Greater Dublin Drainage Project

Irish Water

Environmental Impact Assessment Report: Volume 4 Part B of 6

Appendices

June 2018

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Appendix 3A RBSF Receptors List

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APPENDIX 3A

Receptors List

Receptor ID	Type	Easting	Northing	Comment
P01	Residential	311603.563	241999.266	Ocuppied private residence although noted as a commercial entity on geo directory
P02	Residential	311636.531	241995.563	House appears unoccupied - Demolished
P03	Residential	311656.906	241940.359	House appears unoccupied - Demolished
P04	Commercial	311670.019	241903.502	Yard with no buildings
P05	Commercial	311660.300	241878.200	Motor Traders
P06	Commercial	311779.700	241584.800	Dog's Trust
P07	Commercial	311400.031	242503.344	Appears to be commercial although noted as a residential with geodirectory. Verified as a shed.
P08	Residential	311315.469	242563.375	Private residence
P09	Residential	311340.750	242715.469	Private residence
P10	Residential	311263.250	242805.469	Private residence
P11	Residential	311263.250	242805.469	Private residence
P12	Residential	311259.125	242699.828	Private Residence - Kilshane House
P13	Residential	310789.375	242672.781	Private residence
P14	Commercial	310591.875	242532.859	PD Flaherty Logistics
P15	Residential	310354.629	241989.809	Private Residence - Huntstown House
P16	Residential	310712.094	242738.922	Private residence
P17	Commercial	310817.781	241502.438	Roadstone entities and activities
P18	Commercial	311438.656	241381.266	Huntstown Power Station
P19	Commercial	310348.000	242612.400	Parcare Leatrans Ltd.
P20	Commercial	310298.250	242433.109	Cafco Vehicle Solutions
P21	Residential	310840.281	242790.891	Private residence
P22	Residential	310948.250	242835.234	Private residence
P23	Residential	312429.938	242478.047	Farm - confirmed
P24	Commercial	312530.094	242325.922	Easons
P25	Commercial	312143.250	242394.688	DHL
P26	Residential	311940.094	241416.984	Private residence
P27	Commercial	312032.230	241352.537	Garden Centre
P28	Commercial	312013.844	241358.469	Henley Stoves
P29	Commercial	312077.450	241265.241	Garden Sheds & Allotments

P30	Commercial	312098.219	241129.281	Veterinary
P31	Residential	312139.531	241057.859	Private residence
P32	Residential	312126.729	240997.762	Private residence
P33	Residential	311925.531	241378.250	Private residence
P34	Commercial	311185.392	243108.347	Topaz and additional businesses
P35	Commercial	311108.219	243078.016	Begley Distribution
P36	Residential	311193.625	243179.359	Private residence
P37	Commercial	311265.938	242889.719	Fingal Joinery
P38	Commercial	311384.656	242893.609	TJ O'Mahony
P39	Residential	311269.800	242795.200	Private residence
P40	Commercial	311301.023	242752.181	Kilshane Autos
P41	Residential	312361.719	242150.672	Newtown House
P42	Commercial	312126.219	242195.750	Frank Flanagan Fittings
P43	Commercial	312068.469	242199.063	Gilead Sciences Ltd.
P44	Commercial	312124.781	242060.344	Industrial Unit
P45	Commercial	312059.678	242072.542	Industrial Unit
P46	Commercial	312118.438	241956.938	DHL
P47	Commercial	312033.250	241963.953	Simtech Aviation
P48	Residential	312713.770	242066.156	Private Residence
P49	Residential	312278.595	242998.831	Multiple Private Residences - Newtown Cottages
P50	Residential	310348.997	241964.002	Private Residence

Note: Receptor survey updated February 2018

Appendix 6A RGD EIAR Ecological Criteria

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Appendix 6A

Criteria for Ecological Evaluation

Ecological Valuation Criteria
International Importance: 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation. Proposed Special Protection Area (pSPA). Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended). Features essential to maintaining the coherence of the Natura 2000 Network.[1] Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive. Resident or regularly occurring populations (assessed to be important at the national level)[2] of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and / or Species of animal and plants listed in Annex II and/or IV of the Habitats Directive. Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971). World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972). Biosphere Reserve (UNESCO Man & The Biosphere Programme). Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979). Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979). Biogenetic Reserve under the Council of Europe. European Diploma Site under the Council of Europe. Irish Regulations implementing the Water Framework Directive
National Importance: Site designated or proposed as a Natural Heritage Area (NHA). Statutory Nature Reserve. Refuge for Fauna and Flora protected under the Wildlife Acts. National Park. Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA); Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park. Resident or regularly occurring populations (assessed to be important at the national level)[3] of the following: Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing 'viable areas'[4] of the habitat types listed in Annex I of the Habitats Directive.

[1] See Articles 3 and 10 of the Habitats Directive.

[2] It is suggested that, in general, 1% of the national population of such species qualifies as an internationally important population. However, a smaller population may qualify as internationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[3] It is suggested that, in general, 1% of the national population of such species qualifies as a nationally important population. However, a smaller population may qualify as nationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[4] A 'viable area' is defined as an area of a habitat that, given the particular characteristics of that habitat, was of a sufficient size and shape, such that its integrity (in terms of species composition, and ecological processes and function) would be maintained in the face of stochastic change (for example, as a result of climatic variation).

Ecological Valuation Criteria
County Importance: Area of Special Amenity.[5] Area subject to a Tree Preservation Order. Area of High Amenity, or equivalent, designated under the County Development Plan. Resident or regularly occurring populations (assessed to be important at the County level)[6] of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; Species of animal and plants listed in Annex II and/or IV of the Habitats Directive; Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance. County important populations of species, or viable areas of semi-natural habitats or natural heritage features identified in the National or Local Biodiversity Action Plan (BAP) if this has been prepared. Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county. Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.
Local Importance (higher value): Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared; Resident or regularly occurring populations (assessed to be important at the Local level)[7] of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; Species of animal and plants listed in Annex II and/or IV of the Habitats Directive; Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality; Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.
Local Importance (lower value): Sites containing small areas of semi-natural habitat that are of some local importance for wildlife; Sites or features containing non-native species that are of some importance in maintaining habitat links.

[5] It should be noted that whilst areas such as Areas of Special Amenity, areas subject to a Tree Preservation Order and Areas of High Amenity are often designated on the basis of their ecological value, they may also be designated for other reasons, such as their amenity or recreational value. Therefore, it should not be automatically assumed that such sites are of County importance from an ecological perspective.

[6] It is suggested that, in general, 1% of the County population of such species qualifies as a County important population. However, a smaller population may qualify as County importance where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[7] It is suggested that, in general, 1%of the local population of such species qualifies as a locally important population. However, a smaller population may qualify as locally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

Appendix 7A Waste Management Plan

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Irish Water

PROJECT:

Regional Biosolids Storage Facility

DOCUMENT:

Outline Waste Management Plan

TJ O'CONNOR & ASSOCIATES CONSULTING ENGINEERS

BARRY & PARTNERS consulting engineers

Royal HaskoningDHV *Enhancing Society Together*

May 2018

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SECTION 1: INTRODUCTION

This Waste Management Plan relates to the management and disposal of wastes generated associated with expansion of Ringsend Wastewater Treatment Plant and ancillary works. This Waste Management Plan outlines the waste management framework and the key wastes that are likely to be generated through construction.

Wastes arising from the operation of the facility post construction will be managed in accordance with best practice and/or the site's Certificate of Registration (to be issued by Fingal County Council).

The Contractor is responsible for preparing the contract-specific Waste Management Plan. The plan must comply with the Department of Environment, Heritage and Local Government 'Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects' and will include the following (but not limited to):

- Specific/achievable waste management objectives;
- Analysis of waste arising; and
- Methods for proposed prevention, reuse and recycling of wastes.

It must also specify points of contact for each type of waste generated through the project and reference written procedures for the management of each type of waste.

All waste management records shall be prepared for submission to Irish Water and the site operator to allow updates to any statutory reporting requirements.

SECTION 2: WASTE MANAGEMENT PRINCIPLES

Management of all waste throughout the project life-cycle will be in accordance with EU, national and regional waste management policy and the principles of the Waste Hierarchy i.e. prevention, minimisation, reuse, recovery and recycling.

The contractor will be required to address the following issue within the preparation of the site waste management plan.

2.1 Prevention of Waste

The management of material is key to implementing an effective waste prevention and minimization policy on site. Materials will be ordered in a timely manner and as required to avoid over ordering, excess supply and wastage. The Waste Management Plan shall provide for proper storage and handling of construction material to maximise usage and minimise waste. Materials delivered to site shall be inspected to ensure they are defect free and suitable for use.

2.2 Reuse of Waste

Where possible construction material will be reused on site/ off site. Material removed from site will be organised through an appropriately authorised waste collector removing to an authorised facility (licensed, permitted or registered as required).

2.3 Recycling of Waste

Segregation of waste streams shall be implemented on site to maximise recycling and recovery.

2.4 Disposal or further treatment of Waste

Segregation of waste streams shall also apply to waste streams (if found on-site) that may require specialist treatment, packaging or preparation prior to recovery or disposal e.g. Japanese knotweed, contaminated soil, asbestos, etc. The Contractor shall appoint a designated competent person for the preparation of additional paperwork and/or contact with appropriate officials and this shall be set out in the contract-specific Waste Management Plan.

2.5 Waste segregation, Storage and removal

The Contractor will ensure as much as possible that all recyclable material will be separated at source. Individual waste streams will be segregated through the use of separate bins, storage containers or clearly defined areas for stockpiling. Reusable and recyclable waste streams will be stored separately to residual wastes to avoid contamination and maximize their reuse potential.

Waste will be stored appropriately as follows:

- Clearly marked signs;
- Enclosed to prevent waste escaping;
- Segregated by type where possible;
- Suitable for that waste type, i.e. able to contain waste and prevent escape, including leaking of liquids;

2.6 Hazardous Wastes

Hazardous or contaminated material, including material that requires specialist treatment or disposal, will be stored separately on site to avoid cross-contamination. Hazardous wastes must not be mixed. Any hazardous waste generated (e.g. oil rags or waste oil) will be stored in appropriate receptacles or containers,bunded or other storage areas prior to their removal by an appropriately licensed contractor.

2.7 Waste Carriers/ Treatment Facilities

The materials to be disposed off-site classified as 'wastes' are subject to the provisions of the 'Waste Management Act', 1996 (as amended). Material removed from site will be organised through an appropriately authorised waste collector. Waste shall be brought by them to an authorised facility (licensed, permitted or registered as required). If waste is to be exported from Ireland, the Contractor will liaise with Irish Water or its representative to arrange the necessary Transfrontier Shipment approvals through the Competent Authority.

The Contractor will ensure that:

- any waste carrier holds a valid waste collection permit;
- any disposal or recovery facility (national or international) be used for the management of waste arising from the scheme is suitably permitted, licensed or registered;
- the terms and conditions of these authorisations allow for the acceptance of the waste in question;
- the relevant authorisations remain valid when used within the lifetime of the project; and,
- all records are maintained and made available as set out below.

SECTION 3: MANAGEMENT RESPONSIBILITIES

The Contractors Waste Manager will be responsible for ensuring that the Waste Management Plan is implemented. The Waste Manager may be the Environmental Manager or other suitability experienced person. The Waste Manager shall be assigned the responsibility for waste prevention, minimisation, reuse, recycling and disposal during all stages of this project. The Waste Manager shall liaise with the relevant authorities, environmental specialists and site operations personnel as required to implement the plan.

3.1 Training

The Waste Management Plan will be made available to all personnel on site. The Waste Management Plan and its objectives will be included in site induction for all staff members. Site induction will include instructions on how to support objectives and targets set out in this waste management plan.

Site notices will be positioned throughout the site to assist implementation the Waste Management Plan.

3.2 Records

A record will be maintained of all waste removed from the site (Waste Removal Record). The record will include information on the date removed, LoW Code, description of area where waste, weight and volume, details of whether the waste in question was being removed for either disposal or recovery/recycling, waste transport contractor (including permit number), details of the facility to which waste is removed (including license or permit number).

A monthly summary including quantity, type and composition of all waste removed from site will be prepared by the Waste Manager and performance measured against any agreed targets.

A location will be identified where all records in regard to wastes removed, quantities recycled or disposed will be held for inspection by the Contractor, Employer's representative, site operators and other third parties.

3.3 Inspections

The Waste Manager will carry out weekly inspections of the site which to examine how the waste is segregated and stored The weekly inspections will be documented on the Weekly Environmental Inspection Record Sheet.

3.4 Audits

Waste management will be audited as part of the auditing for the overall CSEMP. Internal audits by the Contractor will be completed at a minimum of twice per year. Upon completions of the audit attention will be given to opportunities for reducing waste and any other areas which could be improved Audit findings will highlight corrective actions that may be taken in relation to management policies or site practices in order to bring about further waste reductions.

All waste records (Waste Record Sheet, records of waste transfers or collections, consignment notes etc.) will be audited externally by the Employer's Representative during the External Audit of the CSEMP.

3.5 Identification and Segregation of Waste

Wastes generated must be identified and segregated according to their category as described by the European List of Waste (LoW). Waste categories may include, but are not limited to, the wastes detailed in the following sections.

Concrete, Bricks, tiles, ceramics

Waste concrete is likely to arise during the construction (and/or demoilition) phase. Where possible, concrete will be returned to the supplier for reuse. In circumstances where this is not possible the concrete may be disposed off-site.

It's unlikely to have waste bricks, tiles or ceramic during the construction phase of this project. Unless they are found in excavated soil. However, careful storage is required to reduce the amount of breakages and waste being created. Offcuts/ trimmings will be re-used where possible. Any waste generated will be stored in containers to removal to a waste facility.

Wood, Glass and plastic

Timber waste will be stored separately and re-used where possible. Unused timber will be disposed of at a recycling facility. Pallets will be returned to the supplier for reuse. A covered container for waste wood will be placed on site in convenient locations (Timber will not be allowed to rot.).

Bituminous mixtures, coal tar and tarred products

Waste bituminous material may arise during the construction of internal site roads.

Metals

Metal waste can have a significant scrap value. Metals will be segregated on site for reuse and recycling.

Soil (including excavated soil from contaminated sites), stones and dredged spoil

Depending on preliminary site investogations, some soils, stones may be identified as suitable for reuse and should be stored in on-site areas prior to re-use. Soils or spoil to be removed from site should be managed as set out in 3.7 below. Such wastes may be transferred to suitable inert landfills, if it is not possible to find a reuse application or if they cannot be accepted as engineering grade material in landfills.

Insulation materials and asbestos-containing construction materials

In the event that asbestos waste is encountered on-site appropriate storage, transportation and disposal of waste must be adhered to.

Packaging and Plastics (Various)

Packaging waste will be segregated at source and removed to a recycling facility. Waste packaging will be stored in separate covered containers.

3.6 Hazardous Material

In the event that hazardous waste is encountered, the Contractor must provide appropriate storage until such voilumes accumulate that will allow safe transportation and disposal or recovery. The Contractor will ensure that a competent person will classify the material in accordance with the List of Waste (LoW). The Waste Management Plan will ensure that non-hazardous waste is not mixed with hazardous waste where possible.

The Contractor will ensure that appropriate measures are taken to safeguard the health of the Contractor's operatives and the general public for the duration of the works. In the event that hazardous materials are discovered on the site, the ER is to be informed immediately. The ER has the right to request that tests be carried out on any suspected hazardous materials to determine their exact nature.

Under certain circumstances, specialist contractors may be required to remove the hazardous materials from site e.g. asbestos. The Contractor will seek the approval of the Employer's Representative where the services of a Specialist Contractor are to be engaged. The Contractor will ensure that the Specialist Subcontractor, if any, will comply with all relative legislation regarding the required permits and licensing for the disposal of hazardous materials.

Hazardous materials arising from site clearance and/or excavations will be disposed of only at suitable licensed facilities.The contractor shall provide details of the health and safety requirements to be implemented during the removal of hazardous materials such as asbestos. This will include any PPE protocol.

3.7 Other wastes requiring specialised management

Wastes other than those listed above may not be easily recovered. Such material should be stored separately or in a designated covered container for removal to a licensed facility for disposal.

In the event that materials such as contaminated soils are discovered, the Waste Manager shall engage with a specialist to gain appropriate authorisations, procurement approval from the Client, TFS approvals (if required) and will establish arrangements to provide for appropriate segregation, storage, collection and treatment. The Waste Manager will maintain records of all relevant correspondence and authorisations.

Rechargable batteries should be used for portable devices where possible and any batteries or electrical equipment which may become redundant during the project should be stored separately prior to transfer to an appropriate WEEE facility.

Food waste management shall account for the need to align with health, safety and welfare at work guidelines to prevent rodent infestation.

Appendix 8A RGD Air Quality

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Appendix 8A

Ambient Air Quality Standards

National standards for ambient air pollutants in Ireland have generally ensued from Council Directives enacted in the EU (& previously the EC & EEC) (see EIAR, Volume 4, Section 8: Table 8-1). The initial interest in ambient air pollution legislation in the EU dates from the early 1980s and was in response to the most serious pollutant problems at that time which was the issue of acid rain. As a result of this sulphur dioxide, and later nitrogen dioxide, were both the focus of EU legislation. Linked to the acid rain problem was urban smog associated with fuel burning for space heating purposes. Also apparent at this time were the problems caused by leaded petrol and EU legislation was introduced to deal with this problem in the early 1980s.

In recent years the EU has focused on defining a basis strategy across the EU in relation to ambient air quality. In 1996, a Framework Directive, Council Directive 96/62/EC, on ambient air quality assessment and management was enacted. The aims of the Directive are fourfold. Firstly, the Directive's aim is to establish objectives for ambient air quality designed to avoid harmful effects to health. Secondly, the Directive aims to assess ambient air quality on the basis of common methods and criteria throughout the EU. Additionally, it is aimed to make information on air quality available to the public via alert thresholds and fourthly, it aims to maintain air quality where it is good and improve it in other cases.

As part of these measures to improve air quality, the European Commission has adopted proposals for daughter legislation under Directive 96/62/EC. The first of these directives to be enacted, Council Directive 1999/30/EC, has been passed into Irish Law as S.I. No 271 of 2002 (Air Quality Standards Regulations 2002), and has set limit values which came into operation on 17th June 2002. Council Directive 1999/30/EC, as relating to limit values for sulphur dioxide, nitrogen dioxide, lead and particulate matter, is detailed in EIAR, Volume 4, Section 8: Table 8-1. The Air Quality Standards Regulations 2002 detail margins of tolerance, which are trigger levels for certain types of action in the period leading to the attainment date. The margin of tolerance varies from 60% for lead, to 30% for 24-hour limit value for PM_{10}, 40% for the hourly and annual limit value for NO_2 and 26% for hourly SO_2 limit values. The margin of tolerance commenced from June 2002, and will start to reduce from 1 January 2003 and every 12 months thereafter by equal annual percentages to reach 0% by the attainment date. At present the attainment date for margins of tolerance have been reached for each pollutant. A second daughter directive, EU Council Directive 2000/69/EC, has published limit values for both carbon monoxide and benzene in ambient air as set out in EIAR, Volume 4, Section 8: Table 8-1. This has also been passed into Irish Law under the Air Quality Standards Regulations 2002.

The most recent EU Council Directive on ambient air quality was published on the 11/06/08 which has been transposed into Irish Law as S.I. 180 of 2011. Council Directive 2008/50/EC combines the previous Air Quality Framework Directive and its subsequent daughter directives. Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$. The margins of tolerance specific to each pollutant were also slightly adjusted from previous directives. In regards to existing ambient air quality standards, it is not proposed to modify the standards but to strengthen existing provisions to ensure that non-compliances are removed. In addition, new ambient standards for $PM_{2.5}$ are included in Directive 2008/50/EC. The approach for $PM_{2.5}$ is to establish a target value of 25 µg/m^3, as an annual average (to be attained everywhere by 2010) and a limit value of 25 µg/m^3, as an annual average (to be attained everywhere by 2015), coupled with a target to reduce human exposure generally to $PM_{2.5}$ between 2010 and 2020. This exposure reduction target will range from 0% (for $PM_{2.5}$ concentrations of

less than 8.5 µg/m^3 to 20% of the average exposure indicator (AEI) for concentrations of between 18 - 22 µg/m^3. Where the AEI is currently greater than 22 µg/m^3 all appropriate measures should be employed to reduce this level to 18 µg/m^3 by 2020. The AEI is based on measurements taken in urban background locations averaged over a three year period from 2008 - 2010 and again from 2018-2020. Additionally, an exposure concentration obligation of 20 µg/m^3 has been set to be complied with by 2015 again based on the AEI.

Although the EU Air Quality Limit Values are the basis of legislation, other thresholds outlined by the EU Directives are used which are triggers for particular actions. The Alert Threshold is defined in Council Directive 96/62/EC as "a level beyond which there is a risk to human health from brief exposure and at which immediate steps shall be taken as laid down in Directive 96/62/EC". These steps include undertaking to ensure that the necessary steps are taken to inform the public (e.g. by means of radio, television and the press).

The Margin of Tolerance is defined in Council Directive 96/62/EC as a concentration which is higher than the limit value when legislation comes into force. It decreases to meet the limit value by the attainment date. The Upper Assessment Threshold is defined in Council Directive 96/62/EC as a concentration above which high quality measurement is mandatory. Data from measurement may be supplemented by information from other sources, including air quality modelling.

An annual average limit for both NO_X (NO and NO_2) is applicable for the protection of vegetation in highly rural areas away from major sources of NO_X such as large conurbations, factories and high road vehicle activity such as a dual carriageway or motorway. Annex VI of EU Directive 1999/30/EC identifies that monitoring to demonstrate compliance with the NO_X limit for the protection of vegetation should be carried out distances greater than:

- 5 km from the nearest motorway or dual carriageway
- 5 km from the nearest major industrial installation
- 20 km from a major urban conurbation

As a guideline, a monitoring station should be indicative of approximately 1000 km^2 of surrounding area.

Under the terms of EU Framework Directive on Ambient Air Quality (96/62/EC), geographical areas within member states have been classified in terms of zones. The zones have been defined in order to meet the criteria for air quality monitoring, assessment and management as described in the Framework Directive and Daughter Directives. Zone A is defined as Dublin and its environs, Zone B is defined as Cork City, Zone C is defined as 23 urban areas with a population greater than 15,000 and Zone D is defined as the remainder of the country. The Zones were defined based on among other things, population and existing ambient air quality.

EU Council Directive 96/62/EC on ambient air quality and assessment has been adopted into Irish Legislation (S.I. No. 33 of 1999). The act has designated the Environmental Protection Agency (EPA) as the competent authority responsible for the implementation of the Directive and for assessing ambient air quality in the State. Other commonly referenced ambient air quality standards include the World Health Organisation. The WHO guidelines differ from air quality standards in that they are primarily set to protect public health from the effects of air pollution. Air quality standards, however, are air quality guidelines recommended by governments, for which additional factors, such as socio-economic factors, may be considered.

Air Dispersion Modelling

The inputs to the DMRB model consist of information on road layouts, receptor locations, annual average daily traffic movements, annual average traffic speeds and background concentrations[19]. Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptor using generic meteorological data.

The DMRB has recently undergone an extensive validation exercise[33] as part of the UK's Review and Assessment Process to designate areas as Air Quality Management Areas (AQMAs). The validation exercise was carried out at 12 monitoring sites within the UK DEFRAs national air quality monitoring network. The validation exercise was carried out for NO_X, NO_2 and PM_{10}, and included urban background and kerbside/roadside locations, "open" and "confined" settings and a variety of geographical locations[33].

In relation to NO_2, the model generally over-predicts concentrations, with a greater degree of over-prediction at "open" site locations. The performance of the model with respect to NO_2 mirrors that of NO_X showing that the over-prediction is due to NO_X calculations rather than the NO_X:NO_2 conversion. Within most urban situations, the model overestimates annual mean NO_2 concentrations by between 0 to 40% at confined locations and by 20 to 60% at open locations. The performance is considered comparable with that of sophisticated dispersion models when applied to situations where specific local validation corrections have not been carried out.

The model also tends to over-predict PM_{10}. Within most urban situations, the model will over-estimate annual mean PM_{10} concentrations by between 20 to 40%. The performance is comparable to more sophisticated models, which, if not validated locally, can be expected to predict concentrations within the range of $\pm$50%.

Thus, the validation exercise has confirmed that the model is a useful screening tool for the Second Stage Review and Assessment, for which a conservative approach is applicable[33].

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Appendix 8B RGD EIAR Dust

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Appendix 8B

Dust Minimisation Plan

Site Management

The aim is to ensure good site management by avoiding dust becoming airborne at source. This will be done through effective design and control strategies.

At the planning stage, the siting of construction activities and storage piles will take note of the location of sensitive receptors and prevailing wind directions in order to minimise the potential for significant dust nuisance (see Section 8: Figure 8-2 for the windrose for Dublin Airport). As the prevailing wind is predominantly south-westerly, locating construction compounds and storage piles downwind of sensitive receptors will minimise the potential for dust nuisance to occur at sensitive receptors.

Good site management will include the ability to respond to adverse weather conditions by either restricting operations on-site or quickly implementing effective control measures before the potential for nuisance occurs. When rainfall is greater than 0.2mm/day, dust generation is generally suppressed[30,31]. The potential for significant dust generation is also reliant on threshold wind speeds of greater than 10 m/s (19.4 knots) (at 7m above ground) to release loose material from storage piles and other exposed materials[32]. Particular care should be taken during periods of high winds (gales) as these are periods where the potential for significant dust emissions are highest. The prevailing meteorological conditions in the vicinity of Newtown, Kilshane are favourable in general for the suppression of dust for a significant period of the year. Nevertheless, there will be infrequent periods where care will be needed to ensure that dust nuisance does not occur. The following measures should be taken in order to avoid dust nuisance occurring under unfavourable meteorological conditions:

- The Principal Contractor or equivalent must monitor the contractors' performance to ensure that the proposed construction phase mitigation measures are implemented and that construction impacts and nuisance are minimised;
- During working hours, dust control methods will be monitored as appropriate, depending on the prevailing meteorological conditions;
- The name and contact details of a person to contact regarding air quality and dust issues shall be displayed on the site boundary, this notice board should also include head/regional office contact details;
- A complaints register will be kept on site detailing all telephone calls and letters of complaint received in connection with construction activities, together with details of any remedial actions carried out;
- It is the responsibility of the contractor at all times to demonstrate full compliance with the dust control conditions herein;
- At all times, the procedures put in place will be strictly monitored and assessed.

The dust minimisation measures shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practise and procedures. In the event of dust nuisance occurring outside the site boundary, site activities will be reviewed and satisfactory procedures implemented to rectify the problem. Specific dust control measures to be employed are described in the sections below.

Site Roads

Site roads (particularly unpaved roads) can be a significant source of fugitive dust from construction sites if control measures are not in place. The most effective means of suppressing dust emissions from unpaved roads is to apply speed restrictions. Studies show that these measures can have a control efficiency ranging from 25 to 80%[30]. The following mitigation measures shall be employed for site roads:

- A speed restriction of 20 km/hr will be applied as an effective control measure for dust for on-site vehicles using unpaved haul roads;
- Access gates to the site shall be located at least 10m from sensitive receptors where possible;
- Bowsers or equivalent watering equipment will be available during periods of dry weather throughout the construction period. Research has found that watering can reduce dust emissions by 50%. Watering shall be conducted during sustained dry periods to ensure that unpaved areas are kept moist. The required application frequency will vary according to soil type, weather conditions and vehicular use;
- Any hard surface roads will be swept to remove mud and aggregate materials from their surface while any unsurfaced roads shall be restricted to essential site traffic only.

Land Clearing / Earth Moving

Land clearing / earth-moving works during periods of high winds and dry weather conditions can be a significant source of dust. The following mitigation measures shall be employed for land clearing or earth moving activities:

- During dry and windy periods, and when there is a likelihood of dust nuisance, watering shall be conducted to ensure the moisture content of materials being moved is high enough to increase the stability of the soil and thus suppress dust;
- During periods of very high winds (gales), construction activities likely to generate significant dust emissions should be postponed until the gale has subsided.

Storage Piles

The location and moisture content of storage piles are important factors which determine their potential for dust emissions. The following mitigation measures shall be employed for storage piles:

- Overburden material will be protected from exposure to wind by storing the material in sheltered regions of the site. Where possible storage piles should be located downwind of sensitive receptors;
- Regular watering will take place to ensure the moisture content is high enough to increase the stability of the soil and thus suppress dust. The regular watering of stockpiles has been found to have an 80% control efficiency[31];
- Where feasible, hoarding will be erected around site boundaries to reduce visual impact. However, this will also have an added benefit of preventing larger particles from impacting on nearby sensitive receptors.

Site Traffic on Public Roads

Spillage and blow-off of debris, aggregates and fine material onto public roads shall be reduced to a minimum by employing the following measures:

- Vehicles delivering or collecting material with potential for dust emissions shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust;

- If feasible, a wheel wash facility shall be installed at the main construction traffic exits. All trucks leaving the site must pass through the wheel wash;
- Public roads outside the site shall be regularly inspected for cleanliness, as a minimum on a daily basis, and cleaned as necessary.

Dust Monitoring

It is recommended that dust deposition monitoring be put in place to ensure dust mitigation measures are adequately controlling emissions. Dust monitoring should be conducted using the Bergerhoff method in accordance with the requirements of the German Standard VDI 2119. The Bergerhoff Gauge consists of a collecting vessel and a stand with a protecting gauge. The collecting vessel is secured to the stand with the opening of the collecting vessel located approximately 2m above ground level. The TA Luft limit value is 350 mg/(m^2*day) during the monitoring period which is between 28 - 32 days.

