EIAR Volume 3: Technical Appendices

Harristown Solar Farm

27/08/2019

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APPENDICES WITHIN THIS VOLUME:

LIST OF FIGURES

- Figure 6.1.11: 1 in 1000-year floodplain for River Boyne
- Figure 6.1.12: Watercourse N cross section locations
- Figure 6.1.13: Watercourse S and B cross section locations
- Figure 6.1.14: Conservative 1000-year flood map to show area suitable for development

Drainage Impact Assessment Appendix 6.2A Figures

- Figure 6.2.1: Site Layout
- Figure 6.2.2: Outline SuDs Design
- Figure 6.2.3: Topographic Survey
- Figure 6.2.4: New Culvert

Residential Visual Amenity Assessment Appendix 8.1A

- Figure 8.1.1 Residential Receptor Map

Construction Traffic Management Plan Appendix 9.1A: Figures

- Figure 9.1.1: Proposed Access Route
- Figure 9.1.2: Swept Path Analysis 1
- Figure 9.1.3: Swept Path Analysis 2
- Figure 9.1.4: Swept Path Analysis 3
- Figure 9.1.5: Swept Path Analysis 4
- Figure 9.1.6: Site Access Design
- Figure 9.1.7: Visibility Splay
- Figure 9.1.8: Temporary Construction Compound

ACCOMPANYING VOLUMES

EIAR Volume 1: Non-Technical Summary

EIAR Volume 2: Chapters

- Chapter 1: Introduction
- Chapter 2: Alternatives Considered
- Chapter 3: Planning Policy
- Chapter 4: Population & Human Health
- Chapter 5: Biodiversity
- Chapter 6: Land, soil & water (hydrology and hydrogeology)
- Chapter 7: Noise & Vibration
- Chapter 8: Landscape and Visual Impact Assessment
- Chapter 9: Material Assets
- Chapter 10: Archaeological, Architectural & Cultural Heritage
- Chapter 11: Air Quality & Climate
- Chapter 12: Resource & Waste Management
- Chapter 13: Interactions of the foregoing

NEO ENVIRONMENTAL

Technical Appendix 4.1: Glint and Glare Assessment

Harristown Solar Farm

27/08/2019

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Contents

1. EXECUTIVE SUMMARY

1.1. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Proposed Development is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for the aviation receptors. There was a total of 41 residential receptors and 19 road receptors within this study area, whilst geometric analysis was conducted at 28 residential receptors and 12 road-based receptors once the non-reflection zones had been established. The Zone of theoretical viability (ZTV) is used in the Glint and Glare assessment also, due to the fact that if the solar PV development is not visible from a receptor, solar reflection will be impossible. However, in this instance all the receptors are within the ZTV which considers a worst-case bald earth scenario.

1.2. Following an initial assessment, rail receptors are scoped out as assets that will be impacted upon from the Proposed Development. The assessment concludes that:

- Solar reflections are only possible at 25 of the 41 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at 21 receptors, **Medium** at two receptors, and **High** at two receptors. Upon reviewing the actual visibility of the four receptors, glint and glare impacts reduce to **None** due to intervening vegetation.
- Effects on one local road were assessed in detail using the bald-earth scenario and it was found that impacts at all receptor points are acceptable apart from at eight receptor locations. Of these eight, seven have no views of the solar farm due to intervening buildings and/or vegetation and therefore the impacts are **None**. The residual impact at the remaining road receptor remains at **Low** once the mitigation planting is considered.
- **No impact** on railway infrastructure is predicted.
- The impact on Aviation Assets is also considered to be **Negligible**.

1.3. Mitigation in the form of new hedgerow planting around the boundary of the Proposed Development where there are minor gaps or open stretches at present is proposed.

1.4. The effects of glint and glare and their impact on local receptors has been analysed in detail and although there are anticipated to be some impacts on local dwellings and roads, these are expected to be extremely limited and therefore of **Low to No Significance**.

2. INTRODUCTION

BACKGROUND

2.1. Neo Environmental Ltd has been appointed by Lightsource BP (the "Applicant") to produce a Glint & Glare Assessment for a proposed solar farm development with associated infrastructure (the "Proposed Development") on lands at Harristown, Castlejordan and Clongall, Co. Meath. The assessment will be submitted to Meath County Council (MCC) as part of an EIAR in response to a request for further Information (Planning Reference TA181225).

DEVELOPMENT DESCRIPTION

2.2. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, battery storage and all ancillary grid infrastructure and associated works.

2.3. Please see Volume 2, Chapter 1: Introduction of this EIAR for a detailed description of the Proposed Development.

SITE DESCRIPTION

2.4. The area containing all elements of the Proposed Development (the "Application Site"), consists of 21 fields currently used as pasture and covers a total area of 91.44 ha. The site lies at an elevation range of 66m to 71m AOD and is centred at approximate Irish Grid Reference (IGR) E260861 N238688. The River Boyne flows 0.19km to the east and 0.62km to the south of the site, forming the county border of Kildare and Offaly, respectively. Access will be via a pre-existing track which runs north to south through the site and connects to the L4091 north of the Application Site. The nearest settlement is the village of Castlejordan, which is located approximately 650m to the northwest of the site.

SCOPE OF REPORT

2.5. Although there may be small amounts of glint and glare from the metal structures associated with the solar farm, the main source of glint and glare will be from the panels themselves and this will be the focus of this assessment.

2.6. Solar panels are designed to absorb as much light as possible and not to reflect it. However, glint can be produced as a reflection of the sun from the surface of the solar PV panel. This can also be described as a momentary flash. This may be an issue due to visual impact and viewer distraction on ground-based receptors and on aviation.

2.7. Glare is significantly less intense in comparison to glint and can be described as a continuous source of bright light, relative to diffused lighting. This is not a direct reflection of the sun, but a reflection of the sky around the sun.

2.8. This report will concentrate on the effects of glint and its impact on local receptors and will be supported with the following Figures and Appendices.

- Appendix 4.1A: Figures
  - Figure 4.1.1: Residential Receptor Map
  - Figure 4.1.2: Road Receptor Map
- Appendix 4.1B: Residential Receptor Glare Results
- Appendix 4.1C: Road Receptor Glare Results
- Appendix 4.1D: Photo Register
- Appendix 4.1E: Solar Module Glare and Reflectance Technical Memo[1]

Statement of Authority

2.9. This Glint and Glare Assessment has been produced by Michael McGhee of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has produced Glint and Glare assessments for a number of solar farm developments across the UK and Ireland.

Definitions

2.10. This study examined the potential hazard and nuisance effects of glint and glare in relation to ground-based receptors, this includes the occupants of surrounding dwellings as well as road

1 Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

users. The FAA in their "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[2] have defined the terms 'Glint' and 'Glare' as meaning;

- Glint – "A momentary flash of bright light"
- Glare – "A continuous source of bright light"

2.11. Glint and glare are essentially the unwanted reflection of sunlight from reflective surfaces. This study used a multi-step process of elimination to determine which receptors had the potential to experience the effects of glint and glare. It then examined, using a computer-generated geometric model, the times of the year and the times of the day such effects could occur. This is based on the relative angles between the sun, the panels and the receptor throughout the year.

General Nature of Reflectance from Photovoltaic Panels

2.12. In terms of reflectance, photovoltaic solar panels are by no means a highly reflective surface. They are designed to absorb sunlight and not to reflect it. Nonetheless, photovoltaic panels have a flat polished surface, which omits 'specular' reflectance rather than a 'diffuse' reflectance, which would occur from a rough surface. Several studies have shown that photovoltaic panels (as opposed to Concentrated Solar Power) have similar reflectance characteristics to water, which is much lower than the likes of glass, steel, snow and white concrete by comparison (**Appendix 4.1E** refers). Similar levels of reflectance can be found in rural environments from the likes of shed roofs and the lines of plastic mulch used in cropping. In terms of the potential for reflectance from photovoltaic panels to cause hazard and/ or nuisance effects, there have been a number of studies undertaken in respect of schemes in close proximity to airports. The most recent of these was compiled by the Solar Trade Association (STA) in April 2016 and used a number of case studies and expert opinions, including that from Neo. The summary of this report states that "*the STA does not believe that there is cause for concern in relation to the impact of glint and glare from solar PV on aviation and airports…*"[3].

Time Zones / Datum's

2.13. Locations in this report were given in Eastings and Northings using the 'OSNI 1952 Irish National Grid' grid reference system unless otherwise stated.

2 Harris, Miller, Miller & Hanson Inc. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at:

https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf

3 Solar Trade Association. (April 2016). Summary of evidence compiled by the Solar Trade Association to help inform the debate around permitted development for non - domestic solar PV in Scotland. Impact of solar PV on aviation and airports. Available at: http://www.solar-trade.org.uk/wp-content/uploads/2016/04/STA-glint-and-glare-briefing-April-2016-v3.pdf

2.14. Ireland uses Irish Standard Time (IST, UTC+01:00) in the summer months and Greenwich Mean Time (UTC+0) in the winter period. For the purposes of this report all time references were in GMT, however if reference was made to a time which falls within the IST then this was outlined in the report.

3. LEGISLATION AND GUIDANCE

UK PLANNING POLICY

3.1. The National Planning Framework (NPF) was adopted by the Irish Government on the 29th of May 2018. However, this policy document provides no current provision within the Irish Planning System for the requirement of Glint and Glare Assessments to support applications for the installation of ground mounted solar PV systems. It is therefore considered appropriate to defer to extant policy guidance within the UK planning system, in particular National Planning Policy Guidance (NPPG) on Renewable and Low Carbon Energy[4].

3.2. Paragraph 013 (Reference ID: 5-013-20150327) sets out particular planning considerations that relate to large scale ground-mounted solar PV farms. This determines that the deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively. One of the considerations to be taken into account by local planning authorities is;

- *"the proposal's visual impact, the effect on landscape of glint and glare and on neighbouring uses and aircraft safety;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun."*

Interim CAA Guidance – Solar Photovoltaic Systems (2010)

3.3. There is little guidance on the assessment of glint and glare from solar farms with regards to aviation safety. The Civil Aviation Authority (CAA) has published interim guidance on 'Solar Photovoltaic Systems[5]', they also intend on undertaking a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.

3.4. The interim guidance identifies the key safety issues with regards to aviation, including *"glare, dazzling pilots of leading them to confuse reflections with aeronautical lights."* It is outlined that solar farm developers should be aware of the requirements to comply with the Air

4 NPPG Renewable and Low Carbon Energy. Available at: http://planningguidance.communities.gov.uk/blog/guidance/renewable-and-low-carbon-energy/particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines/#paragraph_012

5 CAA (2010) Interim CAA Guidance – Solar Photovoltaic Systems. Available at: http://www.enstoneflyingclub.co.uk/files/caa_view_on_solar_panel_instalations.pdf?PHPSESSID=8900a41db8a205da84fca7bbc14eae69

Navigation Order (ANO), published in 2009. In particular developers should take cognisant of the following articles of the ANO[6], including:

- *"Article 137 – Endangering safety of an aircraft – A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft."*
- *Article 221 - Lights liable to endanger – "A person must not exhibit in the United Kingdom any light which:*
  - *a) by reason of its glare is liable to endanger aircraft off from landing at an aerodrome; or*
  - *b) by reason of its liability to be mistaken for an aeronautical ground light liable to endanger aircraft"*
- *Article 222 – Lights which dazzle or distract – "A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft."*

3.5. Relevant studies generally agree that there is potential for glint and glare from photovoltaic panels to cause a hazard or nuisance for surrounding receptors, but that the intensity of such reflections is similar to that emanating from still water. This is considerably lower than for other manmade materials such as glass, steel or white concrete (SunPower – 2009).

3.6. These Articles are considered within the assessment of glint and glare of the Proposed Development.

US Federal Aviation Administration Policy

3.7. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2010)[7] incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):

"…evidence suggests that either significant glare is not occurring during times of operation or if glare is occurring, it is not a negative effect and is a minor part of the landscape to which pilots and tower personnel are exposed."

6 CAA (2015) Air Navigation: The Order and Regulations. Available at: http://publicapps.caa.co.uk/docs/33/CAP%20393%20Fourth%20edition%20Amendment%201%20April%202015.pdf

7 FAA (2010), Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide-print.pdf

3.8. The current policy (Federal Register, 2013)[8] demands that an ocular impact assessment must be assessed at 1-minute intervals from when the sun rises above the horizon until the sun sets below the horizon. Specifically, the developer must use the Solar Glare Hazard Assessment Tool (SGHAT) specifically and reference its results as this was developed by the FAA and Sandia National Laboratories as a standard and approved methodology for assessing potential impacts on aviation interests, although it notes other assessment methods may be considered. The SGHAT tool has since been licensed to a private organisation who were also involved in its development and it is the software model used in this assessment.

3.9. Crucially the policy provides a quantitative threshold which is lacking in the UK guidance. To clarify a solar development would not automatically receive an objection on glint grounds if low intensity glint is visible to pilots on final approach. In other words, low intensity glint with a low potential to form a temporary after-image would be considered acceptable under US guidance.

3.10. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection the following two criteria must be met:

- No potential for glint or glare in the existing or planned Air Traffic Control Tower (ATCT).
- No potential for glare (glint) or "low potential for after-image" along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP). The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glide path.

3.11. The geometric analysis included later in this report, which defines the extent and time at which glint may occur, is required by the FAA as the methodology to be used when assessing glint and glare impacts on aviation receptors. This report will follow the methodology required by the FAA as it offers the most robust assessment method available.

Review of CDP Policy

Meath County Development Plan 2013-2019[9]

3.12. The main aim of the Meath County Development Plan ("CDP") is to provide direction for development in the county, while focusing on six overall objectives which include: sustainable economic and employment growth, competitiveness of business in the area, balanced

[8] FAA (2013), Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports. Available at https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

[9] Meath County Council, 2012, Meath County Development Plan 2013-2019. Available at http://countydevelopmentplan.meath.ie/adoptedplan

development, social inclusion, improve quality of life and maintain and enhance the natural and cultural heritage.

3.13. There are no policies contained within the CDP which are of relevance to this Glint and Glare assessment.

4. METHODOLOGY

4.1. A desk-based assessment was undertaken to identify when and where glint and glare may be visible at receptors within the vicinity of the Proposed Development, throughout the day and the year.

IDENTIFICATION OF RECEPTORS

Ground Based Receptors

4.2. Glint is most likely to impact upon a ground-based receptor close to dusk and dawn, when the sun is at its lowest in the sky. Therefore, any effect would likely occur early in the day or late in the day, reflected to the west at dawn and east at dusk.

4.3. A 1km study area from the panels was deemed appropriate for the assessment of ground-based receptors as this seemed to contain a good spread of residential and road receptors in most directions from the Proposed Development. The further distance a receptor is from a solar farm, the less chance it has of being affected by glint and glare due to scattering of the reflected beam and atmospheric attenuation, in addition to obstructions from ground sources, such as any intervening vegetation or buildings.

4.4. An observer height of 2m was utilised for residential receptors, as this is a typical height for a ground-floor window. With regards to road users, a receptor height of 1.5m was employed as this is typical of eye level. Rail driver’s eye level was assumed to be 2.75m above the rail for signal signing purposes and therefore this is the height used for assessment purposes.

4.5. A Zone of Theoretical Visibility (“ZTV”) was produced to show the potential visibility of the solar farm from ground-based receptors. The ZTV is based on OSI Digital Terrain Model (“DTM”) data which has a contour resolution of 1m. It does not account for any intervening vegetation or buildings which may otherwise provide some degree of screening. As glint and glare can only affect a receptor if it is in line of sight to a solar farm the ZTV is a useful tool in reducing the number of receptors to be analyzed in detail in the final assessment.

4.6. An assessment was undertaken to determine zones where solar reflections will never be directed near ground level.

Aviation

4.7. Glint is only considered to be an issue with regards to aviation safety when the solar farm lies within close proximity to a runway, particularly when the aircraft is descending to land. En-route activities are not considered an issue as the flight will most likely be at a higher altitude than the solar reflection.

4.8. Should a solar farm be proposed within the safeguarded zone of an aerodrome then a full geometric study may be required which would determine if there is potential for glint and glare at key locations, most likely on the descent to land.

4.9. The buffer zones to identify aviation assets to be assessed varies depending on the safeguarding criteria of that asset. For large aerodromes a safeguarding zone of 30km is standard, however for small private airstrips this can be reduced to approximately 5km.

SUN POSITION AND REFLECTION MODEL

Sun Data Model

4.10. The SGHATs sun position algorithm[10] calculates the sun position in two forms: first as a unit vector extending from the Cartesian origin toward the sun, and second as azimuthal and altitudinal angles. The algorithm relies on the latitude, longitude and time zone offset from UTC in order to determine the position of the sun at one-minute intervals throughout the year.

Solar Reflection Model

4.11. The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year being assessed was 2018.

4.12. In order to determine if a solar reflection will reach a receptor the following variables are required:

- Sun position;
- Observer location, and;
- Tilt, orientation, and extent of the modules in the solar array.

4.13. The model assumes that the azimuth and horizontal angle of the sun is the same across the whole solar farm. This is considered acceptable due to the distance of the sun from the proposed development and the miniscule differences in location of the sun over the proposed development.

4.14. Once the position of the sun is known for each time interval, a vector reflection equation determines the reflected sun vector, based on the normal vector of the solar array panels. This assumes that the angle of reflection is equal to the angle of incidence reflected across a normal plane. In this instance the plane being the vector which the solar panels are facing.

[10] Duffie, J.A. and W.A. Beckman (1991) *Solar engineering of thermal processes, 2nd ed.*, Wiley, New York, xxiii, pp919

4.15. On knowing the vector of the solar reflection, the azimuth is calculated and the horizontal reflection from multiple points within the solar farm. These are then compared with the azimuth and horizontal angle of the receptor from the solar farm to determine if it is within range to receive solar reflections.

4.16. The solar reflection in the model is considered to be specular as a worst-case scenario. In practice the light from the sun will not be fully reflected as solar panels are designed to absorb light rather than reflect it. The text above and **Appendix 4.1E** outlines the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report could be argued, it is included as a visual guide and it agrees with most other reports, in that solar glass has less reflective properties than other types of glass and that the amount of reflective energy drops as the angle of incidence decreases.

4.17. Most modern panels have a slight surface texture which should have a small effect on diffusing the solar radiation further. Although, this has not been modelled to conform with the worst-case scenario assessment.

Determination of Ocular Impact

4.18. Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

4.19. The ocular impact[11] of viewed glare can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image, potential for after-image, and potential for permanent eye damage.

4.20. The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

Relevant Parameters of the Proposed Development

4.21. The photovoltaic panels are oriented in a southwards direction to maximise solar gain and will remain in a fixed position throughout the day and during the year (i.e. they will not rotate to track the movement of the sun). The panels will face south and will be inclined at an angle of 20 degrees.

4.22. The height of the panels above ground level is a maximum 2.58m and points at the top, middle and bottom of the panels are used to determine the potential for glint and glare generation.

[11] Ho, C.K., C.M. Ghanbari, and R.B. Diver (2011) Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation, *Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).*

MAGNITUDE OF IMPACT

Static Receptors

4.23. Although there is no specific guidance set out to identify the magnitude of impact from solar reflections, the following criteria has been set out for the purposes of this report:

- High - Solar reflections impacts of over 30 hours per year or over 30 minutes per day
- Medium - Solar reflections impacts between 20 and 30 hours per year or between 20 minutes and 30 minutes per day
- Low - Solar reflections impacts between 0 and 20 hours per year or between 0 minutes and 20 minutes per day
- None - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening

Moving Receptors

4.24. Again, no specific guidance is available to identify the magnitude of impact from solar reflections on moving receptors except in aviation, however it is thought that a similar approach should be applied to moving receptors as aviation, based on the ocular impact and the potential for after-image.

4.25. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection the following criteria must be met:

- No potential for glare (glint) or "low potential for after-image" along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP).

Aviation Receptors

Approach Paths

4.26. Each final approach path which has the potential to receive glint is assessed using the SGHAT model. The model assumes an approach bearing on the runway centreline, a 3-degree glide path with the origin 50ft (15.24m) above the runway threshold.

4.27. The computer model considers the pilots field of view. The azimuthal field of view (AFOV) or horizontal field of view (HFOV) as it is sometimes referred, refers to the extents of the pilot's horizontal field of view measured in degrees left and right from directly in front of the cockpit.

The vertical field of view (VFOV) refers to the extents of the pilot's vertical field of view measured in degrees from directly in front of the cockpit. The HFOV is modelled at 90 degrees left and right from the front of the cockpit whilst the VFOV is modelled at 30 degrees.

4.28. The FAA guidance states that there should be no potential for glare or 'low potential for after-image' at any existing or future planned runway landing thresholds in order for the proposed Development to be acceptable.

Air Traffic Control Tower

4.29. An air traffic controller uses the visual control room to monitor and direct aircraft on the ground, approaching and departing the aerodrome. It is essential that air traffic controllers have a clear unobstructed view of the aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways and aircraft bays.

4.30. The FAA guidance states that no solar reflection towards the ATC tower should be produced by a proposed solar development (see Policy and Guidance Chapter), however this should be assessed on a site by site case and will depend on the operations at a particular aerodrome.

4.31. In order to determine the impact on the ATCT, the location and height of the tower will need to be fed into the SGHAT model and where there is a potential for 'low potential for After-Image' or more, then mitigation measures will be required.

Determination of Ocular Impact

4.32. Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

4.33. The ocular impact[12] of viewed glare can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image (green), potential for after-image (yellow), and potential for permanent eye damage (red).

4.34. The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

12 Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).

ASSESSMENT LIMITATIONS

4.35. Below is a list of assumptions and limitations of the model and methods used within this report:

- The model does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
- The model does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results.
- Due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary slightly from calculated positions.
- The model does not account for the effects of diffraction; however, buffers are applied as a factor of safety.

5. BASELINE CONDITIONS

GROUND BASED RECEPTORS REFLECTION ZONES

5.1. In the northern hemisphere, there will never be solar reflections due south of a solar PV development as the position of the sun is always south. Furthermore, due to the slant of a solar panel (where the sun is due south, with an azimuth angle of 180 degrees), reflections will be directed skyward and not impact on ground-based receptors. The ground-based receptor reflection zone is a procedure which eliminates certain areas in order to reduce the assessment procedure, much in the same way a zone of theoretical visibility (ZTV) map allows a Landscape Architect to focus their assessment on areas where the solar PV development will actually be visible. The ZTV is used in the Glint and Glare assessment also, due to the fact that if the solar PV development is not visible from a receptor then solar reflection will be impossible (however in this instance all the receptor points are within the ZTV which considers a bald earth scenario). The ground based solar reflection zone should be assessed in the same way.

5.2. Based on the relatively flat topography in the area, solar reflections between five degrees below the horizontal plane to five degrees above it are described as near horizontal. Reflections from the proposed solar farm within this arc have the potential to be seen by receptors at or near ground level.

5.3. Further analysis showed that this will only occur between the azimuth of 242.5 degrees and 293.2 degrees in the western direction (late day reflections) and 66.8 degrees and 117.4 degrees in the eastern direction (morning reflections) and therefore any ground-based receptor outside these arcs will not have any impact from solar reflections.

5.4. **Figure 4.1.1 and 4.1.2 of Appendix 4.1A** show the respective study areas whilst also subtracting from this the areas where solar reflections will not impact on ground-based receptors due to the reasons set out in **paragraphs 5.1 to 5.3.**

Residential Receptors

5.5. Residential receptors located within 1km of the Application Site have been identified (**Table 5-1**). Glint was assumed to be possible if the receptor is located within the ZTV and also within the ground-based receptor zones outlined previously.

Table 5-1: Residential Receptors

Receptor	Easting	Northing	Above Sea Level, ASL (m)	Glint and Glare Possible
1	259601	239046	74	Yes

2	259637	239071	74	Yes
3	259828	239282	78	Yes
4	259894	239302	78	Yes
5	259967	239340	78	Yes
6	259964	239426	79	Yes
7	260035	239445	80	Yes
8	260084	239448	80	Yes
9	260293	239273	74	Yes
10	260342	239462	78	Yes
11	260989	239360	76	Yes
12	260966	239584	75	No
13	261088	239608	76	No
14	261105	239613	77	No
15	261131	239624	77	No
16	261163	239634	76	No
17	261178	239656	76	No
18	261477	239720	73	No
19	261659	237838	73	Yes
20	261031	237624	73	No
21	260639	237653	72	No

22	260648	237737	70	No
23	260559	237700	71	Yes
24	259193	239074	71	Yes
25	259273	238882	72	Yes
26	259277	238926	72	Yes
27	259454	238936	73	Yes
28	259477	238950	73	Yes
29	259457	239007	74	Yes
30	259504	238974	73	Yes
31	259430	238377	75	Yes
32	259431	238318	73	Yes
33	259315	238297	70	Yes
34	259622	237902	71	Yes
35	259893	237902	71	Yes
36	262143	237845	84	Yes
37	262124	237902	85	Yes
38	261649	239850	74	No
39	261506	239953	73	No
40	260684	239760	75	No
41	259908	239601	76	Yes

Road / Rail Receptors

5.6. There are no railway lines close to the site which could potentially be affected by glint and glare from the proposed solar farm.

5.7. Within the 1km study area, there is only one road which needs to be assessed which is the L4091 to the north of the Application Site. There are some smaller roads within the study area; however, these are small farm access roads where it is unlikely vehicles will be travelling at such speed that the impacts of glint and glare would be of danger.

5.8. The ground receptor no-reflection zones are clearly identifiable on **Figures 4.1.1 and 4.1.2 of Appendix 4.1A** and the process of how these are calculated is explained in **paragraphs 5.1 to 5.3** of this report. Assessment points 200m apart are assessed below (**Table 5-2**).

Table 5-2: Road Based Receptors

Receptor	Easting	Northing	ASL (m)	Glint and Glare Possible
1	259338	238907	73	Yes
2	259155	238842	70	Yes
3	259510	239008	74	Yes
4	259666	239118	75	Yes
5	259815	239251	77	Yes
6	259961	239370	78	Yes
7	260125	239417	80	Yes
8	260316	239409	78	Yes
9	260507	239438	75	Yes
10	260694	239463	72	Yes
11	260881	239527	75	Yes
12	261061	239586	76	No
13	261246	239665	77	No
14	261417	239748	74	No
15	261539	239874	73	No
16	261583	240055	73	No
17	261740	240159	71	No

18	261905	240229	70	No
19	259182	239030	71	Yes

AVIATION

5.9. Aerodromes within 30km of the proposed solar development can be found in **Table 5-3.**

Table 5-3: Airfields within close proximity

Airfield	Distance	Use
Clonbullogue Airfield	15.6km	Small Grass Airstrip

6. IMPACT ASSESSMENT

6.1. Following the methodology outlined earlier in this report, geometrical analysis comparing the azimuth and horizontal angle of the receptors from the Proposed Development and the solar reflection was conducted. Although this assessment did not take into account obstructions such as vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

Ground Based Receptors

Residential Receptors

6.2. **Table 6-1** identifies the receptors that will experience solar reflections based on solar reflection modelling and whether the reflections will be experienced in the morning (AM), evening (PM) or both.

Table 6-1: Potential for Glint and Glare impact on Residential Receptors

	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact
Receptor	AM	PM	Minutes	Hours	
1	Yes	No	193	3.2	Low
2	Yes	No	218	3.6	Low
3	Yes	No	91	1.5	Low
4	Yes	No	108	1.8	Low
5	Yes	No	100	1.7	Low
6	Yes	No	12	0.2	Low
7	Yes	No	5	0.1	Low
8	Yes	No	3	0.1	Low
9	Yes	No	162	2.7	Low
10	Yes	No	0	0.0	None
11	No	Yes	331	5.5	Low
19	Yes	No	902	15.0	Low
23	No	No	0	0.0	None

24	Yes	No	30	0.5	Low
25	Yes	No	251	4.2	Low
26	Yes	No	215	3.6	Low
27	Yes	No	418	7.0	Low
28	Yes	No	262	4.4	Low
29	Yes	No	252	4.2	Low
30	Yes	No	344	5.7	Low
31	Yes	No	1438	24.0	Medium
32	Yes	No	1342	22.4	Medium
33	Yes	No	114	1.9	Low
34	Yes	No	347	5.8	Low
35	Yes	No	293	4.9	Low
36	No	Yes	1989	33.2	High
37	No	Yes	2295	38.3	High
41	No	No	0	0.0	None

6.3. Where the impact is deemed **Low** or **None** at a receptor point the impact is deemed acceptable and will not be considered further.

6.4. As it can be seen in **Table 6-1**, at receptor points 31, 32, 36, and 37 there is a **Medium** or **High** impact. **Appendix 4.1C** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing which parts of the solar farm the solar glint is reflected from.

6.5. **Appendix 4.1D** shows two Google earth images taken from each of the receptor points where an impact is anticipated. The first image is a ground level view and is based on the height data of the surrounding land showing no intervening vegetation or buildings. The solar farm has been drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The second image is a street view image pointing in the same direction as the street view image, which is straight toward the solar farm. This gives a good indication if the solar farm will be visible from the receptor point.

Receptor 31

6.6. Receptor 31 has potential glint impacts between the times of 06:00 and 07:00 between the months of March and October. The reflections will only occur for between zero and 10 minutes per day as the sun moves past the solar farm and for up to 24 hours per year.

6.7. Based on the criteria set out in the Methodology section of this report, the impact on this receptor is deemed to be **Medium.**

6.8. **Appendix 4.1D** shows two Google earth images taken from the local access road between the receptor and the Proposed Development. The first image is a ground level view and is based on the height data of the surrounding land showing no intervening vegetation or buildings. The Proposed Development has been drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The second image is a street view image pointing in the same direction, which is straight toward the solar farm. This gives a good indication if the solar farm will be visible from the receptor point. As indicated, there is multiple hedges and tree rows which will obscure the views of the Proposed Development completely from this location and therefore the impact can be reduced to **None**.

Receptor 32

6.9. Receptor 32 has potential glint impacts between the times of 06:00 and 07:00 between the months of March and October. The reflections will only occur for between zero and 14 minutes per day as the sun moves past the solar farm and for up to 22.4 hours per year.

6.10. Based on the criteria set out in the Methodology section of this report, the impact on this receptor is deemed to be **Medium.**

6.11. **Appendix 4.1D** shows two Google earth images taken from the local access road near the receptor, the receptor being visible in the image. The first image is a ground level view and is based on the height data of the surrounding land showing no intervening vegetation or buildings. The Proposed Development has been drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The second image is a street view image pointing in the same direction, which is straight toward the solar farm. This gives a good indication if the solar farm will be visible from the receptor point. As demonstrated, the views of the Proposed Development are obscured completely by the vegetation on the field boundary close by and therefore the impact can be reduced to **None**.

Receptor 36

6.12. Receptor 36 has potential glint impacts between the times of 18:00 and 19:00 between the months of April and October. The reflections will only occur for between zero and 18 minutes per day as the sun moves past the solar farm and for up to 33.2 hours per year.

6.13. Based on the criteria set out in the Methodology section of this report, the impact on this receptor is deemed to be **High.**

6.14. **Appendix 4.1D** shows two Google earth images taken from the local access road between the receptor and the Proposed Development. The first image is a ground level view and is based on the height data of the surrounding land showing no intervening vegetation or buildings. The Proposed Development has been drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The second image is a street view image pointing in the same direction, which is straight toward the solar farm. This gives a good indication if the solar farm will be visible from the receptor point. As demonstrated, there is multiple hedges and tree rows which will obscure the views of the Proposed Development completely from this location and therefore the impact can be reduced to **None**.

Receptor 37

6.15. Receptor 37 has potential glint impacts between the times of 18:00 and 19:00 between the months of April and October. The reflections will only occur for between zero and 19 minutes per day as the sun moves past the solar farm and for up to 38.3 hours per year.

6.16. Based on the criteria set out in the Methodology section of this report, the impact on this receptor is deemed to be **High.**

6.17. **Appendix 4.1D** shows two Google earth images taken from the local access road between the receptor and the Proposed Development. The first image is a ground level view and is based on the height data of the surrounding land showing no intervening vegetation or buildings. The Proposed Development has been drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The second image is a street view image pointing in the same direction, which is straight toward the solar farm. This gives a good indication if the solar farm will be visible from the receptor point. As illustrated, the views of the Proposed Development are obscured completely by the vegetation on the field boundary close by and therefore the impact can be reduced to **None**.

Road Receptors

6.18. **Table 6-2** shows a summary of the modelling results for each of the Road Receptor Points whilst the detailed results and ocular impact charts can be viewed in **Appendix 4.1C**.

Table 6-2: Potential for Glint and Glare impact on Road Based Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)
1	0	253	0
2	0	0	0
3	0	248	0
4	0	158	0
5	0	100	0
6	0	51	0
7	0	16	0

8	0	25	0
9	0	0	0
10	0	0	0
11	0	0	0
19	0	20	0

6.19. As can be seen in **Table 6-2**, at Receptor Points 1, 3, 4, 5, 6, 7, 8, and 19 there is 'Potential for temporary After Image,' which is not acceptable according to the FAA guidance. **Appendix 4.1C** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing which parts of the solar farm the solar glint is reflected from.

6.20. **Appendix 4.1D** shows two Google earth images taken from each of the receptor points where an impact is anticipated. The first image is a ground level view and is based on the height data of the surrounding land showing no intervening vegetation or buildings. The solar farm has been drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The second image is a street view image pointing in the same direction, which is straight toward the solar farm. This gives a good indication if the solar farm will be visible from the receptor point. As demonstrated, Receptor 1, 3, 4, 6, 7, 8, and 19 have no views of the solar farm and therefore their impacts will be **None**. Although Receptor 5 will have some intervening vegetation which blocks some views of the solar farm, there will be small gaps which are visible and therefore there will be some limited impact.

6.21. Taking this into account, the resultant impact on road receptor 5, is **Low**.

Ground Based Receptor Mitigation

6.22. As part of the Landscape and Ecology Management Plan (see **Figure 8.20 submitted as part of Volume 2, Chapter 8: LVIA**) new hedgerow and tree planting are proposed along all boundaries of the Proposed Development to infill any gaps and thicken out the exiting boundary vegetation.

6.23. The Application Site is already relatively well screened so this will not mitigate the impact of glint and glare significantly, however it will reduce it slightly.

Aviation Receptors

6.24. There are no large aerodromes within 30km of the Application Site. Clonbullogue Airfield is located approximately 15.6km from the Application Site. As this small airstrip is outside the required 5km impact zone for small airstrips, it can be determined that the Proposed Development will have **negligible impacts** upon this aviation asset. The impacts on aviation receptors is therefore **None**.

7. SUMMARY

7.1. There is no guidance or policy available across Ireland in relation to the assessment of glint and glare from proposed solar farm developments. However, as identified by UK policy, it is recognised as a potential impact which needs to be considered for a proposed solar development.

7.2. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Proposed Development is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for the aviation receptors. There was a total of 41 residential receptors and 19 road receptors within this study area, whilst geometric analysis was conducted at 28 residential receptors and 12 road based receptors once the non-reflection zones had been established. The Zone of theoretical viability (ZTV) is used in the Glint and Glare assessment also, due to the fact that if the solar PV development is not visible from a receptor, solar reflection will be impossible. However, in this instance all the receptors are within the ZTV which considers a worst-case bald earth scenario.

7.3. Following an initial assessment, rail receptors are scoped out as assets that will be impacted upon from the Proposed Development. The assessment concludes that:

- Solar reflections are only possible at 25 of the 41 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at 21 receptors, **Medium** at two receptors, and **High** at two receptors. Upon reviewing the actual visibility of the four receptors, glint and glare impacts reduce to **None** due to intervening vegetation.
- Effects on one local road were assessed in detail using the bald-earth scenario and it was found that impacts at all receptor points are acceptable apart from at eight receptor locations. Of these eight, seven have no views of the solar farm due to intervening buildings and/or vegetation and therefore the impacts are **None**. The residual impact at the remaining road receptor remains at **Low** once the mitigation planting is considered.
- **No impact** on railway infrastructure is predicted.
- The impact on Aviation Assets is also considered to be **Negligible**.

7.4. Mitigation in the form of new hedgerow planting around the boundary of the Proposed Development where there are minor gaps or open stretches at present is proposed.

7.5. The effects of glint and glare and their impact on local receptors has been analysed in detail and although there are anticipated to be some impacts on local dwellings and roads, these are expected to be extremely limited and therefore of **Low to No significance**.

8. APPENDICES

APPENDIX 4.1A – FIGURES

- Figure 4.1.1: Residential Receptor Map
- Figure 4.1.2: Road Receptor Map

APPENDIX 4.1B: RESIDENTIAL RECEPTOR RESULTS

APPENDIX 4.1C: ROAD RECEPTOR RESULTS

APPENDIX 4.1D: PHOTO REGISTER

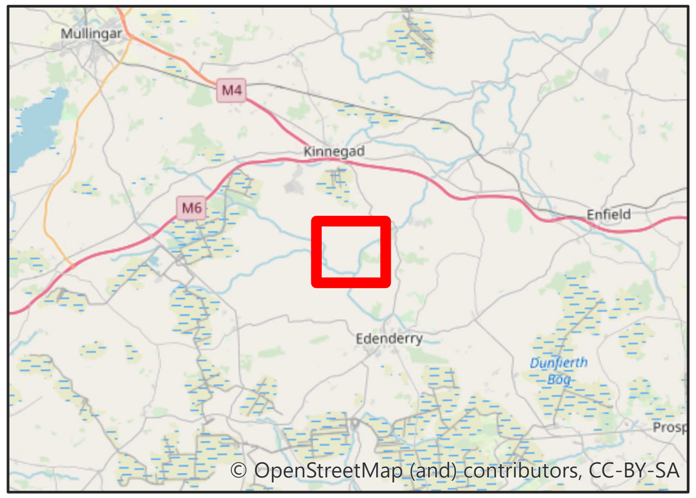
APPENDIX 4.1E: SOLAR MODULE GLARE AND REFLECTANCE TECHNICAL MEMO

Appendix4.1A: Figures

Harristown Solar Farm
Residential Based Receptors
Figure 4.1.1

Key

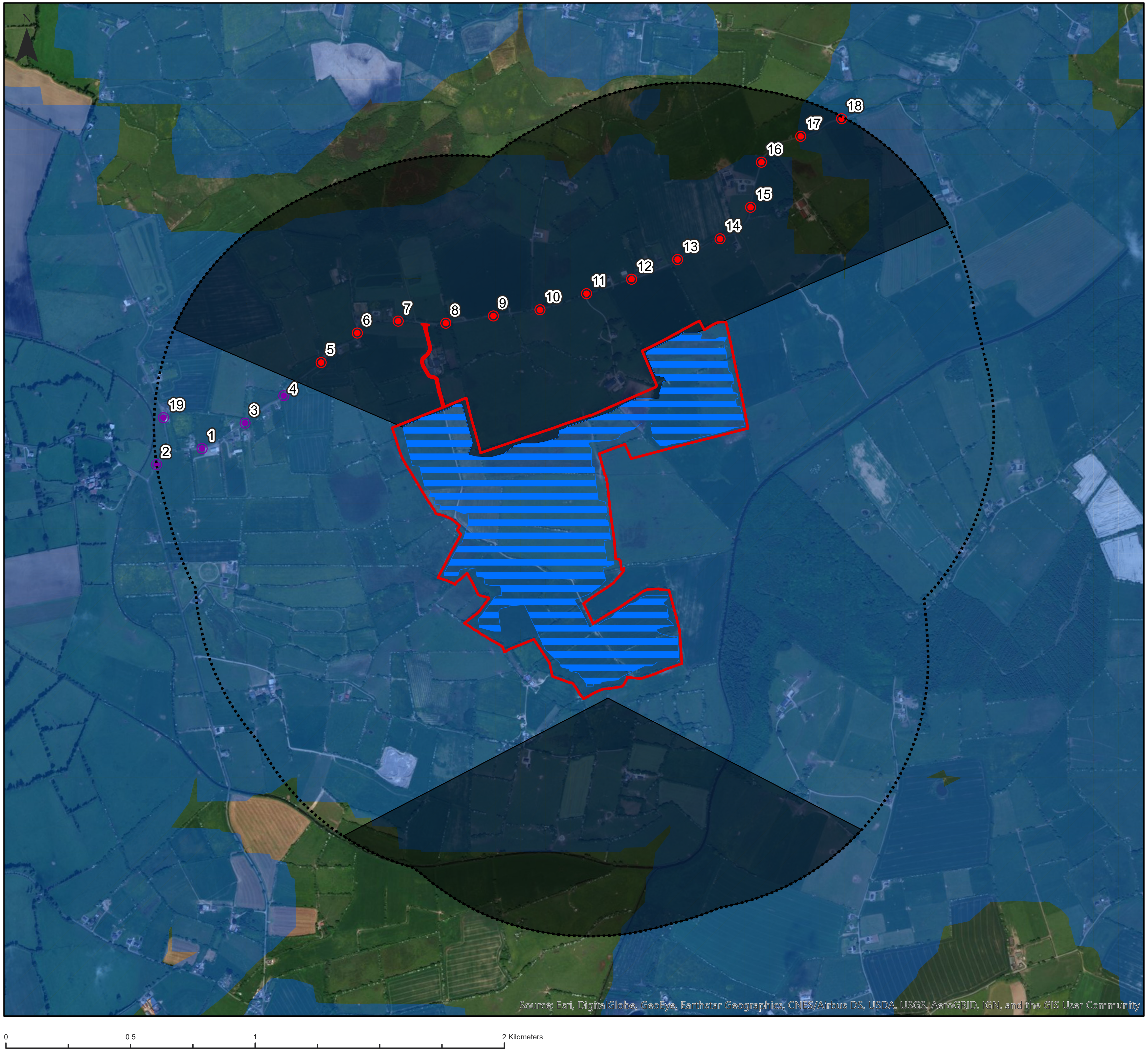
- Development Boundary
- 1km Study Area
- Panel Boundary
- Glare not possible at receptor
- Glare possivle at receptor
- Non Reflection Zones
- Zone of Theoretical Visibility



Date: 15/07/2019
Drawn By: JM
Scale (A3): 1:15,000
Drawing No: NEO00515/026I/D

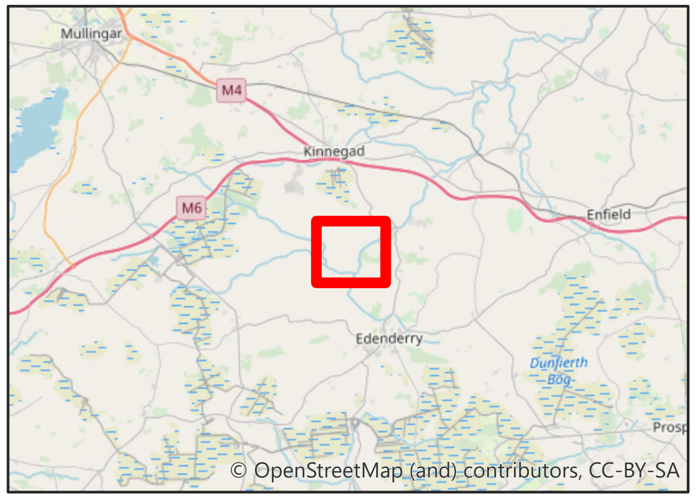
NEO ENVIRONMENTAL

Harristown Solar Farm
Road Based Receptors
Figure 4.1.2



Key

- Development Boundary
- 1km Study Area
- Panel Boundary
- Non Reflection Zones
- Glare not possible from Receptor
- Glare possible from receptor
- Zone of Theoretical Visibility



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Drawn By: JM
Scale (A3): 1:15,000
Drawing No: NEO00515/027I/C

ENVIRONMENTAL

Appendix 4.1B: Residential Receptor Glare Results

GlareGauge Glare Analysis Results

Site Configuration: Harristown Solar Farm

Project site configuration details and results.

Created **Sept. 18, 2018 8:01 a.m.**
Updated **Sept. 18, 2018 8:54 a.m.**
DNI **varies** and peaks at **1,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC0**
Site Configuration ID: 21146.3609

Summary of Results Glare with potential for temporary after-image predicted

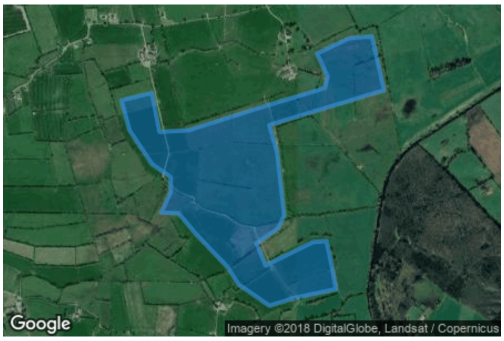
PV name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	20.0	180.0	0	11,715	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 20.0 deg
Orientation: 180.0 deg
Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.398179	-7.096804	70.86	0.80	71.66
2	53.398511	-7.094444	70.00	0.80	70.80
3	53.396720	-7.093843	68.61	0.80	69.41
4	53.396797	-7.091568	68.68	0.80	69.48
5	53.397897	-7.085732	68.66	0.80	69.46
6	53.398742	-7.081054	70.10	0.80	70.90
7	53.399279	-7.080840	71.34	0.80	72.14
8	53.400328	-7.081655	72.87	0.80	73.67
9	53.401044	-7.079166	71.69	0.80	72.49
10	53.401121	-7.077406	71.03	0.80	71.83
11	53.398639	-7.076462	68.91	0.80	69.71
12	53.397027	-7.085346	67.06	0.80	67.86
13	53.395773	-7.084745	67.00	0.80	67.80
14	53.392856	-7.084187	65.00	0.80	65.80
15	53.392267	-7.084659	65.00	0.80	65.80
16	53.391576	-7.086333	66.09	0.80	66.89
17	53.390553	-7.085646	68.38	0.80	69.18
18	53.391628	-7.081955	68.64	0.80	69.44
19	53.391679	-7.080925	68.08	0.80	68.88
20	53.390604	-7.080539	69.48	0.80	70.28
21	53.389452	-7.080196	69.27	0.80	70.07
22	53.389068	-7.083243	70.47	0.80	71.27
23	53.388684	-7.085346	70.71	0.80	71.51
24	53.389682	-7.087749	68.64	0.80	69.44
25	53.390450	-7.088564	67.99	0.80	68.79
26	53.391986	-7.091011	68.28	0.80	69.08
27	53.392958	-7.092384	67.00	0.80	67.80
28	53.392984	-7.093714	67.00	0.80	67.80
29	53.393931	-7.092985	68.04	0.80	68.84
30	53.394622	-7.092985	67.85	0.80	68.65
31	53.395236	-7.094444	66.45	0.80	67.25
32	53.396771	-7.096160	67.68	0.80	68.48



Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	53.398341	-7.104752	74.04	2.00	76.04
OP 2	53.398661	-7.104087	74.44	2.00	76.44
OP 3	53.400584	-7.101307	78.23	2.00	80.23
OP 4	53.400673	-7.100277	78.06	2.00	80.06
OP 5	53.400839	-7.099269	77.65	2.00	79.65
OP 6	53.401825	-7.099269	78.96	2.00	80.96
OP 7	53.401952	-7.098303	79.77	2.00	81.77
OP 8	53.402016	-7.097423	79.67	2.00	81.67
OP 9	53.400430	-7.094269	74.03	2.00	76.03
OP 10	53.402042	-7.093604	78.00	2.00	80.00
OP 11	53.401108	-7.083841	76.41	2.00	78.41
OP 12	53.403117	-7.084120	75.14	2.00	77.14
OP 13	53.403334	-7.082360	76.43	2.00	78.43
OP 14	53.403385	-7.082017	76.68	2.00	78.68
OP 15	53.403500	-7.081673	76.52	2.00	78.52
OP 16	53.403628	-7.081266	76.33	2.00	78.33
OP 17	53.403769	-7.080987	76.12	2.00	78.12
OP 18	53.404332	-7.076309	73.00	2.00	75.00
OP 19	53.387379	-7.074007	72.82	2.00	74.82
OP 20	53.385165	-7.083319	72.83	2.00	74.83
OP 21	53.385753	-7.089370	72.01	2.00	74.01
OP 22	53.386598	-7.089263	70.19	2.00	72.19
OP 23	53.386214	-7.090743	71.39	2.00	73.39
OP 24	53.398716	-7.110849	71.04	2.00	73.04
OP 25	53.396963	-7.109605	72.04	2.00	74.04
OP 26	53.397436	-7.109498	72.03	2.00	74.03
OP 27	53.397462	-7.107030	73.00	2.00	75.00
OP 28	53.397590	-7.106665	73.00	2.00	75.00
OP 29	53.398101	-7.106944	74.24	2.00	76.24
OP 30	53.397628	-7.106064	73.05	2.00	75.05
OP 31	53.392433	-7.107416	74.84	2.00	76.84
OP 32	53.391806	-7.107502	72.87	2.00	74.87
OP 33	53.391678	-7.109047	69.97	2.00	71.97
OP 34	53.388262	-7.104755	70.67	2.00	72.67
OP 35	53.388108	-7.100507	70.99	2.00	72.99
OP 36	53.387366	-7.066668	83.99	2.00	85.99
OP 37	53.387865	-7.067033	85.07	2.00	87.07
OP 38	53.405419	-7.073668	73.56	2.00	75.56
OP 39	53.406340	-7.075899	72.98	2.00	74.98
OP 40	53.404754	-7.088280	75.34	2.00	77.34
OP 41	53.403270	-7.100036	75.67	2.00	77.67

PV Array Results

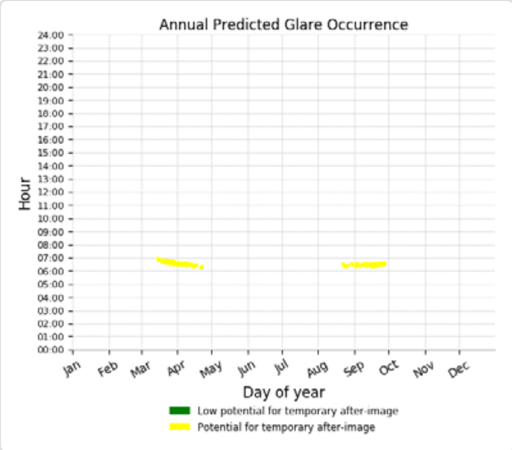
PV array 1 potential temporary after-image

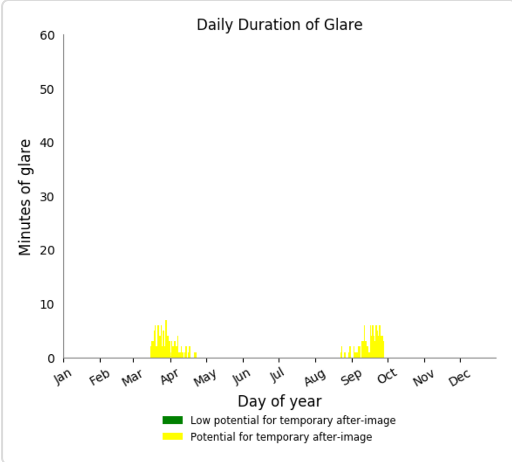
Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	193
OP: OP 2	0	218
OP: OP 3	0	91
OP: OP 4	0	108
OP: OP 5	0	100
OP: OP 6	0	12
OP: OP 7	0	5
OP: OP 8	0	3
OP: OP 9	0	162
OP: OP 10	0	0
OP: OP 11	0	331
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	902
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	30
OP: OP 25	0	251
OP: OP 26	0	215
OP: OP 27	0	418
OP: OP 28	0	262
OP: OP 29	0	252
OP: OP 30	0	344
OP: OP 31	0	1438
OP: OP 32	0	1342
OP: OP 33	0	114
OP: OP 34	0	347
OP: OP 35	0	293
OP: OP 36	0	1989
OP: OP 37	0	2295
OP: OP 38	0	0
OP: OP 39	0	0
OP: OP 40	0	0
OP: OP 41	0	0

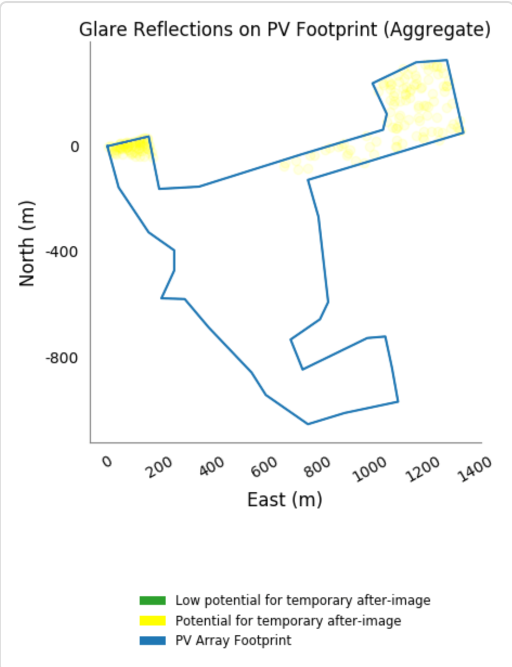
PV array 1 - OP Receptor (OP 1)

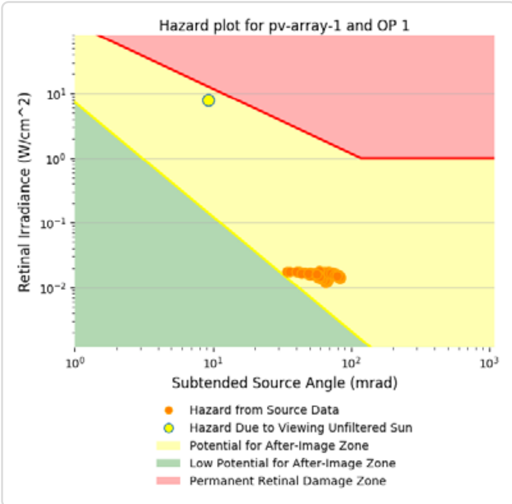
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 193 minutes of "yellow" glare with potential to cause temporary after-image.





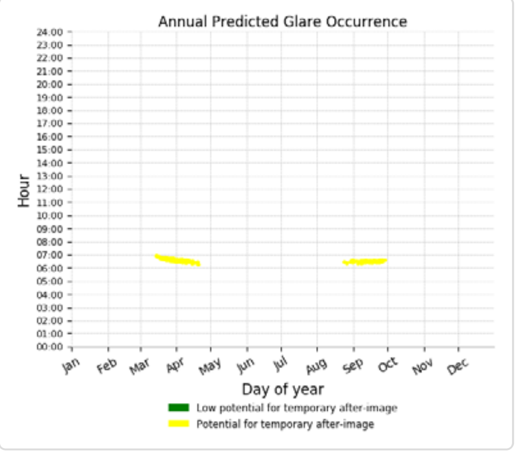


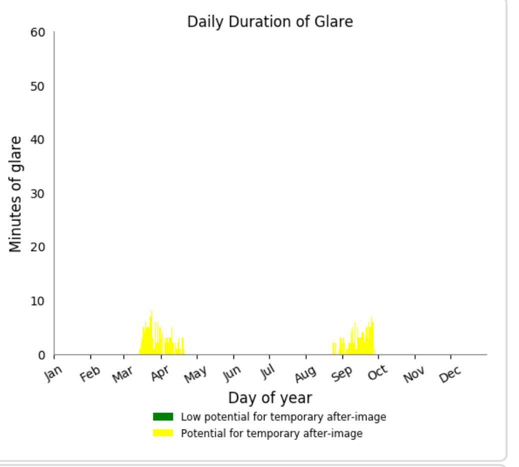


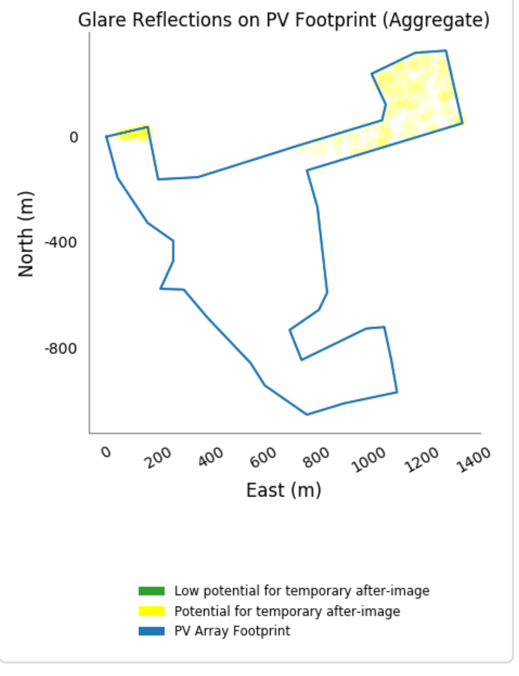
PV array 1 - OP Receptor (OP 2)

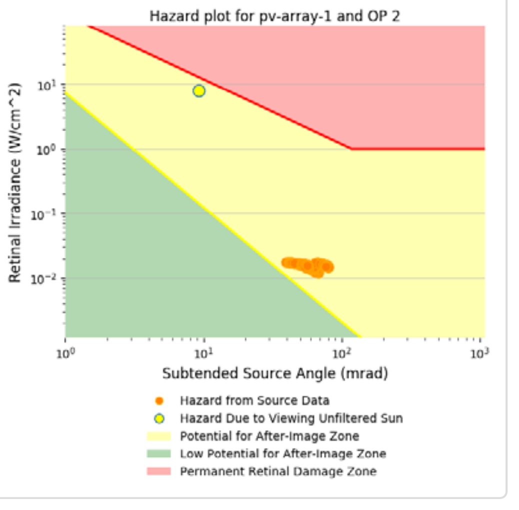
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 218 minutes of "yellow" glare with potential to cause temporary after-image.





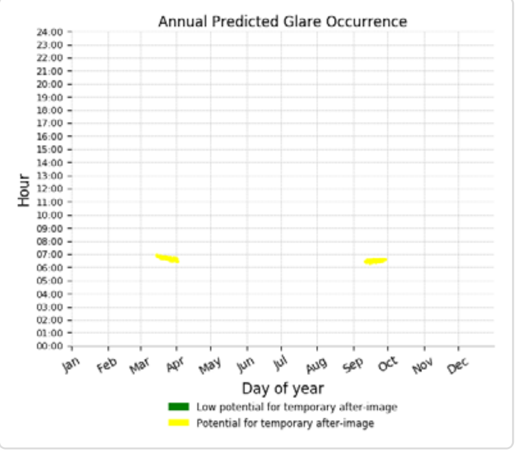


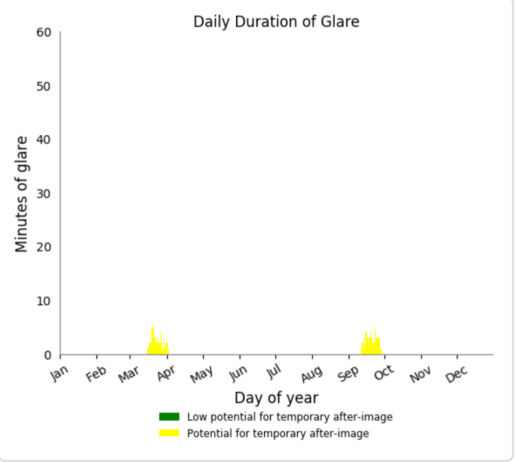


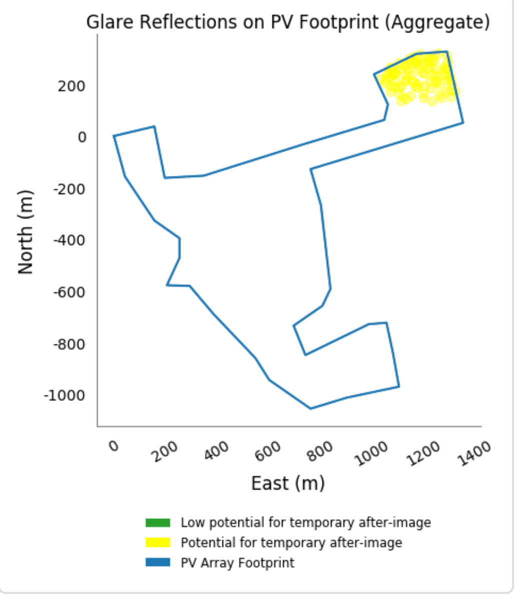
PV array 1 - OP Receptor (OP 3)

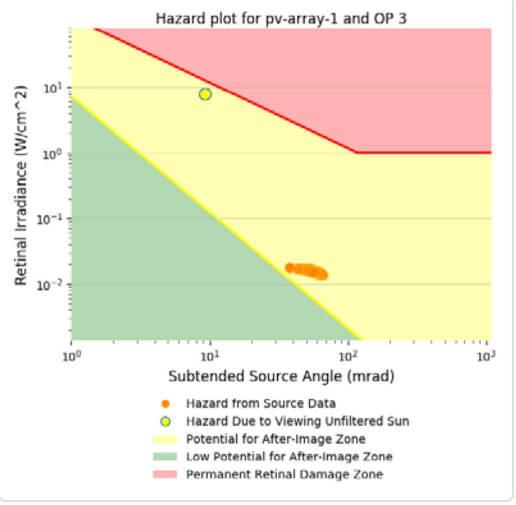
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 91 minutes of "yellow" glare with potential to cause temporary after-image.





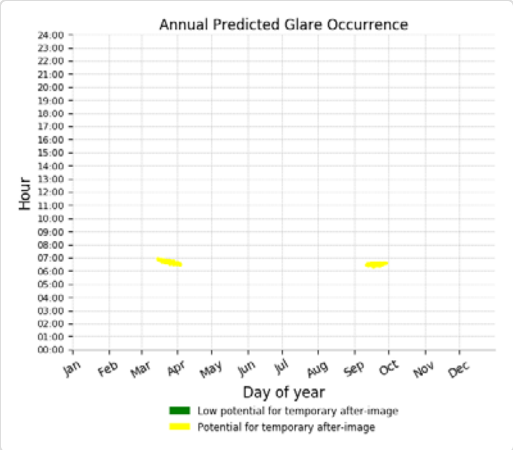


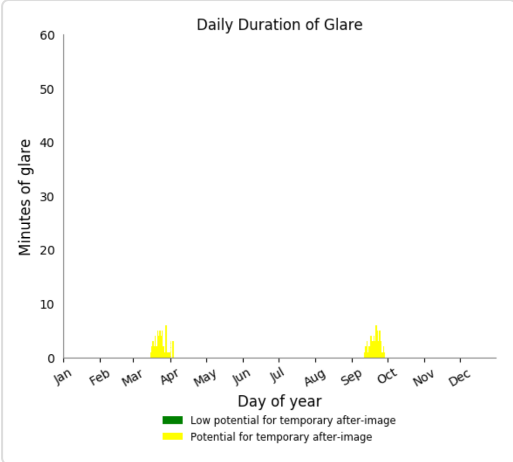


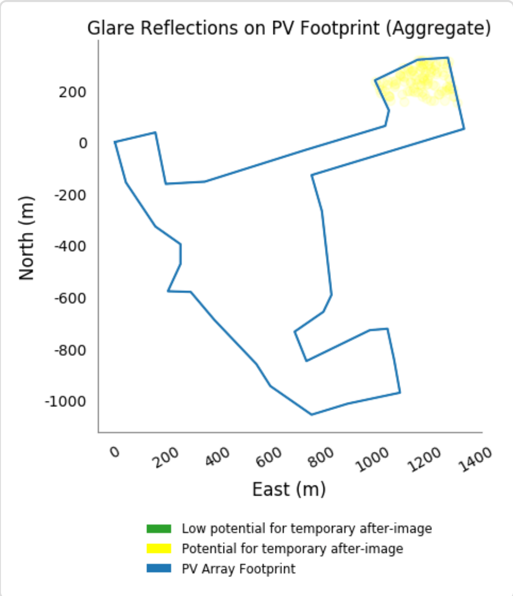
PV array 1 - OP Receptor (OP 4)

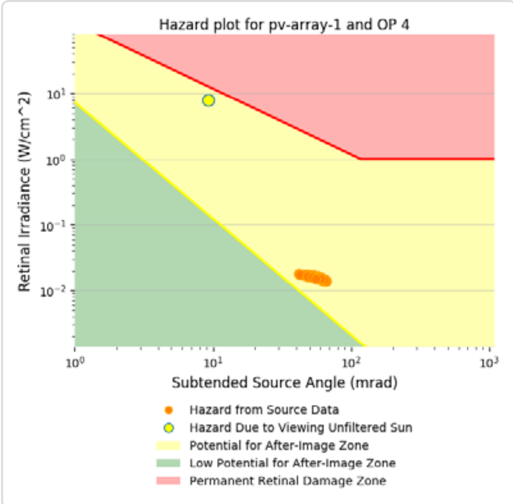
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 108 minutes of "yellow" glare with potential to cause temporary after-image.





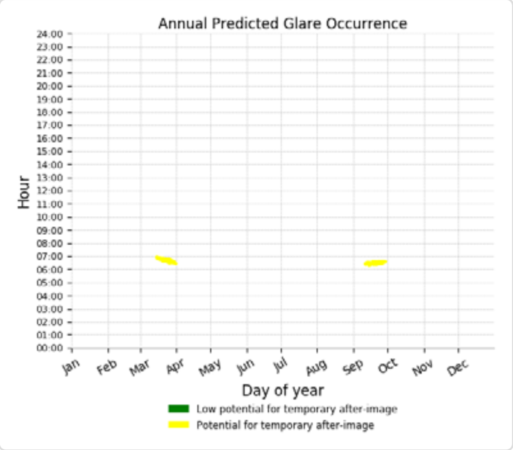


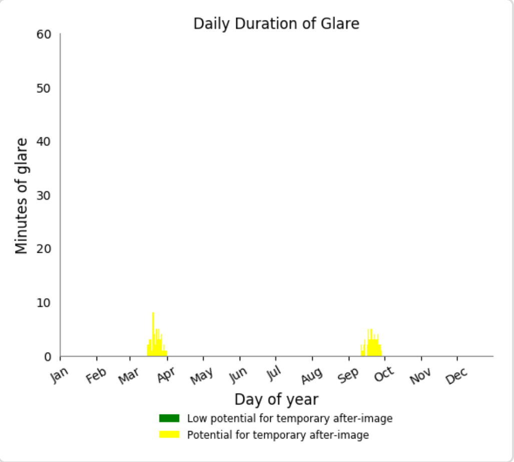


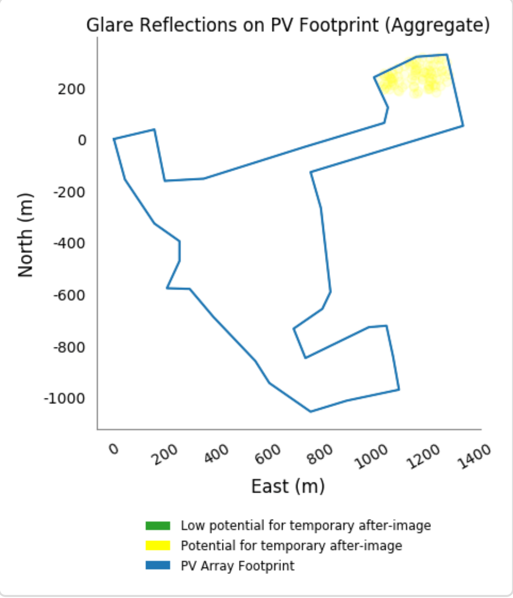
PV array 1 - OP Receptor (OP 5)

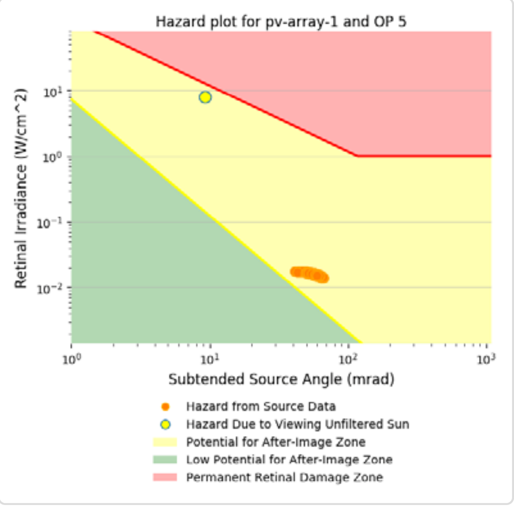
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 100 minutes of "yellow" glare with potential to cause temporary after-image.





