Catchment Characteristics

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

Greenfield Runoff and Stormwater Storage

4.89. 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[16] methodology due to the small-scale nature of the catchment).
- Flow – Causeway Drainage design software (using IH124[17] 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 Amendment layout (**Figure 2 of Volume 2: Planning Application Drawings** for the layout of the Proposed Amendment).

[14] 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

[15] HR Wallingford. Available at: http://www.uksuds.com/drainage-calculation-tools/surface-water-storage

[16] Institute of Hydrology (1994). *Flood estimation for small catchments. Report No IH124*, Wallingford.

[17] Institute of Hydrology (1994). *Flood estimation for small catchments. Report No IH124*, Wallingford.

4.90. Where applicable, the surface water drainage criteria from the Greater Dublin Strategic Drainage Study (GDSDS)[18] was applied.

Greenfield Runoff rates

4.91. The IH24 methodology is used for calculating the Greenfield runoff rates. This is recommended by the Institute of Hydrology for catchments below 200ha.[19]

4.92. The IH124 equation estimates Qbar with the following equation:

$$Qbar - rural = 0.00108\ x\ (0.01\ x\ AREA)0.89\ x\ SAAR1.17\ x\ SPR2.17, m3/s$$

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.

4.93. The GDSDS[20] states that the IH124 method is an accepted method used for determining peak flow rates for small catchments.

Calculating storage estimates

4.94. The storage estimates are calculated using the inputs below:

- Return Period
- Climate Change
- Impermeable Area

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[18] *Greater Dublin Strategic Drainage Study* (2005). Accessed at http://www.dublincity.ie/main-menu-services-water-waste-and-environment-drainage-services/new-development-policy

[19] Institute of Hydrology (1994). *Flood estimation for small catchments*. *Report No IH124*, Wallingford.

[20] 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%202%20-%20Chapter%206%20-%20Stormwater%20Drainage%20Design.pdf

- Peak Discharge

4.95. 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 the attenuation storage required for the Application Site as a result of the additional runoff generated by the Proposed Amendment.

Site and Project Descriptions

4.96. The Proposed Amendment will have a very limited extent of impermeable ground cover. The area beneath the solar panels will remain as grassland and the post-development site infiltration rate will not change.

4.97. Rainwater falling onto each panel will drain freely onto the ground beneath the panels and infiltrate the ground at the same rate as it does in the site's existing greenfield state. Thus, the total surface area of the photovoltaic array is not considered an impermeable area.

4.98. Similarly, any rainwater falling onto the permeable access tracks and hardstanding areas will soak into the ground beneath at the same rate that it presently does.

4.99. The extent of impermeable area created as a result of the Proposed Amendment is summarised in **Table 4-4**.

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

Building	Total Area (m^2)
15 x Inverter Transformer Stations (6.0m x 2.4m = 14.4m2)	216.0
Total Impermeable Area	216.0
Application Site Area (m^2)	819,240.0

4.100. In its current greenfield state, the Application Site is considered to be 100% undeveloped. As a result of the Proposed Amendment, the extent of hardstanding introduced will be approximately 216.0m^2 or 0.03% of the total site area.

4.101. Due to the small size of the Inverter Substations and the widespread nature of their locations across the Application Site, it is impractical to connect them into a drainage scheme. Water runoff from these buildings will slowly drain into the underlying geology through infiltration and the impact of this will be **negligible**. Should surface water accumulate around any of these locations, a simple soakaway can be constructed to allow water soak into the underlying subsoils.

Existing Drainage Arrangements

Existing Runoff Rates

4.102. The existing runoff rates and hydrological characteristics of the Proposed Amendment 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)	0.022
SAAR (mm)	1,039
Soil Index	1
Standard Percentage Runoff	0.1
Region	Ireland
	Runoff rate (l/s)
QBar	0.0
1 year	0.0
1 in 30 year	0.0
1 in 100 year	0.0

4.103. The limiting discharge rate will be the QBar greenfield rate, as detailed in Table 4-5. Should infiltration drainage not be appropriate, the drainage design will need be altered and discharge locations agreed with a revised limiting discharge rate appropriate to the drainage design. A limiting discharge rate of 2l/s would. Seem appropriate, however this will be agreed with the council post consent when the detailed drainage design is being undertaken.

Post Development Runoff Rate

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

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

4.106. 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 $2m^3$, if left unmanaged.

Proposed Drainage Arrangements

4.107. The SuDS Manual[21] 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.
- 4. Regional Control - Designing a system that can efficiently manage the runoff from a site, or several sites.

4.108. The use of SuDS is generally accepted to have greater benefits than conventional drainage systems and these include:[22]

- 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)

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

22 Susdrain. Sustainable drainage. Accessed http://www.susdrain.org/delivering-suds/using-suds/background/sustainable-drainage.html

4.109. The surface water drainage strategy for the Proposed Amendment 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 Amendment to the local water environment in a controlled manner.