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Appendix 9A RGD EIAR Acoustic Glossary

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Appendix 9A

Glossary of Acoustic Terminology

ambient noise	The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.
background noise	The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ($L_{AF90,T}$).
broadband	Sounds that contain energy distributed across a wide range of frequencies.
dB	Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 µPa).
dB L_{pA}	An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Hertz (Hz)	The unit of sound frequency in cycles per second.
$L_{Aeq,T}$	This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).
L_{AFN}	The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.
L_{AFmax}	is the instantaneous slow time weighted maximum sound level measured during the sample period (usually referred to in relation to construction noise levels).
L_{AF90}	Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.
noise	Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a person exposed to it, or any sound that could cause actual physiological harm to a person exposed to it, or physical damage to any structure exposed to it, is known as noise.
noise sensitive receptor	NSR – Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or

	other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.
octave band	A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.
sound power level	The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1 pW) per m^2 where: $$Lw = 10Log\frac{P}{P_0}\ \text{dB}$$ Where: p is the rms value of sound power in pascals; and P_0 is 1 pW.
sound pressure level	The sound pressure level at a point is defined as: $$Lp = 20Log\frac{P}{P_0}\ \text{dB}$$
1/3 octave analysis	Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one–third of an octave each.

Appendix 9B RGD EIAR Noise & Vibration

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A9.1 Construction Noise & Vibration Mitigation

A9.1.1 Liaison with the Neighbours

The Contractor should be proactive in engaging with the occupants of neighbouring properties and should notify them of any works forecast to generate appreciable levels of noise, explaining the nature and duration of the works.

A designated noise liaison should be appointed by the contractor for the duration of the construction works. This person should log any issues and follow up in a prompt fashion.

A9.1.2 Noise & Vibration Monitoring

The following ongoing noise monitoring programme is recommended for the site in relation to demolition and construction activities.

Noise Monitoring Terminals, number and locations to be agreed, to be installed with the following specifications (or similar approved):

- Logging of two concurrent periods, e.g. 15-minute & hourly;
- Daily CIC automated calibrations;
- E-mail alert on threshold exceedance;
- E-mail alert on low battery and low memory;
- Remote access to measured data, and;
- Live display of noise levels.

Vibration monitoring stations should continually log vibration levels using the Peak Particle Velocity parameter (PPV, mm/s) in the X, Y and Z directions, in accordance *with BS ISO 4866: 2010: Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures*.

The mounting of the transducer to the vibrating structure will need to comply with *BS ISO 5348: 1998: Mechanical vibration and shock – Mechanical mounting of accelerometers*. In summary, the following ideal mounting conditions apply:

- The transducer and its mountings should be as rigid as possible;
- The mounting surfaces should be as clean and flat as possible;
- Simple symmetric mountings are best, and;
- The mass of the mounting should be small in comparison to that of the structure under test.

The monitoring equipment should be set to monitor vibration in 5 minute periods. Noise and vibration data should be downloaded and reviewed on a fortnightly basis.

In addition, it is recommended that spot check noise & vibration measurements are conducted on a monthly basis. These spot checks can be organized to coincide with works that have potential to generate high levels of noise or vibration on site in order to confirm the potential extent of impact.

A monthly Noise & Vibration Monitoring Report should be prepared by the contractor. Reports should identify any exceedances above nominal limit values and attempts to clarify the causes etc. Where remedial measures are required and identifiable these should also be clearly stated.

A9.1.3 Noise Control Audits

It is recommended that noise control audits be conducted at regular intervals throughout the demolition/construction programme. In the first instance, it is recommended that such audits take place on a monthly basis. This is subject to review, however, and the frequency of audits may be increased if deemed necessary.

The purpose of the audits will be to ensure that all appropriate steps are being taken to control construction noise emissions. To this end, consideration should be given to issues such as the following (note that this list is not intended to be exhaustive):

- Hours of operation being correctly observed;
- Opportunities for noise control "at source";
- Optimum siting of plant items;
- Plant items being left to run unnecessarily;
- Correct use of proprietary noise control measures;
- Materials handling;
- Poor maintenance, and;
- Correct use of screening provided and opportunities for provision of additional screening.

A9.1.4 Hours of Work

Construction activity will mostly take place during daytime hours Monday to Friday and a half day on Saturdays. In the event of it being deemed necessary to undertake works outside these, it will be necessary to obtain prior written approval from Dublin City Council. Such approval would typically only be granted on submission of details of the activity accompanied by an assessment of potential noise impact.

Consideration should be given to the scheduling of activities in a manner that reflects the location of the site and the nature of neighbouring properties. Each potentially noisy event/activity should be considered on its individual merits and scheduled according to its noise level, proximity to sensitive locations and possible options for noise control.

Depending on the noise emission levels experienced and associated noise impact, the contractor should be flexible and able to conduct certain works at hours which reflect periods when the neighbouring properties have lower sensitivities to noise.

A9.1.5 Selection of Quiet Plant

Careful consideration must be given to the noise emission levels of plant items when they are being considered for use on the site. This practice is recommended in relation to sites with static plant such as compressors and generators. It is recommended that these units be supplied with manufacturers' proprietary acoustic enclosures where possible. The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item should be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action should be to identify whether or not said item can be replaced with a quieter alternative.

A9.1.6 Control of Noise Sources

If the use of low noise plant or replacing a noisy item of plant are not viable or practicable options, consideration should be given to noise control "at source". This refers to the modification of an item of plant or the application of improved sound reduction methods, often in consultation with the supplier. For example, resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can often be controlled by fixing resilient materials in between the surfaces in contact.

BS 5228-1:2009+A1:2014 states that "*as far as reasonably practicable sources of significant noise should be enclosed*". In applying this guidance, constraints such as mobility, ventilation, access and safety must be taken into account. Items suitable for enclosure include pumps and generators. Demountable enclosures that could be moved around site as necessary may also be used to screen operatives using hand tools such as angle grinders.

In practice, a balance may need to be struck between the use of all available techniques and the resulting costs of doing so. It is therefore proposed to adopt the concept of "*Best Available Techniques*". Best Available Techniques is defined as follows in EC Directive 96/61:

> '"*...the most effective and advanced stage in the development of an activity and its methods of operation which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission limit values designed to prevent or eliminate or, where that is not practicable, generally to reduce an emission and its impact on the environment as a whole.*"

In this context "*best*" means "*the most effective in achieving a high general level of protection of the environment as a whole*".

The expression "*available techniques*" means "*those techniques developed on a scale which allows implementation…., under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the operator carrying on the activity*".

The term "*techniques*" includes "*both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned*".

In specifying or otherwise determining Best Available Techniques, consideration should be given to a specified list of considerations and also to "*the likely costs and advantages of measures*" as well as "*the principles of precaution and prevention*".

Thus, the concept of Best Available Techniques requires a degree of balance between the attainment of environmental benefits and the likely cost implications. In the identification of Best Available Techniques, regard should be had to a wide range of factors, however, emphasis should be given to "*practical suitability*" and the need "*to reduce an emission and its impact on the environment as a whole*".

Proposed techniques should also be evaluated in light of their potential effect on occupational health and safety.

BS 5228-1:2009+A1:2014 makes a number of recommendations in relation to "*use and siting of equipment*". These are relevant and hence are reproduced below. These recommendations should be implemented on the site.

> *"Plant should always be used in accordance with manufacturers' instructions. Care should be taken to site equipment away from noise-sensitive areas. Where possible, loading and unloading should also be carried out away from such areas.*
>
> *Circumstances can arise when night-time working is unavoidable. Bearing in mind the special constraints under which such work has to be carried out, steps should be taken to minimise disturbance to occupants of nearby premises.*
>
> *Machines such as cranes that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum. Machines should not be left running unnecessarily, as this can be noisy and waste energy.*
>
> *Plant known to emit noise strongly in one direction should, when possible, be orientated so that the noise is directed away from noise-sensitive areas. Attendant operators of the plant can also benefit from this acoustical phenomenon by sheltering, when possible, in the area with reduced noise levels.*
>
> *Acoustic covers to engines should be kept closed when the engines are in use and idling. The use of compressors that have effective acoustic enclosures and are designed to operate when their access panels are closed is recommended.*
>
> *Materials should be lowered whenever practicable and should not be dropped. The surfaces on to which the materials are being moved could be covered by resilient material."*

We would also offer the following outline guidance in relation to specific considerations.

- For mobile plant items such as cranes, dump trucks, excavators and loaders, the installation of an acoustic exhaust and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10dB. Mobile plant should be switched off when not in use and not left idling.

- For piling plant, noise reduction can be achieved by enclosing the driving system in an acoustic shroud. For steady continuous noise, such as that generated by diesel engines, it may be possible to reduce the noise emitted by fitting a more effective exhaust silencer system or utilising an acoustic canopy to replace the normal engine cover.
- For percussive tools such as pneumatic concrete breakers, rock drills and tools a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensuring any leaks in the air lines are sealed. Erect localised screens around breaker or drill bit when in operation in close proximity to noise sensitive boundaries.
- For concrete mixers, control measures should be employed during cleaning to ensure no impulsive hammering is undertaken at the mixer drum.
- For all materials handling ensure that materials are not dropped from excessive heights and drop chutes/dump trucks are lined with resilient materials.
- For compressors, generators and pumps, these can be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation.
- Demountable enclosures can also be used to screen operatives using hand tools and may be moved around site as necessary.
- All items of plant should be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures.

A9.1.7 Screening

The use of screens can be effective in reducing the noise level at a receiver location and should be employed as a complementary measure to all other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen and its position relative to both the source and receiver. The height and length of any screen should, where practicable, be such that there is no direct line of sight between the source and the receiver.

BS 5228-1:2009+A1:2014 states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the screen should be such that there are no gaps or openings at joints in the screen material. In most practical situations the effectiveness of the screen is limited by the sound transmission over the barrier rather than the transmission through the barrier itself. Screens constructed of materials with a surface mass greater than 10kg/m^2 typically offer adequate sound insulation performance.

Annex B of *BS 5228-1:2009+A1:2014* (Figures B1, B2 and B3) provide typical details for temporary and mobile acoustic screens, sheds and enclosures that can be constructed on site from standard materials. *BS 5228-1:2009+A1:2014* Figure B2 is included here for information purposes.

Figure A9.1: Typical acoustic screen/shed detail

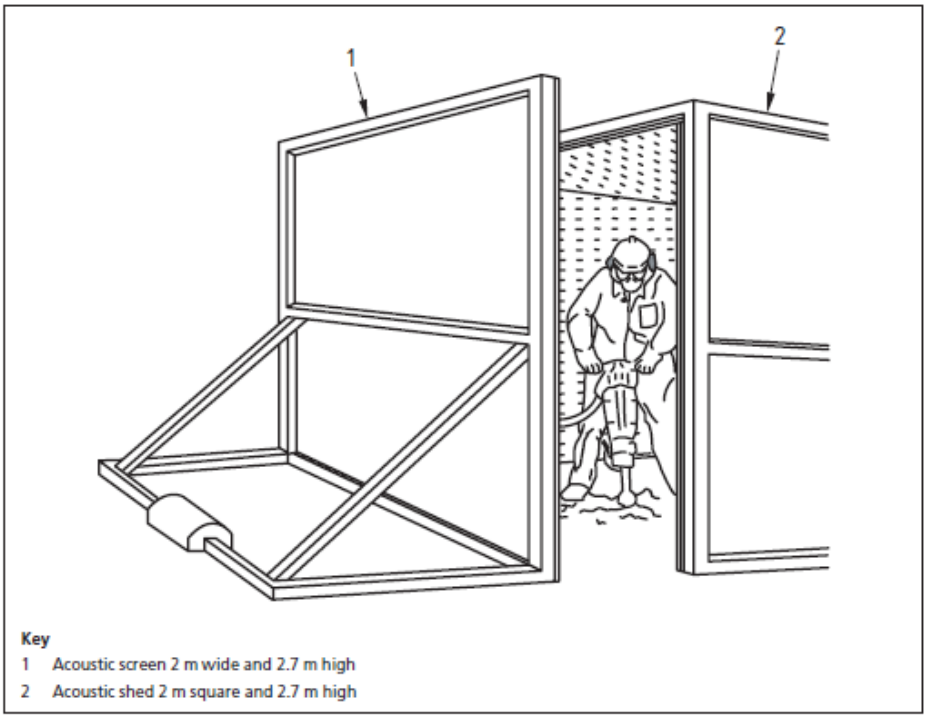

Table B.4 **Measured sound reduction given by types of partial enclosure**

Type of enclosure (see Figure B.3)	Reduction dB(A)		
	Facing the opening(s)	Sideways	Facing rear of shed
Open-sided shed lined with absorbent material; no screen	1	9	14
Open-sided shed lined with absorbent material; with reflecting screen in front	10	6	8
Open-sided shed lined with absorbent material; with absorbent screen in front	10	10	10

A9.1.8 Vibration

The vibration from construction activities will be limited to the values set out within Section 9 of the EIAR, Volume 4. It should be noted that these limits are not absolute, but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Limit values have been provided for the following building types:

- Soundly constructed residential and commercial properties;

- Protected structures and sensitive buildings such as those with no or minimal foundations, and;
- Clinical buildings.
- It is understood that bored piling is to be used in this instance which is a piling method which generates relatively low levels of vibration. Notwithstanding this considerations should be given to the following methods to further mitigate the vibration levels,
- Minimise obstructions between the vibration source and the sensitive receiver, e.g. old basement floors, old foundations etc., which exacerbate the transmission of vibration;
- Reduce the resistance to bored piles by "mudding in". This technique involves lubricating the borehole with a small amount of bentonite slurry.

A9.1.9 Piling

Piling is the construction activity which is most likely to cause disturbance. General guidance in relation to piling is outlined in the following paragraphs.

Piling programmes should be arranged so as to control the amount of disturbance in noise and vibration sensitive areas at times that are considered of greatest sensitivity. If piling works are in progress on a site at the same time as other works of construction or demolition that themselves may generate significant noise and vibration, the working programme should be phased so as to prevent unacceptable disturbance at any time.

During consultation the planner, developer, architect and engineer, as well as the local authority, should be made aware of the proposed method of working of the piling contractor. The piling contractor should in turn have evaluated any practicable and more acceptable alternatives that would economically achieve, in the given ground conditions, equivalent structural results.

It should be remembered that a decision regarding the type of pile to be used on a site will normally be governed by such criteria as loads to be carried, strata to be penetrated and the economics of the system, for example the time it will take to complete the installation and other associated operations such as soil removal. It may not be possible for technical reasons to replace a noisy process by one of the 'quieter piling' alternatives. Even if it is possible, the adoption of a quieter method may prolong the piling operation; the net result being that the overall disturbance to the community will not necessarily be reduced.

On typical piling sites the major sources of noise are essentially mobile and the noise received at any control points will therefore vary from day to day as work proceeds. The duration of piling works is usually short in relation to the length of construction work as a whole, and the amount of time spent working near to noise sensitive areas can represent only a part of the piling period.

Noise reduction can be achieved by enclosing the driving system in an acoustic shroud. For steady continuous noise, such as that generated by diesel engines, it may be possible to reduce the noise emitted by fitting a more effective exhaust silencer system or utilising an acoustic canopy to replace the normal engine cover.

Screening by barriers and hoardings is less effective than total enclosure but can be a useful adjunct to other noise control measures. For maximum benefit, screens should be close either to the source of noise (as with stationary plant) or to the listener. Removal of a direct line of sight between source and listener can be advantageous both physically and psychologically. In certain types of piling works there will be ancillary mechanical plant and equipment that may be stationary, in which case, care should be taken in location, having due regard also for access routes. When appropriate, screens or enclosures should be provided for such equipment.

Contributions to the total site noise can also be anticipated from mobile ancillary equipment, such as handling cranes, dumpers, front end loaders etc. These machines may only have to work intermittently, and when safety permits, their engines should be switched off (or during short breaks from duty reduced to idling speed) when not in use.

All mechanical plant should be well maintained throughout the duration of the piling works. When a site is in a residential environment, lorries should not arrive at or depart from the site at times incontinent to residents.

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Appendix 10A RGD EIAR Odour Contours

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Appendix 10A

Sensitivity Assessment

The odour assessment presents predicted results which were considered appropriate and most representative of the study area and proposed development. In accordance with the recommendations in the Environment Protection Agency AG4 guidance, several sensitivity studies were undertaken to demonstrate the potential impact of using alternative input data. The sensitivity assessment consisted of individually changing specific parameters of one of the dispersion modelling scenarios used in the assessment.

From the suggested possible sensitivity studies detailed within the AG4 guidance document the following were considered appropriate for this assessment.

- Meteorological Data – Consideration of a second nearby meteorological station
- Terrain - Consideration of the model run with and without terrain
- Building Downwash - Consideration of the model run with and without building downwash
- Surface parameters – Use an alternative value, suggested value of 1m

Table 10A.1 details the parameters considered and identifies the variances in predicted odour concentrations when applied to the 2011 'with development' scenario.

Table 10A-1: Calculated Odour Emission Rates – Do-Nothing Scenario – Point Sources

Parameter	Odour Concentration at Worst Case Receptor (ouE/m3)*	Change from Scenario Considered in Assessment (ouE/m3)*
Model used in Assessment	0.97	-
Removal of Terrain	1.03	+0.06
Removal of all Buildings	0.72	-0.24
Surface Roughness at 1m for whole study area	0.83	-0.13
Use of 2011 Casement Meteorological Data	0.68	-0.29

* as the 98th percentile of hourly averages.

The sensitivity assessment has shown that consideration of alternative assessment criteria could result in different odour concentrations at receptor locations. The largest variations were observed when removing buildings from the model or use of the alternative metrological data. Variations between different meteorological sites are expected. The removal of buildings is likely to reduce predicted odour concentrations in the near field as the impact of building downwash or early grounding of the plume would be removed. As these assumptions result in a reduction in predicted concentrations, it is considered that the modelled assessment is conservative.

Removal of terrain from the dispersion model resulted in a small increase in the predicted odour concentration at the worst affected receptor. The magnitude of change, calculated to be 0.06 $ou_E.m^{-3}$, as the 98th percentile of hourly averages, was small and unlikely to have a significant impact on the assessment conclusions.

It was considered that inclusion of, buildings, terrain, meteorological data from Dublin Airport and use of surface roughness representing the study area within the model would provide results which were more representative of site specific conditions.

All of the sensitivity studies showed that the adopted odour annoyance criterion of $3.0ou_E.m^{-3}$ as the 98th percentile of hourly averages was not predicted to be exceeded at any receptor location. In accordance with the EPA AG4 guidance, as the results of the sensitivity assessment are well below the relevant assessment level, no further consideration of input parameters was considered necessary.

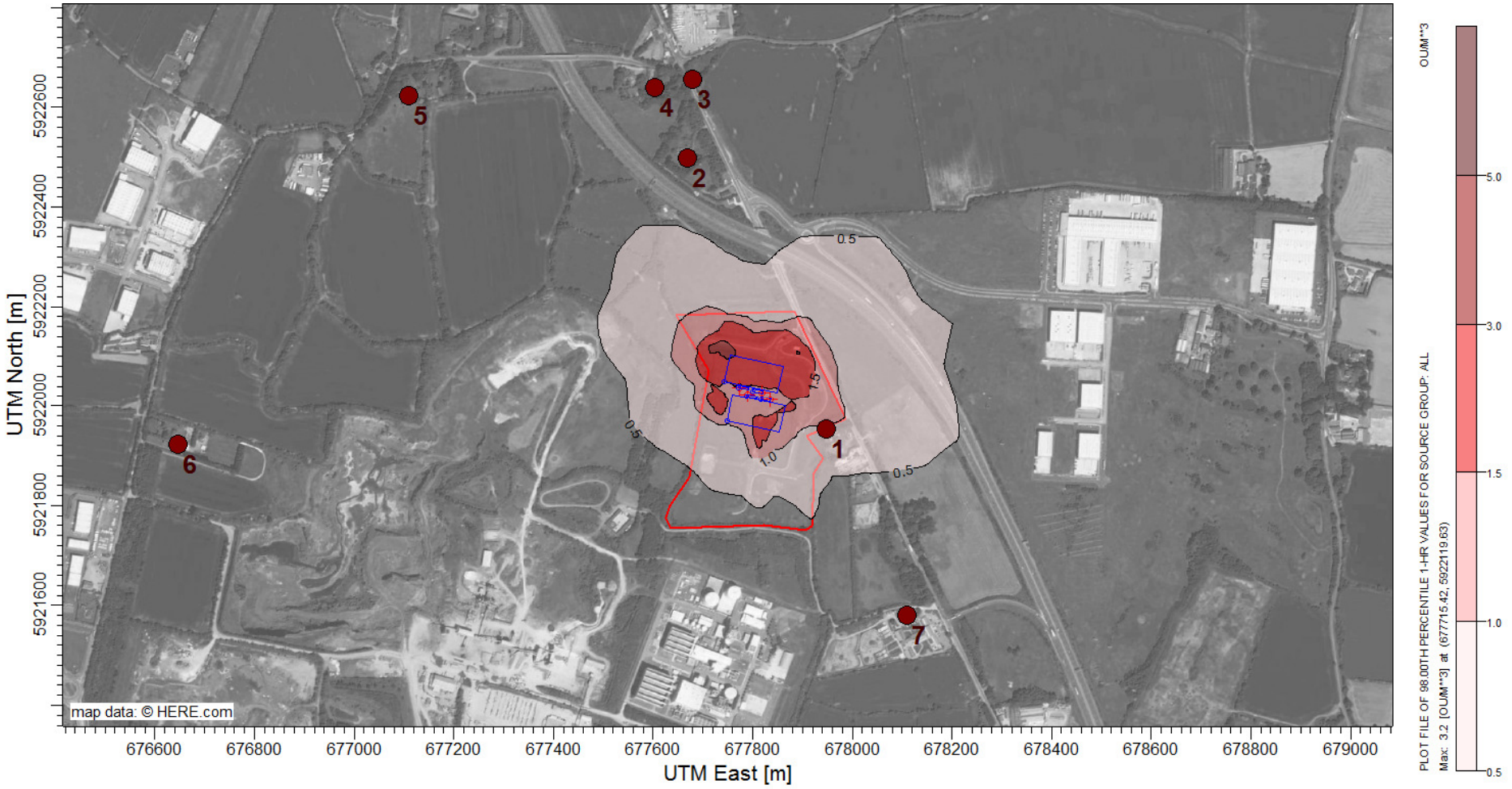

Figure 1: Predicted Odour Concentration – 'RBSF' Scenario, 17.5m stack - 2011 Meteorological Data (ou_E/m^3 as the 98th Percentile of Hourly Averages)

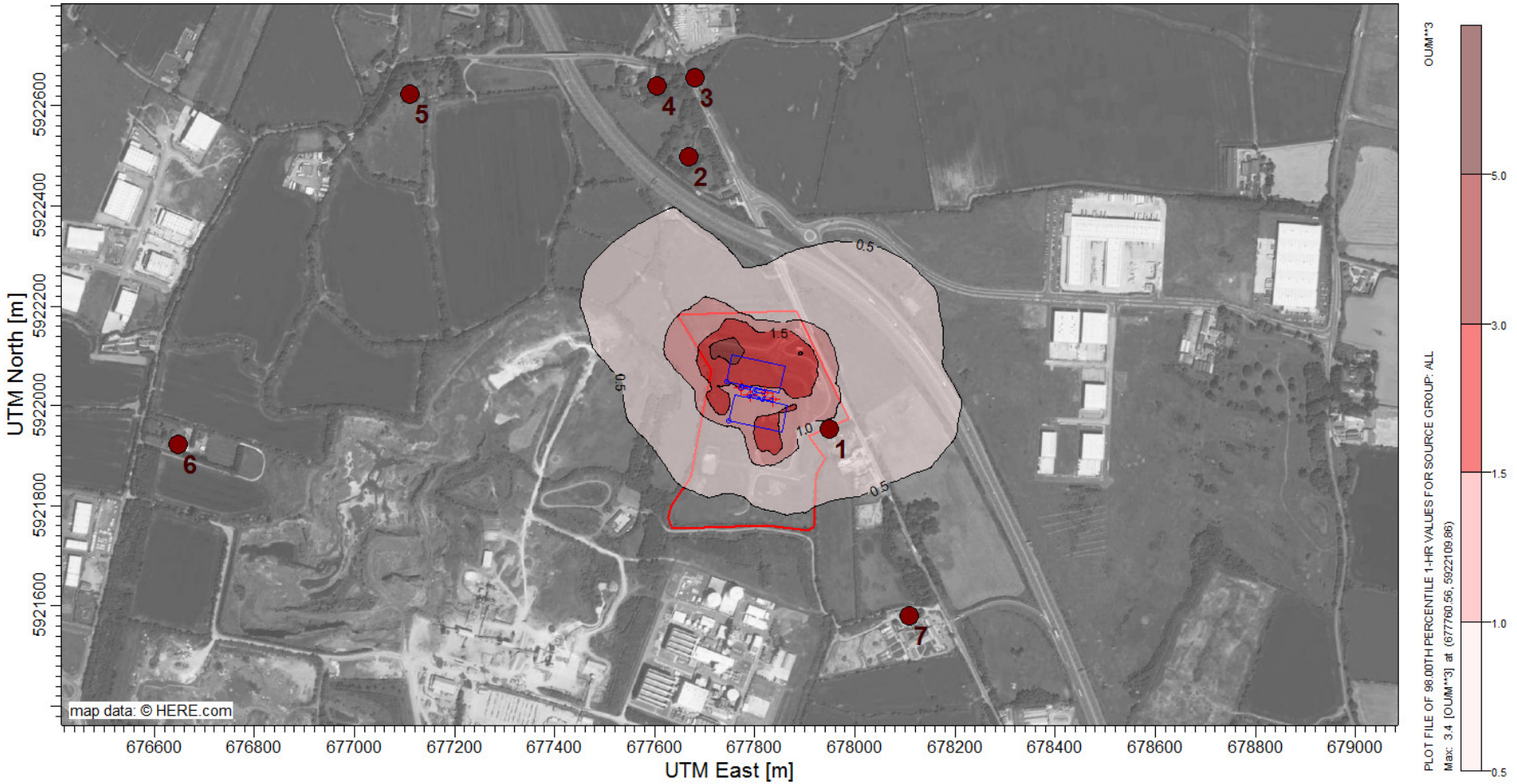

Figure 2: Predicted Odour Concentration – 'RBSF' Scenario, 17.5m stack - 2012 Meteorological Data (ou_E/m^3 as the 98th Percentile of Hourly Averages)

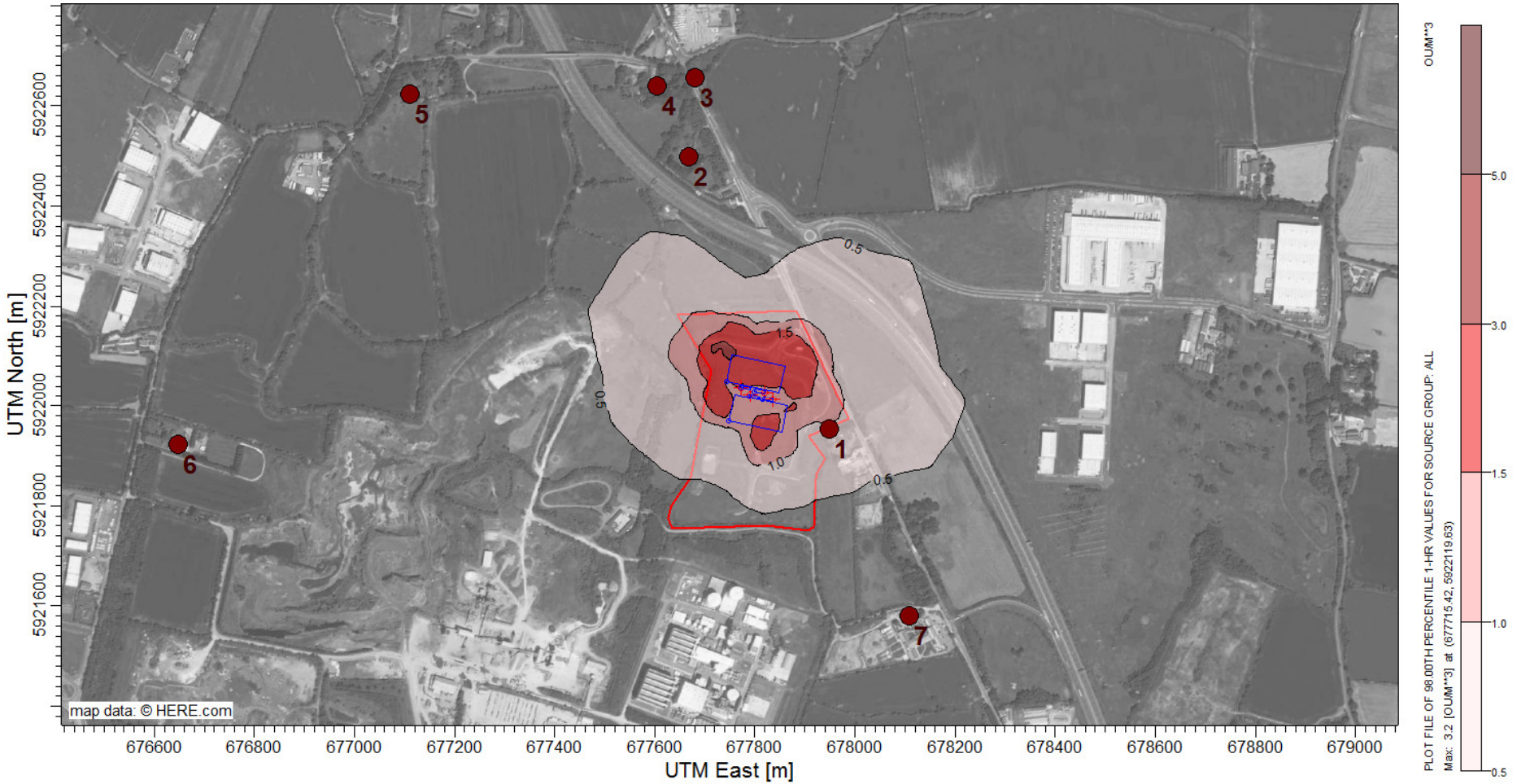

Figure 3: Predicted Odour Concentration – 'RBSF' Scenario, 17.5m stack - 2013 Meteorological Data (ou_E/m^3 as the 98th Percentile of Hourly Averages)