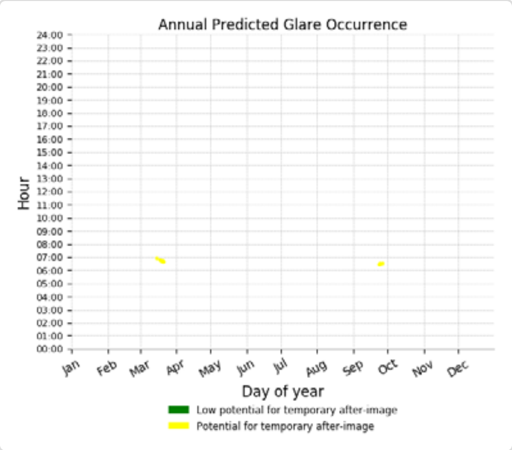


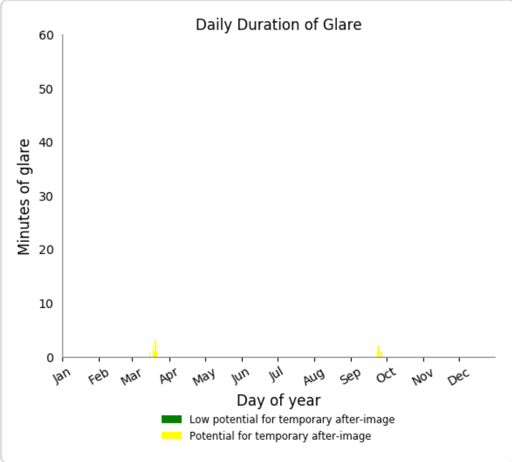


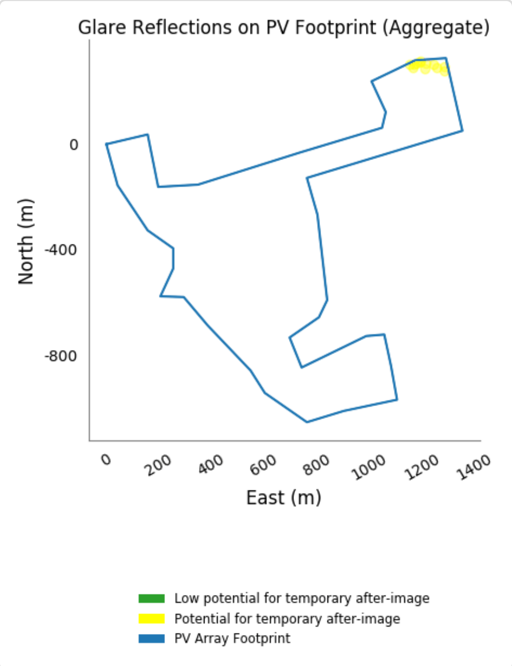
PV array 1 - OP Receptor (OP 6)

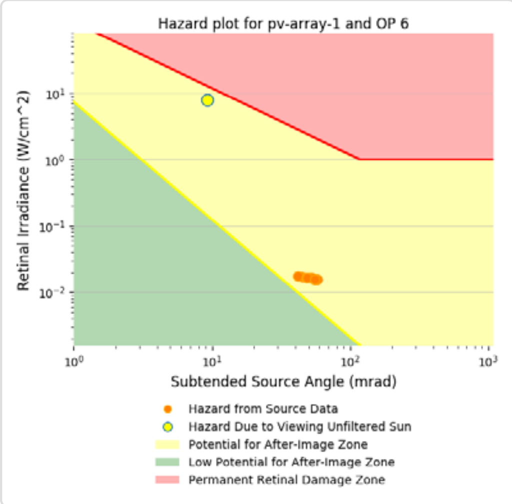
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 12 minutes of "yellow" glare with potential to cause temporary after-image.





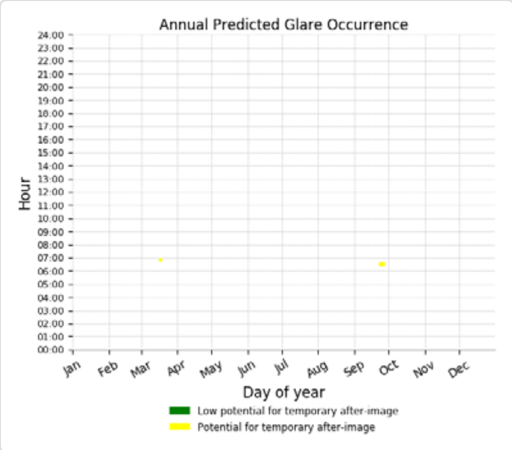


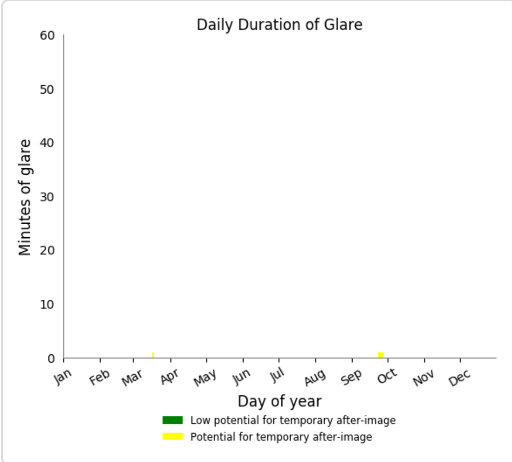


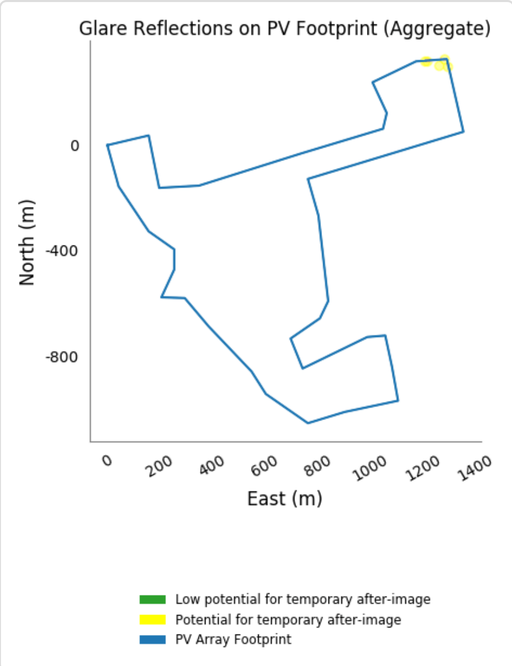
PV array 1 - OP Receptor (OP 7)

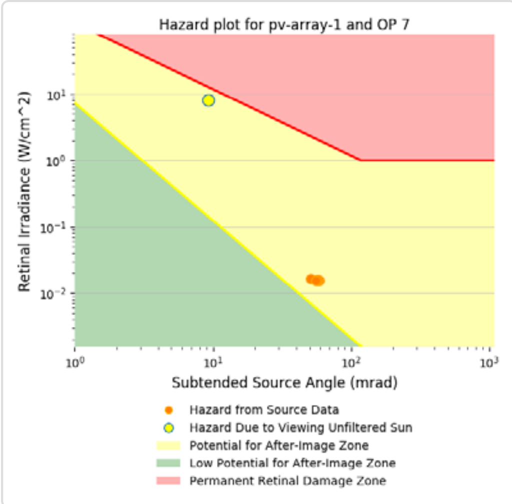
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 5 minutes of "yellow" glare with potential to cause temporary after-image.





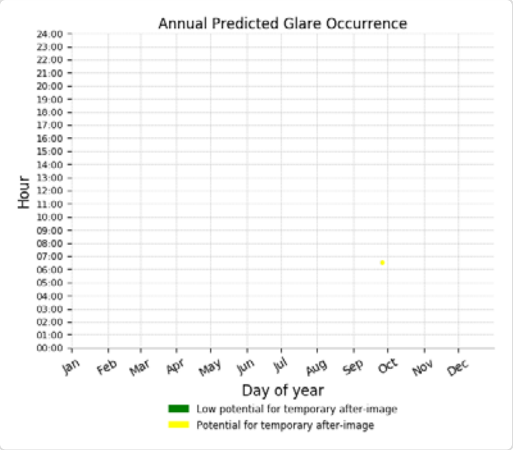


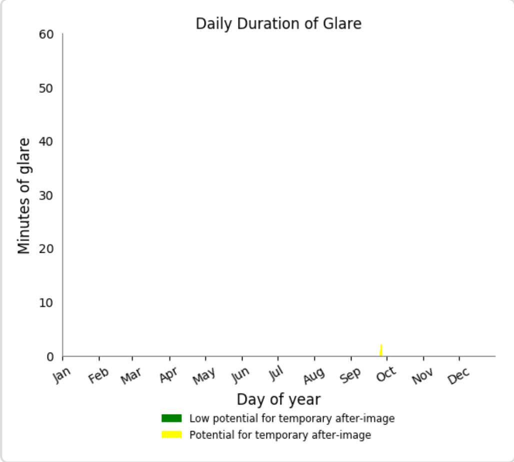


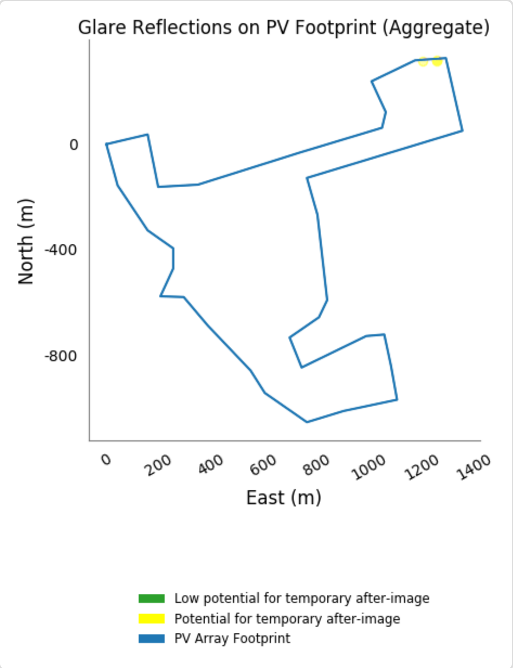
PV array 1 - OP Receptor (OP 8)

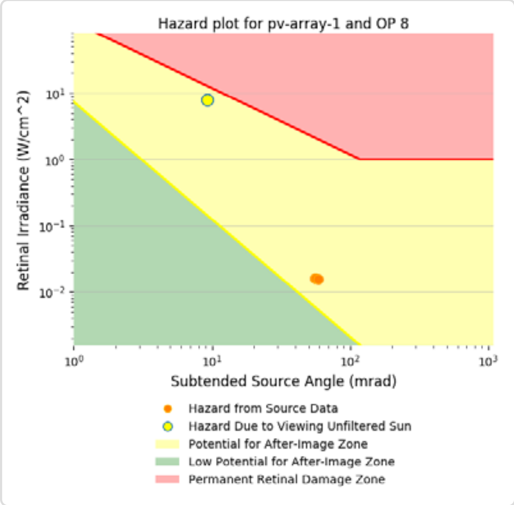
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 3 minutes of "yellow" glare with potential to cause temporary after-image.





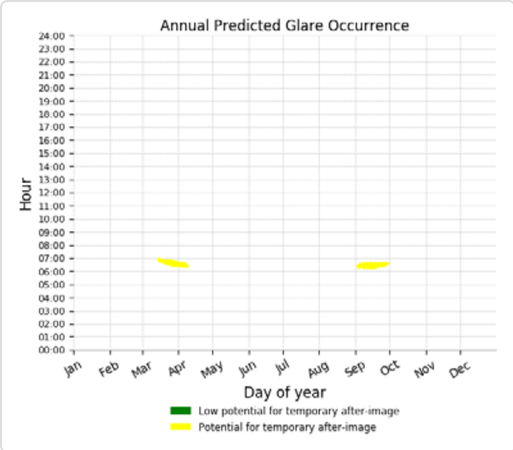


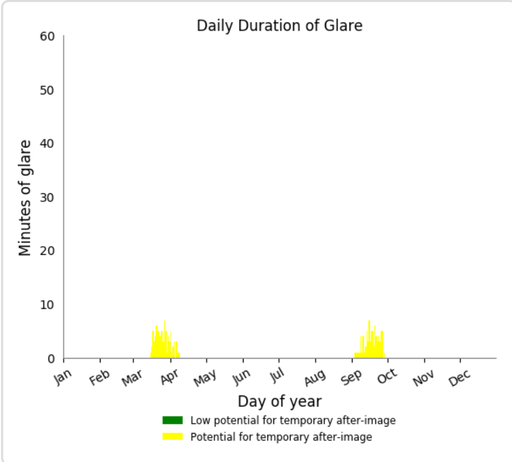


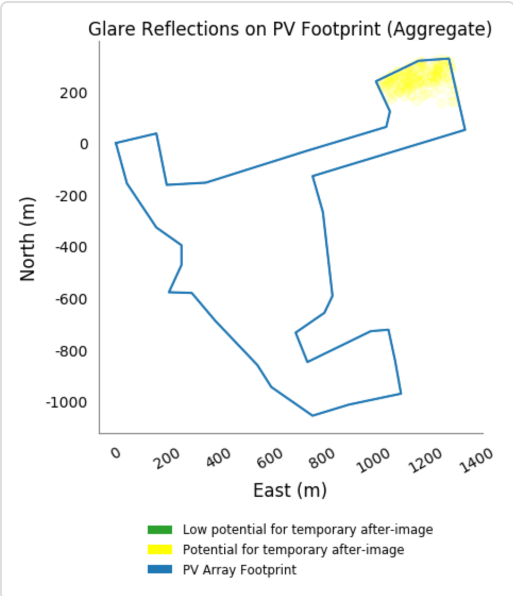
PV array 1 - OP Receptor (OP 9)

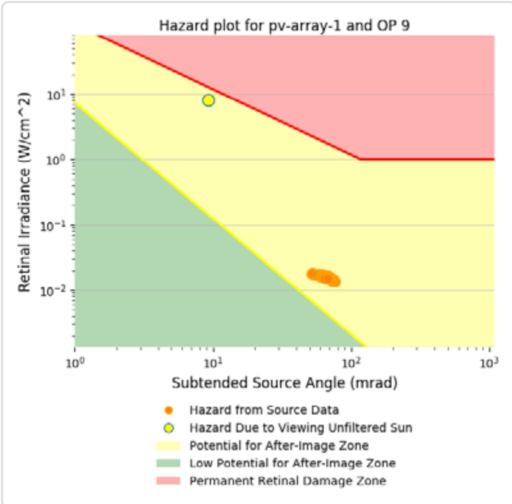
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 162 minutes of "yellow" glare with potential to cause temporary after-image.









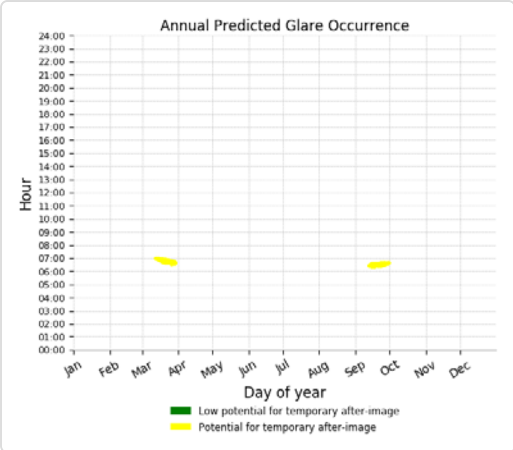
PV array 1 - OP Receptor (OP 10)

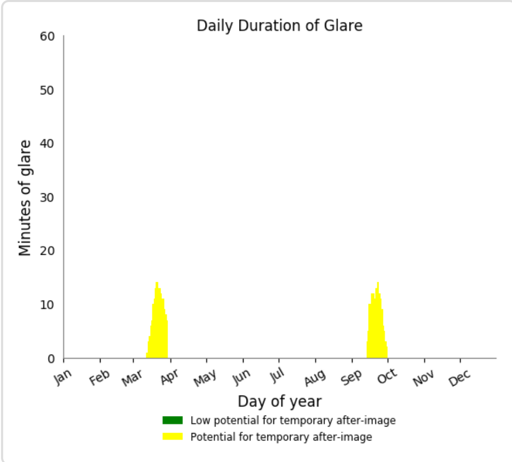
No glare found

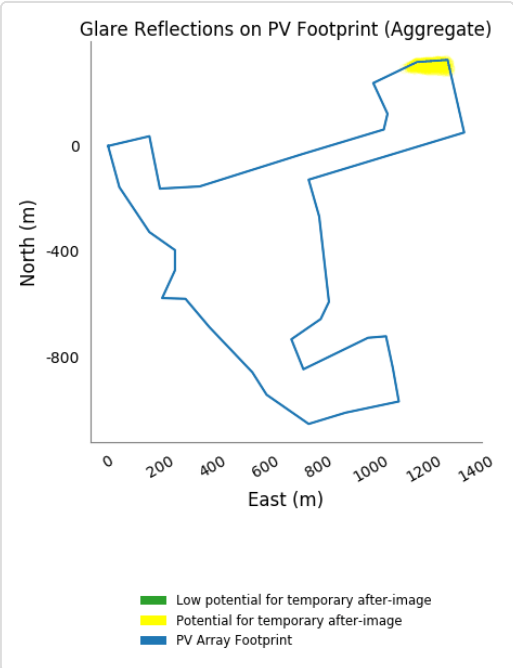
PV array 1 - OP Receptor (OP 11)

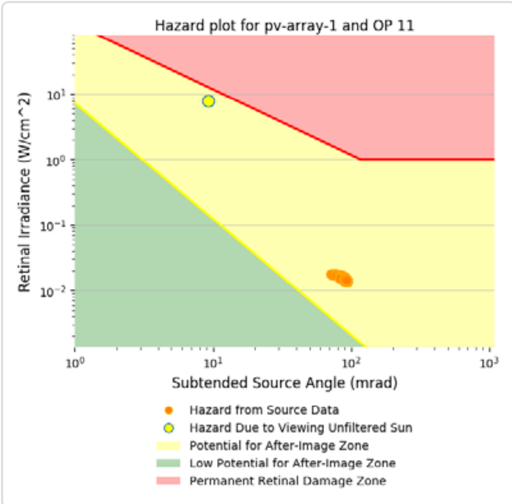
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 331 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 12)

No glare found

PV array 1 - OP Receptor (OP 13)

No glare found

PV array 1 - OP Receptor (OP 14)

No glare found

PV array 1 - OP Receptor (OP 15)

No glare found

PV array 1 - OP Receptor (OP 16)

No glare found

PV array 1 - OP Receptor (OP 17)

No glare found

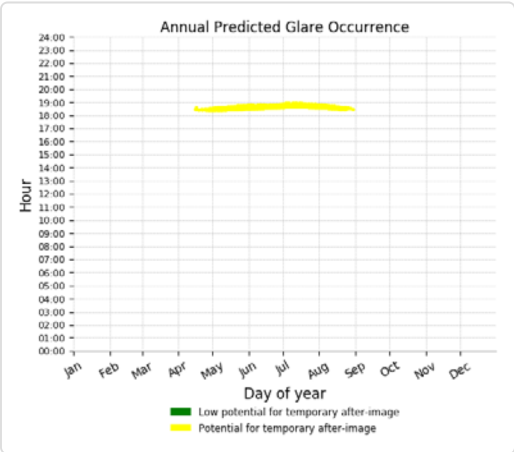
PV array 1 - OP Receptor (OP 18)

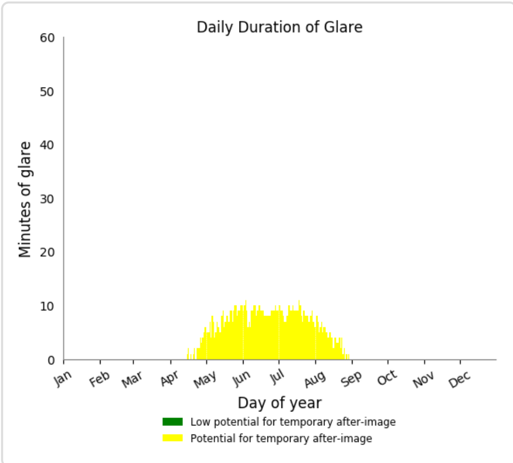
No glare found

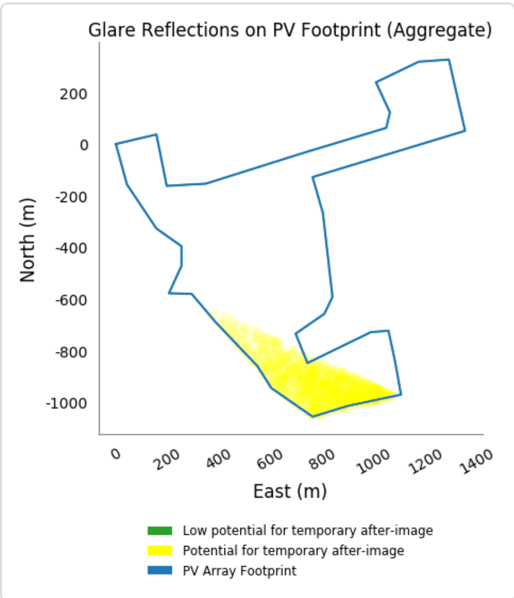
PV array 1 - OP Receptor (OP 19)

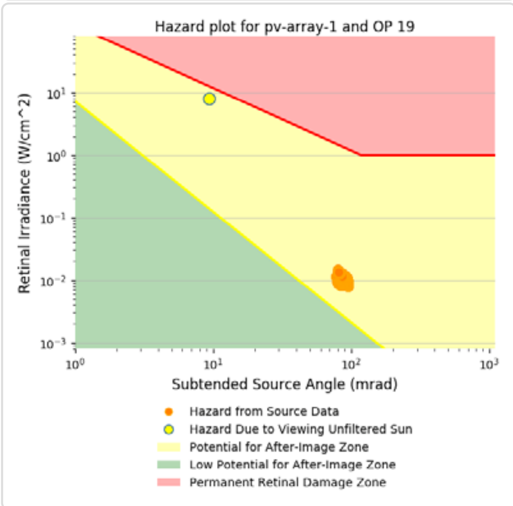
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 902 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 20)

No glare found

PV array 1 - OP Receptor (OP 21)

No glare found

PV array 1 - OP Receptor (OP 22)

No glare found

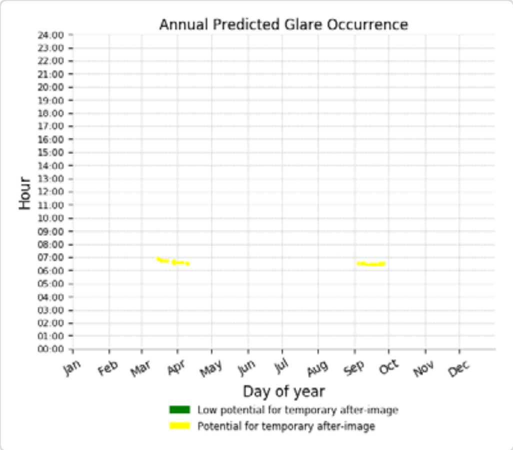
PV array 1 - OP Receptor (OP 23)

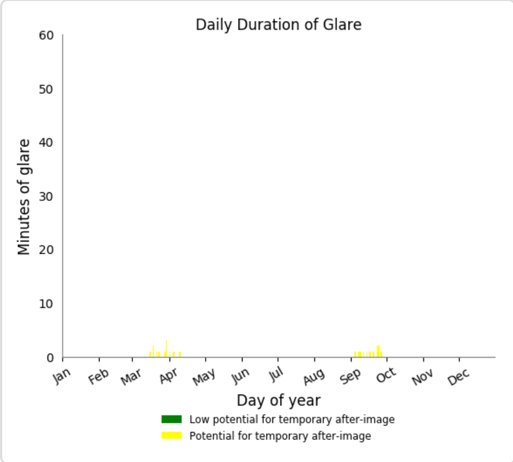
No glare found

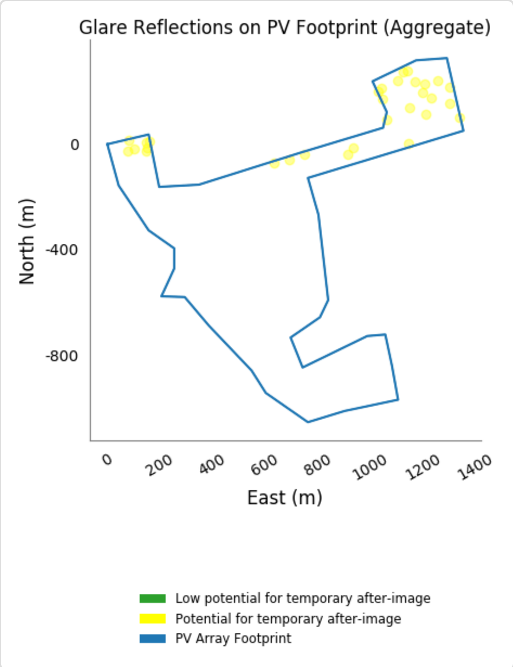
PV array 1 - OP Receptor (OP 24)

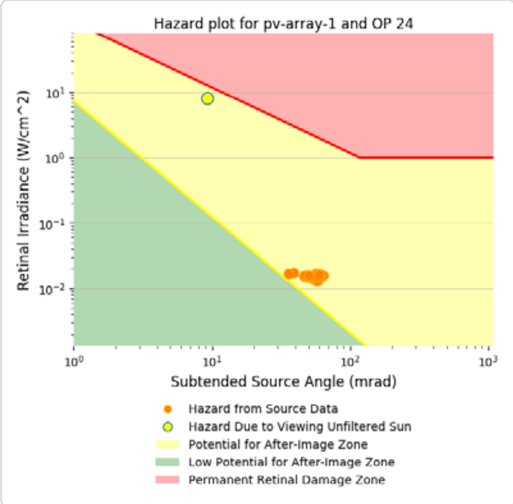
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 30 minutes of "yellow" glare with potential to cause temporary after-image.





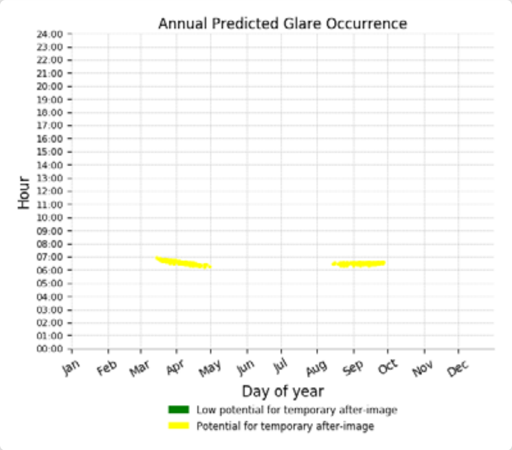


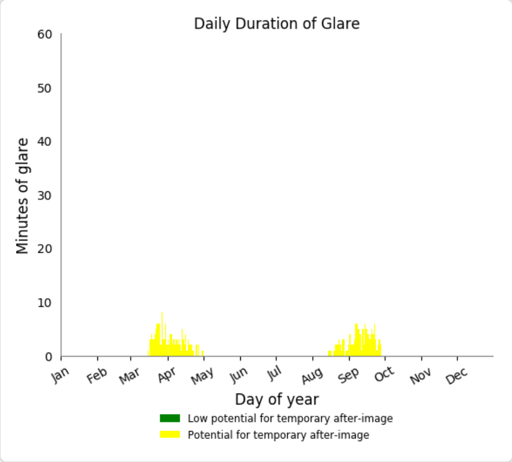


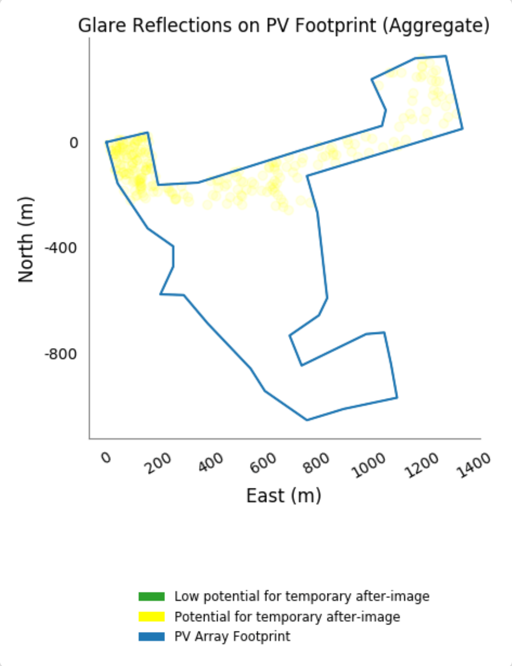
PV array 1 - OP Receptor (OP 25)

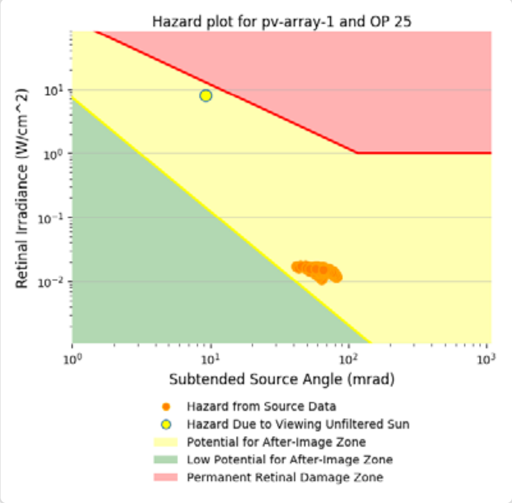
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 251 minutes of "yellow" glare with potential to cause temporary after-image.





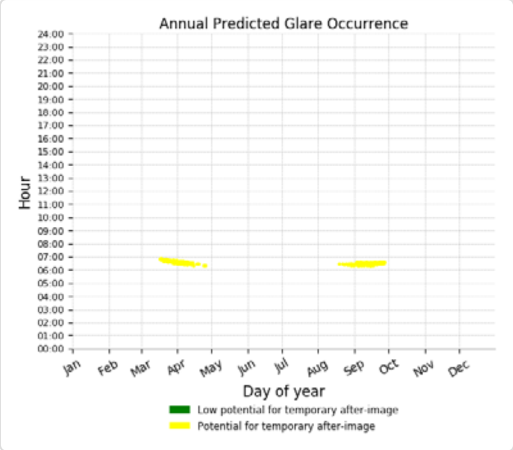


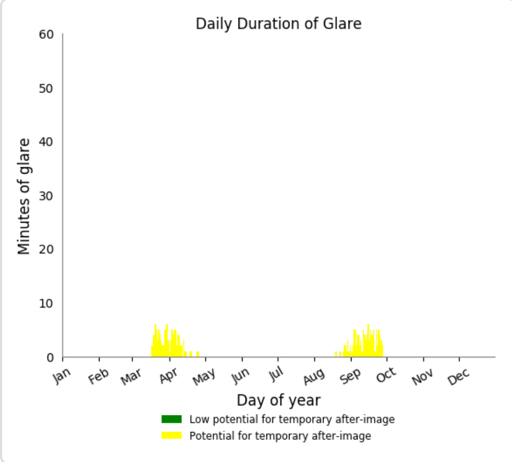


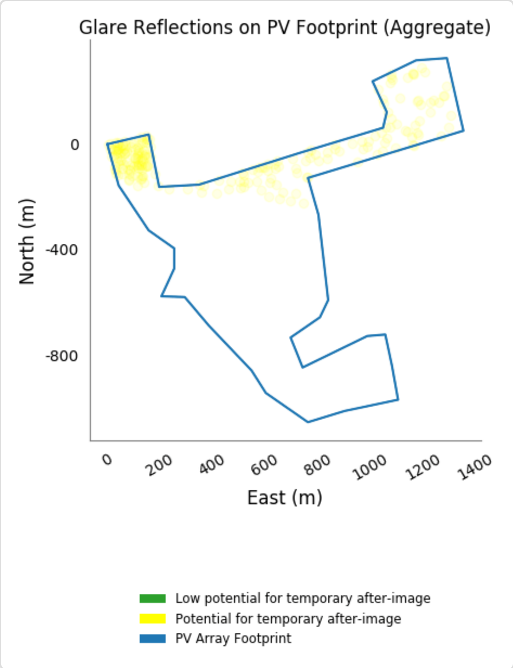
PV array 1 - OP Receptor (OP 26)

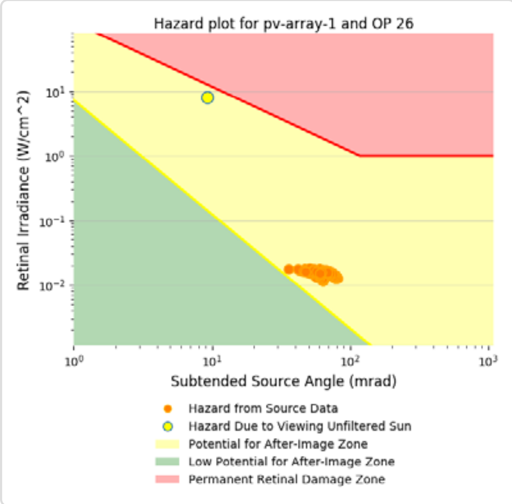
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 215 minutes of "yellow" glare with potential to cause temporary after-image.





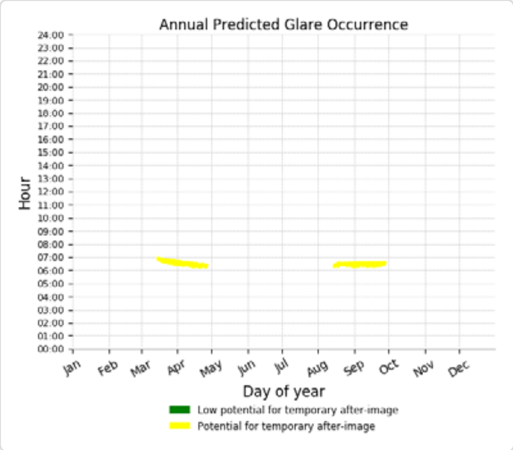


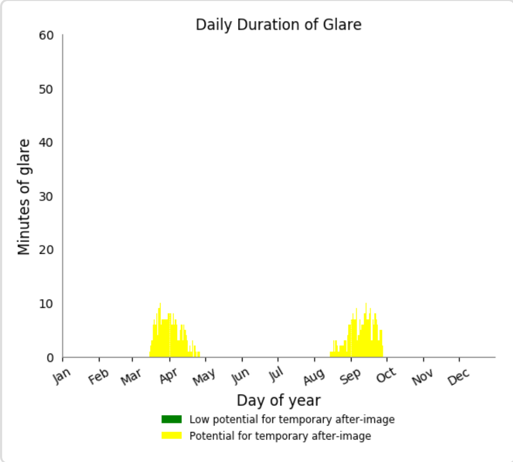


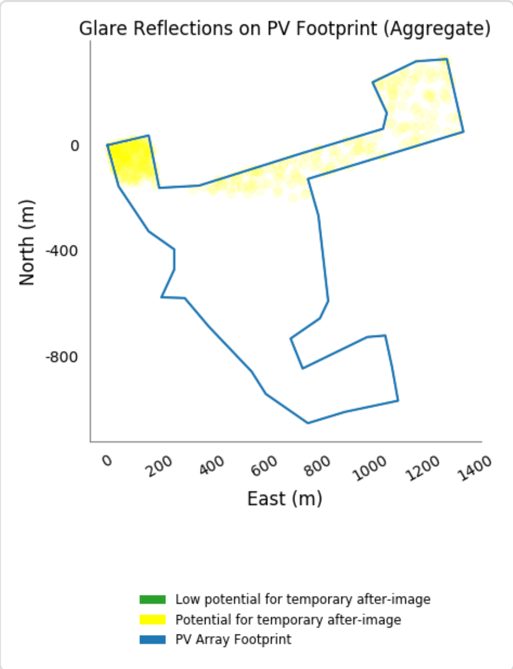
PV array 1 - OP Receptor (OP 27)

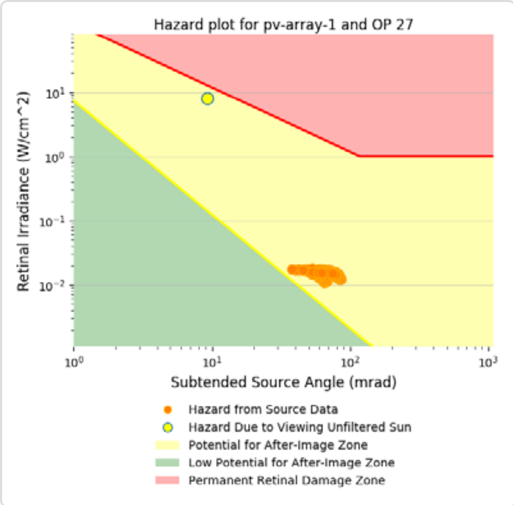
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 418 minutes of "yellow" glare with potential to cause temporary after-image.





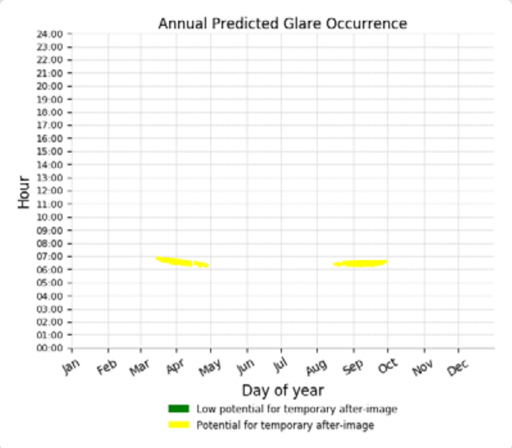


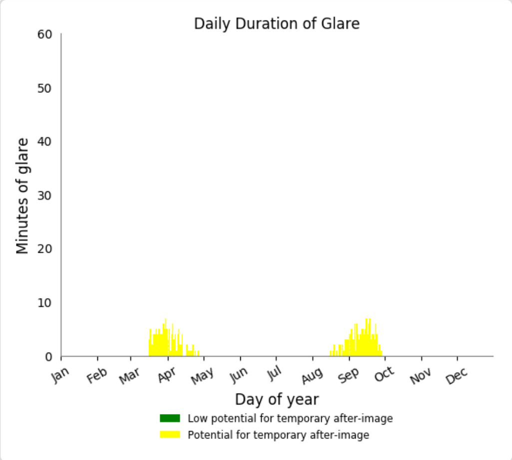


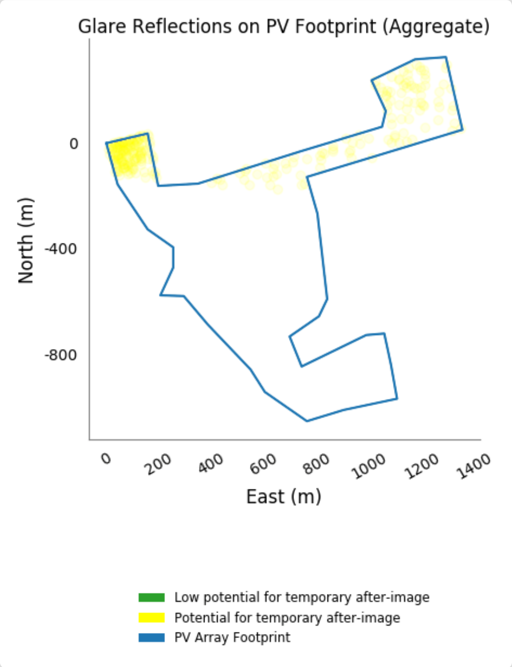
PV array 1 - OP Receptor (OP 28)

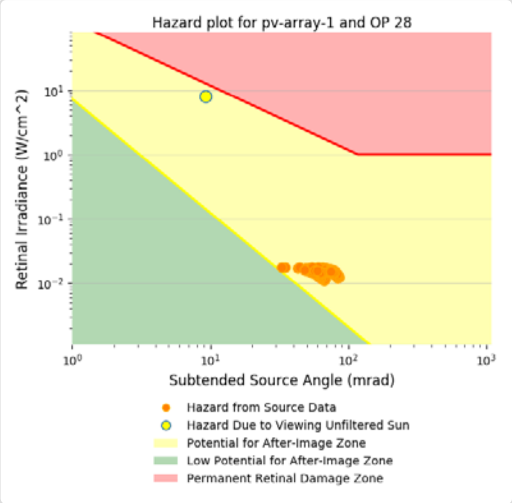
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 262 minutes of "yellow" glare with potential to cause temporary after-image.





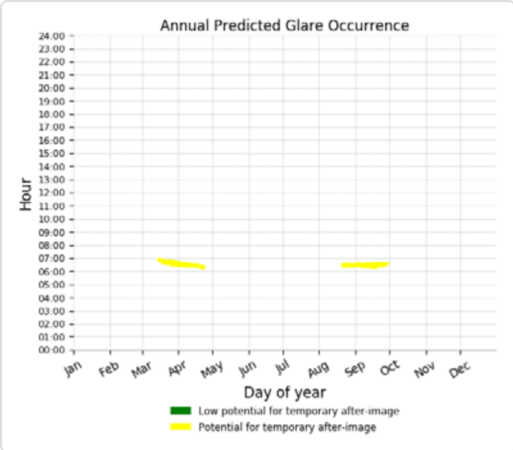


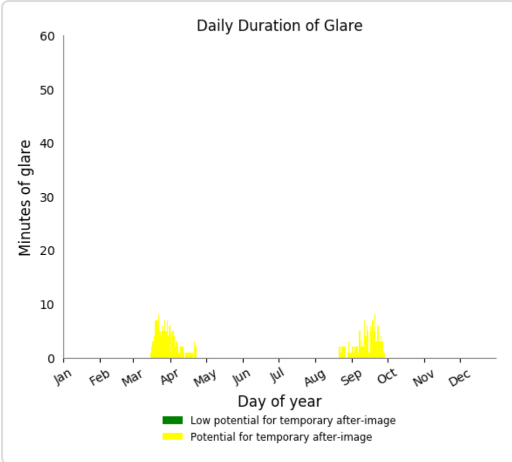


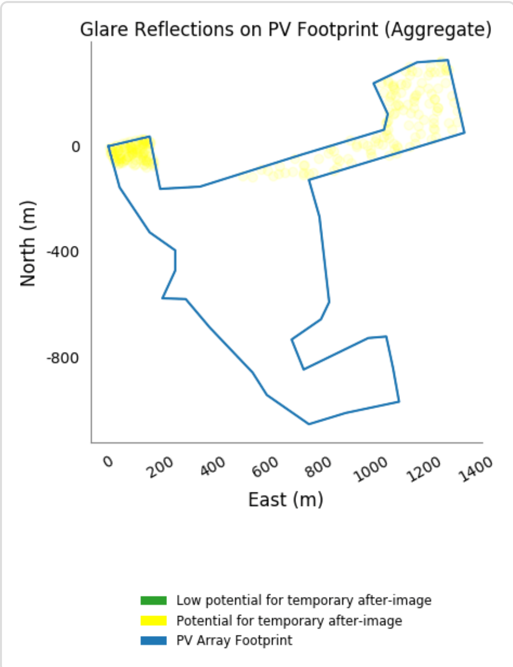
PV array 1 - OP Receptor (OP 29)

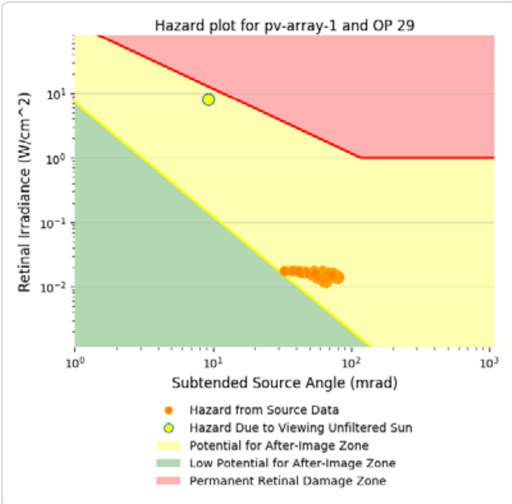
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 252 minutes of "yellow" glare with potential to cause temporary after-image.





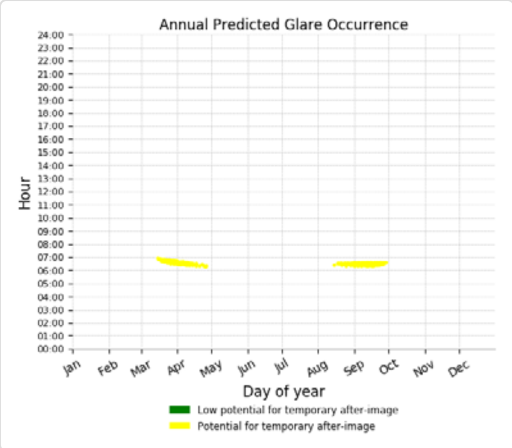


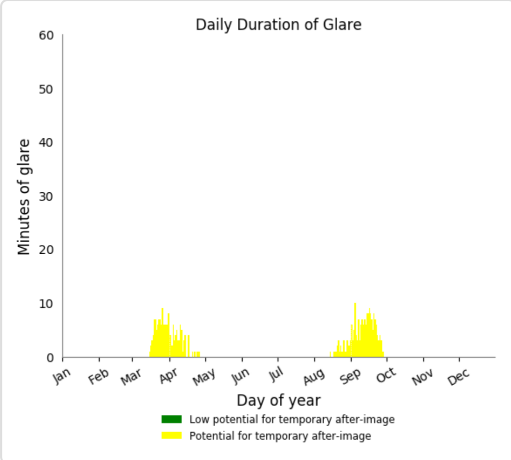


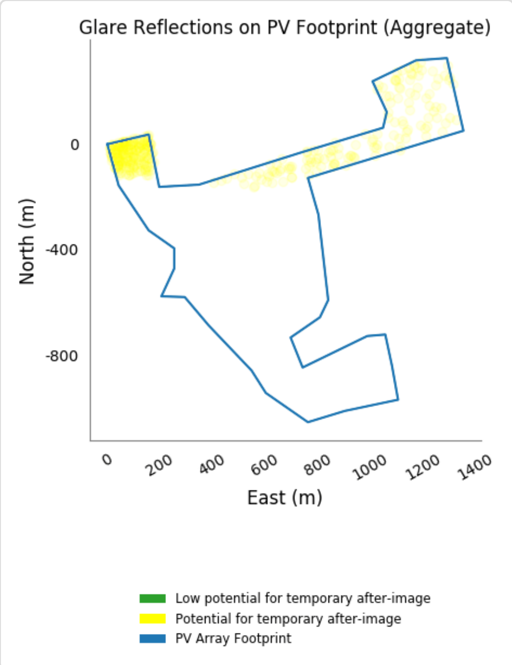
PV array 1 - OP Receptor (OP 30)

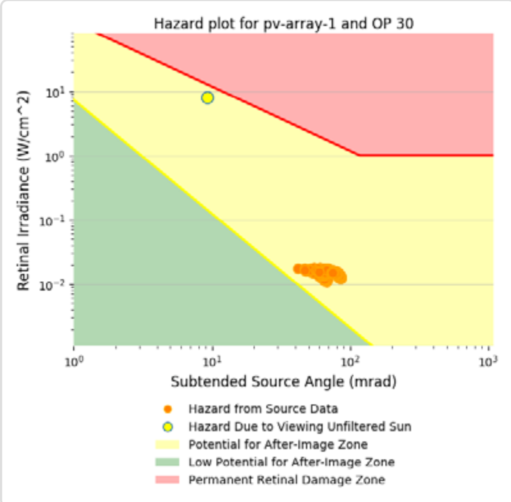
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 344 minutes of "yellow" glare with potential to cause temporary after-image.





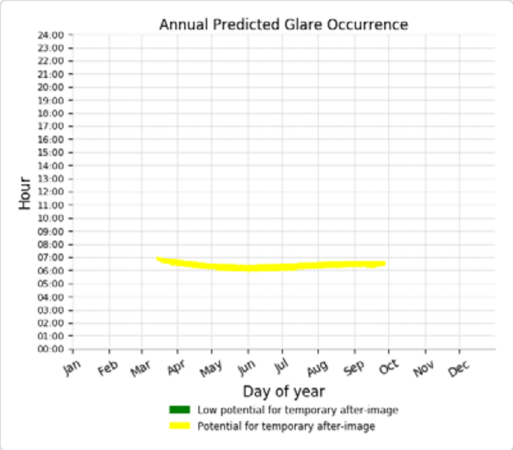


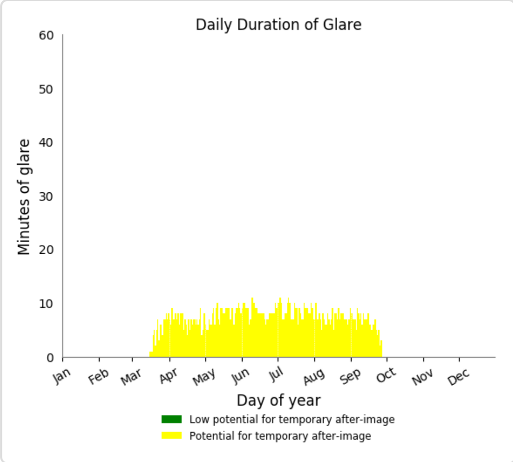


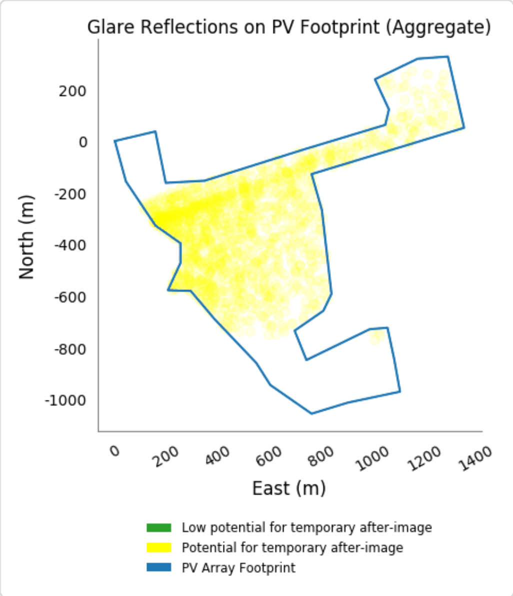
PV array 1 - OP Receptor (OP 31)

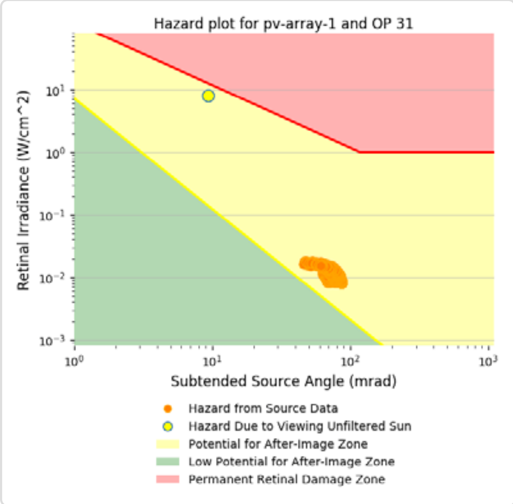
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,438 minutes of "yellow" glare with potential to cause temporary after-image.





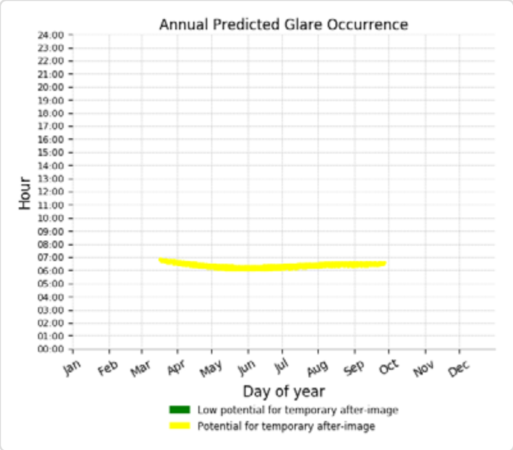


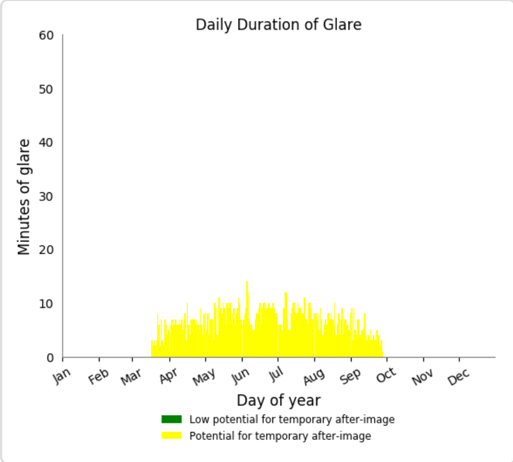


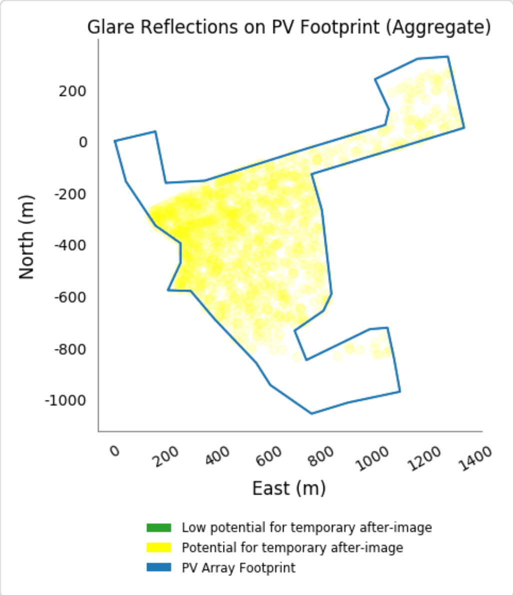
PV array 1 - OP Receptor (OP 32)

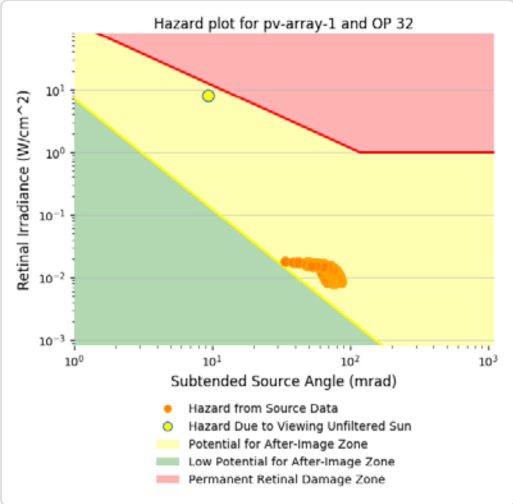
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,342 minutes of "yellow" glare with potential to cause temporary after-image.





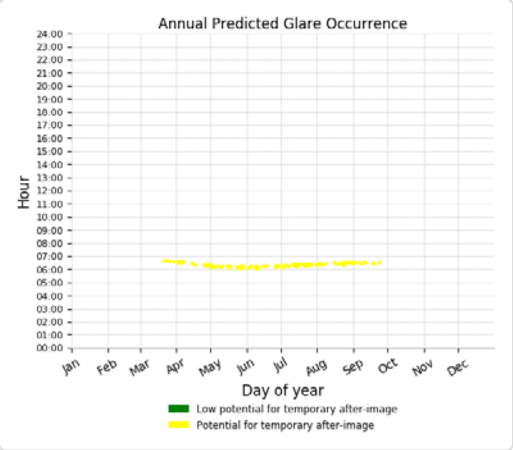


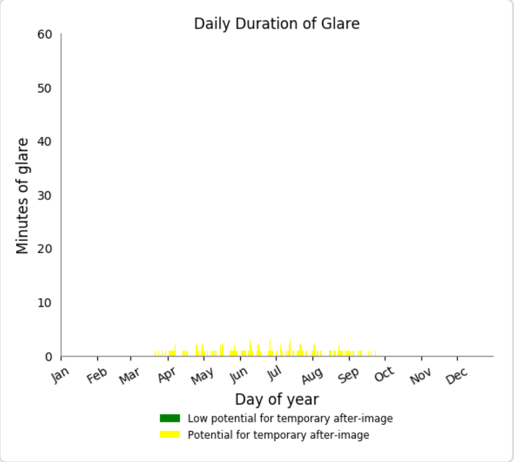


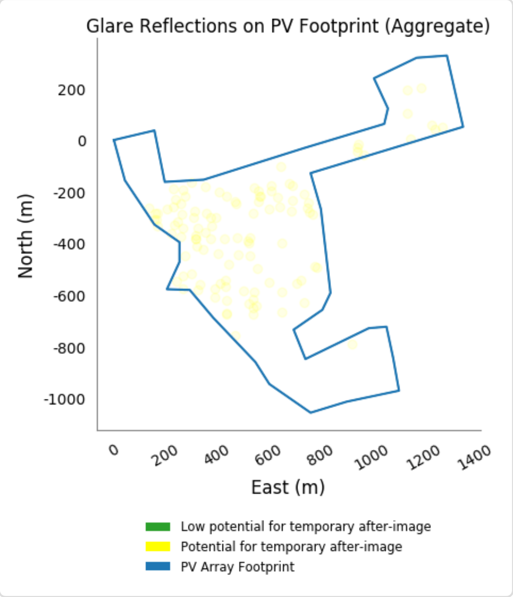
PV array 1 - OP Receptor (OP 33)

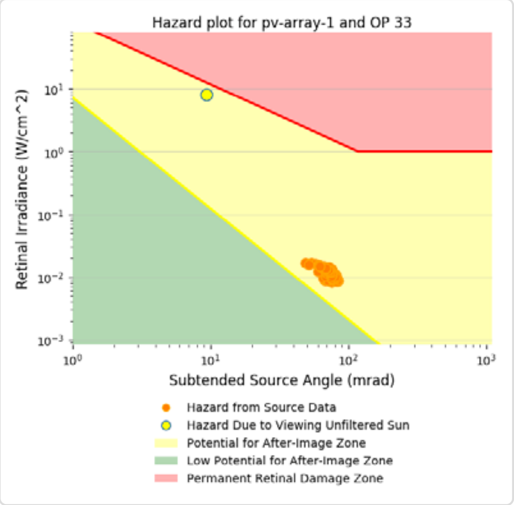
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 114 minutes of "yellow" glare with potential to cause temporary after-image.





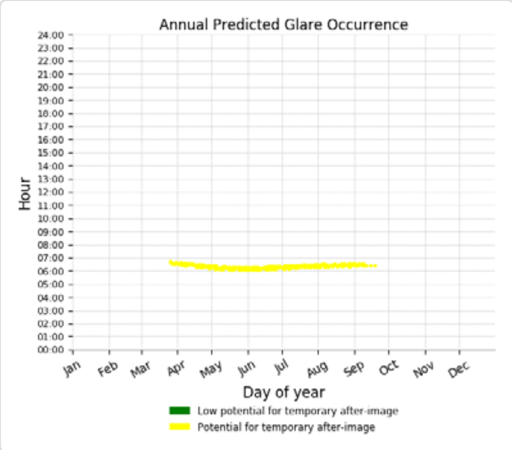


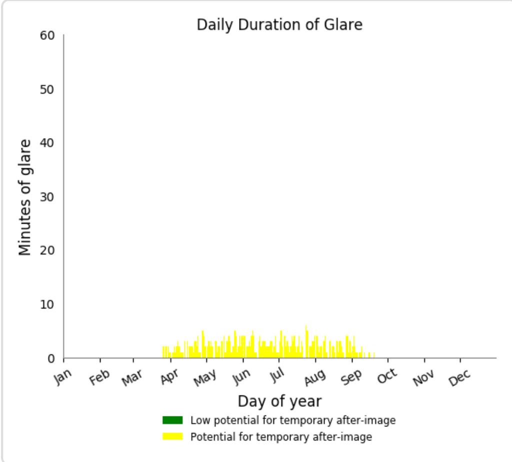


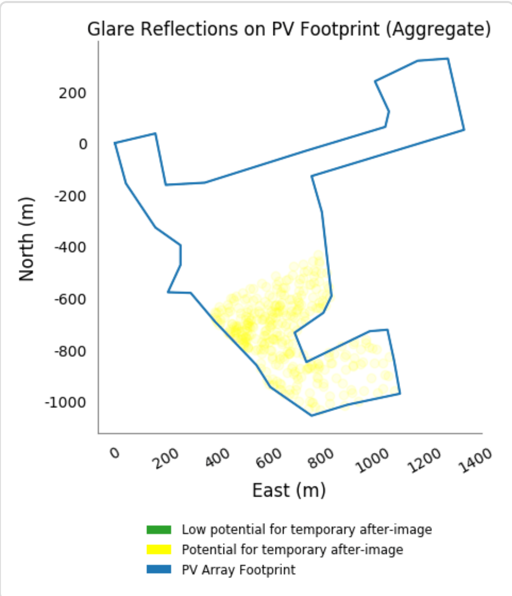
PV array 1 - OP Receptor (OP 34)

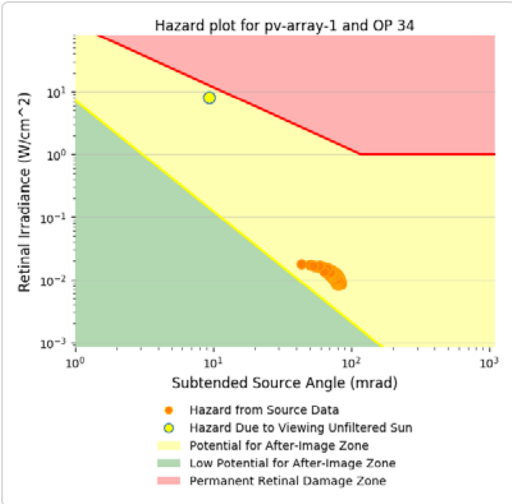
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 347 minutes of "yellow" glare with potential to cause temporary after-image.





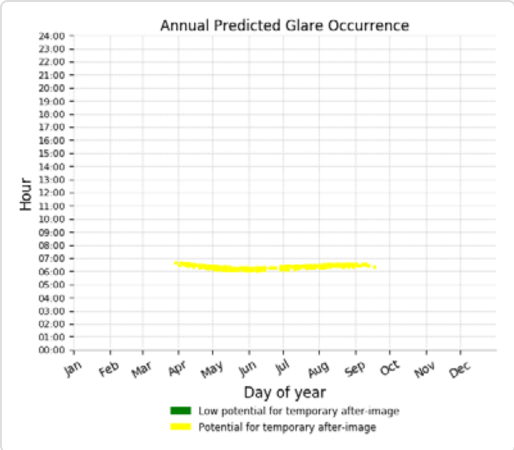


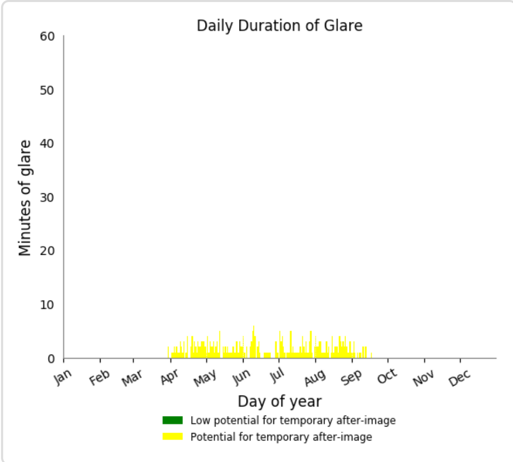


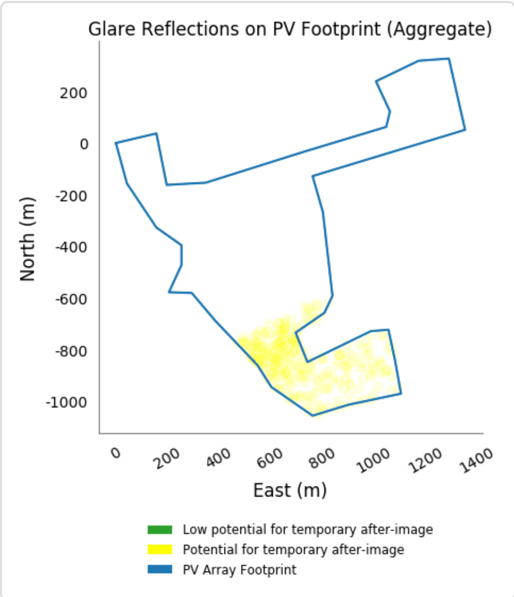
PV array 1 - OP Receptor (OP 35)

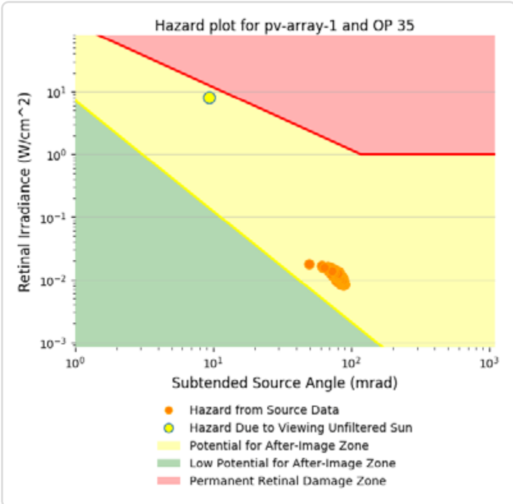
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 293 minutes of "yellow" glare with potential to cause temporary after-image.





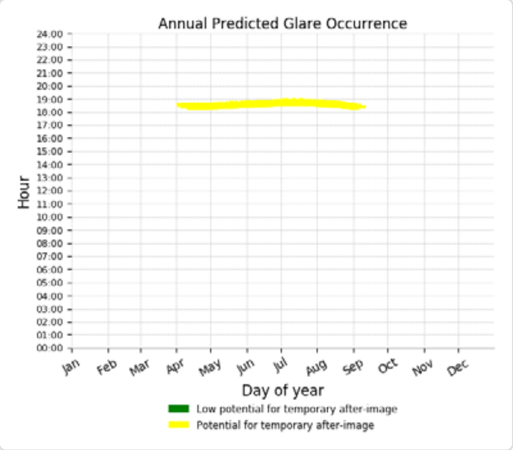


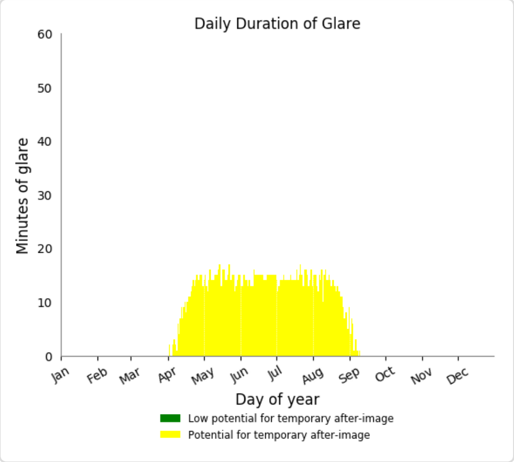


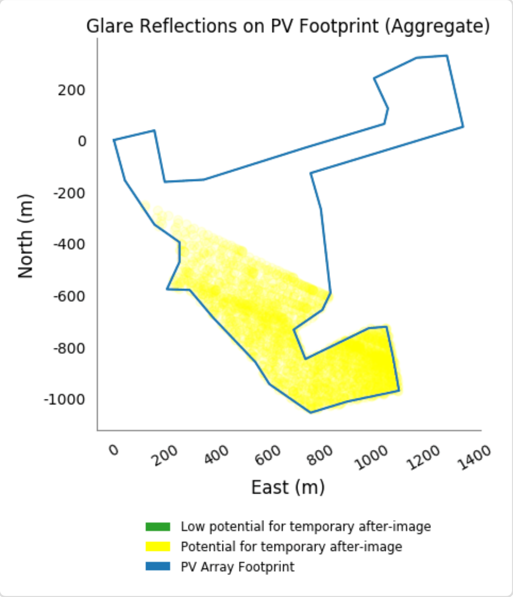
PV array 1 - OP Receptor (OP 36)

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,989 minutes of "yellow" glare with potential to cause temporary after-image.