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

4.111. 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;
- 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

4.112. 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 Amendment.

- Attenuation storage limits the rate of surface runoff discharge from the Proposed Amendment 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.

Table 4 - 6: Storage Estimates

Storage Estimates	
Return Period (years)	100 years
Climate Change (%)	20

Impermeable Area (ha)	0.022
Peak Discharge (l/s)	0.0
Total storage Requirement (m^3)	**19m^3**

Proposed Drainage Strategy

4.113. The outline drainage design proposes to construct multiple infiltration drains/soakaways and within the Application Site. The locations of the schemes have been chosen on the downward slope or near to existing watercourses or drainage features or on the external boundary of any field which has a relatively steep gradient, see **Figure 4.4: Appendix 4A**. The idea is to capture any overland flow in the SuDS device before infiltrating into the surrounding soils. Calculations are included in **Appendix 4C.**

4.114. The outline design proposes filter drains which will have an overall length of approximately 1,337m, with a base width of 0.5m, a 0.5m 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 66.9m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (19.0m^3). It is therefore considered that this not only adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area but provides a minor improvement. It is important to note that this is the outline drainage design stage and is subject to change on receipt of the infiltration testing which will be undertaken post consent.

4.115. The SuDS features will be implemented during the construction phase of the Proposed Amendment and the swales will be planted with vegetation to protect against soil erosion. They will be maintained throughout the lifespan of the Proposed Amendment, generally in accordance with the recommendations in the appropriate guidance.

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

- Solar Panels: current grass cover is to be retained or reinstated adjacent to and under panels in order to maximise bio-retention;
- Access Tracks: 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; and
- Transformers: the scale of these types of structures is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing

should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations then a simple soakaway can be constructed to allow water soak into the underlying subsoils.

Construction Phase Drainage Arrangements

4.117. Due to the addition of the temporary construction compound's during the construction phase, additional drainage measures will be implemented to help attenuate the increase in surface water flows, from the construction compounds.

4.118. Runoff from these areas is anticipated to potentially have high silt loading due to mobilised soils from excavated surfaces, fines from track aggregate and sludge due to traffic.

4.119. Hardstanding runoff will be directed to a swale on the construction compound's lowest boundary. This drainage scheme will be removed at the end of the construction stage and the area reinstated.

Designing for Exceedance Events

4.120. Overland flow routes will not be altered by the construction of the Proposed Amendment 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).

4.121. 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.

Long Term Maintenance of SuDS

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

Filter drain/ Soakaway

- 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.

Potential for Soil Erosion

4.123. The key to avoiding increased runoff and the transport of soil into watercourses is to maintain soil permeability and vegetative cover. Permeable land surfaces underneath and between panels should be able to absorb rainfall as long as they are not compacted and there is some vegetation to bind the soil surface.

4.124. Soil compaction will be limited during construction and operation of the solar farm. During construction, only light machinery will be required to install the solar arrays. Any HGVs delivering components will be restricted to site access tracks and the temporary construction compounds.

4.125. The risks of runoff and soil erosion are lowest on land with a gradual gradient with cohesive soils and are highest on dry, sandy and steeply sloping soil surfaces. Furthermore, the slope aspect of the land can also have an effect on runoff rates and soil erosion. The aspect of solar panels will be south-facing and, therefore, north or south facing slopes will result in runoff flowing in a parallel direction to that of the runoff from the panels; thereby remaining relatively diffuse and unlikely to result in concentrated flows that could cause soil erosion, apart from where very steep slopes occur.

4.126. East or west facing slopes will result in runoff flowing in a perpendicular direction to that of runoff from the panels; this will result in runoff becoming concentrated along the drip-line of each row, which could lead to increased soil erosion.

4.127. With regard to the Proposed Amendment, the site has a gentle gradient across most of the fields, however some of the fields have a slightly higher slope. The orientation of the solar panels could concentrate surface water flow in some areas of the Application Site and increase the risk of soil erosion. However, there is only a small increase in non-permeable land due to the development so the surface waters will mostly continue as present. The soakaways design has been designed to mitigate the risks from the slightly steeper slopes and therefore risks from soil erosion will be low.

4.128. Other mitigation techniques which are in place to avoid soil erosion include:

- Maintaining vegetative areas in between the solar arrays to help interrupt and slow the channelised flows, reducing erosion and also enhance and promote the infiltration and interception capacity. Where possible bare ground or gravel should be avoided.
- A robust soil, grass, and/or land management plan will be in place to keep land in good condition. If the ground becomes bare due to lack of maintenance the peak discharge has the potential to increase significantly.

- After construction the soil should be chisel ploughed, harrowed, or similar, to mitigate soil compaction during construction. This will ensure that the site can infiltrate to its potential.

SUMMARY & CONCLUSIONS

4.129. 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.