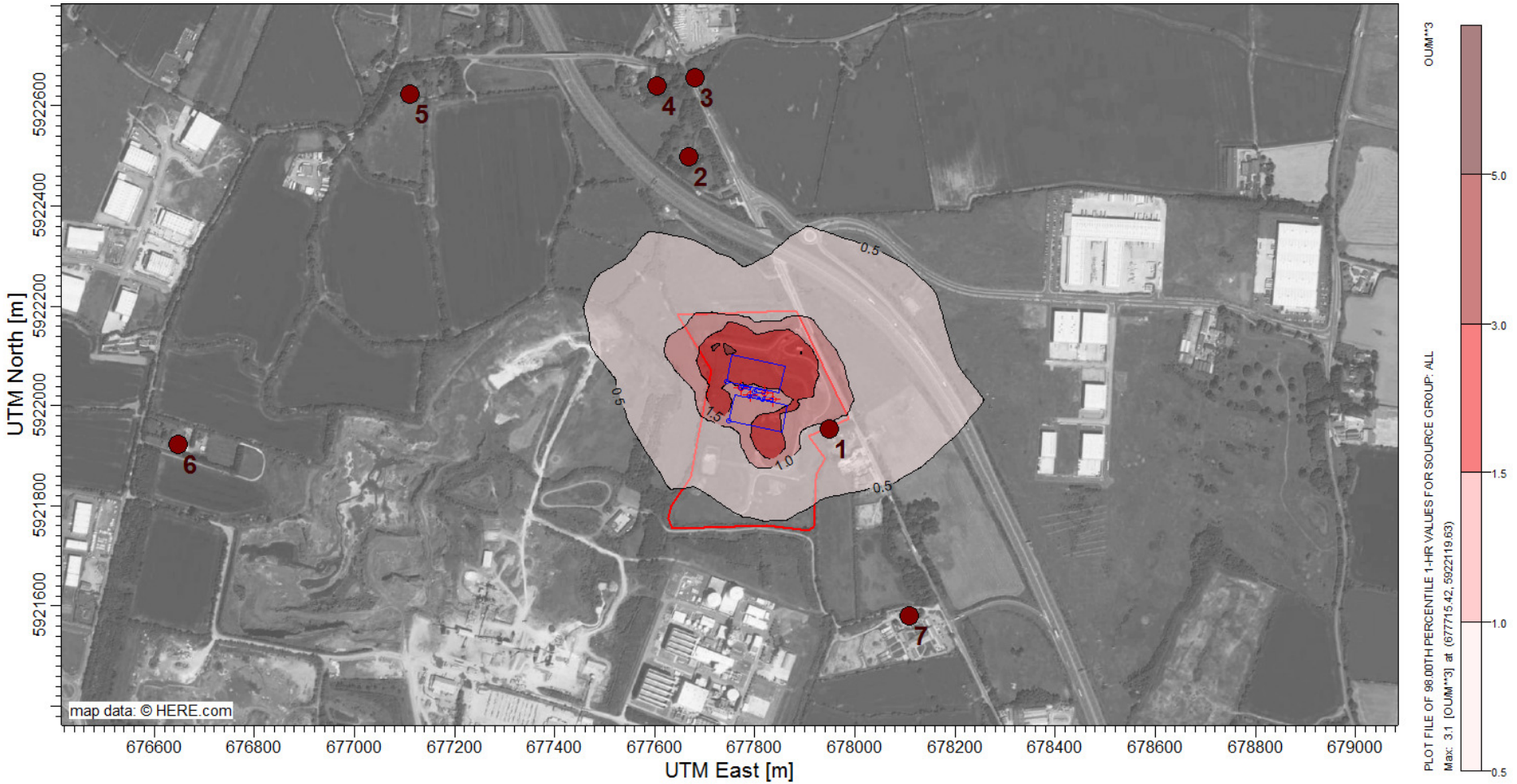

Figure 4: Predicted Odour Concentration – 'RBSF' Scenario, 17.5m stack - 2014 Meteorological Data (ou_E/m^3 as the 98th Percentile of Hourly Averages)

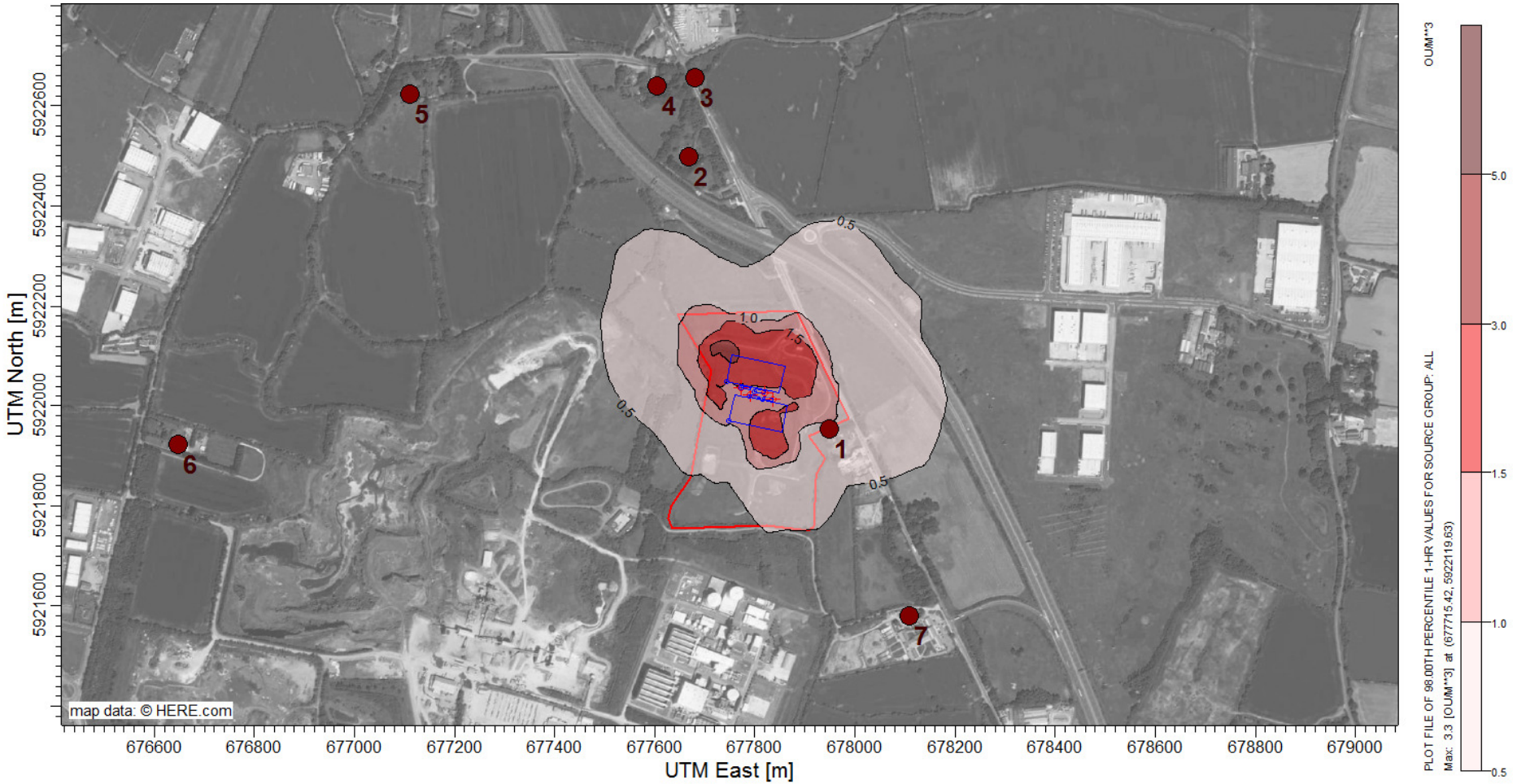

Figure 5: Predicted Odour Concentration – 'RBSF' Scenario, 17.5m stack - 2015 Meteorological Data (ou_E/m^3 as the 98th Percentile of Hourly Averages)

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Appendix 11A RGD EIAR Record Monuments

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APPENDIX 11A

Record Monuments in the study area

DU014-00601- Newtown Ringfort Site Possible

Located on wasteland within the Dublin Airport Logistics Park. Previously a golf course. A series of aerial photographs taken after site destruction (BDR 27, BDQ 65, BGM, 70, AVS 38, 37) shows detailed cropmark evidence for two distinct building phases on the site. A roughly circular enclosure (diam. c. 45m) with field system attached to the west appears to pre-date the ringfort (DU014-006001-) levelled in 1953.

DU014-00602- Newtown Ringfort Site Possible

Located on wasteland within the Dublin Airport Logistics Park. Previously a golf course. A series of aerial photographs taken after site destruction (BDR 27, BDQ 65, BGM, 70, AVS 38, 37) shows detailed cropmark evidence for two distinct building phases on the site. A roughly circular enclosure (diam. c. 45m) with field system attached to the west appears to pre-date the ringfort (DU014-006001-) levelled in 1953.

DU014-007--- Newtown Ringfort Site Possible

Situated on a slight rise in a large open field of tillage. An oval-shaped, single-ditched enclosure (max. dims. L 33m; Wth. 30m) appears as a cropmark on a Cambridge aerial photograph (CUCAP, BGM 68). Visible on Bing (Viewed 22 January 2015). Entrance to the east. Not visible at ground level.

DU014-012--- Kilshane Ecclesiastical remains

This ecclesiastical site is marked on the Ordnance Survey 1st Ed. Map 1837 as Church Field, Old burying ground and Church Well. All but the well location are situated in a quarry void.

DU014-01201- Kilshane Church Possible Site

On the 1st edition OS 6-inch (1842) there is a field named 'Church Field' and an area identified as the 'Old Burying Ground' outlined in the N end of the same field. Other than this placename there is no supporting documentary evidence for a church at this location. The area has been extensively quarried. Not visible at ground level.

DU014-01202- Kilshane Burial ground

On the 1st edition OS 6-inch map (1842) there is an area identified as the 'Old Burying Ground' outlined in the N end of this field. The area has been extensively quarried. Not visible at ground level.

DU014-01203- Kilshane Holy Well Possible Site

The 1st edition OS 6-inch map (1842) marks the site 'Church Well'. In 1958 it was being used for domestic purposes and not considered to be a holy well. It has been removed by quarrying.

DU014-0013--- Newtown Motte and Bailey Site

Situated in a field next to the N2. Prior to its destruction in 1952 this site comprised a circular platform (diam. 28m; H 3m) which was enclosed around the base by a wide fosse. This flat-topped platform was further enclosed by an oval earthwork or bailey (dims. 100m E-W; 70m N-S; NMI IA 245/1952). The site is visible as a soilmark on an aerial photograph taken in 1971 (FSI 2.4154/4) and on colour vertical

photograph (OS 8/Flight 31, 7616). A cropmark showing oval enclosure with the faint traces of a smaller oval enclosure within is visible on digital globe aerial view created on the 9 June 2016

DU014-015--- Coldwinters Ring-ditch Site

Located in pasture (formerly the green of a golf course) between the Dublin-Ashbourne Road and the N2. A circular cropmark (diam. c. 15m) visible on an aerial photograph (CUCAP, BDQ 66). Not visible at ground level.

DU014-016--- Coldwinters Enclosure Site

An aerial photograph (CUCAP, BDQ 66) shows cropmark evidence for a circular, single-ditched enclosure (diam. c. 45m). It had been truncated by field boundaries in the east and was formerly incorporated into a golf course. The site was subject to test excavation (Licence no. 05E0236) but not identified. Not visible at ground level.

DU014-048--- Kilshane Cemetery

Topsoil removal prior to construction of a gas pipeline in 1988 exposed the remains of several skeletons. The follow-up excavations revealed 123 skeletons, many of whom were children and adolescents. These were aligned roughly east-west in the Christian manner, many haphazardly placed. Some of the individuals had stones around and under the heads. The presence of 'pillowstones' may indicate an 9th-13th-century date for the site.

DU014-053--- Newtown Enclosure Site Possible

Enigmatic enclosures are evident in aerial photograph (GSI 161-2). The evidence has been re-assessed and these are likely to be fungus rings rather than man-made features.

Appendix 11B RGD EIAR SMR Sites

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Appendix 11B

Sites in the Sites and Monuments Record

DU014-097--- Newtown Ringfort

Aerial photograph (GB89. L.04) shows cropmark of a circular enclosure defined by a fosse. This is probably a ploughed-out ringfort. Just one of four monuments within this large open field behind Newtown Caroline. No visible remains.

DU014-0100--- Newtown Ring-ditch

Aerial photograph (GB90. BY.03) shows cropmark of a ring-ditch. Circular ring-ditch visible on Bing Maps (accessed 30/10/13). Just one of four monuments within this large open field behind "Newtown Caroline".

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Appendix 11C RGD EIAR Archaeological Investigations

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Appendix 11C

Archaeological Investigations Carried Out in the Study Area

NEWTOWN: Site of motte and Bailey: SMR 14:13: 01E1214

In November 2001 seven test pits were monitored in connection with the pre-development works for a proposed waste recycling facility in the townland of Newtown, Kilshane, Co. Dublin. No artefacts or features of archaeological significance were identified during the monitoring (Rooney 2001).

NEWTOWN: Site of motte and Bailey: SMR 14:13: 01E1214 ext

An archaeological assessment of a proposed waste recycling facility in the townland of Newtown, Kilshane, Co. Dublin, found that one monument, the site of a possible motte and bailey, was located within its boundary. The site was inspected in 1952 by a representative from the National Museum of Ireland, prior to its demolition as part of a land project scheme. The monument was recorded as a circular platform 28m in diameter and 3m in height. The base of the flat-topped platform was enclosed by a wide ditch, which was in turn enclosed by an oval earthwork (100m by 70m). At present the site is only visible as a soil-mark on aerial photographs. The test excavation consisted of the machine excavation of nineteen test trenches in July – August 2002 that were set across the entire application area. None of the trenches produced any significant archaeological features. The area tested had undergone large scale land improvement and was crossed by numerous field drains. The archaeological assessment report recommended a buffer zone to the monument and that recommendation has been followed by the current development proposal. Monitoring of ground disturbance at the site was recommended by the assessment (Fitzpatrick 2002).

TEST AREA 1, COLDWINTERS: No archaeological significance 02E1353 ext.

The excavation of engineering test-pits on the N2 Road Improvement Scheme was monitored in September and October 2003. No archaeological features were exposed.

COLDWINTERS: No archaeological significance: 03E1450

This work was undertaken as part of a programme of testing, ahead of the construction of the N2 Road Improvement Scheme. A single oval pit, measuring 0.9m by 0.4m by 0.13m deep (maximum), was uncovered.

COLDWINTERS / NEWTOWN: Prehistoric/medieval: 05E0236

Test excavation (Licence no. 05E0236) of ringfort DU014-006001- was undertaken in advance of the industrial park development. A strategy of open area testing was adopted to find the extent of remains. A total of 33 features were identified including human remain, pits, postholes, stakeholes, hearths and large ditch features. The testing confirmed the presence of large ditches illustrated on the OS maps in the form of two enclosing ditches and a bank between. The burials, aligned east-west, are located to the north-east quadrant of the ditches cut into its fill indicating a later deposition. The burials and eastern quadrant of the site was preserved in situ under the carpark of DHL. The western quadrant of the ringfort was covered in terram and stone. Now within wasteland. Drop of c.1m down to stone. No indication of significance of the site.

HUNTSTOWN: No archaeological significance: 31064 23986: 01E1108

A monitoring brief was undertaken in advance of the expansion of an existing quarry at Huntstown, Finglas, Co. Dublin. The area of topsoil-stripping was c. 10–12 acres. Nothing of archaeological significance was noted throughout all subsurface works within the development area.

BROWNSBARN- KILSHANE Bord Gáis Éireann Pipeline: Various 00E0043

Monitoring of topsoil construction for the southern section of the new North-Eastern Pipeline 3 was carried out in mid-2000. In the townland of Mitchelstown two modern metalled surfaces were revealed. A shallow charcoal-rich pit was found to the north of this.

KILSHANE: Neolithic segmented enclosure: Early Bronze Age activity 311000 242900: 03E1359 ext.

This excavation was undertaken as part of the archaeological mitigation in advance of the N2 Road Improvement Scheme. Site 5a: The earliest activity is defined by the construction and infilling of a large ditched enclosure dating to mid-Neolithic times. It had maximum external dimensions of 45m northwest/south-east by 34m. The enclosure was almost egg-shaped, coming to a notable point (the 'apex') in the north. The ditch had been excavated in a series of interconnecting regular and irregular segments. Once the initial natural slumping and silting in the base of the ditch began, a large volume of animal bone was deposited around the full circumference of the ditch. The bone assemblage, consisting of 60-70 individual cattle, is the largest Neolithic bone assemblage from an excavated context (Finbar McCormick, pers comm.).

The cattle bone was placed in both a disarticulated and articulated state with apparent selection of certain bones, such as vertebra or long bones, to be deposited together. A further series of infillings took place, culminating in the placement of pottery within the ditch. This consisted of a large mid-Neolithic broad-rimmed, round bottomed vessel, which appears to have been deliberately placed on top of this sealing deposit in the south-eastern portion of the ditch. Other fragmentary pieces of ceramic material were recovered from just above the bone layer in the north-western section of the enclosure ditch and these also may prove, using thin section analysis, to be Neolithic. The enclosure then appears to have been abandoned for a considerable period.

The next phase of major activity at the site occurs in the Early to Middle Bronze Age, with the deposition within the ditch of a relatively uniform deposit of orange sandy clay. This appears to have been deliberately placed into the ditch around its full circumference, possibly to seal the earlier (Neolithic) activity. The deposition of the orange clay appears to have been immediately preceded by deposition of charcoal / wood lenses, especially in the western portion of the enclosure.

The next phase of activity at Site 5a occurs during the Early Bronze Age. This activity consists primarily of a series of deposits and features associated with the later stages of the main enclosure ditch and a series of cut features, some of which, based on ceramic associations, may date to the Earlier Bronze Age.

During the course of the excavation of the interior of the main enclosure, a number of features were uncovered which gave the impression of having been cleaned out (sterilised) in antiquity. Several appear to have been pits for probable unprotected cremations, with much of the cremation deposits (and the putative pots into which they were placed) having been 'cleaned out' of the pits as the material was deposited into the ditch.

The only intact burial was that of a single crouched inhumation, located south of the centre point of the enclosure. The burial was orientated east-west in a shallow oval pit with no evident grave goods. It was in an extremely degraded condition due to the nature of preservation. The grave might have been tampered with, which may account for the lack of grave goods.

A further series of rather irregular features was also encountered within the interior of the enclosure and these consisted of irregularly shaped pits, which contained small amounts of charcoal and occasionally burnt bone and pottery. The pottery recovered appeared to date to the Early Bronze Age. Only one feature, a hearth, represents activity later in the Bronze Age.

KILSHANE: No archaeological significance: Various (centred on c. 115 424) 04E1191

The diversion of two gas pipelines by Bord Gáis was monitored over two and a half weeks in August and September 2004. The removal of topsoil and excavation of the pipeline trenches were supervised and no archaeological features or artefacts were uncovered.

NEWTOWN: Burnt spread: 31155 24233: 03E1450 ext.

The site (Site 1) was excavated as part of the archaeological mitigation in advance of the N2 Road Improvement Scheme between 6 and 20 April 2004. Excavation was carried out in two separate areas separated by c. 15m. Area 1 measured c. 20m by 13m and contained the remains of a spread of burnt-mound material, measuring 3.5m by c. 10m with an average depth of 0.15m, which was located adjacent to and south of a natural waterlogged peat basin. This basin measured c. 15m east-west and extended beyond the limit of excavation to the north. Two pits and a sub-circular trough containing heat-shattered stones and charcoal-rich deposits were excavated in the vicinity of the burnt spread. No archaeological finds were encountered during the excavation. Within the peat basin a large number of preserved timbers were encountered. While most of the wood consisted of natural brushwood and branch material, two large split roundwood logs were positioned roughly parallel to each other. Although no evidence of woodworking was apparent, it cannot be ruled out that they may have been deliberately deposited within the basin to serve as an artificial subdivision, possibly contemporary with the burnt spread.

Area 2, c. 15m to the north of Area 1, covered an area measuring in total 24m2. The only archaeological feature encountered here was a small and shallow isolated deposit of burnt-mound material. No finds were recovered. The proximity and nature of this deposit could indicate that it was contemporary with the burnt-mound material in Area 1.

KILSHANE: Christian Cemetery: 0106431.

This site lies on flat, low lying land about half a mile to the west of the N2.

The Remains: The site was discovered when topsoil removal uncovered the remains of several skeletons and areas of disturbed bone. Excavation revealed the remains of 123 individuals, many of whom were children and adolescents. There was no enclosing element, though a linear ditch which appeared to be an old field boundary was revealed at the north of the excavated area. No historic references have yet been found for this site but a more detailed study of the documentary sources may yield some information on it.

The Burials: Burial occurred on a c.21m stretch of the pipeline corridor and only on the western side of the area excavated (which was an 8m wide strip running beneath the spoil heap of topsoil). Burial probably extended beyond the western limit of the pipeline corridor. The area to the east was

intensively trenched and no further burials were located. There was thus a dramatic density of burial in the small area excavated as many as 3-4 individuals (one on top of the other in places).

While the burials were aligned east-west, in the Christian mode, the burial alignment was far more haphazard than had been noted on the other sites investigated during the same pipeline campaign. Some of the bodies appeared to have been buried either in rigor mortis or in a very hurried manner, as some were crouched, folded or lying to one or other side and there appeared to be little regard in many cases for the position of the hands. The remains of at least ten infants / young children occurred among those excavated.

In general, the bone was remarkably well preserved, even in the case of the infants. This may indicate that the cemetery is of relatively recent date, perhaps dating back to the Famine Period. However, the presence of stones around and under the heads of some individuals, and the presence of 'pillowstones' may indicate a rather earlier date for the site.

Other Features: Two, apparently agricultural, ditches/drains were revealed, one to the south and one to the north of the excavated area. The fill of the northernmost feature, a linear ditch 5m wide where excavated (crossed diagonally) and 1m deep, which crossed the pipeline corridor in a north west/south east direction, contained animal bone and shell. This feature appeared to be an old field boundary or open drain and could be traced as a depression crossing the field through which the pipeline corridor passed in this area. The second feature, a land drain 1m wide with a fill of stones at the base, ran north/south at the eastern limit of the site, lying outside the burial area.

Finds: The only finds retrieved were a plain blue glass bead and a fragment of a large tanged iron knife of relatively modern appearance.

Appendix 14A RGD EIAR Photomontages

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PHOTOMONTAGES

for

Project No. 6194
RINGSEND STW
Regional Biosolids Storage Facility

for

Client: JB Barry

Date: 10 May 2018
Document Number: RP02

Brady Shipman Martin
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BSM Est. 1968
Brady Shipman Martin.
Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

CONTENTS AMENDMENT RECORD

This report has been issued and amended as follows:

REVISION	DESCRIPTION	DATE	PREPARED BY	CHECKED BY
00	View Location Map and 7no. of Draft Options Photomontages	03 October 2017	BP	JK
01	4 no of Photomontages developed further	26 October 2017	BP	JK
02	Revision to all Photomontages	11 January 2018	BP	JK
03	Revision to 3 Photomontages	17 January 2018	BP	JK
04	Update to Figure descriptions	09 March 2018	BP	JK
05	Update to 4 Photomontages	10 May 2018	JK	JK

PHOTOMONTAGE TABLE OF CONTENT

Day:	03	26	11	17	09	10												
Month:	10	10	01	01	03	05												
Year:	17	17	18	18	18	18												
FIGURE NUMBER	**REVISION**																	
1.0	00	00	00	00	00	00												
1.1.1	00	00	00	00	00	00												
1.1.2	00	00	02	02	02	02												
1.2.1	00	00	00	00	00	00												
1.2.2	00	01	02	02	02	04												
1.2.3		01																
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1.4.3		01																
1.5.1	00	00	00	00	00	00												
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1.5.3		01																
1.6.1	00	00	00	00	00	00												
1.6.2	00	00	02	02	02	02												
1.7.1	00	00	00	00	00	00												
1.7.2	00	00	02	02	02	02												

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Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

Figure: 1.0 View Location Map

Rev: 00

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.1.1 **Rev: 00**

View 1 from footbridge over N2/M50 Interchange
As Existing

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

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Figure: 1.1.2 **Rev: 02**

View 1 from footbridge over N2/M50 Interchange
As Proposed (Outline)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

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Figure: 1.2.1 **Rev: 00**

View 2 from North Road (R135) southeast of the Site
As Existing

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

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Figure: 1.2.2 **Rev: 04**

View 2 from North Road (R135) southeast of the Site
As Proposed

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.3.1 **Rev: 00**

View 3 from North Road (R135) east of the Site
As Existing

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

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Figure: 1.3.2 **Rev: 04**

View 3 from North Road (R135) east of the Site
As Proposed

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Project Number:	6194	Document Number:	RP02	Revision:	05
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Figure: 1.4.1 **Rev: 00**

View 4 from North Road (R135) north of the Site entrance
As Existing

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

					ANGLE OF VISION / LENS FOCAL LENGTH				
< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm		70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.4.2 **Rev: 04**

View 4 from North Road (R135) north of the Site entrance
As Proposed

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

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Figure: 1.5.1 **Rev: 00**

View 5 from N2 bridge over R135
As Existing

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.5.2 **Rev: 04**

View 5 from N2 bridge over R135
As Proposed

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.6.1 **Rev: 00**

View 6 from Kilshane Road (L3120) bridge over N2

As Existing

BSM Brady Shipman Martin. Built. Environment. Est. 1968

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.6.2 **Rev: 02**

View 6 from Kilshane Road (L3120) bridge over N2
As Proposed

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

					ANGLE OF VISION / LENS FOCAL LENGTH				
< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm		70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.7.1 **Rev: 00**

View 7 Newtown Cottages (L7231)
As Existing

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	6194	Document Number:	RP02	Revision:	05
Project Name:	RINGSEND STW, Regional Biosolids Storage Facility	Document Title:	PHOTOMONTAGES	Date:	10 May 2018

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: 1.7.2 **Rev: 02**

View 7 Newtown Cottages (L7231)
As Proposed (Outline)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

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Appendix 14B RGD EIAR Glint and Glare

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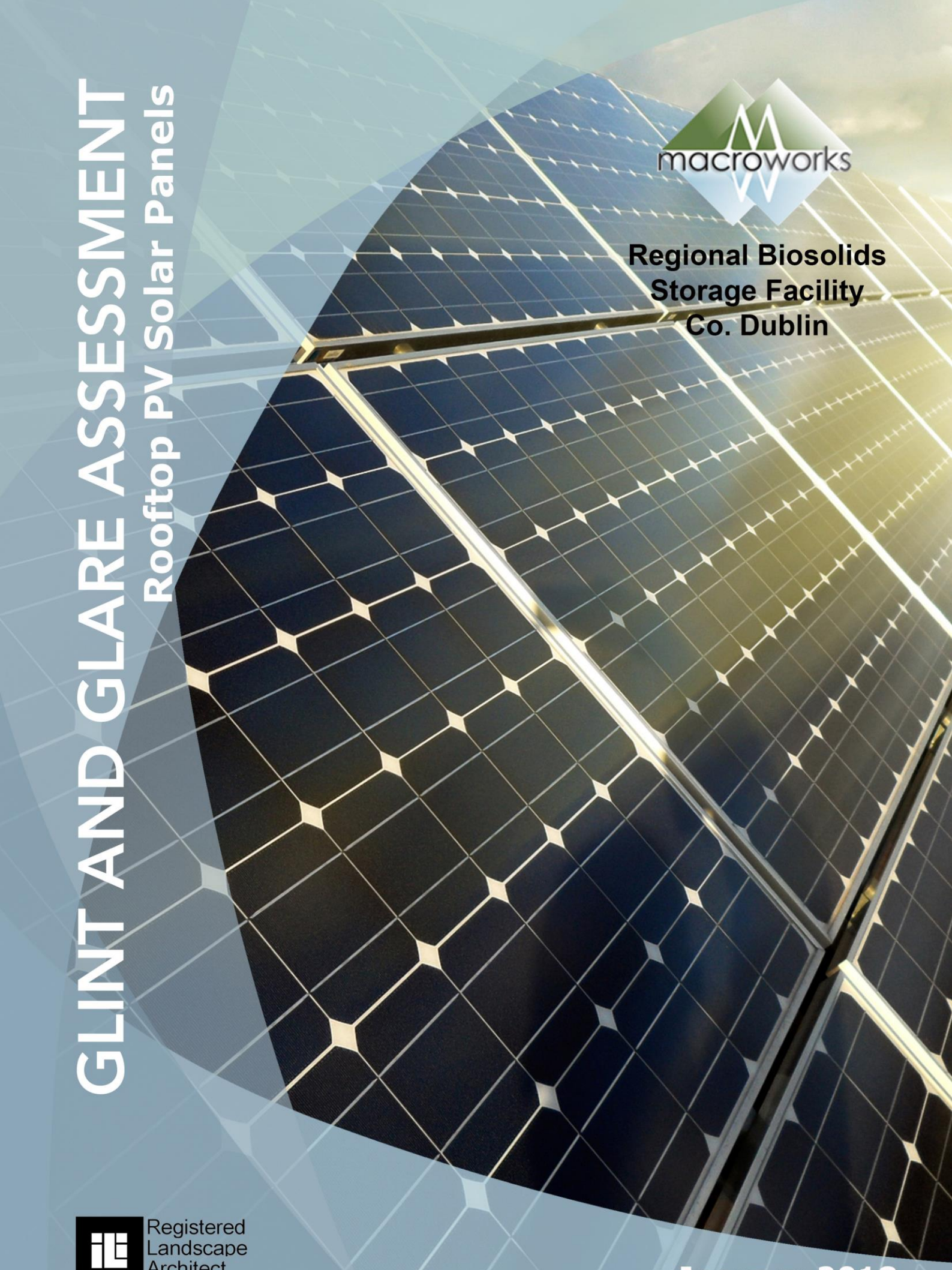
GLINT AND GLARE ASSESSMENT

Rooftop PV Solar Panels



macroworks

Regional Biosolids Storage Facility Co. Dublin

Registered Landscape Architect 2017-2018

January 2018

Executive Summary

The proposed Regional Biosolids Storage Facility (RBSF), located adjacent to the R135 at Newtown, Dublin 11, shall include a roof mounted PV solar installation on one of the two storage buildings. This study aims to determine whether this installation will have any glint and glare impact upon surrounding houses, routes and the aviation activities at the nearby Dublin Airport.