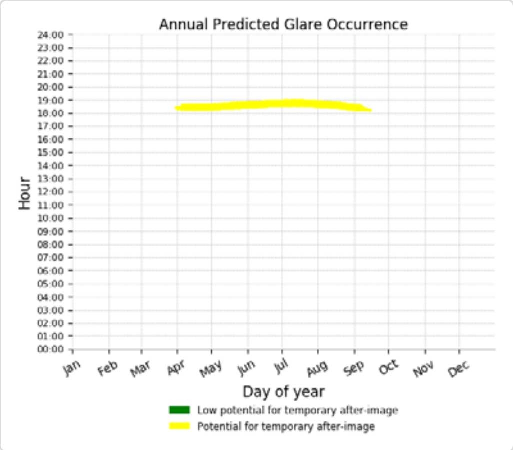


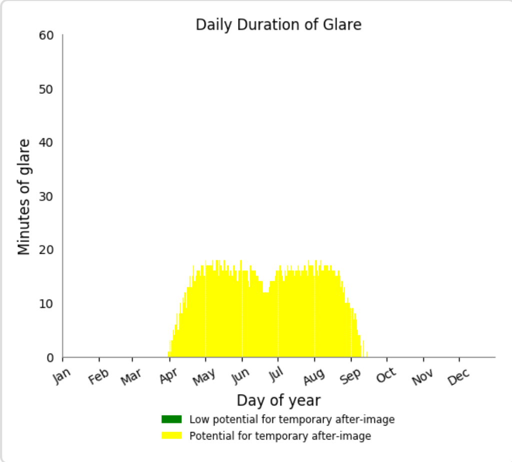


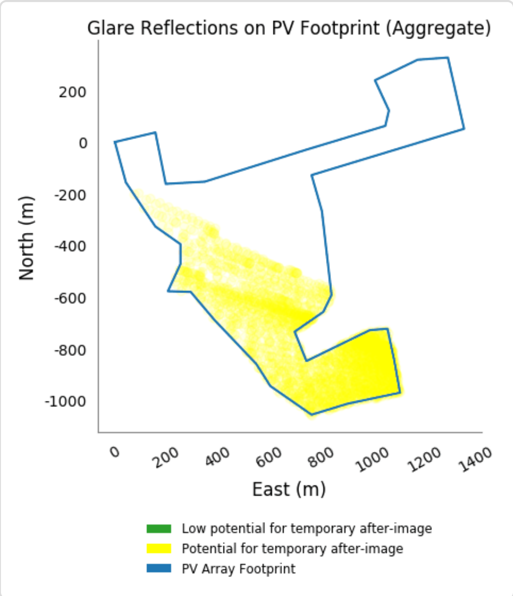
PV array 1 - OP Receptor (OP 37)

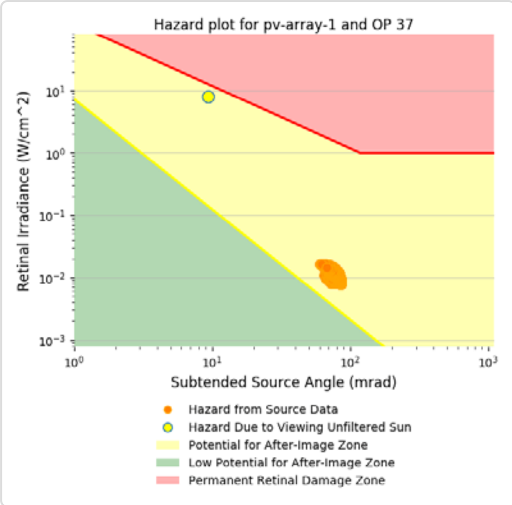
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,295 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 38)

No glare found

PV array 1 - OP Receptor (OP 39)

No glare found

PV array 1 - OP Receptor (OP 40)

No glare found

PV array 1 - OP Receptor (OP 41)

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Appendix 4.1C: Road Receptor Glare Results

Site Configuration: Harristown Solar Farm

Project site configuration details and results.

Created **Sept. 18, 2018 8:01 a.m.**
Updated **Sept. 18, 2018 8:13 a.m.**
DNI **varies** and peaks at **1,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC0**
Site Configuration ID: 21146.3609

Summary of Results Glare with potential for temporary after-image predicted

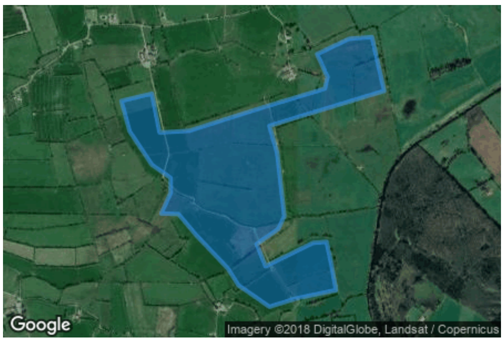
PV name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	20.0	180.0	0	871	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 20.0 deg
Orientation: 180.0 deg
Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.398179	-7.096804	70.86	0.80	71.66
2	53.398511	-7.094444	70.00	0.80	70.80
3	53.396720	-7.093843	68.61	0.80	69.41
4	53.396797	-7.091568	68.68	0.80	69.48
5	53.397897	-7.085732	68.66	0.80	69.46
6	53.398742	-7.081054	70.10	0.80	70.90
7	53.399279	-7.080840	71.34	0.80	72.14
8	53.400328	-7.081655	72.87	0.80	73.67
9	53.401044	-7.079166	71.69	0.80	72.49
10	53.401121	-7.077406	71.03	0.80	71.83
11	53.398639	-7.076462	68.91	0.80	69.71
12	53.397027	-7.085346	67.06	0.80	67.86
13	53.395773	-7.084745	67.00	0.80	67.80
14	53.392856	-7.084187	65.00	0.80	65.80
15	53.392267	-7.084659	65.00	0.80	65.80
16	53.391576	-7.086333	66.09	0.80	66.89
17	53.390553	-7.085646	68.38	0.80	69.18
18	53.391628	-7.081955	68.64	0.80	69.44
19	53.391679	-7.080925	68.08	0.80	68.88
20	53.390604	-7.080539	69.48	0.80	70.28
21	53.389452	-7.080196	69.27	0.80	70.07
22	53.389068	-7.083243	70.47	0.80	71.27
23	53.388684	-7.085346	70.71	0.80	71.51
24	53.389682	-7.087749	68.64	0.80	69.44
25	53.390450	-7.088564	67.99	0.80	68.79
26	53.391986	-7.091011	68.28	0.80	69.08
27	53.392958	-7.092384	67.00	0.80	67.80
28	53.392984	-7.093714	67.00	0.80	67.80
29	53.393931	-7.092985	68.04	0.80	68.84
30	53.394622	-7.092985	67.85	0.80	68.65
31	53.395236	-7.094444	66.45	0.80	67.25
32	53.396771	-7.096160	67.68	0.80	68.48



Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	53.397228	-7.108507	72.66	1.50	74.16
OP 2	53.396576	-7.111597	70.02	1.50	71.52
OP 3	53.398072	-7.106276	74.15	1.50	75.65
OP 4	53.399109	-7.103722	75.09	1.50	76.59
OP 5	53.400068	-7.101834	76.98	1.50	78.48
OP 6	53.401335	-7.099280	78.37	1.50	79.87
OP 7	53.401706	-7.096748	79.68	1.50	81.18
OP 8	53.401604	-7.094002	77.71	1.50	79.21
OP 9	53.401859	-7.091084	75.32	1.50	76.82
OP 10	53.402128	-7.088079	72.11	1.50	73.61
OP 11	53.402601	-7.085354	75.17	1.50	76.67
OP 12	53.403113	-7.082543	76.42	1.50	77.92
OP 13	53.403778	-7.079840	76.89	1.50	78.39
OP 14	53.404533	-7.077351	74.28	1.50	75.78
OP 15	53.405761	-7.075419	73.22	1.50	74.72
OP 16	53.407283	-7.074754	73.01	1.50	74.51
OP 17	53.408153	-7.072265	70.81	1.50	72.31
OP 18	53.408729	-7.070141	70.10	1.50	71.60
OP 19	53.398354	-7.111060	70.77	1.50	72.27

PV Array Results

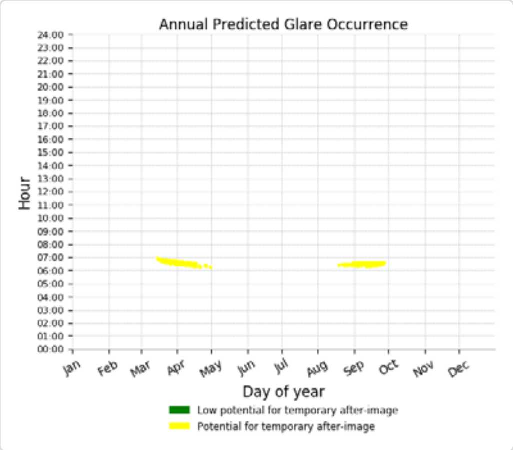
PV array 1 potential temporary after-image

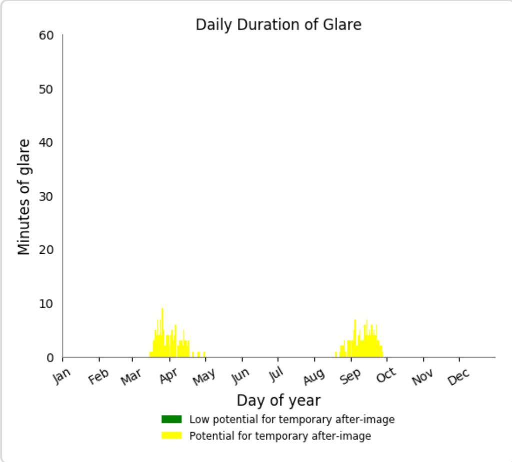
Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	253
OP: OP 2	0	0
OP: OP 3	0	248
OP: OP 4	0	158
OP: OP 5	0	100
OP: OP 6	0	51
OP: OP 7	0	16
OP: OP 8	0	25
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	20

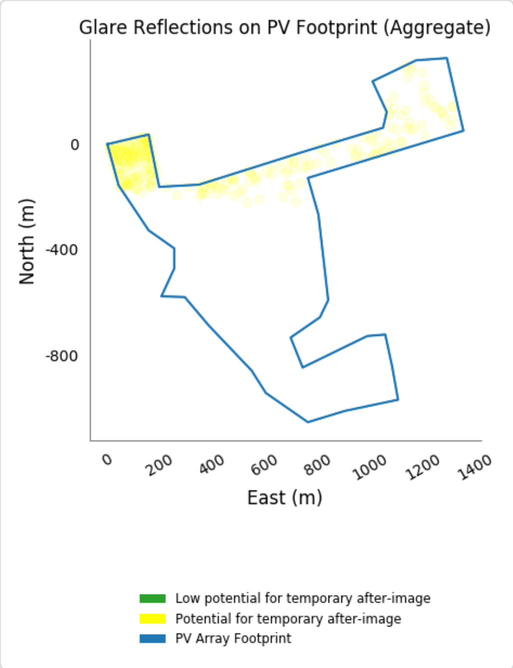
PV array 1 - OP Receptor (OP 1)

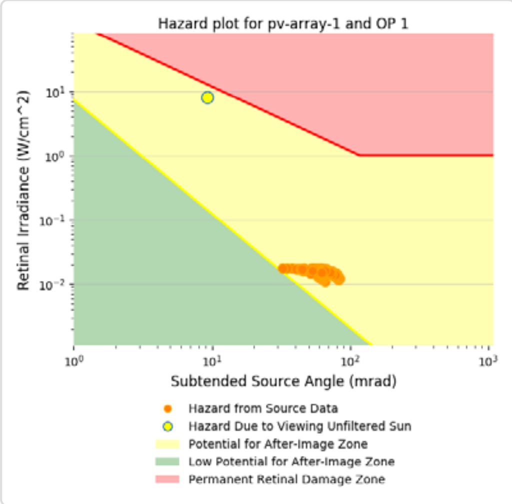
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 253 minutes of "yellow" glare with potential to cause temporary after-image.









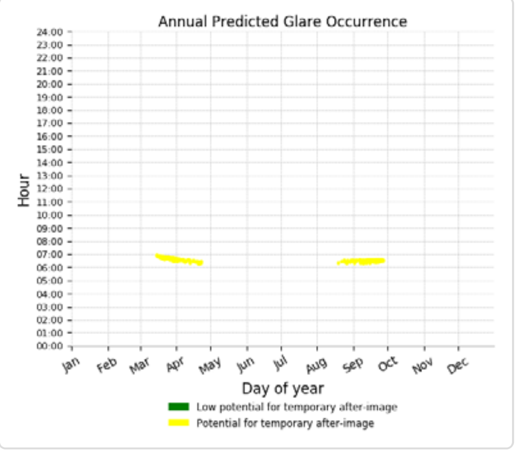
PV array 1 - OP Receptor (OP 2)

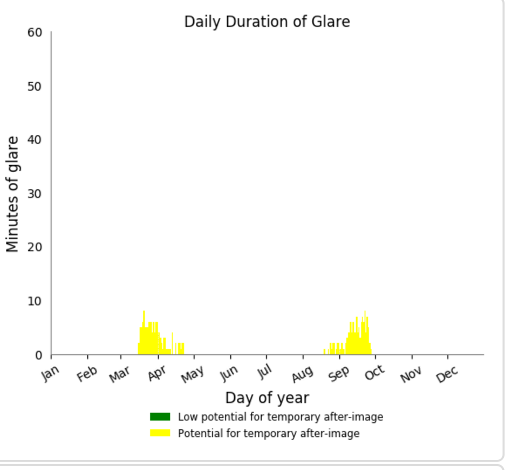
No glare found

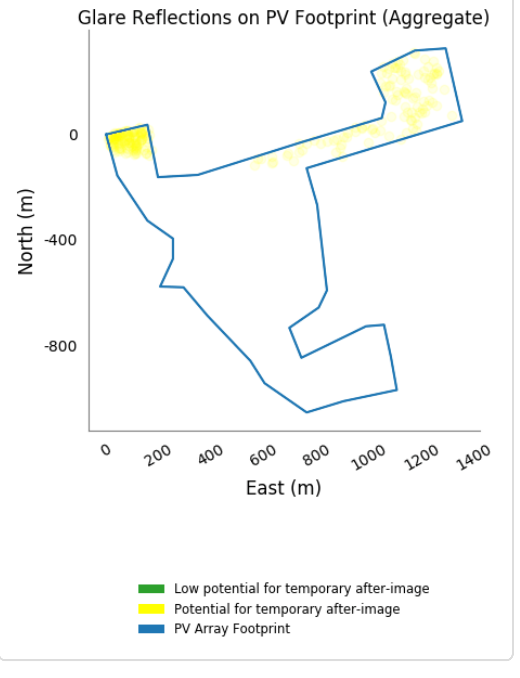
PV array 1 - OP Receptor (OP 3)

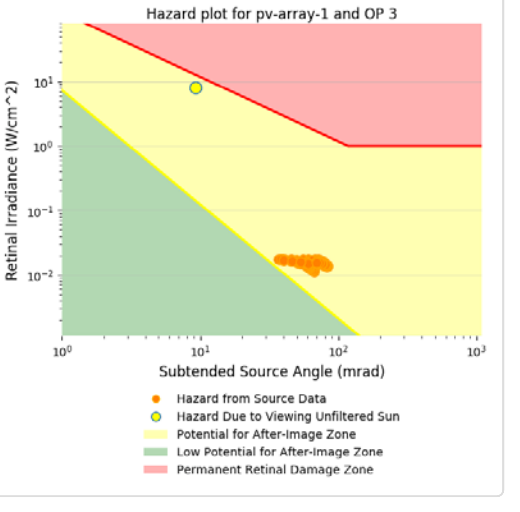
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 248 minutes of "yellow" glare with potential to cause temporary after-image.





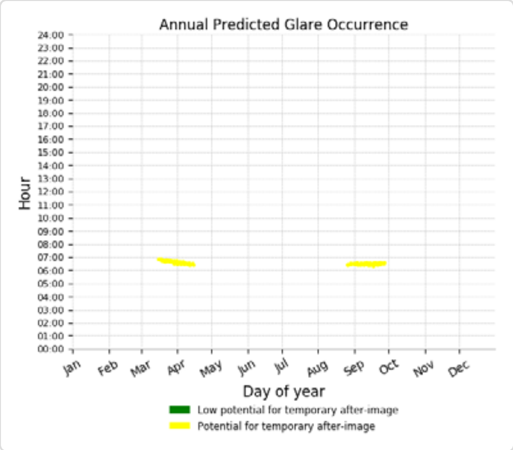


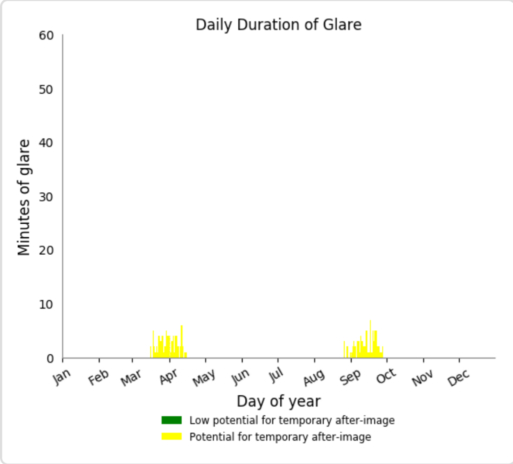


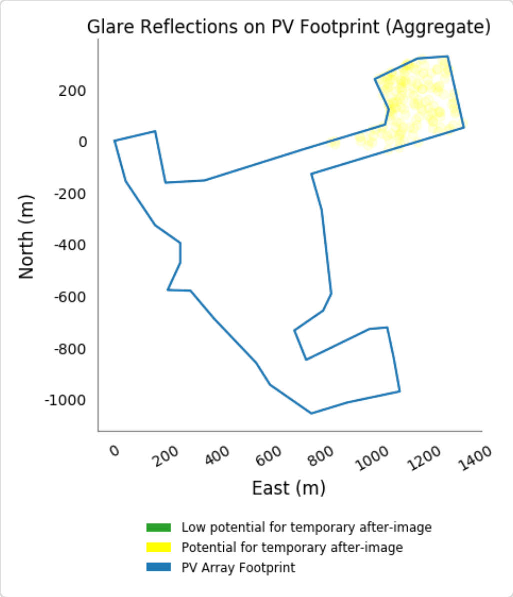
PV array 1 - OP Receptor (OP 4)

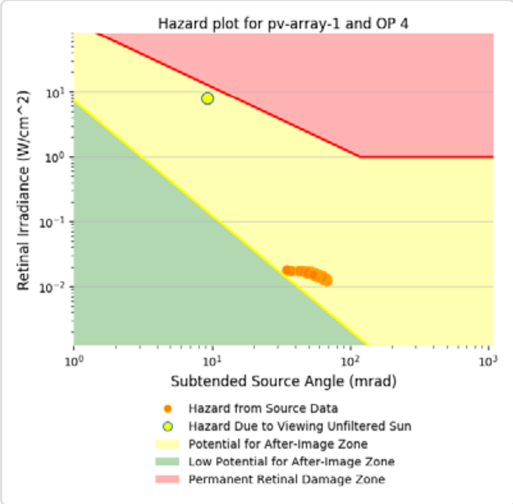
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 158 minutes of "yellow" glare with potential to cause temporary after-image.





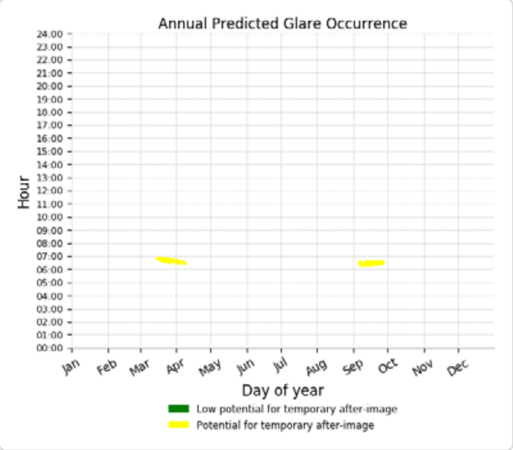


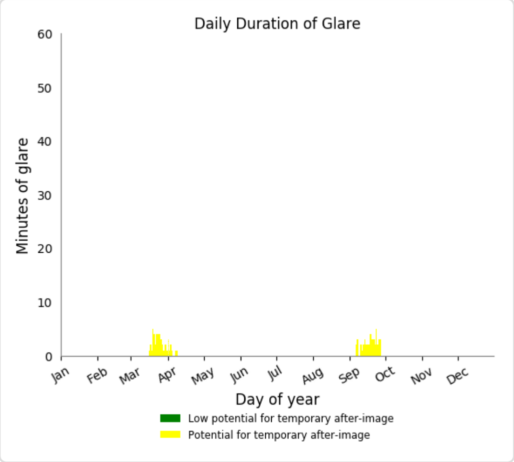


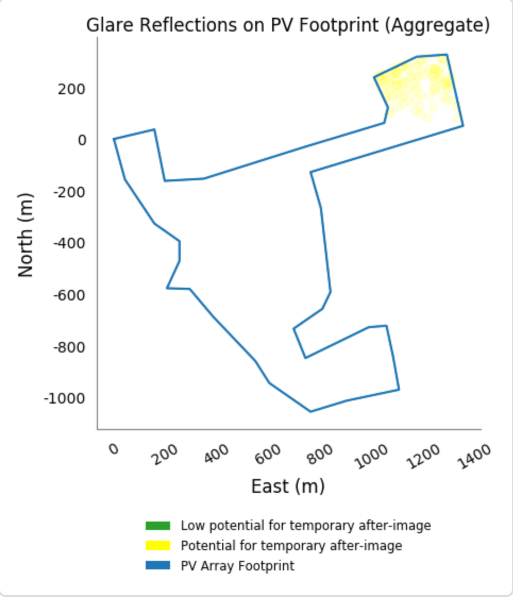
PV array 1 - OP Receptor (OP 5)

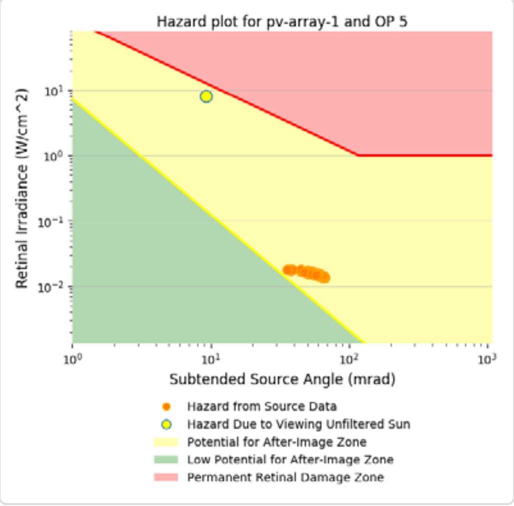
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 100 minutes of "yellow" glare with potential to cause temporary after-image.





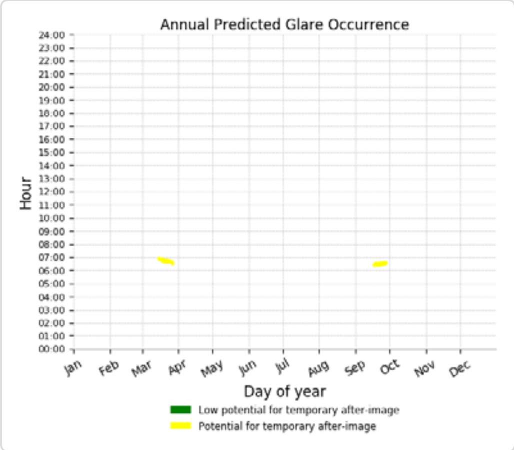


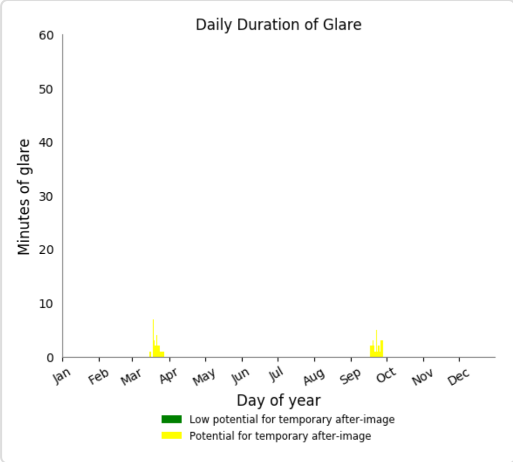


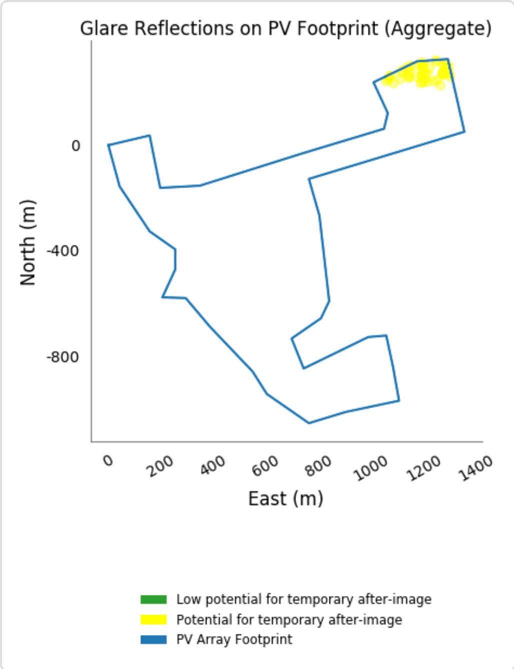
PV array 1 - OP Receptor (OP 6)

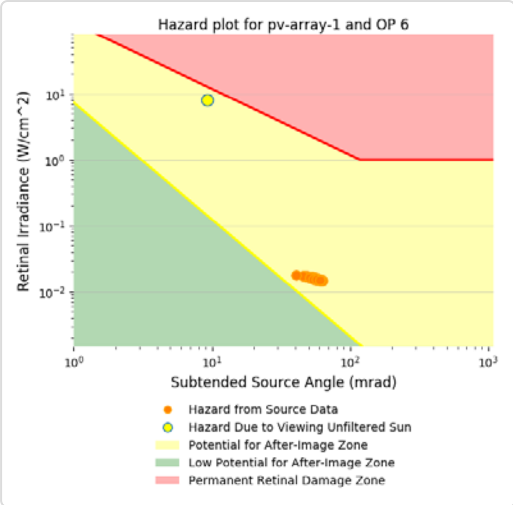
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 51 minutes of "yellow" glare with potential to cause temporary after-image.





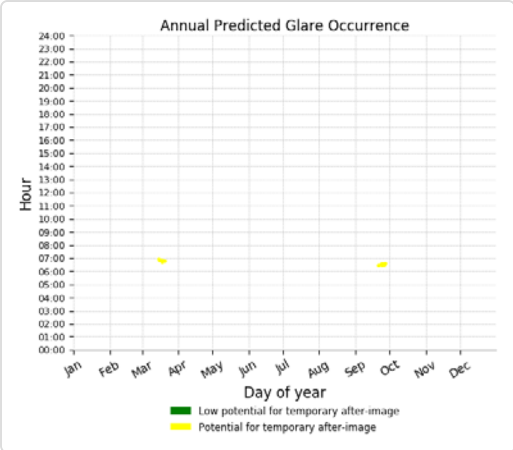


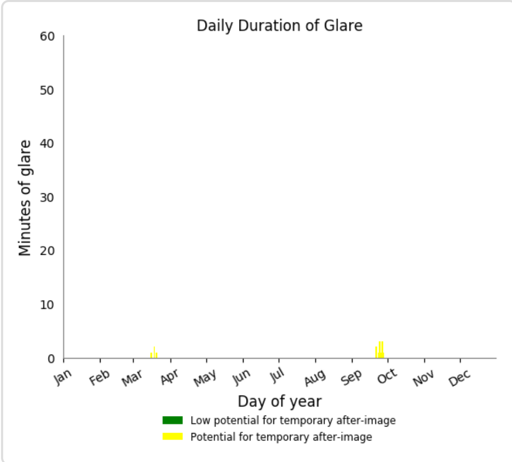


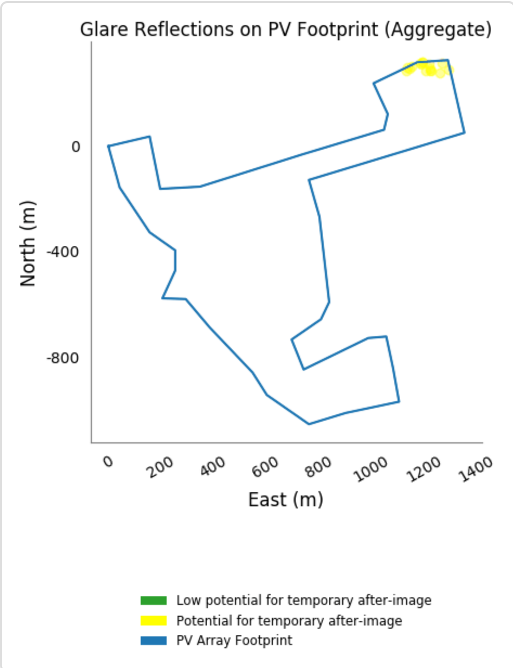
PV array 1 - OP Receptor (OP 7)

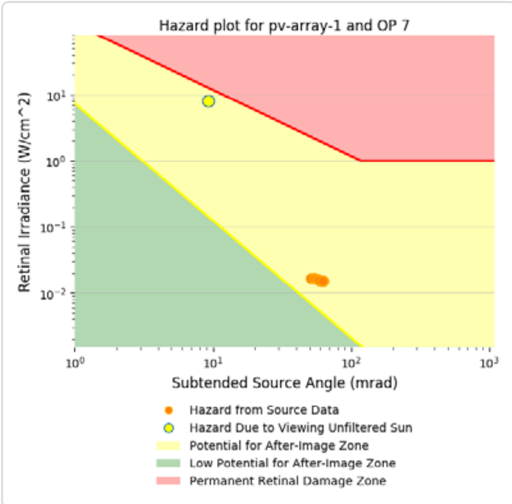
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 16 minutes of "yellow" glare with potential to cause temporary after-image.





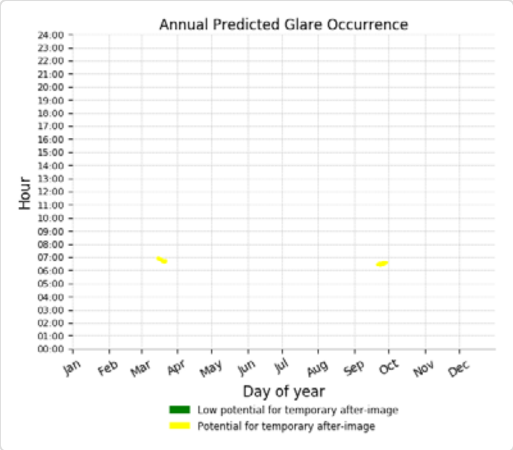


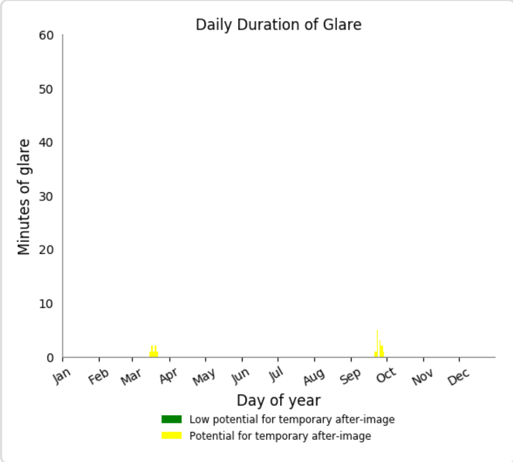


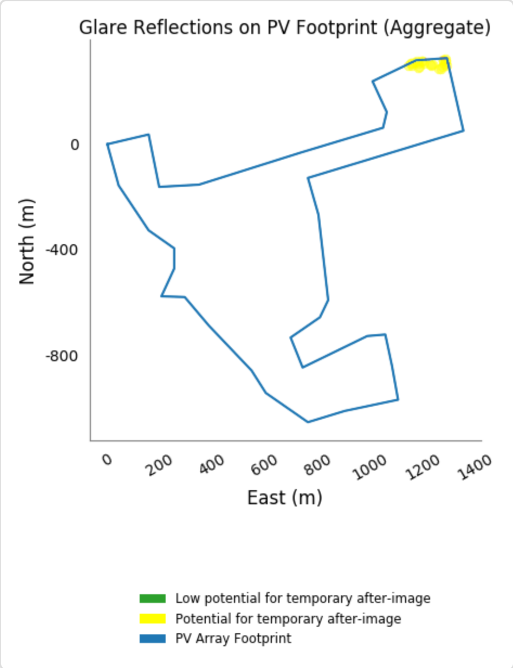
PV array 1 - OP Receptor (OP 8)

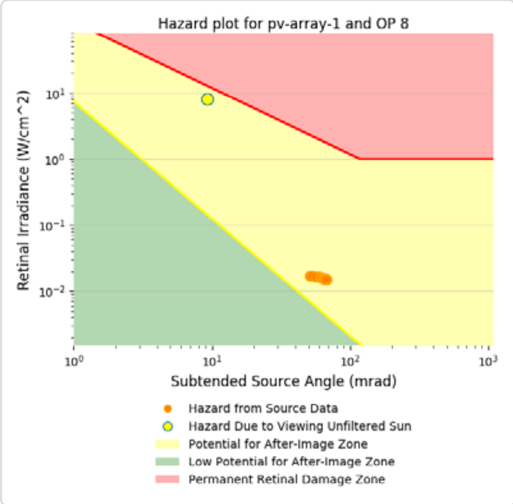
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 25 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 9)

No glare found

PV array 1 - OP Receptor (OP 10)

No glare found

PV array 1 - OP Receptor (OP 11)

No glare found

PV array 1 - OP Receptor (OP 12)

No glare found

PV array 1 - OP Receptor (OP 13)

No glare found

PV array 1 - OP Receptor (OP 14)

No glare found

PV array 1 - OP Receptor (OP 15)

No glare found

PV array 1 - OP Receptor (OP 16)

No glare found

PV array 1 - OP Receptor (OP 17)

No glare found

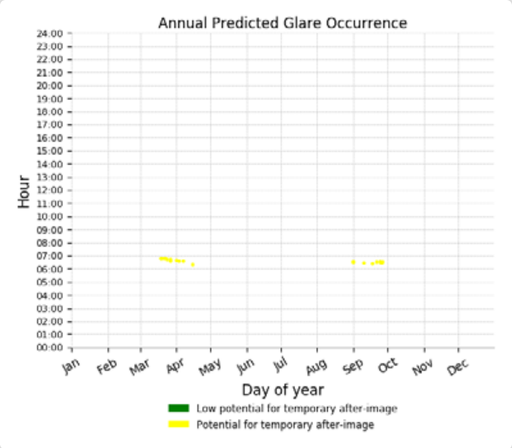
PV array 1 - OP Receptor (OP 18)

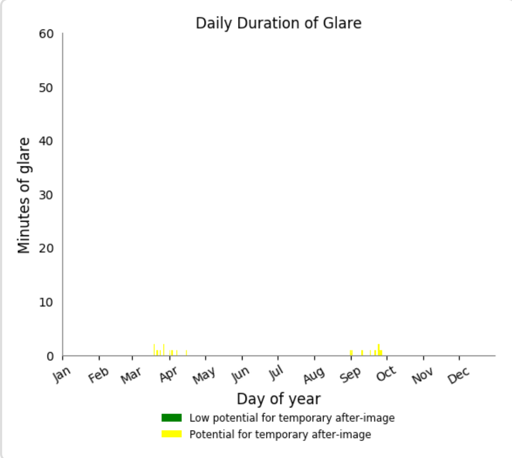
No glare found

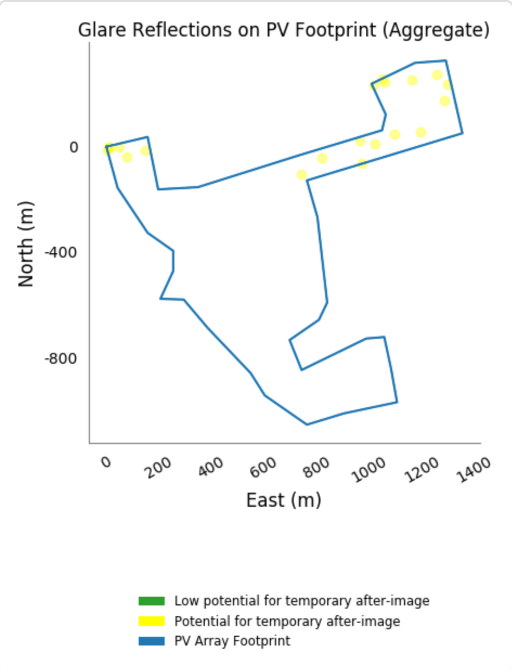
PV array 1 - OP Receptor (OP 19)

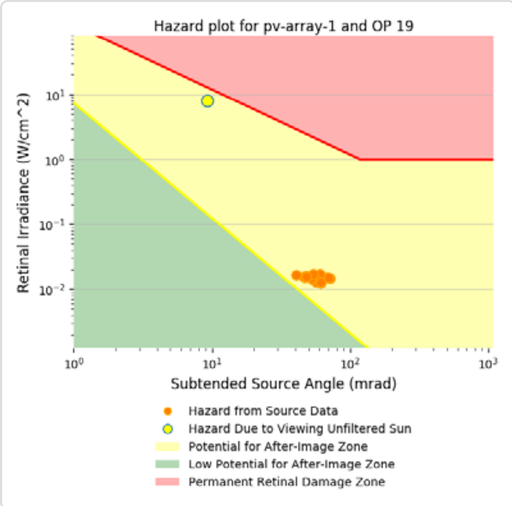
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 20 minutes of "yellow" glare with potential to cause temporary after-image.









Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Appendix 4.1D: Photo Register

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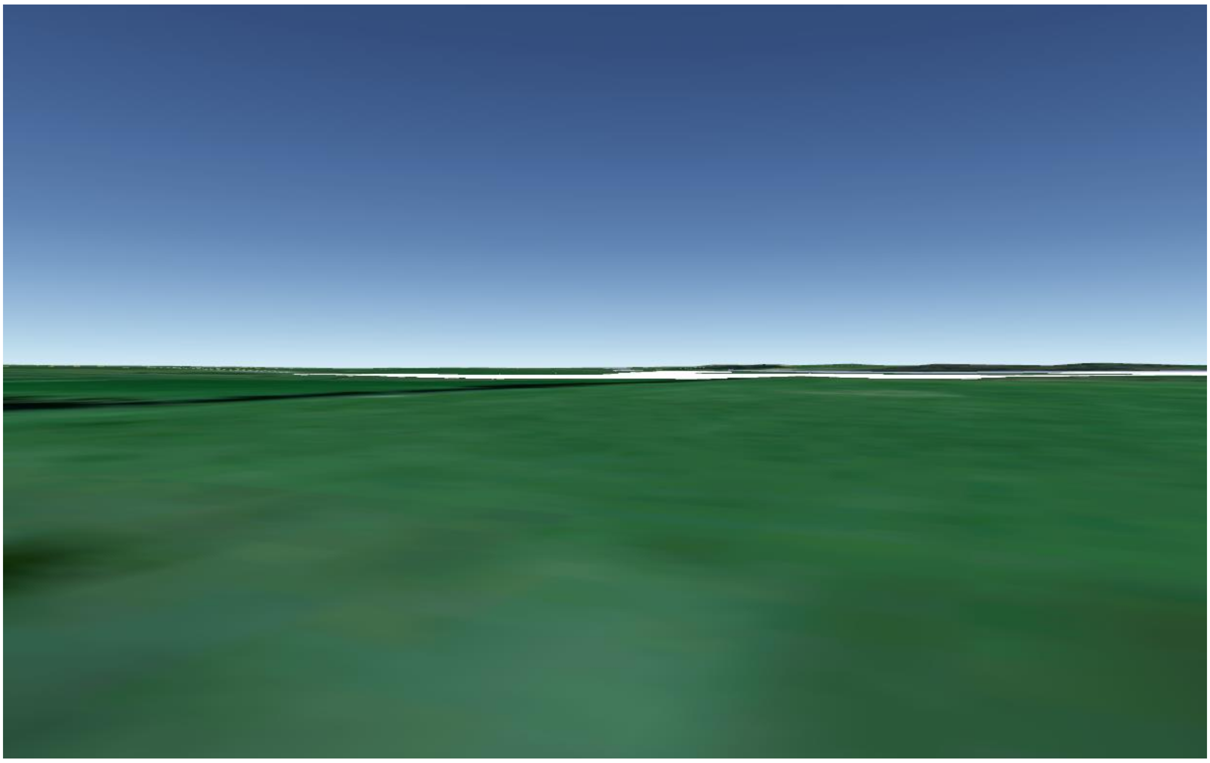
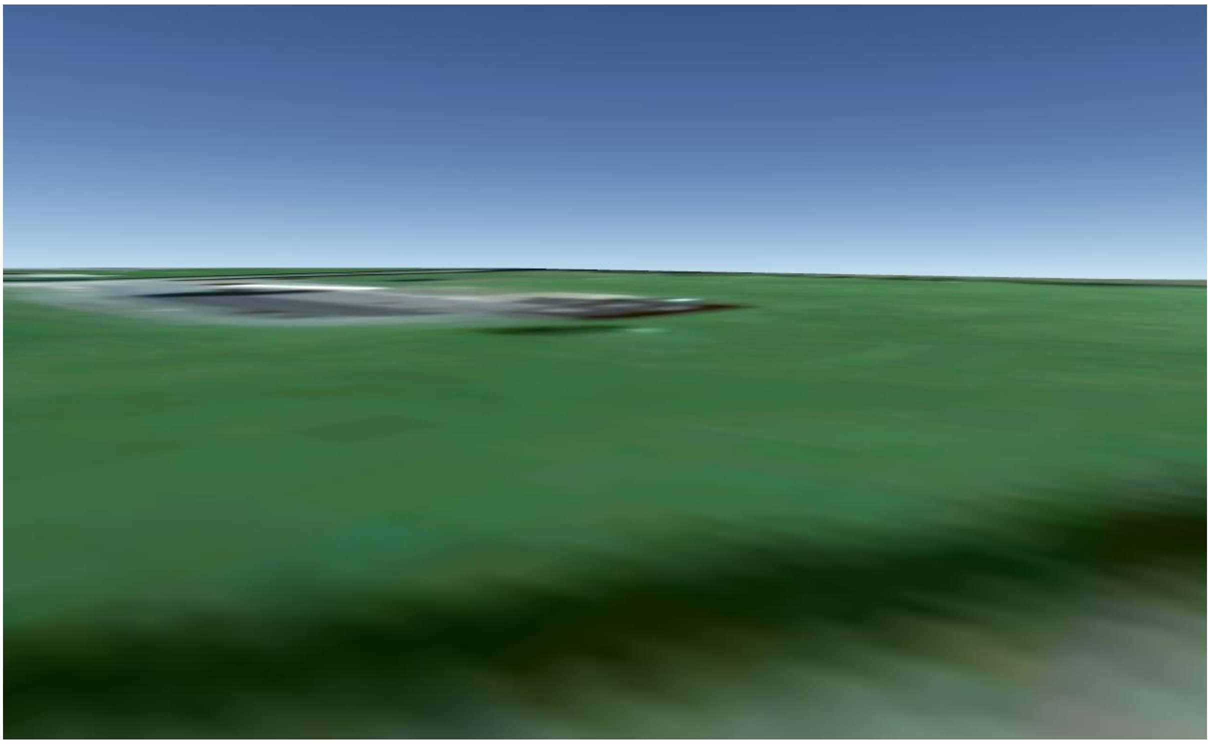
Residential Receptors

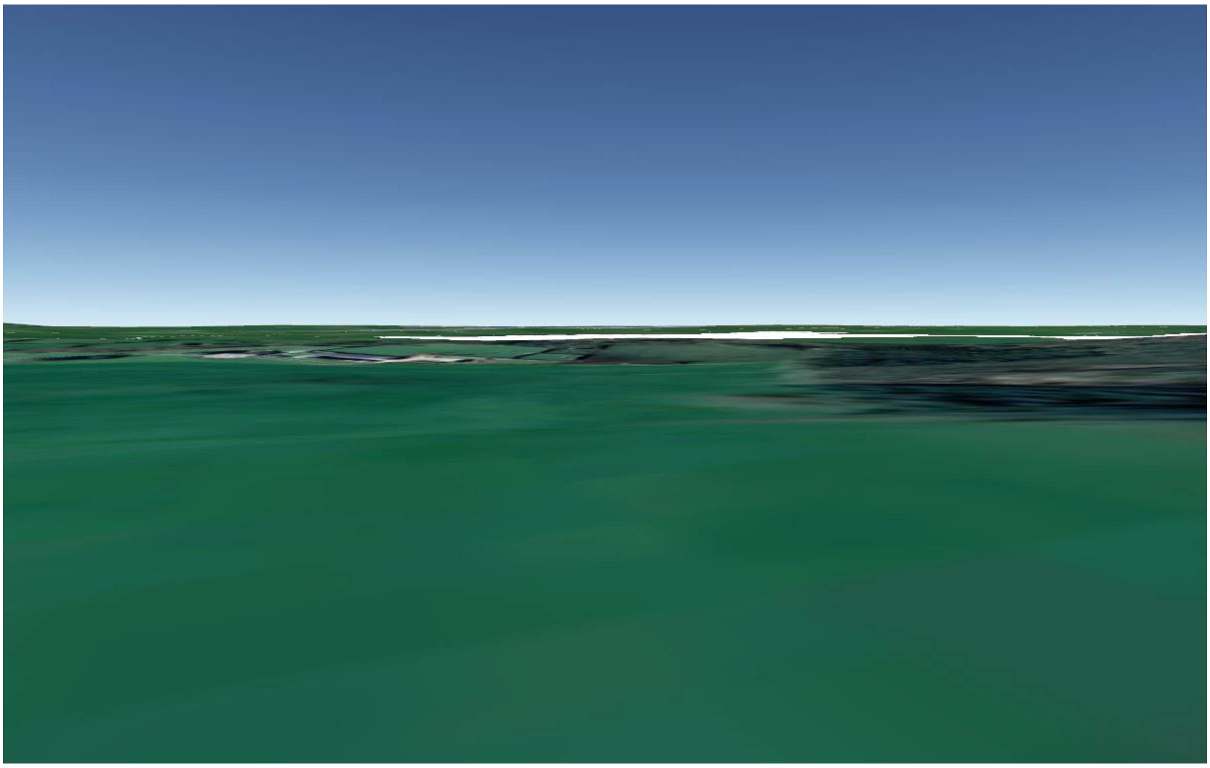
Receptor 31



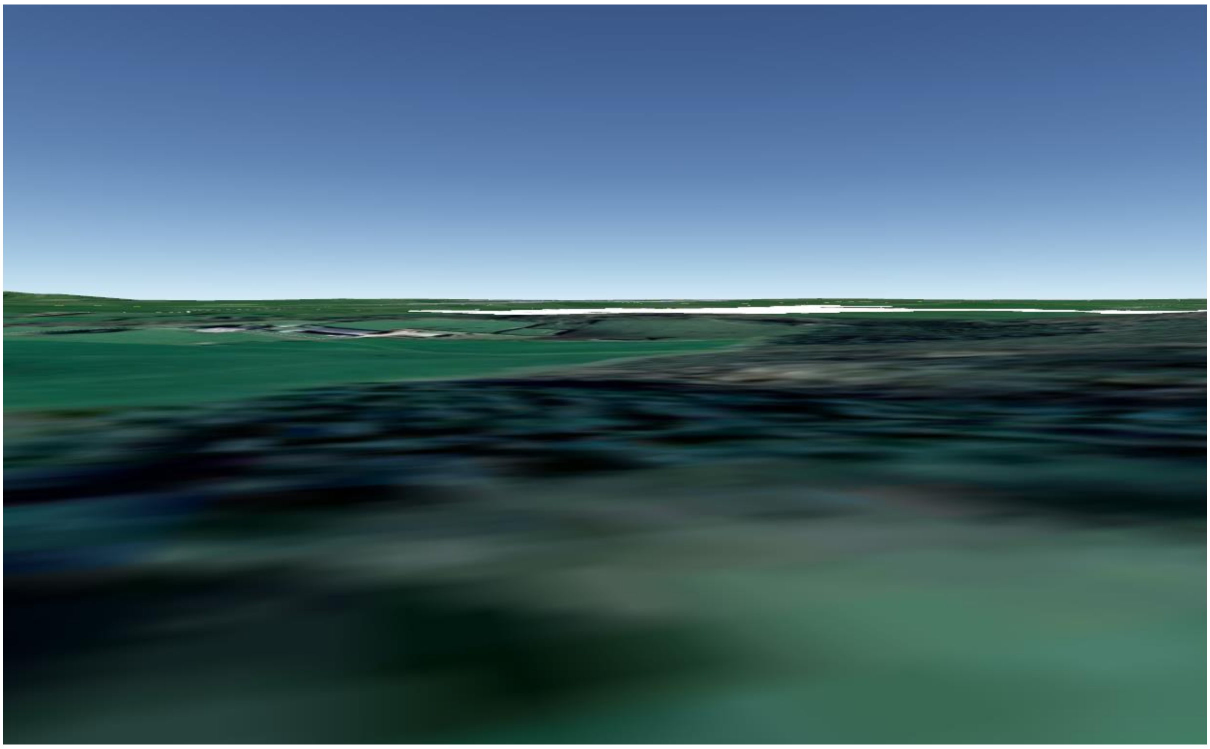
Receptor 32



Receptor 36

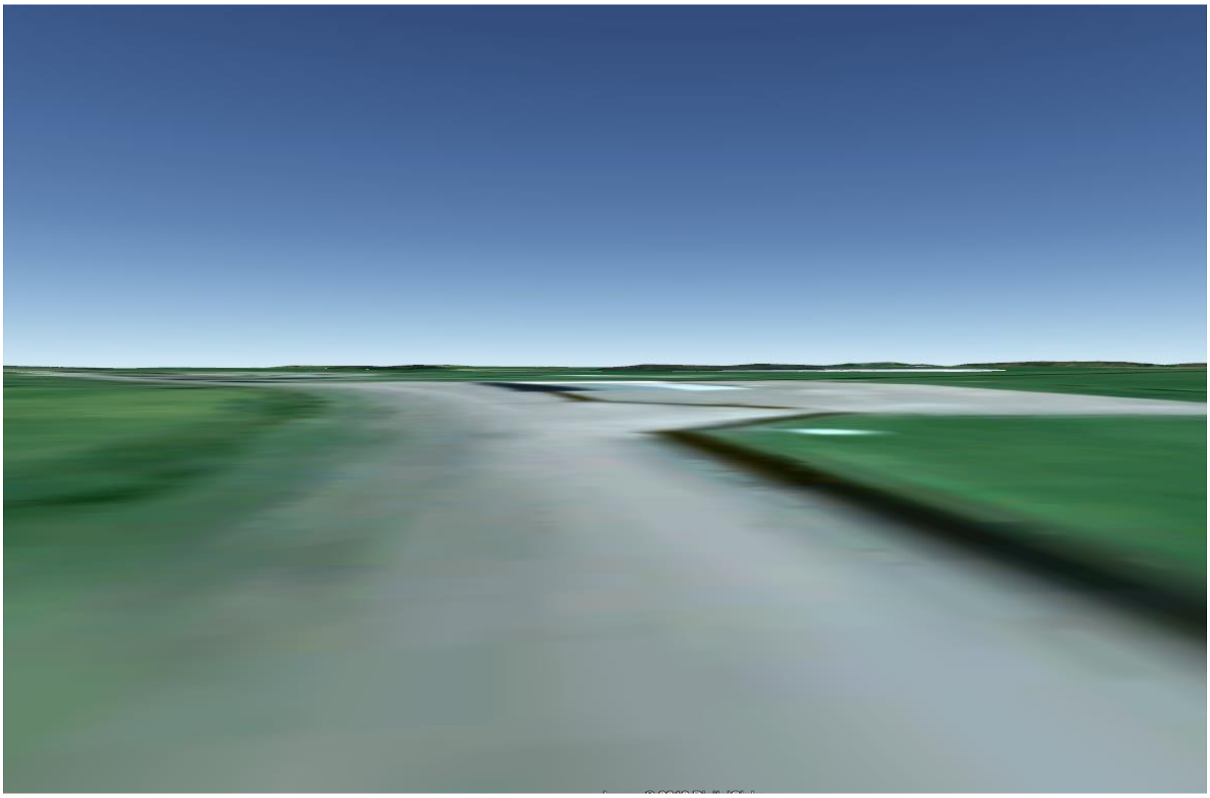


Receptor 37

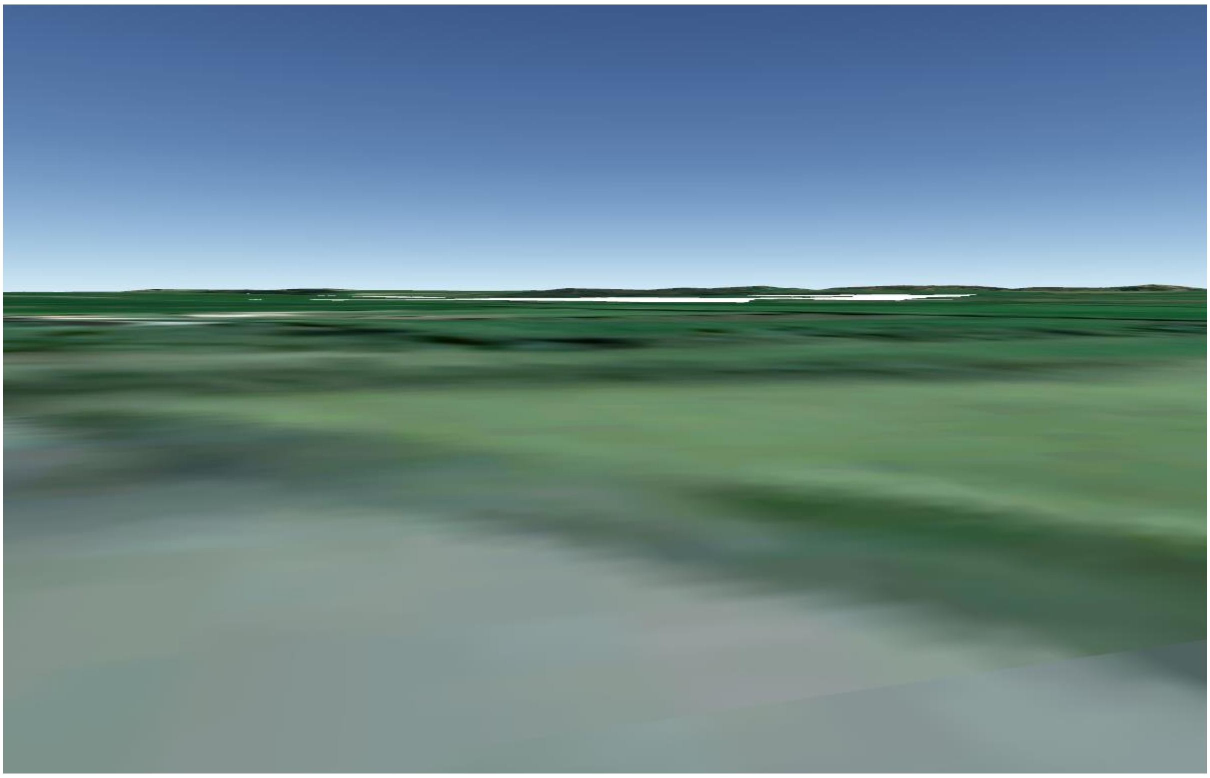


Road Receptors

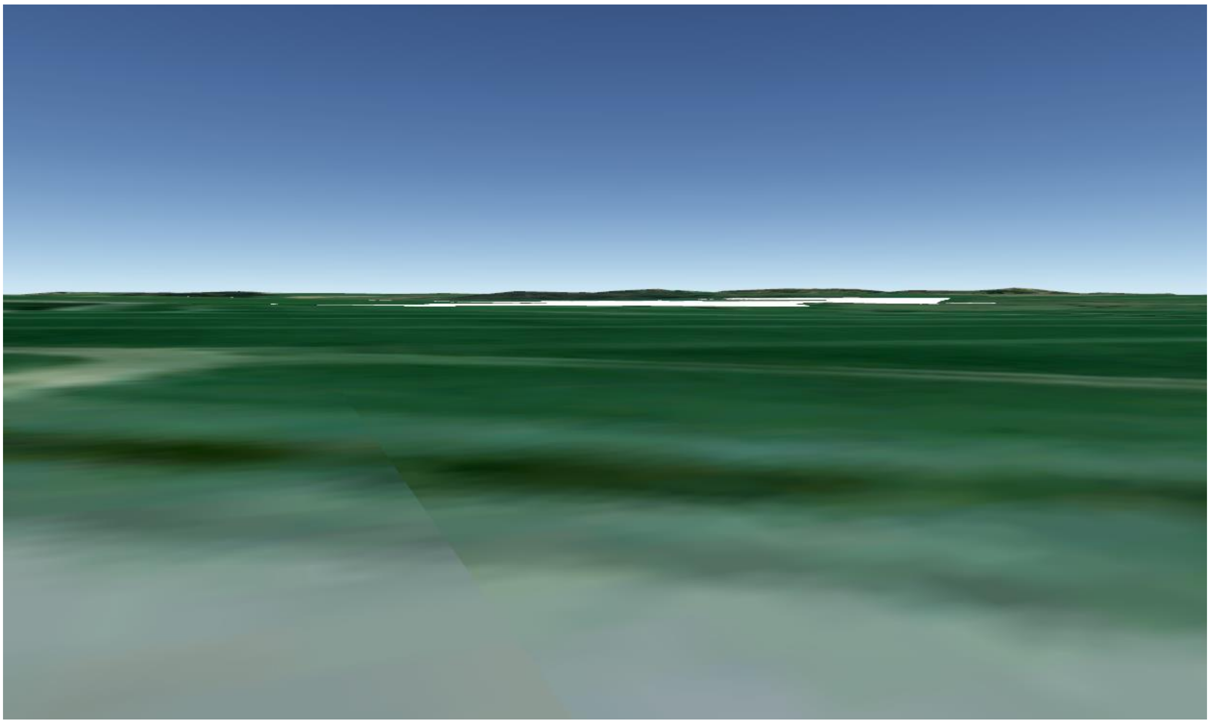
Receptor 1



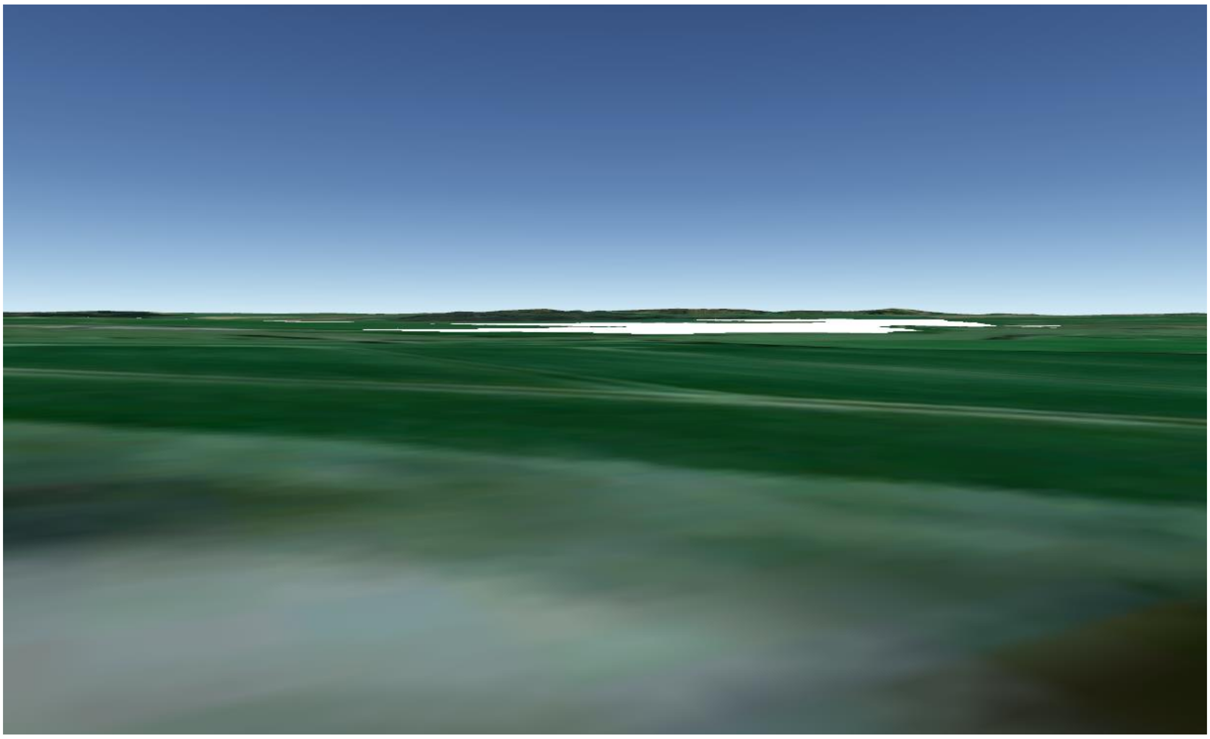
Receptor 3



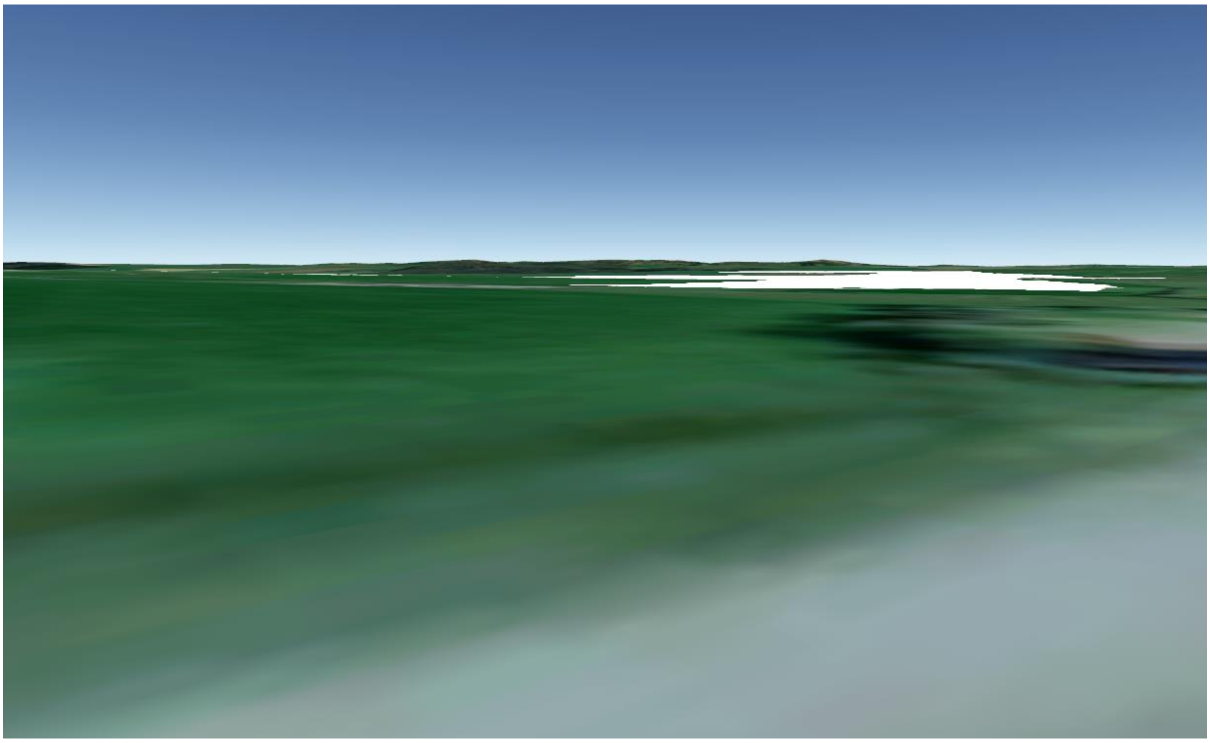
Receptor 4



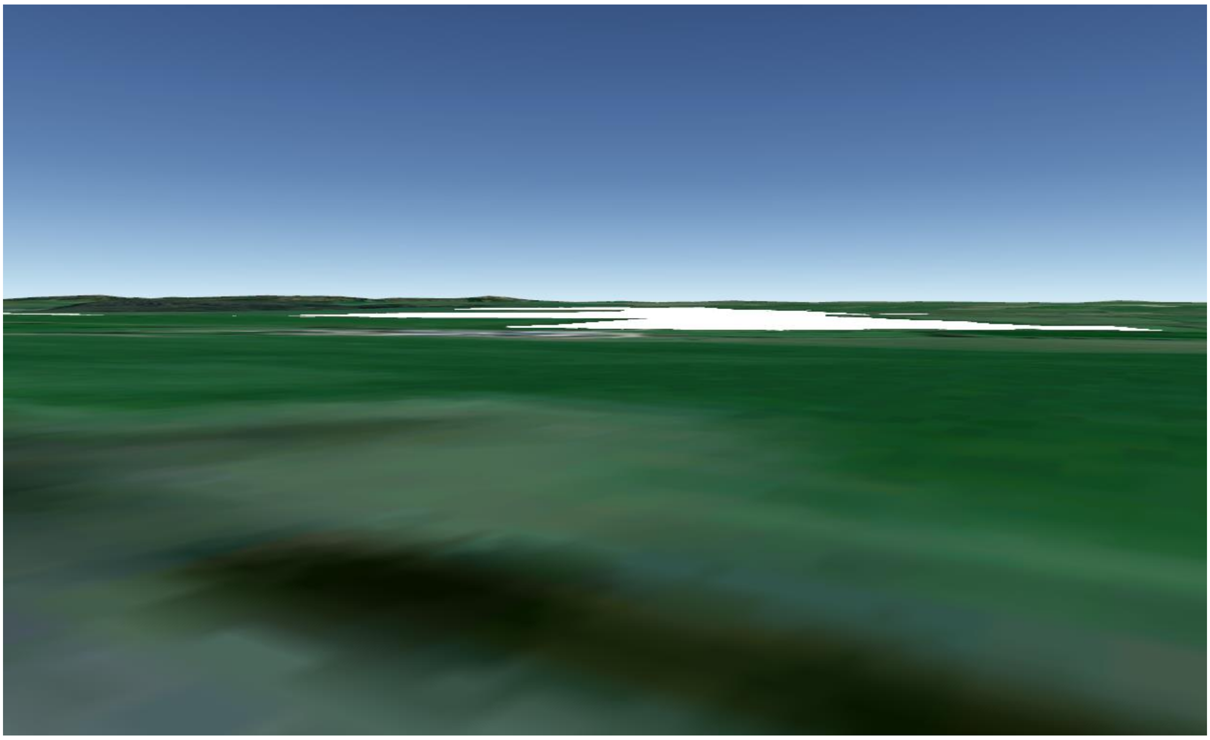
Receptor 5



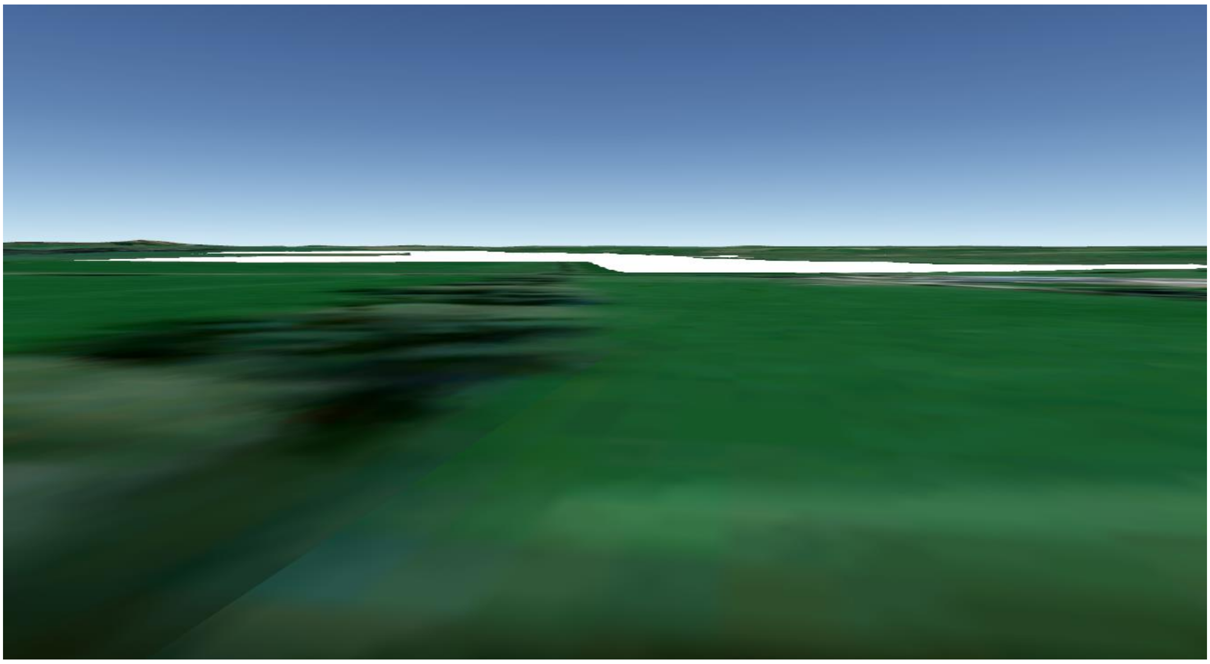
Receptor 6



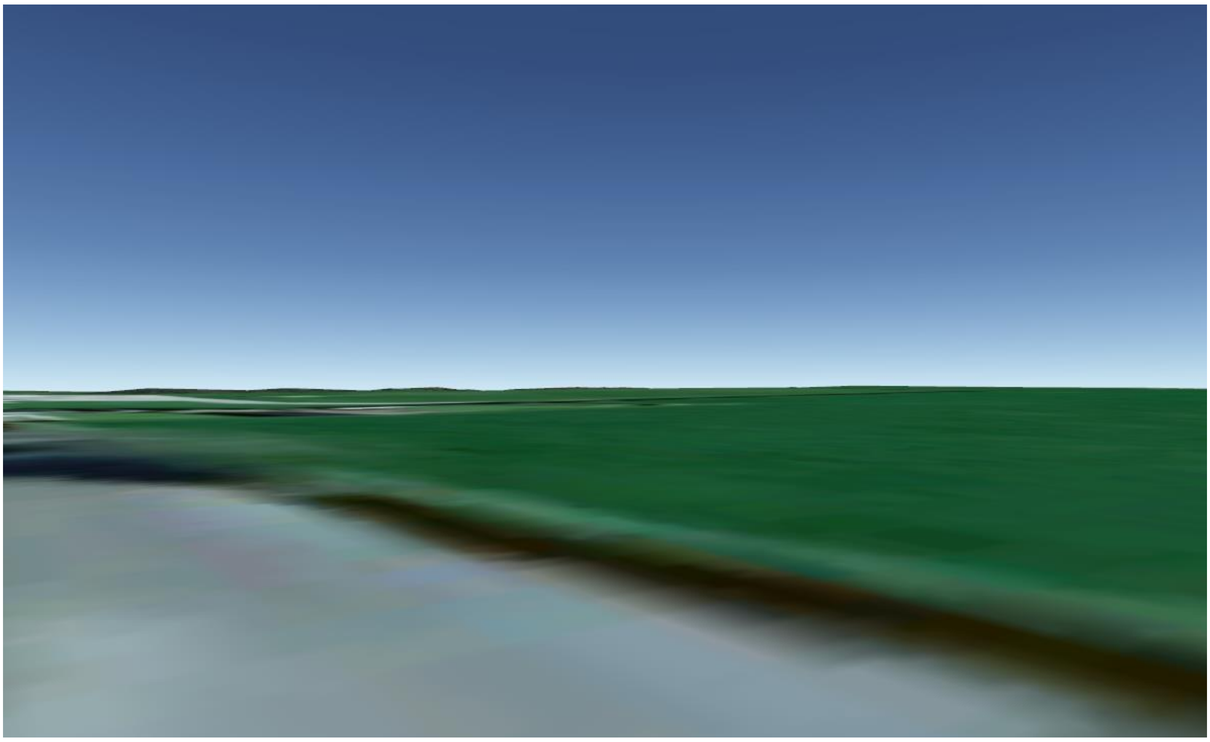
Receptor 7



Receptor 8



Receptor19



Appendix 4.1E: Solar Module Glare Tech Memo

Appendix 4.1E
Solar Module Glare and Reflectance Technical Memo

SUNPOWER

Technical Notification

TITLE: SunPower Solar Module Glare and Reflectance
AUTHORS: Technical Support
APPLICATION: Residential/ Commercial
SCOPE: SunPower Modules

SUMMARY:

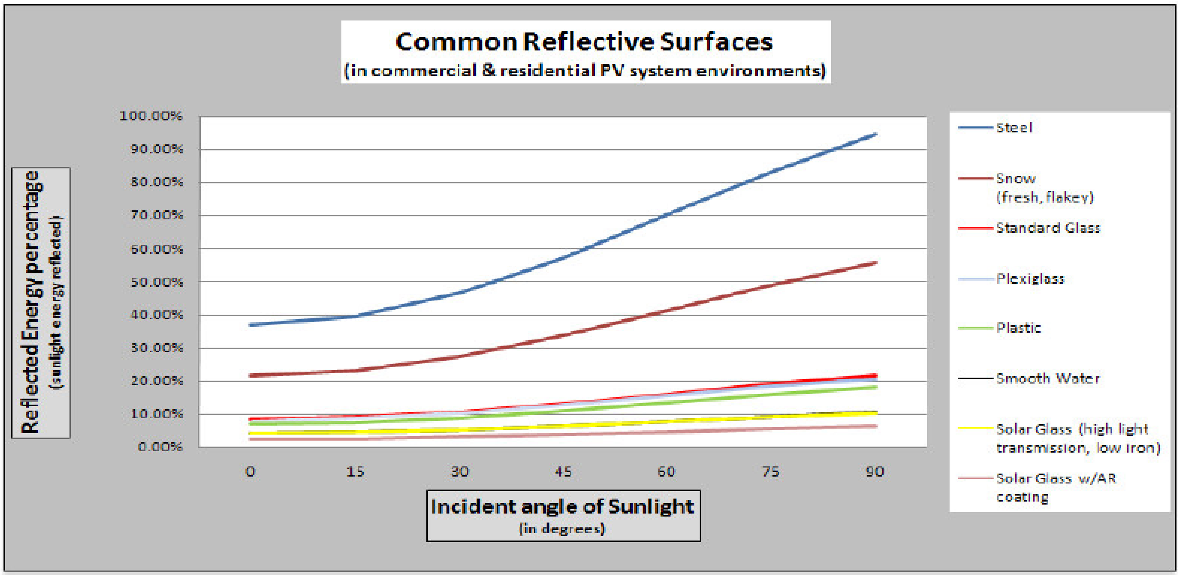
The objective of this document is to increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment.