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

4.131. The proposed type of development is not specifically mentioned within any of the three land use vulnerability categories outlined in The Planning System and Flood Risk Management Guidelines. Solar Panels can be classed as 'Water Compatible Development' provided that the panels are raised above the flood depths with a suitable freeboard. Access tracks, as long as they are not raised above ground, can also be classed as 'Water Compatible Development', as can the fencing and CCTV. All other electrical infrastructure such as the string inverters and central transformers are classed as 'Essential Infrastructure'.

4.132. The PFRA flood map present areas within the Application Site identified as being at risk of fluvial flooding events along the West Kiltormer Stream and where the East Loughturk Watercourse converges with the West Kiltormer Stream. These areas are classed as Flood Zone A and B, however the majority of the Application Site is within Flood Zone C.

4.133. In a recent appeal to An Bord Pleanala (**Ref: ABP-311460-21)** of a solar farm consented by Meath County Council (**Ref: 21/396**), An Bord Pleanala commented on solar panels being located within Flood Zones A and B and that it was appropriate as long as the panel minimum height was raised above the flood level with an appropriate freeboard.

4.134. Only the 'Water Compatible Development' infrastructure has been located in areas that are shown on the PFRA map to be within Flood Zones A and B. The panels will be pile driven and have a minimum height of at least 0.8m above ground level (AGL). It is recommended that hydraulic modelling be undertaken post consent to determine the flood depths, this is to ensure that any panels located within the flood zone will have a sufficient freeboard of 0.3m above the 1 in 1000 year flood event level.

4.135. All infrastructure classed as 'Highly Vulnerable Development' is in Flood Zone C. Using the matrix of vulnerability versus flood zone, the site design is considered appropriate.

4.136. In addition to fluvial and coastal flood risk, the PFRA map also indicates areas of flood risk due to pluvial sources. This indicated a number of locations where surface water flooding was predicted, with panels only located in these areas. However, on examination of the topographical survey, the majority is only minimal ponding of up to approximately 0.3m, however the eastern section of Field 22 that will have ponding up to approximately 1.7m deep. Where pluvial flooding is possible, only solar panels and access tracks have been proposed. The panels will be pile driven and raised above ground level by a minimum height of 0.8m

(2.0m in the eastern section of Field 22) and therefore any ponding will occur below the panels with a sufficient freeboard.

4.137. This soil class within the Application Site has an SPR of 0.1 which suggests it provides excellent opportunity for infiltration drainage. The extent of impermeable area created is due to the buildings associated with the Proposed Amendment and the QBar run off rate was 0.0l/s used to calculate the storage volume requirement.

4.138. It is proposed to construct multiple infiltration drains/soakaways within the Application Site. The locations of the schemes have been chosen on the downward slope or near to impermeable infrastructure or on the external boundary of any field which has a relatively steep gradient. The idea is to capture any overland flow in the Sustainable Urban Drainage Scheme) SuDS device before infiltrating into the surrounding soils. 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.

4.139. The proposed filter drains will have an overall length of approximately 1,337m, with a base width of 0.5m, a 0.5m 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 66.9m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (19.0m^3). It is therefore considered that this not only adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area but provides a minor improvement.

4.140. The SuDS features will be implemented during the construction phase of the Proposed Amendment and the swales will be planted with vegetation to protect against soil erosion. They will be maintained throughout the lifespan of the Proposed Amendment, generally in accordance with the recommendations in the appropriate guidance.

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

- Solar Panels: current grass cover is to be retained or reinstated adjacent to and under panels in order to maximise bio-retention;
- Access Tracks: 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; and
- Transformers: the scale of these types of structures is unlikely to warrant a formalised drainage system. Runoff from this infrastructure and any associated hard standing

should be directed to a percolation area for discharge to ground. Should surface water accumulate around any of these locations then a simple soakaway can be constructed to allow water soak into the underlying subsoils.

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

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
- Figure 4.5: Arterial Drainage Schemes

Appendix 4B: Photo Appendix

Appendix 4C: Flow Output

An **Origin Enterprises** Company

GLASGOW - HEAD OFFICE

Wright Business Centre, 1 Lonmay Road,
Glasgow, G33 4EL
T: 0141 773 6262

NORTHERN IRELAND OFFICE

83-85 Bridge Street, Ballymena, Co. Antrim,
Northern Ireland, BT43 5EN
T: 0282 565 04 13

BRISTOL OFFICE

Spaces 8th Floor
The Programme Building
The Pithay
Bristol, BS1 2NB
T: 0282 565 04 13

DUBLIN OFFICE

C/O Origin Enterprises PLC
4-6 Riverwalk,
Citywest Business Campus
Dublin 24, D24 DCW0
T: 00 353 (1) 5634900

RUGBY OFFICE

Valiant Office Suites
Lumonics House, Valley Drive,
Swift Valley, Rugby,
Warwickshire, CV21 1TQ
T: 01788 297012

WARRINGTON OFFICE

Lakeview 600, Lakeside Drive
Centre Park Square
Warrington
WA1 1RW
T: 01925 984 682