Based on an in depth analysis of receptors in the landscape (dwellings and routes) surrounding the proposed development and from the aviation receptors as recommended by the Federal Aviation Authority (FAA) technical guidance, we can determine no reason to suggest that there will be any adverse impacts from the solar development at Newtown as proposed.

Introduction

Macro Works Ltd. was commissioned by J.B. Barry and Partners Ltd to prepare this glint and glare report for a proposed roof top PV Solar Installation at RBSF, to accompany the engineers design report, as part of the overall planning application.

Macro Works' relevant experience includes nineteen years of analysing the visual effects of a wide range of infrastructural and commercial development types. These include numerous solar farms and wind farms, both domestic and international. Macro Works has developed Ireland's only Glint and Glare analysis software (MWGG) in conjunction with the National University of Ireland, (NUI) Maynooth. This has been deployed for the glint and glare analysis of over 60 solar farms to date.

The receptors (features of interest) typically assessed for glint and glare for this scale of PV solar installation include residential buildings, routes (road and rail) and aviation activities. In this instance, special attention has been given to the N2 National Route located to the north and east of the site, and also to the aviation receptors of Dublin Airport, located just over 2km to the east.

Guidance

While there is a requirement by certain local authorities to assess the potential for glint and glare from proposed PV developments, there is no guidance in Ireland as yet to specifically address how or under what circumstances this should be undertaken for ground-based receptors (residential dwellings or routes) surrounding such a proposal. Despite the UK's more established solar industry it too equally lacks such guidance, however, as it has been the subject of greater debate, Macro Works has drawn from accepted practices there.

Guidelines have been prepared by the Federal Aviation Authority (FAA) to address the safety concerns of siting solar PV installations in close proximity to airports. These guidelines coupled with the FAA-endorsed Solar Glare Hazard Analysis Tool (SGHAT) are commonly regarded as the accepted industry standard by aviation authorities internationally when considering the glint and glare effects upon aviation-related receptors. Both the Irish Aviation Authority (IAA) and the Dublin Airport Authority (DAA) defer to these guidelines and the use of SGHAT for proposed PV installations in Ireland.

The IAA requires the referral to it of all solar PV development submissions within 10km of an approved airport or aerodrome. As of August 2017, the DAA has specifically expanded this extent for both Dublin Airport and Cork Airport to a radius of 15km.

Analysis Software

SGHAT

The Solar Glare Hazard Analysis Tool (SGHAT) produced by Sandia National Laboratories in the US is endorsed by the Federal Aviation Authority (FAA) and is commonly regarded as the accepted industry standard by aviation authorities internationally when considering the glint and glare effects upon aviation related receptors.

> *"As of the date of publication (23rd Oct 2013) of this interim policy, the FAA requires the use of the SGHAT to demonstrate compliance with the standards for measuring ocular impact stated above for any proposed solar energy system located on a federally-obligated airport. The SGHAT is a validated tool specifically designed to measure glare according to the Solar Glare Hazard Analysis Plot."*

The tool is described as follows:

> *"This tool determines when and where solar glare can occur throughout the year from a user-specified PV array as viewed from user-prescribed observation points. The potential ocular impact from the observed glare is also determined ……"*

In preparing this assessment, Macro Works used the SGHAT for its analysis of aviation receptors.

The principal output from the SGHAT is a glare report per receptor that indicates the time of day and days per year that glare has the potential to occur. The plot is coloured according to the intensity of the glare per period and whether it is harmful to human vision (see Figure 2).

MWGG

The Macro Works' Glint and Glare analysis software program (MWGG) was developed by Macro Works Ltd in conjunction with the Dept. of Experimental Physics, NUI Maynooth. This collaboration has been ongoing for since early 2016 and continues to undergo updates and enhancements.

MWGG utilises the exact layout and panel parameters for a proposed development and accounts for the complex mutual screening of panels by other panels. Further, MWGG accepts complex Digital Surface Models allowing it to account for existing and enhanced screening proposals. Both circumstances can result in a significant reduction in the visibility and thus the potential for glare from particular ground-based receptor positions.

The MWGG process looks each receptor and analyses the solar reflection that occurs from each panel as the sun passes through its arc over the course of a day. This is measured for every minute of every day over the course of a year. The table and graphic outputs are similar in type to that of SGHAT. SGHAT is deferred to for solar intensity calculations.

MWGG has consistently and successfully replicated results from the FAA-approved SGHAT software (where parameters and terrains are equal) and has been utilised to assess the effects of glint and glare for more than 60 no. solar development sites throughout Ireland to date.

Due to limitations and inflexibility of the SGHAT at handling detailed development and terrain features (see Appendix E), Macro Works' MWGG has been used for all non-aviation ground-based receptors.

Development Description

The proposed installation occupies the southern rooftop portion of Storage Building A at the proposed RBSF at Newtown, Dublin 11. The facility provides treated sludge storage for the upgraded Ringsend Wastewater Treatment Plant (WwTP) and new Greater Dublin Drainage WwTP. The building rooftop is a large curved convex shape which measures approx. 107m x 60m and is approximately oriented along an east-west axis. It is proposed to install the PV panels flush to the roof on the south facing aspect (approx. 107m x 30m).

The building where the solar development is proposed is a part of a proposed large 2-building complex off the R135 just west of the N2 at Newtown/Kilshane. The area, characterized by industrial buildings and activity, is bounded by an extensive Roadstone quarry and processing plant to the south, the Northwest Business Park to the west and the Dublin Airport Logistics Park to the east. To the north, the land remains principally in arable agriculture. The site is presently bounded to the west, south and southeast by mature hedgerow vegetation. The N2 route to the east of the site follows a northwesterly direction from the M50 to Ashbourne and crosses above the R135 just to the north. As roadside planting has not fully established there are elevated perpendicular views from the N2 route across the site.

Methodology

Solar Development Layout

The proposed installation of roof mounted PV panels differs from a standard ground-based installation in that the building orientation guides the orientation of the panels (facing direction = 193 degrees from True North) and roof curvature guides the tilt of the panels (from 0.1º – 9.6º). Accounting for the roof curvature, the 'tilt' parameter is variable, increasing in value from the apex of the roof towards the eaves of the roof.

We have accounted for this variability by defining the roof as 9 arrays of panels (A – I) parallel to the roof apex ranging in tilt from 0.1 º – 9.6 º (see Figures 1 & 2). Note: As SGHAT analyses each row of panels separately it results in a lengthy report.

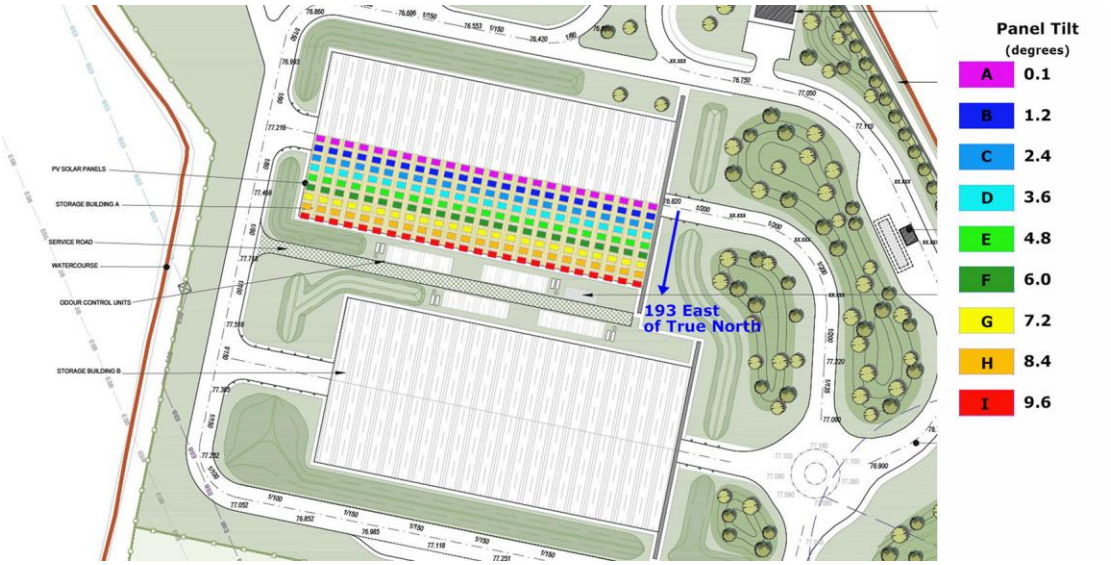


Figure 1: Orientation and tilt of the panel layout used to calculate glint and glare

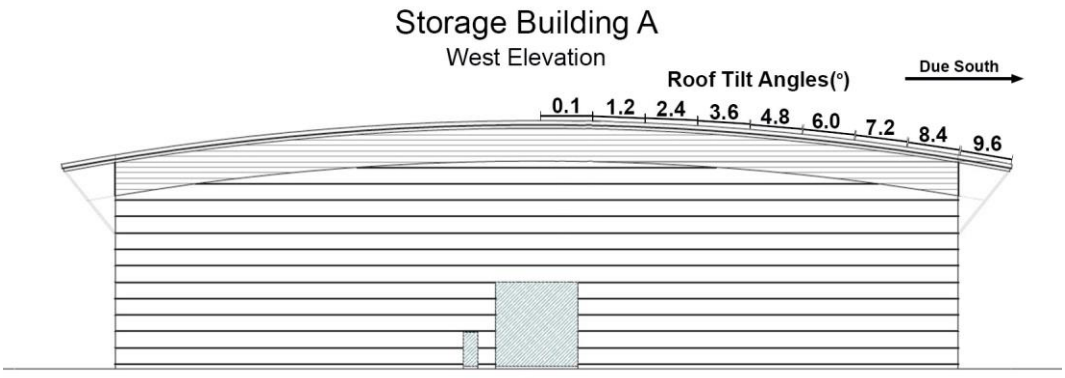


Figure 2: Tilt angles of the curved roof section of Storage Building A used to calculate glint and glare

Local Ground Receptors

In accordance with current best practice, the study area for receptors was defined by a 1.0km radius extent about the proposed PV installation. Digital Surface Model (DSM) data was procured for this area specifically for the purposes of carrying out glint and glare analysis. Such data depicts terrain as well as land cover and is particularly useful in accounting for landscape features that may have a screening effect – such as dwellings, vegetation and small undulations in landform. In this instance specifically, the DSM data had the added benefit of accurately depicting the profile and banking of the N2 route relative to the surrounding terrain. To further enhance the accuracy of the predicted results, the profile of the Storage Building B was carefully added to our surface model as this is likely to screen views of the proposed PV panels from areas to the south.

To identify those zones within the study area with the theoretical potential to be affected by glint and glare, an array of points was placed within the study area at 25m centres (25m x 25m). Each point was thoroughly tested using the MWGG for a full year of sun path reflectance (1-minute intervals).

Residential

All residential receptors and their building type (1 or 2 storey) within or in close proximity to the above zones were identified using the Eircode Geodirectory and verified by a site visit/survey. These are identified in Figure 3 below.

Figure 3: Residential receptors identified within 1km of the proposed solar PV development relative to the predicted glare pattern.

Houses H15 – H18 are located in close proximity to a small area predicted to be impacted by glare. The rear of these properties has been assessed individually for glare effects.

Routes

Taking account of the orientation of the roof section and the proposed PV panels, the routes of interest for assessment consideration are as follows:

(a) R135 immediately to the east of the site
(b) N2 (northbound only) to the east of the site (the orientation of the roof section renders the proposed solar PV development outside of the field of view for motorists travelling south).
(c) Elm Road, which links the N2 with the R122 to the east of the site.

Further to our initial general assessment of glint and glare, a secondary more thorough route specific assessment was carried out that concentrated on those route sections where glint and glare was predicted to be a theoretical possibility. For this exercise, 10 x receptor points were placed at 25m intervals along each of the identified route sections – one 250m section along the R135 and another 250m section along the N2-northbound.

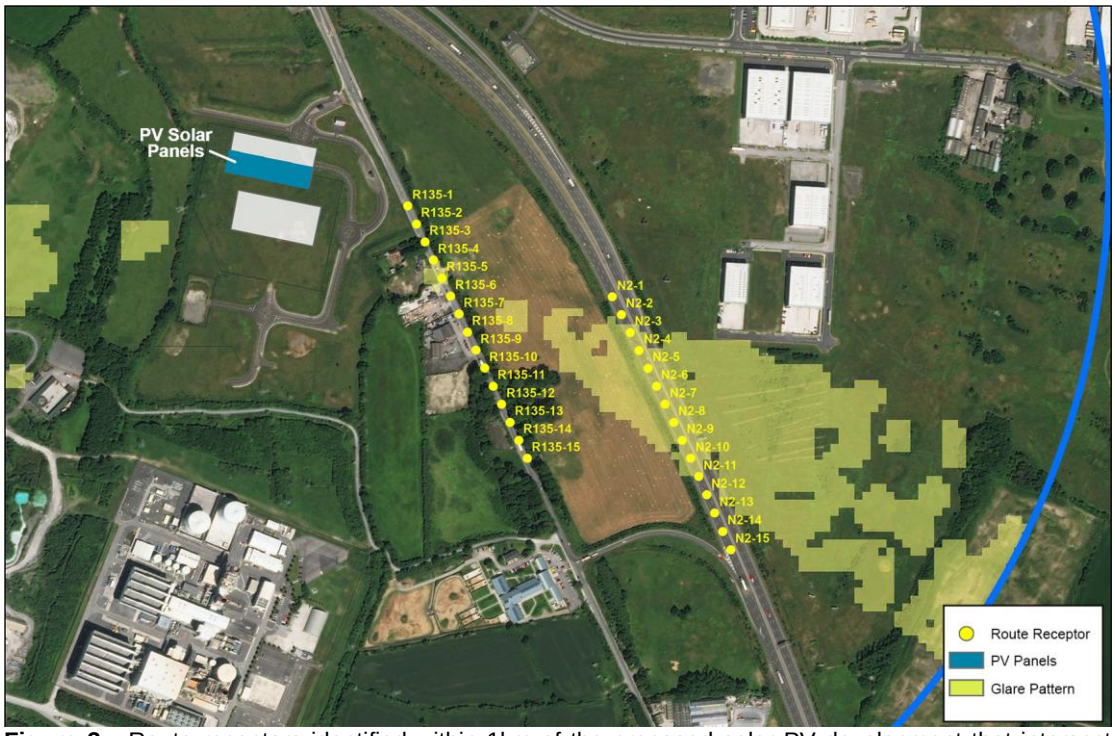


Figure 3: Route receptors identified within 1km of the proposed solar PV development that intersect with the predicted glare pattern.

To qualify the intensity of the reflected light that would be emitted from the solar PV panels during a period of reflectance, SGHAT analysis was carried out. The results provide us with a valid measure of the hazard level for motorists in instances where glare can be experienced.

Aviation Receptors

The Irish Aviation Authority (IAA) has indicated that all applications for PV solar arrays within a 10km radius of an airport or aerodrome should be referred the authority review. Dublin Airport, located approximately 2.4kms to the east of the proposed installation, is the principal airport being considered in this assessment. Casement Aerodrome and Weston Airport located 14.5km and 12.5km to the southwest of the site respectively both fall outside of this threshold and will not be regarded further in this study.

Guided by the FAA *Technical Guidance for Evaluating Selected Solar Technologies on Airports* (2013), the IAA and DAA have requested appropriate glint and glare assessments to include for the following:

(a) Glare towards the 2 mile (3.2km) approach path for runways
(b) Glare towards any Air Traffic Control Towers (ATCTs)

Such assessment requires detailed analysis of the path of the sun throughout the year while also considering the specific position, size and angle of the solar panels relative to the following:

a) Size and position of the airport air traffic control towers (ATCTs)
b) Orientation of approach paths to runways of the airport

Using SGHAT as the analysis tool for aviation receptors it is important that the results confirm the following:

1. There can be no potential for any glint and glare episodes to affect any existing or planned Airport Traffic Control Tower (ATCT) cab, and
2. No potential for glare of type that will result in 'temporary after-image' or 'permanent eye damage' (shown in yellow and red respectively in Figure X) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.

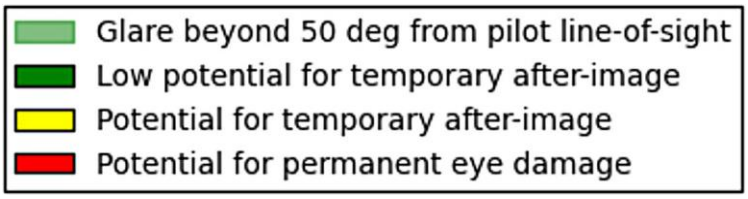


Figure 2: Glare report – hazard intensity legend

Note that the glare type *'Low potential for temporary after-image'* is acceptable for approaching aircraft. It is not acceptable, however, for ATCTs.

Dublin Airport

Located approx 45 º – 85 º due NNE of proposed site
2.4 kms from proposed site to closest runway (Runway 10 Threshold)
4.2 kms from proposed site to new permitted ATCT

Dublin Airport is an international airport operated by the DAA. It is located approx. 10km north of Dublin in Collinstown, Fingal. It hosts 2 operational runways 10/28 and 16/34 as detailed in Figure 2. A 3rd runway is planned to the north (Reg. Ref. SID/01/09 / ABP PI06FPA0014) to help accommodate increasing passenger numbers that will run parallel to runway 10/28 to the south. This will render the 16/34 runway as a purely taxiing runway when operational.

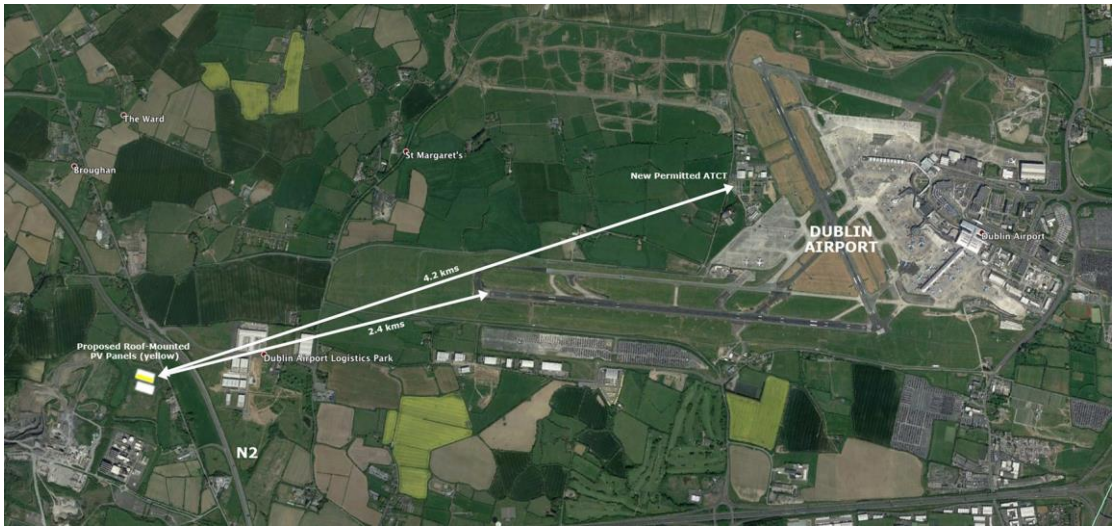


Figure 3: Location of the proposed roof-mounted PV solar panels relative to Dublin Airport

A new taller control tower was recently granted planning by ABP (Reg. Ref 04/1755 ABP PL06F217429) to cater for greater traffic volumes and allow for visibility of the new runway to the north, which would be screened from the smaller tower by airport buildings when built.

Runway Approaches

All 6 runway approaches were tested for Glint and Glare effects using the SGHAT. This includes the recently proposed northern runway (approach 10L and 28R).

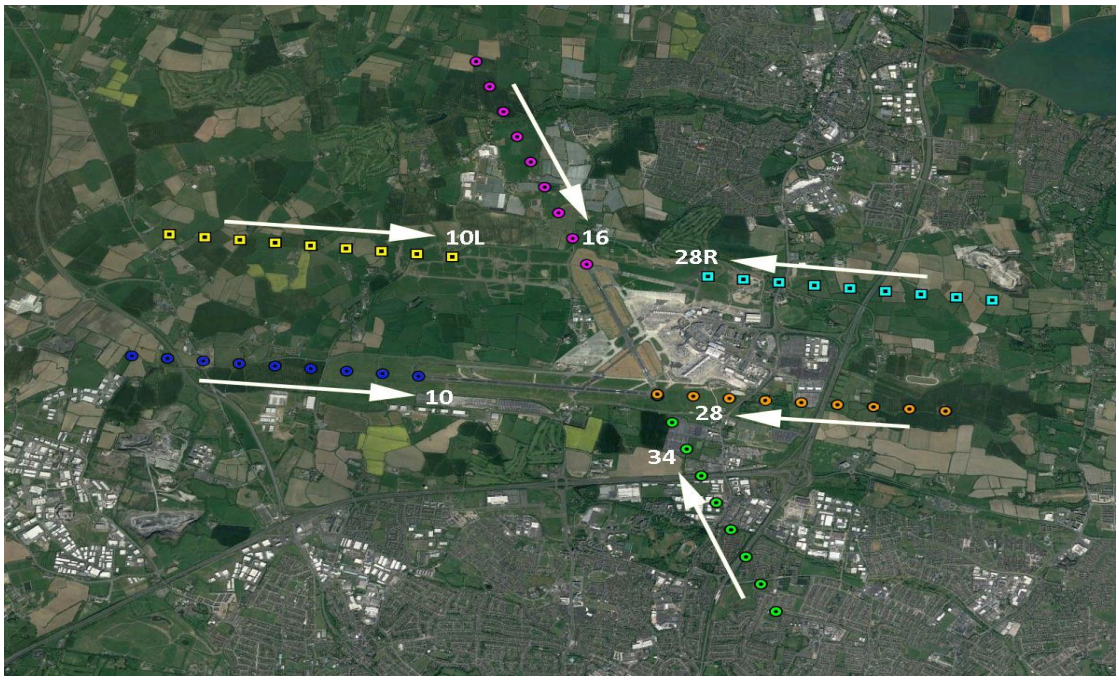


Figure 4: 2 mile approach lines to runways at Dublin Airport (at ¼ mile intervals) as assessed by SGHAT. Includes the proposed northern runways 10L and 28R.

Air Traffic Control Towers (ATCT)

Dublin airport currently has a control tower to the west of the main terminal buildings. This has viewing height of 21.9m.

The recently permitted more modern tower is due to be built in conjunction with the new proposed northern runway, by 2020. This is considerably taller with a viewing height of 75.6m and is situated close by to the west of the existing tower.

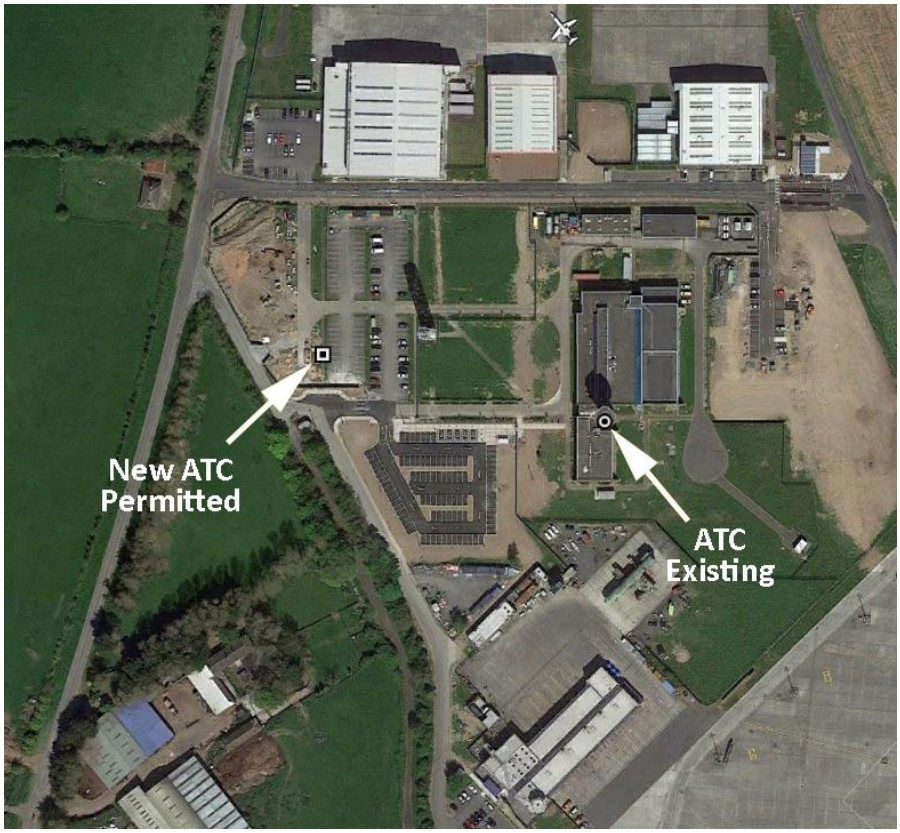


Figure 5: Air Traffic Control Towers (existing and newly permitted)

Results

Residential

Due to the elevation and orientation of the roof section to be developed with PV panels, those residences to the north of the roof apex line have no possibility of a view and thus cannot be affected by glint and glare. Through a combination of roof elevation, roof orientation and screening by the second of the 2 proposed storage buildings – the calculations have determined that none of the residences to the south have any potential to be affected by episodes of glint and glare.

Houses **H15 – H18**, located close to a zone of potential glare were specifically assessed for the effects of glare. Representative points placed immediately to the rear of each property indicate that there is no potential for any glare episode to occur (see Appendix A)

Routes

Our secondary route-specific assessment yielded a similar, albeit more precise pattern of glare impact to our initial assessment of the overall study area. Of the 20 route receptors assessed (see Appendix B) just one (1) of the receptors on the R135 (R135-5) and eight (8) of the receptors along the N2 (N2-3 – N2-9 and N2-11) were identified as having the theoretical potential to experience glare.

R135: The single point on the R135 that is predicted to be impacted by glare, has the potential to be effected for a total of 126 minutes across the months of June and July. This amounts to a maximum daily effect of 4 minutes (See Appendix B). Taking account of the roadside screening (buildings and vegetation) and assuming the typical speeds of cars (60kmph) travelling along this route, the experience of such glint effects will be momentary at worst, lasting no more than a couple of seconds. Given the light absorbing nature of modern PV panels coupled with their anti-reflective coating, this brief glint episode would be far less intense than that experienced from the glass of a building or an aluminium façade.

N2: Of the 8 points on the N2 (northbound) that are identified as being theoretically impacted by glare, all are subject to the screening afforded by the roadside mixed-species tree planting which is now approaching a leader height of 4-5m (this was not identified by the DSM as it was collected prior to the establishment of these trees). This visual barrier will be especially effective during the summer months in which glare is predicted to occur, this being the period when the foliage is flush and less visually porous. This screening effectively negates the glare episodes that are predicted to occur and will prove to be an even more effective barrier over time as the trees grow taller and the foliage becomes more dense.

In addition to the screening effect of the roadside planting, SGHAT analysis of these road points has revealed that the intensity of the glare (predicted as having the theoretical potential to impact the section of route) is of a type *'Low Potential for After-Image'*. This is acceptable by standards set by the FAA for pilots landing aircraft. It follows therefore, that such glare (located oblique to the direction of travel) should not pose any hazard of nuisance to motorists.

Further ameliorating factors include:

1. The panels causing glare are located at an angle approximately 40^{o} – 50^{o} to the left of the direction of travel. This is at the limit of the field of view of a motorist and should not present as a hazard or nuisance to normal driving.
2. At the times of day and year when these episodes are predicted to occur, the sun will be shining from the same direction and will be a far more intense source of light than the refection that it is causing.

Aviation

SGHAT analysis (see Appendix C) has identified the following:

1. There will be no glare experienced by either of the Air Traffic Control Towers (ATCTs), existing or permitted.
2. There will be no glare experienced by aircraft on their approaches to runways 10L (proposed) or 16 (existing).
3. There will be glint/glare experienced by aircraft on their approaches to existing runways 10, 28 and 34 and to the proposed northern runway 28R.

In each case the glint/glare identified will be of a type 'Low Potential to Cause After-Image (flash blindness)' which is acceptable by FAA standards.

Conclusion

From our detailed analysis of this proposed PV Solar development we can state with a high level of confidence that there will be no nuisance or hazard effect upon local residences or the routes running through the study area.

In respect of local residences, the elevated nature and orientation of the PV panels coupled with the screening effect of the adjacent second storage building that is proposed, all combine to limit the area that is potentially impacted by glare episodes. The low housing density of the predominantly industrial and agricultural landscape surrounding the development site results in no house being affected.