The glare and reflectance levels from a given PV system are decisively lower than the glare and reflectance generated by the standard glass and other common reflective surfaces in the environments surrounding the given PV system. Concerning random glare and reflectance observed from the air: SunPower has several large projects installed near airports or on air force bases. Each of these large projects has passed FAA or Air Force standards and all projects have been determined as “No Hazard to Air Navigation”. Although the possible glare and reflectance from PV systems are at safe levels and are usually decisively lower than other standard residential and commercial reflective surfaces, SunPower suggests that customers and installers discuss any possible concerns with the neighbors/cohabitants near the planned PV system installation.

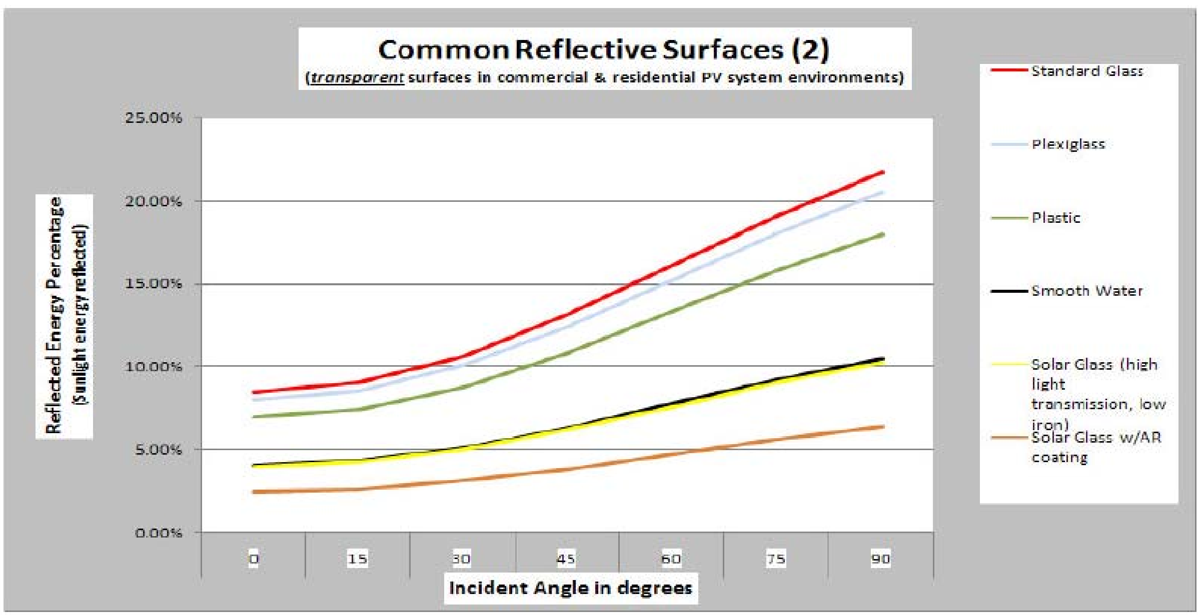
DETAILED EXPLANATION:

In general, since the whole concept of efficient solar power is to absorb as much light as possible while reflecting as little light as possible, standard solar module produces less glare and reflectance than standard window glass. This is pointed out very well in US Patent #6359212 which explains the differences in the refraction and reflection of solar module glass versus standard window glass. Solar modules use “high-transmission, low iron glass” which absorbs more light, producing small amounts of glare and reflectance than normal glass.

In the graph below, we show the reflected energy percentages of sunlight, of some common residential and commercial surfaces. The legend and the graph lists the items from top to bottom in order of the highest percentage of reflected energy.



It should be noted that the reflected energy percentage of Solar Glass is far below that of a standard glass and more on the level of smooth water. Also, below are the ratios of the common reflective surfaces:



Light beam physics resolves that the least amount of light is reflected when the beam is the normal, in other words, least light energy is reflected when the beam is at 0 degrees to the normal. The chart below is a result of light beam physics calculations:

Common Reflective Surfaces (in surrounding environments for PV systems)		Incident angle in degrees						
		0	15	30	45	60	75	90
Material Reflectivity (percent of incident light reflected)	Steel	36.73%	39.22%	46.34%	57.11%	70.02%	83.15%	94.40%
	Snow (fresh, flakey)	21.63%	23.09%	27.29%	33.63%	41.23%	48.96%	55.59%
	Standard Glass	8.44%	9.01%	10.65%	13.12%	16.09%	19.10%	21.69%
	Plexiglass	8.00%	8.54%	10.09%	12.44%	15.25%	18.11%	20.56%
	Plastic	6.99%	7.46%	8.82%	10.87%	13.33%	15.83%	17.97%
	Smooth Water	4.07%	4.35%	5.14%	6.33%	7.76%	9.22%	10.47%
	Solar Glass (high light transmission, low iron)	3.99%	4.26%	5.03%	6.20%	7.61%	9.03%	10.26%
	Solar Glass w/AR coating	2.47%	2.64%	3.12%	3.84%	4.71%	5.59%	6.35%

(Note: Index of refraction values may vary slightly depending on suppliers and reference documentation. The values for the above calculations are averages or single values obtained from the list of references for this document).

Important reference – "Stipples glass": In addition to the superior refractive/reflective properties of solar glass versus standard glass, SunPower uses stippled solar glass for our modules. Stippled glass is used with high powered telescopes and powerful beacons and lights. The basic concept behind stippling is for the surfaces of the glass to be textured with small types of indentations. As a result, stippling allows more light energy to be channeled/ transmitted through the glass while diffusing the reflected light energy. This concept is why the reflection of off a SunPower solar module will look hazy and less-defined than the reflection from standard glass, this occurs because the stippled SunPower glass is transmitting a larger percentage of light to the solar cell while breaking up the intensity of the reflected light energy.

SUMMARY/ACTION REQUIRED:

The studies, data and light beam physics behind the charts and graphs prove beyond a reasonable doubt that solar glass has less glare and reflectance than standard glass. The figures also make it clear that the difference is very decisive between solar glass and other common residential/commercial glasses. In addition, not to be lost in the standard light/glass equations and calculations, the SunPower solar glass is stippled and has a very photon-absorbent solar cell attached to the back side, contributing two additional factors which results in even less light energy being reflected.

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****

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  - Germany: SunPower – Technischer Support: technischersupport@sunpowercorp.com
  - Italy: SunPower – Servizio Tecnico Italia: serviziotecnico@sunpowercorp.com
  - France: SunPower – Support Technique France: supporttechnique@sunpowercorp.com

USA Toll Free number: SunPower Technical Support, **1-800–SUNPOWER (786-76937)**

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Korea – SPK (SunPower Korea) contact number: (02) 3453-0941

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Technical Appendix 5.1: Biodiversity Management Plan

Harristown Solar Farm

14/08/2019

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Lightsource BP

Prepared By:

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	Name	Date
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Checked By:	Karen Mulryan	14/08/2019
	Name	**Signature**
Approved By	Paul Neary	

Contents

1. EXECUTIVE SUMMARY

1.1. Objectives have been established to enhance and maintain the biodiversity of the land at Harristown within the proposed solar farm development. These include planting of species-rich hedgerows to provide a plentiful source of food and shelter for a range of fauna species. Other enhancement measures include developing species-rich grassland across the site, as well as creating a wildflower area, herptile hibernaculum and a log pile.

1.2. Action tasks have been formulated within this document to enable the objectives to be met and to maximise the sites potential for supporting wildlife. Species which have been given priority within this management plan include farmland birds, butterflies, bats and herptile species.

1.3. An extended phase 1 habitat survey was conducted in June 2019 in order to assess the current state of the Application Site. Previous extended phase 1 habitat surveys were also undertaken in March and May 2018. A Biodiversity Chapter (Chapter 5 of Volume 2 of the EIAR) has been produced to assess the local area and its ability to support a range of wildlife.

1.4. The enhancements and mitigation measures outlined in this document have been developed in accordance with the findings of the extended phase 1 habitat surveys.

2. GUIDANCE

2.1. Biodiversity is declining across Ireland; however, recent agri-environment schemes indicate that through appropriate management of the land, biodiversity can significantly increase. Appropriate solar farm developments have the potential to support wildlife and increase biodiversity when located on agricultural land through appropriate management.

2.2. Due to the nature of solar farm developments, a large proportion of the site is accessible for plant growth and potential wildlife enhancements. Currently no standard guidance is available in Ireland regarding the enhancement of solar farms for the benefit of local wildlife. In the UK each solar farm development requires a Biodiversity Management Plan (BMP), the purpose of which is to identify objectives for biodiversity and the means in which these objectives will be achieved. This can include the protection of existing species and habitats and the establishment of new habitats, as well as their maintenance and monitoring. Given the similarities between the species and habitats present in the UK and Ireland it has been deemed that the adoption of the UK standard guidance is appropriate in the absence of current Irish guidance.

2.3. According to 'Biodiversity Guidance for Solar Developments'[1] the BMP should:

- *"identify key elements of biodiversity on site, including legally protected species, species and habitats of high conservation value such as those listed on Section 41 of Natural Environmental and Rural Communities (NERC) Act 2006[2], and designated areas in close proximity to the proposed site;*
- *identify any potential impacts arising from the site's development, and outline mitigations to address these;*
- *detail specific objectives for the site to benefit key elements of biodiversity and the habitat enhancements that are planned to achieve these;*
- *contribute to biodiversity in the wider landscape and local ecological network by improving connectivity between existing habitats;*
- *identify species for planting and suitable sources for seed and plants;*
- *consider wider enhancements such as nesting and roosting boxes;*
- *summarise a management regime for habitats for the entire life of the site;*

---

[1] BRE (2014) Biodiversity Guidance for Solar Developments. Eds G E Parker and L Greene

[2] Natural Environmental and Rural Communities Act (NERC) 2006, available at www.legislation.gov.uk

- *provide a plan for monitoring the site; and adapting management as appropriate to the findings of this monitoring; and,*
- *set out how the site will be decommissioned. "*

2.4. The BMP has also been informed by the extended phase 1 habitat survey which was conducted in November 2016.

OBJECTIVE OF THE BIODIVERSITY MANAGEMENT PLAN

2.5. The objective of this BMP is to minimise any potential negative impacts, arising from the Proposed Development, while increasing the habitat diversity. The enhancement of the land within the Application Site boundary will increase the sites capability of supporting wildlife, through generation of renewable energy.

2.6. This will be achieved by:

- Creating and maintaining a species-rich diverse grassland with a varied sward structure;
- Creating and maintaining a wildflower meadow;
- Creating and maintaining wild bird seed mix strips;
- Creating and maintaining species-rich hedgerows;
- Creating and maintaining wildlife shelters for priority and locally important species;
- Ensure no net loss of biodiversity on the Field Farm site as a result of the habitat creation scheme; and
- Maximise the floral and faunal biodiversity of the created and retained habitats.

3. CURRENT CONSERVATION & BIODIVERSITY

NATIONAL CONSERVATION

Ireland's National Biodiversity Action Plan 2017 - 2021[3]

3.1. The National Biodiversity Action Plan[4] sets out a vision and seven strategic objectives to halt the decline of biodiversity across Ireland which are outlined below:

"Objective 1

- Mainstream biodiversity into decision-making across all sectors.

Objective 2

- Strengthen the knowledge base for conservation, management, and sustainable use of biodiversity.

Objective 3

- Increase awareness and appreciation of biodiversity and ecosystem services.

Objective 4

- conserve and restore biodiversity and ecosystem services in the wider countryside.

Objective 5

- conserve and restore biodiversity and ecosystem services in the marine environment.

Objective 6

- Expand and improve management of protected areas and species.

Objective 7

- Strengthen international governance for biodiversity and ecosystem services."

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[3] Department of Culture, Heritage, and the Gaeltach (2017) National Biodiversity Action Plan 2017-2021

[4] Department of Arts, Heritage and the Gaeltacht (2011) Actions for Biodiversity 2011 – 2016 Ireland's National Biodiversity Action Plan. Available at: http://www.npws.ie/sites/default/files/general/national-biodiversity-plan-english.pdf

3.2. This document outlines that special protection to sites of highest nature value and species most at risk, including designated sites should be afforded. However, effective conservation and sustainable use of biodiversity should also occur within the wider countryside, as this is where much of the biodiversity lies.

3.3. The primary threat to biodiversity both within and outside protected areas is from habitat degradation, fragmentation and loss due to changes in agricultural practices (such as intensification), commercial forestry, fisheries over exploitation, peat extraction, air and water pollution, invasive alien species, land clearance and development, tourism and recreational activities and climate change.

All Ireland Pollinator Plan 2015-2020[5]

3.4. On the 17th of September 2015, Ireland joined a small number of countries in Europe who have developed a strategy to address pollinator decline and protect pollination services.

3.5. Sixty-eight governmental and non-governmental organisations have agreed a shared Plan that identifies eighty-one actions to make Ireland pollinator friendly. The Plan identifies voluntary actions for farmers to make agricultural land more pollinator friendly, such as:

- Maintaining good quality hedgerows;
- Allow wild flowers to grow around the farm;
- Plant nectar and pollen rich trees and shrubs;
- Provide nesting areas around the farm; and
- Maximise wildflowers within field margins/buffer strips.

3.6. The enhancements set out within this BMP will create areas of flower-rich habitat that will support Ireland's pollinator species, including bees and flies.

Meath County Development Plan 2013-2019[6]

3.7. The main aim of the Meath County Development Plan is to provide a direction and focus for development in the county while focusing on six overall objectives which include; sustainable economic and employment growth, competitiveness of business in the area, balanced development, social inclusion, improve quality of life and maintain and enhance the natural and cultural heritage.

[5] National Biodiversity Data Centre (2015) All Ireland Pollinator Plan 2015 – 2020. Available at: http://www.biodiversityireland.ie/wordpress/wp-content/uploads/All-Ireland%20Pollinator%20Plan%202015-2020.pdf

[6] Meath County Council, 2012, Meath County Development Plan 2013-2019. Available at http://countydevelopmentplan.meath.ie/adoptedplan

3.8. Chapter 9.7 of the Plan refers to the county's natural heritage and contains a number of key policies aimed at protecting and enhancing biodiversity and designated sites within the county.

NH POL 1

- *To protect, conserve and seek to enhance the County's biodiversity.*

NH POL 2

- *To promote measures to protect biodiversity in the development management process by creating and improving habitats, where possible.*

NH POL 3

- *To raise public awareness and understanding of the county's natural heritage and biodiversity.*

NH POL 5

- *To permit development on or adjacent to designated Special Areas of Conservation, Special Protection Areas, National Heritage Areas or those proposed to be designated over the period of the plan, only where an assessment carried out to the satisfaction of the Meath County Council, in consultation with NPWS, indicates that it will have no significant adverse effect on the integrity of the site.*

Local Conservation

3.9. The Proposed Development does not lie within or adjacent to any statutory on non-statutory designated environmental sites. Within 15km of the Application Site boundary, there are three Special Area of Conservation (SAC), one Special Protection Area (SPA) and one Natural Heritage Area (NHAs).

3.10. The closest designated site to the Proposed Development is Black Castle Bog NHA located 3.25km southwest of the Application Site boundary.

3.11. From the findings of this assessment it is considered that the Proposed Development will **not significantly impact** upon any of the designated and non-designated sites located within 5km of the Proposed Development.

4. HABITATS & SPECIES PRESENT

4.1. An extended habitat survey was completed as part of the ecological appraisal in June 2019, which highlighted the presence of the following seven habitat types:

- Improved grassland (GA1)
- Buildings and artificial surfaces (BL3)
- Treelines (WL2)
- Hedgerows (WL1)
- Drainage ditch (FW4)
- Watercourses (FW2)
- Arable Crops (BC1)

RECORDED SPECIES

4.2. The extended phase 1 habitat survey covered all land within the Application Site and a 50m buffer around the entire site.

4.3. A list of flora species present onsite was compiled as part of the extended phase 1 habitat survey, details of species observed can be found in **Table 5.1.1** below.

Table 5.1.1: Flora Species Present within the Study Area at Harristown

Scientific Name	Common Name
Juncus effusus	Soft rush
Juncus squarrosus	Hard rush
Apium nodiflorum	Fools' water-cress
Lolium perenne	Perennial rye-grass
Ranunculus acris	Meadow buttercup
Holcus lanatus	Yorkshire fog
Urtica dioica	Stinging nettle
Carex nigra	Black sedge

Ranunculus flammula	Lesser spearwort
Filipendula ulmaria	Meadowsweet
Cardamine pratensis	Cuckooflower
Cardamine flexuosa	Wavey bittercress
Agrostis stolonifera	Creeping bent
Crataegus monogyna	Hawthorn
Quercus robur	Oak
Ilex acuifolium	Holly
Fagus sylvatica	Beech

FAUNA

4.4. The potential presence of protected species within the study area was assessed through a data search conducted via the National Biodiversity Data Centre (NBDC). This identified records of invasive, rare, scarce and protected species within 2km of the Proposed Development location. The Application Site is located within the 2km grid square N63E. A database search was also carried out for adjacent grid squares to ensure a full assessment of the 2km radius, which included grid squares N5841, N5941, N6041, N6141, N6241, N6241, N6341, N5840, N5940, N6040, N6140, N6240, N6340, N5838, N5939, N6039, N6139, N6239, N6339, N5838, N5938, N6038, N6138, N6238, N6338, N5837, N5937, N6037, N6137, N6237, N6337, N5836, N5936, N6036, N6136, N6236 and N6336.

4.5. Protected and notable species returned by the data search includes (but not limited to): badger (*Meles meles*), otter (*Lutra lutra*), pine marten (*Martes martes*), red squirrel (*Sciurus vulgaris*), soprano pipistrelle (*Pipistrellus pygmaeus*), whiskered Bat (*Myotis mystacinus*), brown long-eared bat (Plecotus a*uritus*), Leisler's bat (*Nytalus leisleri*), hen harrier (*Circus Cyaneus*) and corncrake (*Crex crex*).

4.6. Additional information on the suitability of habitats in the surrounding area for bats was also obtained from the NBDC in the form of a habitat suitability map. The map provides enhanced information on the recorded distribution of bats and broad-scale geographic patterns of occurrence and local roosting habitat requirements for Irish bat species.

4.7. In addition, the extended phase 1 habitat survey included a species scoping survey in order to assess the potential of the site to support protected species.

4.8. The Application Site and adjacent areas offer suitable habitat for otter, badger, bat and bird species which are known to be present in the local area. Although no records within the study area were noted for herptile species, it is considered that the area offers suitable habitat for common frog (*Rana temporaria*).

5. POTENTIAL IMPACTS

5.1. Potential impacts which could arise from a development include:

- Potential habitat loss and fragmentation;
- Disturbance during construction and decommissioning; and
- Potential contamination of surface waters

5.2. Each of these potential impacts have been considered below in relation to the Proposed Development at Harristown.

POTENTIAL HABITAT LOSS AND FRAGMENTATION

5.3. The solar panels will be set on piles with minimal disturbance to the ground. The proposed panels also have no moving parts and the overall ground-level footprint of the Proposed Development will generally take up less than 2.89% of the site, with piles taking approximately 0.02% of the overall developable area. As the panels will be raised off the ground, greater than 97% of the Application Site will be accessible for plant growth and potential wildlife enhancements.

5.4. Currently, the habitats present under the Proposed Development footprint are improved grassland and wet grassland fields. Theses habitats offer limited potential to support local wildlife, and therefore the loss of these small areas **will not be significant**. Also, as the surrounding landscape is of a similar nature, the alteration of this habitat will not result in fragmentation.

5.5. Post-construction, with the implementation of this BMP, existing habitats are to be enhanced, and new habitats created. This document sets out how the habitats including hedgerows, trees and grasslands within the Application Site will be sensitively managed to ensure the maximum potential of these habitats are maintained throughout the lifetime of the solar farm.

5.6. It is therefore demonstrated that the Proposed Development will have **a positive significant impact** on local habitats and will deliver biodiversity enhancements to the benefit of the site and wider area.

Disturbance During Construction And Decommissioning

5.7. The construction and decommissioning phases of the Proposed Development have the potential to impact upon local wildlife.

5.8. Measures will be implemented prior to construction and decommission work taking place to minimise any potential disturbance to wildlife. Mitigation measures recommended within the Ecological Impact Assessment include:

- Pre-construction bird surveys, if works commence between March and August inclusive;
- Pre-construction badger survey;
- Pre-construction otter survey;
- Bat roost assessments for any bat roost potential (BRP) trees to be removed;
- Securely covering all excavations at the end of each working day to prevent accidental trapping of badger, otter or other small mammals; and
- Mammal gates within the security fencing to permit the movement of wildlife across the local area.

5.9. During the operational phase, the disturbance to local wildlife will not be significantly greater than the levels of disturbance the land is currently subject to, from the current farming practice.

5.10. With the creation of new species-rich grassland, along with the enhancement of existing hedgerows and sensitive management, the sites potential for supporting local wildlife could be greatly increased post-construction.

Potential Contamination of Surface Waters

5.11. The construction phase of a development has the potential for contamination of surface waters if appropriate measures are not implemented. As part of the integral design of the Proposed Development, swales have been implemented to control the movement of surface waters within the Application Site. During the construction phase, all contractors working onsite will follow current best practice measures, which include the appropriate use and storage of fuels, oils and chemicals as required. These measures are outlined within the supporting Outline Construction Management Plan (See Technical Appendix 6.3: OCEMP).

6. MANAGEMENT & RECOMMENDATIONS

6.1. The following management recommendations have been made:

- to maintain and improve the biodiversity of species within the site;
- to enhance the quality of habitats present;
- increase the sites potential for supporting wildlife; and
- to avoid any potential negative impacts arising from the Proposed Development of the site.

6.2. Recommendations of management actions required to achieve the desired condition of the site are summarised within Table 5.1.2 of this document. The table also provides a brief summary of the rationale and possible constraints to adopt the recommended management.

Recommended Management

6.3. Currently, the improved grassland, marshy grassland and arable fields offer limited benefit to wildlife. The potential of the site to support wildlife will be significantly increased by the habitat creation measures set out in Table 5.1.2 below.

Habitat Enhancement

6.4. Various options exist to enhance the biodiversity value of a solar farm site, including the creation of different habitats, such as: hedgerows, field margins, wild flower meadows, nectar-rich areas and winter bird crops.

6.5. Habitats that will be created at the proposed solar farm development will include:

- Sections of species rich grass;
- Wild bird seed mixture;
- Wildflower meadow;
- Hibernaculum;
- Bird, bat and insect boxes; and
- Log and stone piles.

6.6. These habitats individually offer shelter and a food source for supporting a variety of wildlife. The mosaic of these new habitats combined with the existing hedgerows, will support the existing wildlife within the site. They also have excellent potential to allow the biodiversity of the site to increase, by offering a wider range of habitats that benefit local wildlife.

6.7. The nectar-rich areas will not only support a wide variety of wildlife but this will also contribute towards the *All Ireland Pollinator Plan*, by creating habitats that will support important pollinator species such as bees and flies.

GENERAL CONSIDERATIONS

Obligations

6.8. During each of the Proposed Development phases there are a number of legal obligations that should be considered by all those involved in site work:

- Ensure obligations of the European Communities (Birds and Natural Habitats) Regulations 2011 are met by all involved with the site.
- Ensure obligations of the Wildlife Act 1976 and Wildlife (Amendment) Act 2000 are met by all involved with the site.
- Ensure all relevant Health & Safety at Work Act obligations

Good Ecological Practice

6.9. Whilst management practices should only be altered if there is a good ecological reason for doing so, they should not be rigidly adhered to if they are obviously detrimental.

Invasive Non-Native Species

6.10. During the extended phase 1 habitat survey carried out in June 2019 no field signs or evidence of invasive non-native species were observed.

MANAGEMENT OBJECTIVES AND ACTION PLAN

Table 5.1.2: Recommended Management

Objective	Action Plan Task	Timescale	Notes
To enhance the quality of habitats present	Create a diverse grassland with varied structure After the development of the solar farm, sections of wildflower, fine grasses and wild bird seed mix will be sown across the site.	Year 1	Most of the site will be sheep grazed with a stocking rate that will allowed varied sward structure across the site. The area of wild bird seed mix and wetland meadow will be fenced off from the reset of the field to prevent grazing by sheep.
Creating a diversity of habitats within the site	Wildflower mix to contain: Common knapweed (*Centaurea nigra*), field scabious (*Knautia arvensis*), Devil's-bit scabious (*Succisa pratensis)*, wild carrot (*Daucus carota*), common bird's-foot-trefoil (*Lotus corniculatus*), red clover (*Trifolium pratense*), selfheal (*Prunella vulgaris*), cuckoo flower (*Cardamine pratensis*), ox-eye daisy (*Leucanthemum vulgare*), black medic (*Medicago lupulina*), hawkbits (*Leontodon spp*), hawk's-beards (*Crepis spp*), common dandelion (*Taraxacum officinale*), yellow rattle (*Rhinanthus minor*), cowslip (*Primula veris*) and primrose (*Primula vulgaris*).	Year 1	Wildflower mix will provide an insect rich habitat. Sections of wildflower meadow to be fenced off to create un-grazed wildflower area.
Creating a diversity of habitats within the site	Fine grass mix to contain: Common bent (Agrostis capillaris), creeping red fescue (Festuca rubra), hard fescue (festuca longifolia) and smooth	Year 1	Fine grasses contain an ideal nesting habitat for ground nesting birds such as skylarks. This will also provide habitat for small

	stalked meadow grass (Poa pratensis).		mammals and larvae of pollinating insects, including butterflies and moths.
Creating a diversity of habitats within the site	Wild bird seed mix to contain: Mustard, spring wheat (*Triticum spp*), white/red millet (*Panicum miliaceum*), triticale (*× Triticosecale*) and barley (*Hordeum vulgare L*).	Year 1	Wild bird seed mix provides a seed rich habitat, providing a further food source for farmland birds and small mammals. The area of wild bird seed mix will be fenced off from the rest of the field to prevent grazing by sheep.
To enhance the quality of habitats present	Enhance existing hedgerow boundary Gap existing hedgerows with blackthorn (*Prunus spinosa*), hawthorn (*Crataegus monogyna*), ash (*Fraxinus excelsior*), alder (*Alnus glutinosa*), hazel (*Corylus avellana*) and holly (*Ilex aquifolium*). These corridors will allow the movement of small mammals and herptile species. To ensure a diverse hedgerow with a good structure it is important to plant and maintain ground flora along the hedgerow.	Year 1	A hedgerow provides shelter and a source of food for a variety of species including birds, small mammals, amphibians, reptiles and butterflies. If the correct species are planted and maintained correctly, a hedgerow's potential can be maximised, providing food and shelter throughout the year.
Ensure fencing does not inhibit the movement of wildlife	To allow movement of badgers, small mammals and herptiles across the Proposed Development area the fence will include badger gates, allowing access for these species where required.	Year 1 (during construction phase)	NA
Creating a diversity of habitats within the site	Creation of hibernaculum, stone piles and log piles	Year 1	See appendix 5.1A The hibernacula comprise of log, rock and stone piles, which are aimed at providing shelter for

			herptile species to hibernate. However, the hibernaculum and log pile may also be used by a variety of insects and small mammals.
Creating a diversity of habitats within the site	Creation of bat roosting habitat Bat boxes will be placed on a few of the mature trees within the site	Year 1	The creation of roosting habitat, along with the creation of species rich habitat that will encourage an abundance of invertebrate life (a potential food source) will be beneficial to local bats.
Creating a diversity of habitats within the site	Creation of bird nesting habitat Bird boxes will be placed on a few of the mature trees within the site	Year 1	The creation of nesting habitat, along with the creation of species rich habitat that will encourage an abundance of invertebrate life (a potential food source) and the wild bird seed mix areas will be beneficial to local birds. Boxes installed should include a mixture of single hole, and open fronted bird boxes.
Creating a diversity of habitats within the site	Creation of invertebrate banks Several earth banks shall be created across the site to support invertebrates.	Year 1	See **Appendix 5.1B** Some banks should be left bare, and south facing for insects such as solitary bees, while others should be sown with grass for beetles etc.
Maintaining the species rich ground flora around solar PV installation	Low intensity sheep grazing	Each year	Low intensity sheep grazing will ensure that the areas of shorter swards and scrub will be managed and maintained. This will result in an overall increase in biodiversity within the site.

Maintaining the hedgerows	Section of hedgerow to be cut	Each year between January and February	Cutting on a rotational basis, following standard advice[7], to ensure the optimal availability of berry and blossom for wildlife throughout the year, as a potential food source. Management will also ensure a good base is maintained within the hedgerow, to provide suitable habitat for a range of wildlife.

[7] Hedgelink UK, The Complete Hedge Good Management Guide, Available at www.hedgelink.org.uk

7. HABITAT CREATION

7.1. The existing farmland groundcover (currently improved grassland and wet grassland) will be replaced by a mix of grasses and wildflower species. Existing hedgerows will be enhanced, with a new hedgerow created within the Application Site. These habitats will be in place and managed for the duration of the Proposed Development.

GRASSLAND

7.2. Within the Application Site, the planting of species-rich diverse grassland will occur, with the management regime ensuring a varied sward structure.

Soil Stabilisation and sward establishment

7.3. Prior to sowing, the ground will be harrowed to a fine tilth and rolled to make the surface firm. A grass seed comprised of the mixture set out in **Table 5.1.3** below, or a mix further tailored to the soil conditions following soil testing, will be sowed. The grass seed will be applied at a low-density rate of 20kg per ha, which will allow for natural regeneration.

7.4. Species such as common couch, broad-leaved dock, stinging nettle and creeping thistle can be difficult to eradicate and may cause problems with sward establishment. These species should therefore be targeted when undertaking weed control measures on site.

7.5. Low intensity sheep grazing will ensure that areas of shorter swards will be managed and maintained. Due to selective grazing habits, sheep grazing can lead to a diverse sward structure, if stocked at correct numbers. Sheep grazing the grassland areas post-development benefits local biodiversity by eliminating the requirement of pesticides used as part of the current management regime for crops in the arable field.

Table 5.1.3: Grassland Mix Component

SCIENTIFIC NAME	ENGLISH NAME	PERCENTAGE MIX (%)
Festuca ovina	Hard/sheep's fescue	27
Festuca rubra	Red fescue	35
Poa pratensis	Smooth stalked meadow grass	15
Cynosurus cristatus	Crested dog's tail	4
Poa trivialis	Rough stalk meadow grass	15
Argostis capillaris	Common bent	4

Management

7.6. The grass seed will be sown in either early autumn (August - September), or spring (March – April). The seeds should be applied to the soil surface, which should be clear of weeds and gently firmed-in by rolling, to provide direct contact with the soil.

7.7. In the first year, the grass should be regularly cut and/or grazed to promote grass growth and control weeds. As a guide, once the sward reaches 10-15cm in height it should be cut to a height of 5-7cm.

7.8. Once the grassland area has established, a grazing regime will allow for light grazing by sheep (10 or less per hectare) through the autumn and winter months, thus allowing vegetation to flower and seed throughout the summer. Another option is to use a lower stock density for grazing all year round.

Wildflower Meadow

7.9. The wildflower meadow, as shown within **Figure 8.20 of Volume 2 of the EIAR**, is a species-rich grassland composed of wild flowers and fine grasses and this will create an insect rich habitat and support a range of birds, mammals and invertebrates.

7.10. A wildflower mixture comprised of the mixture set out in **Table 5.1.4** below. The seed will be applied at a low-density rate of 25kg per ha, with a 20% wildflower and 80% grass mix.

Table 5.1.4: Wildflower Mix Component

Scientific name	English name	Percentage mix (%)
Lotus corniculatus	Birds foot trefoil	8
Centaurea nigra	Black knapweed	5
Medicago lupulina	Black medick	3
Vicia sativa	Common vetch	3
Galium verum	Lady's bedstraw	0.5
Lathyrus pratensis	Meadow vetchling	3
Ranunculus acris	Meadow buttercup	3
Malva moschata	Musk mallow	2
Leucanthemum vulgare	Ox-eye daisy	8
Silene dioicia/latifolia	Red/white campion	1.5
Trifolium repens	Red clover	10
Prunella vulgaris	Selfheal	5
Onobrychis viciifolia	Sainfoin	36
Achillea millefolium	Yarrow	6
Rhinanthus minor	Yellow rattle	3

Management

7.11. The wildflower mix will be sown in September or March/April, after the completion of the construction phase.

7.12. Within the first year the main aim is to control weeds and to reduce competition from grasses. The sward will be kept short in the first year until the end of June to reduce competition and then allowed to grow in July and August to permit any wildflowers to seed. All cuttings should be removed from site several days after cutting to avoid smothering the sward, but allowing any seeds to disperse.

7.13. After the wildflower mix has established, this area should only require one cutting in late summer (August – September), allowing flowering species to seed with an additional cut in October. Cuttings should be left on site for several days to disperse any seeds, then removed from site.

Wild Bird Seed Mix

7.14. Wild bird seed mix provides a rich habitat, providing a further food source for farmland birds and small mammals. Locations of the wild bird seed mix can be found within **in Volume 2 of the EIAR** for the **Landscape and Ecology Management Plan (LEMP).**

7.15. The composition of the wild bird seed mixture is detailed in **Table 5.1.5** below and will be applied a rate of 250kg per ha.

Table 5.1.5: Wild Bird Seed Mix Component

English Name	Percentage Mix (%)
Mustard	10
Spring wheat	25
White millet	20
Red millet	10
Tritiicale	10
Barley	25

Management

7.16. Wild bird seed crops are normally sown in the spring, grow through the summer and are left un-harvested through the winter. It is anticipated that this approach will be undertaken at Ballyvatta-Clash. The crop is sown annually following ploughing and harrowing to a fine tilth.

7.17. **The wild seed mix will be fenced off to prevent any grazing by livestock**.

HEDGEROW

7.18. Currently the hedgerows on site are a mixture of species-rich and species-poor. This management plan will enhance the existing hedgerow boundary by infilling gaps and planting a new species-rich hedgerow. Please see **Figure 8.20 in Volume 2 of the EIAR** for the **Landscape and Ecology Management Plan (LEMP).**

7.19. Creating hedgerows will benefit a range of local species including Biodiversity Action Plan (BAP) Priority Species such as terrestrial mammals, herptiles, invertebrates and birds. If the correct species are planted and maintained correctly, a hedgerow's potential can be maximised, providing food and shelter throughout the year, as well as connecting corridors.

7.20. The hedgerows will be planted as double staggered rows at 5-6 per metre, with a spacing of 400mm between rows and should contain the following species as proposed in **Table 5.1.6.** Hedgerow mix A is to be planted as new lengths of hedgerows along open stretches of existing field boundaries. Hedgerow mix B is to infill minor gaps in the existing internal and external field boundary hedgerows. Hedgerow added through new and existing lengths of Hedgerow.

Table 5.1.6: Hedgerow Species Mix

SCIENTIFIC NAME	ENGLISH NAME	PERCENTAGE OF TREES
HEDGEROW MIX A		
Corlyus avellane	Hazel	10
Crategus monogyna,	*Hawthorn*	55
Euonymus europeaus	*Spindle*	5
Ilex aquifolium	*Holly*	3
Prunus spinosa	*Blackthorn*	15
Rosa canina	*Dog Rose*	2
Salix cinera	*Grey Willow*	5
Viburnum opulus	*Guelder Rose*	5
HEDGEROW MIX B		
Corlyus avellane	*Hazel*	10
Crategus monogyna	*Hawthorn*	50
Euonymus europeaus	*Spindle*	5
Ilex aquifolium	*Holly*	3
Prunus spinosa	*Blackthorn*	15
Rosa canina	*Dog Rose*	2
Salix cinera	*Grey Willow*	7
Viburnum opulus	*Guelder Rose*	8
HEDGEROW TREES MIX		
Prunus padus	*Bird Cherry*	20
Corylus avellane	*Hazel*	20
Quercus petrea	*Sessile Oak*	10
Sorbus aria	*Whitebeam*	20

Salix pentandra	*Bay Willow*	30

7.21. It is also important to plant and maintain ground flora along the hedgerow to provide suitable commuting corridors for small mammals and herptiles.

Management

7.22. New hedgerows will be planted within the first available planting season (November – March).

7.23. In year 2, newly planted hedgerow sections will be lightly pruned. Existing hedgerows should be cut on a 2- or 3-year cycle, with no more than 1/3 cut in any one year. Any pruning or cutting should be done outside of the breeding bird season (March to August inclusive) to minimise disturbance to nesting birds.

WILDLIFE SHELTERS

7.24. The creation of wildlife shelters strategically placed throughout the Application Site, will provide shelter to a wide range of species.

Bat boxes

7.25. Providing bat boxes will increase opportunities for roosting bats within the local area. Approximately eight bat boxes should be erected in suitable locations throughout the site. It can however take bats a long time to make use of artificial roosts, therefore a number of factors must be considered when installing a new bat box.

7.26. Microclimate within a new roost is a very important factor in terms of increasing the chance of successful uptake by bats. In line with Bat Conservation Trust guidelines[8] bat boxes should be draught-proof and made from a thermally stable material. They should be located where they will receive full/partial sunlight (southerly orientation). The boxes should be positioned a minimum of 2m above the ground. Access points should be clear of any obstructions.

7.27. To allow a choice of roosting, bat boxes should be installed in more than one aspect. Bat boxes located on a shady side will be cooler and may be suitable as a hibernation roost or used by male bats throughout the entire year.

7.28. There is a wide range of bat boxes currently available, some which are more suitable for certain species. A variety of bat boxes are recommended in **Table 5.1.7** below. It is recommended that three of each type of box detailed below be installed on site.

[8] Bat Conservation Trust – Bat Box Information Pack – Available at: http://www.bats.org.uk/data/files/publications/Bat_Box_Information_Pack_FINAL.pdf

Table 5.1.7: Details of Bat Boxes

BAT BOX	DETAILS	IMAGE
Schwegler 1FF[9]	Can be used as a summer roost or nursery site. Is open at the bottom and does not require cleaning.	
Schwegler 2F[10]	Standard box and most popular. Simple entrance role. Used as summer roosting space.	
Schwegler 1FD[11]	Specific for smaller bats such as common pipistrelle, nathusius pipistrlle, daubenton's bat and brown long-eared.	

Bird boxes

7.29. In order to enhance the site for nesting birds, a number of bird boxes shall be placed throughout the site. Several types of nest boxes will be installed at suitable locations to favour a variety of bird species.

7.30. Open-fronted boxes will provide enhanced nesting opportunities for species such as robins, pied wagtails and spotted flycatchers. Boxes with entrance holes are suitable for tits, wren and tree sparrows.

7.31. Bird boxes should be mounted so they face between the southeast and north to avoid direct sunlight. They should be tilted forwards so that rain is directed away from the entrance.

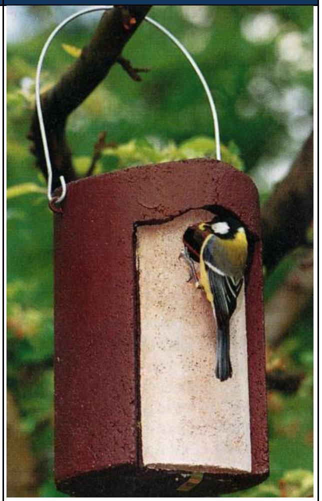
7.32. A variety of bird boxes are recommended in the table below.

[9] Full specification available at: http://www.nhbs.com/title/158636/1ff-schwegler-bat-box-with-built-in-wooden-rear-panel

[10] Full specification available at: http://www.nhbs.com/title/158629

[11] Full specification available at: http://www.nhbs.com/title/177076/1fd-schwegler-bat-box

Table 5.1.8: Details of Bird Boxes

BIRD BOX	DETAILS	IMAGE
1B Schwegler Nest Box[12]	This nest box will attract a wide range of species and is available with different entrance hole sizes to prevent birds from competing with each other for the boxes. The 32mm entrance hole will attract Great, Blue, Marsh, Coal and Crested Tit, Redstart, Nuthatch, Collared and Pied Flycatcher, Wryneck, Tree and House Sparrow and bats. The 26mm entrance hole suits Blue, Marsh, Coal and Crested Tit and possibly Wren. All other species are prevented from using the nest box due to the smaller entrance hole.	
2H Schwegler Robin Box[13]	This traditional design has proved to be highly effective in attracting robins, as well as other small species such as black redstart, spotted flycatcher and wren.	

7.33. It is recommended that six 1B Schwegler nest boxes (three 32mm and three 26mm holes) and three 2H Schwegler robin boxes are installed.

Hibernacula

7.34. The hibernacula comprise of log, rock and stone piles and is aimed at providing shelter for reptile and amphibians to hibernate. It may also be used by a variety of insects and small mammals. The hibernacula will follow the instructions laid out within **Appendix 5.1A** below.

[12] Full specification available at: http://www.nhbs.com/title/158587/1b-schwegler-nest-box
[13] Full specification available at: http://www.nhbs.com/title/161277/2h-schwegler-robin-box

Bee banks and invertebrate hotels

7.35. Bee banks and invertebrate hotels will be created as per the instructions within **Appendix 5.1B**.

Management

7.36. The wildlife shelters can be installed at any stage within the first year.

7.37. Bird and bat boxes should be cleaned annually to ensure that parasite build up does not occur.

7.38. Bird boxes should be cleaned in October. This prevents the build-up of parasites and avoids the risk of disturbing birds using it as a roosting site during the cold winter months.

7.39. All bats and their roosts are protected by law and it is an offence to deliberately disturb, handle or kill bats. If a bat box needs to be opened at any stage, a suitably licenced bat worker must be present. **This includes cleaning of the bat boxes**.

8. INDICATIVE MANAGEMENT SCHEDULE

8.1. **Table 5.1.9** below shows possible months in which activities will commence within the initial planting period after the construction phase.

Table 5.1.9 Timeframes for Management Activities

Management Activity	Jan	Feb	Mar	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Year 1 – Initial Habitat Enhancement												
Hedgerow and tree planting	✓	✓								✓	✓	✓
Removal of existing vegetation and seeds beneath solar panels			✓	✓	✓							
Cultivate and allow soil to settle						✓	✓					
Grassland sowing beneath solar panels								✓	✓			
Field margin cutting									✓	✓		
Installation of bat and bird boxes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year 2 - Annual Habitat Management												
Grazing of grassland beneath solar panels (if sward is established)	✓	✓							✓	✓	✓	✓

Field margin cutting									✓	✓		
Light pruning of newly planted hedgerow sections	✓	✓							✓			
Checks by contractor through the initial maintenance period to comprise weed clearance, watering and pruning			✓	✓	✓	✓	✓	✓				
Replacement of any dead, dying or diseased newly planted trees or hedgerow										✓	✓	✓
Existing hedgerows cut on a 2- or 3-year cycle, with no more than 1/3 cut in any one year	✓	✓										
Ongoing Annual Management – Year 3 onwards												
Grazing of grassland beneath solar panels	✓	✓							✓	✓	✓	✓
Ongoing Annual Management – Year 3-4												
Field margin cutting									✓	✓		

Ongoing Annual Management – Year 4 onwards												
Field margin wildflower sowing								✓	✓			
Grassland margin cutting (after year three)									✓	✓		
Light pruning of newly planted hedgerow sections	✓	✓							✓			
Existing hedgerows cut on a 2- or 3-year cycle. All hedgerows from year 5, with no more than 1/3 cut in any one year	✓	✓										

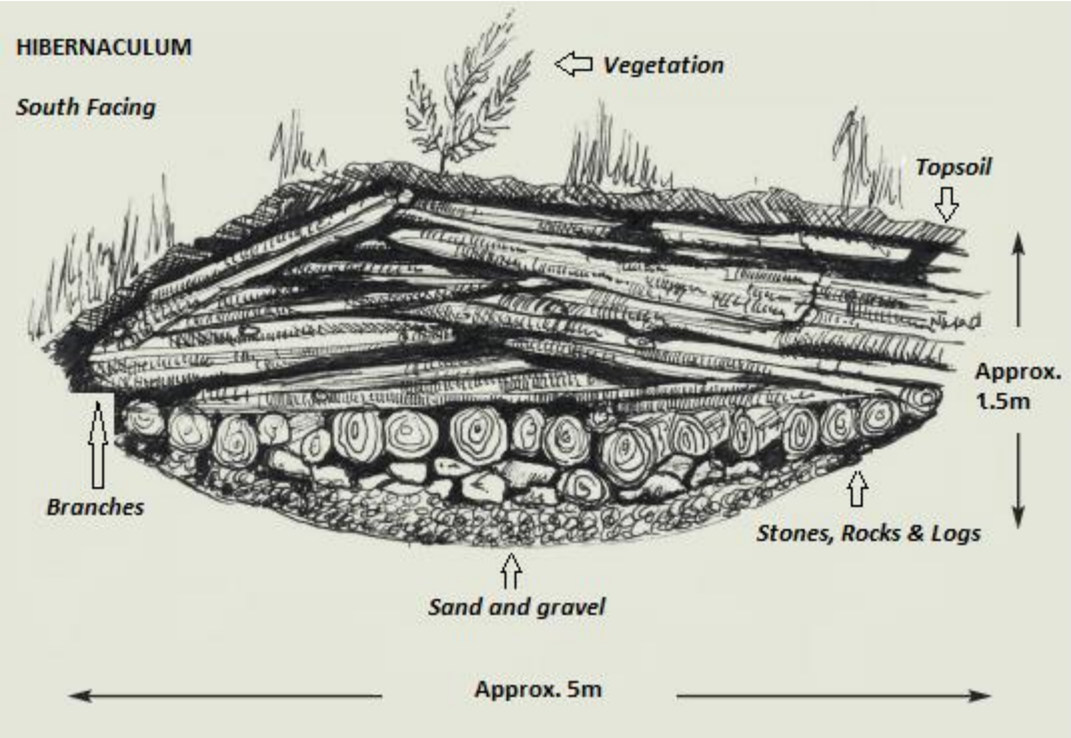
9. DECOMMISSIONING

9.1. At the end of the operational period, decommissioning will take place which will entail, dismantling and removing all of the materials and equipment in order to reinstate the land back to its original condition. Where possible retaining sections of grassland and maintaining the hedgerow boundary after the 30-35-year lifespan of the Proposed Development will be of benefit to wildlife.

10. APPENDIX

APPENDIX 5.1A - HIBERNACULUM CONSTRUCTION

10.1. The hibernaculum will follow the basic construction set out below, with the log and stone piles situated to the north of the hibernaculum.



- A 5m long east-west running ditch 1m deep and 1m wide will be dug.
- The base will be lined with sand and gravel.
- This will be followed with layers of stones, rocks and logs.
- Smaller branches will then be placed on top, and covered soil from the excavation will be placed over the pile, leaving gaps for access.
- The soil will be shaped into a mound.
- North facing side of the mound will be seeded / planted with species that will attract insects and will also provide extra shelter.
- South facing side will be maintained with a sparse vegetation cover to provide an area to bask.
- A log pile of approximately 2m by 1m will be placed to the north of the hibernaculum.

APPENDIX 5.1B – INVERTEBRATE BANK CREATION

Beetle Bank

- September is the best month to establish the grass sward that forms a beetle bank.
- Create a raised bank of about 0.4 metres
- The grass mix should include up to 60% of tussock-forming species such as cocksfoot or Scots timothy grass. For the rest of the mix choose native species and include fescues
- Up to three cuts may be needed in the first summer (when the sward reaches 10 cm in height) to encourage the grasses to tiller and to help control invasive annual weeds.
- Once established, the grass strips should be cut typically no more than once every three years.

Bee Bank

- Material (such as aggregate and sand) will be shaped into a mound with various slopes, hollows and angles that may be utilised and favoured by different species.
- Vertical banks created on bee banks take much longer to vegetate and this makes them attractive to many species. Over time a bee bank will be vegetated over through succession.
- Planting vegetation in an open structure in front of a bee bank will provide extra habitat 0for invertebrates that are attracted to the bee bank.
- These banks should be created close to flower rich areas which will provide important foraging areas for pollinators.

Bug Hotel

- To be located within close proximity to hedgerow or tree to offer some shade
- Main structure to comprise of wooden pallets, with the bottom pallet turned upside down to provide stability
- Gaps created between the pallets should be filled with various materials such as:
  - Dead wood
  - Straw and hay
  - Dry leaves
  - Loose bark
  - Hollow stems, such as old bamboo canes, or holes drilled into blocks of wood, make good nest sites for solitary bees
  - Stones and tiles
  - Hedgehog boxes could be incorporated into these bug hotels to provide additional habitat for this species within the Development site

Technical Appendix 6.1: Flood Risk Assessment

Harristown Solar Farm

04/10/2018

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Contents

1. EXECUTIVE SUMMARY

1.1. Neo Environmental Ltd has been appointed by Lightsource BP to produce a Flood Risk Assessment for a proposed solar farm development with associated infrastructure on lands at Harristown, Castlejordan and Clongall Co. Meath. The assessment will be submitted to Meath County Council as a technical appendices of an Environmental Impact Assessment Report (EIAR) required as part of a request for further information (RFI) for the project.

1.2. This assessment involved detailed hydrological analysis of the River Boyne and three small watercourses which run through the Application Site and drain into the river.

1.3. The River Boyne was modelled in 1D using survey and LiDAR topographic information. Model results for both the 1 in 100 and 1 in 1000-year flood events indicate a potential for the flooding of a low-lying area of the Proposed Development. A model sensitivity analysis was also undertaken which indicates that the model is sensitive to changes to the downstream boundary. It is recommended that the Proposed Development is located outside this flood extent based on the conservative downstream boundary estimate.

1.4. Three internal Watercourses were also modelled in 1D using survey data. Model results indicate that all three channels are not predicted to overtop during a 100-year and 1000-year event.

1.5. Ground levels rise to the north, east and south of the Application Site; however, based on a number of existing local drainage ditches and the relatively small upstream catchment, the risk of flooding from surface water runoff is low.

1.6. The GSI indicated that the site is in an area of "Moderate" groundwater vulnerability and is situated close to "High" areas of groundwater vulnerability. Local groundwater levels often respond to water levels within nearby watercourses. Therefore, it is likely that groundwater levels within the lower part of the Application Site may be dictated by water levels in the adjacent watercourse. This has been considered in the design of the Proposed Development which is located in the 1 in 1000-year flood level.

1.7. 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 document.

1.8. That being said, the council Flood Officer David Keyes has indicated that MCC classes the whole development as essential infrastructure and therefore must to be located entirely in Flood Zone C, except for the access tracks, fencing and temporary construction compounds. As a result, the client has moved all development outside the predicted 1000-year flood extent assuming the more conservative downstream boundary condition.

2. INTRODUCTION

BACKGROUND

2.1. Neo Environmental Ltd has been appointed by Lightsource BP (the "Applicant") to produce a Flood Risk Assessment (FRA) for a proposed solar farm development with associated infrastructure (the "Proposed Development") on lands at Harristown, Castlejordan and Clongall, County Meath. The assessment will be submitted to Meath County Council (MCC) as an appendix to the **Land, Soil and Water EIAR Chapter** (**Chapter 6 in Volume 2).**

DEVELOPMENT DESCRIPTION

2.2. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, battery storage and all ancillary grid infrastructure and associated works.

2.3. For a full description of the Proposed Development and the various elements, please see **Chapter 1: Introduction in Volume 2** of this EIAR.

2.4. A substation will need to be constructed, which will form part of a separate Strategic Infrastructure Development (SID) application to An Bord Pleanála. However, an assessment of this has been included within the main sections of this report and where undertaken has been clearly identified.

SITE DESCRIPTION

2.5. The area containing all elements of the Proposed Development (the "Application Site"), consists of 21 fields (including field 15 with the SID substation) currently used as pasture and covers a total area of 91.44 ha. The site lies at an elevation range of 66m— 71m AOD and is centred at approximate Irish Grid Reference (IGR) E260861 N238688. The River Boyne flows 0.19km to the east and 0.62km to the south of the site, forming the county border of Kildare and Offaly, respectively. Access will be via a pre-existing track which runs north to south through the site and connects to the L4091 north of the Application Site. The nearest settlement is the village of Castlejordan, which is located approximately 650m to the northwest of the site.

Scope of Report

2.6. The OPW Preliminary FRA maps for Ireland indicate that the southeastern extent of the Application Site is at risk of fluvial flooding.

2.7. The scope of work included in this FRA assessment includes the following:

- Walkover site visit;
- Review of historical maps and available historical flood records;
- Hydrological assessment to estimate various return period flows in the adjacent watercourse, based on standard methods;
- Development of a mathematical model of the watercourse and associated floodplains in the vicinity of the site;
- Preparation of flood maps; and
- Preparation of a technical report summarising the study and its findings.

2.8. Information made available to Neo for the study includes the following:

- Site location map;
- Topographic survey; and
- LiDAR DTM data (purchased from Ordnance Survey Ireland).

2.9. The work carried out to assess the flooding risk of the Proposed Development and main findings of the study are summarised in the following sections.

Consultation

2.10. The request for further information (FI) item 3 stated the following:

"Having regard to Meath County Development Plan in which it is policy to consider the DOEHLG / OPW publication "The Planning System and Flood Risk Management, Guidelines for Planning Authorities" and with reference to OPW CFRAM flood mapping for the relevant area the proposed development site is partially situated in Flood Zone A and B with regards to flood Risk, i.e. part of the site is at medium to high risk of flooding. In accordance with the aforementioned guidelines the applicant shall prove to the satisfaction of the Planning Authority that critical elements of the development are within Flood Zone C or otherwise apply

the 'Development Management Justification Test' as set out in Chapter 5 of the same guidelines to rigorously assess the appropriateness of the proposed development and shall submit all matters relating to this Justification Test and all matters relevant to flood risk including critical flood levels and extents on the proposed development site to the Planning Authority for their further consideration".

2.11. A meeting regarding the FI took place on the 13th November 2018 and the county councils flood officer, David Keyes, was in attendance. Mr Keyes stated that there were no major issues with the original Flood Risk Assessment submitted with the planning application, however wanted the following clarified:

- Consultation with Office for Public Works to check the modelling method used is compliant.
- Clarify how conclusions of the modelling analysis and flood zones used.

2.12. The OPW were consulted on the 11th July 2019 regarding the methodology chosen when undertaking the flood modelling for planning application TA/181225. They responded by stating that they do not comment on individual planning applications, however they could confirm that:

- The flow estimation techniques used in our hydraulic modelling, when applied correctly and are applicable to flood estimation in Ireland.
- Flood Modeller Pro (which was used for the modelling) is an industry standard software that is accepted by the OPW for use on the design of flood relief schemes

3. LEGISLATIVE AND POLICY ASPECTS

THE PLANNING SYSTEM AND FLOOD RISK MANAGEMENT – GUIDELINES FOR PLANNING AUTHORITIES

3.1. National guidelines set out by the Office of Public Works (OPW) require the planning system at national, regional and local levels to:

- Avoid development in areas at risk of flooding, particularly floodplains, unless there are proven wider sustainability grounds that justify appropriate development and where the flood risk can be reduced or managed to an acceptable level without increasing flood risk elsewhere;
- Incorporate FRA into the process of making decisions on planning applications and planning appeals; and
- Adopt a sequential approach to flood risk management when assessing the location for new development based on avoidance, reduction and mitigation of flood risk.

3.2. A five-stage process is followed as part of the sequential approach to flood risk management. This involves: **Avoiding** high risk areas; **Substituting** the type of development for that of lower vulnerability; **Justifying** why the development is suitable; **Mitigating** against flood risk to a suitable level and; **Proceeding** with the proposals if the Justification Test is passed.

3.3. In the Planning System and Flood Risk Management Guidelines, flood zones are used to indicate the likelihood of a flood occurring. These zones indicate a high, moderate or low probability of flooding from fluvial or tidal sources and are defined below in **Table 3-1**.

Table 3-1: Definition of Flood Zones

Zone	Description
Zone A **High Probability of flooding**	This zone defines areas with the highest risk of flooding from rivers (i.e. more than 1% probability or more than 1 in 100) and the coast (i.e. more than 0.5% probability or more than 1 in 200).

Zone B Moderate probability of flooding	This zone defines areas with a moderate risk of flooding from rivers (i.e. 0.1% to 1% probability or between 1 in 100 and 1 in 1000) and the coast (i.e. 0.1% to 0.5% probability or between 1 in 200 and 1 in 1000).
Zone C Low Probability of flooding	This zone defines areas with a low risk of flooding from rivers and the coast (i.e. less than 0.1% probability or less than 1 in 1000).

3.4. The Planning System and Flood Risk Management guidelines provide three landuse 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 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 3-2: 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

3.5. 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 Justification Test comprise 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.

3.6. When assessing flood risk, the impact of climate change and residual risk (such as culvert blockage), should be considered and used in the design of the finished floor levels (FFLs) in addition to an extra freeboard allowance.

RELEVANCE TO PROPOSED DEVELOPMENT

3.7. The proposed type of development is not specifically mentioned within any of the three landuse vulnerability categories outlined in The Planning System and Flood Risk Management document. Our interpretation of the guidelines is that any electricity generation, transformers, sub-stations, etc., associated with the development would be regarded as Highly Vulnerable Development.

3.8. Although the prime function of the development is for electricity generation, it is not a power station or substation on which local power supply rely; rather it is a facility contributing to the national electricity network. It may not be critical if it is not operational during a 1000-year flood event, or if it cannot be accessed during such an extreme event. Therefore, it is considered that Flood Zones B and C would be suitable for the development and a Justification Test would be required for Zone A. However, any transformer or other associated buildings critical to the operation of the scheme should be located in Zone C.

3.9. That being said, the council Flood Officer David Keyes has indicated that the council classes the whole development as essential infrastructure and therefore it is to be located entirely in Flood Zone C, except for the access tracks and fencing.

4. SITE LOCATION AND DESCRIPTION

4.1. The Application Site is located in a rural area, 650m to the southeast of Castlejordan and approximately 5km to the north of Edenderry. It is comprised of grass and scrub vegetation measuring 91.3ha in area, see **Photo 1 Appendix 6.1B.**

4.2. The Application Site and surrounding area is shown in **Figure 6.1.2 Appendix 6.1A**. The Proposed Development is surrounded by undeveloped farmland to the south, west and north. The River Boyne runs approximately 0.19km to the east.

4.3. An internal access track runs though part of the site before connecting to a local road to the north of the site.

TOPOGRAPHY

4.4. The general topography in the area slopes to the southeast, as shown in **Figure 6.1.3 Appendix 6.1A**. The topography was derived from 0.5 m LiDAR data which was flown specifically for this study and provided by the client.

4.5. Ground levels within low lying areas of the Application Site vary from approximately 66m – 65m AOD (Above Ordnance Datum); there are pockets of high ground which rise up to around 69m AOD within the centre of the Application Site. In addition, an area of high ground rises up to approximately 71m AOD to the south of the Application Site, this provides a defence from any potential food waters leaving the western bank of the River Boyne. Ground levels also rise to the north see **Photo 2 Appendix 6.1B.**

WATERCOURSES & WATER FEATURES

River Boyne

4.6. The River Boyne flows north near the eastern boundary of the Application Site. Historical maps of 1837-1842 indicate that the river experienced a number of meanders; however, the channel has since been straightened and runs north before turning northeast, away from the Application Site.

4.7. The main channel of the river adjacent to the Application Site measures approximately 3.5 m deep and 10 m wide from bank to bank, see **Photo 3 Appendix 6.1B**. There are no crossings present within the Application Site.

Internal Watercourses

4.8. There are three internal watercourses which drain land within the Application Site before discharging to the River Boyne, see **Figure 6.1.4 Appendix 6.1A**. The channels have been identified and named; "Watercourse N" "Watercourse S" and "Watercourse B". Watercourses S and B join close to the downstream reach of the Application Site before entering the River Boyne; Watercourse N runs along the northern area of the Application Site and enters the River Boyne a short distance north of the point where Watercourses S and B enter the river. **Photo 4 Appendix 6.1B** shows a view of Watercourse "N", showing the typical condition of the watercourses within the Application Site.

Local Drains

4.9. The Application Site is drained by a series of drainage ditches which drain low lying land and convey water into the internal watercourses. The Application Site is surrounded by undulating land; therefore, the ditches drain land which is generally limited to the Application Site only.

Historic Flood Search

4.10. The OPW National Flood Hazard Mapping website provides information on historic flood events including details on reports, photos, videos and newspaper articles.

4.11. No site-specific information on flooding of the Application Site could be identified.

4.12. The CFRAM maps for Ireland show the eastern part of the Application Site to be at risk of fluvial flooding from the River Boyne.

Council Consultation

4.13. Meath County Council were consulted with respect to flood risk for the Proposed Development and as parts of the Application Site are within Flood Zones A and B, they requested the applicant should undertake a Site-Specific Flood Risk Assessment for the Proposed Development. The council identified that this assessment should determine critical flood levels and extents on the site and shall apply the "development management

Justification Test" as set out in Chapter 5 of the "The Planning System and Flood Risk Management Guidelines." All matters relating to the Justification Test should be submitted to the council for their consideration.

4.14. The council Flood Officer David Keyes has indicated that the council classes the whole development as essential infrastructure and therefore it was to be located entirely in Flood Zone C, except for the access tracks and fencing. He had the following comments to make regarding any fencing and access track to be located within the 1 in 1000-year flood zone:

- Fencing which is within the Flood Zone B is to be limited to deer fencing and any deer fencing crossing a watercourse cannot extend into the watercourse and a gate/retainer must be used to keep out cattle and not to impact on the flow of water in a 1 in 1000-year flood event.
- Where access tracks are to be located within the Flood Zone B, they must not be raised above the local ground level so as not to remove any flood plain storage. Tracks within this area must also be delineated with a marker pole that shows the depth of the 1 in 1000-year flood level.

4.15. The flood officer also stated that the construction compound could be located within the 1 in 100-year flood zone, as it was only temporary. The compound location should be restored to its natural condition at the end of the construction period.

5. HYDROLOGICAL ANALYSIS

5.1. A hydrological assessment was undertaken to estimate peak design flows for the River Boyne and the watercourses which flow through the Application Site and discharge into the River. Design hydrographs were also estimated for modelling purposes.

5.2. The standard flow estimation method employed in Ireland is the Office of Public Works (OPW) Flood Studies Update 3 Variable (OPW FSU 3V) method. This is similar to the UK FEH statistical method where catchment descriptors are used to estimate a QMED value for the catchment which can be adjusted with a suitable gauged pivotal (donor) catchment, if applicable. A pooling group is subsequently developed, using gauged data, and a suitable growth curve chosen to produce estimated peak flows. However, it should be noted that this method has not been specifically designed for catchments of less than 25km², similar to the FEH statistical method; however, studies (FSU WP4.2, 2012) have shown the results to be better than commonly used older methods, such as the IH124 method.

5.3. The alternative method for smaller catchments is the FSU 4.2a regression method (FSU WP4.2, 2012). This is an equation based on catchment descriptors that has been developed specifically for use in smaller catchments. This method has also been used as part of this assessment for comparison.

5.4. The IH124 (Institute of Hydrology 124 – Flood Estimation for small catchments) method is still commonly used in the UK and Ireland for the estimation of flows for smaller watercourses due to its simplicity. However, the FSU methods are now considered to be more accurate by the OPW. Although the IH124 method is an older method, it generally predicts more conservative flows and has been used as part of this assessment.

5.5. Peak flows have been estimated for the relevant watercourses as follows:

- River Boyne; and
- Southern Watercourse “N”, Watercourse “B” and Watercourse “S”

ESTIMATION OF DESIGN FLOWS FOR RIVER BOYNE

5.6. The catchment area for the River Boyne at site is approximately 279.1km². The catchment descriptors were obtained from the OPW Rainfall and Flood Estimation application that is accessed via the FSU web portal. The catchment is shown in **Figure 6.1.5 Appendix 6.1A** and the extracted catchment characteristics are shown in **Table 5.1**.

Table 5-1: Catchment descriptors for River Boyne at site

Parameter	Value
Location Number	07_271_3
Contributing Catchment Area	279.097 km^2
BFISOIL	0.6349
SAAR	873.25 mm
FARL	1
DRAIND	0.761 km/km^2
S1085	0.995 m/km
ARTDRAIN2	0.751
URBEXT	0.0143
Centroid distance	27.7049 km
Coordinates	[261409.9964, 238085.9987]

5.7. Flows were estimated using the FSU 3V and FSU 4.2a methods. The results are tabulated in **Table 5-3**.

5.8. The FSU V3 method uses data from similar, gauged catchments to estimate design flows. Based on observed gauged data, this method is generally considered more accurate than others, if used correctly.