While the N2 falls within an area highlighted by the predicted glare pattern, the northbound roadside embankment planting will serve (increasingly) to screen motorists from any nuisance that this may result in. Any glare, should it be experienced through any gap in the vegetation, has been determined to be of a low intensity (far less than that experienced from other surfaces commonly found in this environment such as glass houses and aluminium roofing) and will not present any safety hazard to motorists. Note that any glare predicted for the southbound carriageway of the N2 will fall outside of the field of view of motorists and will not present any nuisance effect.

Further, while there is the potential for glare episodes to be visible from a number of the approach paths into Dublin Airport, they are predicted to be of an intensity that is within the threshold deemed acceptable to the FAA and the Irish aviation authorities. Neither of the Air Traffic Control Towers (existing or permitted) will be affected in any way by this development.

Appendices

Appendix A – Analysis of Dwelling Receptors

Appendix B – Analysis of Route Receptors

Appendix C – Analysis of Aviation Receptors (SGHAT)

Appendix D – Relevant FAA Guidance for Aviation Receptors

The US Federal Aviation Authority (FAA) published guidance in November 2010, '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'* which contains most comprehensive guidance available for the assessment of Glint and Glare on airports and aviation activity. This was updated with an interim policy in 2013, *'FAA Review of Solar Energy System Projects on Federally Obligated Airports'*.

Pertinent issues from this guidance document are listed below:

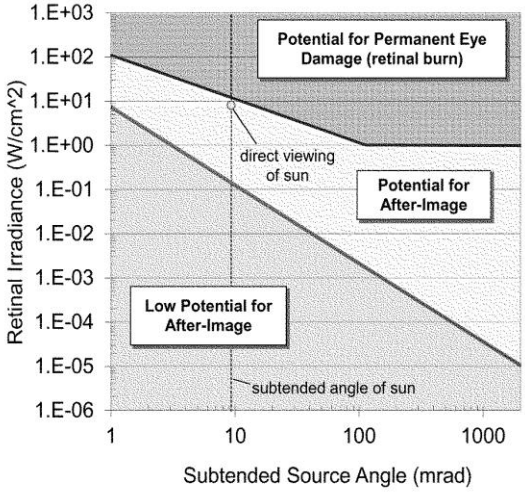
Standard for Measuring Ocular Impact FAA adopts the Solar Glare Hazard Analysis lot shown in Figure 1 below as the standard for measuring the ocular impact of any proposed solar energy system on a federally-obligated airport.

To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a "no objection" to a Notice of Proposed Construction Form 7460–1, the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:

1. *No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab, and*
2. *No potential for glare or "low potential for after-image" (shown in green in Figure 1) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.*

Ocular impact must be analyzed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.

Figure 1



Solar Glare Ocular Hazard Plot: The potential ocular hazard from solar glare is a function of retinal irradiance and the subtended angle (size/distance) of the glare source. It should be noted that the ratio of spectrally weighted solar illuminance to solar irradiance at the earth's surface yields a conversion factor of ~100 lumens/W. Plot adapted from Ho et al., 2011.

Chart References: 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, J. Solar Energy Engineering, August 2011, Vol. 133, 031021-1 – 031021-9.

Figure 8: Plot used by SGHAT to assess the ocular impact of light intensity from reflections

The SGHAT was designed to determine whether a proposed solar energy project would result in the potential for ocular impact as depicted on the Solar Glare Hazard Analysis Plot shown above.

As of the date of publication of this interim policy, the FAA requires the use of the SGHAT to demonstrate compliance with the standards for measuring ocular impact stated above for any proposed solar energy system located on a federally-obligated airport.

Appendix E – Limitations of SGHAT as they apply to this study

SGHAT has a number of documented limitations in its Users Manual. Not all of them have relevance to the results that have been calculated for this study, however, there are a couple that are important to note.

1: *"SGHAT 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."*

Macro Works has tested the results from SGHAT with the results from its own software. The results are broad agreement between the 2 systems in terms of the start and end dates for glare periods and the times at which glare occurs.
Due to the intensity of the setup with our proprietary software where panel design and layout is accurately accounted for, the lines of panels are continuous without gaps and follow the undulations of the site more faithfully. The result can be marginally longer individual glare periods.
In this report we have defaulted to the longer glare periods. Other result parameters such as intensity, not dependent on period, have remained faithful to the SGHAT results.

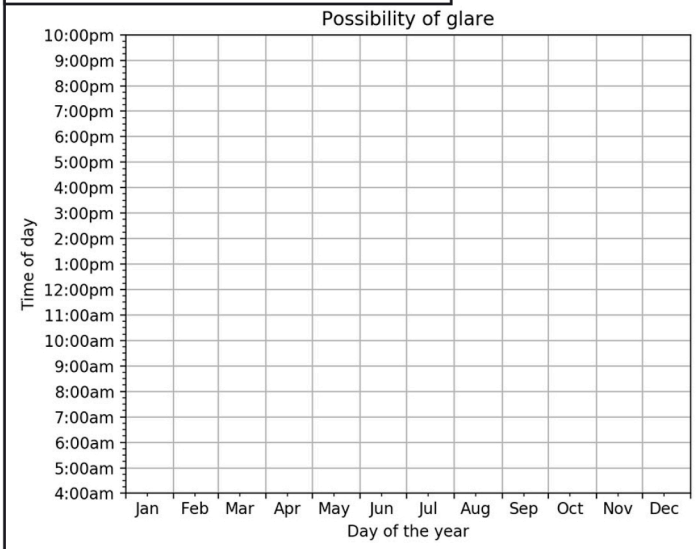
2: *"SGHAT does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc."*

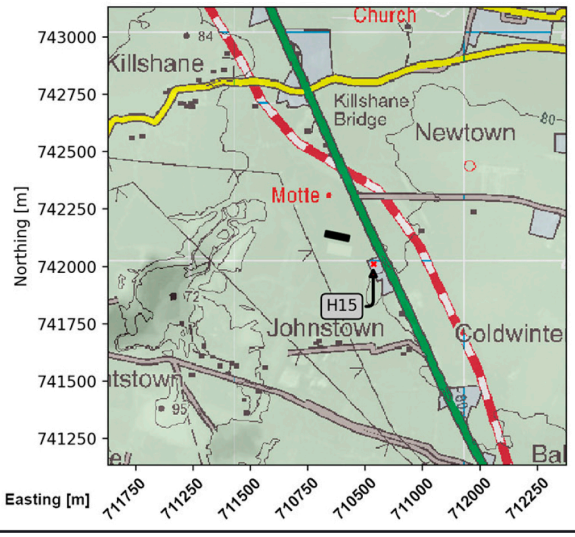
As part of our visibility and glint and glare calculations for solar sites Macro Works insists on using the best terrain input data. For this we capture the site terrain in high-resolution (25cm) to a distance of 700m from site boundary. From this data we derive a digital surface model which enables us to account for screening afforded by trees, building and any small undulations that may occur across the site. This is a system intensive process, however, it gives a far truer statement of visibility and thus glare than the bare-earth terrain employed by SGHAT.

The net result of this is that SGHAT overestimates the level of exposure of sites. In many instances only a portion of the site is actually visible once screening is accounted for.

3: SGHAT does not account for the mutual screening of panels, i.e. front panels that screen the view of other rear panels. This can result in an exaggeration of the intensity of the glare effect and can alter the duration of glare periods. This is more so the case for lower receptors where panels have a greater capacity to screen one another.
Macro Works proprietary software takes account of this, however, this has not been a significant issue for the results of this project where the majority of views have been elevated.

House 15





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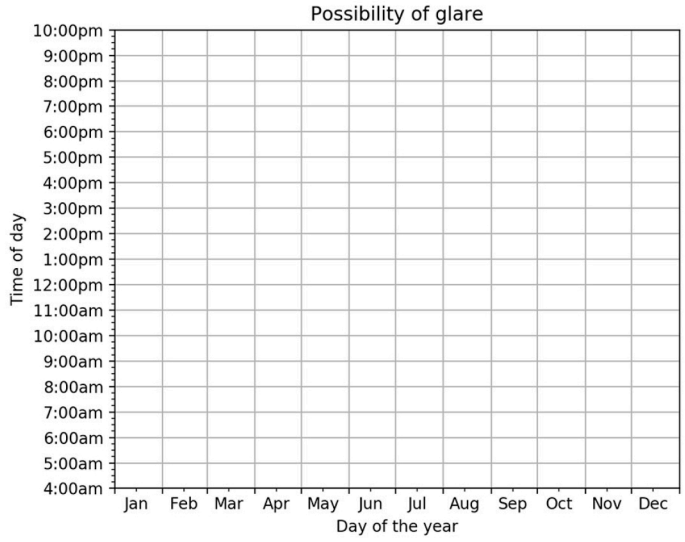

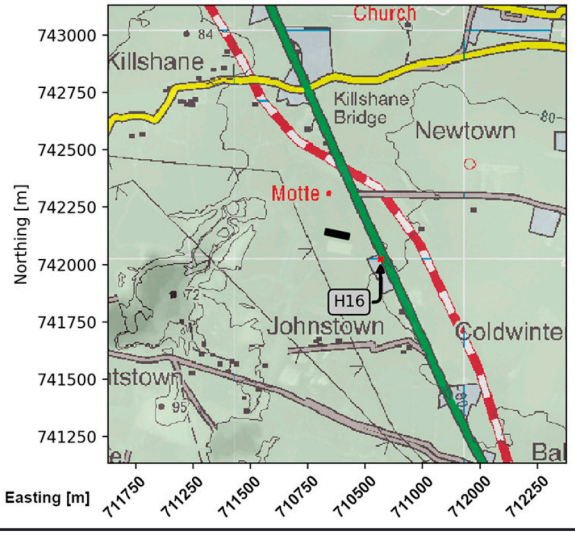

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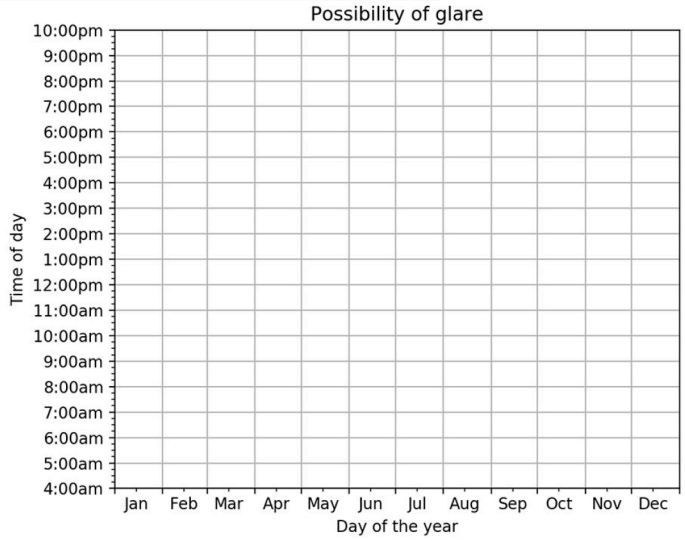
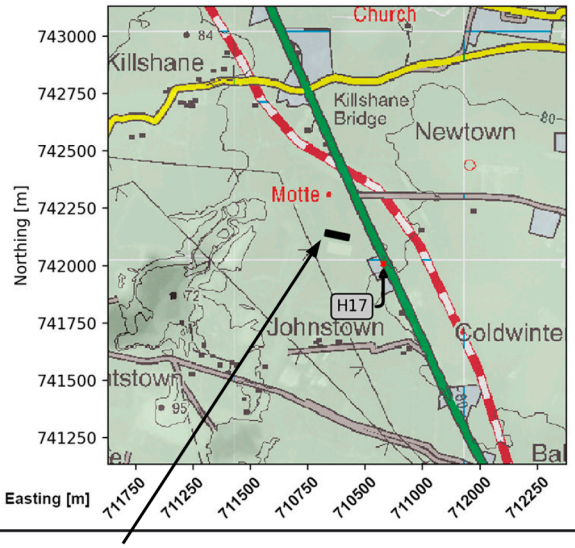
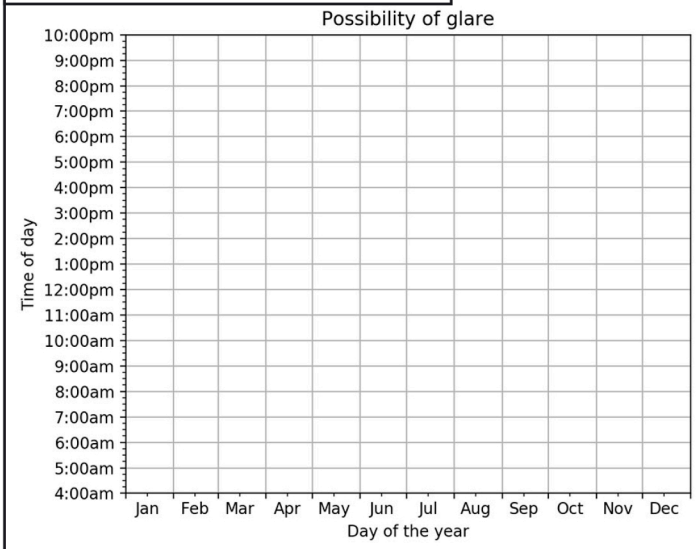


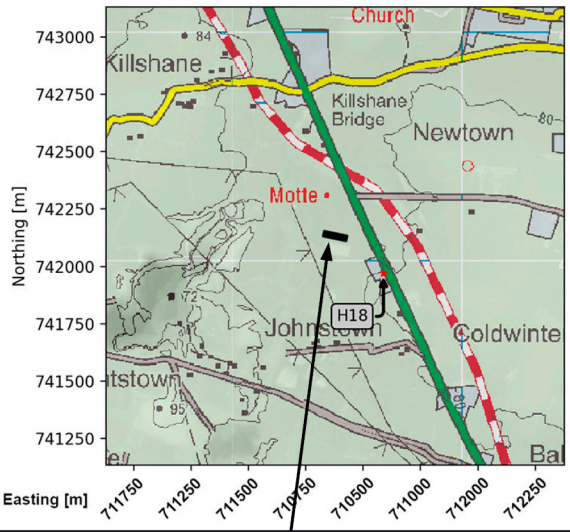


Panel Colour Legend

- glare is possible at times
- glare is not possible
- only the rear of the panel is visible
- panel not visible from receptor
- panel screened from the sun

House 18

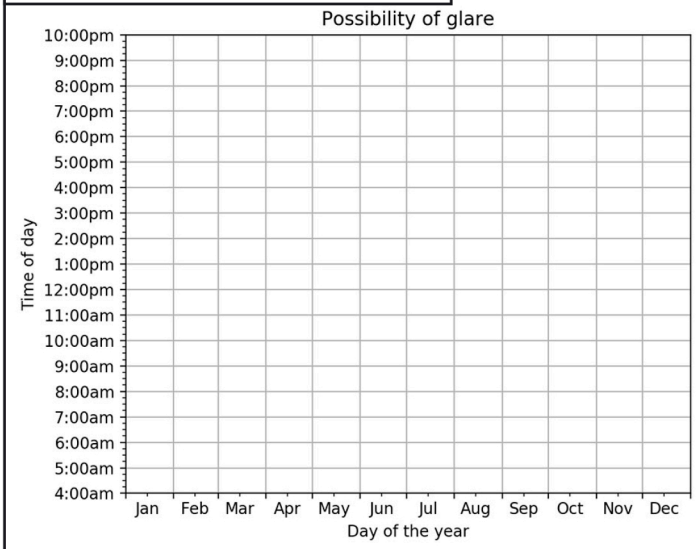


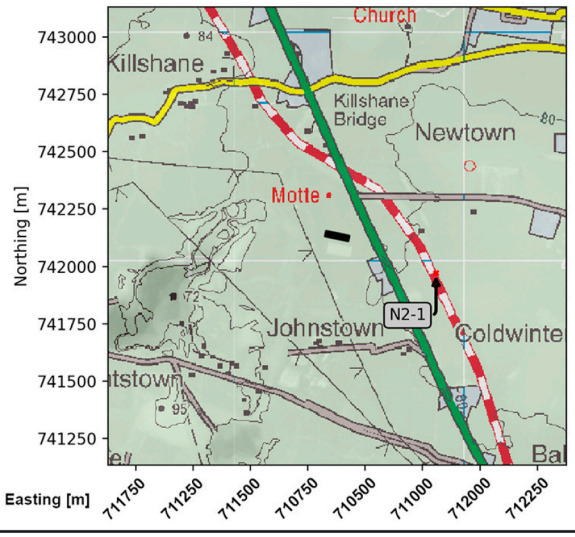


Panel Colour Legend

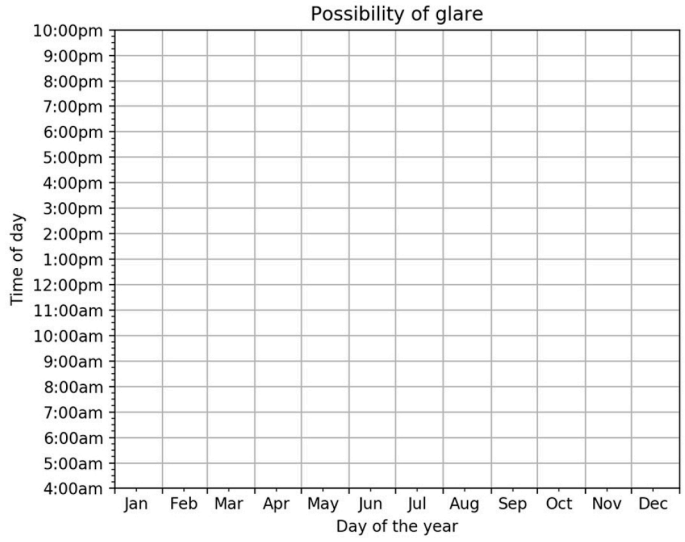
glare is possible at times	panel not visible from receptor
glare is not possible	panel screened from the sun
only the rear of the panel is visible	

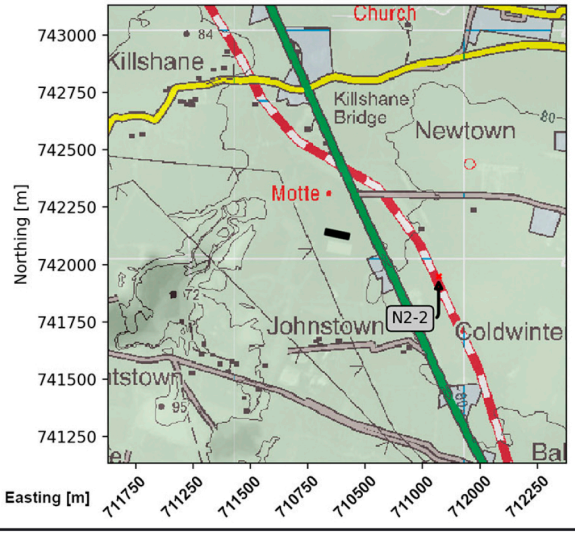
N2 Point 1



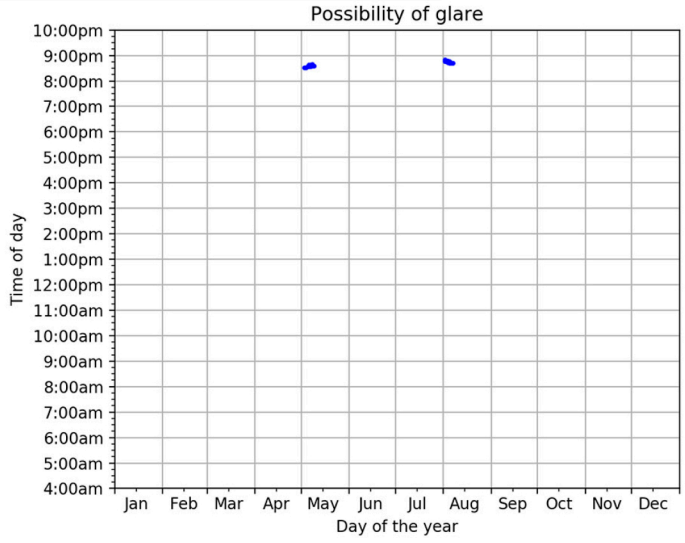


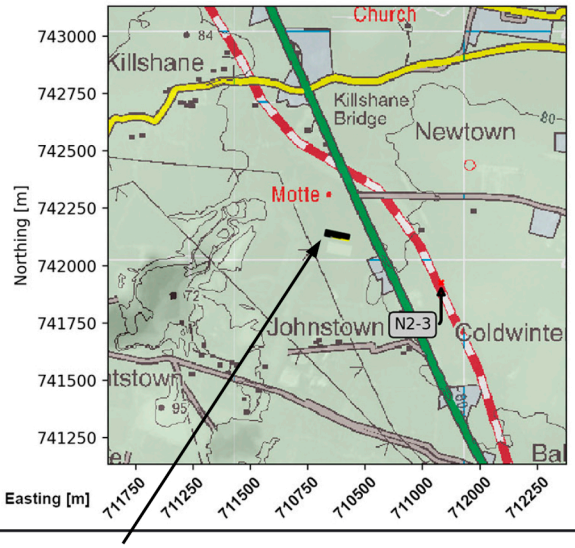
N2 Point 2





N2 Point 3





Panel Colour Legend

- glare is possible at times
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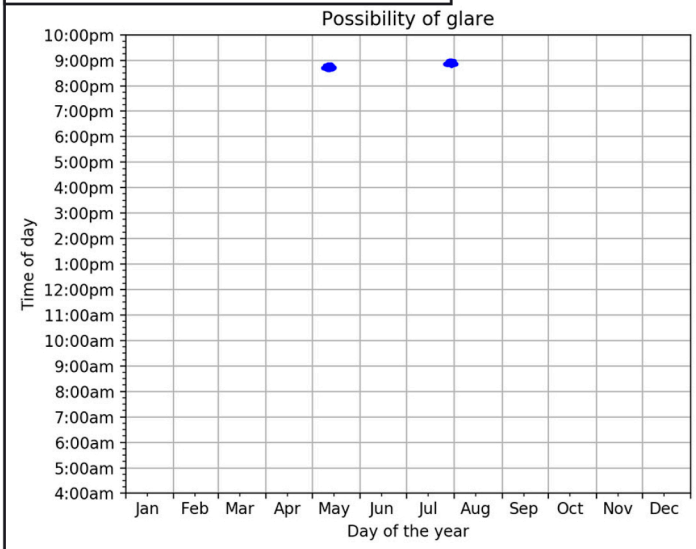
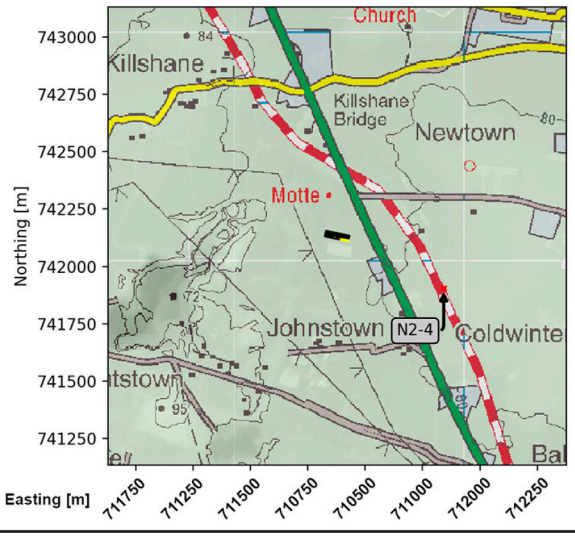
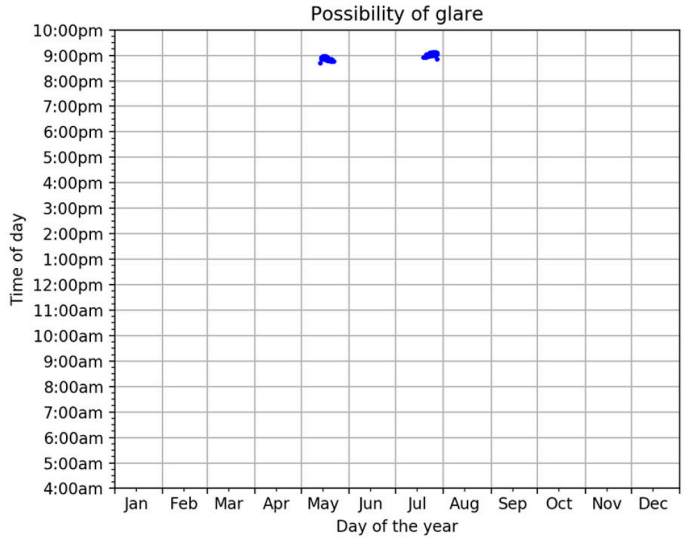
- panel not visible from receptor
- panel screened from the sun

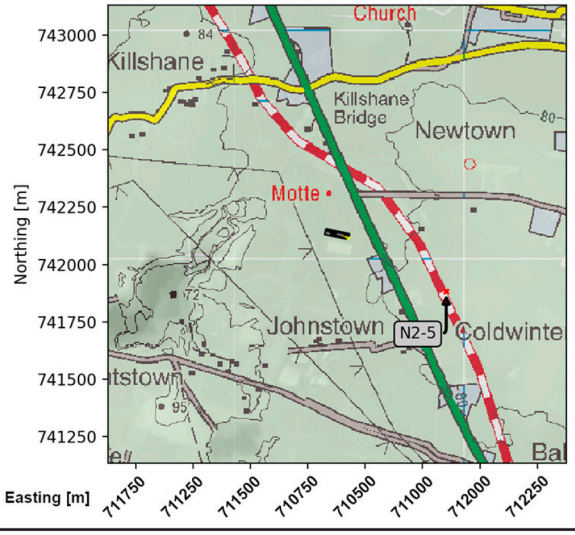
N2 Point 4



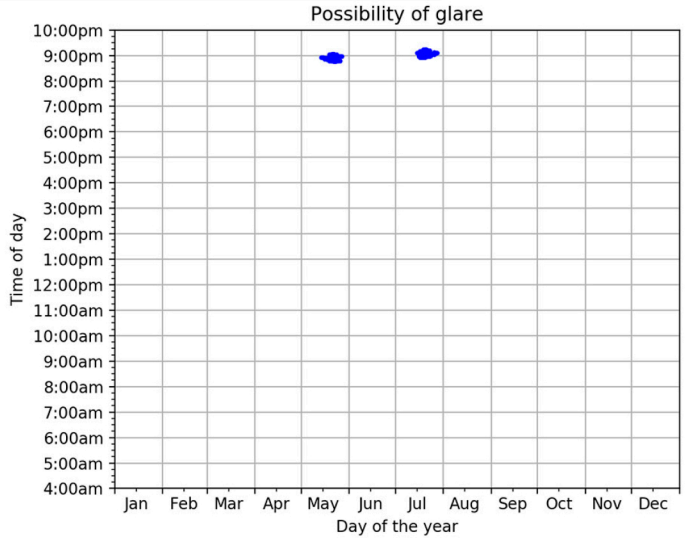


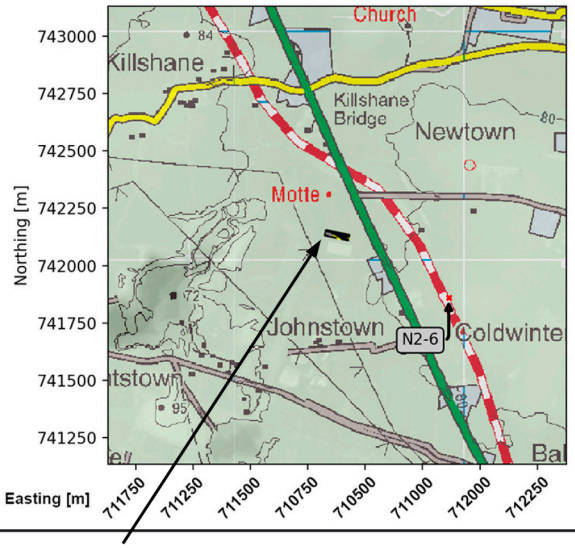
N2 Point 5





N2 Point 6





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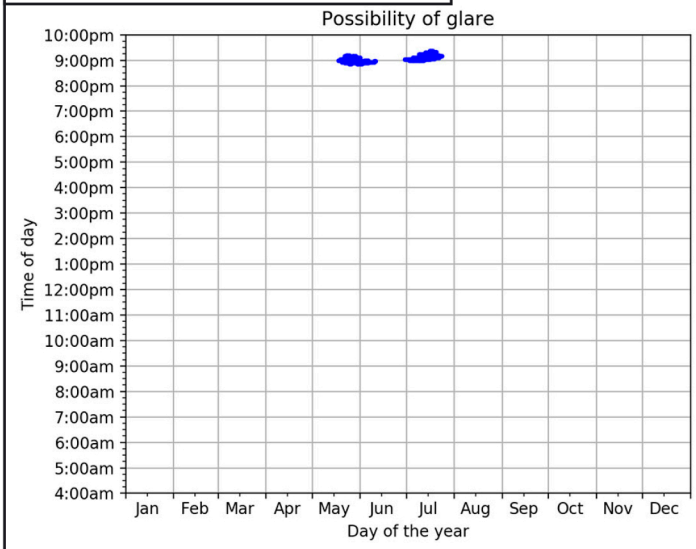
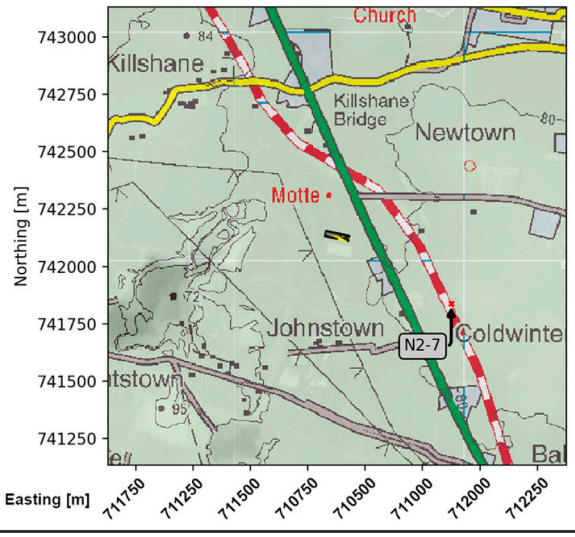
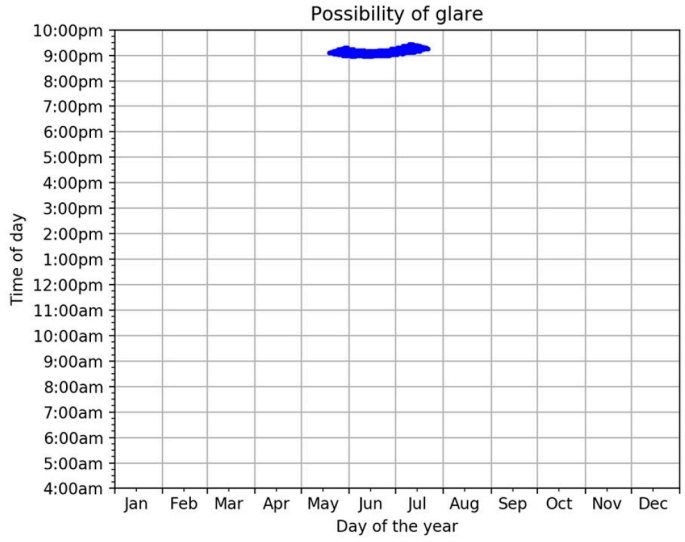
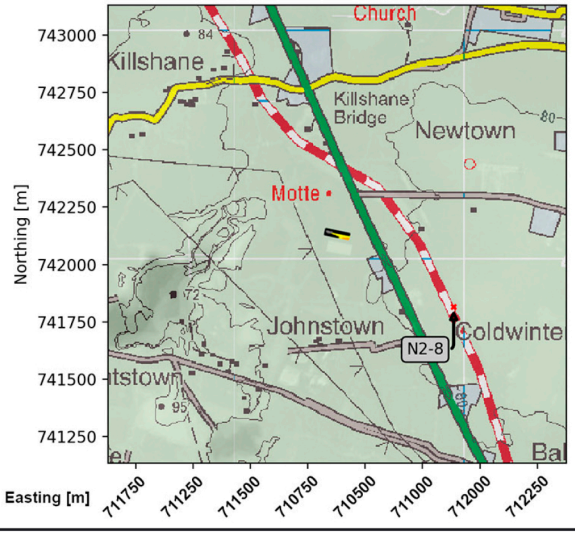
N2 Point 7



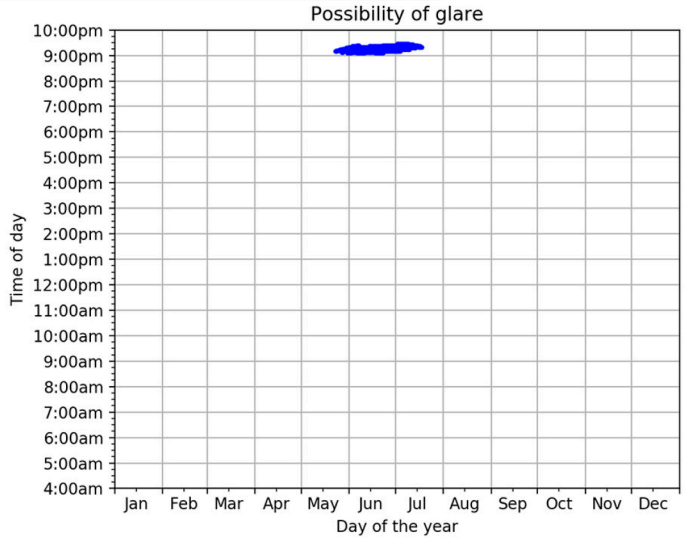


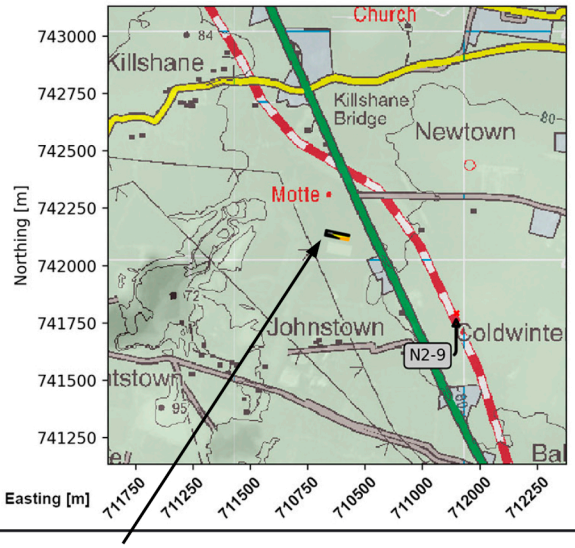
N2 Point 8





N2 Point 9





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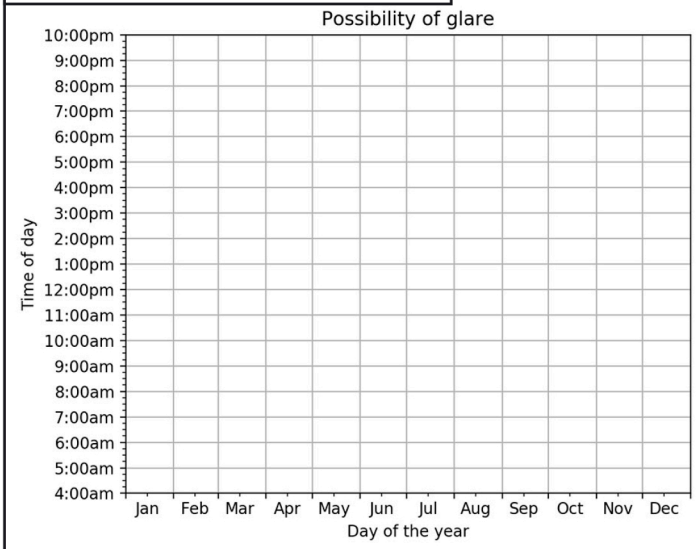
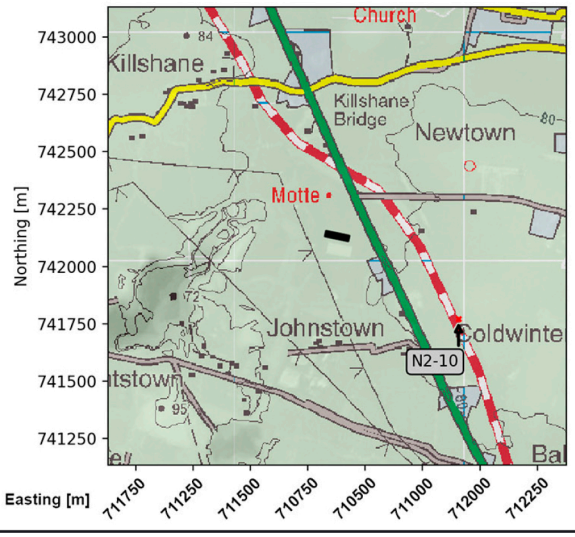
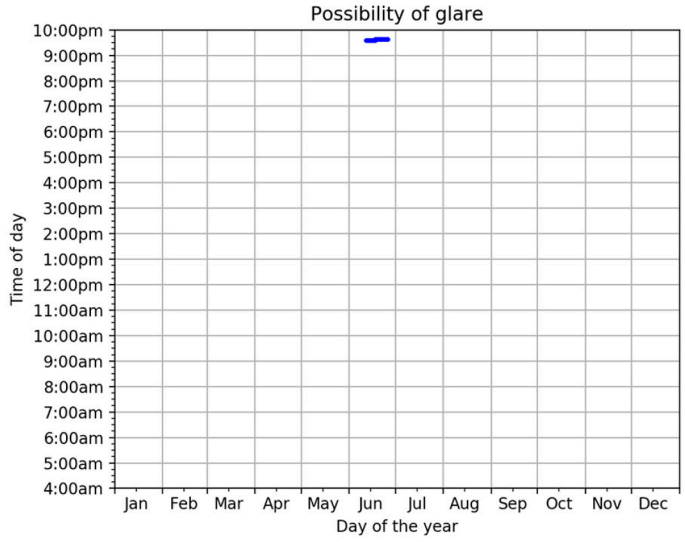
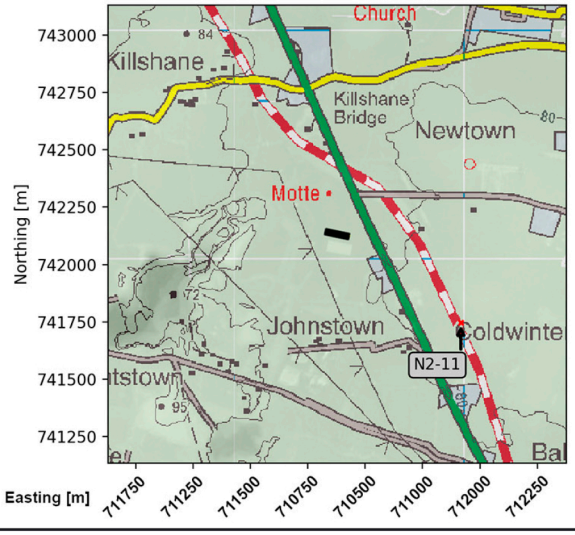
N2 Point 10



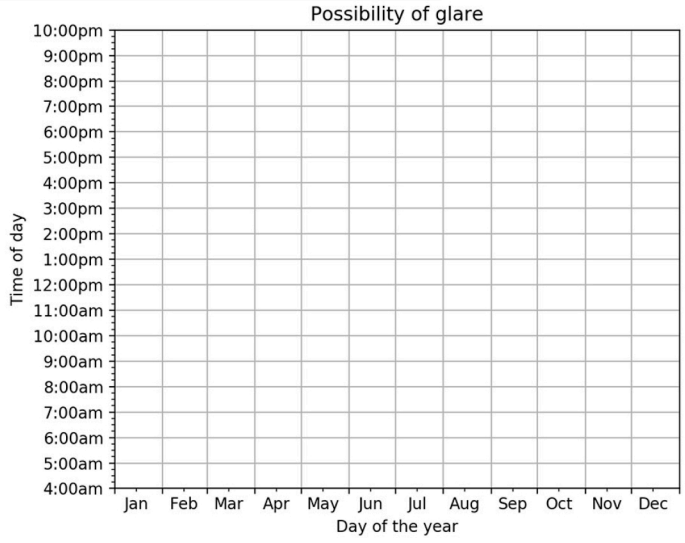


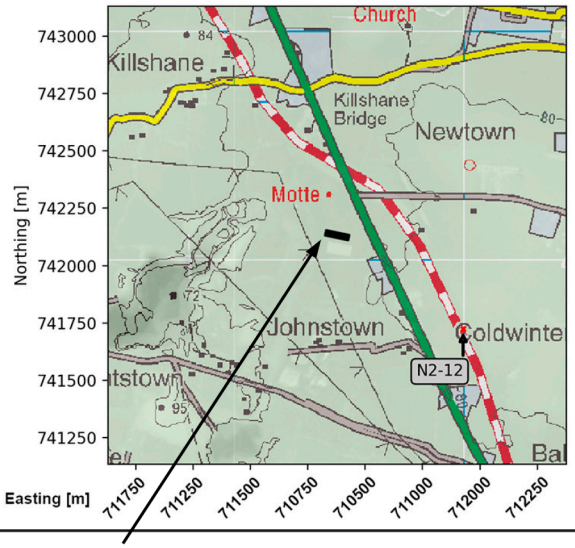
N2 Point 11





N2 Point 12





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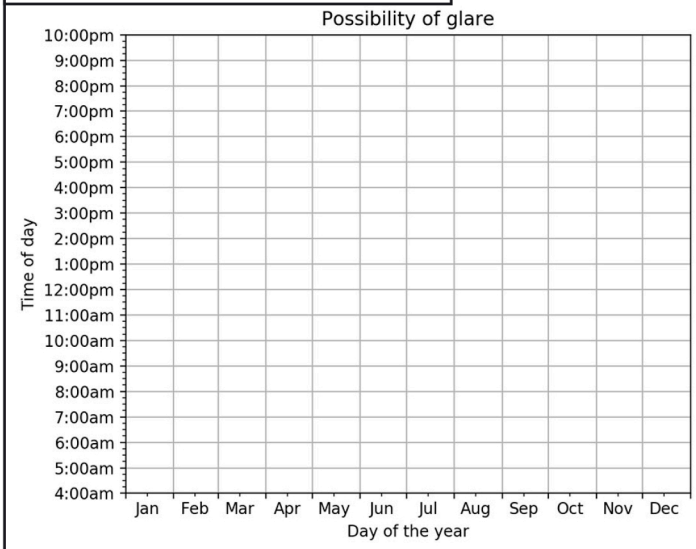
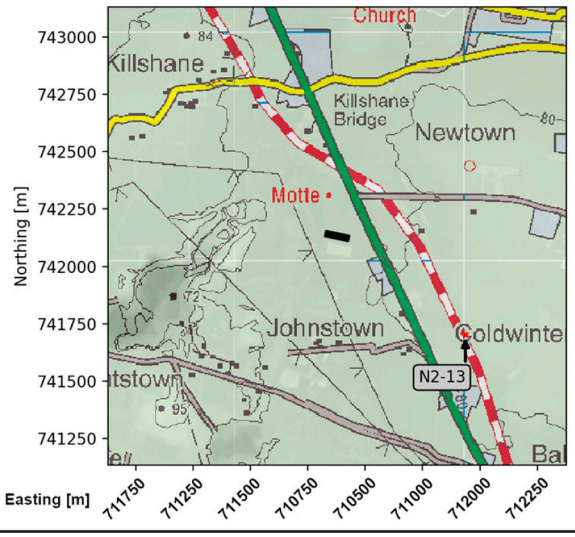
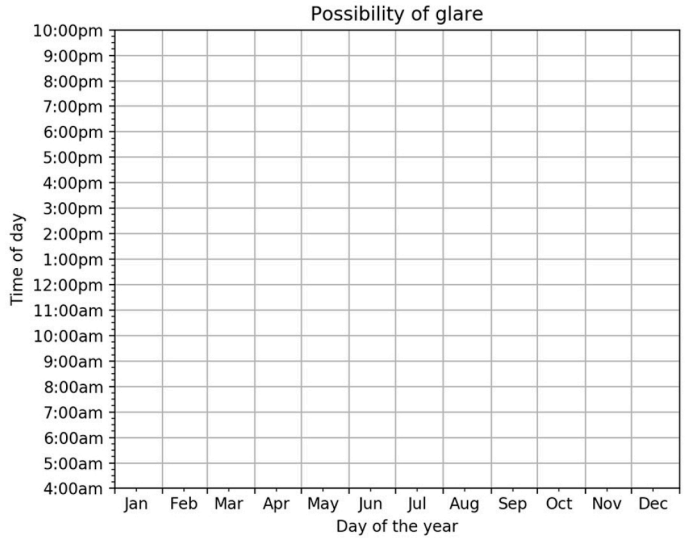
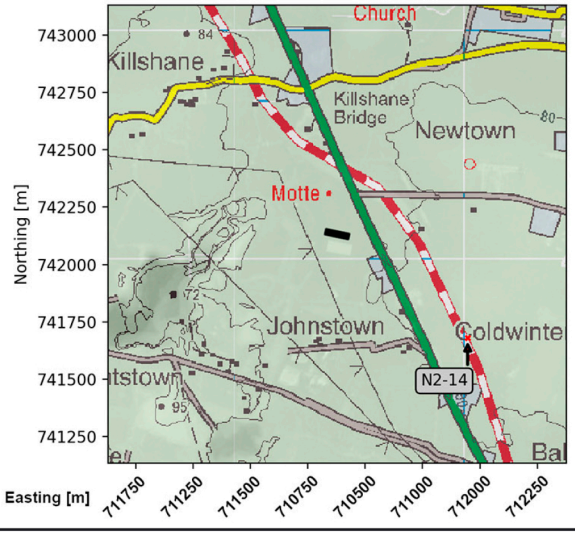
N2 Point 13



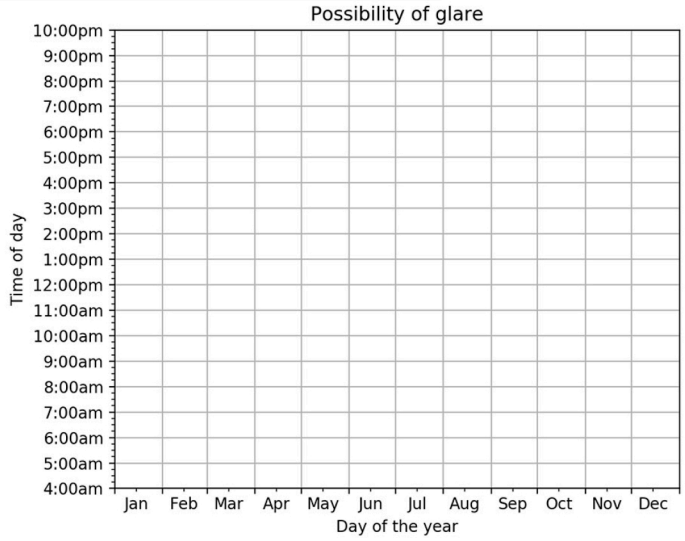


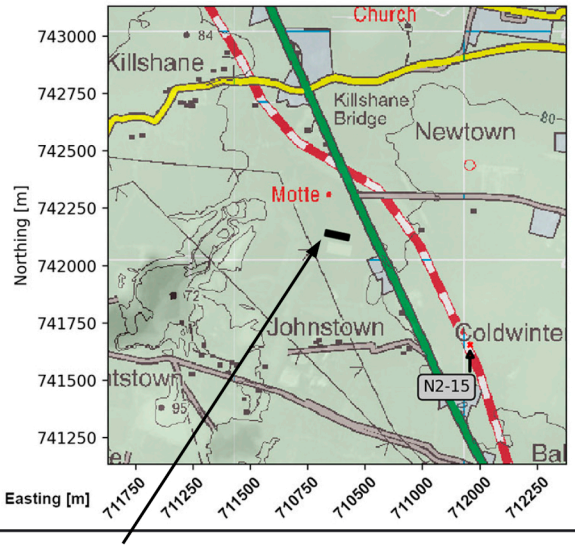
N2 Point 14





N2 Point 15





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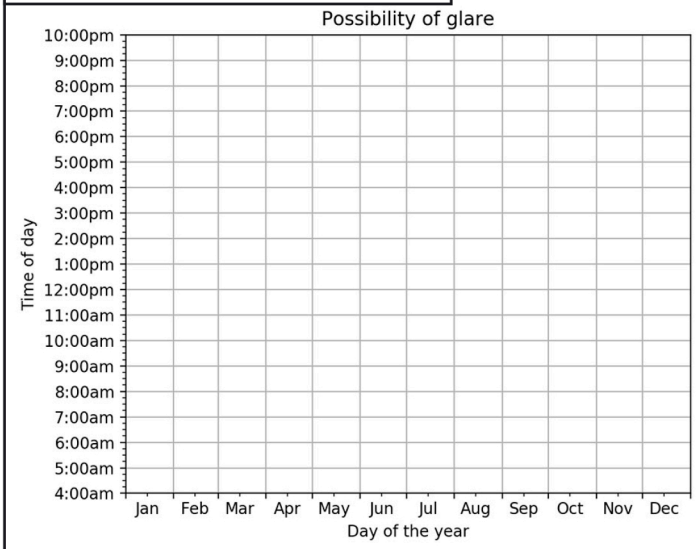
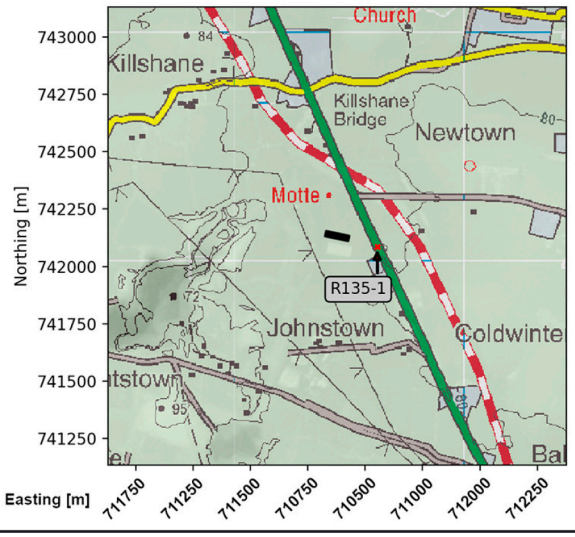
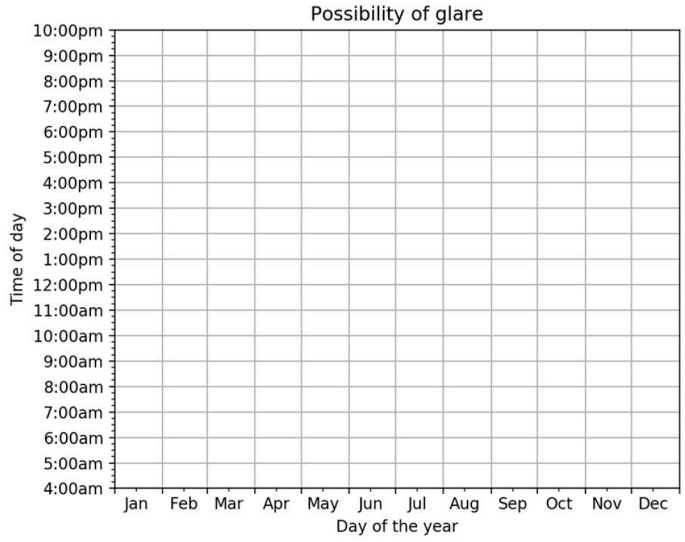
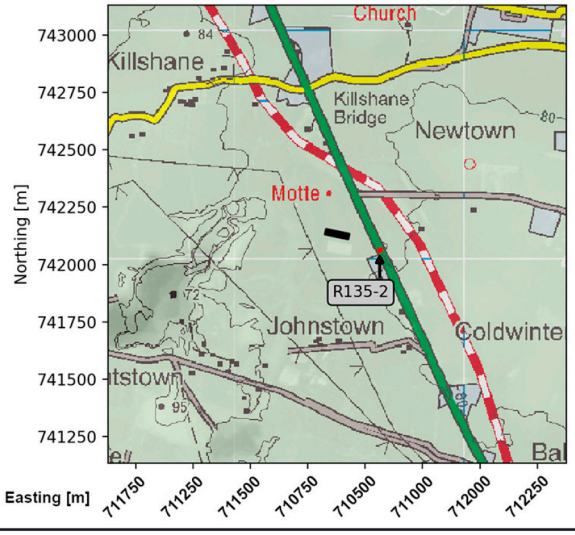
R135 Point 1



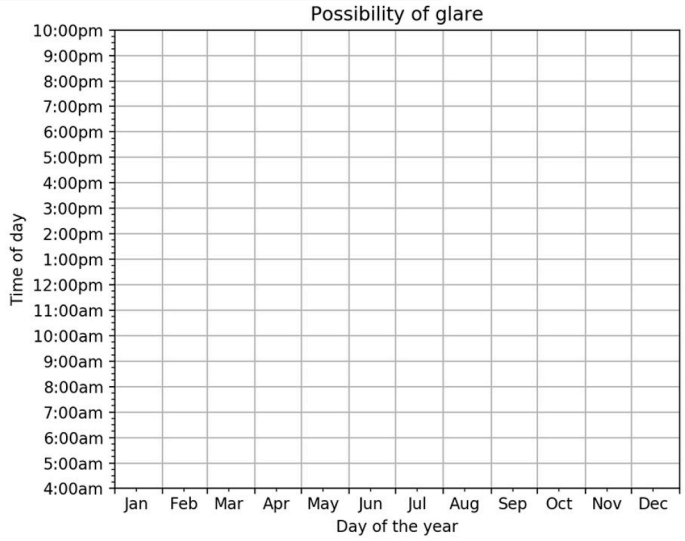


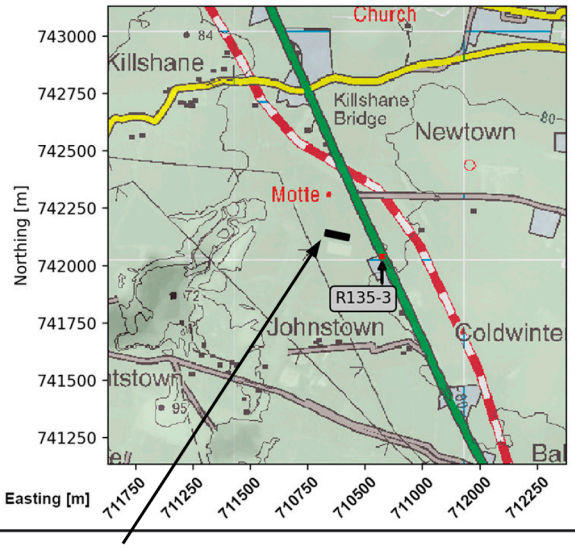
R135 Point 2





R135 Point 3





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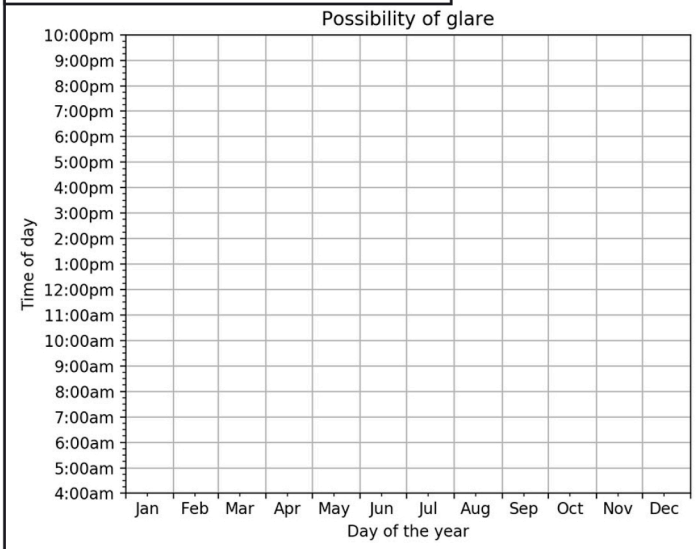
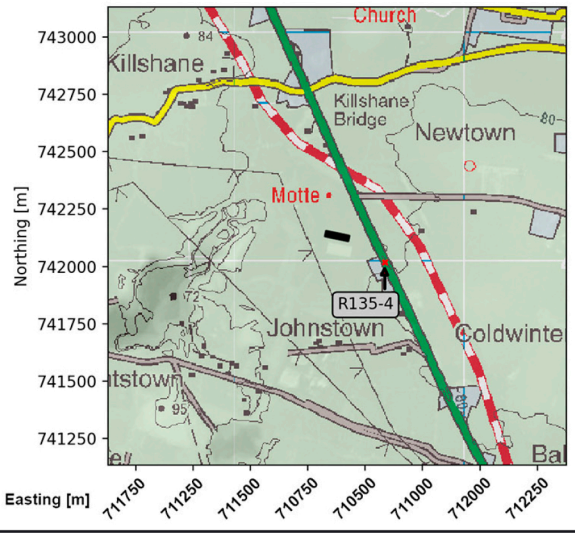
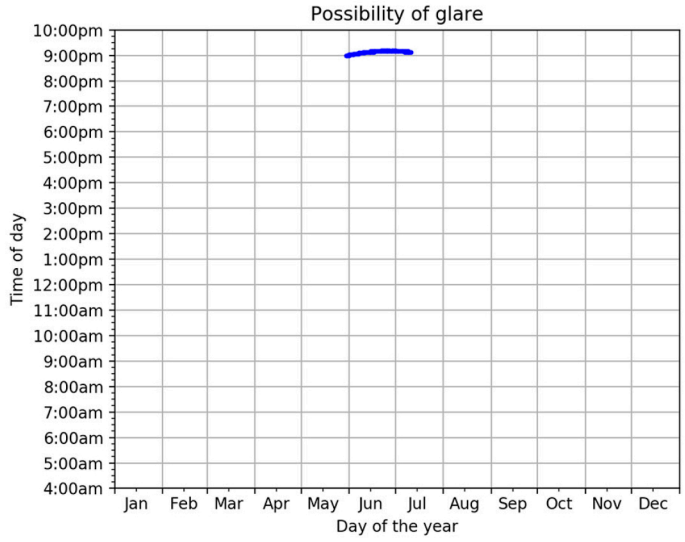
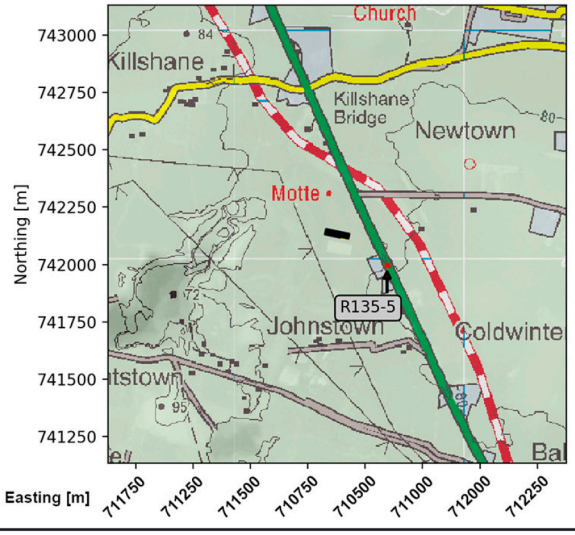
R135 Point 4