5.9. First the QMED is estimated for the subject catchment. The QMED estimated using catchment descriptors was 29.8 m^3/s. Adjusting the QMED based on a similar gauged catchment reduced the QMED to 25.1 m^3/s. The QMED was adjusted using the pivotal catchment 07007 BOYNE AQUEDUCT. This gauge lies within the same watershed as the subject site, some way downstream of the Application Site. The guidance suggests that it is preferable to use pivotal catchments from within the same catchment. A flow estimate was also made using the unadjusted QMED for comparative purposes. **Figure 6.1.6 Appendix 6.1A** shows the pivotal catchment and the subject catchment.

5.10. A Euclidean pooling group was then developed to produce a suitable growth curve. Various pooling groups were designed and tested. It is normally recommended that a pooling group should be developed in line with "T5" criteria to provide sufficient gauged data to provide good flow estimates. The T5 refers to the total gauged years of data needing to be five times that of the required return period. This means that 5000 years of data is required for a 1 in 1000-year return period event. However, due to a lack of gauged data, meeting the T5 criteria for a 1 in 1000-year return period event means using a heterogenous pooling group.

5.11. A number of pooling groups were developed. It was determined that a smaller pooling group, using 500 years of gauged data, provided more conservative flow estimates for both the 1 in 100 and 1 in 1000-year return period events, compared to a larger pooling group, regardless of the growth curve used. For this reason, it was decided to employ the smaller, more homogenous, pooling group. Details of the pooling group used are shown in Table 5-2.

Table 5-2: Pooling Group – River Boyne at site

Station	Euclidean DIST(ij)	# years in FSU database	Cumulative # station-years
06013	0.157	30	30
06014	0.349	30	60
07007	0.413	45	105
06025	0.454	30	135
24002	0.5	32	167
25016	0.505	48	215
07003	0.565	46	261
16002	0.578	51	312
15005	0.583	49	361
16004	0.627	48	409
36018	0.64	50	459
14013	0.658	49	508
16001	0.673	33	541
14011	0.677	25	566
06026	0.679	46	612
25021	0.685	44	656

07001	0.706	18	674
18004	0.784	45	719

5.12. The software then calculates a number of growth curves including the GEV (Generalised Extreme Value), LO (Logistic), GLO (Generalised Logistic) and LN3 (Generalised Log normal distribution). The LO growth curve resulted in the most conservative 1 in 100-year and 1 in 1000-year flows. The GEV and GLO growth curves are generally recommended for ungauged catchments but in this instance the most conservative LO estimates were used. These estimates are shown in **Table 5-3**. Estimates using the unadjusted QMED are also provided.

5.13. For smaller catchments, the FSU 4.2a regression equation method can be used to estimate the QMED from the catchment descriptors. However, it should be noted that this method is only recommended for use in smaller catchments and so the results have only been provided here as a comparison. The 1 in 100-year and 1 in 1000-year flows are estimated using the LO growth curve.

Table 5-3: Design flows for Western and Southern Watercourse

Estimation Method	QMED (m^3/s)	1 in 100-year flow (m^3/s)	1 in 1000-year return period (m^3/s)
FSU 3V - Adjusted Q_{MED}[1]	25.1	*53.8*	*68.4*
FSU 3V – Q_{MED}[2]	*29.8*	63.8	81.1
FSU 4.2a - Q_{MED}[3]	*31.2*	66.7	84.8

5.14. The most conservative estimates were made using the FSU 4.2a method. It is likely that this flow is an overestimation; however, to be conservative the resultant peak flows have been used for the modelling assessment undertaken in the 'Mathematical Modelling' section of the report below.

1 QMED estimated from catchment descriptors and adjusted using a pivotal gauged catchment. See main text.

2 QMED estimated from catchment descriptors.

3 QMED estimated using the FSU 4.2a regression equation for small catchments of less than 25km². This is not suitable for larger catchments but is shown for comparison.

DESIGN HYDROGRAPH

5.15. Design hydrograph shapes in Ireland are based upon those derived from gauged catchments. They are estimated using the relevant OPW Rainfall and Flood Estimation application that is accessed via the FSU web portal.

5.16. For the River Boyne, the hydrograph was derived using pivotal catchment 07007 BOYNE AQUEDUCT. This should be the most relevant catchment as it lies within the same watershed.

5.17. It was determined that the hydrograph estimated using the catchment descriptors was similar to that using the adjusted donor catchment. The most conservative hydrograph (longest) was used in this assessment. Due to the size of this catchment, the final hydrograph is in excess of a 120-hour duration. The design hydrograph for the 1 in 100-year event is shown in **Figure 6.1.7 Figure 6.1A.**

ESTIMATION OF DESIGN FLOWS FOR INTERNAL WATERCOURSES

5.18. Based on OPW contour information and available LiDAR data, the combined catchment area for the internal watercourses is approximately 3.25km² at the confluence with the River Boyne. Smaller catchments cannot be extracted from the OPW Rainfall and Flood Estimation application that is accessed via the FSU web portal; therefore, catchment descriptors could not be obtained for the watercourses due to their small size.

5.19. OPW maps indicate that the internal watercourses merge at the eastern boundary of the Application Site before discharging into the River Boyne. However, further assessment of the Application Site indicated that Watercourses S and B merge before entering the Boyne; Watercourse N is separate and flows directly into the Boyne. The flows from the combined catchment have been calculated based on the FSU 4.2a regression equation and the IH124 method. The flows can then be apportioned by catchment area.

5.20. For smaller catchments, the FSU 4.2a regression equation method can be used to estimate the QMED from the catchment descriptors. This was undertaken using the catchment descriptors from the River Boyne with the S1085 slope figure estimated using LiDAR DTM data for the surrounding area. The total results are shown in **Table 5-4.**

5.21. In addition, the IH124 method was used to estimate peak flows. A soil value of 4 was used due to the poorer permeability of the soils in this area. The Ireland East Growth Curves were used from table 6 of *'Comment on Estimation of Greenfield Runoff Rates'* [4]. The estimates are also shown in **Table 5-4.**

[4] A. M. Cawley & C. Cunnane, Comment on Estimation of Greenfield Runoff Rates, 2015. Found at https://www.researchgate.net/publication/255621672_Comment_on_estimation_of_Greenfield_Runoff_Rates

Table 5-4: Design flows for the Internal Watercourse combined catchment

Estimation Method	QMED (m^3/s)	1 in 100-year flow (m^3/s)	1 in 1000-year flow (m^3/s)
IH124	1.48	2.80	3.60
FSU 4.2a Q_{MED}	0.44	0.94	1.20

5.22. To be conservative, the IH124 flow was used as the highest flow estimate. To ascertain the individual flow in each watercourse, the IH124 total was apportioned based on the size of the corresponding catchment, see **Table 5-5.** The below estimates were used in the modelling (see 'Mathematical Modelling' section of the report).

Table 5-5: Design flows for the Internal Watercourses

Watercourse/Catchment	Area (km^2)	1 in 100-year flow (m^3/s)	1 in 1000-year flow (m^3/s)
Watercourse "N"	1.09	0.94	1.21
Watercourse "S"	0.75	1.21	1.56
Watercourse "B"	1.41	0.64	0.82

6. MATHEMATICAL MODELLING

6.1. Watercourses “N”, “S”, “B” and the River Boyne and associated floodplains were modelled in 1D using Flood Modeller Pro software package.

RIVER BOYNE

Model Development

6.2. The River Boyne runs north, parallel to the Application Site for a short reach before turning northeast and flowing away from the Application Site. In total, five channel cross sections were surveyed and, due to access restriction, six cross sections were extracted from LiDAR data which was flown specifically for this assessment. Model cross section locations are provided in **Figure 6.1.8 Appendix 6.1A.**

6.3. Whilst cross sections extracted from LiDAR are accurate for bank and floodplain areas, they do not account for the full shape of the bed of the channel. This is because LiDAR does not penetrate water; therefore, a comparison between surveyed bed levels and LiDAR data of the channel was made and it was found that surveyed bed levels were generally 1.4m lower than bed level extracted from LiDAR, see **Figure 6.1.9 Appendix 6.1A**.

6.4. Where surveyed cross sections ended at bank top, LiDAR data was used to extend cross sections into the floodplain, where required.

6.5. The model was based on Flood Modeller Pro 1D Module and was run dynamically with a one second timestep.

6.6. Channel bed friction (Manning’s n) values were set to 0.065 for the main channel and floodplains, respectively, based on field observations.

6.7. Due to a lack of survey data, a normal depth of 0.000524 (1 in 1900) was estimated for the downstream boundary based on general slope of the channel. This value is likely to be conservative and a sensitivity analysis was undertaken to assess the effect of the downstream boundary slope on peak water level at the Application Site.

6.8. A flow boundary was used at the upstream boundary set to the 100-year and 1000-year flows as described in the 'Hydraulically Analysis' section of the report.

Model Results

6.9. The 1D model was run for the 100-year and 1000-year floods. The predicted water levels are provided in **Table 6-1** below.

Table 6-1: Predicted peak water levels at modelled cross sections

Model cross-section (see Figure 4-8)	Predicted 100 year flood level (m AOD)	Predicted 1000 year flood level (m AOD)
I6	65.38	65.77
W5	65.14	65.63
W4	64.97	65.50
W3	64.86	65.34
W2	64.80	65.25
W1	64.66	65.12
I1	64.75	65.23
I2	64.71	65.22
I3	64.57	65.13
I4	64.49	65.06
I5	64.25	64.84

6.10. A flood map showing the extent of the 100-year and 1000-year flow is provided in **Figure 6.1.10 and Figure 6.1.11 Appendix 6.1A**, respectively.

Model Sensitivity Analysis

6.11. There are no bridge crossings or hydraulic structures within the reach of the model therefore; there are two key parameters which could affect the modelled flood levels. These are changes to the downstream boundary water level and changes to friction.

6.12. A conservative downstream boundary of 0.000524 (1 in 1900) was used as the base case which was derived from the gradient of the last two cross sections used in the model. However, the cross sections are based on LiDAR data and there is a degree of uncertainty regarding the actual bed levels and channel gradient in this area. As a sensitivity check, a downstream boundary gradient of 0.00278 (approximately by a factor of two) was chosen to assess the effect of changes to the boundary on peak water levels at the Application Site.

6.13. Model results indicated that by decreasing the downstream boundary slope by a factor of approximately two, average peak water levels increase by approximately 0.44m for the 100-year event and 0.48m for the 1000-year event.

6.14. An additional model run was undertaken with friction coefficient multiplied by a factor of 1.2 (i.e. friction increased by 20%). Model results for the 100-year event indicated that peak water levels could increase by an average of 0.33m throughout the reach of the model.

Watercourse N

Model Development

6.15. Watercourse N runs east, close to the northern boundary of the Application Site before turning southeast and heading towards the River Boyne. In total, seven channel cross sections were surveyed. Model cross section locations are provided in Figure 6.1.12 Appendix 6.1A.

6.16. The model was based on Flood Modeller Pro software package 1D Module and was run dynamically with a one second timestep.

6.17. Channel bed friction (Manning's n) values were set to 0.04 for main channel and 0.060 for the banks and floodplains, respectively.

6.18. Due to the difference in catchment size, the chance of the River Boyne and the channel peaking at the same time is statistically very small, therefore, a normal depth downstream boundary based on the gradient of the last two surveyed cross sections was used as the downstream boundary.

6.19. A constant inflow boundary set to the 100-year and 1000-year flows as described in the 'Hydraulically Analysis' section of the report, was used at the upstream inflow boundary.

Model Results

6.20. The 1D model was run for the 100-year and 1000-year floods.

6.21. The model results indicated that flows would be confined in bank and no overtopping of the channel was predicted for either event; hence, a flood map has not been produced.

Model Sensitivity Analysis

6.22. Increasing flow from 100-year to 1000-year results in an average increase in water level of up to 0.09m.

6.23. The downstream boundary slope was decreased by a factor of two, giving a higher water level at the boundary for a given flow. Model results indicated that the predicted peak water level was increased by up to a maximum of 0.12m in close proximity of the downstream boundary.

6.24. An additional model run was undertaken with friction coefficients increased by a factor of 1.2 (i.e. an increase of 20%). This model run with higher friction indicated that average peak water levels did not increase more than 0.06m through the Application Site, indicating the model results are relatively insensitive to changes in friction.

6.25. There are two crossings on Watercourse N. The detailed topographic survey of the Application Site indicated that ground levels rise on both sides of the crossing, and therefore flood waters would be expected to overtop the crossing and spill back into the open channel downstream during a blockage event.

WATERCOURSE S AND B

Model Development

6.26. Watercourse S and B drain land within the centre and south of the Application Site before combining and discharging into the River Boyne; as a result, both channels have been modelled together. In total, 12 channel cross sections were surveyed along these watercourses. Model cross section locations are provided in **Figure 6.1.13 Appendix 6.1A.**

6.27. The model is based on Flood Modeller Pro software package 1D module and was run dynamically with a one second timestep.

6.28. Channel bed friction (Manning's n) values were set to 0.04 for main channel and 0.060 for the banks and floodplains respectively.

6.29. Due to the difference in catchment sizes between these watercourses and the River Boyne, the chance of the large river and the small watercourse peaking at the same time is statistically very small, therefore, a normal depth downstream boundary based on the gradient of the last two surveyed cross sections was used as the downstream boundary condition.

6.30. A constant inflow boundary set to the 100-year and 1000-year flows as described in the 'Hydraulically Analysis' section of the report, was used as the inflows at the top of the watercourses.

Model Results

6.31. The 1D model was run for the 100-year and 1000-year floods.

6.32. The model predictions indicated that flows would be confined in bank and no overtopping of the channel was predicted for either event; hence a flood map has not been produced.

Model Sensitivity Analysis

6.33. Increasing flow from 100-year to 1000-year results in an average increase of water levels of up to 0.11m.

6.34. The downstream boundary slope was decreased by a factor of 10. Model results indicated that water levels could increase up to 0.48m at the downstream boundary. The effect of this is discussed as part of the flood mitigation measures.

6.35. An additional model run was undertaken with friction coefficients increased by a factor of 1.2 (i.e. increased by 20%). This model runs with higher friction indicated that water levels increased by an average of 0.34m at the site.

6.36. In the event of a full blockage to the Watercourse N channel at the upstream reach, outside of the Application Site boundary, it is possible that flows from the north could enter the Watercourse S channel. As a result, an additional model run was undertaken where a total flow of 3.6m^3/s entered Watercourse S (i.e. 1.56m^3/s plus 1.21m^3/s from Watercourse N). The results indicated that the channels had sufficient capacity to contain the additional flows.

7. FLOOD RISK ASSESSMENT

7.1. The FRA considers flooding risk from:

- River Boyne;
- Watercourses N, S and B
- Surface water;
- Groundwater; and
- Infrastructure failure.

RIVER BOYNE

7.2. The River Boyne flows north before turning northeast close to the western boundary of the Application Site. The channel has been straightened and follows a uniform shape adjacent to the Application Site.

7.3. Flood Modeller Pro software package was used to model the river channel and associated floodplains using flows calculated in the 'Hydraulically Analysis' section of the report. The model comprised cross section data based on a specific topographical survey as well as sections extracted from LiDAR data.

7.4. The River was modelled in 1D and assessed against the 100-year and 1000-year flood events. Model results for both events indicated that a low-lying area of land close to the south eastern boundary of the Application Site is predicted to be at risk of flooding. Figures 6.1.10 and 6.1.11

Appendix 6.1A show the extent of the functional floodplains for the 100 and 1000-year respectively.

7.5. A sensitivity analysis was undertaken which indicated that there was uncertainty with the derivation of the downstream boundary conditions and therefore peak water levels could increase by an average of approximately 0.5m. Therefore, to be conservative, it is recommended that the Proposed Development is situated outside the 1000-year flood extent based on the extreme downstream boundary conditions, see **Figure 6.1.14 Appendix 6.1A**.

Watercourses N, S and B

7.6. Watercourses N, S and B drain low lying land within the site. Watercourse N flows close to the northern boundary of the Application Site. Whereas Watercourses S and B flow through the central and southern areas of the Application Site. All watercourses discharge into the River Boyne close to the eastern boundary of the Application Site

7.7. Flood Modeller Pro was used to model all three watercourses. Watercourse N was modelled independently, and Watercourses S and B were modelled together.

7.8. All channels were assessed against the 100-year and 1000-year flow events. Model results indicated that flood waters would be confined in bank and no overtopping of the channel banks was predicted from the respective channels.

Surface Water Flooding

7.9. The Application Site is situated on an area of sloping land, which gently falls to the southeast, towards the River Boyne.

7.10. Based on OPW contour information of the surrounding site, a limited area of high ground surrounds the Application Site to the north, west and south. However, it is noted that a number of local drainage ditches are located within and upslope of the Application Site. The ditches were likely constructed to manage surface water within the Application Site.

7.11. Based on the limited catchment area and the number of drainage ditches which could flow towards the Application Site, the risk of flooding from surface water runoff is considered to be low. However, internal flow paths through the Application Site have been considered in the design of the site so that such flows are routed through the site without affecting the Proposed Development.

Groundwater Flooding

7.12. 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.

7.13. The Preliminary FRA (PFRA) mapping for County Meath considered groundwater flooding. This mapping does not show any groundwater flooding close to or within the Application Site.

7.14. The Geological Survey Ireland (GSI), provide groundwater vulnerability maps that indicate the vulnerability index of the groundwater across Ireland. Theoretically, the more vulnerable the groundwater is to contamination (caused by contaminated particulates infiltrating through the soil), the greater the chance there is of the groundwater rising to the surface.

7.15. The mapping marks the Application Site as generally lying within a "Moderate" vulnerability zone, suggesting that there is a risk of flooding from groundwater sources. Land close to the northeast of the Application Site is marked as having a "High" vulnerability.

7.16. Local groundwater levels often respond to water levels within nearby watercourses. Therefore, it is likely that groundwater levels within the lower part of the Application Site may roughly be dictated by water levels in the adjacent watercourse.

7.17. Based on the above information, the risk of flooding due to groundwater contamination within the floodplain area of the Application Site is predicted to be **low**.

Flooding from Infrastructure Failure

Drainage Systems

Proposed Development

7.18. The design of the site drainage system is included in **Technical Appendix 6.2: Drainage Impact Assessment**.

7.19. While it has been argued above that the Proposed Development will not result in a material increase in surface water runoff flow rates, it is proposed to construct a swale within Field 15 of the Application Site (See **Figure 6.2.2 Appendix 6.2A**). The location of the swale has been chosen to attenuate runoff from the battery storage area which is the largest part of new impermeable development associated with the Proposed Development. The other buildings are located at various locations across the Application Site and are too small to require specific drainage schemes on their own and any excess water will slowly drain into the underlying geology through infiltration. That being said the swale has been sized to attenuate to the 1 in 100-year greenfield rate for all of the new areas of impermeable development.

7.20. The proposed swale will be approximately 65m in length, with a base width of 500mm, a 500mm design depth, 150mm freeboard and a maximum side slope of 1 in 3.

7.21. It will provide a total storage volume of approximately 65m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (41.5m^3). It is therefore considered that this adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area and provides improvement.

7.22. The swale will be implemented during the construction phase of the proposed solar farm and planted with vegetation to protect against soil erosion. The swale will be maintained throughout the operational period (30—35 years) of the Proposed Development, in accordance with the recommendations in the appropriate guidance.

110kV Substation Compound (Separate SID Application to ABP)

7.23. Surface water drainage proposals for the Substation Compound have been developed to mimic the natural drainage patterns of the site and thereby be in accordance with the Best Management Practices (BMPs) of Sustainable Drainage Systems (SuDS).

7.24. The attainment of this aspiration is easily achieved when the following parameters are considered (see drawing pack site layout):

- The Substation Compound construction is formed with permeable stone thus mimicking a soak away scenario. Substation Compound stone is single sized for the first 150mm for safety purposes. It then changes to a graded 6F2 material. The area of this permeable surface is approximately 12,375m^2.
- The area to be drained includes the roofs and the bunded plinths. These equate to 591.7m^2 and are very modest in themselves and in comparison, to the overall compound area.
- Assuming even the most basic of infiltration rates down through the permeable compound stone, it is clear that the existing greenfield situation is easily maintained.

7.25. The surface water generated in the bunded areas will discharge to the existing drainage via a Class 1 Full Retention Oil Separator. The electrical transformer in the substation is oil filled equipment and, as such, is protected with impermeable bunds. Surface water generated in this bund will be pumped out by an oil sensitive pump ensuring that only non-contaminated water enters the site drainage network. The Class 1 Full Retention Oil Separator will provide a second level of defense.

7.26. The Substation Compound Drainage network consists of a number of pipes connecting to a small soak away, which will need to be sized to attenuate 11.5m^2 of surface water. This will then flow into the existing site drainage network. This is subject to minor change depending on the final Substation Compound Application.

Reservoirs & Flood Defences

7.27. Ordnance Survey Ireland mapping does not show any reservoirs upstream of the Application Site that may impact the site in the event of dam failure. The Application Site is therefore considered to be at low risk of flooding from reservoir failure.

7.28. There are no flood defences within the vicinity of the Proposed Development. The Application Site is therefore considered to be at low risk of flooding from flood defence failure.

SITE ACCESS

7.29. Access to the Application Site will be from the existing local road to the north. Site access points should be designed to dissuade excess surface water entering the Application Site from the existing road, or vice versa.

7.30. None of the internal access tracks are located in any of the 100 or 1000-year flood zones.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. The Proposed Development consists of a solar farm with associated infrastructure. AN EIAR has been requested as part of an RFI for the Proposed Development and this Flood Risk Assessment forms an Appendix to **Chapter 6: Land, soil and Water,** located in **Volume 2.**

8.2. A site-specific FRA was carried out which involved detailed hydrological analysis of the River Boyne and three small watercourses which run through the Application Site and drain into the river.

8.3. The River Boyne was modelled in 1D using survey and LiDAR topographic information. Model results for both the 1 in 100 and 1 in 1000-year flood indicated that flooding of a low-lying area of the Proposed Development was predicted. Model sensitivity analysis was also undertaken which indicated that the model is sensitive to changes to the downstream boundary. It is recommended that the Proposed Development is located outside the more extensive flood extent based on the conservative downstream boundary estimate.

8.4. Three internal Watercourses were also modelled in 1D using survey data. Model results indicated that all three channels were not predicted to overtop during a 100-year and 1000-year event.

8.5. Ground levels rise to the north, east and south of the Application Site; however, based on a number of existing local drainage ditches and the relatively small upstream catchment, **the risk of flooding from surface water runoff is low**.

8.6. The GSI indicated that the site is in an area of "Moderate" groundwater vulnerability and is situated close to "High" areas of groundwater vulnerability. Local groundwater levels often respond to water levels within nearby watercourses. Therefore, it is likely that groundwater levels within the lower part of the Application Site may roughly be dictated by water levels in the adjacent watercourse. This has been considered in the design of the Proposed Development which is located above the 1 in 1000-year flood level.

8.7. The proposed type of development is not specifically mentioned within any of the three landuse vulnerability categories outlined in The Planning System and Flood Risk Management document.

8.8. That being said, the council Flood Officer David Keyes has indicated that MCC classes the whole development as essential infrastructure and therefore it was to be located entirely in Flood Zone C, except for the access tracks, fencing and temporary construction compounds. As a result, the client has moved development outside the predicted 1000-year flood extent assuming the more conservative downstream boundary condition.

9. APPENDICES

APPENDIX 6.1A– FIGURES

- Figure 6.1.1: General Site Location
- Figure 6.1.2: Detailed site location (Application site boundary shown in red)
- Figure 6.1.3: Topography of site and surrounding area based on LiDAR data
- Figure 6.1.4: Schematic and watercourse locations
- Figure 6.1.5: Combined catchment of River Boyne
- Figure 6.1.6: Pivotal catchment for River Boyne
- Figure 6.1.7: 1 in 100-year design hydrograph for River Boyne
- Figure 6.1.8: River Boyne 1D cross section locations (W – represent surveyed I – represent extracted from LiDAR)
- Figure 6.1.9: Cross section comparison
- Figure 6.1.10: 1 in 100-year floodplain for River Boyne
- Figure 6.1.11: 1 in 1000-year floodplain for River Boyne
- Figure 6.1.12: Watercourse N cross section locations
- Figure 6.1.13: Watercourse S and B cross section locations
- Figure 6.1.14: Conservative 1000-year flood map to show area suitable for development

APPENDIX 6.1B – PHOTO REGISTER

Appendix 6.1A: Figures

Figure 6.1.1: General site location

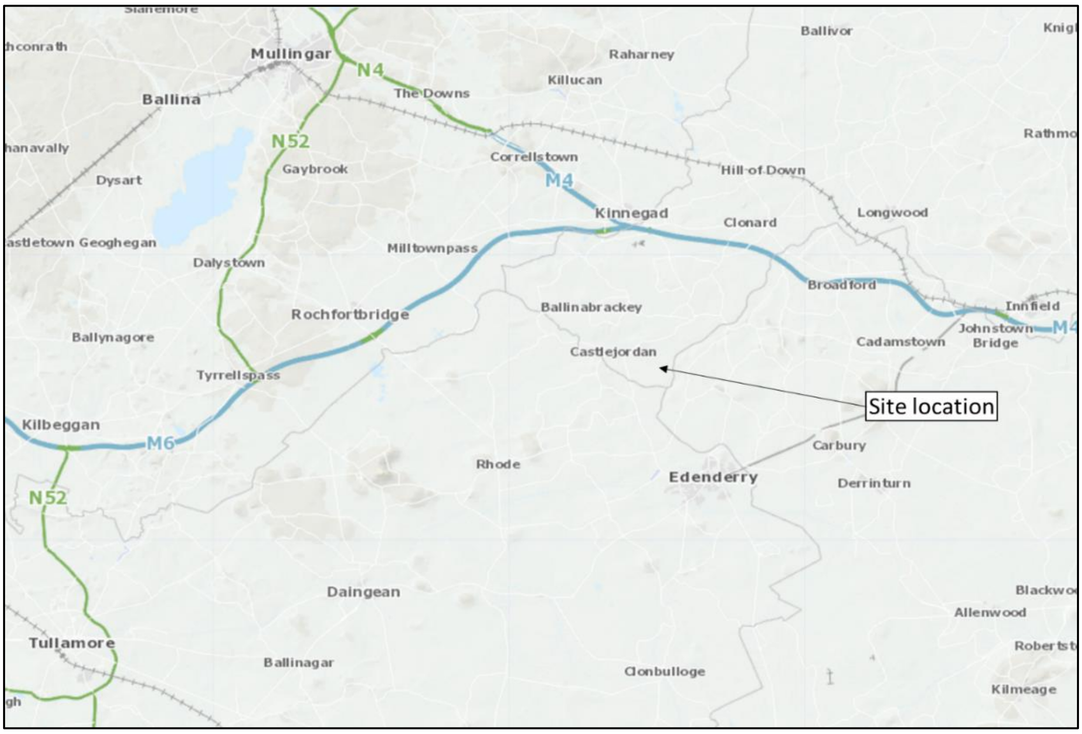

Figure 6.1.2: Detailed site location (Application site boundary shown in red)

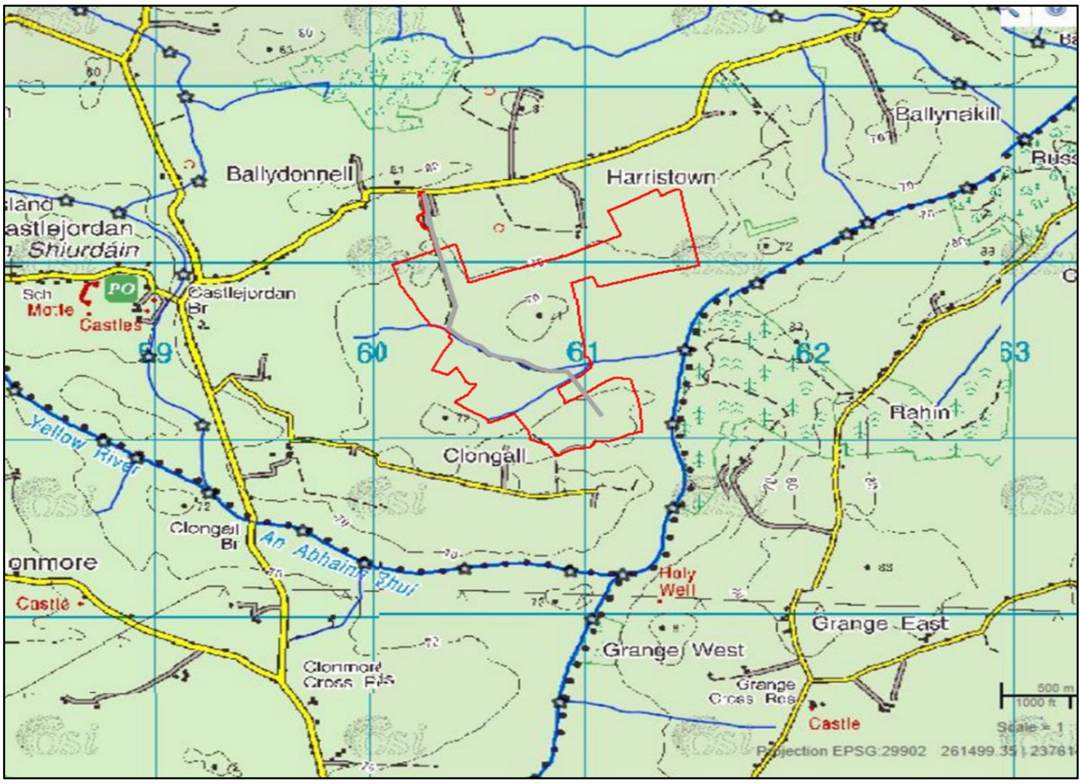

Figure 6.1.3– Topography of site and surrounding area based on LiDAR data

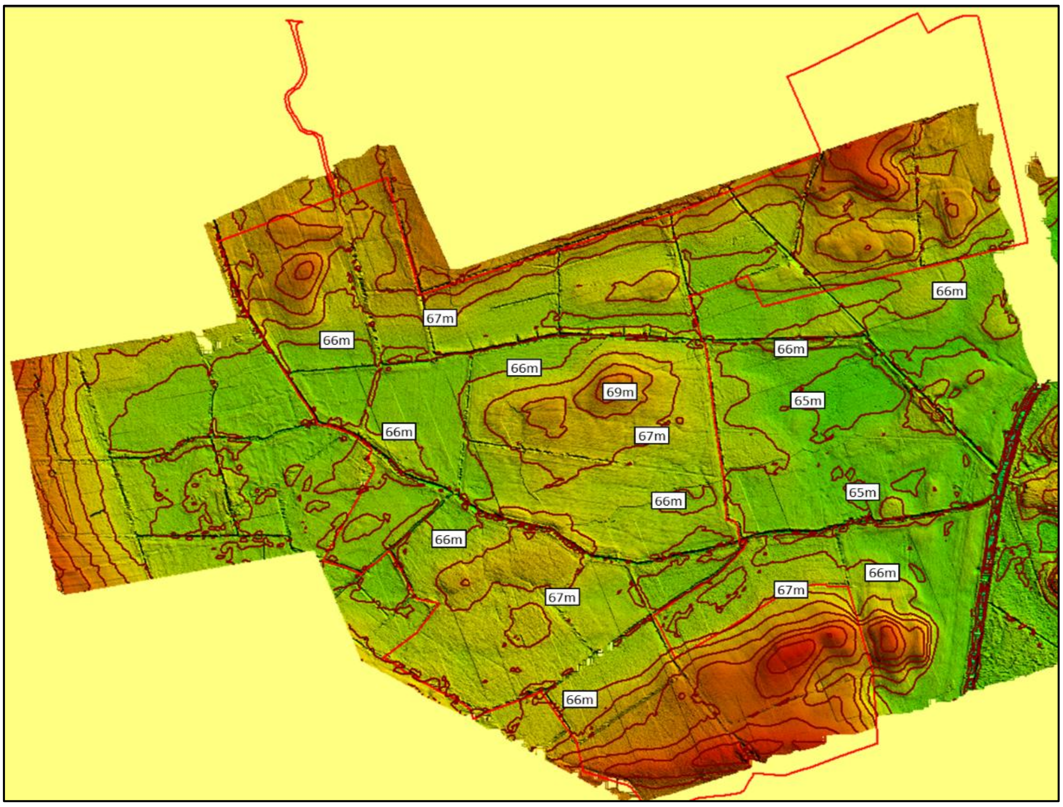

Figure 6.1.4- Schematic and watercourse locations

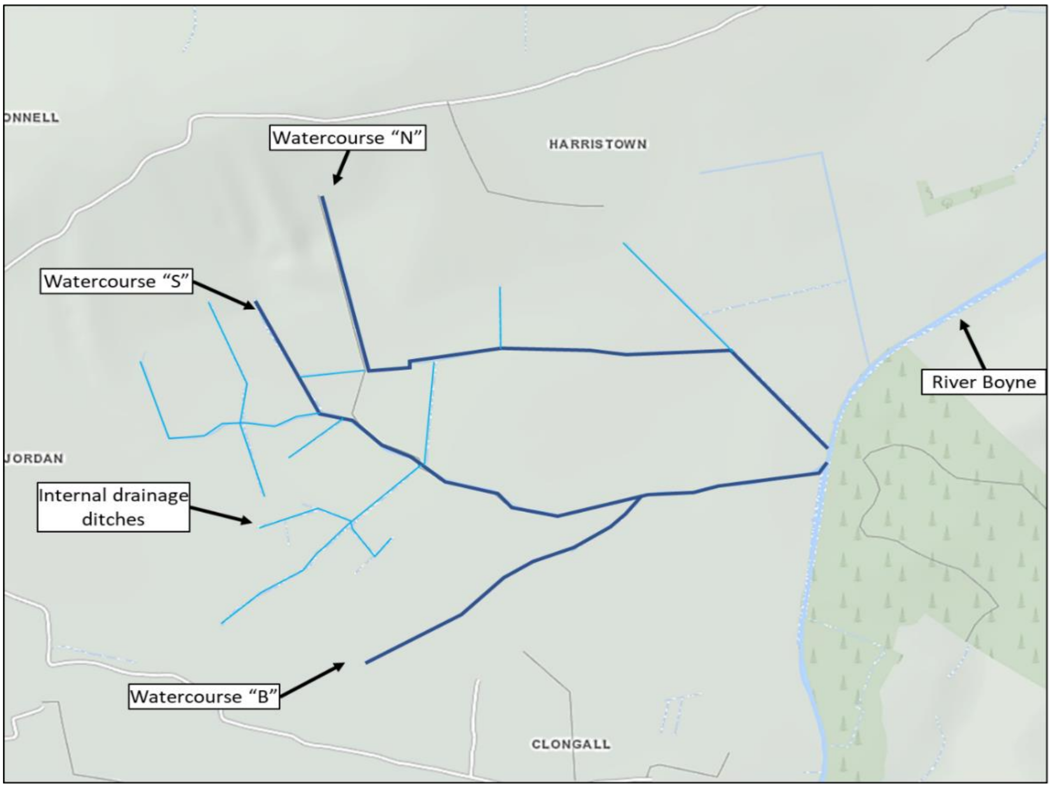

Figure 6.1.5: Catchment of River Boyne at site

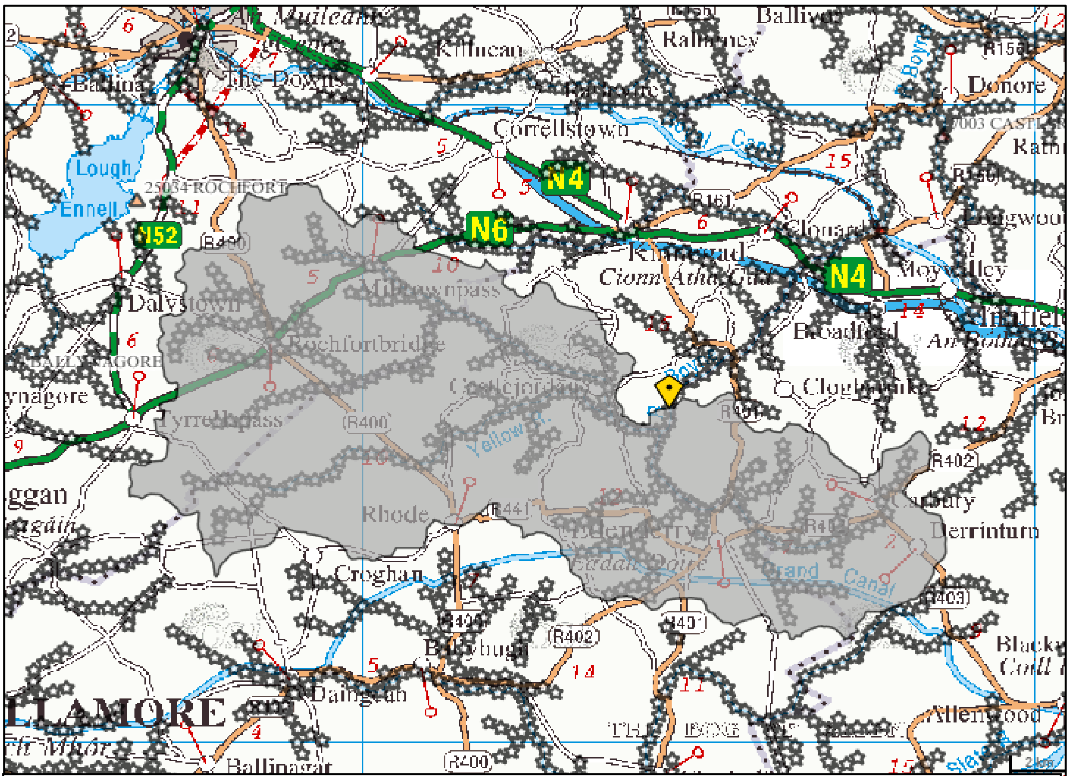

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Figure 6.1.6: Pivotal catchment for River Boyne at site

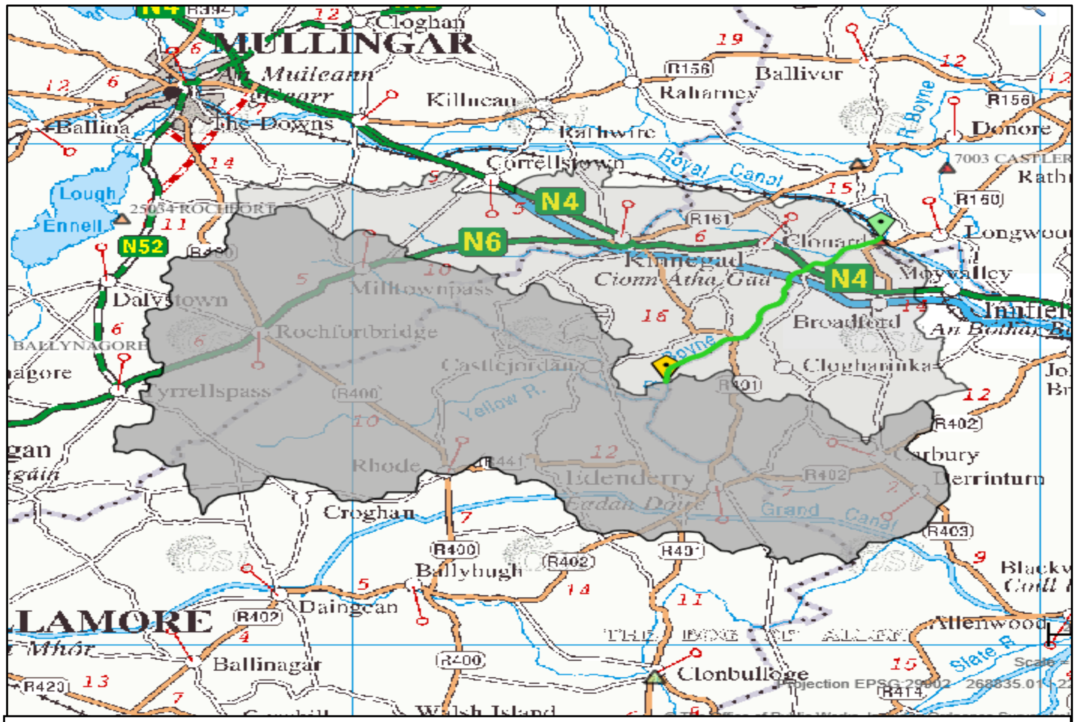

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Figure 6.1.7: 1 in 100 year design hydrograph for River Boyne

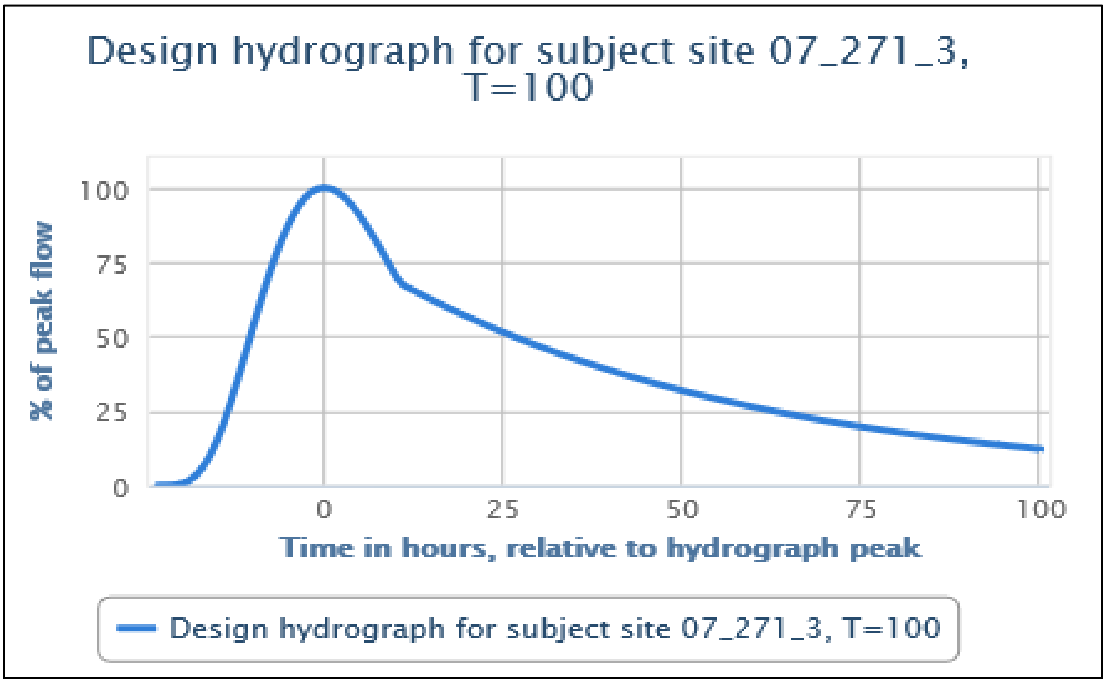


Figure 6.1.8- River Boyne 1D cross section locations (W – represent surveyed I – represent extracted from LiDAR)

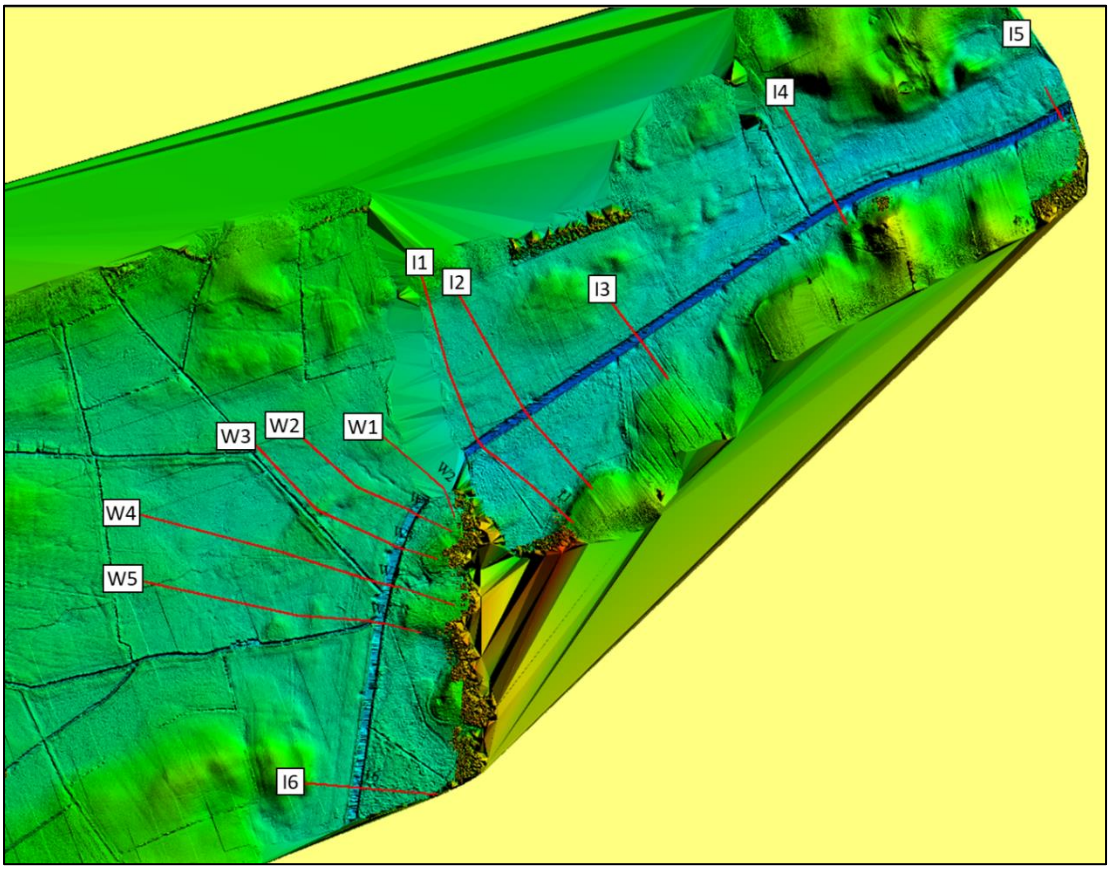


Figure 6.1.9: Cross section comparison

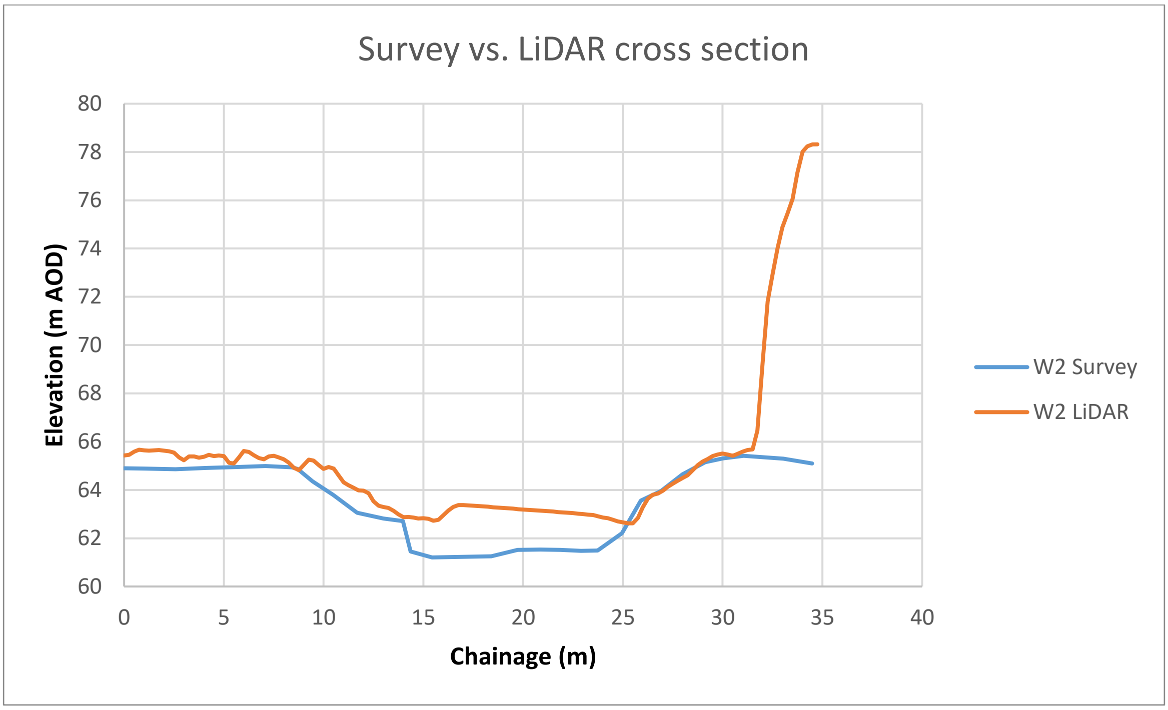


Figure 6.1.10: 1 in 100 year floodplain for River Boyne

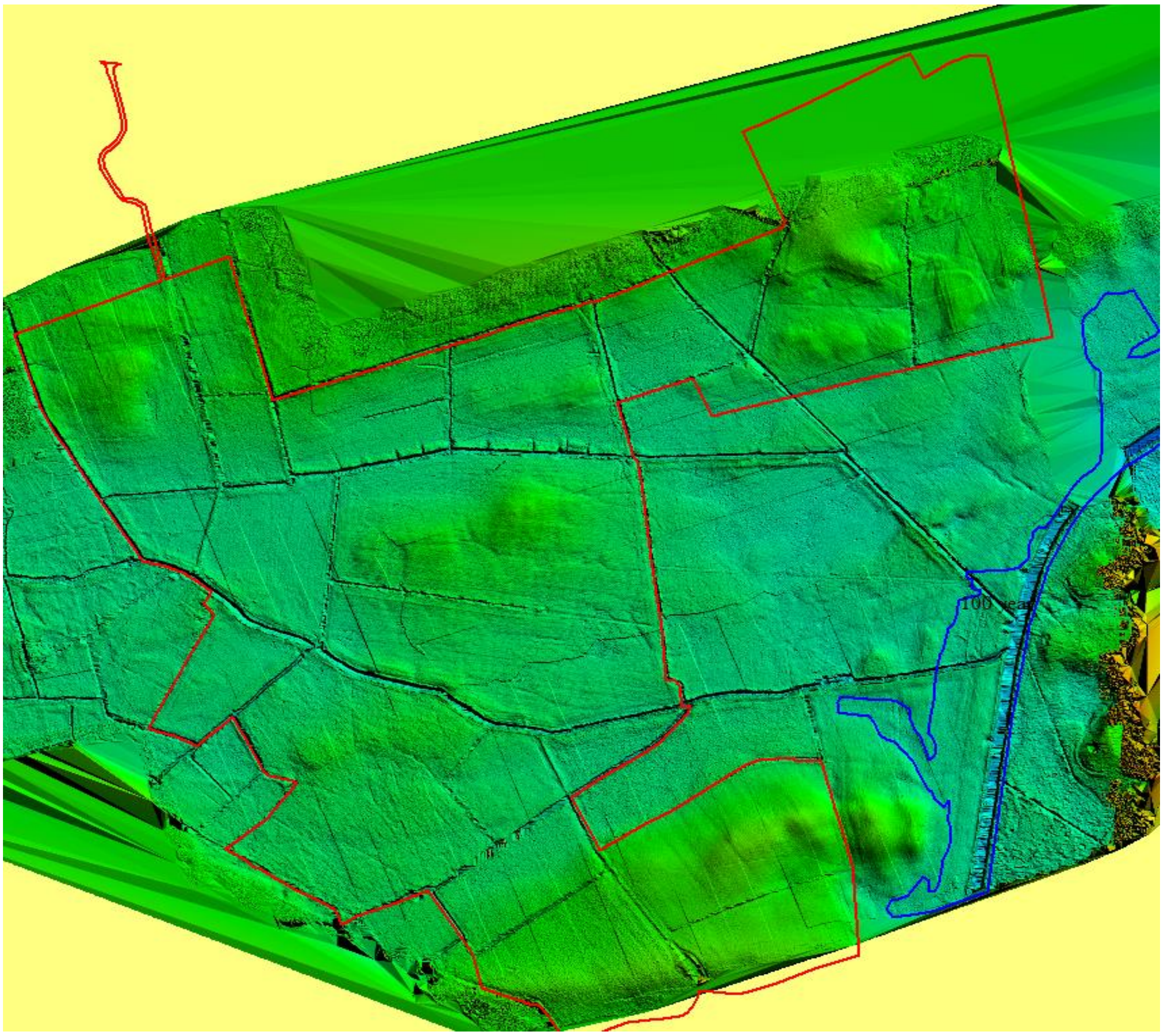


Figure 6.1.9: 1 in 1000 year floodplain for River Boyne

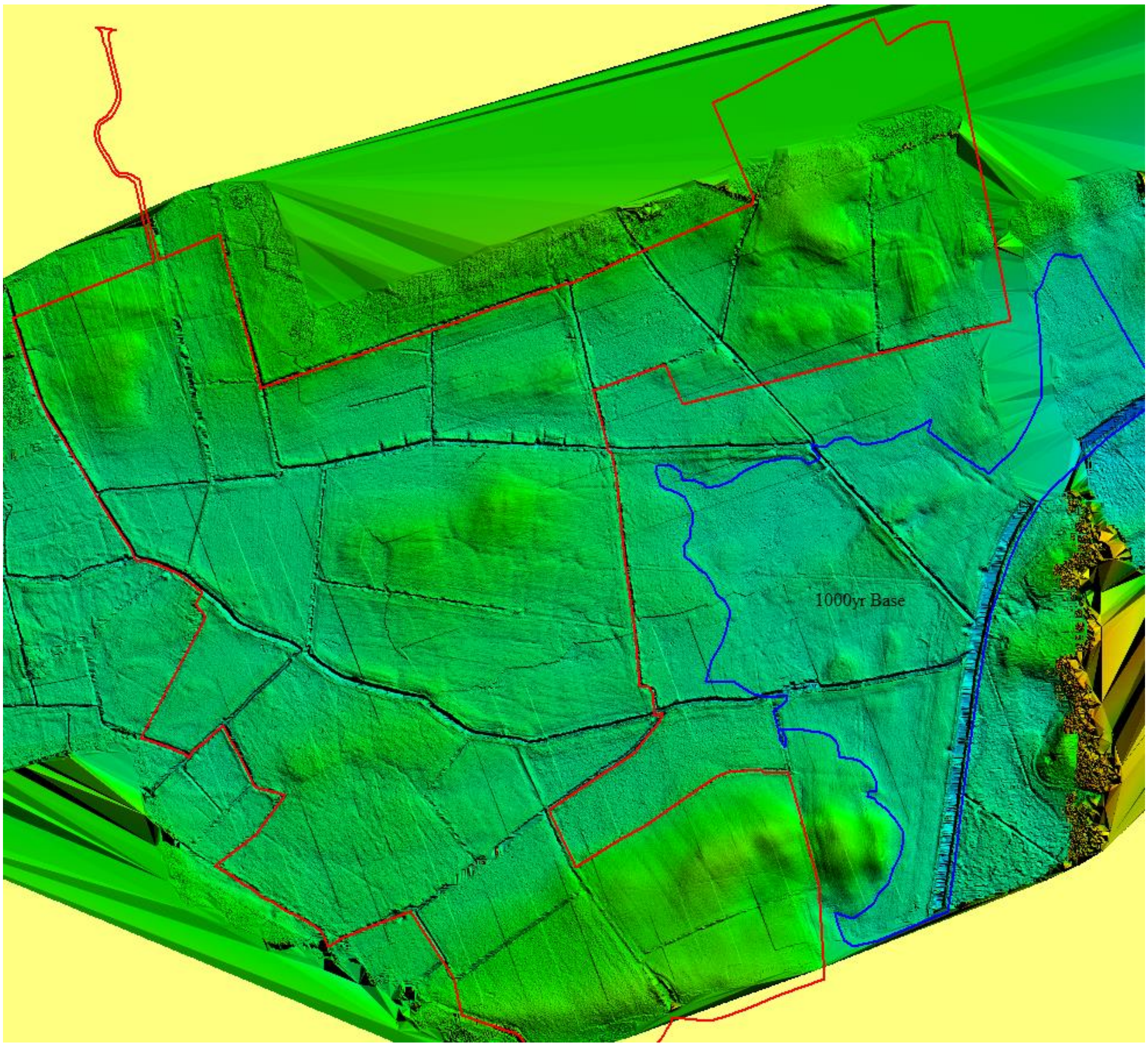


Figure 6.1.12: Watercourse N cross section locations

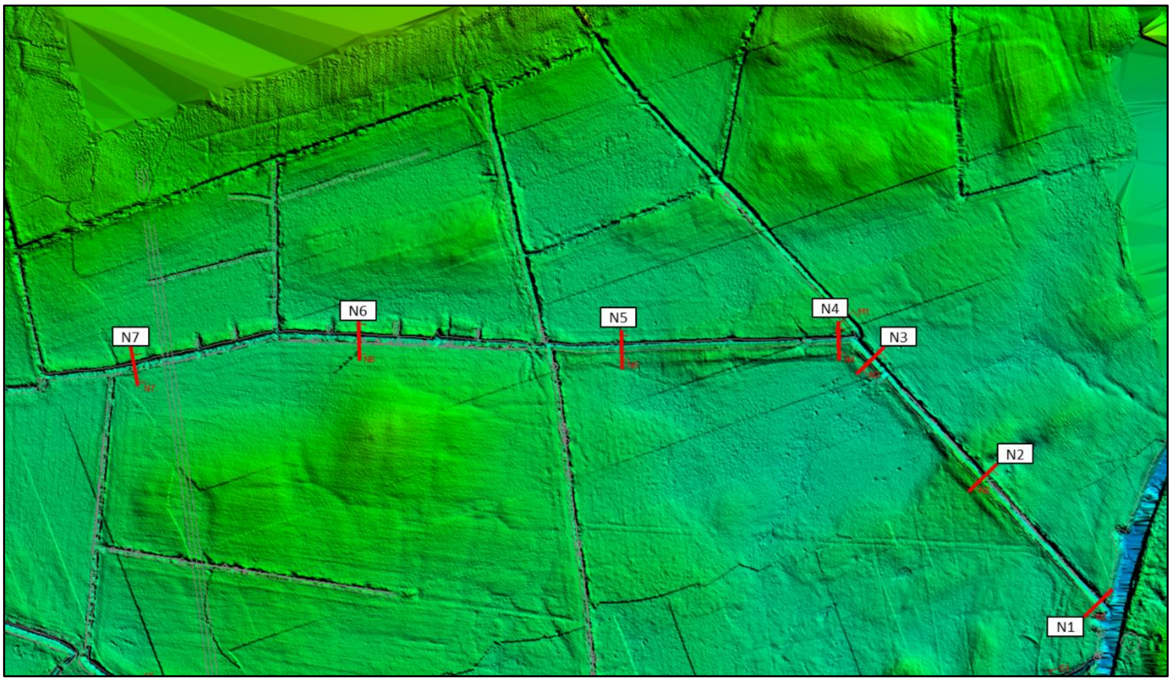


Figure 6.1.10: Watercourse S and B cross section locations

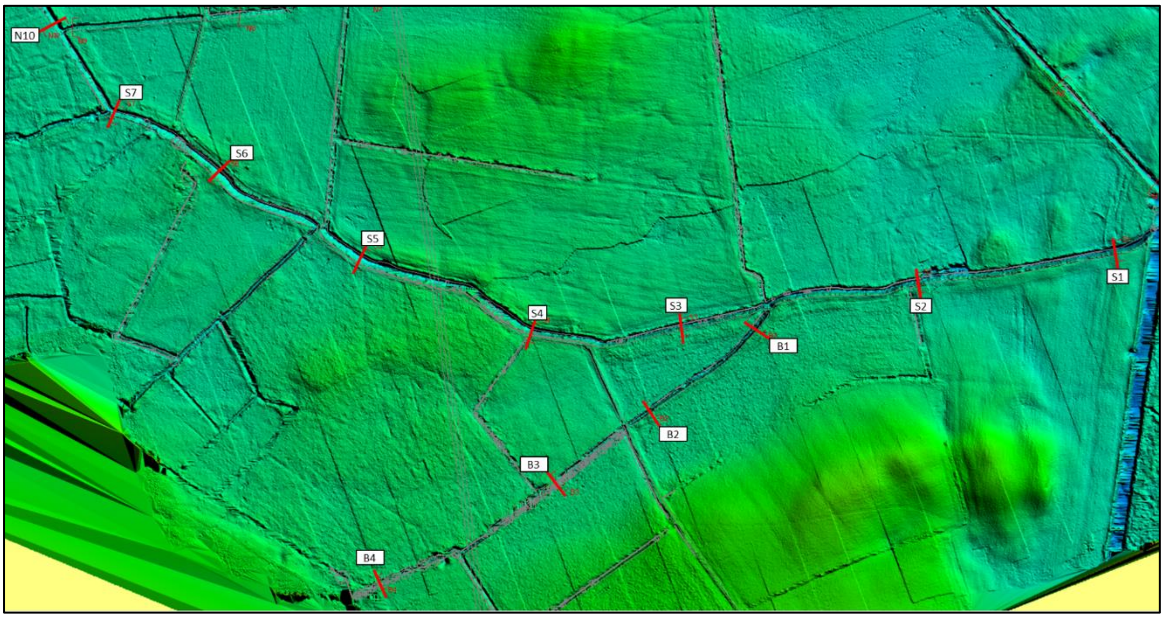
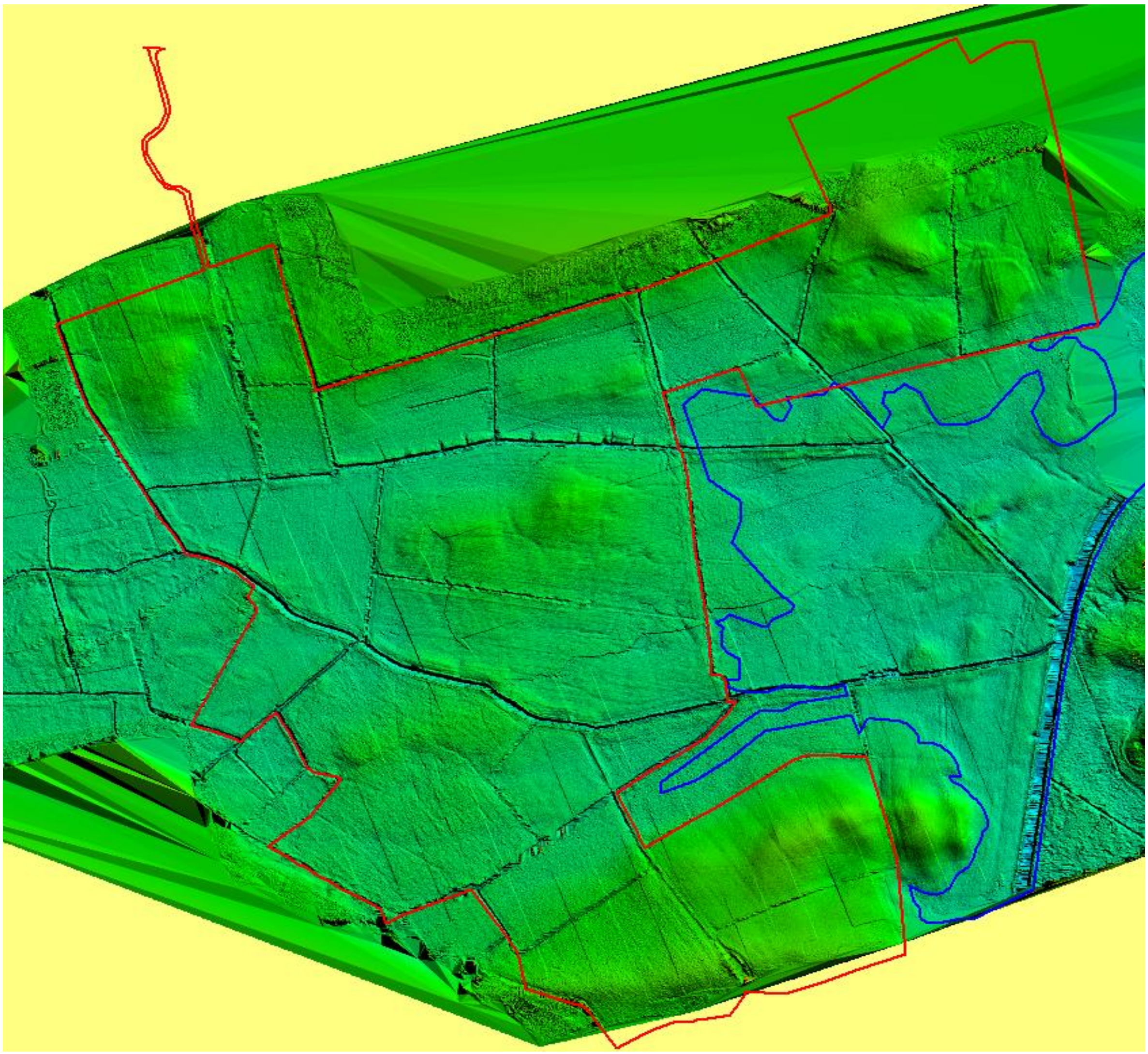


Figure 6.1.14: Conservative 1000 year flood map to show area suitable for development



Appendix 6.1B: Photo Register

Photo 1: General view of site

Photo 1: View of ground rising to the north of the Application Site

Photo 2: View of River Boyne adjacent to the Application Site

Photo 4: View of Watercourse "N"

Technical Appendix 6.2: Drainage Impact Assessment

Harristown Solar Farm

14/08/2019

Disclaimer

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	Name	**Signature**
Approved By	Paul Neary	

Contents

1. EXECUTIVE SUMMARY

1.1. It has been demonstrated that the solar farm's impact on surface water runoff is minimal due to the small amount of impermeable infrastructure on the site. Attenuation storage however, has still been factored into the design.

1.2. The Proposed Development includes the solar farm and associated infrastructure, whilst the Substation Compound will be a separate application for consent. However, they are both assessed in this drainage assessment and they both have drainage schemes which have been designed separately.

1.3. The extent of impermeable area created is due to the buildings associated with the Proposed Development. The 1 in 100 year plus climate change discharge limit of 0.7l/s is very low and therefore a 5l/s discharge rate was used. In relation to the Substation compound the 1 in 100 year plus climate change discharge limit of 0.3l/s is again very low and therefore a 5l/s discharge rate was used.

1.4. This soil class has a Standard Percentage Runoff (SPR) of 0.3 which suggests that they provide a good opportunity for infiltration.

1.5. The following design mitigation measures have been proposed:

- A swale of approximately 65m in length has been proposed which will be sown with the appropriate seed mix upon construction; and
- Temporary swales or similar shall be utilised to collect runoff from access tracks with discharge to ground through percolation areas.
- The Substation Compound Drainage network consists of a number of pipes connecting to a small soak away, which will need to be sized to attenuate 11.5m^2 of surface water. This will then flow into the existing site drainage network. This is subject to minor change depending on the final Substation Compound Application.

1.6. There are three watercourses within the application site which are part of the Arterial Drainage Scheme. The Office of Public Works (OPW) requested a 6m maintenance buffer unpaved or planted, to facilitate a tracked excavator accessing the channel for maintenance. This has been incorporated into the design of the Proposed Development.

1.7. There is one new culvert crossing an internal watercourse and therefore will require a Section 50 Application under the Arterial Drainage Act 1945. This should be conditioned to any planning consent.

1.8. The Drainage Impact Assessment (DIA) has determined that the Proposed Development will not increase flood risk away from the Application Site during the construction, operation and decommissioning phases. Specific measures will be implemented which will result in a net reduction in surface water flow to the sensitive receptors in the locality. The Proposed Development is therefore considered to be acceptable in planning policy terms.

2. INTRODUCTION

BACKGROUND

2.1. Neo Environmental Ltd has been appointed by Lightsource BP (the "Applicant") to undertake a Drainage Impact Assessment ("DIA") for a proposed solar farm with associated infrastructure (the "Proposed Development") on lands at Harristown, Castlejordan, and Clongall, Co. Meath. The assessment will be submitted to Meath County Council (MCC) as part of an EIAR in response to a request for further Information (Planning Reference TA181225).

2.2. This assessment has been submitted as an appendix to **Volume 2, Chapter 6 Land, Soil & Water** of the EIAR.

Development Description

2.3. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, battery storage and all ancillary grid infrastructure and associated works.

2.4. Please see **Volume 2, Chapter 1: Introduction** of this EIAR for a detailed description of the Proposed Development.

Site Description

2.5. The area containing all elements of the Proposed Development (the "Application Site"), consists of 21 fields (including field 15 with the SID substation) currently used as pasture and covers a total area of 91.44 ha. The site lies at an elevation range of 66m— 71m AOD and is centred at approximate Irish Grid Reference (IGR) E260861 N238688. The River Boyne flows 0.19km to the east and 0.62km to the south of the site, forming the county border of Kildare and Offaly, respectively. Access will be via a pre-existing track which runs north to south through the site and connects to the L4091 north of the Application Site. The nearest settlement is the village of Castlejordan, which is located approximately 650m to the northwest of the site.

Scope of Report

2.6. This DIA has been prepared in accordance with 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities[1]' document (the "FRM Guidelines"), prepared by the Department of Environment, Heritage and Local Government. It aims to prove that the Proposed Development will not increase runoff rates from the Greenfield levels, when proposed mitigation measures are taken into account.