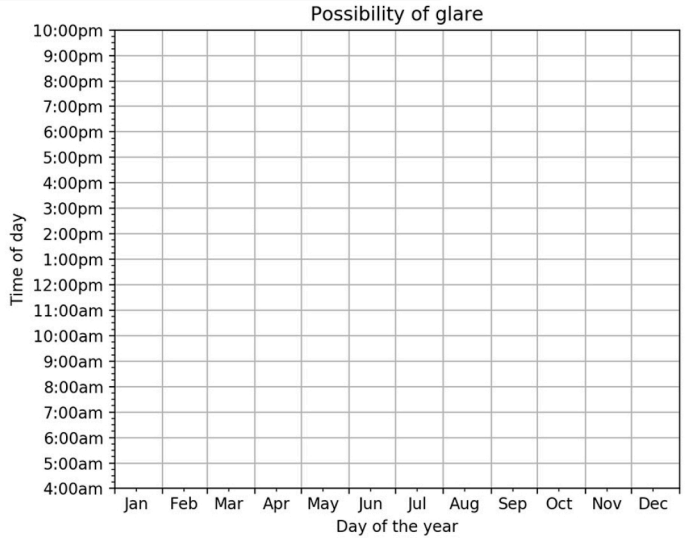


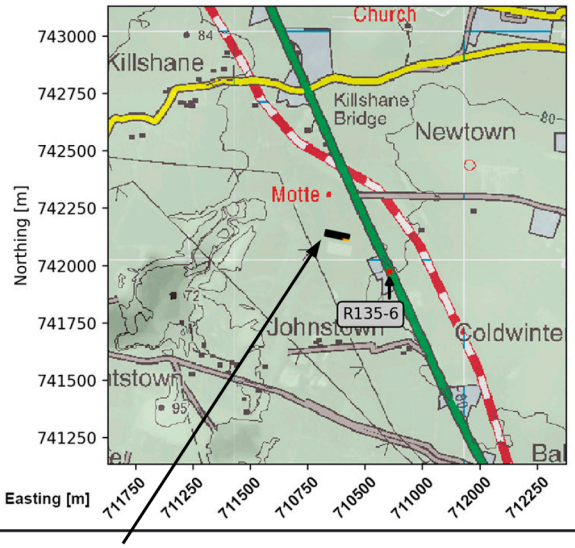
R135 Point 5





R135 Point 6





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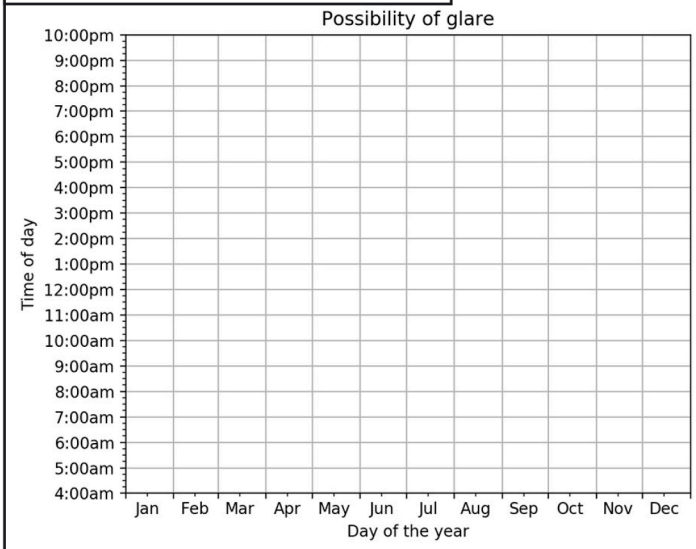
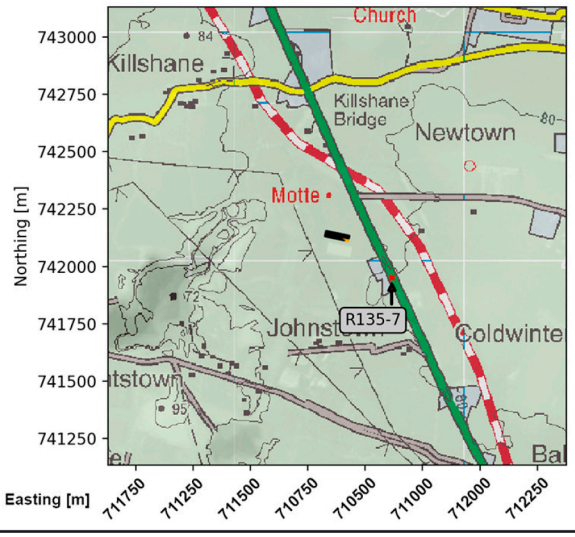
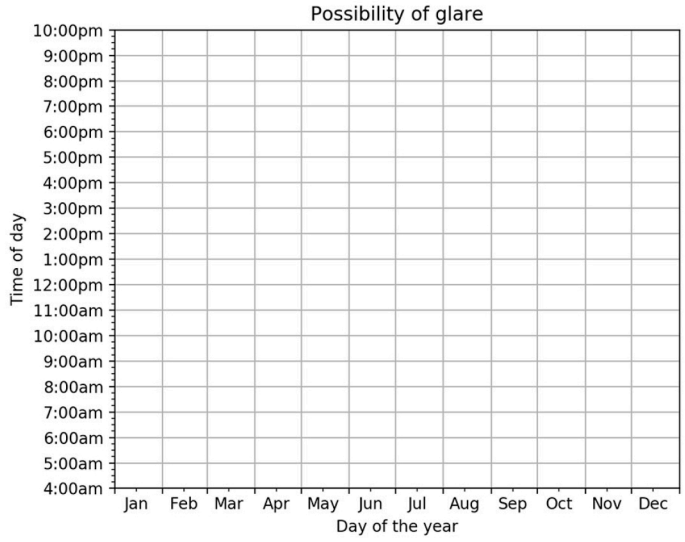
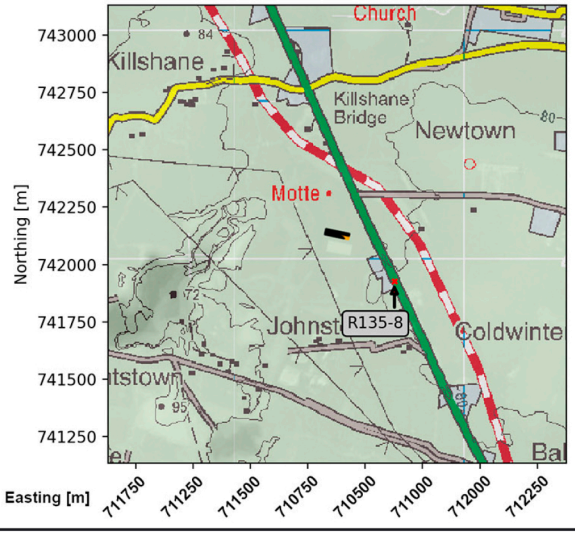
R135 Point 7



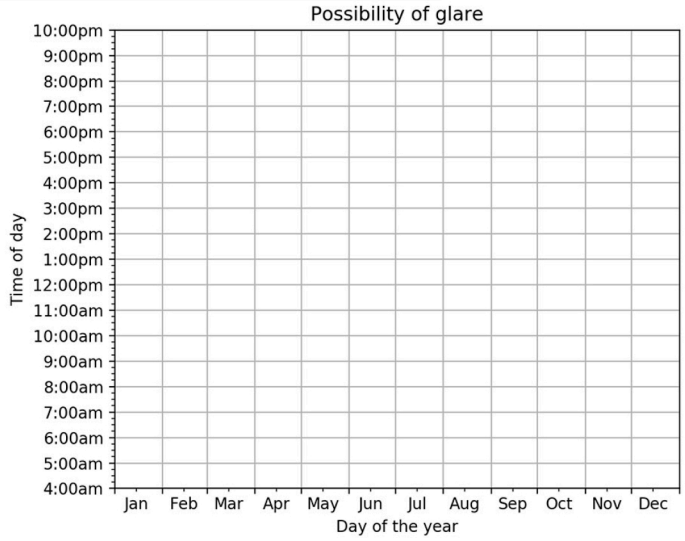


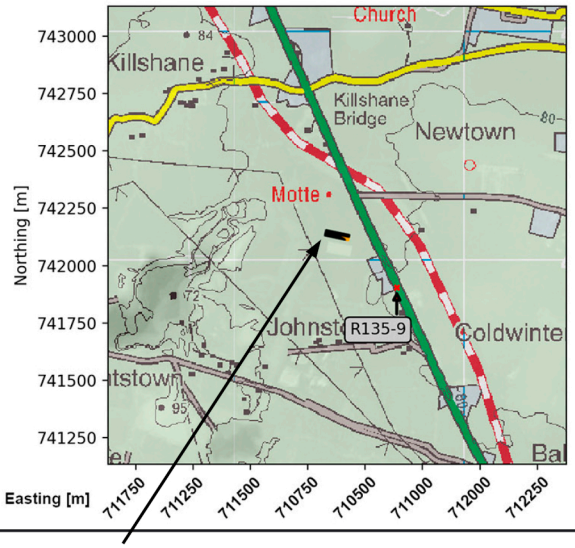
R135 Point 8





R135 Point 9





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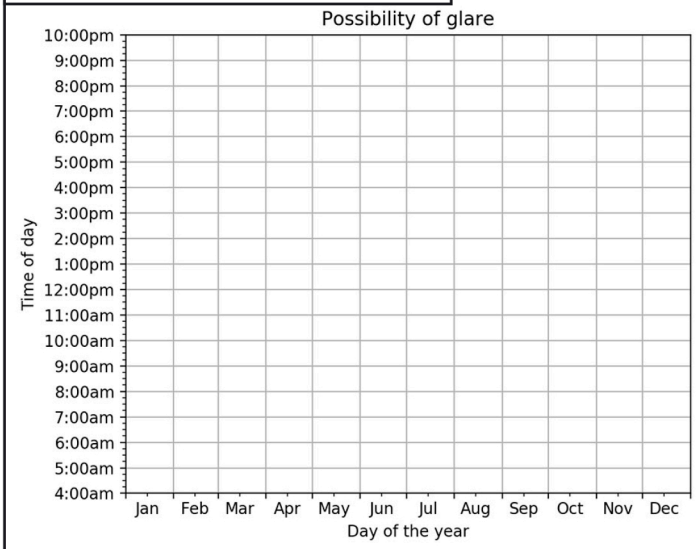
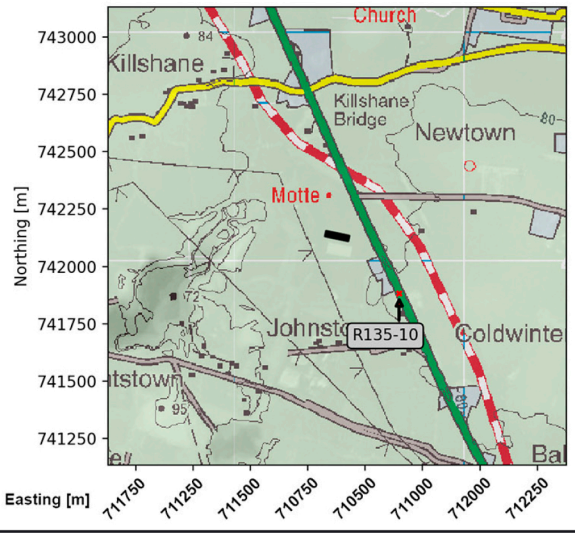
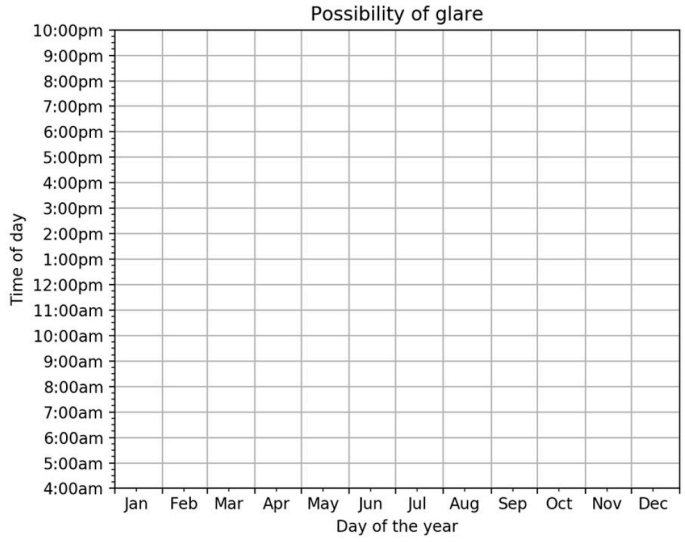
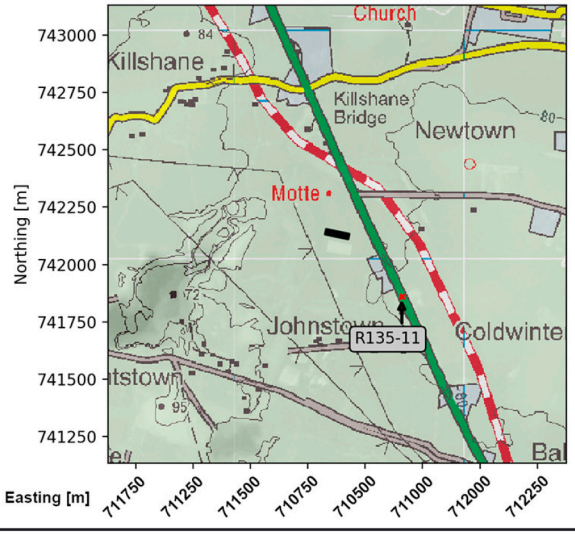
R135 Point 10



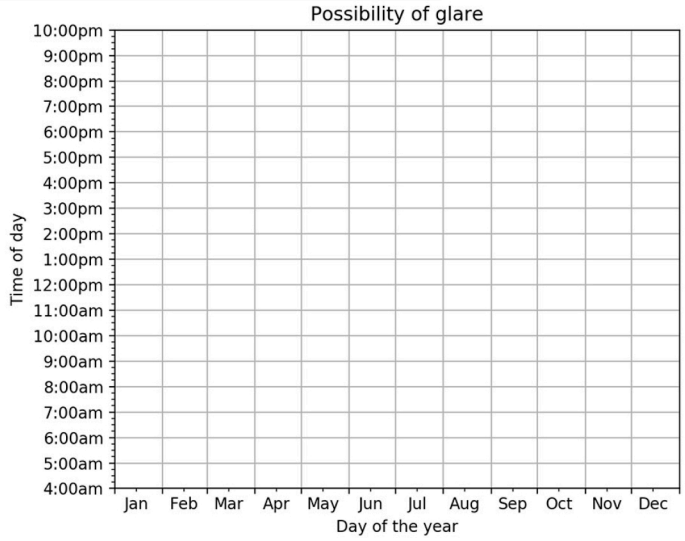


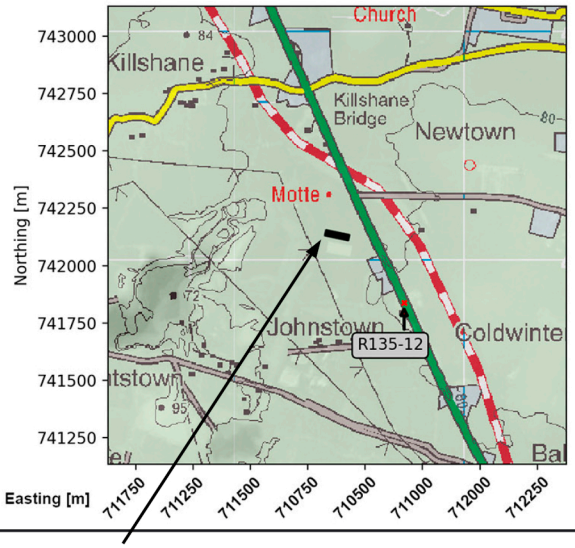
R135 Point 11





R135 Point 12





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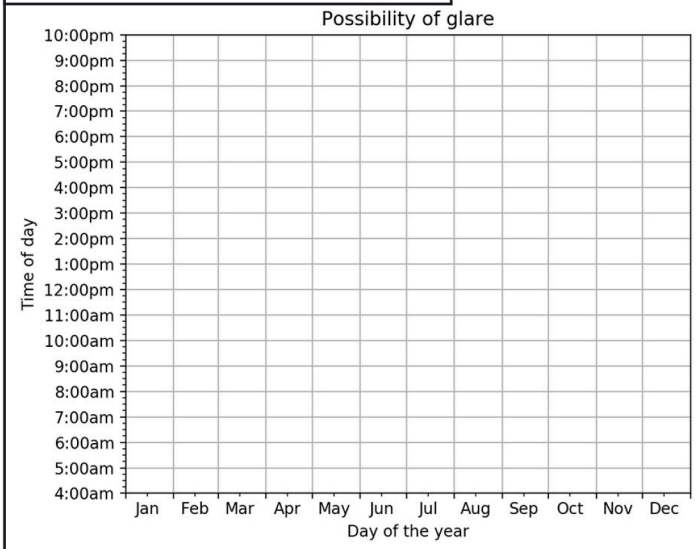
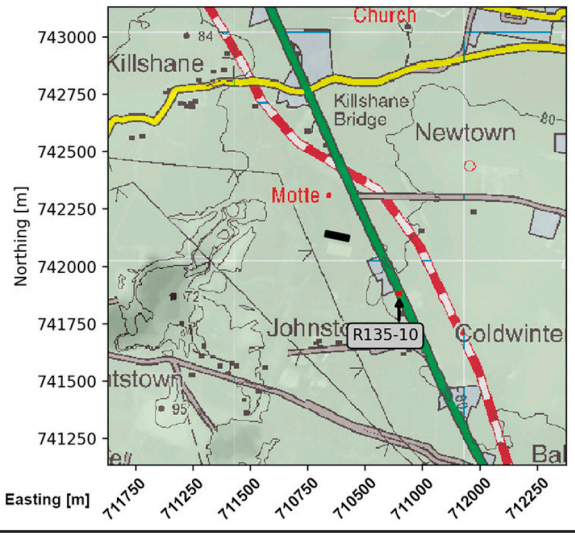
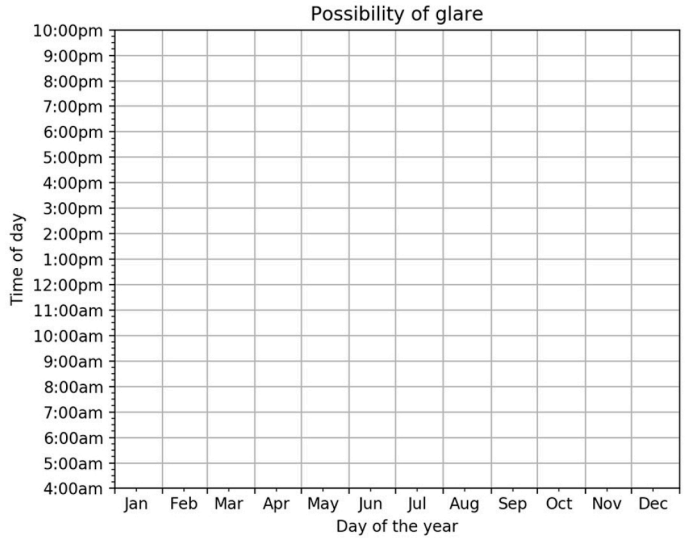
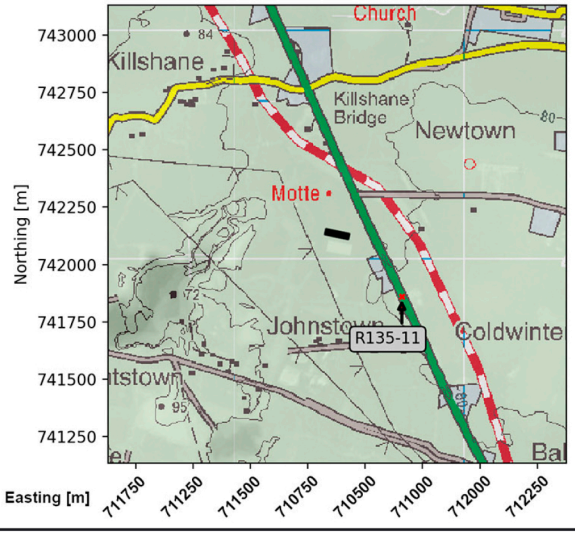
R135 Point 13



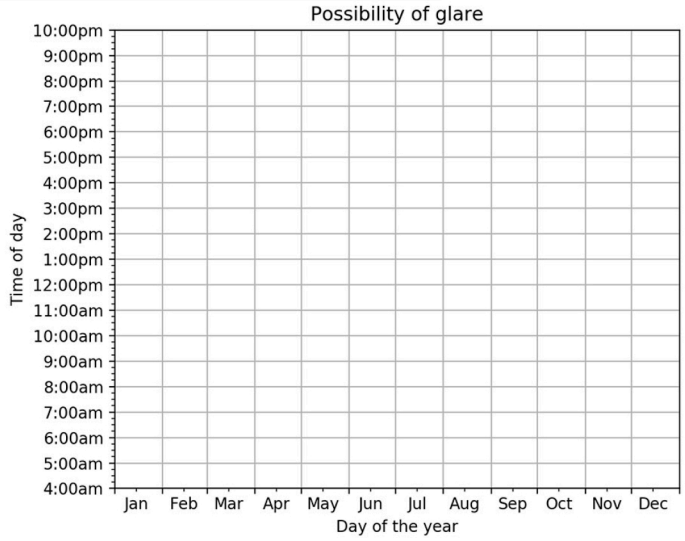


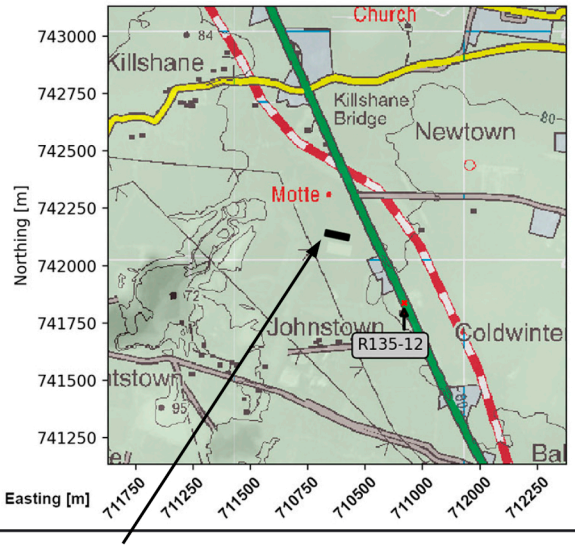
R135 Point 14





R135 Point 15





Panel Colour Legend

- glare is possible at times
- glare is not possible
- only the rear of the panel is visible
- panel not visible from receptor
- panel screened from the sun

FORGESOLAR GLARE ANALYSIS

Project: **Dublin Airport**
Site configuration: **DUBLIN AIRPORT - RBSF Roof**
Analysis conducted by Nikolas Hennessy (nik@macroworks.ie) at 16:26 on 31 Jan, 2018.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis and observer eye characteristics are as follows:

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

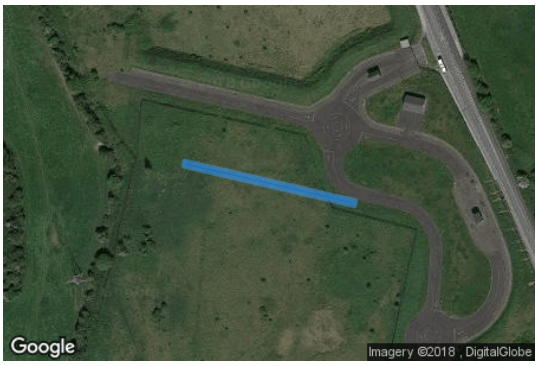
SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 14596.2021

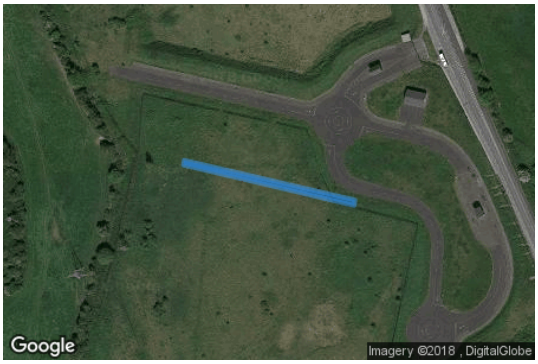
PV Array(s)

Name: Section A
Axis tracking: Fixed (no rotation)
Tilt: 0.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



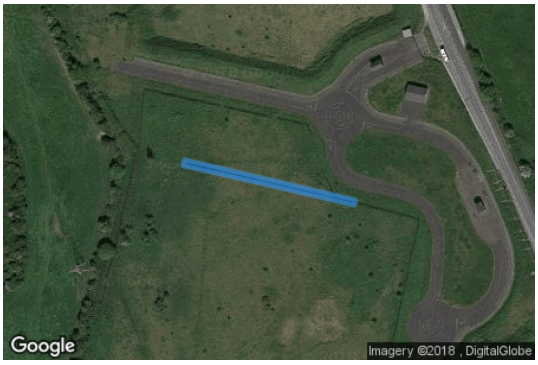
Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417557	-6.323648	77.30	15.10	92.40
2	53.417530	-6.323656	77.30	15.10	92.40
3	53.417743	-6.325207	77.30	15.10	92.40
4	53.417772	-6.325201	77.30	15.10	92.40

Name: Section B
Axis tracking: Fixed (no rotation)
Tilt: 1.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417530	-6.323659	77.30	15.00	92.30
2	53.417501	-6.323667	77.30	15.00	92.30
3	53.417719	-6.325215	77.30	15.00	92.30
4	53.417744	-6.325209	77.30	15.00	92.30

Name: Section C
Axis tracking: Fixed (no rotation)
Tilt: 2.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

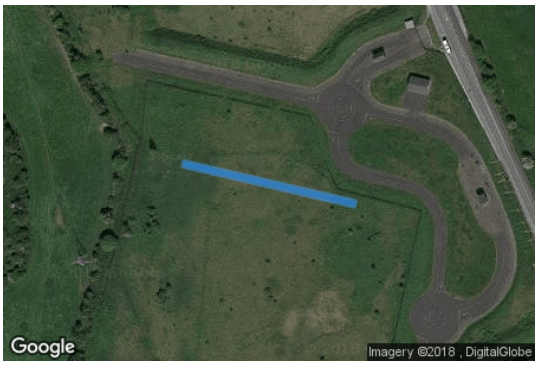


Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417501	-6.323667	77.30	14.90	92.20
2	53.417474	-6.323681	77.30	14.90	92.20
3	53.417687	-6.325234	77.30	14.90	92.20
4	53.417719	-6.325220	77.30	14.90	92.20

Name: Section D
Axis tracking: Fixed (no rotation)
Tilt: 3.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417474	-6.323683	77.30	14.70	92.00
2	53.417449	-6.323691	77.30	14.70	92.00
3	53.417663	-6.325242	77.30	14.70	92.00
4	53.417685	-6.325234	77.30	14.70	92.00

Name: Section E
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

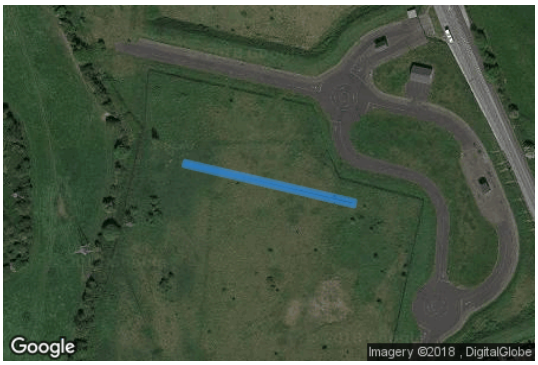


Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417449	-6.323694	77.30	14.50	91.80
2	53.417423	-6.323705	77.30	14.50	91.80
3	53.417637	-6.325252	77.30	14.50	91.80
4	53.417663	-6.325247	77.30	14.50	91.80

Name: Section F
Axis tracking: Fixed (no rotation)
Tilt: 6.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417423	-6.323710	77.30	14.20	91.50
2	53.417394	-6.323718	77.30	14.20	91.50
3	53.417610	-6.325258	77.30	14.20	91.50
4	53.417637	-6.325258	77.30	14.20	91.50

Name: Section G
Axis tracking: Fixed (no rotation)
Tilt: 7.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417394	-6.323718	77.30	13.90	91.20
2	53.417366	-6.323726	77.30	13.90	91.20
3	53.417583	-6.325271	77.30	13.90	91.20
4	53.417607	-6.325260	77.30	13.90	91.20

Name: Section H
Axis tracking: Fixed (no rotation)
Tilt: 8.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417366	-6.323726	77.30	13.40	90.70
2	53.417338	-6.323737	77.30	13.40	90.70
3	53.417559	-6.325285	77.30	13.40	90.70
4	53.417580	-6.325274	77.30	13.40	90.70

Name: Section I
Axis tracking: Fixed (no rotation)
Tilt: 9.0°
Orientation: 193.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.417337	-6.323737	77.30	13.00	90.30
2	53.417311	-6.323745	77.30	13.00	90.30
3	53.417533	-6.325290	77.30	13.00	90.30
4	53.417559	-6.325285	77.30	13.00	90.30

Flight Path Receptor(s)