2.7. This report is supported by the following figures and appendices:

- Appendix 6.2A Figures:
  - Figure 6.2.1: Site Layout
  - Figure 6.2.2: Outline SuDS Design
  - Figure 6.2.3: Topographical Survey
  - Figure 6.2.4: New Culvert
- Appendix 6.2B: Flow Software Drainage Output
- Appendix 6.2C: Flow Software Drainage Output Substation

STATEMENT OF AUTHORITY

2.8. This DIA has been produced by Michael McGhee of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has worked on over 500MW of solar farm flood risk and drainage impact assessments across the UK and Ireland whilst working towards becoming a Charted Engineer. Michael has over eight years of environmental consultancy experience, mainly producing technical assessments for energy projects.

CONSULTATION

2.9. The request for further information item 2 states the following:

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[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

"The applicant should note that the drains that traverse the site are part of the OPW Arterial Drainage Scheme and that 10m buffer zones between the development and these streams are required. The Applicant should liaise with Mr David Keyes, Environment Department (Flooding) in advance of submitting the Further Information".

2.10. The OPW were consulted on the need for a 10m maintenance buffer on the 14th December 2018. They responded by email stating that a 6m buffer would suffice, measured from the top of the bank. This maintenance strip should not be planted or paved in any way which would prevent a tracked excavator from accessing the channel.

2.11. A further email was sent to Mr Keyes on the 22nd January 2019 to confirm that the 6m buffer would suffice, however no response was received.

3. LEGISLATION

3.1. 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];
- The Water Framework Directive [2000/60/EC];
- The Groundwater Directive [2006/118/EC];
- 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 to 2011.

Review of County Development Plan Policy

Meath County Development Plan

3.2. The Meath County Development Plan 2013 Consolidated version (CDP)[2] 2013 – 2019 came into effect on 22nd January 2013 and presents an extensive list of policies regarding development management within the County.

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

Table 3-1: Meath CDP Flood Management Policies/Objectives

PLANNING POLICY/OBJECTIVE	COMMENT
WS POL 31 *"To ensure that all developments have regard to the surface water management policies in the Greater Dublin Strategic Drainage Study (GDSDS). Compliance with the recommendations*	

[2] The Meath County Development Plan 2013. *County Development Plan 2013-2019:* Written Statement. MCC. Available at: https://meathcountydevelopmentplan.files.wordpress.com/2011/01/meath-county-development-plan-2013-2019-consolidated-version-written-statement-december-2016.pdf

contained in Technical Guidance Document, Volume 2, Chapter 4 of the Greater Dublin Strategic Drainage Study shall be required in all instances."	The DIA has been undertaken in compliance with the GDSDS[3].
WS POL 32 *With regards to the use of Sustainable Urban Drainage Systems (SUDS), the CDP states in objective WS OBJ 17 that all new developments require the use of SUDS in accordance with the Greater Dublin Regional Code of Practice for Drainage Works.*	This DIA will consider SuDS as part of the outline drainage design
WS OBJ 16 *"To incorporate and promote the use of Sustainable Urban Drainage Systems within County Council Developments and other infrastructural projects as required in the Greater Dublin Regional Code of Practice for Drainage Works."*	A Drainage Impact Assessment has been undertaken in accordance with the Planning System and Flood Risk Management Guidelines.

[3] Dublin Drainage (2005) Greater Dublin Strategic Drainage Study, Final Strategy Report. Available at: http://www.greaterdublindrainage.com/wp-content/uploads/2011/11/GDSDS-Final-Strategy-Report-April-051.pdf

4. BASELINE CONDITIONS

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

TOPOGRAPHY

4.2. A topographical survey was undertaken at the proposed Application Site (**Figure 6.2.3 Appendix 6.2A**). According to the topographical survey, ground levels within low lying areas of the Application Site vary from approximately 66m – 65m AOD (Above Ordnance Datum); there are pockets of high ground which rise up to approximately 69m AOD within the centre of the Application Site. In addition, an area of high ground rises up to approximately 71m AOD to the south of the Application Site. Ground levels also rise to the north.

GEOLOGY & SOIL

4.3. The geological conditions of the Application Site were identified utilising the Geological Survey of Ireland ("GSI") Spatial Resources online geological mapping[4] system. It is underlain by Edenderry Oolite Member (CDEDEN) bedrock which comprises of oolitic limestone. Oolitic limestones are often devoid of sedimentary structures, but sometimes are cross bedded. GSI does not identify any karst features (caves) within the Application Site or the surrounding area.

4.4. There are no Bedrock Boreholes located within or near the Application Site. Nothing further in this respect was identified during the site walkover.

Soil

4.5. Different soil types have different capabilities for soaking up water, the efficiency of which is dependent upon the structure and infiltration capacity. The GSI interactive map has been utilised to obtain Teagasc soil data. There are two type of soils distributed across the proposed Application Site, including:

- A – Alluvium (AlluvMIN – Alluvial (mineral)

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

- TLs – Till derived chiefly from limestone (Bmin DW- Deep well drained mineral (Mainly Basic))

4.6. Both surface and ditch examination of the soil during the site walkover suggests the soil type recorded within the GSI database as correct.

4.7. According to the Wallingford Procedure Winter Rain Acceptance Potential (WRAP) map[5], the soil classification for the Application Site is Class 2 which is indicative of "*very permeable soils with shallow ground-water.*" This soil class has a Standard Percentage Runoff (SPR) of 0.3 which suggests that they provide a good opportunity for infiltration.

Overall Evaluation

4.8. Based upon the National Road Authority (NRA) methodology the criteria for rating site importance of geological features at this site are considered to be of **High** importance due to the soils within the Application Site likely to be well draining.

Hydrogeology

4.9. According to the EPA map, the proposed Application Site lies within the Trim Groundwater Body ("GWB"). This groundwater body occupies an area of mostly undulating low lands in Co. Meath, with some hillier areas located at the GWB boundaries. Elevations range from 120 m OD along the eastern boundary, to 20 m OD at Slane. Only in localized areas where there are isolated hills, and along the eastern boundary, are there significantly steep slopes. The course of the River Boyne is almost completely enclosed in this GWB and elevations fall towards the river from southwest to northeast. In the northeast between Navan and Slane the GWB narrows as it has hills on both sides, formed to the north by Ordovician Tuff and to the south by Namurian Shales. In this area the hills formed by these harder rocks raise the slope of the land surface on both sides of the Boyne.

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

"Two recharge mechanisms occur in this GWB: point recharge and diffuse recharge. Diffuse recharge occurs over the majority of the area, being higher in areas where subsoil is thinner and/or more permeable. Due to the karstic nature of the aquifer it is possible to have point recharge, typically at swallow holes where a large amount of concentrated recharge occurs in a small area. Where the subsoil is not thick, and where the impure limestones occupy lowlands adjacent to Namurian and Lower Paleozoic strata, there may be karstification at the boundary between the two rock types, since the relatively corrosive/acidic runoff from these rocks would facilitate solution of the impure limestones e.g. the swallow hole at Mell, Co. Louth. It is likely

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5 UK Sustainable Drainage and Guidance Tools, Greenfield Runoff Estimation for the Sites. Available at: http://www.uksuds.com/greenfieldrunoff_js.htm

that all streams along this contact will lose some portion of their flow, if not entirely sink underground. Note that the number of quarries within the area will facilitate the direct access of rainfall into the bedrock."

4.11. The underlying bedrock aquifer at the proposed Application Site is considered by GSI to be 'Locally important aquifer which is generally moderately productive'.

WATERCOURSES & WATER FEATURES

4.12. The River Boyne flows north near the eastern boundary of the Application Site. Historical maps from 1837-1842 indicate that the river experienced a number of meanders; however, the channel has since been straightened and runs north before turning northeast, away from the Application Site.

4.13. The main channel of the river adjacent to the Application Site measures approximately 3.5m deep and 10m wide from bank to bank. There are no crossings present within the Application Site.

4.14. There are three internal watercourses which drain land within the Application Site before discharging to the River Boyne. The two most southern watercourses join close to the downstream reach of the Application Site before entering the River Boyne; whilst the northern watercourse runs along the northern area of the Application Site and enters the River Boyne a short distance north of the point where the other two enter the river. These watercourses are part of the Arterial Drainage Scheme and the OPW requested a 6m unplanted and unpaved maintenance buffer to facilitate a tracked excavator accessing the channel. This has been incorporated into the design of the Proposed Development.

4.15. The Application Site is drained by a series of drainage ditches which drain low lying land and convey water into the internal watercourses

5. DRAINAGE IMPACT ASSESSMENT

INTRODUCTION

5.1. The Planning System and Flood Risk Management Guidelines[6] 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.

METHODOLOGY

Catchment Characteristics

5.2. Catchment characteristics were obtained from HR Wallingford UK Sustainable Drainage Greenfield Runoff Estimation Tool and Surface Water storage tool.[7] Catchment sizes were measured using ArcGIS and catchment boundaries were produced based on the site-specific contours.

Greenfield Runoff and Stormwater Storage

5.3. 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[8] methodology due to the small-scale nature of the catchment).
- Flow – Causeway Drainage design software (using IH124[9] methodology due to the small-scale nature of the catchment).

[6] 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

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

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

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

- The areas of permeable and impermeable surfaces have been estimated and are based upon the Proposed Development layout (**Figure 6.2.1, Appendix 6.2A).**

5.4. Where applicable, the surface water drainage criteria from the Greater Dublin Strategic Drainage Study (GDSDS)[10] was applied.

Greenfield Runoff rates

5.5. The IH24 methodology is used for calculating the Greenfield runoff rates. This is recommended by the Institute of Hydrology for catchments below 200ha.[11]

5.6. 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.

5.7. The GDSDS[12] states that the IH124 method is an accepted method used for determining peak flow rates for small catchments.

Calculating storage estimates

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

- Return Period

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

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

[12] 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

- Climate Change
- Impermeable Area
- Peak Discharge

5.9. 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 Development.

Site and Project Descriptions

5.10. The Proposed Development includes the solar farm and associated infrastructure, whilst the Substation Compound will be a separate application for consent. However, they will both be covered in this drainage assessment and they will both have separate drainage schemes.

Proposed Development

5.11. As described previously, the Proposed Development 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.

5.12. 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 will not be considered an impermeable area in this assessment.

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

110 kv Substation (Separate SID Application to ABP)

5.14. The substation compound will include two buildings to house electrical equipment and an electrical transformer bund within a fenced off compound and the remaining area surfaced with permeable single size clean stone.

5.15. The extent of impermeable area created as a result of the Proposed Development and substation compound is summarised in **Table 5-1**.

Table 5-1: Extent of less permeable areas created by the Proposed Development

BUILDING	DIMENSIONS	QUANTITY	TOTAL AREA (M2)
Proposed Development			
AC Box	4.0m x 1.0m	14	56.0
Transformer	4.5m x 5.5m	14	346.5
Switchgear Substation	4.2m x 2.6m	14	152.9
Battery Storage, including maintenance platform	4.4m x 12.2m	16	858.88
Storage Shed	3.2m x 3.9m	1	12.5
Monitoring House	3.2m x 3.9m	1	12.5
Proposed Development Total			1,439.3
Substation Compound			
Customer MV Switchgear Room	10.0m x 9.0m	1	90.0
DNO Substation	25.0m x 15.0m	1	375.0
Transformer Bund	8.5m x 14.9m	1	126.65
Substation Total			591.7
Total Impermeable infrastructure			1,640.6
Site Area (m2)			914,277.35

5.16. 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 1,640.6m^2 or 0.2% of the total site area.

Existing Drainage Arrangements

Existing Runoff Rates

5.17. The existing runoff rates and hydrological characteristics of the Proposed Development are detailed in **Table 5-2** below (there are no hardstanding areas on the site at present).

Table 5-2: Pre-Development Greenfield runoff rates.

Site Make Up	Green Field Proposed Development	Green Field Substation Compound
Greenfield Method	IH124	IH124
Positively Drained Area (ha)	0.143	0.059
SAAR (mm)	888	888
Soil Index	2	2
Standard Percentage Runoff	0.3	0.3
Region	Ireland	Ireland
	Runoff rate (l/s)	Runoff rate (l/s)
1 year	0.3	0.1
1 in 30 year	0.6	0.2
1 in 100 year	0.7	0.3

5.18. The limiting discharge should be calculated as the flow rates from the pre-developed site, as detailed in **Table 5-2**. Where this calculation results in a peak flow rate of less than 5l/s, the limiting discharge rate may be increased up to a level of no more than 5l/s at the point of discharge from the site to reduce the risk of blockage.

5.19. Therefore, the proposed surface water to be attenuated will need to be limited to 5l/s to replicate greenfield runoff rates as per the GDSDS[13], for both the Proposed Development and Substation Compound.

[13] 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

Post Development Runoff Rate

5.20. 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.

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

5.22. Using this approach, the runoff rate for the 1-in-100-year event, inclusive of the 20% climate change allowance, would be **36.9l/s** if left unmanaged. This includes the Substation compound.

PROPOSED DRAINAGE ARRANGEMENTS

5.23. The SuDS Manual[14] 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.

5.24. The use of SuDS is generally accepted to have greater benefits than conventional drainage systems and these include:[15]

- 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

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

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

- 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)

5.25. The proposed 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.

5.26. To comply with current policies, guidance and best practice, the amount and quality of surface water runoff discharged off-site from any Proposed Development at this Application Site will need to be controlled using Sustainable Drainage Systems (SuDS).

5.27. 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

5.28. 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 6.2B and 6.2C.** These are estimated from the new surfaces added to the Proposed Development and Substation Compound.

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

Table 5-3: Storage Estimates

Storage Estimates		
	Proposed Development	Substation Compound
Return Period (years)	100 years	100 years
Climate Change (%)	20	20
Impermeable Area (ha)	0.143	0.059
Peak Discharge (l/s)	5.0	5.0
Required Attenuation Storage (m3)	**41.5**	**11.5**

5.29. Using the approach outlined in the methodology the storage requirement to be attenuated from the critical storm 100-year return period (including 20% for climate change) from the Proposed Development would be **41.5m^3**.

5.30. Using the approach outlined in the methodology the storage requirement to be attenuated from the critical storm 100-year return period (including 20% for climate change) from the Substation Compound would be **11.5m^3**.

Proposed Drainage Strategy

5.31. Any existing on-site drainage ditches or features will be retained in their existing state, and will continue to intercept overland flows from the site.

Proposed Development

5.32. While it has been argued above that the Proposed Development will not result in a material increase in surface water runoff flow rates, it is proposed to construct a swale within Field 15 of the Application Site (See **Figure 6.2.2 Appendix 6.2A**). The location of the swale has been chosen to attenuate runoff from the battery storage area which is the largest part of new impermeable development associated with the Proposed Development. The other buildings are located at various locations across the Application Site and are too small to require specific drainage schemes on their own and any excess water will slowly drain into the underlying geology through infiltration. That being said the swale has been sized to attenuate to the 1 in 100-year greenfield rate for all of the new areas of impermeable development.

5.33. The proposed swale will be approximately 65m in length, with a base width of 500mm, a 500mm design depth, 150mm freeboard and a maximum side slope of 1 in 3.

5.34. It will provide a total storage volume of approximately 65m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (41.5m^3). It is therefore considered that this adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area and provides improvement.

5.35. The swale will be implemented during the construction phase of the proposed solar farm and planted with vegetation to protect against soil erosion. The swale will be maintained throughout the operational period (30—35 years) of the Proposed Development, in accordance with the recommendations in the appropriate guidance.

5.36. 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, check dams formed from gravels and other excavated material shall be placed in the swale at frequent intervals; and
- Inverter/Transformer AC units (and similar hardstands): 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.
- A new culvert for crossing an internal watercourse is proposed. As this watercourse forms part of the OPW arterial drainage scheme, an application for Consent for this undertaking in compliance with Section 50 of the Arterial Drainage Act 1945 will be required. This should be conditioned as part of a consent for Proposed Development. A draft drawing of the watercourse crossing can be found in **Figure 6.2.4**. This includes a 1.5m diameter precast concrete culvert overlain with compacted stone. Engineering designs will be completed post planning; however, the culvert has been sized so as the 1 in 1000-year flow ($1.6m^3/s$) can pass with ought surcharging.

110kv Substation Compound (Separate SID Application to ABP)

5.37. Surface water drainage proposals for the Substation Compound have been developed to mimic the natural drainage patterns of the site and thereby be in accordance with the Best Management Practices (BMPs) of Sustainable Drainage Systems (SuDS).

5.38. The attainment of this aspiration is easily achieved when the following parameters are considered (see drawing pack site layout):

- The Substation Compound construction is formed with permeable stone thus mimicking a soakaway scenario. Substation Compound stone is single sized for the first 150mm for safety purposes. It then changes to a graded 6F2 material. The area of this permeable surface is approximately 12,375m².

- The area to be drained includes the roofs and the bunded plinths. These equate to 591.7m² and are very modest in themselves and in comparison, to the overall compound area.

- Assuming even the most basic of infiltration rates down through the permeable compound stone, it is clear that the existing greenfield situation is easily maintained.

5.39. The surface water generated in the bunded areas will discharge to the existing drainage via a Class 1 Full Retention Oil Separator. The electrical transformer in the substation is oil filled equipment and, as such, is protected with impermeable bunds. Surface water generated in this bund will be pumped out by an oil sensitive pump ensuring that only non-contaminated water enters the site drainage network. The Class 1 Full Retention Oil Separator will provide a second level of defense.

5.40. The Substation Compound Drainage network consists of a number of pipes connecting to a small soak away, which will need to be sized to attenuate 11.5m^2 of surface water. This will then flow into the existing site drainage network. This is subject to minor change depending on the final Substation Compound Application.

Foul Water Drainage

Proposed Development

5.41. There is one small composting toilet within the Proposed Development, situated near the Substation Compound for use by operations and maintenance staff as well as any future tours of the site. The toilet is waterless, chemical free and self-composting, and is made from sustainabe logged wood; thus, it is compatible with the environmental aims of the Proposed Development. The toilet uses a dehydration process resulting in an odour free compost which is collected annually for further processing off-site.

Substation Compound

5.42. There are no existing foul sewer water drains within or near the Application Site. The dispersed settlement pattern of the surrounding area suggests that the individual farm dwellings use standalone private foul treatment and disposal systems. A proposed toilet facility may form part of the future SID application to ABP for the 110kv substation and will be assessed within that application.

Construction Phase Drainage Arrangements

5.43. Due to the addition of the temporary construction compounds during the construction phase additional drainage measures will be implemented to help attenuate the increase in surface water flows if surface water is observed discharging from the construction compound.

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

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

Designing for Exceedance Events

5.46. Overland flow routes will not be altered by the construction of the Proposed Development as it is not proposed to significantly vary ground levels. A proposed storage area 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).

5.47. Should an exceedance of this 1 in 100-year critical storm event occur, surface water will flow the same way as at present, north and into the existing field drains. There are no sensitive receptors between the Application Site and the field drains which would be affected by an exceedance event.

5.48. Should an exceedance of this 1 in 100-year critical storm event occur, surface water will continue to flow in the same direction as per the pre-development stage.

Long Term Maintenance of SuDS

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

Swale

- 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

5.50. 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.

5.51. 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.

5.52. To alleviate the effects of any limited compaction during the construction process, it is recommended any affected areas will be harrowed prior to being reseeded.

5.53. 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 in Ireland will always 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.

5.54. 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.

5.55. With regard to the Proposed Development, there is a slight gradient into existing field drains across the Application Site. 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, due to the gradient changes the likelihood of increased overland flow or soil erosion occurring is considered Low.

6. SUMMARY & CONCLUSIONS

6.1. It has been demonstrated that the solar farm's impact on surface water runoff is minimal due to the small amount of impermeable infrastructure proposed for the site. Attenuation storage however, has still been factored into the design.

6.2. The Proposed Development includes the solar farm and associated infrastructure, whilst the Substation Compound will form a separate SID application to ABP.

6.3. The area beneath the solar panels will remain as grassland and the post-development site infiltration rate will not change.

6.4. 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 impermeable.

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

6.6. The substation compound will include two buildings to house electrical equipment and an electrical transformer bund within a fenced off compound and the remaining area surfaced with permeable single size clean stone.

6.7. The extent of impermeable area created is due to the buildings associated with the Proposed Development. The 1 in 100 year plus climate change discharge limit of 0.7l/s is very low and therefore a 5l/s discharge rate was used. In relation to the Substation compound the 1 in 100 year plus climate change discharge limit of 0.3l/s is again very low and therefore a 5l/s discharge rate was used.

6.8. This soil class has an SPR of 0.3 which suggests that they provide a good opportunity for infiltration.

6.9. The following design mitigation measures have been proposed:

- A swale of approximately 65m in length has been proposed which will be sown with the appropriate seed mix upon construction; and
- Temporary swales or similar shall be utilised to collect runoff from access tracks with discharge to ground through percolation areas.
  - The Substation Compound Drainage network consists of a number of pipes connecting to a small soak away, which will need to be sized to attenuate 11.5m^2 of surface water. This will then flow into the existing site drainage network. This is subject to minor change depending on the final Substation Compound Application.

6.10. There are three watercourses within the application site which are part of the Arterial Drainage Scheme. The OPW has requested a 6m unpaved and unplanted maintenance buffer along these watercourses to allow access by a tracked excavator for maintenance. This has been incorporated into the design of the Proposed Development.

6.11. There is one new culvert crossing an internal watercourse and therefore will require a Section 50 application under the Arterial Drainage Act 1945 prior to undertaking these works. This should be conditioned to any future planning consent.

6.12. The Drainage Impact Assessment has demonstrated that the Proposed Development will not increase flood risk away from the Application Site during the construction, operational and decommissioning phases. Specific measures will be implemented which will result in a net reduction in surface water flow to the sensitive receptors in the locality. The Proposed Development is therefore considered to be acceptable in planning policy terms.

7. APPENDICES

APPENDIX 6.2A - FIGURES

- Figure 6.2.1: Site Layout
- Figure 6.2.2: Outline SuDs Design
- Figure 6.2.3: Topographic Survey
- Figure 6.2.4: New Culvert

APPENDIX 6.2B: FLOW SOFTWARE DRAINAGE OUTPUT

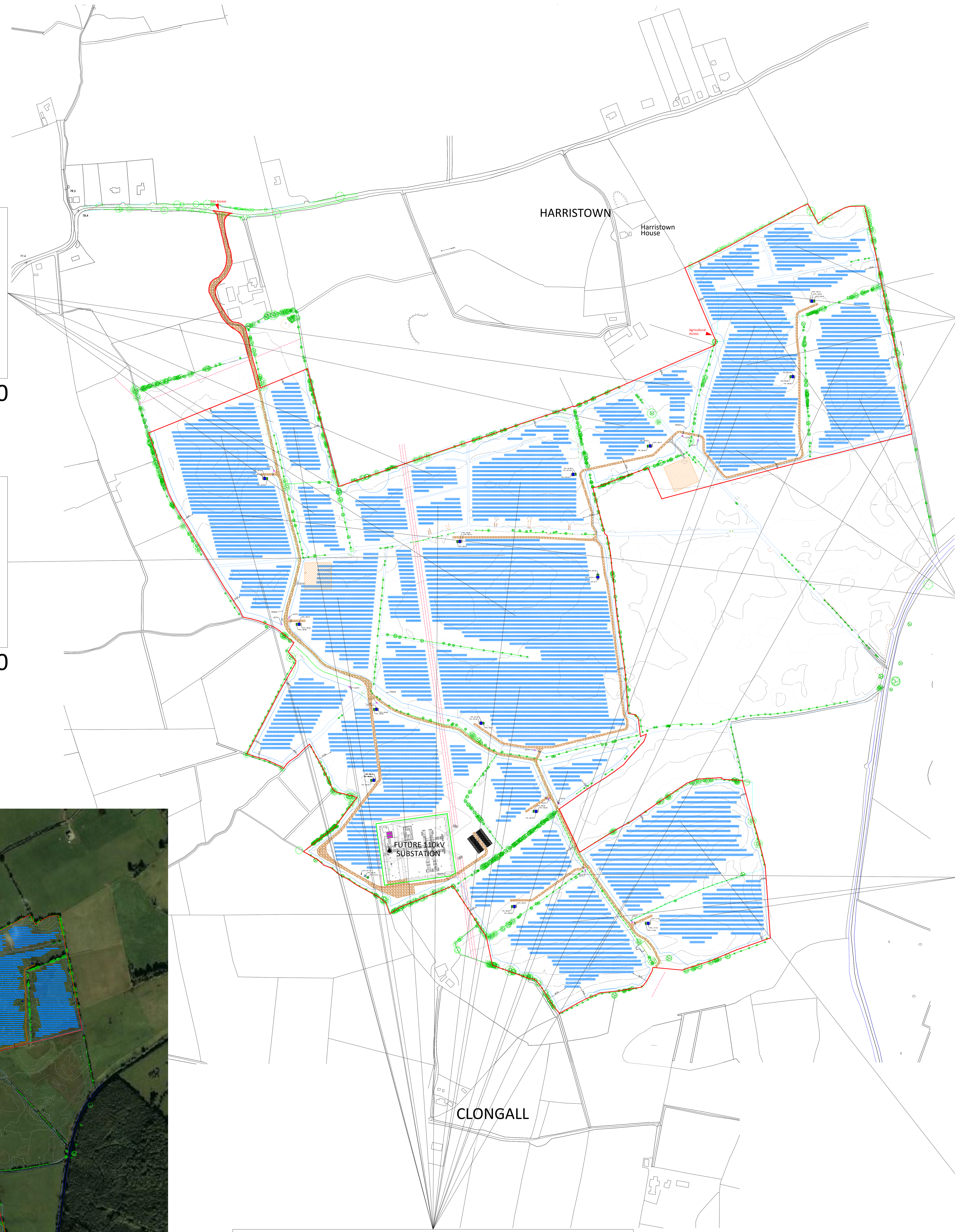
APPENDIX 6.2C: FLOW SOFTWARE DRAINAGE OUTPUT SUBSTATION

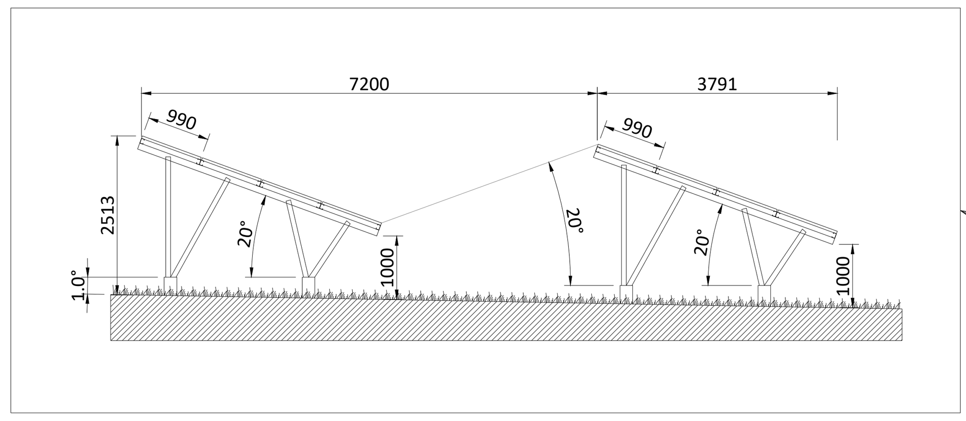
ENVIRONMENTAL

Appendix6.2A

Harristown Solar Farm_Indicative_Layout_Rev14

Area 914,412 m2 (225.96 acres)





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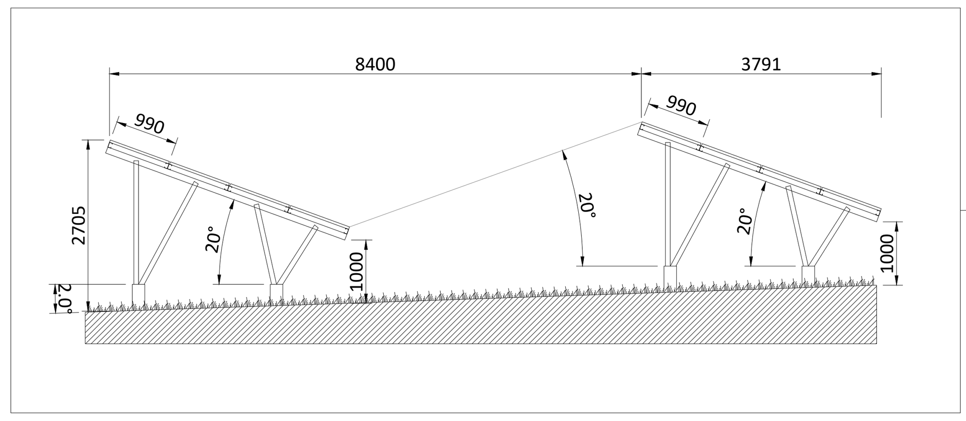

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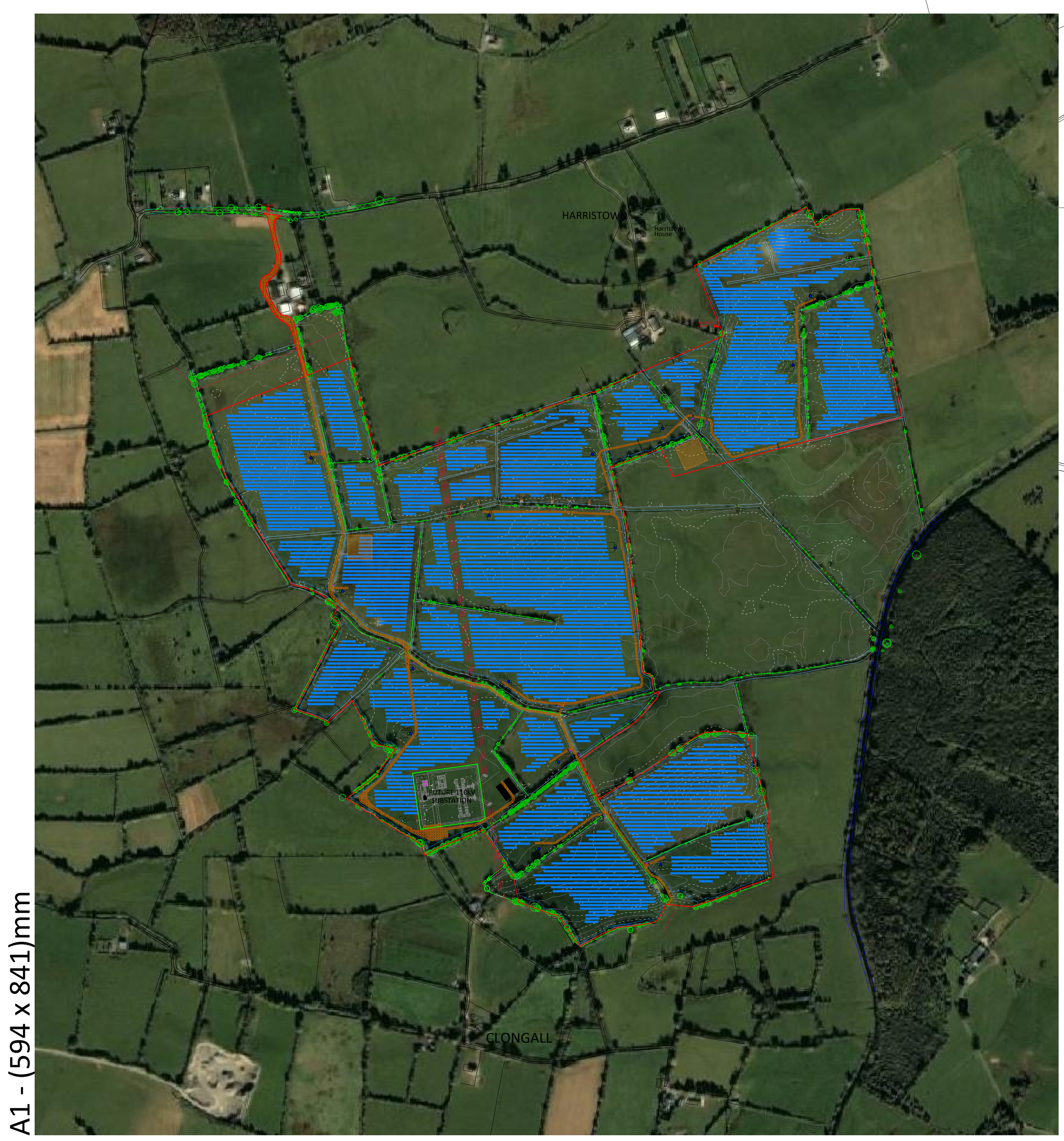

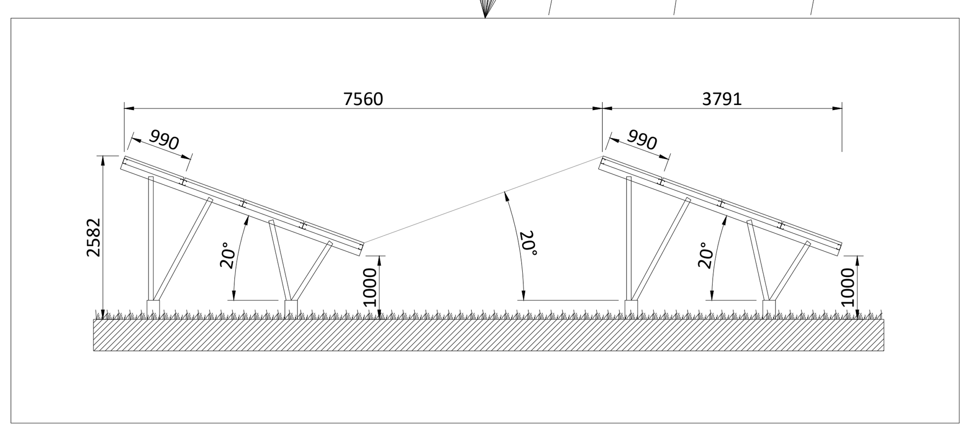

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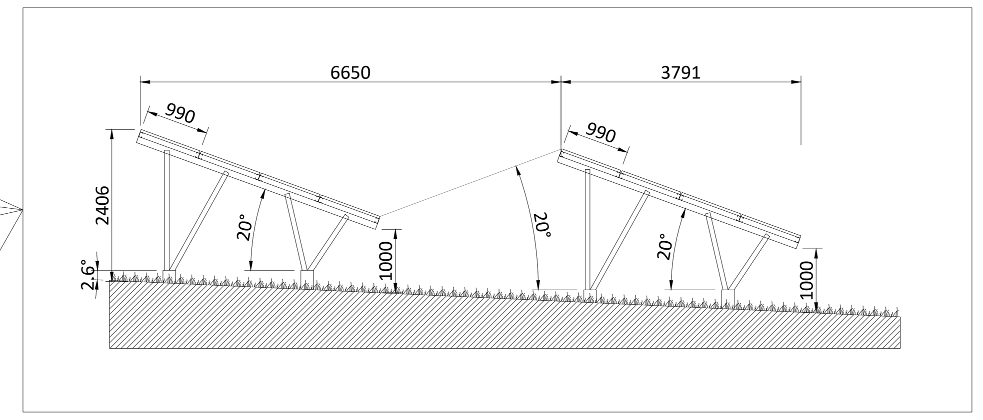

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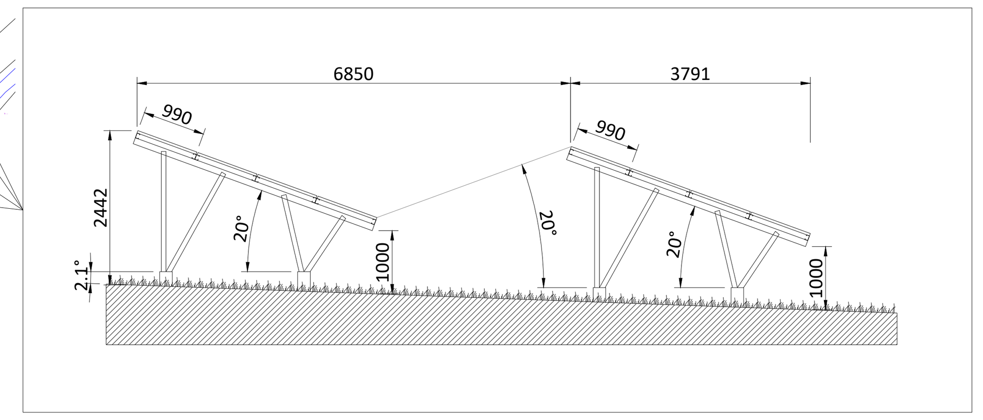

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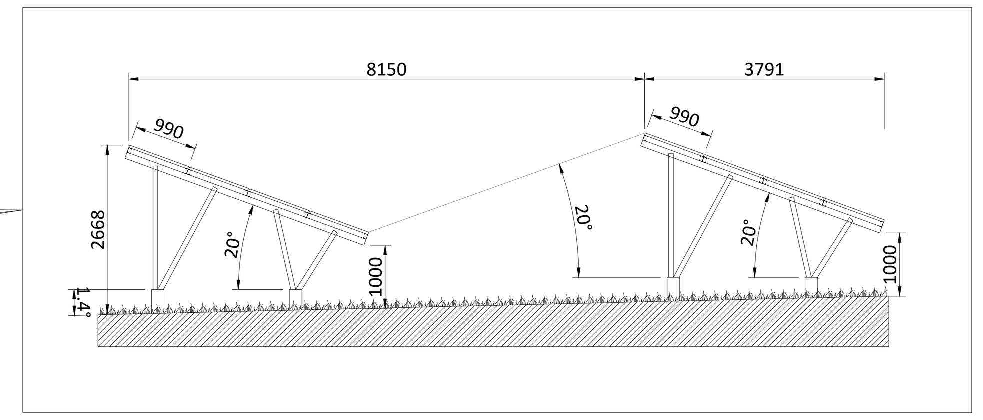

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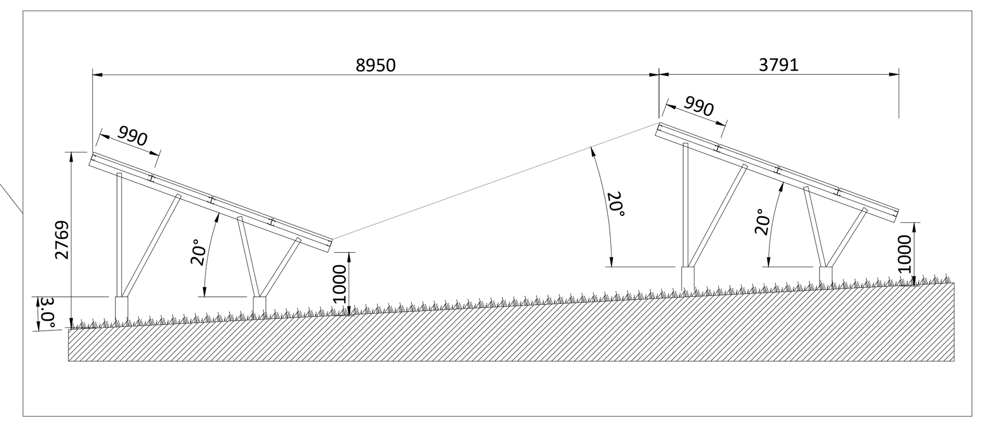


Scale 1:100

Legend
Site Boundary
Site Access
Security Fence
Module Table 14 x 4
Module Table 28 x 4
Transformer
AC Box
Switchgear Substation
Client Side Substation
Monitoring House
Storage
Access Road
Compound Area
Overhead Line
Tree
Access Gates
CCTV
Temporary Access Road
Toilet
Battery Container
Site Boundary of Future 110kV Substation

Revisions:

Rev	Date	Comments	Dwn	Chkd
14	19/08/19	Future 110kV Substation Boundary added	DA	
13	24/07/19	Panels and batteries updated	DA	
12	10/07/19	Buffers added	GM	
11	04/07/19	Configuration changed	DA	
10	26/04/19	Substation location changed	DA	
9	19/12/18	Changed to bifacial	DA	
8	24/10/18	Minor amendments	GM	
7	10/10/18	Minor amendments	DA	
6	25/09/18	Field removed	DA	
5	17/08/18	Field added	DA	
4	31/07/18	Topo added, fields changed	DA	
3	23/05/18	Estimated flood area taken into account	DA	
2	19/04/18	Flood risk area added	DA	
1	11/04/18	Fields added	DA	

DRAWN	CHECKED	APPROVED	DATE
DA			24.05.17

PROJECT NAME & ADDRESS:
Location: Harristown Farm
Co. Meath

NOTES:
- Bifacial 410 Wp modules
-
-
-

Paper Size:	Scale:	Sheet:
A1	1:5000@A1	1

CAPACITY:
133,000_Modules 54.53 MWp

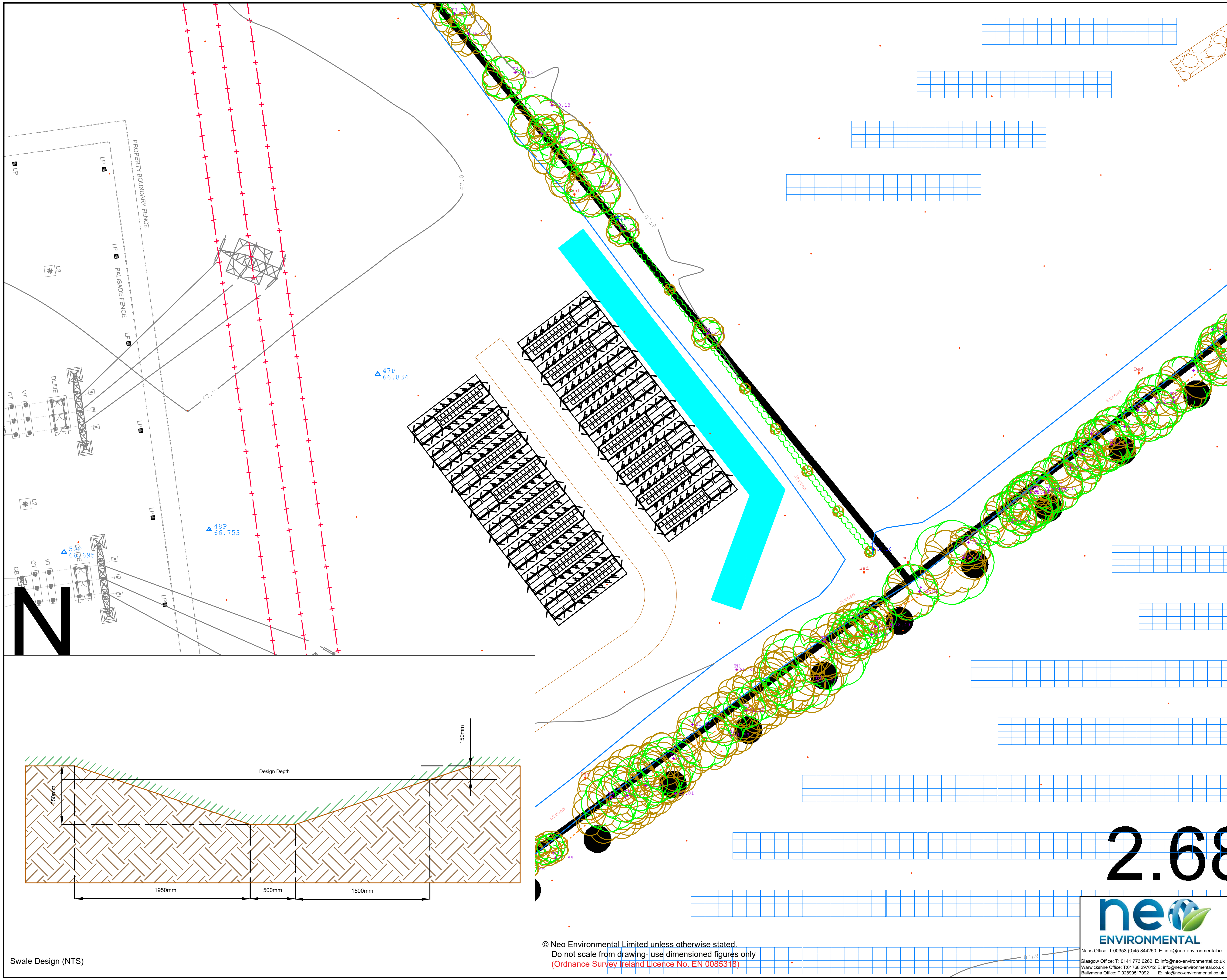
DRAWING TITLE:
Harristown Solar Farm_Indicative_Layout_Rev14

DRAWING NUMBER:	STATUS:
HTW_01_Rev14	Preliminary

lightsource bp

Lightsource Renewable Energy Ireland Limited
Suite 27, 20 Harcourt Street
Dublin 2, Republic of Ireland
General: +353 (0) 1 685 6263
Web: www.lightsourcebp.com

A1 - (594 x 841)mm



Swale Design (NTS)

Key

Swales

GENERAL

1. Do not scale from drawing.
2. All dimensions are in metres, unless stated otherwise.
3. This drawing to be read & printed in colour.
4. This drawing to be read in conjunction with other contract drawings.

neo ENVIRONMENTAL
Naas Office: T:00353 (0)45 844250 E: info@neo-environmental.ie
Glasgow Office: T:0141 773 6262 E: info@neo-environmental.co.uk
Warwickshire Office: T:01768 297012 E: info@neo-environmental.co.uk
Ballymena Office: T:02890517092 E: info@neo-environmental.co.uk

Project: Harristown Solar Farm
Client: Lightsource BP
Drawing: Figure 6.2.2: Outline SuDS Design
Project No.: NEO00515
Drawing No.: NEO00515/042I/B

Drawn	Checked	Approved
MM	KM	PN

Scale	Date	Status	Rev
1:500@A3	01/08/2019	PLAN	A

Rev	Date	Comments
A	04/10/2018	

Naas Office: T:00353 (0)45 844250 E: info@neo-environmental.ie

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Warwickshire Office: T:01768 297012 E: info@neo-environmental.co.uk
Ballymena Office: T:02890517092 E: info@neo-environmental.co.uk

Project: Harristown Solar Farm

Client: Lightsource BP

Drawing: Fig 6.3.2 Topographical Survey

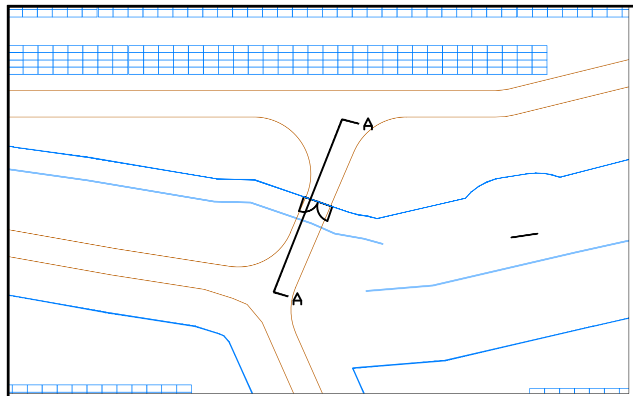
Project No.: NEO00515

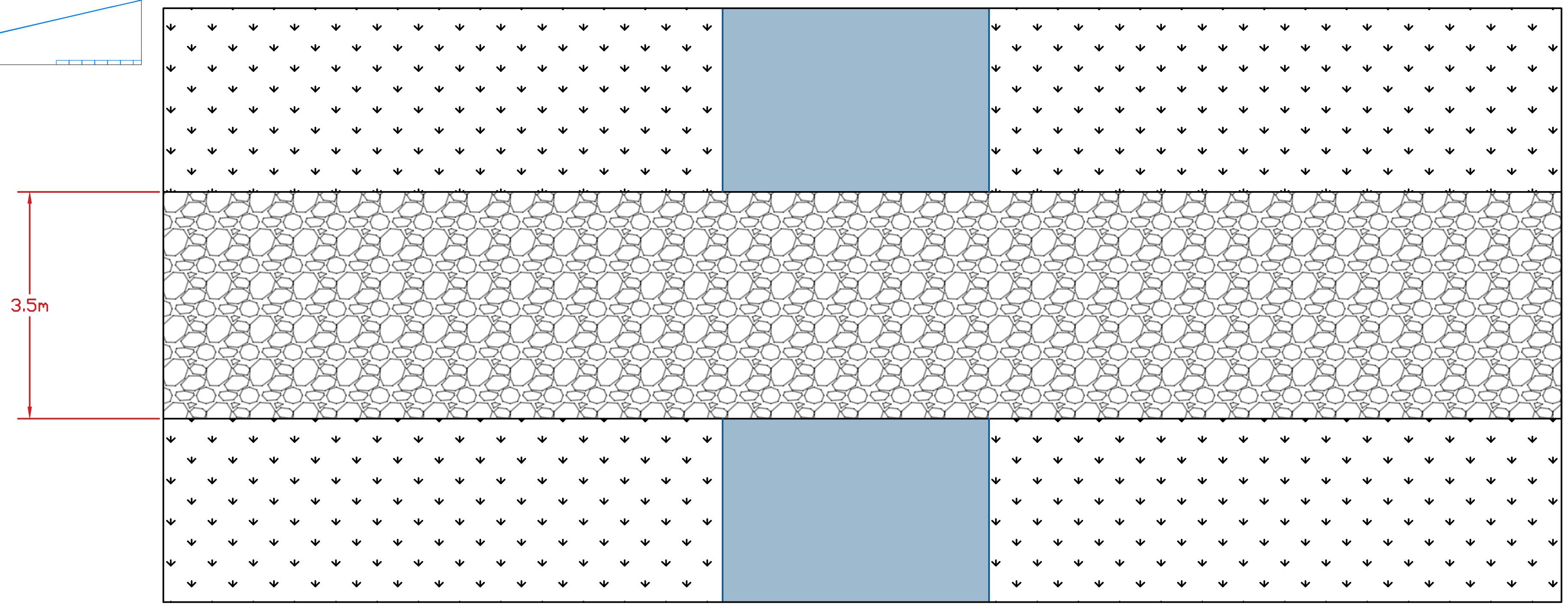
Drawing No. : NEO00515_042I_A

Drawn: JM **Checked:** MM **Approved:** KM

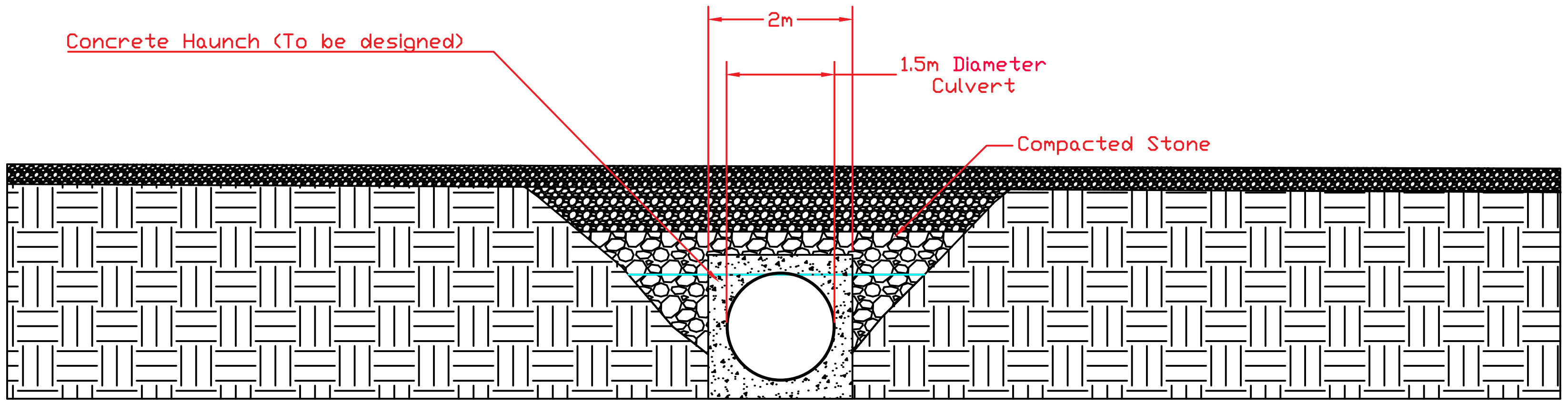
Scale: 1:4,000 @ A1 **Revision:** A

Date: 04 October 2018





PLAN VIEW OF WATERCOURSE CROSSING



CROSS SECTION A-A THROUGH WATERCOURSE CROSSING

GENERAL

1. Do not scale from drawing.
2. All dimensions are in metres, unless stated otherwise.
3. This drawing is to be read & printed in colour.
4. This drawing to be read in conjunction with other contract drawings.

The culvert, measuring 1.5m in diameter, will be able to pass the 1000 year flow (1.6m3/s) without surcharging.

Concrete collar shall be designed by final contract engineer, for the specific project and site conditions to carry all anticipated loading.

Naas Office: T:00353 (0)45 844250 E: info@neo-environmental.ie
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Warwickshire Office: T:01768 297012 E: info@neo-environmental.co.uk
Ballymena Office: T:02890517092 E: info@neo-environmental.co.uk

Project: Harristown Solar Farm
Client: Lightsource BP
Drawing: Culvert Design
Project No.: NEO00515
Drawing No.: NEO00515_044I_A Figure 6.2.4

Drawn	JM	Checked	MM	Approved	KM		
Scale	1:100@A3	Date	10/10/2018	Status	PLAN	Rev	A

Appendix6.2A

Drainage Design Report

Flow+

v8.1

Network	Storm Network
Filename	D:\Dropbox (Neo Environmental)\Projects\Lightsource\NEO00515 Harristown Solar Farm\A0890 Environmental Services\R. Hydrology\Drainage Software File\Harristown.pfd
Username	Michael McGhee (michael@neo-environmental.co.uk)

Report produced on	01/08/2019 12:14:43

Causeway Sales

Tel:	+44(0) 1628 552000
Fax:	+44(0) 1628 552001
Email:	marketing@causeway.com
Web:	www.causeway.com

Technical support web portal:

http://support.causeway.com

Rainfall Methodology	FSR
Return Period (years)	5
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	17.000
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)	Notes

Link Name	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node Name	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node Name	Dia (mm)	Width (mm)	Node Type	MH Type

Node Name	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Node Type	MH Type		Link ID	IL (m)	Dia (mm)	Link Type

Rainfall Methodology	FSR		**Return Period (years)**	**Climate Change (%)**
FSR Region	Scotland and Ireland		1	0
M5-60 (mm)	17.000		30	20
Ratio-R	0.300		100	20
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	0.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)				
1 year (l/s)	0.3			
30 year (l/s)	0.6			
100 year (l/s)	0.7			
Check Discharge Volume				
100 year 360 minute (m³)	27			

Site Makeup	Greenfield
Greenfield Method	IH124
Positively Drained Area (ha)	0.143
SAAR (mm)	888
Soil Index	2
SPR	0.30
Region	11
Growth Factor 1 year	0.83
Growth Factor 30 years	1.65
Growth Factor 100 years	1.96
Betterment (%)	0
QBar	0.3
Q 1 year (l/s)	0.3
Q 30 year (l/s)	0.6
Q 100 year (l/s)	0.7

Site Makeup	Greenfield
Greenfield Method	FSR/FEH
Positively Drained Area (ha)	0.143
Soil Index	2
SPR	0.30
CWI	124.720
Return Period (years)	100
Climate Change (%)	0
Storm Duration (mins)	360
Betterment (%)	0
PR	0.332
Runoff Volume (m3)	27

Default Values			**Overrides**						
Entry Loss (manhole)	0.250		**Link**	**Entry Loss**	**Exit Loss**			**Node**	**Flood Risk (m)**
Exit Loss (manhole)	0.250								
Entry Loss (junction)	0.000								
Exit Loss (junction)	0.000								
Flood Risk (m)	0.300								

Node Size	
Node Losses	
Link Size	
Minimum Diameter (mm)	150
Link Length	
Maximum Length (m)	100.000
Coordinates	
Accuracy (m)	1.000
Crossings	
Cover Depth	
Minimum Cover Depth (m)	
Maximum Cover Depth (m)	3.000
Backdrops	
Minimum Backdrop Height (m)	
Maximum Backdrop Height (m)	1.500
Full Bore Velocity	
Minimum Full Bore Velocity (m/s)	
Maximum Full Bore Velocity (m/s)	3.000
Proportional Velocity	
Return Period (years)	
Minimum Proportional Velocity (m/s)	0.750
Maximum Proportional Velocity (m/s)	3.000
Surcharged Depth	
Return Period (years)	
Maximum Surcharged Depth (m)	0.100
Flooding	
Return Period (years)	30
Discharge Rates	
1 year (l/s)	
30 year (l/s)	
100 year (l/s)	
Discharge Volume	

100 year 360 minute (m³)	

Adoptable						
Max Width (mm)	**Diameter (mm)**	**Width (mm)**		**Max Depth (m)**	**Diameter (mm)**	**Width (mm)**
374	1200			1.500	1050	
499	1350			99.999	1200	
749	1500					
900	1800					
>900	Link+900 mm					

Circular						
Shape	Circular		**Dia (mm)**			
Barrels	1		100			
Height (mm)			150			
Width (mm)						
Side Slope (1:X)						
Auto Increment (mm)	75					
Preferred Cover (m)						
Steep Slope (1:X)						
Follow Ground	x					
Velocity	Default					
ks (mm) / n						

Appendix 6.2C Flow Software Drainage Output-Substation

Drainage Design Report

Flow+

v8.1

Network	Storm Network
Filename	D:\Dropbox (Neo Environmental)\Projects\Lightsource\NEO00515 Harristown Solar Farm\A0890 Environmental Services\R. Hydrology\Drainage Software File\Harristown Substation.pfd
Username	Michael McGhee (michael@neo-environmental.co.uk)

Report produced on 01/08/2019 12:13:40

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Rainfall Methodology	FSR
Return Period (years)	5
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	17.000
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)	Notes

Link Name	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node Name	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node Name	Dia (mm)	Width (mm)	Node Type	MH Type

Node Name	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Node Type	MH Type		Link ID	IL (m)	Dia (mm)	Link Type

Rainfall Methodology	FSR		**Return Period (years)**	**Climate Change (%)**
FSR Region	Scotland and Ireland		1	0
M5-60 (mm)	17.000		30	20
Ratio-R	0.300		100	20
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	0.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)				
1 year (l/s)	0.1			
30 year (l/s)	0.2			
100 year (l/s)	0.3			
Check Discharge Volume				
100 year 360 minute (m³)	11			

Site Makeup	Greenfield
Greenfield Method	IH124
Positively Drained Area (ha)	0.059
SAAR (mm)	888
Soil Index	2
SPR	0.30
Region	11
Growth Factor 1 year	0.83
Growth Factor 30 years	1.65
Growth Factor 100 years	1.96
Betterment (%)	0
QBar	0.1
Q 1 year (l/s)	0.1
Q 30 year (l/s)	0.2
Q 100 year (l/s)	0.3

Site Makeup	Greenfield
Greenfield Method	FSR/FEH
Positively Drained Area (ha)	0.059
Soil Index	2
SPR	0.30
CWI	124.720
Return Period (years)	100
Climate Change (%)	0
Storm Duration (mins)	360
Betterment (%)	0
PR	0.332
Runoff Volume (m3)	11

Default Values			Overrides					
Entry Loss (manhole)	0.250		Link	Entry Loss	Exit Loss		Node	Flood Risk (m)
Exit Loss (manhole)	0.250							
Entry Loss (junction)	0.000							
Exit Loss (junction)	0.000							
Flood Risk (m)	0.300							

Node Size	
Node Losses	
Link Size	
Minimum Diameter (mm)	150
Link Length	
Maximum Length (m)	100.000
Coordinates	
Accuracy (m)	1.000
Crossings	
Cover Depth	
Minimum Cover Depth (m)	
Maximum Cover Depth (m)	3.000
Backdrops	
Minimum Backdrop Height (m)	
Maximum Backdrop Height (m)	1.500
Full Bore Velocity	
Minimum Full Bore Velocity (m/s)	
Maximum Full Bore Velocity (m/s)	3.000
Proportional Velocity	
Return Period (years)	
Minimum Proportional Velocity (m/s)	0.750
Maximum Proportional Velocity (m/s)	3.000
Surcharged Depth	
Return Period (years)	
Maximum Surcharged Depth (m)	0.100
Flooding	
Return Period (years)	30
Discharge Rates	
1 year (l/s)	
30 year (l/s)	
100 year (l/s)	
Discharge Volume	

100 year 360 minute (m^3)	

Adoptable						
Max Width (mm)	**Diameter (mm)**	**Width (mm)**		**Max Depth (m)**	**Diameter (mm)**	**Width (mm)**
374	1200			1.500	1050	
499	1350			99.999	1200	
749	1500					
900	1800					
>900	Link+900 mm					

Circular						
Shape	Circular		**Dia (mm)**			
Barrels	1		100			
Height (mm)			150			
Width (mm)						
Side Slope (1:X)						
Auto Increment (mm)	75					
Preferred Cover (m)						
Steep Slope (1:X)						
Follow Ground	x					
Velocity	Default					
ks (mm) / n						

Technical Appendix 6.3: Outline Construction Environmental Management Plan

Harristown Solar Farm

11/07/2019

Disclaimer

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Prepared For:

Lightsource BP

Prepared By:

Dawn Thompson BSc (Hons) MCIEEM MEECW

Michael McGhee BSc TechIOA

	Name	Date
Edited By:	Dawn Thompson	11/07/2019
Checked By:	Karen Mulryan	11/07/2019
	Name	**Signature**
Approved By	Paul Neary	

Contents

1. INTRODUCTION

BACKGROUND

1.1. Neo Environmental Ltd has been appointed by Lightsource BP (the "Applicant") to produce an outline Construction Environmental Management Plan (OCEMP) for a solar farm (the "Proposed Development") on lands at Harristown, Castlejordan and Clongall Co. Meath (the "Application Site") as part of an EIAR in response to a request for further Information (**Planning Reference TA181225**).

1.2. This assessment has been submitted as an appendix to Volume 2, Chapter 6: Land, Soil & Water of the EIAR.

DEVELOPMENT DESCRIPTION

1.3. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, battery storage and all ancillary grid infrastructure and associated works. Please see Volume 2, Chapter 1: Introduction for a detailed description of the Proposed Development.

SITE DESCRIPTION

1.4. The area containing all elements of the Proposed Development (the "Application Site"), consists of 21 fields currently used as pasture and covers a total area of 91.44 ha. The site lies at an elevation range of 66m to 71m AOD and is centred at approximate National Grid Reference (NGR) E260861 N238688. The River Boyne flows 0.19km to the east and 0.62km to the south of the site, forming the county border of Kildare and Offaly, respectively. Access will be via a pre-existing track which runs north-south through the site and connects to the L4091 north of the Application Site. The nearest settlement is the village of Castlejordan, which is located approximately 1.0km to the northwest of the site.

SCOPE OF REPORT

1.5. This OCEMP has been produced in support of the planning application to Meath County Council and includes:

- Construction method statement which identifies works likely to impact upon water quality;
- Pollution prevention, integral design measures and mitigation measures;
- Drainage management plan; and
- Waste management.

1.6. The OCEMP has been prepared with reference to the environmental assessments which have been undertaken in support of the planning application, these include the Flood Risk Assessment, Drainage Impact Assessment and the Ecological Impact Assessment. Following the approval of planning consent, this OCEMP will be developed by the contractor and be amended where necessary.

1.7. The Applicant will appoint a main contractor who will be responsible for the construction of the Proposed Development. The contractor will ensure that all measures and mitigation identified within this OCEMP are taken into account and implemented during the construction and decommissioning phases. In addition, the OCEMP will be monitored regularly throughout the duration of the construction phase to ensure best practice is implemented.

1.8. A Site Manager will be appointed and will be in charge of activities on site, including personnel. They will ensure that all personnel on site follow and adhere to the procedures outlined within the OCEMP.

Statement of Authority

1.9. This OCEMP has been produced by Neo Environmental, with input from Dawn Thompson BSc (Hons) MCIEEM MEECW and Michael McGhee BSc TechIOA. Neo Environmental have produced detailed OCEMPs for a range of development types, including for over 1GW of solar farm developments across the UK and Ireland.

2. LEGISLATION

2.1. Current legislation has been taken into consideration during the production of this OCEMP. The legislation covers all relevant areas including; water pollution, wildlife species protection, waste and noise. In the case of the Proposed Development, the following legislation has been considered:

- The Local Government (Water Pollution) Act 1977[1]
- The Local Government (Water Pollution) (Amendment) Act 1990[2]
- EC (Water Policy) (Amendment) Regulations, 2003[3]
- The Wildlife Act 1976 (amended 2000)[4]
- EC (Birds and Natural Habitats) Regulations 2011 (amended 2015)[5]
- Protection of the Environment (POE) Act 2003[6]
- Environmental Noise Regulations 2006[7]
- Environmental Protection Agency Act 1992[8]
- Waste Management Acts (WMA) 1996 to 2005[9]
- Waste Management (Hazardous Waste) Regulations 1998[10]

1 Office of the Attorney General (1977). Local Government (Water Pollution) Act 1977. Available at www.irishstatutebook.ie

2 Office of the Attorney General (1990). Local Government (Water Pollution) (Amendment) Act 1990. Available at www.irishstatutebook.ie

3 Office of the Attorney General (2003) S.I. No. 722/2003 – European Communities (Water Policy) Regulations 2003, as amended 2014. Available at www.irishstatutebook.ie

4 Office of the Attorney General (1976) Wildlife Act 1976 (amended 2000), available at www.irishstatutebook.ie

5 Office of the Attorney General (2011) European Communities (Birds and Natural Habitats Regulations 2011 (amended 2015), available at www.irishstatutebook.ie

6 Office of the Attorney General (2003) Protection of the Environment Act 2003. Available at www.irishstatutebook.ie

7 Office of the Attorney General (2006) Environmental Noise Regulations 2003. Available at www.irishstatutebook.ie

8 Office of the Attorney General (1992) Environmental Protection Agency Act 1992. Available at www.irishstatutebook.ie

9 Office of the Attorney General (1996) Waste Management Act 1996, as amended. Available at www.irishstatutebook.ie

10 Office of the Attorney General (1998) S.I. No. 163/1998- Waste Management (Hazardous Waste) Regulations 1998. Available at www.irishstatutebook.ie

- Carriage of Dangerous Good by Road Act 1998[11]
- EC Environmental Objectives (Surface Waters) Regulations 2009[12]
- EC Environmental Objectives (Groundwater) Regulations 2010[13]
- Article 4 of Waste Framework Directive (Directive 2008/98/EC)[14]
- Water Framework Directive (2000/60/EC)[15]

GUIDANCE

2.2. The Environmental Protection Agency has produced Pollution Prevention Guidelines (PPGs). The most relevant guidelines to the Proposed Development include:

- IPC Guidance Note – Guidance Note on Storage and Transfer of Materials for Scheduled Activities (EPA 2004) (amended 2012, 2013)[16]. This guidance note covers tanks, bunds and pipelines which store or transmit potentially polluting substances.
- National Hazardous and Waste Management Plan 2014-2014 (EPA 2014)[17]. The plan details guidance on how to prevent, reduce and collect hazardous waste.

2.3. Key guidance from other bodies that are relevant to the Proposed Development construction phase include:

- Best Practice Guide BPGCS005 – Oil Storage Guidelines[18]

11 Office of the Attorney General (1998) Carriage of Dangerous Goods by Road Act 1998. Available at www.irishstatutebook.ie

12 Office of the Attorney General (2009) European Communities Environmental Objectives (Surface Waters) Regulations 2009. Available at www.irishstatutebook.ie

13 Office of the Attorney General (2010) European Communities Environmental Objectives (Groundwater) Regulations 2010. Available at www.irishstatutebook.ie

14 European Parliament and the Council (2008) Directive 2008/98/EC on waste and repealing certain directives. Available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098

15 European Parliament and the Council (2000) Directive 2000/60/EC, establishing a framework for community action in the field of water policy. Available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060

16 Environmental Protection Agency, Ireland (EPA) (2004) IPC Guidance Note – Guidance Note on Storage and Transfer of Materials for Scheduled Activities. Available at www.epa.ie

17 Environmental Protection Agency, Ireland (EPA) (2014) National Hazardous Waste Management Plan 2014-2020. Available at www.epa.ie

18 Best Practice Guide BPGCS005 – Oil Storage Guidelines. Available at www.envirocentre.ie

- Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects[19]
- Construction and Demolition Waste Management – a handbook for Contractors and Site Managers[20]
- IEMA Environmental Impact Assessment Guide to: Delivering Quality Development[21].

2.4. UK Pollution Prevention Guidelines have also been considered in the production of this plan. The suite of Pollution Prevention Guidelines published by the Scottish Environmental Protection Agency (SEPA), the Environment Agency and the Northern Ireland Environment Agency (NIEA), are considered as a source of information on good practice only. Currently, a review for the PPGs is underway, and will result in a replacement guidance series. However, only some have been completed and therefore a mixture of guidelines and guidance documents are available. These documents provide a sound basis for any OCEMP and can be accessed online.[22] The PPGs/GGPs most relevant to the Proposed Development construction phase include:

- PPG1 'General Guide to the Prevention of Pollution'
- GPP2 'Above Ground Oil Storage'
- GGP5 'Works and Maintenance in or Near Water'
- PPG6 'Working at Construction and Demolition sites'
- PPG7 'Safe Storage – The Safe Operation of Refuelling Facilities'

2.5. These PPGs/GGPs provide guidance as to the various environmental considerations and potential mitigation and prevention measures.

19 Department of the Environment, Heritage and Local Government (2006) Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects. Available at www.envirocentre.ie

20 FÁS and Construction Industry Federation (2002) Construction and Demolition Waste Management – A handbook for Contractors and Site Managers. Available at www.ncdwc.ie

21 IEMA (2016) EIA Guide to: Delivering Quality Development. Available at: http://www.iema.net/assets/newbuild/documents/Delivering%20Quality%20Development.pdf

22 Environmental Guidance (Wales, Scotland, and NI). Available online: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

HEALTH AND SAFETY MANAGEMENT

2.6. A construction works Health and Safety plan should be implemented and followed during construction of the Proposed Development. All work should be carried out in accordance with the following health and safety regulations:

- Safety, Health and Welfare at Work Act 2005[23]
- Safety, Health and Welfare at Work (Construction) Regulations 2013[24]
- Safety, Health and Welfare at Work (General Application) Regulations 2007[25]

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[23] Office of the Attorney General, 2005. Safety, Health and Welfare Act 2005. Available at www.hsa.ie

[24] Office of the Attorney General, 2013. Safety, Health and Welfare at Work (Construction) Regulations 2013. Available at www.hsa.ie

[25] https://www.hsa.ie/eng/Legislation/Regulations_and_Orders/General_Application_Regulations_2007/General_Application_Regulations_2007_S_I_2007_.pdf

3. RESPONSIBILITIES

KEY CONTACTS & ROLES

3.1. The detailed OCEMP will need to confirm the details outlined in **Table 3-1** below.

Table 3-1: Key Contacts & Responsibilities

	Name	Role	Address	Name & Contact Details
Developer	Lightsource BP	To ensure all planning condition requirements are implemented	7th Floor, 33 Holborn, London EC1N 2HU	TBC
Contract Manager	TBC	Responsible for the development of the CEMP in line with planning condition requirements	TBC	TBC
Site Manager	TBC	Responsible for the implementation of the CEMP with all site personnel	TBC	TBC
Environmental Compliance Officer	TBC	Responsible for the coordination and development	TBC	TBC
Consulting Engineers	TBC	Responsible for the development of method statements and design	TBC	TBC

4. ENVIRONMENTAL SENSITIVITIES

4.1. The environmental assessments which were undertaken in support of the planning application identified some sensitivities onsite.

4.2. The key potential environmental impacts associated with the site preparation and construction works are set out in **Table 4-1**. Relevant potential sensitive receptors to the works are identified. These potential sensitive receptors, the environmental considerations and potential impacts are to be considered as the basis for a future detailed CEMP.

Table 4-1: Environmental Considerations and Impacts

Environmental Issue	Potential Receptor	Potential Impacts
Protected Species	Badger	Disturbance, destruction of a sett, accidental trapping, and the restriction of movement through the site (foraging habitat)
Protected Species	Otter	Disturbance, accidental trapping, and the restriction of movement through the site
Protected Species	Breeding birds	Disturbance / damage to nest
Environmental Designated Site	River Boyne And River Blackwater SAC & River Boyne And River Blackwater SPA	Contamination of aquatic environment Potential impacts for qualifying features (habitats and species) of the SAC/SPA
Water	Waterways within and adjacent to the Development	Contamination of aquatic environment
Water	Groundwater	Contamination of groundwater by additional pathways. Risk to aquifer recharge. Risk to existing groundwater flow route.
Soil	Soil on site	Contamination, compaction & soil degradation

		Reduced filtration

ECOLOGY

Habitats

4.3. An extended phase 1 habitat survey was undertaken on 27th-28th March 2018 by Gala Podgornik and 2nd May 2018 by Karen Banks for the original application. An extended phase 1 habitat survey was also undertaken on the 19th and 20th of June 2019 by Eilish Smyth for the EIA application. Both surveys covered all land within the Application Site, and a 50m buffer around the entire site (the "Ecological Survey Area"). Survey work was carried out in accordance with the Joint Nature Conservation Committee (JNCC) guidelines (2010)[26] and the Fossitt Guide to Habitats in Ireland (2000)[27].

4.4. The proposed Application Site comprises mainly improved grassland (GA1) and wet grassland (GS4), with drainage ditches (FW4), water courses (FW2) hedgerow (WL1) and treelines (WL2).

4.5. Please refer to Volume 2 Chapter 5, Biodiversity of the EIAR for full details on the habitats present within the Proposed Development site.

Protected Species

4.6. As part of the Biodiversity assessment, a desk-based assessment of available species records was undertaken. In addition, the extended phase 1 habitat surveys included a species scoping survey to identify the potential of the site to support protected and notable species.

4.7. Records of badger were identified within 2km of the Application Site during the data search which confirmed evidence of badger setts and prints, both inside and outside the ecological survey area (ESA).

4.8. A search of the database identified records of otter within 2km of the Application Site. Evidence of otter prints and otter spraint were identified outside of the ESA on the banks of the River Boyne, circa 100m from the revised development boundary.

4.9. No sightings or field signs of bats were observed within the survey area. However, mature trees within the hedgerows surrounding the Application Site may provide potential roosting

26 JNCC (2010) Handbook for Phase 1 habitat survey – a technique for environmental audit

27 Fossitt (2000) A guide to habitats in Ireland

http://www.heritagecouncil.ie/fileadmin/user_upload/Publications/Wildlife/Guide_to_Habitats.pdf features, although these structures are to remain intact. Only a single small tree at the access point for the Proposed Development will be removed, which offers no bat roosting potential. Tree lines and taller hedgerow may act as commuting routes and ditches may provide potential foraging sites.

4.10. It is considered that some of the ditches and watercourses offer suitable foraging and commuting habitat for bats and otter.

Environmental Designations

4.11. The Proposed Development at Harristown does not lie within any statutory or non-statutory designated environmental sites. Within 5km of the Application Site there is a single NHA; Black Castle Bog NHA. Within 15km of the Application Site there are four Natura 2000 designated sites; three SACs and one SPA.

4.12. The findings of the Natural Impact Statement (NIS) (Item 1 Response of the RFI **Planning Reference TA181225**) concluded that in the absence of mitigation, there will be **no likely significant effects** for the Natura 2000 sites from the Proposed Development. As a standard, best practice pollution prevention measures will be implemented prior to and throughout the construction phase to prevent contaminants entering the aquatic environment.

WATERCOURSES & WATER FEATURES

River Boyne

4.13. The River Boyne flows north near the eastern boundary of the Application Site. Historical maps from 1837-1842 indicate that the river experienced a number of meanders; however, the channel has since been straightened and runs north before turning northeast, away from the Application Site.

4.14. The main channel of the river adjacent to the Application Site measures approximately 3.5m deep and 10m wide from bank to bank. There are no crossings present within the Application Site.

Internal Watercourses

4.15. There are three internal watercourses which drain land within the Application Site before discharging to the River Boyne. The two most southern watercourses join close to the downstream reach of the Application Site before entering the River Boyne; whilst the northern watercourse tends to run along the northern area of the Application Site and enters the River Boyne a short distance north of the point where the other two enter the river.

Local Drains

4.16. The Application Site is drained by a series of drainage ditches which drain low lying land and convey water into the internal watercourses.

Groundwater Vulnerability

4.17. 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.

4.18. According to the GSI map the groundwater vulnerability across the proposed Application Site is considered to be mostly 'Moderate' with a small section of Field 7 is classed as 'High'. The subsoil permeability again is mostly is classed as 'Medium' which indicates a subsoil thickness over 10m, whilst the small section of Field 7 is classed as 'High' which suggests a subsoil thickness of over 3m.

5. CONSTRUCTION METHOD STATEMENT

INTRODUCTION

5.1. This Construction Method Statement outlines the management plan for the construction and decommissioning phases of the Proposed Development. Employed contractors will be instructed on compliance within the contents of this document prior to accessing the site for construction.

CONSTRUCTION OPERATIONS

5.2. The Proposed Development will be constructed in accordance with the drawings submitted in support of the planning application.

Construction Activities

5.3. The following activities will be undertaken during the construction phase:

- Erecting construction traffic signage;
- Creation on internal site tracks;
- Sustainable Drainage Systems (SuDS) installation;
- Erecting security fence;
- Erecting temporary construction compound;
- Site preparation, including mowing and marking out if required;
- Piling the frame supports into the ground;
- Affixing the mounting frames and panels;
- Concrete base formation for the substations and inverters;
- Substation and inverter / transformer station construction;
- Cable route trenching and cable laying;
- Connecting cables and backfilling trenches;

- Removal of construction compound; and
- Installation of ecological and landscape mitigation measures as outlined within the supporting Landscape and Ecology Management Plan (LEMP). Please see **Figure 8.20 of Volume 2 Chapter 8: LVIA** for details.

Schedule & Hours of Operation

5.4. The construction for the Proposed Development is anticipated to occur over a 6-month period. During this period, there will be a combination of HGVs (for the component and material deliveries) and cars/vans (for construction staff) on site. HGV movements are expected to be most intense during the first two months of construction, tailing off towards the final weeks. Car/van movements are expected to be constant throughout.

5.5. All traffic movements will be carried out between the hours of 08.00 to 18.00 on Monday to Friday and 08.00 to 16.00 on Saturdays. Public holidays will be observed unless otherwise agreed with the local planning authority. Deliveries will also be scheduled to avoid peak times, i.e. avoiding rush hours and after school pick-up times.

5.6. At the end of the operational phase, decommissioning will take place during the same hours.

Staff

5.7. It is forecast that there will be a maximum of 115 staff on site at any one time during the construction and decommissioning periods, although this will vary subject to the overall programme of works.

Equipment

5.8. Plant equipment required for the construction phase may include but not be limited to:

Table 5-1: Plant Equipment

Equipment	Function
JCB Diggers	Trenching for cables
Dump trucks	Earth removal if required
Vibrating roller	Compacting access tracks
Piling machine(s)	Ramming piles of mounting frames into the ground
Telehandler(s)	Distributing materials

Crane	Capable of lifting inverter and transformer cabinets into place
Fuel bowser	Refuel plant as required

6. WASTE MANAGEMENT

INTRODUCTION

6.1. Surplus or waste materials may arise from materials imported to the site, or those generated on site during the construction and decommissioning phases.

6.2. The Waste Management Plan follows the waste hierarchy, as outlined within Article 4 of the Waste Framework Directive 2008/98/EC. The waste hierarchy, as defined within the legislation, is detailed below:

- Prevention;
- Re-use;
- Recycling;
- Other recovery; and
- Disposal.

Excavated Areas

Transformer/Switchgear Stations/AC Unit

6.3. There are expected to be 14 transformer/switchgear/AC Unit stations positioned alongside the internal access tracks throughout the Application Site. Each station comprises one transformer station with a ground disturbance of 5.48m by 4.4m (24.11m^2) one switchgear substation with a ground disturbance of 4.2m by 2.6m (10.92m^2), and one AC Unit with a ground disturbance of 4.0m by 1.0m (4.0m^2). Total ground disturbance associated with the transformer/switchgear stations will therefore be 546.42m^2.

6.4. Each of these transformer/switchgear/AC Unit stations are expected to be positioned onsite through the use of a crane. It is anticipated that the site tracks can be used to provide a hardstanding for the crane and that no additional hardstanding areas will need to be constructed.

6.5. The transformer/switchgear/AC Unit stations will require ground excavation before establishing a hardstanding base for stability.

Future 110kV Substation

6.6. A 110kV substation will be constructed within the site as part of a separate future planning application. However, as this substation is integral to the operation of the proposed solar farm it has been included within this assessment in order to determine the full extent of the ground disturbance effects associated with the Proposed Development in its entirety.

6.7. Ground disturbance associated with the future 110kV substation will occur mainly from topsoil stripping the area, but foundations and plinths required for the transformer, client-side substation and EirGrid building will require deeper disturbance. The total ground disturbance area associated with these elements is anticipated to be 13,811.82m^2.

Battery Storage

6.8. A total of 16 battery storage containers are proposed in close formation. Each container will require a ground disturbance area of 54.12m^2, resulting in a total ground disturbance of 865.92m^2.

Monitoring House

6.9. A single monitoring house is proposed which will require a ground disturbance area of 12.35m^2.

Storage Container

6.10. A single storage container is proposed which will require a ground disturbance area of 12.35m^2.

Cable Trenches

6.11. Approximately 7,846.5m in length of trenching will be required for the implementation of the cable routes within the Application Site boundary. Depending on the functionality of the trench, the trenches will measure approximately 0.5m wide and will have a total ground disturbance area of c. 3,923.25m^2.

6.12. The trenches will be excavated to a depth of approximately 1m and will be backfilled after the cables have been laid.

CCTV Bases

6.13. There will be approximately 12 CCTV cameras along the perimeter fences. Each base will require a concrete foundation of 0.8m by 0.8m which will therefore have an area of disturbance of c. 0.64m^2 each. This will result in a total ground disturbance of 7.68m^2 of the Application Site area.

Topsoil stripping

Access and Site Tracks

6.14. The access and site tracks will measure an average width of 3.5m and cover an area of approximately 21,817.07m^2. Approximately 25% of the access tracks are existing and will be reused and therefore only 15,271.95m^2 will result in new disturbed ground. The access tracks will be constructed by stripping the topsoil and laying down a geotextile/geogrid. Crushed rock will then be layered and compacted on to the geotextile/geogrid in order to establish the access and site tracks.

Temporary Compound and Assembly Areas

6.15. Two temporary compound areas will be utilised in the construction phase, having a total ground disturbance area of c. 5,000m^2 in two square shapes of 50m by 50m each. This will be constructed by the stripping of topsoil and subsequent layering of crushed stone similar to the process for the site access tracks.

6.16. This area will then be reinstated and used for the placement of solar panels towards the end of the construction phase.

Piling

Solar Panels

6.17. Solar panels will be mounted on galvanised metal mounting frames which will be supported by posts piled into the ground at a depth of up to c. 1.5m. The direct impacts from the piling are considered to be minimal due to the small total area covered, with each pile having a diameter of 0.1m and an area of disturbance of 0.008m^2. The development will comprise 335 small panel racks, with 16 legs each, and 1021 large panel racks, with 30 legs each. As such, the number of pile-drive legs required for the panels will be approximately 35,990, resulting in a total area of ground disturbance of c. 287.92m^2.

6.18. Piling is anticipated to be done by a c. 2.95 tonne pile driver with rubber tracks. The vehicle is of relatively low weight (compared to standard agricultural vehicles which are currently on use on the Application Site) and will have rubber tracks (as opposed to tyres).

6.19. A standard agricultural vehicle will also be used to move panels on areas without an access track, where this is required. This vehicle will be of similar weight and specifications as other agricultural vehicles which are commonly used on the land.

Perimeter Fence

6.20. Poles will also be inserted into the ground to support the perimeter fence. The total length of fence will be 9,898.43m with approximately 2,828 fence posts (based on one post every 3.5m). Each fence post will disturb c. 0.015m^2 of ground, resulting in a total area of ground disturbed by the perimeter fence of 42.42m^2 of the Application Site area.

Summary of Excavated Areas

6.21. Overall, the proposed footprint constitutes a relatively small percentage of the total area of the Application Site (91.44ha):

- 40,542.59m^2 for infrastructure (c. 4.43% of the Application Site area); and
- 330.34m^2 for piling (c. 0.04% of the Application Site area).

6.22. It is estimated that approximately 15,200.30m^3 of spoil will be created. However, 5,423.25m^3 will be used to backfill the cable trenches and reinstate the temporary compounds. This shall leave a total of 9,777.05m^3, which will be used in the regrading of the site, particularly along access tracks and to level off uneven areas. No soil will be removed from the Application Site and no soil will be introduced to the Application Site.

Identification of Waste

6.23. There will be limited waste generated during the construction phase of the Proposed Development.

6.24. The contractor on site during each phase will ensure that all waste will be disposed of responsibly from the site. Potential waste generated during the construction phase is likely to include:

- Wooden crates or cardboard boxes in which the building materials will be packaged. These will be removed from the site and recycled appropriately at regular intervals.
- Packaging materials from various components including cabling, mounting frames screws, etc. These will also be removed regularly and recycled.
- Aggregate and substrate from groundworks – soil will be excavated for the construction of the access tracks, construction slabs, cable trenches, sub stations and inverter and transformer units. All of which is expected to be reused on site.

- As the Proposed Development involves a minor amount of groundworks (ground works are limited to inverter/Transformer AC Unit (approximately 273.21m^3), storage container (approximately 6.18m^3), monitoring house (approximately 6.18m^3), battery storage containers (approximately 432.96m^3), substation (approximately 4,143.55m^3), access tracks (approximately 4,908.84m^3), and CCTV bases (approximately 6.14m^3), any topsoil and subsoil extracted will be kept separate on site to ensure contamination does not occur and to avoid damage to soil quality and structure. Any excavated soil which is not immediately re-used or dispersed across the site shall be stored on the impermeable surface at the site compound (see **Figure 9.1.8: Technical Appendix 9.1**) and covered in order to prevent silt runoff and dust creation. Any spoil storage will be done in accordance with the development buffers specified, i.e. 5m from drains and ditches, outside Badger exclusion zones, etc. Spoil heaps will be deposited as per standard spoil heap ratios.
- Site office waste will be collected separately in order to maximise the potential for recycling.
- Any kitchen waste will be taken off site in refuse containers and disposed of off-site.
- Oils/fuels, paints, solvents or other chemicals.
- Burning of waste on site will be prohibited

6.25. During the decommissioning phase of the Proposed Development, the Application Site will be reinstated as close as practicable to its original condition. This will involve the removal of the substation components, including: access tracks (if not of beneficial use to the landowner), security fencing, electrical infrastructure buildings and concrete foundations.

Waste Segregation and Storage

6.26. A specific segregation area within the temporary site construction compound (see **Figure 9.1.8: Technical Appendix 9.1**) will be identified where the separation of materials will take place during both the construction and decommissioning phases. This area will allow for the separation of materials into those which can be reused, recycled or disposed.

6.27. All waste containers should be appropriate to the nature of the substances stored and should be secure to ensure no waste can escape. In addition, all waste containers should be appropriately labelled to ensure that it is clear to all construction staff what types of waste can be stored in each container. These containers should be located appropriately to reduce any potential hazards and to ensure no waste is released into the external environment.

6.28. Relevant waste and resource management procedures will be communicated to all construction operatives during the initial site induction, which is mandatory for all staff working on site. This will include instruction on the segregation, handling, re-use and return methods to be used by all parties at all appropriate stages of development. Where possible, waste will be eliminated, re-used or recycled as per the requirements of the waste hierarchy.

STORAGE OF FUELS AND CHEMICALS

6.29. As per Best Practice Guidance (BPGCS005),[28] all fuels, oils and chemicals on site will have a secondary containment system of 110% capacity and be located more than 20m from any watercourse (i.e. outside of the water course buffer).

6.30. A bunded diesel bowser will be located inside a fenced off area within the temporary construction compound (see **Figure 9.1.8: Technical Appendix 9.1**). Any other chemicals will be stored within a storage container with an accompanying Control of Substances Hazardous to Health ("COSHH") Datasheet in accordance with health and safety regulations. If generators are used on site, these shall be bunded (the bund shall be capable of containing 110% of the fuel tank's capacity). The bund shall be kept empty of water.

6.31. Where chemicals are required on site, they must be placed in an appropriate bund to prevent ground contamination. All chemicals must be stored in a correctly marked container clearly identifying the contents. Where labels are worn off, they must have a new label placed on them or the contents transferred to a correctly marked container. All safety data sheets for all chemicals should be filed on site as part of the CEMP.

6.32. Spill kits will be on site and, for ease of access, located in the site office. Contingency plans will be in place for dealing with a spillage should a spillage occur.

REFUELLING

6.33. During construction, fuel and oil deliveries shall take place within the designated refuelling area within the Temporary Construction Compound only (see **Figure 9.1.8: Technical Appendix 9.1**), the location of this area will fall outside the watercourse buffers. The Contractor shall supervise site deliveries to ensure that the correct amount of material is delivered to the correct tank and the level is checked prior to refilling to avoid spillage.

6.34. Where refuelling of vehicles on site is necessary, the following guidelines will be strictly adhered to:

28 Best Practice Guide BPGCS005 - Oil Storage Guidelines. Available at:

http://www.envirocentre.ie/includes/documents/OilStorageBPG.pdf;

- Mobile plant will be filled in a designated area, on an impermeable surface well away from any drains or watercourses;
- A spill kit will be stored (and clearly marked) near refuelling areas;
- A bunded tank / bowser will be used with capacity of the bund to be 110% of the fuel storage capacity;
- Vehicles will never be left unattended during refuelling and drip trays should be located under all static plant vehicles;
- Hoses and valves will be checked regularly for signs of wear, and will be turned off and securely locked when not in use;
- Vehicles will not be left running unnecessarily and low emission fuels will be used where possible; and
- Diesel pumps and similar equipment will be checked regularly and any accumulated oil removed for appropriate disposal.

Excavation and Earthworks

6.35. All excavation and earthworks will be carried out in accordance with BS6031:2009 Code of Practice for Earthworks.[29] Soil handling, extraction and management will be undertaken with regard to best practice guidelines such as Guidance on the Waste Management (Management of Waste from the Extractive Industries) Regulations 2012.[30]

6.36. The following practices will be followed in relation to the excavation of cable trenches, topsoil stripping and any other earthworks:

- Any excavated material will be stored and re-used to infill excavations. Where the soil is to be re-used, this will be side casted. All side casted soil to be kept a minimum of 20m from and watercourse.
- Install silt traps at the toe of a slope where excavation or road construction crosses existing drainage. This will reduce silt transportation and to filter out suspended solids in the water caused by excavation works.

29 British Standards Institute (BSI), 2009. BS 6031:2009 Code of Practice for Earthworks

30 Environmental Protection Agency (EPA) 2012. Guidance on the Waste Management (Management of Waste from the Extractive Industries) Regulations 2012. Available at www.epa.ie

- Although unlikely, if any contaminated earth is uncovered, this will be stored separately and disposed of accordingly once the contaminant has been identified.
- Efforts will be made to ensure that water does not accumulate in excavated areas.
- All topsoil and subsoil will be stored separately, and care will be given to ensure the structure and quality of the soil is not damaged.
- The amount of exposed ground and soil stockpiles will be kept to a minimum and any stockpiles in place for an extended period of time will be allowed to re-vegetate naturally.
- Earthworks shall not occur during unsuitable weather conditions, including when soils are waterlogged or very dry.
- The Proposed Development does not propose to change ground levels and only small sections of land are to be regraded around the buildings and possibly at the access track edges; however, this will only be over a few metres.
- Any excavated soil which is not re-used or dispersed across the site and shall be stored on the impermeable surface at the construction compound (see Figure 9.1.8: Technical Appendix 9.1) and covered to prevent silt runoff and dust creation.

CONCRETE

6.37. Concrete will not be allowed to enter watercourses under any circumstances, and drainage from excavations in which concrete is being poured will not be discharged directly into existing watercourses without appropriate treatment and consent from the relevant authority. The construction compound will be lined by an impermeable geomembrane and will have a concrete storage location (see Figure 9.1.8: Technical Appendix 9.1). This will be a small pit so that no wet concrete can flow out.

6.38. No washing out of plant associated with concrete delivery operations will be allowed on site.

6.1. Buffers from the site drainage ditches of 2m and to the three arterial drainage scheme watercourses of 6m have been incorporated into the design of the Proposed Development and therefore there will be no concrete being used within the immediate vicinity of a watercourse.

Monitoring

6.2. Operations and activities that have the potential to impact on the water environment will be regularly monitored throughout the construction of the Development. This is to ensure compliance with planning conditions and environmental regulations.

6.3. The Site Manager is responsible for ensuring that all monitoring is carried out according to the Environmental Monitoring Programme, summarised in **Table 6-1** below.

Table 6-1: Environmental Monitoring

Environmental Aspect	Monitoring Location	Monitoring Frequency	Monitoring Arrangements
Site housekeeping	Entire site	Daily	Visual inspection
Surface water courses	All water courses	After periods of rain; Weekly, if no rain	Visual inspection
Fuels and chemicals – appropriate storage	Entire site	Daily	Visual inspection

6.4. These records and results will be maintained by the Site Manager and will be stored on site during the construction phase.

Site Office Waste

6.5. The proposed site layout includes for a temporary construction compound (see **Figure 9.1.8: Technical Appendix 9.1**).

- A Project Supervisor Construction Stage will be employed to ensure that welfare facilities in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013, Statutory Instrument No. 291 are located at the proposed site for the duration of the construction. Welfare facilities will be provided within the construction compound to cater for up to 115 staff members at any one time. The welfare facilities will include:

  – The provision of toilet, washing and changing facilities;

  – Clothing Storage;

  – Facilities for eating;

  - Rest room; and
  - Car Parking

- Water will be held within a holding tank within the temporary welfare facility. There will also be a separate tank for waste. The Project Supervisor will be responsible for organising the tanks to be emptied/filled by an approved local contractor as and when required.

7. POLLUTION PREVENTION

INTRODUCTION

7.1. This OCEMP identifies elements of the Proposed Development which are potentially capable of giving rise to pollution and identifying pollution prevention and mitigation measures.

7.2. The associated infrastructure will require earthworks, including the foundation construction for the accompanying electrical infrastructure and cable trench excavation.

MITIGATION MEASURES

7.3. Suitable protection for watercourses potentially affected by the works will be installed prior to relevant works proceeding. These measures will be in-line with Environmental Protection Agency (EPA) Pollution Prevention Guidelines. Protection measures will include:

- Plant and equipment will be stored on dedicated hard standing within the construction compound. This will minimise the risk of pollution caused by leakages occurring out of hours. Drip trays will be used where appropriate.
- All plant and equipment will utilise biodegradable hydraulic oil.
- Spill kits will be readily available to all personnel. The spill kits will be of an appropriate size and type for the materials held on site.
- Diesel fuel will be stored in a bunded diesel bowser which will be located within a fenced off area in the construction compound (see Figure 9.1.8: Technical Appendix 9.1).
- Refuelling and maintenance of vehicles and plant will take place in designated areas of hardstanding.
- All other chemicals will be stored within a storage contained with an accompanying COSHH Datasheet.
- Wastewater from the temporary staff toilets and washing facilities will be discharged to sealed containment systems and disposed via licensed contractors.
- Early seeding of embankments near watercourses would be undertaken to reduce the potential for sediment run-off.

7.4. All staff on site will be made aware of the pollution prevention measures being implemented throughout the construction and decommissioning phases using appropriate toolbox talks and the site induction.

Noise and Vibration

7.5. Operating plant noise will be kept within the standards and time periods dictated for the site. Any noncomplying plant will be stopped and stood down until it can be rectified or removed from the site.

- The British Standard which gives guidance on noise from construction and mineral working sites is BS 5228. This document does not specify absolute noise limits relating to construction activities; however, it does provide detailed guidance on the steps that can be taken to minimise potential noise & vibration effects. Reasonable mitigating measures are as follows: vehicles and machinery will be switched off when not in use and properly maintained.
- Operation of plant, including fitting and proper maintenance of silencers and/or enclosures, avoiding excessive and unnecessary revving of engines and parking of equipment in locations which avoid possible effects on residential properties.
- Traffic movement limited to:
  - 08.00 to 18.00 Monday to Friday
  - 08.00 to 16.00 Saturdays
  - Public holidays will be observed unless otherwise agreed with the local planning authority
  - When loading and unloading material, attempts shall be made not to drop material from a height
- Controlling the spread of noise, e.g., by increasing the distance between plant and noise-sensitive receptors or by the provision of acoustic screening.

7.6. Any noise complaints shall immediately be directed to the site agent. Depending on the nature of the complaint, the initial response could be to immediately cease the activity until suitable mitigation measures have been put in place and agreed with the affected individual.

Dust

7.7. In order to control, prevent and minimise dirt on the access route and emissions of dust and other airborne contaminants during the construction works, the following measures will be implemented:

- Wheel washing equipment will be available and used on-site (see Figure 9.1.8: Technical Appendix 9.1), as required to prevent the transfer of dirt and stones onto the public highway. All drivers will be required to check that their vehicle is free of dirt, stones and dust prior to departing from the site. Wheel washing will likely be a water bowser and power spray. It will not have any cleaning additives and will drain into the temporary drainage feature at the site compound.
- During windy conditions, any dust generating activities will be avoided or minimised, where practical.
- Any soil stockpiles will be covered when left for extended periods of time.
- Driving practices which minimise dust generation will be adopted.
- Loads into and out of the site will be covered where required.

8. DRAINAGE MANAGEMENT PLAN

INTRODUCTION

8.1. The measures described in this section will be adopted during the construction phase in order to manage on-site drainage in accordance with current best practice and legislation.

MONITORING RECORDS AND EMERGENCY SPILL RESPONSE

Monitoring

8.2. To ensure compliance with the detailed Drainage Management Plan ("DMP"), drainage management works will be supervised by the site engineer.

Emergency Spill or Pollution Response

8.3. In the event of a liquid spill occurring on a construction site, the Contractor shall cease work immediately in the vicinity. Contractor's trained personnel shall do an appropriate PPE and as follows:

- Locate the source of the pollution and stop/contain any further flow if possible;
- If spillage is flammable, extinguish all ignition sources;
- Immediately deploy the spill kit in accordance with the manufacturer's instructions;
- Clean up the spill;
- All used spill kit materials should be disposed of in the proper manner as outlined in spill summary procedures.

8.4. The Site Manager shall contact:

- The Client;
- Environmental Protection Agency ("EPA") 24-hour emergency incident line 1890 33 55 99;
- Inland Fisheries 24-hour pollution line 1890 34 74 24. The pollution hotline number shall be referenced in the construction site rules and displayed in the Site Office and in the Emergency preparedness & response plan.

8.5. Each Contractor working with controlled substances shall supply appropriate spill kits which shall be kept on site. The spill kits shall be made accessible at all times to all site personnel.

8.6. In the event of a fire, all personnel must evacuate the site and assemble at the site entrance. The Site Manager is responsible for calling the Fire Service, who will handle the emergency.

PROPOSED DRAINAGE ARRANGEMENTS

Construction Phase

8.7. Due to the addition of the temporary construction compounds, during the construction phase additional drainage measures will be implemented to help attenuate the increase in surface water flows if surface water is observed discharging from the construction compound.

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

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

Operational Phase

8.10. Any existing on-site drainage ditches or features will be retained in their existing state, and will continue to intercept overland flows from the site.

Proposed Development

8.11. While it has been argued above that the Proposed Development will not result in a material increase in surface water runoff flow rates, it is proposed to construct a swale within the site (See **Figure 6.2.2 Appendix 6.2A**). The location of the swale has been chosen to attenuate runoff from the battery storage area which is the largest part of new impermeable development associated with the Proposed Development. The other buildings are located at various locations across the Application Site and are too small to require specific drainage schemes on their own and any excess water will slowly drain into the underlying geology through infiltration. That being said the swales have been sized to attenuate to the 1 in 100-year greenfield rate for all of the new areas of impermeable development.

8.12. The proposed swale will be approximately 65m in length, with a base width of 500mm, a 500mm design depth, 150mm freeboard and a maximum side slope of 1 in 3.

8.13. It will provide a total storage volume of approximately 65m^3. This is greater than the volume of additional runoff generated as a result of the impermeable buildings (41.5m^3). It is therefore considered that this adequately mitigates the increase in flow rates as a result of the minor increase in impermeable area and provides improvement.

8.14. The swale will be implemented during the construction phase of the proposed solar farm and planted with covering vegetation to protect against soil erosion. The swale will be maintained throughout the design life of the Proposed Development, generally in accordance with the recommendations in the appropriate guidance.

8.15. 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, check dams formed from gravels and other excavated material shall be placed in the swale at frequent intervals; and
- Inverter/Transformer AC Units (and similar hardstands): 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.
- There is one new culvert crossing proposed over an internal watercourse. This is part of the OPW arterial drainage scheme and will therefore require a Section 50 Application under the Arterial Drainage Act 1945. This should be conditioned to any planning consent. A draft drawing of the watercourse crossing can be found in **Figure 6.2.4**. This includes a 1.5m diameter precast concrete culvert overlain with compacted stone. Engineering designs will be completed post planning; however, the culvert has been sized so as the 1 in 1000-year flow (1.6m^3/s) can pass with ought surcharging.

Substation Compound

8.16. Surface water drainage proposals for the Substation Compound have been developed to mimic the natural drainage patterns of the site and thereby be in accordance with the Best Management Practices (BMPs) of Sustainable Drainage Systems (SuDS).

8.17. The attainment of this aspiration is easily achieved when the following parameters are considered (see drawing pack site layout):

- The Substation Compound construction is formed with permeable stone thus mimicking a soak away scenario. Substation Compound stone is single sized for the first 150mm for safety purposes. It then changes to a graded 6F2 material. The area of this permeable surface is approximately 12,375m².
- The area to be drained includes the roofs and the bunded plinths. These equate to 591.7m² and are very modest in themselves and in comparison, to the overall compound area.
- Assuming even the most basic of infiltration rates down through the permeable compound stone, it is clear that the existing greenfield situation is easily maintained.

8.18. The surface water generated in the bunded areas will discharge to the existing drainage via a Class 1 Full Retention Oil Separator. The electrical transformer in the substation is oil filled equipment and, as such, is protected with impermeable bunds. Surface water generated in this bund will be pumped out by an oil sensitive pump ensuring that only non-contaminated water enters the site drainage network. The Class 1 Full Retention Oil Separator will provide a second level of defense.

8.19. The Substation Compound Drainage network consists of a number of pipes connecting to a small soak away, which will need to be sized to attenuate 11.5m^2 of surface water. This will then flow into the existing site drainage network. This is subject to minor change depending on the final Substation Compound Application.

Drainage Mitigation

Clean Water Diversion

8.20. Where feasible, clean water (e.g. water that has yet to come into contact with any disturbed construction or working areas), will be kept separate from watershed or intercepted by the solar farm construction.

8.21. Up-gradient cut-off ditches and water diversion measures will be installed in order to intercept and divert clean water around construction compound area. These measures will be installed ahead of the main construction works. This will reduce or prevent the amount of potential silt-laden or polluted water that might require treatment.

8.22. Clean runoff that has been diverted around an area of working should be discharged into an area of vegetation for dispersion or infiltration, in accordance with SuDS techniques.

8.23. Sediment control measures, such as silt traps, gravel, sand bags, anchored straw bales or silt fencing might be required at the discharge point to prevent erosion at the outlet and aid dispersion of the diverted water.

Silt Control

8.24. Silt-laden runoff should be expected from any areas of recently exposed soil or rock. There is also potential for pollution to occur from machinery used in the solar farm construction.

8.25. Any introduced or artificial materials required (e.g. silt fencing, straw bales, sand bags etc.) that might need to be deployed onsite, will be removed on completion of the works.

8.26. Discharge from the silt control measures will be discharged into an area of vegetation for dispersion or infiltration, in accordance with SuDS techniques or discharged into the existing drainage network within the Application Site.

Culvert Construction / Existing Culverts

8.27. Run off from site roads and river crossings can contain high levels of silt, especially during the construction phase. Road drains typically drain to the local water environment so are a pathway for pollution. At all the stages of culvert construction, the contractor will be contractually bound to follow the relevant pollution prevention guidelines which will include the following mitigation measures:

- Track culvert will be pre cast and not poured in situ.
- brushing or scraping roads to reduce dust and mud deposits, appropriately disposing of material collected;
- Excavated material should be kept well away from watercourses;
- Putting small dams or silt fencing in artificial roadside ditches to retain silt;
- Working from the bank where possible (taking steps to stabilise the bank during and after works), avoiding working in the river; and
- Divert run-off to settlement lagoons.

9. DECOMMISSIONING– LAND RESTORATION

9.1. Upon the end of the operational phase of the Proposed Development, the subject land shall be reinstated as agricultural lands within an agreed period of the last export.

9.2. It is considered that the potential impacts during the decommissioning phase will be similar to those identified for the construction phase of the Proposed Development. Therefore, it is recommended that the pre-construction mitigation measures (pre-commencement surveys) should also be applied at this stage of the development.

9.3. Most of the infrastructure will be removed from site and recycled. Due to the long-life span of the project, no details of this can be provided at present. However, it is recommended that a pre-commencement condition outlining the requirement for a Decommissioning Method Statement is attached to any planning decision by Meath County Council.

10. SUMMARY & CONCLUSIONS

10.1. To minimise potential impacts on the environment, a number of measures have been incorporated into the Proposed Development as part of the iterative design process. These include buffers from potentially sensitive ecological receptors. Standard best practice pollution prevention measures for the construction stage have also been outlined and relevant mitigation measures. Please see **Table 10-1** below for further details.

Table 10-1: OCEMP Measures

Potential Receptor	Potential Impact	Phase of Development	Discipline	Recommended Measure
Integral Design Measures				
Aquatic environment	Pollution	Construction	Ecology	2m buffer around drainage ditches.
Badger	Destruction/disturbance of setts and badger	Construction and Operational	Ecology	30m buffer zone to be erected around each badger set.
	Exclude from foraging habitat	Operational	Ecology	Security fencing to have mammal gates to allow free movement of badger through the site.
Otter	Excluded from foraging habitat	Operational	Ecology	Security fencing to have mammal gates to allow free movement of otter through the site.
Standard Best Practice Measures				
Aquatic environment	Pollution	Construction	Ecology	Best practice pollution prevention measures

				implemented prior to and throughout the construction phase to prevent contaminants entering the aquatic environment.
Badger	Accidental trapping with excavations	Construction	Ecology	All excavations should be securely covered, or a suitable means of escape provided at the end of each working day.
Otter	Accidental trapping with excavations	Construction	Ecology	All excavations should be securely covered, or a suitable means of escape provided at the end of each working day.
Watercourses both insider and outside the Application Site, where surface water runoff will be discharged to	Pollution	Construction and Operational	Water	Implementation of pollution prevention measures detailed within Section 7 of this OCEMP
	Increased surface water runoff	Construction and Operational	Water	Implementation of Drainage Management Plan outlined within Section 8 of this OCEMP

Groundwater contamination	Pollution	Construction	Water	Implementation of pollution prevention measures detailed within Section 7 of this OCEMP
Soil	Pollution	Construction	Water	Implementation of pollution prevention measures detailed within Section 7 of this OCEMP
Mitigation Measures				
Badger	Destruction/disturbance of badger setts.	Pre-construction	Ecology	Pre-commencement survey (Measures dependant on survey findings).
Otter	Disturbance	Pre-construction	Ecology	Pre-commencement survey (Measures dependant on survey findings).
Breeding birds (Only if works are undertaken between March and August)	Disturbance / destruction of nest	Construction	Ecology	Pre-commencement survey (Measures dependant on survey findings).

10.2. The overall objective of this OCEMP is to reduce the potential impact on the environment during the construction and decommissioning phases of the Proposed Development. As outlined previously, the appointed contractor will need to follow the measures identified within this document.

NEO ENVIRONMENTAL

Technical Appendix 8.1: Residential Visual Amenity Assessment

Harristown Solar Farm

09/08/2019

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Prepared For:

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Prepared By:

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Contents

1. INTRODUCTION

BACKGROUND

1.1. This Residential Visual Amenity Assessment ("RVAA") considers the potential visual effects of the proposed solar farm (the "Proposed Development") at Harristown, Castlejordan and Clongall Co. Meath upon individual and groups of residences within a 1km study zone.

1.2. The assessment will be submitted as part of the suite of supporting Environmental Impact Assessment Report (EIAR) for the planning application to Meath County Council (MCC). It should be read alongside **Chapter 8: Landscape and Visual Appraisal (LVIA)** and **Technical Appendix 4.1: Glint and Glare Assessment** of the EIAR (found **in Volume 2** and **Volume 3** respectively).

1.3. This RVAA is also supported by:

- Appendix 8.1A Figures
  - Figure 8.1.1: Residential Receptor Map
- Appendix 8.1B: Plates

Project Description

1.4. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, battery storage and all ancillary grid infrastructure and associated works. Further details on the Proposed Development can be found within **Chapter 1: Introduction** in **Volume 2 of the EIAR**.

Site Description and Receiving Environment

1.5. The area containing all elements of the Proposed Development (the "Application Site"), consists of 21 fields (including field 15 with the SID substation) currently used as pasture and covers a total area of 91.44 ha. The site lies at an elevation range of 66m— 71m AOD and is centred at approximate Irish Grid Reference (IGR) E260861 N238688. The River Boyne flows 0.19km to the east and 0.62km to the south of the site, forming the county border of Kildare and Offaly, respectively. Access will be via a pre-existing track which runs north to south through the site and connects to the L4091 north of the Application Site. The nearest settlement is the village of Castlejordan, which is located approximately 650m to the northwest of the site.

STATEMENT OF AUTHORITY

1.6. This Residential Visual Amenity assessment was prepared by Ronan Finnegan BSc PGDip LA CMLI, who is a Chartered Landscape Architect with over 12 years of consultancy experience. Whilst working at Neo Environmental, Ronan has gained experience in undertaking LVIAs for a range of development types including: energy, housing, and infrastructure. Ronan has previously worked on over 1GW of solar photovoltaic (PV) energy development projects located throughout the UK and Ireland.

CONSULTATION

1.7. The proposed study zone and scope of study was submitted via email on the 19th of June 2019 to Dr Loreto Guinan Heritage Officer at Meath County Council whom initially requested the study as part of the EIA scoping meeting. No feedback was provided by the council's heritage officer.

2. LEGISLATION, POLICY AND GUIDANCE

EIA Legislation

2.1. The requirement for EIA for certain types and scales of development is set out in the EIA Directives (85/337/EEC, 97/11/EC, 2003/35/EC, 2008/1/EC and most recently 2014/52/EU) and transposed into Irish Law through the:

- European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018;
- European Communities (Environmental Impact Assessment) Regulations 1989-2006;
- Planning and Development Act 2000 (as amended); and
- Planning and Development Regulations 2001-2018 (Unofficial Consolidation).

2.2. The aim of an EIA, as set out within the 2014 EIA Directive, is to identify, describe and assess the direct and indirect significant impacts of a project on designated Natura 2000 sites, population and human health, biodiversity, land, soils, water, air & climate (including noise), material assets, cultural heritage and the *landscape* and the interaction between the aforementioned factors. The EIAR must outline its findings based on the EIA procedures so as to inform the Planning Authority, statutory consultees and the public in general about the likely effects of the project on the environment.

Article 3 of the Directive 2014/52/EU

"The environmental impact assessment shall identify, describe and assess in an appropriate manner, in light of each individual case and in accordance with Articles 4 to 12, the direct and indirect effects of a project on the following factors:

(a) Human beings, fauna and flora;

(b) Soil, water, air, climate and the landscape;

(c) Material assets and the cultural heritage;

(d) The interaction between the factors mentioned in paragraphs (a), (b) and (c)."

Environmental Protection Agency Guidelines

2.3. The RVAA has been undertaken in compliance with the Environmental Protection Agency (EPA) document entitled 'Guidelines on the Information to be Contained in Environmental

Impact Assessment Reports'[1]. The RVAA follows a similar approach to the LVIA (**Volume 2: Chapter 8)** of the EIAR in the providing an objective assessment of the potential effects from the Proposed Development upon the existing views of the identified residential receptors. The topic of Amenity is considered within the EPA, which notes that it may be relevant across a range of Environmental Factors such as Population and Human Health (**Volume 2: Chapter 4)** and Landscape (**Volume 2: Chapter 8**). The purpose of this RVAA assessment is to consider only 'amenity' in the sense of the visual amenity as experienced visually from the grounds and property of private residential receptors.

MEATH COUNTY DEVELOPMENT PLAN 2013-2019

2.4. There are no specific planning policies on residential visual amenity within the Meath County Council's Development Plan 2013-2019[2] (the "County Development Plan"). However, residential visual amenity is one component of Residential Amenity which is a material consideration for Renewable energy Developments.

2.5. Visual amenity is considered in the CDP within the context of the wider landscape. The CDP will seek that any development does not greatly adversely affect the area's visual amenity and rural character. Those particularly valued viewpoints and prospects which are experienced from publicly accessible areas throughout the County have been designated by Meath County Council under Objective LC OBJ 5, and are listed in Appendix 12 and on Map 9.5.1. of the CDP.

LANDSCAPE INSTITUTE RESIDENTIAL VISUAL AMENITY ASSESSMENT

2.6. The Landscape Institute has produced guidance on the production of Residential Visual Amenity Assessments (RVAA) (2019)[3]. This is separate guidance to the Guidelines for Landscape and Visual Impact Assessment, GLVIA3 (2013)[4] which is used in the LVIA. The RVAA guidance seeks to consider only private views and private visual amenity.

2.7. The guidance defines residential visual amenity within the context of the guidance as meaning:

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[1] Environmental Protection Agency (Draft 2017) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*. EPA: Wexford: Ireland. Last accessed 01/08/19 at https://www.epa.ie/pubs/advice/ea/EPA%20EIAR%20Guidelines.pdf

[2] Meath County Council (December 2012) Meath County Development Plan 2013-2019. Available at: https://meathcountydevelopmentplan.files.wordpress.com/2013/12/meath-development-plan-volume-1-written-statement_lowres.pdf

[3] Landscape Institute (March 2019) Residential Visual Amenity Assessment: Techincal Guidance Note 2/19. Available at: https://landscapewpstorage01.blob.core.windows.net/www-landscapeinstitute-org/2019/03/tgn-02-2019-rvaa.pdf

[4] Landscape Institute and Institute of Environmental Management and Assessment (2013, 3rd edition) Guidelines for Landscape and Visual Impact Assessment, Routledge, London.

'the overall quality, experience and nature of views and outlook available to occupants of residential properties, including views from gardens and domestic curtilage'. Residential Visual Amenity is one component of 'Residential Amenity'.

3. METHODOLOGY

3.1. The RVAA approach and methodology follow a similar scope to that used in the LVIA assessment. The RVAA considers only the potential changes to the existing views of the residential receptors as a result of the Proposed Development. It does not consider glint and glare, noise or other factors which may influence their overall residential amenity. These have been assessed in separate chapters and technical appendices of the accompanying EIAR.

3.2. The RVAA has considered a study zone of 1km from the Application Site boundaries, which is the same Glint and Glare assessment. It has also used the same numbering of the residential receptors for ease of cross referencing. The RVAA has measured the distance from the Application Site boundary to the nearest curtilage of each property and not the house, as listed in **Table 8.1.2** below. These may differ slightly from measurements recorded within other assessments in this EIAR, for example the Glint and Glare assessment which measures the distance to the house of the same set of receptors.

3.3. The assessment is based on the final layout of the proposed solar farm as shown on the Proposed Development Layout (**Figure 8.1; Appendix 8A**) and considers the proposed landscape mitigation measures incorporated into the overall design scheme as shown on the Landscape & Ecology Management Plan (**Figure 8.20; Appendix 8A**).

3.4. The RVAA has taken the following approach:

- Identify the study zone and properties to be included within the assessment;
- Evaluate the existing residential receptors visual amenity;
- Assess the likely changes to the visual amenity, establishing a judgement of the ‘degree of effects’ the Proposed Development based on GLVIA3.
- Further assessment of predicted change to the visual amenity, where the Residential Visual Threshold may be engaged.

3.5. The asserted ‘degrees of effects’ grades used within in this LVIA are provided in **Table 8.2** below. These effects are attained by combining the level of sensitivity with the level of magnitude of change to provide the effects upon each receptor. These effects are graded as **Very Significant, Significant, Moderate, Slight, Imperceptible** or **No Change**, either direct or indirect effects and can be characterised as adverse or beneficial. For the purpose of this report Significant and Very Significant effects are considered ‘significant’ due to the type of development and the environment in which the proposal will be sited. The table does not necessarily provide a clear correlated value which is where professional judgment will be used in the RVAA on asserting a value.

Table 3-1-1: Significance of landscape and visual effects

Sensitivity (Susceptibility & Value)	Magnitude of Change				
	High	Medium	Low	Negligible	None
High	Very Significant	Significant	Moderate	Imperceptible	No Change
Medium	Significant	Moderate	Slight	Imperceptible	No Change
Low	Moderate	Slight	Slight	Imperceptible	No Change
Negligible	Slight	Not Significant	Imperceptible	Imperceptible	No Change
None	No Change	No Change	No Change	No Change	No Change

3.6. For the purpose of this assessment the potential duration of any predicted landscape and visual effects is grouped into five bands, based on the EPA EIAR guidance and the maximum proposed operational timeframe of the Proposed Development. The duration bands include: Temporary effects (less than one 1 Year); Short-Term effects (one to seven years); Medium-Term effects (seven to fifteen years); Long-Term effects (fifteen to thirty-five years); and Permanent effects (lasting over thirty-five years).

Limitations & Assumptions

3.7. The assessment considered only residential receptors already present within the study zone and not any speculative development on the surrounding farmland. Views were considered from the nearest publicly accessible land to each of the residential receptors. Some assumptions must be made on the outward views experienced by residential receptors as views were not observed from within these private properties but from the public road adjacent to these receptors and from within the Application Site.

3.8. Potential views will be further influenced by weather which will vary from the day of the field assessment and other days through the year. Any reduction or increase heights of the garden or intervening field hedgerows and their seasonal leaf coverage will also potentially affect the receptors degree of visibility.

4. BASELINE CONDITION

4.1. The RVAA has consider all properties within a 1km radius of the Application Site's boundary. A total of 41 residential receptors (house and gardens) are found to be fully or partially located within the study zone, as mapped in Figure 8.1.1 of Appendix 8.1A. All receptors are located within the local rural area, with properties consisting of a range of small bungalow to large two storey houses. Most of these properties are clustered in small groups directly alongside the local roads and laneways. Outward views are often curtailed by either these properties garden hedges or the high field boundary hedgerows within the surrounding farmland.

4.2. A number of site photographs which show outwards views from within the Application Site towards the affected receptors are listed in the table below and included in Appendix 8.1B.

5. IMPACT ASSESSMENT

5.1. The following section assesses the potential visual effects of the Proposed Development upon the 41 residential receptors' existing views and their visual amenity.

5.2. A description of the existing view and any subsequent changes occurring due to the addition of the Proposed Development's structures are provided in **Table 8.1.2** below. The predicted magnitude of change (None to High) is combined with the receptor's level of sensitivity (High) to determine the Proposed Development's Degree of Effects for each receptor.

5.3. The numbering order of the assessed residential receptors listed in **Table 8.1.2** below and mapped in **Figure 8.1.1 of Appendix 8.1A**. follow those within the supporting Glint and Glare assessment to aid cross referencing. Where any views from these residents has been considered within the LVIA these are crossed referenced as *VPx.*

Do Nothing Scenario

5.4. If the Proposed Development did not progress, the views of the residential receptors assessed would still be subject to potential future visual changes within the immediate and wider surrounding landscape. Potential future visual changes could occur from the likes of new rural houses, changes to farmland practice resulting in widening of fields or new farm buildings, woodland management, or other renewable energy developments. Other simple alterations such as trimming or the removal of garden and field hedgerows could further affect the outward views experienced from their grounds and house.

Construction Phase

5.5. Potential views of the site work from these receptors will be largely contained by the field boundary hedgerows of the Application Site and surrounding farmland. There will be some limited temporary views occurring from those receptors looking into parts of the Application Site through gaps in the boundary hedgerow or from more elevated views. Overall the site works will result in a **Temporary Slight to Moderate Adverse** effect on these affected receptors, although most receptors will have **No Change** to their existing views.

5.6. A greater number of receptors will be affected Indirectly by open to partial views of the site traffic as it passes next to those receptors bounding the local road directly north of the Application Site. The greatest views will occur from residential receptors 1 to 10, 12 to 17, 24 to 29 and 39. These views will be temporary in nature and greatest during certain stages of the construction works. Overall this will result in a Temporary **Slight to Moderate Adverse** effect.

Operational Phase

5.7. **Table 8.1.2** is an assessment of the 41 residential receptors once the Proposed Development is built out, fully operational and a feature within the local landscape.

Table 8.1.2: Visual assessment of those residential receptors located within 1km of the proposed Harristown Solar Farm

Receptor Number	Distance and Direction of Property boundary from the Application Site boundary	Description of Property and Views	Description of Proposed Development's effects
Group: 1 & 2	430m northwest	Two bungalows. Views from the group of two bungalows are orientated northwest-southeast facing onto the local road. Outward views in the direction of the Application Site from their grounds are screened by the various trees and hedgerow along the garden boundary of House no.1 and through the surrounding farmland. Also see **Viewpoint 6**, **Figure 1.14** within **Appendix 8A** of the LVIA report for similar views of the surrounding high field boundaries.	The Proposed Development will not be visible from either house or their grounds due to heavily screening by the surrounding trees and hedgerows. **No Change** to the existing views.

3	310m North-northwest	One dormer bungalow Views are orientated southeast-northwest, facing onto the road. Outward views in the direction of the Application Site from the front end of this property are screened by the various trees along the intervening field boundaries.	The Proposed Development will not be visible from the house or their grounds due to heavily screening by the surrounding trees and hedgerows. **No Change** to the existing views.
Group: 4 & 5	260m and 340m North-northwest	Two houses (bungalow and dormer bungalow) Orientated north-northwest to southeast facing onto the road. Potential views to the Application Site from House No. 4 fully screened by boundary vegetation. Some very minor views of the Application Site's Field 1 northern hedgerow through gaps in the rear boundary tree lined hedgerow of House no. 5.	Potential views of the Proposed Development will be largely screened by the garden and intervening field hedgerows. Very minor views of the northernmost section of the Proposed structures within Field 1 through minor gaps in this field hedgerow boundary from House No.5. However, these structures are set back within this field will further limit their visibility. House 5: - **Short Term Slight adverse** reducing to **No Change** as the mitigation planting along the northern boundary thickens out limiting any visibility of the Proposed Development. House 4: - **No Change** to the existing views.
Group:	390m North-northwest	Group of x2 two storey and x1 bungalow.	Potential views of the Proposed Development from

6, 7, 8 *VP5*		Orientated north-south facing onto the road. All ground views towards the Application Site are screened by the high roadside field hedgerow opposite all houses. Some limited oblique views of the Application Site's Field 1, 13 and 15 from two dormer windows of No.7 and balcony of No.8. These views are filtered through gaps in the tree aligning northern boundary of Field 1. See **Photos No. 1, Appendix 8.1B.** Also see **Viewpoint 5, Figure 8.14** within **Appendix 8A** of the LVIA report, ground views blocked by hedgerow.	all three properties ground floor and front gardens will be fully screened by the roadside hedgerows. Some limited elevated oblique views of the Proposed Development from the upper floors of the two two-storey properties (Houses 7 & 8) will be possible with Fields 1, 13 and 15. These filtered views through the boundary tree-lined hedgerows will include views of the security fencing, rear profile of the panels and tips of the inverter/transformer AC units within these fields. House 7 & 8: - **Long-Term Slight Adverse** House 6: - **No Change** to the existing views.
9	200m North	A two-storey farmhouse, which belongs to one of the landowners. Orientated north-south. Views south towards the Application Site are contained by the various farm sheds and mature trees within close proximity to this property.	Potential views of the Proposed Development are screened by the various farm buildings and mature trees. **No Change** to the existing views.

10 *VP4*	320m North	Two storey House Orientated north-south. Elevated setting above road allows views across roadside hedgerow towards parts of the Application Site Field's 4, 5, 21 and 22. See **Photos No. 2 and 6, Appendix 8.1B.** Also see **Viewpoint 4, Figure 8.14** within **Appendix 8A** of the LVIA report for similar views from road next to property.	The Proposed Development will be visible within parts of Field's 4, 5, 21 and 22. These views will include the rear facing profiles of the solar arrays, and upper tips of the inverter/transformer units together with partial views of the security fencing and cameras within the above fields. **Short-Term Moderate Adverse** reducing to **Long-Term Slight Adverse** as the mitigating planting along the outer boundaries fills out and reduces views within Field 4 and 5, with some more distance views remaining of the Proposed Development along the more elevated lands of Field 21 and 22.
11	100m North	Two-storey house farmhouse belonging to one of the landowners. Orientated north-south. Views towards the Application are largely contained by the mix of trees, hedgerows and farm buildings. Partial views into Fields 4, 23/24 from upper floor views or its rear grounds. See **Photos No. 3 and 4, Appendix 8.1B.**	The Proposed Development will partially visible within the northern ends of Fields 4, 23 and 24 through gaps in the existing hedgerows. Views will include looking onto the rear facing profiles of the solar arrays, and upper tips of the inverter/transformer units together with partial views of the security fencing and cameras visible through gaps in the Application Sites' northeastern boundary These views will be greatly reduced as the mitigation

			planting on these fields northern boundaries thickens out. **Long-Term Slight Adverse** to the existing views.
12 *VP3*	290m North	Two-storey house. Orientated south-north, facing onto road. Views from the ground towards the Application Site are screened by the garden and roadside hedgerows. Front views from 3 upper windows are possible looking onto the north east end of Application Site's Field 23 and 24. More oblique views from these same windows are possible towards Field 4. See **Photos No. 3, 4 and 5, Appendix 8.1B.** Also see **Viewpoint 3, Figure 8.14** within **Appendix 8A** of the LVIA report for similar views from field gate opposite this property.	The Proposed Development within Fields 23 and 24 may be partially visible above the existing and additional boundary mitigation planting. Some oblique views are possible towards northern ends of Fields 4 to the southwest. Views will be looking onto the series of rear facing profiles of the solar arrays, and upper tips of the inverter/transformer units together with partial views of the security fencing and cameras along the Application Sites' northeastern and northern boundaries. These views will be partially reduced as the mitigation planting on these fields northern boundaries thicken out. **Short Term Moderate Adverse** reducing to **Long-Term Slight Adverse** as the new mitigating planting fills out the northern boundary
Group: 13, 14, 15, 16, 17	260m North	Four bungalows and one two storey house.	The Proposed Development with Fields 23 and 24 will partially visible from only House 17 and 15 including

VP2		Orientated south-north, facing onto road. Views towards the Application Site from this group of property are largely screened by the roadside hedgerow directly opposite these houses. The only potential views of the Application Site include those from the grounds of House 17 on the far eastern end and upper floors from House 15 across to Field 23 and 24. Also see the photomontage produced for **Viewpoint 2, Figure 8.7b to 8.7c** within **Appendix 8A** of the LVIA report for view across shorter section of roadside hedgerow.	rear facing profiles of the solar arrays, and upper tips of the inverter/transformer AC units together with partial views of the security fencing and cameras along the Application Sites' northeastern boundary House 15 & 17: - **Short Term Moderate Adverse** with the effects reducing to **Long Term Slight Adverse** where views become less apparent as the existing scrub and mitigation planting along the northern boundary grow over time. Houses 13, 14 & 16: - No **Change** for Houses to the existing views.
18	280m Northeast	Single bungalow. Orientated north-south, facing onto road. Views to the Application Site contained by beech hedge surrounding the property's edge.	Potential ground level views of the Proposed Development are screened by the dense hedge which surrounds the property's edge. **No Change**
19	430m Southeast	Bungalow. Rear views towards the Application Site are fully screened by the trees within Rahin Woods.	The Proposed Development is not visible from this property **No Change**

20	320m Southeast	Bungalow. Orientated West-East Limited oblique views from this property's side and front through gaps in the intervening hedgerows towards the ridge within Field 21 of the Application Site. See **Photos No. 7, Appendix 8.1B.** Also see **Viewpoint 10, Figure 8.15** within **Appendix 8A** of the LVIA report for similar views from field gate entrance near to property.	Partial views of the solar arrays with part of Field 21 above lower sections of the boundary hedgerow. Some views will be reduced as the southern boundary mitigation hedgerow planting increases in height and thicken out. **Long-Term Slight adverse**
21	320m Southwest	Bungalow Orientated northeast-southeast, facing onto road. Front views towards Application Site contained by the high field hedgerows and garden planting with the grounds of the house opposite this receptor.	The Proposed Development is not visible from this property **No Change**
22	260m Southwest	Bungalow. Orientated southwest-northwest, facing onto road. Front views towards Application Site	Views of the Proposed Development will be limited to some minor views of the upper tips of the mast within the Proposed Substation (Separate SID Application to ABP) may be visible through

		contained by the high field hedgerows. See **Photos No. 8, Appendix 8.1B.**	lower sections of the intervening hedgerows. **No Change** from the Proposed Development. **Long-Term Slight Adverse** due the Proposed Substation (separate application)
23	380m Southwest	Bungalow. Orientated northeast-southwest, facing onto road. Front views towards Application Site contained by the high field hedgerows. Also see **Viewpoint 9, Figure 8.14** within **Appendix 8A** of the LVIA report for similar views at field entrance opposite.	Views of the Proposed Development will be limited to some minor views of the upper tips of the mast within the Proposed Substation (Separate SID Application to ABP) may be visible through lower sections of the intervening hedgerows. **No Change** from the Proposed Development. **Long-Term Slight Adverse** due the Proposed Substation (separate application)
24	870m Northwest	Bungalow. Orientated west-east, facing onto road. Rear views from this property towards the Application Site are screed by the intervening field hedgerows.	The Proposed Development is not visible from this property **No Change**
Group: 25 & 26	800m Northwest	Two Bungalows. Orientated north-south, facing onto road. Side views towards the Application Site are fully screened by farm sheds	The Proposed Development is not visible from this group of properties **No Change**

		and the football pitch trees	
Group: 27, 28, 29 & 30	590-640m Northwest	Four Bungalows. Orientated north-south, facing onto road. Side views towards the Application Site are fully screened by the mix of garden and field hedgerows.	The Proposed Development is not visible from this group of properties **No Change**
Group: 31, 32, 33	780m West	Three Bungalows. Orientated south-north & west-east. Mix of side and rear views towards the Application Site are fully screened by the mix of garden hedgerows, sheds and field hedgerows. Also see **Viewpoint 7, Figure 8.12** within Appendix 8A of the LVIA. Looking across to No.31	The Proposed Development is not visible from this group of properties **No Change**
34	810m Southwest	Two-storey house. Orientated southeast-northwest. Side views towards the Application Site are fully screened by the mix of mature trees and field hedgerows.	The Proposed Development is not visible from this property **No Change**
35	550m Southwest	Bungalow.	The Proposed Development is not visible from this property

		Orientated east-southeast-west-northwest. Mix of front and side views towards the Application Site are fully screened by the mix of garden hedgerows, shed and field hedgerows. Also see **Viewpoint 8, Figure 8.14** within **Appendix 8A** of the LVIA report for views from opposite this property entrance.	**No Change**
Group: 36 & 37	880m Southeast	Two Bungalows. Orientated West-East, onto road. Front views towards the Application Site are fully screened by the trees within Rahin Woods.	The Proposed Development is not visible from these properties **No Change**
38	460m Northeast	Two Storey House known as Harristown House. Orientated northwest-southwest, onto road. Main views from the house face northwards towards the road and away from the Application Site. Only some limited oblique views of the northeastern end of the Application Site Field 24 from a single upper	Potential views of the Proposed Development will be limited to a small proportion within Field 24 through minor gaps in the Application Site's existing eastern boundary hedgerow. These views will be reduced as the mitigation boundary planting thickens out. **Short-Term Slight adverse** reducing to **No Change** as the mitigation boundary planting thickens out and reduces inward views.

		window on the house's western side.	
39	520m Northeast	Two storey property. Orientated southeast-northwest, onto road. Main view orientated onto the road, facing away from the Application Site which is not visible from the property or grounds.	The Proposed Development is not visible from this property No Change
40	720m North	Single bungalow. Orientated southwest-northeast. Views towards the Application Site are fully screened by variations in the topography and intervening hedgerows.	The Proposed Development is not visible from this property No Change
41	530m North-northwest	Single bungalow. Orientated south-southeast-north-northwest. Views towards the Application Site are fully screened by hedgerows surrounding the property and the intervening hedgerows.	The Proposed Development is not visible from this property No Change

Decommissioning Phase

5.8. Potential views of the site work from these receptors will be largely contained by the thickened-out field boundary hedgerows of the Application Site and surrounding farmland. By this stage, the mitigation planting will have filled out and closed any gaps in the Application

Site's existing field hedgerows. This will also have improved the appearance of these boundary hedgerows from the 12 receptors (Nos. 5, 7, 8, 10, 11, 12, 15, 17, 20, 22, 23 & 38) with their varying views towards the Application Site. Overall this will result in **No Change to Slight beneficial**.

5.9. A greater number of receptors will be affected Indirectly by open to partial views of the site traffic as it passes next to those receptors bounding the road. The greatest views will occur from residential receptors 1 to 10, 12 to 17, 24 to 29 and 39. These views will be temporary in nature and being greatest during certain stages of the decommissioning works. Overall this will result in **Temporary Slight to Slight/Moderate adverse.**

6. SUMMARY

6.1. This RVAA has been undertaken based on views from the public road nearest these residential receptors and looking out from within the Application Site. Thus, further variations may occur as experienced within the private grounds or property of each receptor. For this assessment, it is assumed all windows are accessible and have unobstructed views. However, some skylights may be positioned high up on the roofline preventing easily accessible outward views from within certain internal rooms. Variations in the weather and seasonality of vegetation cover and any changes to its heights e.g. hedgerow cutting, will further influence the various potential views experienced by the residents at each property.

6.2. Out of the 41 receptors assessed only 12 are identified as having potential to experience varying views of the Proposed Development. These receptors include: two receptors (10 & 11) experiencing both ground and upper floor views; five receptors (5,17,20,22,23) experiencing ground level views only; and five receptors (7, 8, 12, 15 & 38) experiencing upper floor views only of the Proposed Development. The remaining 29 receptors (1-4, 6, 9, 13, 14, 16, 18, 19, 21, 24-37, 39 -41) will not experience any views of the Proposed Development from their grounds or house. It should be noted that receptors 22 and 23 will only have views of the 110kV substation which is a separate SID application to ABP.

6.3. The visibility of the Proposed Development from these affected receptors will vary greatly resulting in initial **Slight to Moderate adverse** effects which is **not significant**. Their potential views will include only a small portion of the Proposed Development across a few fields of the Application Site or less. No one receptor will experience full views of the Proposed Development. Typically, views will include looking onto the rear facing solar arrays and associated infrastructure which are often partially filtered by the existing and mitigation hedgerow planting along the Application Site's outer boundaries. There will be some greater views in the winter months when the hedgerows through the Application Site, surrounding farmland and roadside are lacking leaf coverage.

6.4. As the new mitigation boundary planting grows up and thicken out, it will further enclose these structures and reduce their overall visibility from most receptors, thus reducing the initial visual adverse effects. Due to their more elevated setting, some upper floor views from the nearest receptors will allow for views looking above and beyond the thickened boundary planting into the Proposed Development.

6.5. The Proposed Development will not exceed the Residential Visual Amenity Threshold, in that it will not be over dominant on any of the affected residential receptors as the variation in the topography, distance, scale of the proposed structures and presence of the existing and proposed hedgerow planting all help reduce its potential visual prominence.

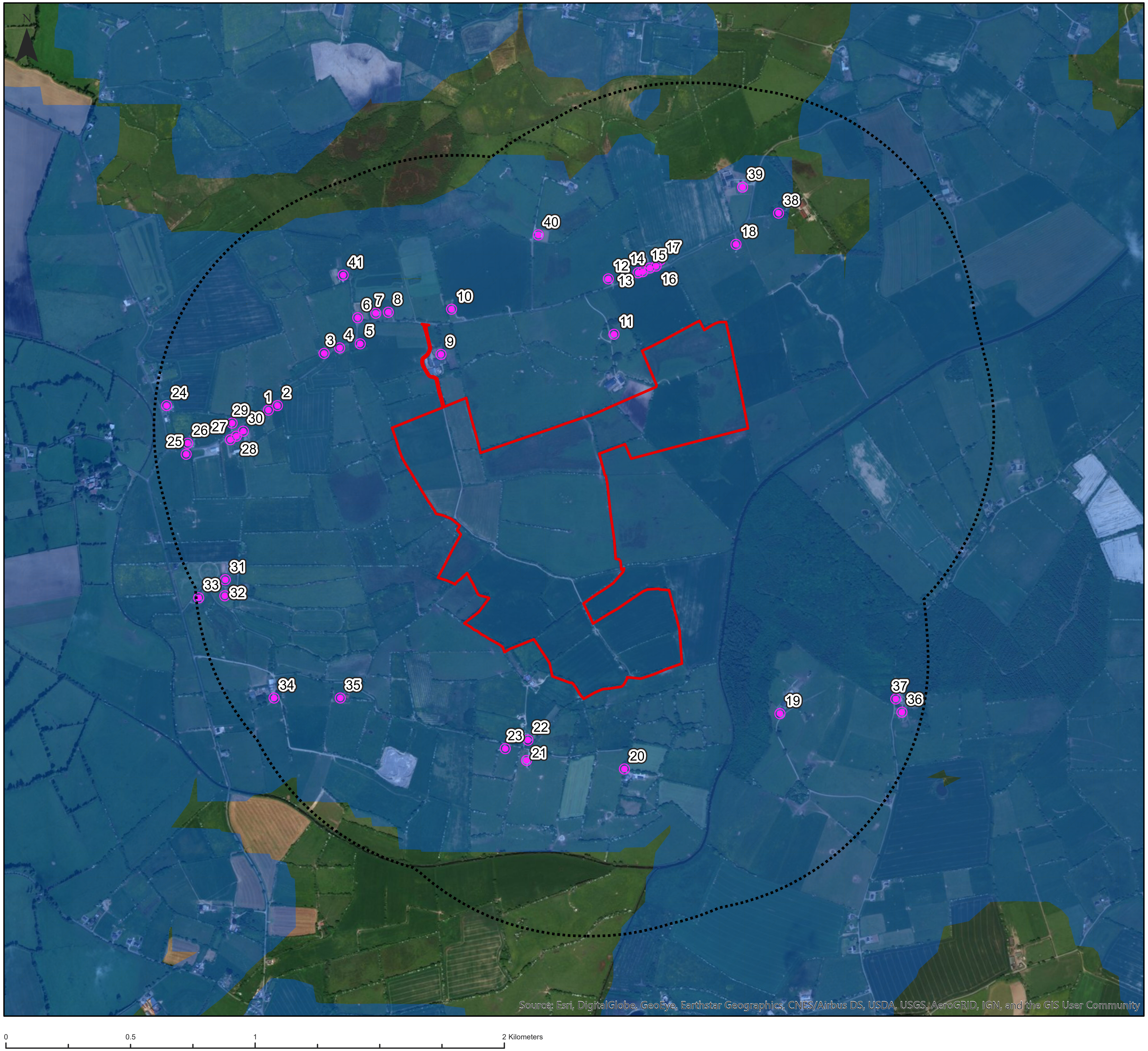
6.6. None of the above assessed residential receptors will be visually affected by any glint or glare from the Proposed Development, as the intervening vegetation will mitigate any potential visual effects. The Glint and Glare Assessment concludes:

*"Solar reflections are only possible at 25 of the 28 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at 21 receptors, **Medium** at two receptors, and **High** at two receptors. Upon reviewing the actual visibility of the latter four receptors, glint and glare impacts reduce to **None** due to intervening vegetation. "*

Proposed 110kV Substation

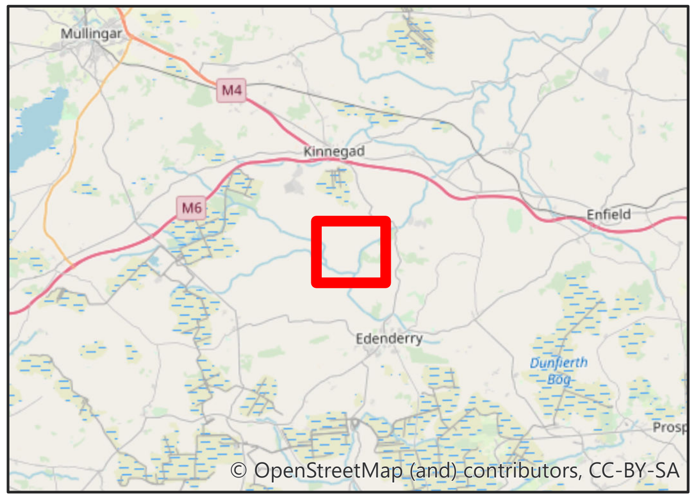
6.7. As previously determined by the LVIA assessment (**Volume 2: Chapter 8**) the addition of the Proposed Substation within Field 15 of the Application Site will have very limited visibility across the study zone due to the high degree of enclosure and relatively lower heights of most structures. Of the 41 residential receptors considered within the RVAA only the two receptors No. 22 and 23 will experience any potential views of the Proposed Substation. These views will consist of only the upper portions of the lightning and electricity masts peering above the high tree lined field boundaries of the Application Site and surrounding farmland. The addition of these narrow structures within the two receptors views will likely result in Long Term **Slight Adverse** effects.

Harristown Solar Farm
Residential Receptors
Figure 8.1.1



Key

- Development Boundary
- 1km Study Area
- Residential Receptors
- Zone of Theoretical Visibility



Date: 09/08/2019
Drawn By: JM
Scale (A3): 1:15,000
Drawing No: NEO00515/058I/A

neo ENVIRONMENTAL

Appendix 8.1B

APPENDIX 8.1B - PLATES

1: Along the northern boundary of Field 15 looking to the northwest towards houses no. 7 and 8.

2: Along the southern end of Field 4 looking northwards out towards the house no.10.

3: Along the southern end of Field 4 looking towards the northeast to house no. 11 and no. 12.

4: Along the southern end of Field 23 looking northwards out towards the house no.11 and no.12.

5: Along the southern end of Field 23 looking towards the north towards house no. 12 to no. 17.

6: From elevated point along southeastern boundary of Field 21 looking northwest towards house no. 10.

7: From the southern part of Field 21 looking southeast towards house no.20.

8: Along the southernwestern boundary edges of Field 21 looking southwest to the roof and sheds of house no.22.

Technical Appendix 9.1: Construction Traffic Management Plan

Harristown Solar Farm

16/08/2019

Disclaimer

Neo Environmental Limited shall have no liability for any loss, damage, injury, claim, expense, cost or other consequence arising as a result of use or reliance upon any information contained in or omitted from this document.

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Contents

1. EXECUTIVE SUMMARY

1.1. This Construction Traffic Management Plan (CTMP) outlines the overall framework for managing the movement of construction and delivery traffic to and from the proposed Harristown Solar Farm, as well as considering the type of traffic that will be generated. The traffic assessment for the operational and decommissioning phases is also considered.

1.2. Impacts from the operational phase of the site, consisting of between 5-10 Light Goods Vehicles (LGVs) per year, will be below the threshold for a Traffic Impact Assessment, as stated in the National Road Authority's (NRAs) Traffic and Transport Assessment Guidelines.

1.3. The CTMP considered parts of the guidance which are suitable for this project, namely to include details of the existing conditions and issues relating to the Proposed Development.

1.4. Increased volumes of traffic will be generated by the Proposed Development during the construction period. However, the overall volumes of traffic generated by the Proposed Development during the construction period are considered to be quite low. During the anticipated 6-month construction period, a total of 1,212 Heavy Goods Vehicle (HGV) deliveries will be made to the Application Site. During the peak construction period, there will be a maximum of 20 daily HGV deliveries.

1.5. It is proposed that the haul route for construction traffic will operate a one-way system for deliveries from Dublin Port. Vehicles coming from Dublin will travel along the M4 and follow onto the M6 at Kinnegad. They will then exit the M4 at Junction Exit 2 and then travel south along the Ballinabrackey Road (L8021) for around 7km before turning left onto the L4091. They will follow this road for just over 1km before turning right to enter the site. On leaving the site vehicles must turn right and travel east towards the R401 Edenderry to Kinnegad Road, where they will re-join the M4 back to Dublin. This one-way system of traffic is proposed to minimise disruption with other road users.

1.6. The site access point was redesigned after swept path analysis was conducted and showed the largest construction vehicles could not turn into the Site Entrance. Swept path analysis was used to define the extents of the new access. To facilitate this widened access point there will be minor land clearing and hedgerow removal as well as the removal of one tree required.

1.7. Visibility splays measuring 90m by 3m can be achieved at the Application Site Entrance, with only minor tree pruning required.

1.8. A dedicated person will be appointed for the management of the delivery booking system during the construction stage.

1.9. The Applicant will conduct a pre and post construction condition survey of L4091, with the Applicant liable to repair any damage to the public roads. This should be conditioned as part of any planning consent.

1.10. The CTMP sets out a variety of specific mitigation measures that will be implemented during construction that will minimise the impact of the construction traffic on the environment and local communities; the following provides a brief summary of each:

- Limitations on working times and HGV scheduling.
- Site security and signage.
- Measures to control emissions of dust and other airborne contaminants

1.11. This Construction Traffic Management Plan conforms to the policies and objectives of the Meath County Council Development Plan 2013-19, and the Design Manual for Roads and Bridges published by the National Roads Authority (NRA).

2. INTRODUCTION

BACKGROUND

2.1. Neo Environmental Ltd has been appointed by Lightsource BP Ltd (the "Applicant") to undertake a Construction Traffic Management Plan ("CTMP") for a proposed solar farm with associated infrastructure (the "Proposed Development") on lands at Harristown, Castlejordan and Clongall Co. Meath. The assessment will be submitted to Meath County Council (MCC) as part of an EIAR in response to a request for further Information (Planning Reference TA181225).

2.2. This assessment has been submitted as an appendix to Volume 2, Chapter 9: Material Assets of the EIAR.

DEVELOPMENT DESCRIPTION

2.3. The Proposed Development will consist of the construction of PV panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, battery storage and all ancillary grid infrastructure and associated works. Please see Volume 2, Chapter 1: Introduction for a detailed description of the Proposed Development.

SITE DESCRIPTION

2.4. The area containing all elements of the Proposed Development (the "Application Site"), consists of 21 fields ((including field 15 with the SID substation) currently used as pasture and covers a total area of 91.44 ha. The site lies at an elevation range of 66m to 71m AOD and is centred at approximate Irish Grid Reference (IGR) E260861 N238688. The River Boyne flows 0.19km to the east and 0.62km to the south of the site, forming the county border of Kildare and Offaly, respectively. Access will be via a pre-existing track which runs north to south through the site and connects to the L4091 north of the Application Site. The nearest settlement is the village of Castlejordan, which is located approximately 650m to the northwest of the site.

Scope of the Assessment

2.5. The purpose of this CTMP report is to provide a framework for managing the movement of traffic to and from the Application Site, and to minimise the impact on the local road network during the construction period of the Proposed Development. The potential impact of traffic during the operation and decommissioning periods are also assessed.

2.6. This CTMP will provide details of:

- Traffic route identification and assessment;
- Swept path analysis; and
- Construction traffic management procedures.

2.7. This report is supported by the following appendices:

- Appendix 9.1A: Figures
  - Figure 9.1.1: Proposed Access Route
  - Figure 9.1.2: Swept Path Analysis 1
  - Figure 9.1.3: Swept Path Analysis 2
  - Figure 9.1.4: Swept Path Analysis 3
  - Figure 9.1.5: Swept Path Analysis 4
  - Figure 9.1.6: Site Access Design
  - Figure 9.1.7: Visibility Splay
  - Figure 9.1.8: Temporary Construction Compound

Statement of Authority

2.8. This Construction Traffic Management Plan has been produced by Michael McGhee of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has worked on over 500MW of solar farm Construction Traffic Management Plans across the UK and Ireland, as well as more detailed transport statements for major developments.

Consultation

2.9. Email consultation with the MCC Senior Roads Engineer John O'Malley took place on the 21st of May 2018. The email stated:

"It is proposed that the haul route for construction traffic will operate a one-way system for deliveries from Dublin Port. Vehicles coming from Dublin will travel along the M4 and will exit onto the M6 at Junction Exit 2. They will be required to use the Ballinabrackey Road (L8021) and progress south along the latter, turning right to enter the site. On leaving the site they must turn right and travel east towards the R401 Edenderry to Kinnegad Road, where they will re-join the M4 back to Dublin. This one-way system of traffic is proposed to minimise disruption with other road users ".

2.10. This was agreed verbally on a phone call with Mr O'Malley.

3. LEGISLATION

3.1. The assessment has been collated and considered based on the following legislative and guidance context:

- Spatial Planning and National Roads Guidelines for Planning Authorities[1]
- National Roads Authority, Traffic and Transport Assessment Guidance[2];
- Design Manual for Roads and Bridges[3]; and
- TII Publications, online suite of Standards and Technical publications related to national road and light rail networks in Ireland[4].

SPATIAL PLANNING & NATIONAL ROADS GUIDELINES FOR PLANNING AUTHORITIES

3.2. The Spatial Planning and National Roads Guidelines for Planning Authorities document ("the Spatial Planning and Roads Guidelines") sets out planning policy considerations in relation to development affecting national primary and secondary roads.

3.3. Section 3.4 of the Spatial Planning and Roads Guidelines 'Traffic and Transport Assessments (TTA)' describes a TTA as *"a methodology used to assess the transport impacts of a proposed development, incorporating any subsequent measures necessary to ensure roads and junctions and other transport infrastructure in the vicinity of the development remain fit for purpose…"*

3.4. The Spatial Planning and Roads Guidelines indicate the following:

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1 Department of Environment, Community and Local Government (2012) Spatial Planning and National Roads Guidelines for Planning Authorities. Available at: http://www.environ.ie/sites/default/files/migrated-files/en/Publications/DevelopmentandHousing/Planning/FileDownLoad%2C29322%2Cen.pdf

2 National Roads Authority (2014) Traffic and Transport Assessment Guidelines. Available at: http://www.tii.ie/tii-library/land-use-planning/Transport-Assessment-GuidelinesMay2014.pdf

3 National Roads Authority, The Design Manual for Roads and Bridges (2013). Found Here: http://www.dttas.ie/corporate/publications/english/design-manual-urban-roads-and-streets

4 Transport Infrastructure Ireland, TII Publications, online suite of Standards and Technical publications related to national road and light rail networks in Ireland, Found here http://www.tiipublications.ie/

- *"The TTA should be written as an impartial assessment of the traffic impacts of the proposed development and it should not be seen to be a "best case" promotion of the development. All impacts, whether positive or negative, should be recorded.*
- *The level of detail included within the TTA should be sufficient to enable the planning authority and those making observations on the proposed development to follow all stages of the assessment process, to know what assumptions have been made and to arrive at a similar set of results and conclusions.*
- *The TTA should assist the developer and local planning authority in deciding if any adverse traffic impact identified is significant enough to require revision of the development proposal or whether the proposed response measures are sufficient to mitigate the impact of the development on the road network to acceptable levels. This is the fundamental test and is often regarded as the main purpose of a Traffic and Transport Assessment as related to road infrastructural considerations."*

3.5. Where proposed developments have the potential to impact upon national and non-national roads, a TTA should be submitted in support of the planning application.

Traffic & Transport Assessment Guidance

3.6. The Traffic and Transport Assessment Guidance produced by the National Roads Authority ("the NRA Guidance") aims to provide a framework to promote an integrated approach to development, which ensures that proposals promote efficient use of investment in transportation infrastructure, reduce travel demand and promote road safety.

3.7. The NRA Guidance states:

"A Traffic and Transport Assessment is a comprehensive review of all the potential transport impacts of a proposed development or re-development, with an agreed plan to mitigate any adverse consequences.

It is essential that the developer or promoter should provide a full and detailed assessment of how the trips to and from the development might affect the transport network. The assessment should be an impartial description of the impacts of the proposed development and should outline both its positive and negative aspects."

3.8. The trip generation from the operational phase of the Proposed Development will not reach the numbers required to justify a full Traffic & Transport Assessment. As per the NRA Guidance, a TTA is only necessary when traffic to and from the development exceeds 10% of the traffic flow on the adjoining road or 5% where congestion exists or the location is sensitive.

3.9. This CTMP will consider elements of the NRA Guidance which are relevant to this project, namely to include details of the existing conditions and issues relating to the Proposed Development.

REVIEW OF COUNTY DEVELOPMENT PLAN POLICY

Meath County Development Plan 2013-2019[5]

3.10. The Meath County Development Plan (CDP) provides a clear direction and focus for development over the CDP period, while setting the scene for ongoing growth in the context of the Region and Country as a whole.

3.11. Chapter 6 'Transport' contains policies in relation to transport across the County. Much of the emphasis of these policies is to promote sustainable transport measures for new developments, which is not relevant for this type of development as transport during the operational stage will be minimal.

3.12. Although the reference to the use of public transportation is not relevant to the construction phase of the Proposed Development, this CTMP will aim to promote sustainable and efficient transportation to the site throughout the construction, operation and decommissioning phases.

[5] Meath County Council. Meath County Development Plan 2013 – 2019. Available at: https://meathcountydevelopmentplan.files.wordpress.com/2011/01/meath-county-development-plan-2013-2019-consolidated-version-december-2016.pdf

4. TRAFFIC ROUTE IDENTIFICATION AND ASSESSMENT

4.1. This delivery route and subsequent CTMP is based upon information provided by the Applicant as well as a thorough review of the local and national roads in the vicinity of the Application Site.

SITE ACCESS

The Application Site will be accessed from the existing farm entrance off the L4091 which is approximately 4.5metres wide. It is intended that all traffic generated by the Proposed Development will use this access point. A site visit was undertaken at which no speed signs along this road were evident. However, local roads generally have statutory speed limit of 80km/hr and it was observed that vehicles did not travel at this speed on this section of the L4091. This section of road contains no markings and is not lit by public lighting. There are no pedestrian facilities along this section of road.

4.2. The County Transportation officer has previously agreed visibility splay dimensions at a site access from a Local Road which were 90m x 3m. These are standard and are achievable; however, some minor remedial work including the removal of one tree is required (see **Figure 9.1.4 Appendix 9.1A**).

4.3. The Applicant will conduct a pre and post construction condition survey of the L4091, with the extents of which are show on **Figure 9.1.1 Appendix 9.1A**. The Applicant will be liable to repair any damage to the public roads attributed to the construction of the Proposed Development and this should be conditioned as part of any planning consent.

INTERNAL SITE TRACKS

4.4. Additional and upgraded access tracks will be constructed to allow access for the construction, operation, maintenance and decommissioning of the solar panels and associated infrastructure.

4.5. Tracks will measure between 3.5 and 5m wide. All new tracks will be unpaved and constructed from local stone. A geotextile / geogrid will be laid apart from where the track is being laid directly onto a rock base; this will minimise the need for stone and reduce the impact on soils. The track will then be constructed upon the geotextile by layering and compacting granular material (crushed rock) up to a total maximum thickness of 0.5m, dependent on the ground conditions.

4.6. Where tracks cross existing field drainage ditches, suitably sized culverts will be constructed so water can flow as normal below the new access track.

4.7. Load bearing crane hardstanding areas are required during construction to support the cranes as they lift the inverter stations from the delivery vehicles. The site tracks can be used for this purpose, with some localised widening where required.

4.8. The access tracks will be left in situ after completion of the solar farm construction, as they will provide:

- Access for the Proposed Development maintenance and repair works;
- Access for the Landowner; and
- Access for decommissioning of the Proposed Development.

4.9. Once decommissioned, unless required by the landowner and agreed with the council, the access tracks will be removed.

Proposed Delivery Route

4.10. The proposed delivery route has been identified by considering the ability of the route to physically accommodate the required vehicles, in addition to the sensitivity of the route to potential disruption by the movements of traffic to and from the site.

4.11. It is proposed that the haul route for construction traffic will operate a one-way system for deliveries from Dublin Port. Vehicles coming from Dublin will travel along the M4 and follow onto the M6 at Kinnegad. They will then exit the M4 at Junction Exit 2 and then travel south along the Ballinabrackey Road (L8021) for approximately 7km before turning left onto the L4091. They will follow this road for just over 1km before turning right to enter the Application Site. On leaving the Application Site, vehicles must turn right and travel east towards the R401 Edenderry to Kinnegad Road, where they will re-join the M4 back to Dublin. This one-way system of traffic is proposed to minimise disruption with other road users. A map showing the proposed local access route is presented in **Figure 9.1.1 in Appendix 9.1A**.

Route Assessment

4.12. This route assessment was conducted as a desk-based exercise. Where required, swept path analysis has been conducted using Autotrack software to model the movement of the most onerous load, to determine what actions are required to address any issues identified.

4.13. As per the specifications provided, the most onerous load for the purpose of the swept path is the deliveries of the grid connection transformer. As part of the swept path analysis, the following vehicle was used:

- Mercedes Actros with Trafo Low Boy (29.17m overall length)

4.14. The exact dimensions of this vehicle and turning details can be found on the drawing in **Figures 9.1.2 Appendix 9.1A.** As this is an abnormal load, a permit will be required. As the vehicle is over 27.4m in length, this will be administered by the local authority under the Road Traffic (Special Permits for Particular Vehicles) Regulations 2007.

4.15. The analysis was conducted using Ordnance Survey Ireland mapping data.

4.16. Allowances have been made for the provision of independent driver-operated rear steering. The approved haulage operator for the project will confirm final vehicle types before construction begins.

4.17. The load bearing capacity of any bridges or structures has not been measured. As the Proposed Development will not require any abnormal roads, any bridges on the main transport network should be capable of carrying all the transport loads. As there will be no abnormal roads, the consultation point regarding the protection of bridges, culverts and other structures will not apply.

4.18. All traffic management and safety implications will be considered by suitably qualified and experienced personnel when arranging the transit of the loads and can be agreed through a suitably worded condition following planning approval.

4.19. **Table 4-1** provides a brief commentary of the route analysis at specific points on the haul route. These points can also be viewed on **Figure 9.1.1 Appendix 9.1A.**

Table 4-1: Route Analysis

Ref	Manoeuvre Required	Analysis	Required Action	Swept Path Drawings
1	Vehicles must negotiate the right-hand turn into the Site Entrance.	The largest construction vehicles cannot access the development with the road design in its current form.	Access to be widened as part of the Proposed Development	Figures 9.1.2
2	Vehicles must negotiate the left-hand turn on the L4091.	The largest construction vehicle can make this turn	None	Figures 9.1.3

		without any enabling works.		
3	Vehicles must negotiate the left-hand turn on the L8021.	The largest construction vehicle overhangs the outer verge slightly, however there is space for this to occur.	None	Figures 9.1.4
4	Vehicles must negotiate the left-hand turn on the R401.	The largest construction vehicle can make this turn without any enabling works.	None	Figures 9.1.5

Summary of Enabling Works

4.20. As the proposals include a new access point, there will be enabling works required for access to the Proposed Development. This will include clearing of the land and hedgerow at the Site Entrance, removal of one tree and the development of the new track, details of which can be found on **Figure 9.1.3 Appendix 9.1A**.

4.21. To enable the required visibility at the Site Entrance the following will be required:

- Some tree pruning may be required
- Removal of one tree

4.22. To achieve this visibility splay, all work will be contained within the Application Site boundary.

5. CONSTRUCTION TRAFFIC MANAGEMENT

CONSTRUCTION PROGRAMME

5.1. Construction for the Proposed Development is anticipated to occur over a six-month period, whilst the construction of the grid compound will also take six months. The grid connection compound will be constructed prior to the Proposed Development and therefore there will be no cumulative impacts; however, the duration of the combined projects will take one year. During this period, there will be a combination of HGVs (for the component and material deliveries) and cars/vans (for construction staff) on site. HGV movements are expected to be most intense during the first two months of construction, tailing off towards the final weeks. Car/van movements are expected to be constant throughout.

5.2. **Table 5-1** below shows the estimated amount of deliveries and movements for the main infrastructure.

Table 5-1: Estimates HGV Deliveries for construction equipment and infrastructure

TRANSPORT	ESTIMATED NUMBER OF VEHICLES	MOVEMENTS
Delivery of Mounting Frames	84	168
Delivery of Modules	630	1260
Delivery of Cabinets	42	84
Delivery of Cables	42	84
Delivery of Plant Equipment	84	168
Delivery of Gravel Hard Core Material	290	580
Delivery of Fencing / CCTV	40	80
Total	**1212**	**2424**

5.3. The construction of the 110kV Substation is likely to reach a maximum peak of 31 vehicles (HGV and staff combined) and there the impacts are likely to be limited.

5.4. More visits may be required due to site conditions, weather restrictions, etc., therefore, these numbers should be treated as a guideline for planning purposes only.

5.5. In total, the construction of the Proposed Development is expected to give rise to 1,212 HGV deliveries over the six-month construction period. There is expected to be a daily maximum of approximately 20 HGV deliveries (40 HGV movements).

5.6. The expected HGV volumes are based on best estimates of trips generated for similar sized solar farms and will be subject to amendments based on local conditions and contractor working practices.

5.7. Combined with the staff vehicles the peak daily vehicle rate is likely to be 90 (22% HGV).

Delivery Booking System

5.8. On a weekly basis, the Site Manager will evaluate details of the daily profile of deliveries proposed for the upcoming week. Through discussions with hauliers, the Site Manager will ensure that the deliveries are spread out across the week and across the day to minimise any potential disruption.

5.9. Deliveries will be checked against the weekly delivery schedule. This will be overseen by the Site Manager to ensure that construction deliveries are managed in an efficient manner, with minimal disruption and delays.

5.10. It is proposed that temporary signage would be used to highlight the entrance to the site and to direct construction traffic to the site via the local and regional roads. The Applicant will provide banksmen to assist with the manoeuvring of delivery vehicles to and from the site, as well as internal site movements.

5.11. The proposed construction compound will provide an area for waiting vehicles, if required. Hauliers will be required to contact the Site Manager to give an indicative delivery time, to ensure that the delivery space and banksmen are ready for their arrival on site.

5.12. Sufficient time will be provided between deliveries to allow for any delays (such as loading / unloading taking longer than expected) and to avoid any vehicles waiting.

5.13. Deliveries will be managed and scheduled to ensure that no vehicles would have to wait on the surrounding road network.

Timing Restrictions

5.14. All traffic movements will be carried out between the hours of 08.00 to 18.00 on Monday to Friday and 08.00 to 16.00 on Saturdays. Public holidays will be observed unless otherwise agreed with the local planning authority. In addition to this, a start-up and close down period for up to an hour before and after the core working hours is proposed. This does not include the operation of plant or machinery likely to cause a disturbance.

5.15. Deliveries will also be scheduled to avoid peak times, i.e. avoiding rush hours and after school pick-up times.

Temporary Site Construction Compound

5.16. Two temporary construction compounds (see **Figure 9.1.8**) will be required during the construction phase of the Proposed Development. The proposed locations of the compounds are shown on the submitted planning drawings and measures an area of approximately 50m by 50m each. The locations are out with any watercourses or ecologically sensitive areas. The compounds will contain the following:

- Temporary cabin (Port-a-Cabin type) to be used for site office and welfare facilities including welfare facilities with provision for sealed waste storage and removal;
- Container storage unit(s) for tools and equipment storage;
- Container storage unit(s) for components and materials;
- Refuelling compound for construction vehicle and machinery;
- Chemical toilets;
- Adequate parking area for cars, construction vehicles and machinery; and
- Designated skips for construction waste.
- Wheel washing facility.

Construction Parking

5.17. It is forecast that there will be approximately 115 staff on site at any one time during the construction period, although this will vary subject to the overall programme of works. It is likely that there will be a degree of vehicle sharing by staff and, therefore, it is anticipated there will be significantly less than 115 staff vehicles per day arriving on site (estimated maximum at 60 per day at peak construction periods). Labour vehicle sharing will be actively encouraged to reduce vehicular movements.

5.18. On entrance/exit to and from the site, worker's vehicles will report directly to the area of hard standing at the temporary site construction compound where there will be sufficient space for parking and turning. Site opening hours will be before the peak traffic period and closing time will be after evening time peak hours, and should therefore, not cause disruption at the peak periods on entrance/exit of the site.

5.19. No parking will be allowed for construction workers on the public road network in the vicinity of the Application Site. A number of additional unscheduled visits may be required throughout the construction period for site inspections and due to unforeseen circumstances, which is accounted for in the existing car parking plans.

Turning Facilities

5.20. The construction compound has been designed to provide adequate space for vehicle manoeuvring and turning, and all HGV deliveries will report here for unloading. The turning area will ensure that all vehicles will ingress and egress in a forward gear to maintain safety on the public highway.

Site Security

5.21. For security and safety purposes, the Proposed Development will be closed to the general public via security fencing and a locked gate. The security fence installed around the perimeter of the solar farm will be erected at the start of the construction programme and will remain for the duration of the operation until decommissioning of the solar farm.

5.22. Access to the construction site during construction hours will be controlled by personnel located at the entrance of the solar farm. All visitors will sign in and out with security. Visitors to the site will be given a Health and Safety site induction, escorted around the site and will remain with an appropriately trained person at all times. The escort will alert the visitors to hazards on site (including workplace health and safety issues) together with appropriate Personal Protective Equipment requirements.

Operational Period

5.23. The operational phase of the solar farm is anticipated to have negligible trip generation potential with approximately 5-10 Light Goods Vehicles (LGVs) expected every year for scheduled maintenance checks, with additional visits required to attend to remedial issues when necessary. The operational access point will use the same entrance to the site as during the construction period.

DECOMMISSIONING PERIOD

5.24. The number of HGVs required for the decommissioning period will be slightly higher than the construction phase due to the materials not being as neatly packed as when shipped from factory conditions. However, whilst the construction phase had a total of approximately 2,424 movements, the decommissioning phase will have a total of circa 2,666 movements (estimate includes a 10% increase on the construction stage). This increase is not considered to be significant.

6. MITIGATION

6.1. The impact of the Proposed Development has been identified as being temporary in nature and associated with short construction and decommissioning stages only. It is still important that any impact is minimised as far as possible and, in light of this, the following mitigation measures have been considered:

- A dedicated person will be appointed for the management of the delivery booking system during the construction stage. It will also be this person's duty to make sure haulage companies use the chosen haul route (See **Figure 9.1.1 Appendix 9.1A**), without fail.

- The Applicant will conduct a pre and post construction condition survey of the L4091, with the extents of which are show on **Figure 9.1.1 Appendix 9.1A**. The Applicant will be liable to repair any damage to the public roads attributed to the construction of the Proposed Development. This should be conditioned as part of any planning consent.

- Traffic movements will be limited to 08:00 - 18:00 on Monday to Friday and 08:00 – 16:00 on Saturdays, unless otherwise agreed in writing with Meath County Council. Further, deliveries will be scheduled to avoid peak times around the morning and evening peak hours. This will avoid HGV traffic arriving during the morning peak hour creating conflict with local residents on their daily commute or school run. Construction personnel will be encouraged to car-pool, or to travel to site in minibuses;

- During the construction phase, clear construction warning signs will be placed on the L4091 that the site is accessed from, advising the general public as to the presence of the construction site. The Site Entrance will also be appropriately signed. Further signage will be located at the Site Entrance to direct drivers east on exit from the site. Access to the construction site will be controlled by on-site personnel and all visitors will be asked to sign in and out of the site by security/site personnel. Site visitors will all receive a suitable Health and Safety site induction, and Personal Protective Equipment ("PPE") will be worn.

- To control, prevent and minimise dirt on the access route and emissions of dust and other airborne contaminants during the construction works, the following mitigation measures will also be implemented:

- Wheel washing equipment will be available and used on-site within the construction compound, as required, to prevent the transfer of dirt and stones onto the public highway. All drivers will be required to check that their vehicle is free of dirt, stones and dust prior to departing from the site.
  - Wheel washing facilities should consist of a water bowser with pressure washer;
  - The bowser will contain water only and no other additives.
  - Run-off from this activity will be directed to the drainage situated on the lower boundary of the construction compound.
- Damping down site roads to minimise dust emissions;
- Any soil stockpiles will be covered when left for extended periods of time;
- Drivers will adopt driving practices that minimise dust generation including a 30km/h internal access road speed limit; and
- Any dust generating activities will be avoided or minimised, wherever practical, during windy conditions;

- Once construction of the Proposed Development is completed, all portacabins, machinery and equipment will be removed and hard standing excavated. The area will be re-graded with the stockpiled topsoil to a natural profile.

7. SUMMARY

7.1. This CTMP outlined the overall framework for managing the movement of construction and delivery traffic to and from the Proposed Development, as well as considering the type of traffic that will be generated. The traffic assessment for the operational and decommissioning phases were also considered.

7.2. Impacts from the operational phase of the site, consisting of between 5-10 LGVs per year, will be below the threshold for a Traffic Impact Assessment, as stated in the NRAs Traffic and Transport Assessment Guidelines.

7.3. The CTMP considered parts of the guidance which are suitable for this project, namely to include details of the existing conditions and issues relating to the Proposed Development.

7.4. An Increased volume of traffic will be generated by the Proposed Development during the construction period. However, the overall volume of traffic generated by the Proposed Development during the construction period is considered to be quite Low. During the anticipated 6-month construction period, a total of 1,212 HGV deliveries will be made to the Application Site. During the peak construction period there will be a maximum of 20 daily HGV deliveries.

7.5. The site access point was redesigned after swept path analysis was conducted and showed the largest construction vehicles could not turn into the Site Entrance. Swept path analysis was used to define the extents of the new access. To facilitate this widened access point there will be minor land clearing and hedgerow removal as well as the removal of one tree required.

7.6. Visibility splays measuring 90m by 3m can be achieved at the Application Site Entrance, with only minor tree pruning required.

7.7. A dedicated person will be appointed for the management of the delivery booking system during the construction stage.

7.8. The Applicant will conduct a pre and post construction condition survey of the L4091, with the Applicant liable to repair any damage to the public roads. This should be conditioned as part of any planning consent.

7.9. The CTMP sets out a variety of specific mitigation measures that will be implemented during construction that will minimise the impact of the construction traffic on the environment and local communities; the following provides a brief summary of each:

- Limitations on working times and HGV scheduling.
- Site security and signage.
- Measures to control emissions of dust and other airborne contaminants

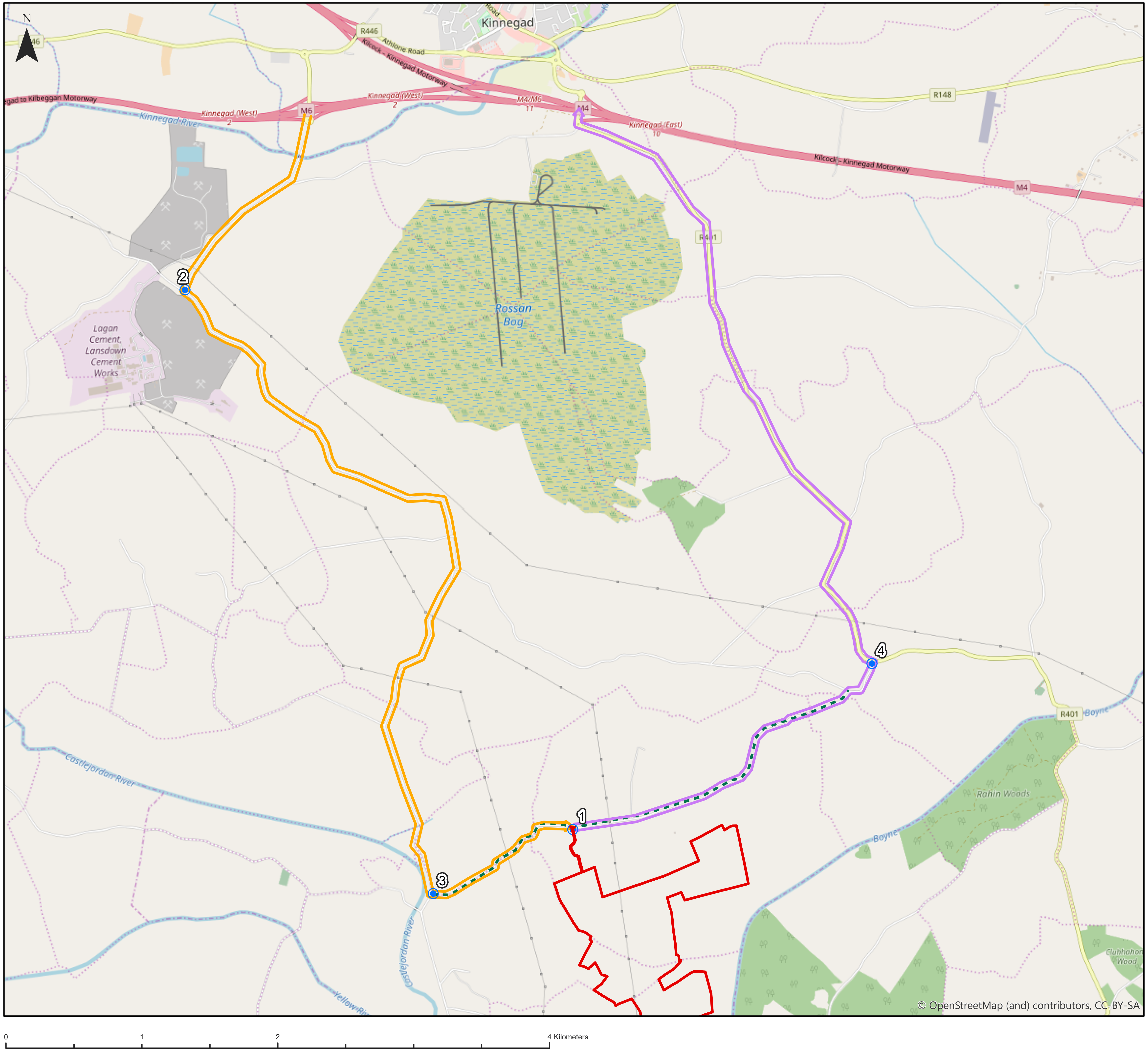
7.10. This Construction Traffic Management Plan conforms to the policies and objectives of the Meath County Council Development Plan 2013-19, and the Design Manual for Roads and Bridges published by the National Roads Authority (NRA).

8. APPENDICES

APPENDIX 9.1A - FIGURES

- Figure 9.1.1: Proposed Access Route
- Figure 9.1.2: Swept Path Analysis 1
- Figure 9.1.3: Swept Path Analysis 2
- Figure 9.1.4: Swept Path Analysis 3
- Figure 9.1.5: Swept Path Analysis 4
- Figure 9.1.6: Site Access Design
- Figure 9.1.7: Visibility Splay
- Figure 9.1.8: Temporary Construction Compound

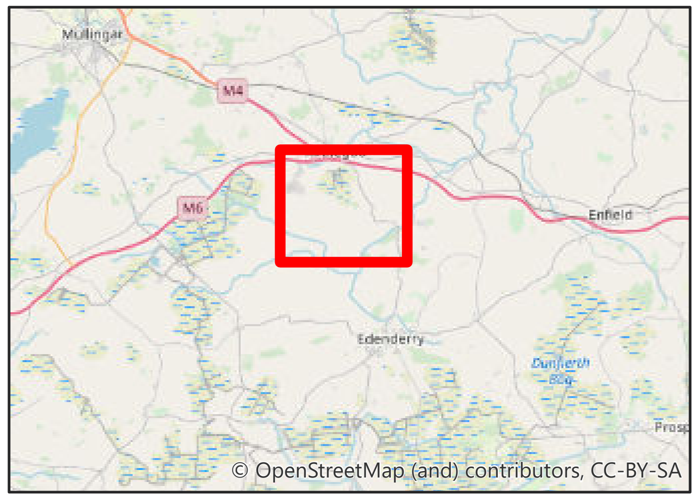
Appendix 6A



Harristown Solar Farm
Proposed Haul Route
Figure 9.1.1

Key

- Development Boundary
- Route Analysis
- Road Condition Survey Extents
- Entrance to Application Site
- Exit from Application Site



Date: 05/08/2019
Drawn By: MM
Scale (A3): 1:27,500
Drawing No: NEO00515/025I/C

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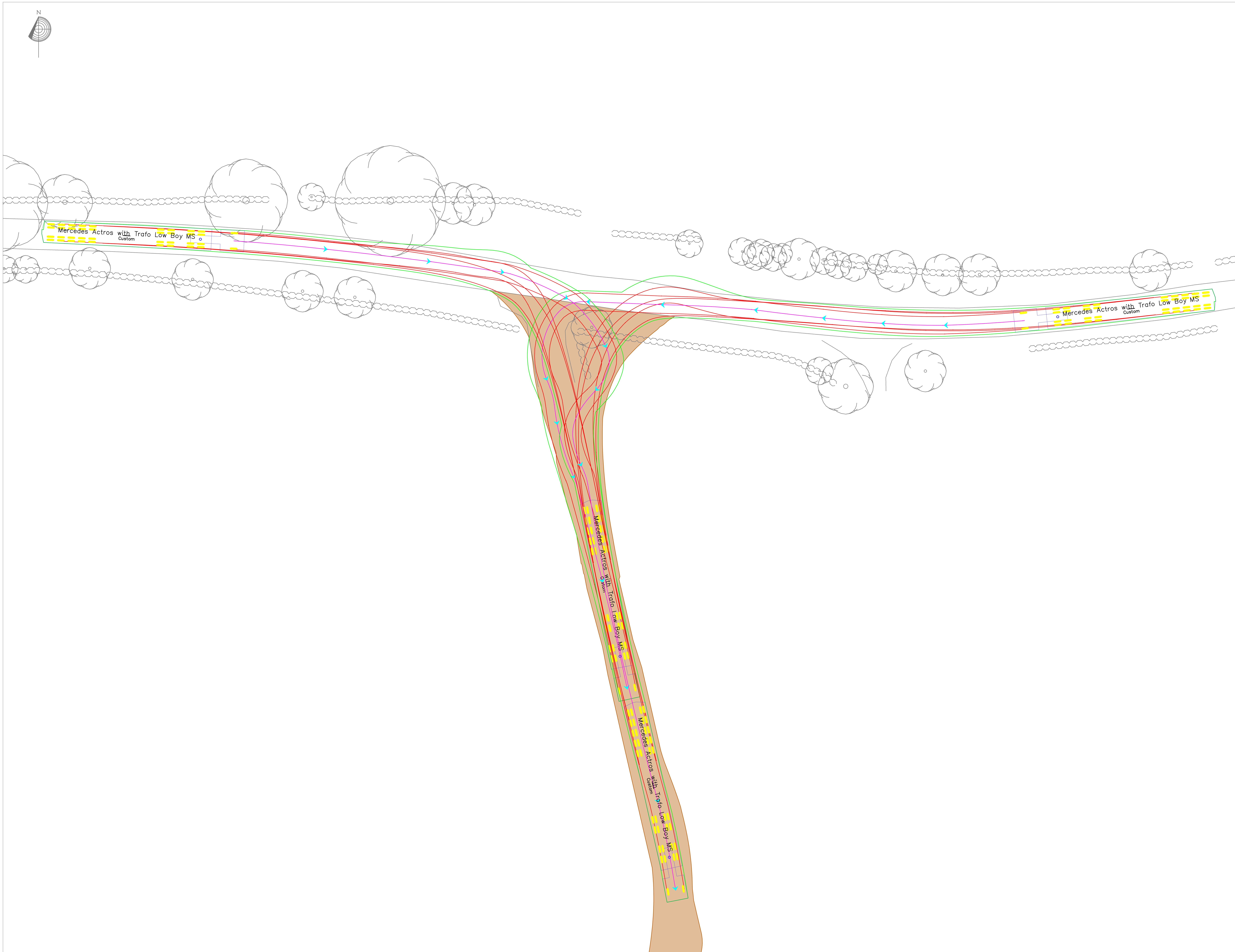


Key

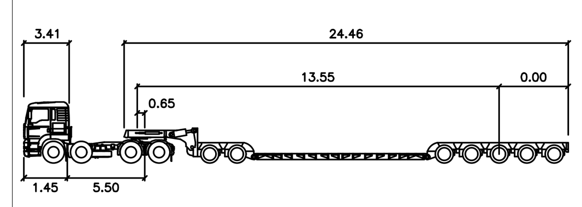
- Wheel Swept Path
- Vehicle Overhang
- Centre Line
- Vehicle

Notes:

- Simulated Speed - 8kph
- Actual vehicle dimensions may vary. Route should be assessed by hauler with regard to the vehicle combinations prior to transport.
- No allowances made for rear steering.
- Does not show load.

Disclaimers:

- All dimensions are to be checked by the contractor prior to the commencement of work. Any discrepancy should be reported immediately to Neo Environmental Ltd.
- All work to be carried out in accordance with the local authority, statutory authority and health & safety requirements.



Mercedes Actros with Trafo Low Boy MS

meters

Tractor Width	: 3.09	Lock to Lock Time	: 6.0
Trailer Width	: 3.09	Steering Angle	: 55.0
Tractor Track	: 2.50	Articulating Angle	: 70.0
Trailer Track	: 2.50		
Curb to Curb Turning Radius	: 7.50		

Rev	Date	Comments
C	31/07/2019	Amended to Rev13 for EIAR
B	25/09/2018	Revised to Final Layout Revision 6
A	28/03/2018	

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Project: Harristown Solar Farm

Client: Lightsource BP

Drawing: Swept Path Analysis 1

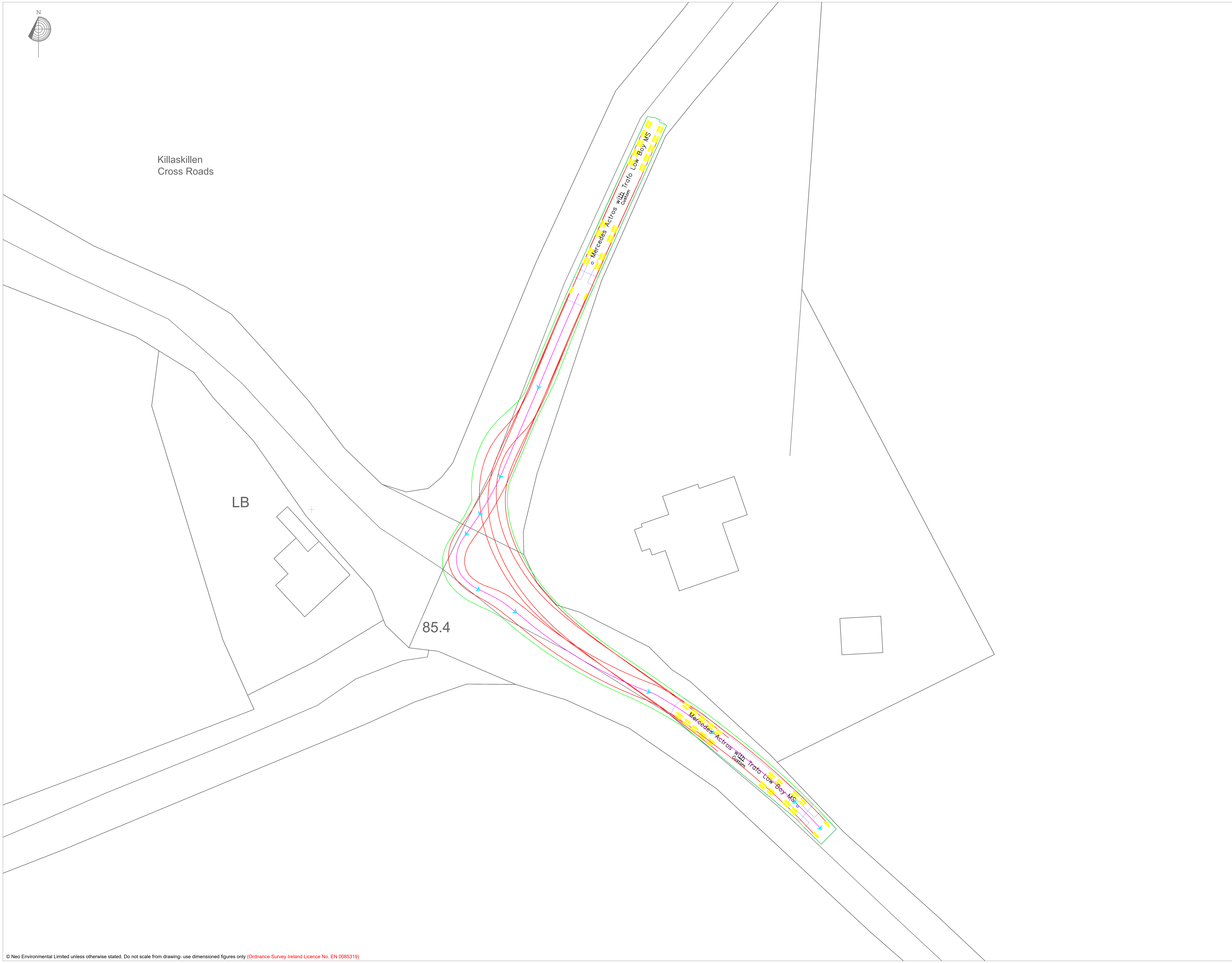
Project No.: NEO00515

Drawing No. : NEO00515_008I_C Figure 9.1.2

Drawn: JM **Checked:** MM **Approved:** KM

Scale: 1:250 @ A1 **Revision:** C

Date: 30 July 2019



Key

- Wheel Swept Path
- Vehicle Overhang
- Centre Line
- Vehicle

Notes:

- Simulated Speed - 8kph
- Actual vehicle dimensions may vary. Route should be assessed by hauler with regard to the vehicle combinations prior to transport.
- No allowances made for rear steering.
- Does not show load.

Disclaimers:

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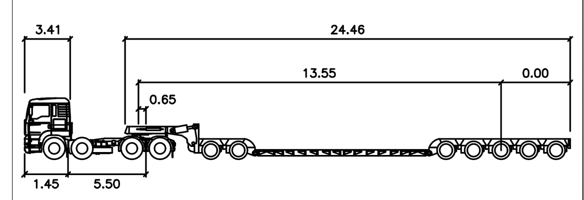

Mercedes Actros with Trafo Low Boy MS

meters

Tractor Width	: 3.09	Lock to Lock Time	: 6.0
Trailer Width	: 3.09	Steering Angle	: 55.0
Tractor Track	: 2.50	Articulating Angle	: 70.0
Trailer Track	: 2.50		
Curb to Curb Turning Radius	: 7.50		

Rev	Date	Comments
A	31/07/2019	

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Project: Harristown Solar Farm

Client: Lightsource BP

Drawing: Swept Path Analysis 2

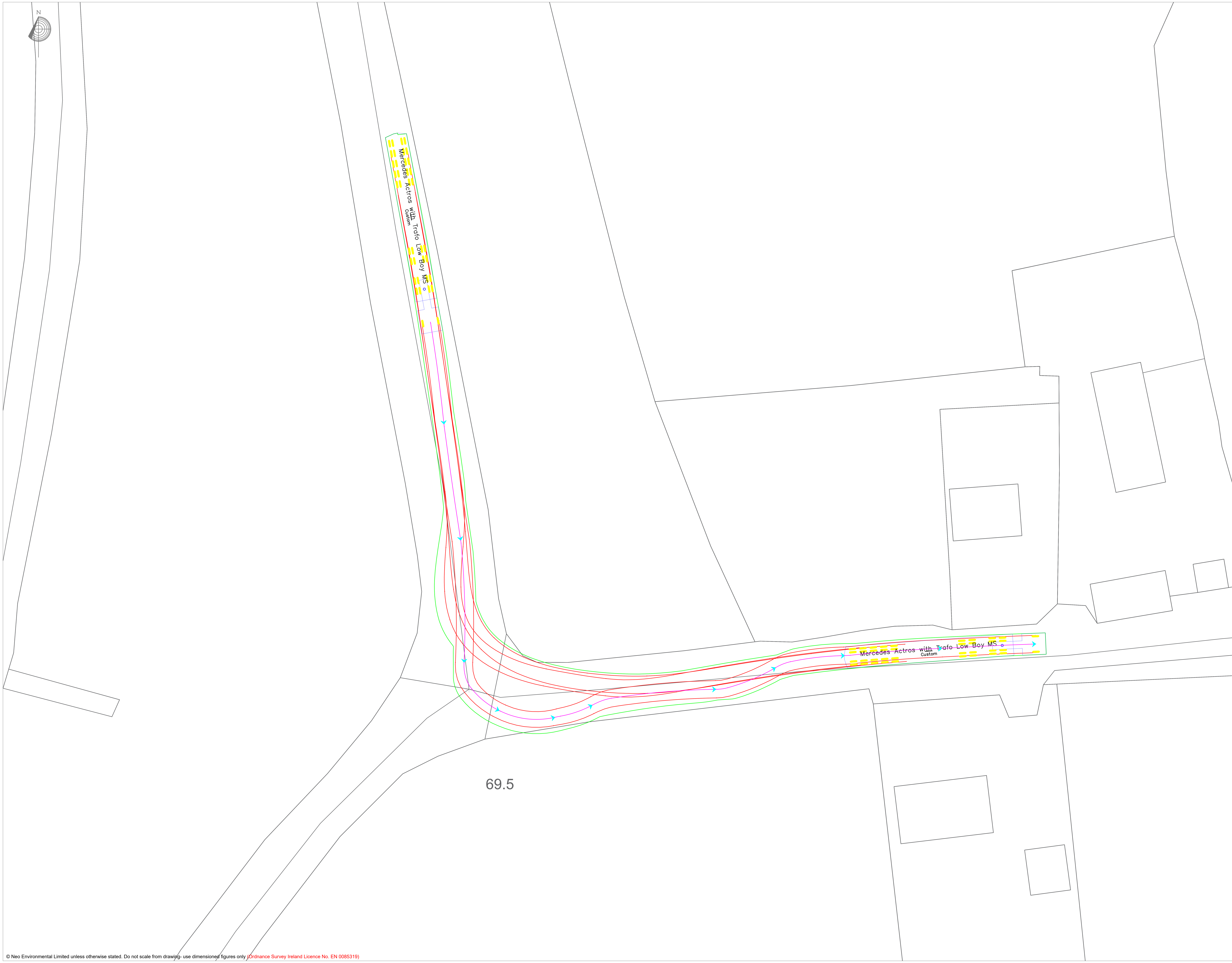
Project No.: NEO00515

Drawing No. : NEO00515_054I_A Figure 9.1.3

Drawn: JM **Checked:** MM **Approved:** KM

Scale: 1:250 @ A1 **Revision:** A

Date: 31 July 2019



Key

- Wheel Swept Path
- Vehicle Overhang
- Centre Line
- Vehicle

Notes:

- Simulated Speed - 8kph
- Actual vehicle dimensions may vary. Route should be assessed by hauler with regard to the vehicle combinations prior to transport.
- No allowances made for rear steering.
- Does not show load.

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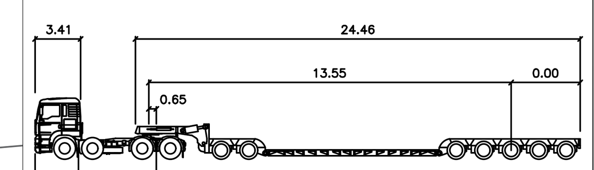

Mercedes Actros with Trafo Low Boy MS

meters

Tractor Width : 3.09
Trailer Width : 3.09
Tractor Track : 2.50
Trailer Track : 2.50
Curb to Curb Turning Radius : 7.50
Lock to Lock Time : 6.0
Steering Angle : 55.0
Articulating Angle : 70.0

Rev	Date	Comments
A	31/07/2019	

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Project: Harristown Solar Farm
Client: Lightsource BP

Drawing: Swept Path Analysis 3

Project No.: NEO00515
Drawing No. : NEO00515_055I_A Figure 9.1.4

Drawn: JM **Checked:** MM **Approved:** KM

Scale: 1:250 @ A1 **Revision:** A
Date: 31 July 2019

Key

- Wheel Swept Path
- Vehicle Overhang
- Centre Line
- Vehicle

Notes:

- Simulated Speed - 8kph
- Actual vehicle dimensions may vary. Route should be assessed by hauler with regard to the vehicle combinations prior to transport.
- No allowances made for rear steering.
- Does not show load.

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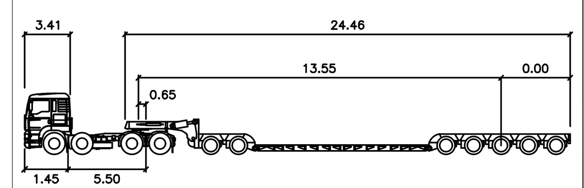

Mercedes Actros with Trafo Low Boy MS

meters

Tractor Width	: 3.09	Lock to Lock Time	: 6.0
Trailer Width	: 3.09	Steering Angle	: 55.0
Tractor Track	: 2.50	Articulating Angle	: 70.0
Trailer Track	: 2.50		
Curb to Curb Turning Radius : 7.50			

Rev	Date	Comments
A	31/07/2019	

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Project: Harristown Solar Farm

Client: Lightsource BP

Drawing: Swept Path Analysis 4

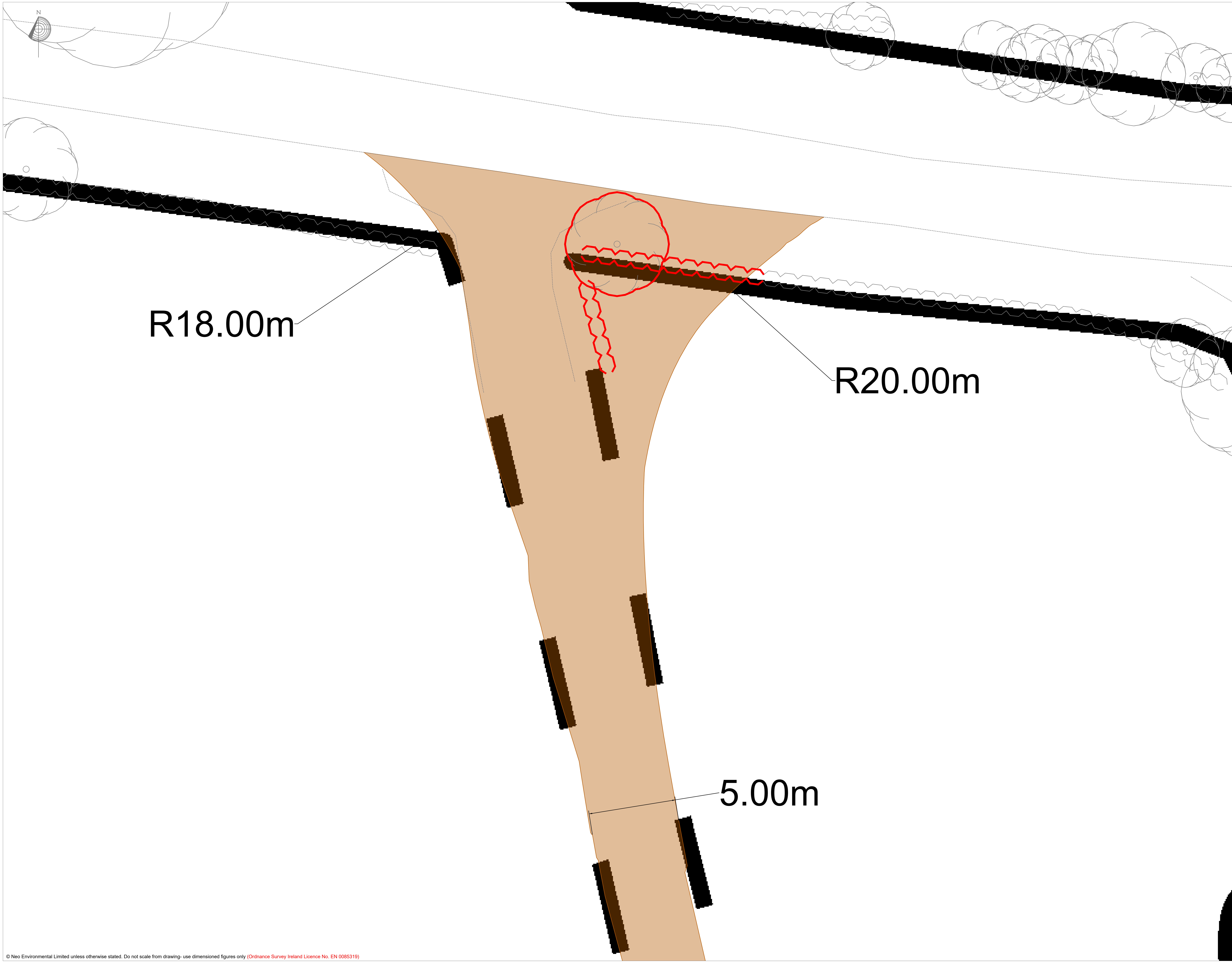
Project No.: NEO00515

Drawing No. : NEO00515_056I_A Figure 9.1.5

Drawn: JM **Checked:** MM **Approved:** KM

Scale: 1:250 @ A1 **Revision:** A

Date: 31 July 2019



Key

Foliage to be removed

Access Track

Rev	Date	Comments
B	30/07/2019	Amended to Rev13 Design
A	03/10/2018	

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Ballymena Office: T:02890517092 E: info@neo-environmental.co.uk

Project: Harristown Solar Farm

Client: Lightsource BP

Drawing: Site Access Design

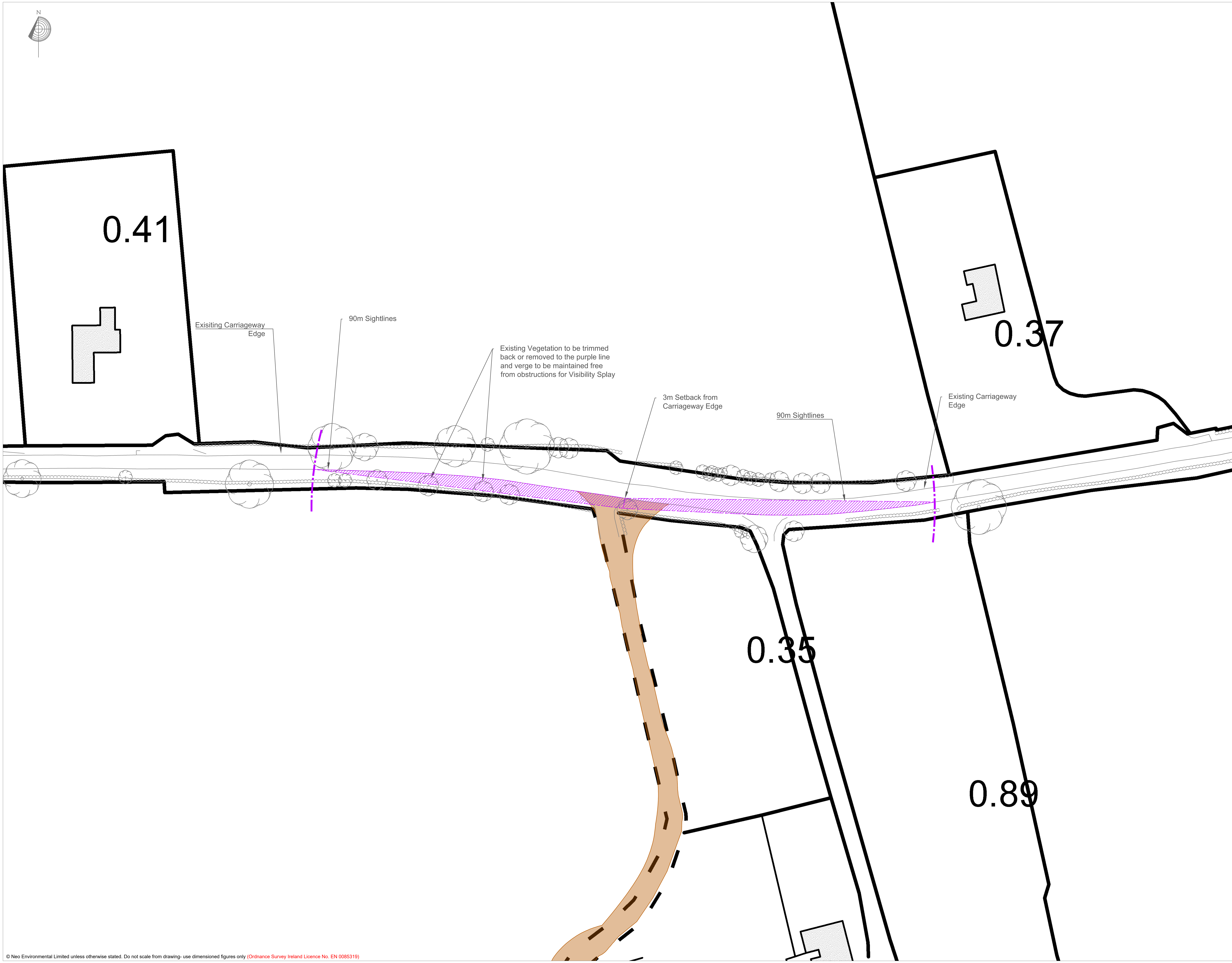
Project No.: NEO00515

Drawing No. : NEO00515_041I_B Figure 9.1.6

Drawn: JM **Checked:** MM **Approved:** KM

Scale: 1:100 @ A1 **Revision:** B

Date: 30 July 2019



Key

Visibility Splay

Rev	Date	Comments
A	31/07/2019	

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Project: Harristown Solar Farm

Client: Lightsource BP

Drawing: Visibility Splay (90 x 3m)

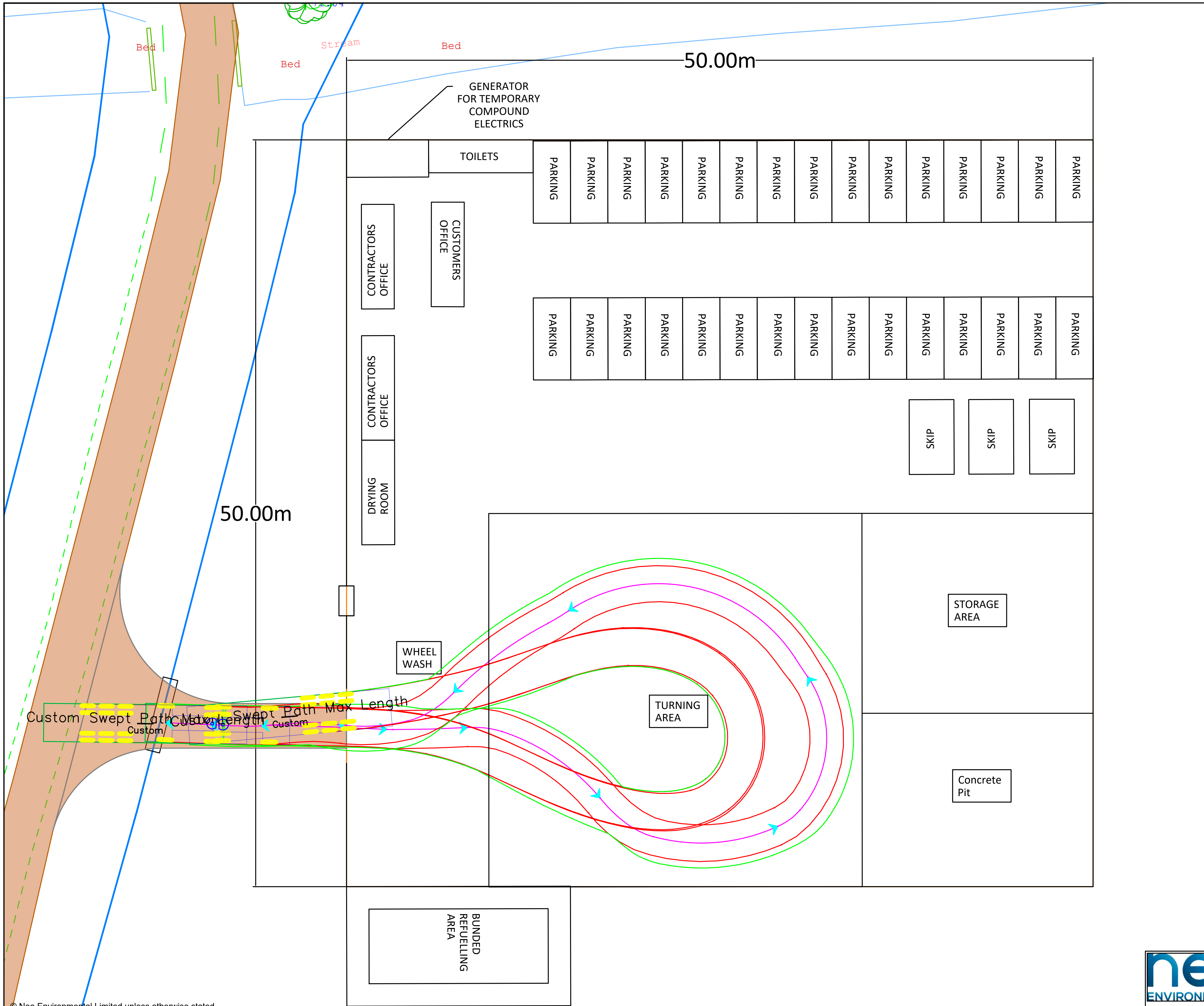
Project No.: NEO00515

Drawing No. : NEO00515_053I_A Figure 9.1.7

Drawn: JM **Checked:** MM **Approved:** KM

Scale: 1:500 @ A1 **Revision:** A

Date: 31 July 2019



Notes:

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.
2. FOLLOWING CONSTRUCTION PERIOD ALL SITE OFFICES, CONTAINERS, MACHINERY AND EQUIPMENT SHALL BE REMOVED. THE COMPOUND AND LAY-DOWN AREA SHALL BE FULLY RESTORED TO BEST PRACTICE.
3. COMPOUND SHOULD BE LINED WITH IMPERMEABLE GEOMEMBRANE AND RUN OFF DIRECTED TO SWALE/SETTLEMENT LAGOONS ON LOWER EDGE.

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Ballymena Office: T:02890517092 E: info@neo-environmental.co.uk

Project: Harristown Solar Compound
Client: Lightsource BP
Drawing: Temporary Construction Compound
Project No.: NEO00515
Drawing No.: NEO00515_057I_B Figure 9.1.8

Drawn JM	Checked MM	Approved KM	
Scale 1:250@A3	Date 02/08/2019	Status PLAN	Rev A

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