Name: 10L Runway
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

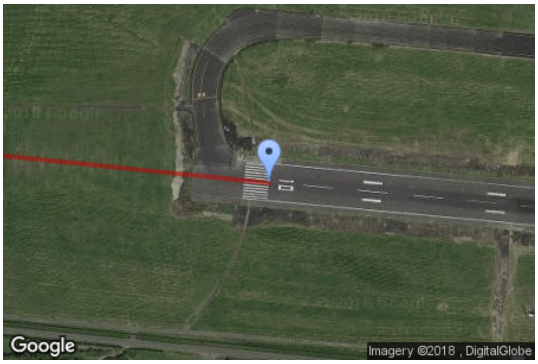
Flight path map

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.436880	-6.280253	71.90	15.20	87.10
Two-mile	53.439822	-6.328592	74.90	180.90	255.80

Name: 10L_Runway 2-4M
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.439800	-6.328661	255.80	15.20	271.00
Two-mile	53.442721	-6.377008	255.80	183.90	439.70

Name: 10 Runway
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.422405	-6.289520	74.00	15.30	89.30
Two-mile	53.425327	-6.337846	80.30	177.60	257.90

Name: 10 Runway 2-4M
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.425318	-6.337856	257.90	15.30	273.20
Two-mile	53.428240	-6.386186	257.90	184.00	441.90

Name: 16 Runway
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.436699	-6.261764	66.50	15.20	81.70
Two-mile	53.463138	-6.281428	69.70	180.70	250.40

Name: 16 Runway 2-4M
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.463143	-6.281433	250.40	15.20	265.60
Two-mile	53.489576	-6.301132	250.40	183.90	434.30

Name: 28R Runway
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.435084	-6.240975	65.50	15.30	80.80
Two-mile	53.432097	-6.192645	34.00	215.50	249.50

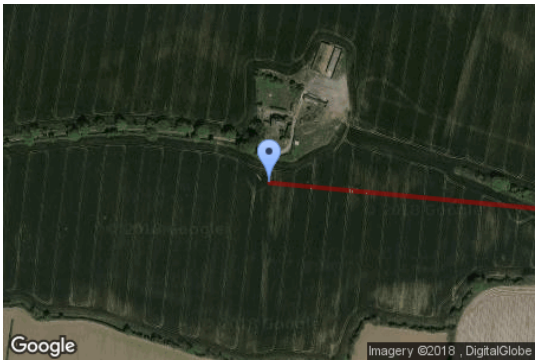
Name: 28R Runway 2-4M
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.432099	-6.192652	34.00	15.30	49.30
Two-mile	53.429127	-6.144323	5.90	212.00	217.90

Name: 28 Runway
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420299	-6.251111	62.00	15.20	77.20
Two-mile	53.417517	-6.202763	41.90	204.00	245.90

Name: 28 Runway 2-4M
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.417522	-6.202769	245.90	15.30	261.20
Two-mile	53.414751	-6.154423	245.90	183.90	429.80

Name: 34 Runway
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420211	-6.249810	62.20	15.30	77.50
Two-mile	53.393680	-6.230504	49.00	197.10	246.10

Name: 36 Runway 2-4M
Description: None
Threshold height: 15 m
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.393625	-6.230493	246.10	15.30	261.40
Two-mile	53.367090	-6.211214	246.10	184.00	430.10

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
ATCT 1	1	53.428489	-6.262201	65.90	21.90
ATCT 2	2	53.428937	-6.264259	65.60	75.60

Map image of ATCT 1

Map image of ATCT 2

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
Section A	0.0	193.0	4,600	0	-
Section B	1.0	193.0	4,423	0	-
Section C	2.0	193.0	4,333	0	-
Section D	3.0	193.0	3,991	0	-
Section E	4.0	193.0	3,809	0	-
Section F	6.0	193.0	3,305	0	-
Section G	7.0	193.0	3,229	0	-
Section H	8.0	193.0	3,134	0	-
Section I	9.0	193.0	2,794	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	2879	0
10 Runway	3489	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
10 Runway 2-4M	16358	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	223	0
28R Runway 2-4M	104	0
28 Runway	355	0
28 Runway 2-4M	546	0
34 Runway	4304	0
36 Runway 2-4M	5360	0
None	0	0
None	0	0

Results for: Section A

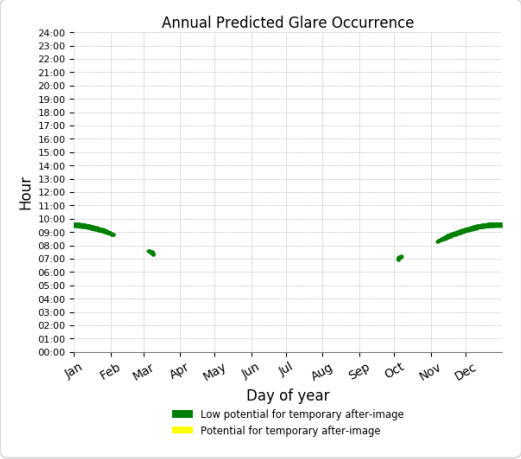
Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	691	0
10 Runway	580	0
10 Runway 2-4M	1627	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	187	0
28R Runway 2-4M	104	0
28 Runway	207	0
28 Runway 2-4M	140	0
34 Runway	474	0
36 Runway 2-4M	590	0
ATCT 1	0	0
ATCT 2	0	0

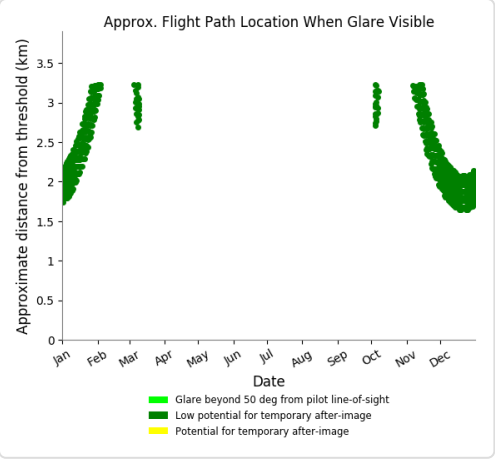
Flight Path: 10L Runway

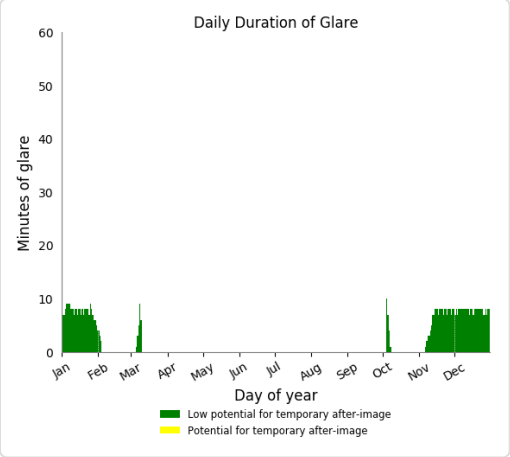
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
691 minutes of green glare



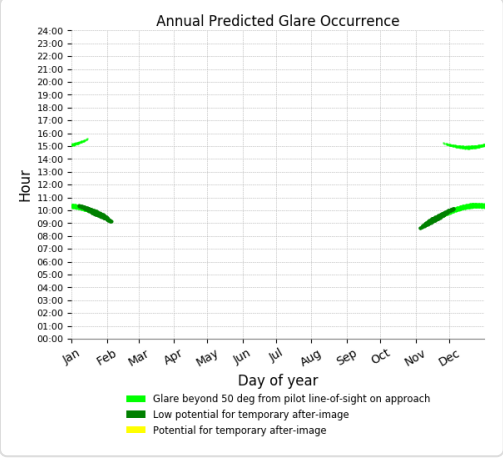


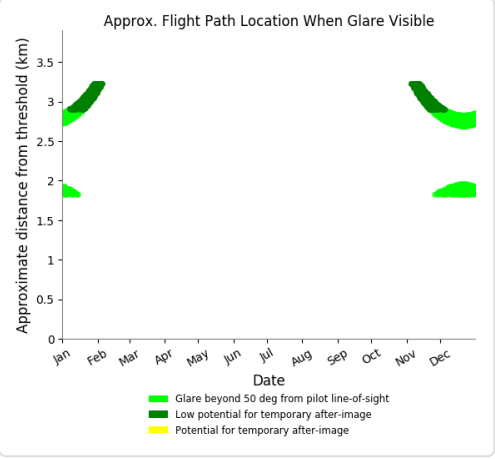


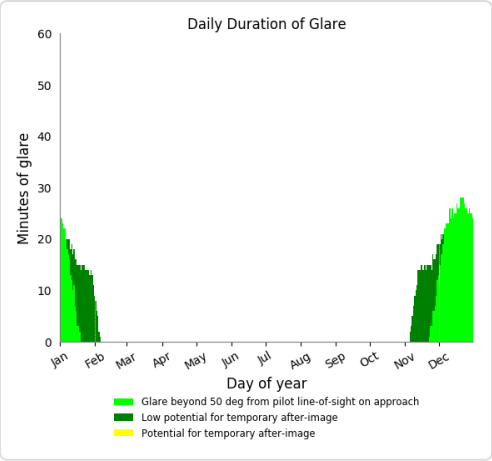
Flight Path: 10 Runway

0 minutes of yellow glare

580 minutes of green glare



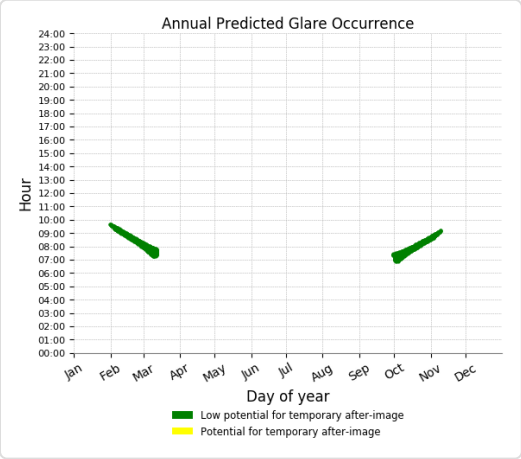


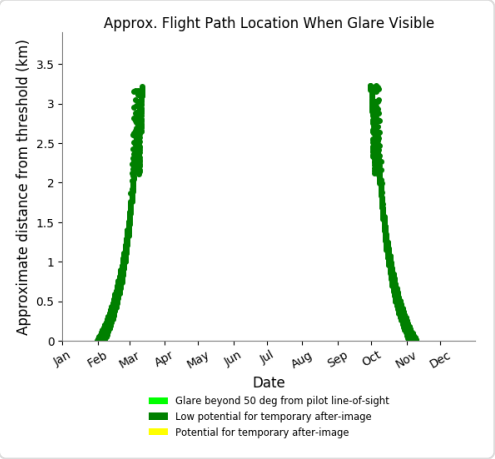


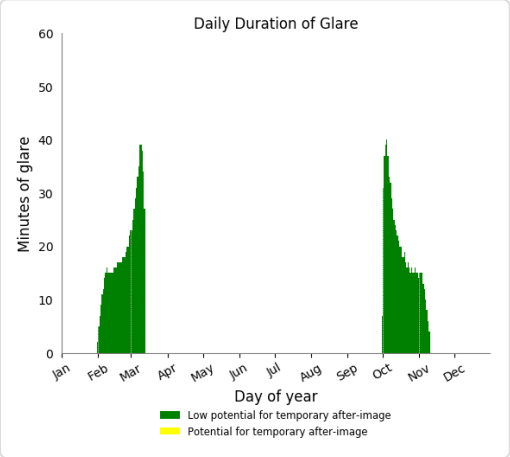
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

1627 minutes of green glare



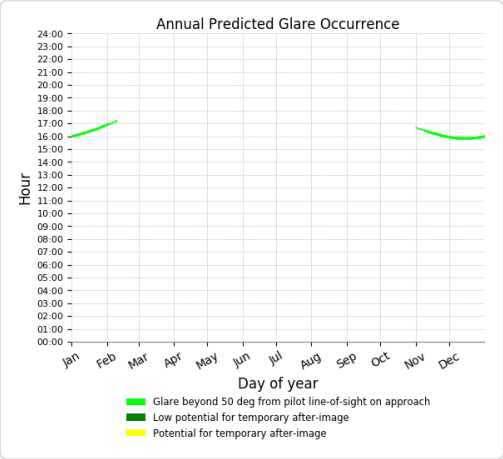


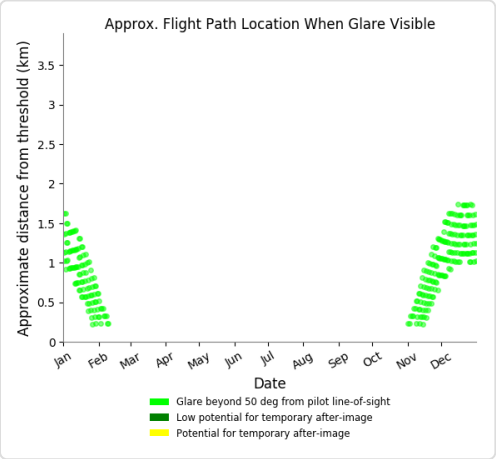


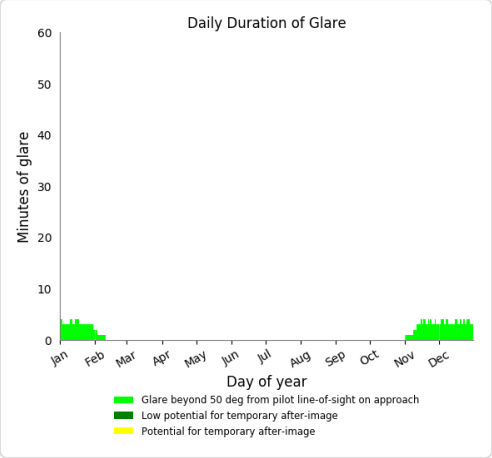
Flight Path: 16 Runway

0 minutes of yellow glare

0 minutes of green glare







Flight Path: 16 Runway 2-4M

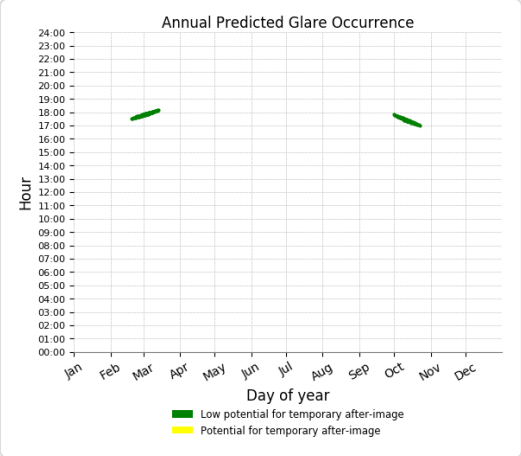
0 minutes of yellow glare

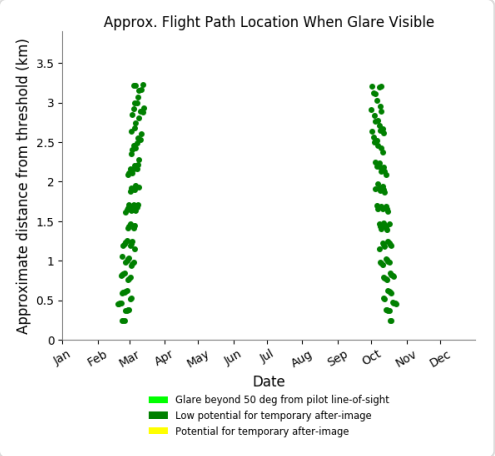
0 minutes of green glare

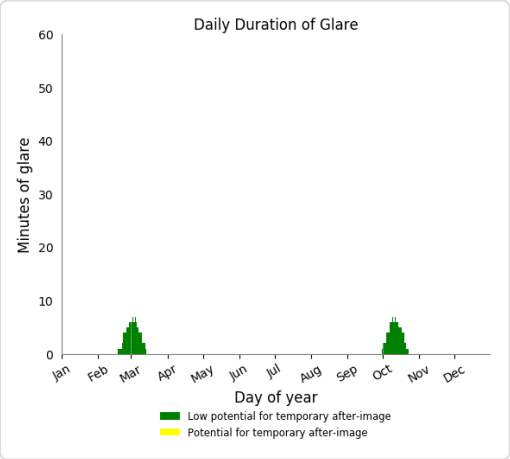
Flight Path: 28R Runway

0 minutes of yellow glare

187 minutes of green glare



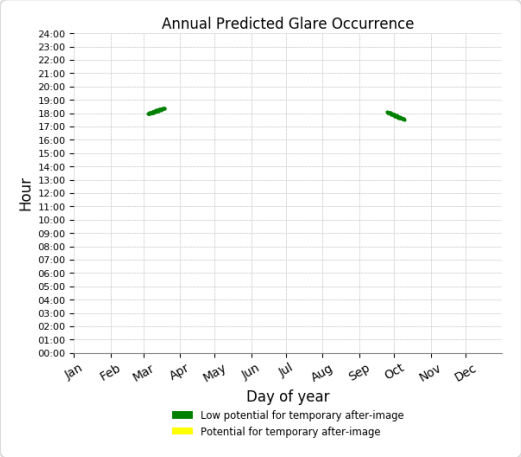


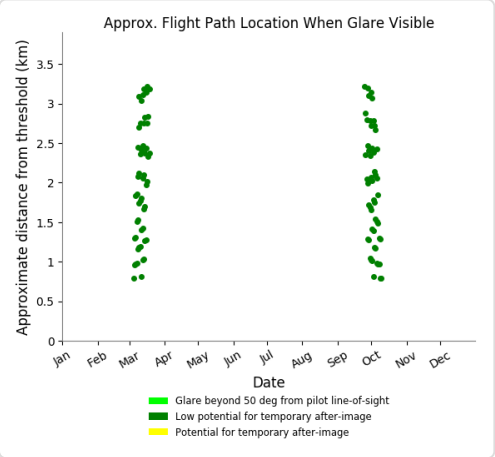


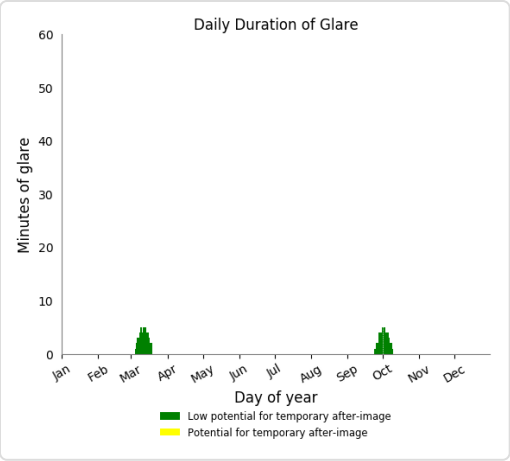
Flight Path: 28R Runway 2-4M

0 minutes of yellow glare

104 minutes of green glare



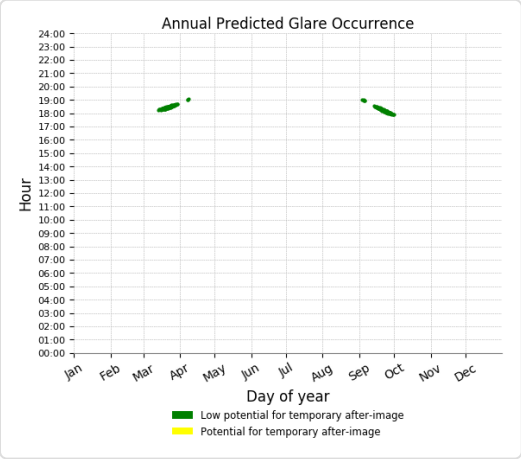


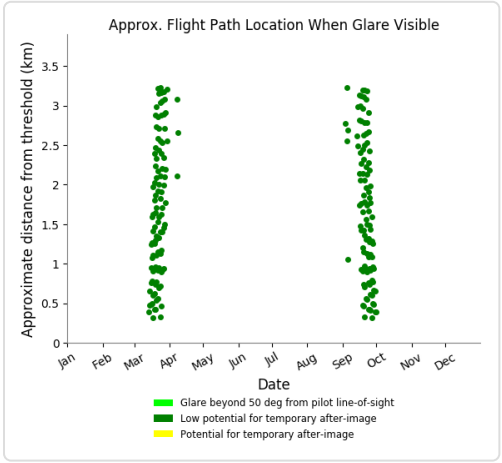


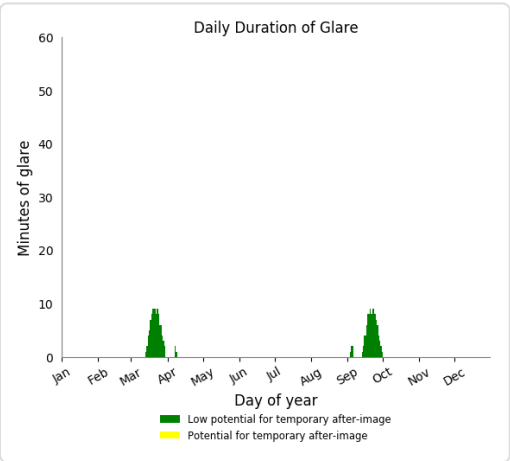
Flight Path: 28 Runway

0 minutes of yellow glare

207 minutes of green glare



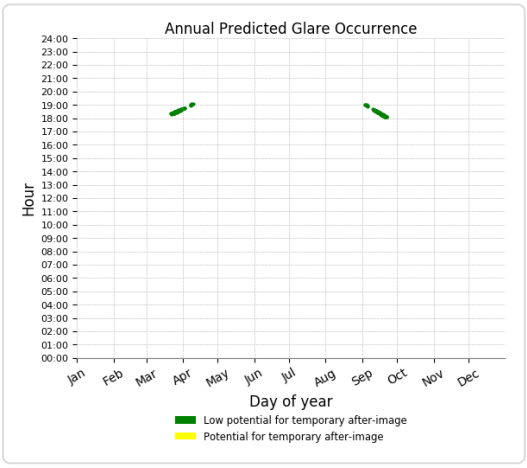


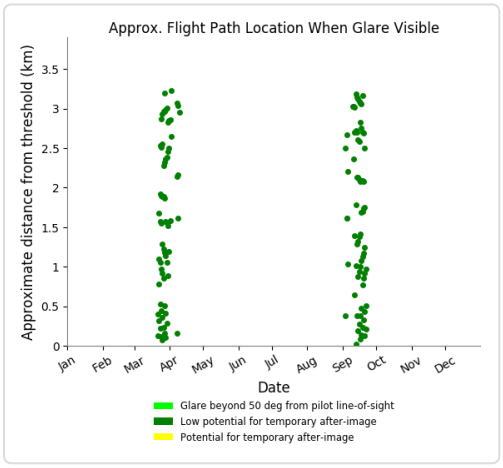


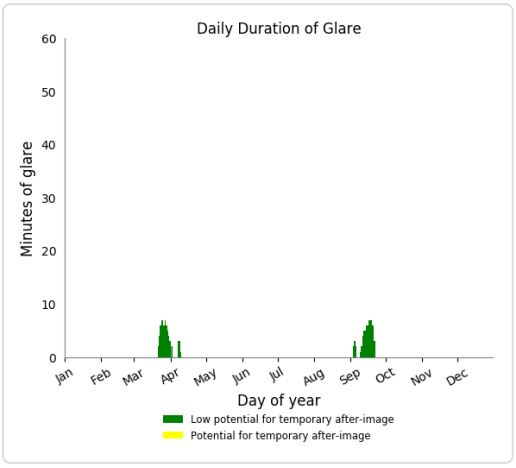
Flight Path: 28 Runway 2-4M

0 minutes of yellow glare

140 minutes of green glare



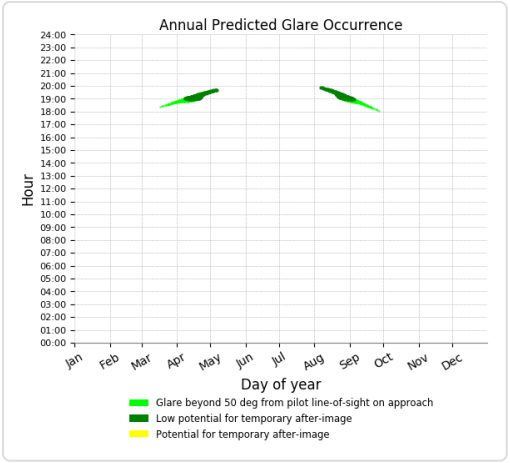


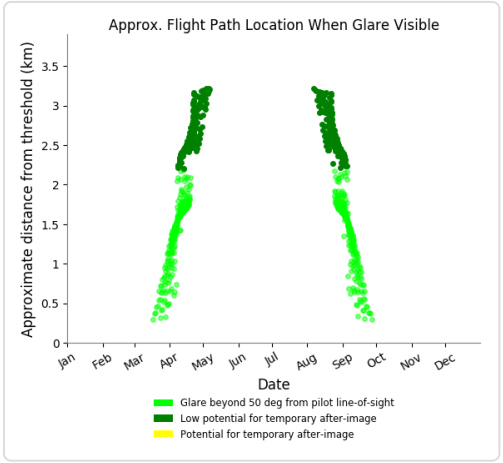


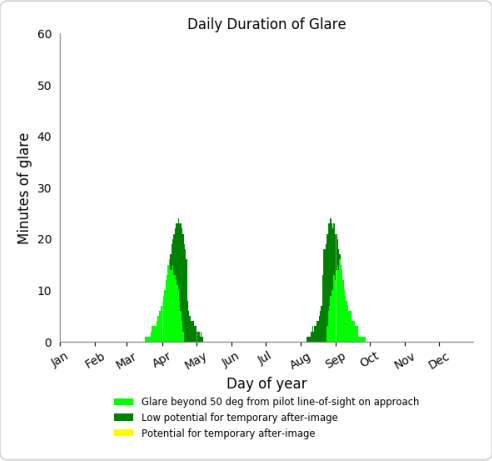
Flight Path: 34 Runway

0 minutes of yellow glare

474 minutes of green glare



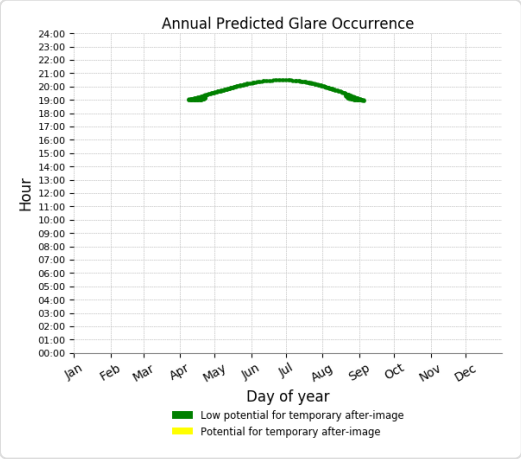


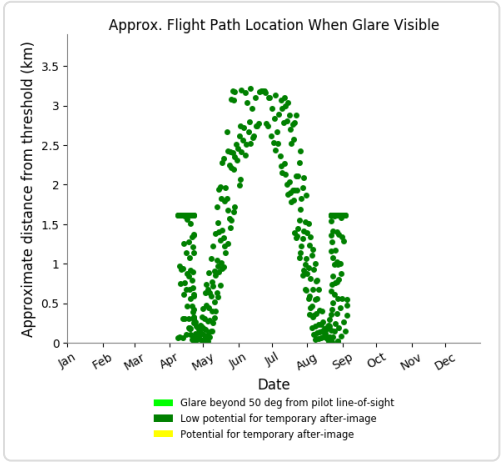


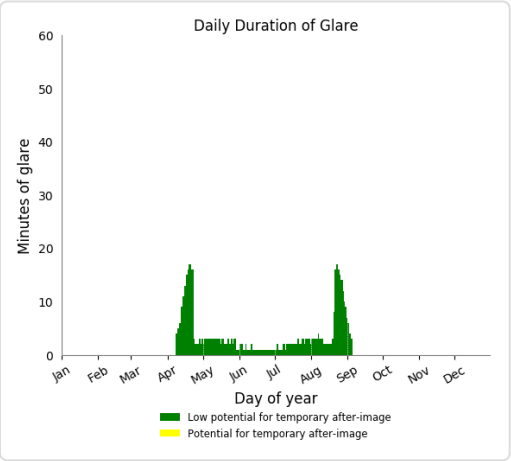
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

590 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section B

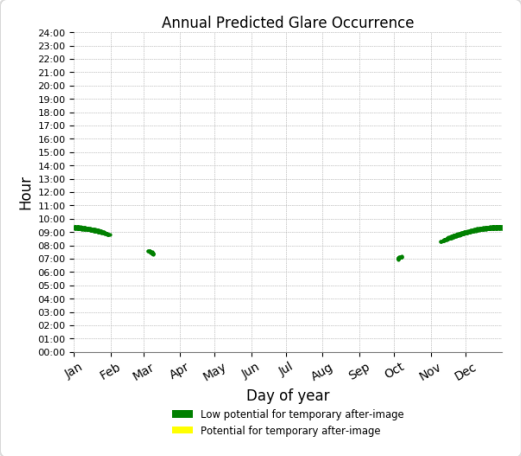
Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	606	0
10 Runway	780	0
10 Runway 2-4M	1669	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	36	0
28R Runway 2-4M	0	0
28 Runway	113	0
28 Runway 2-4M	138	0
34 Runway	477	0
36 Runway 2-4M	604	0
ATCT 1	0	0
ATCT 2	0	0

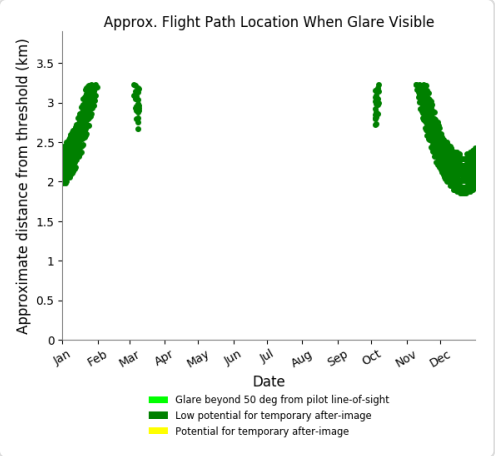
Flight Path: 10L Runway

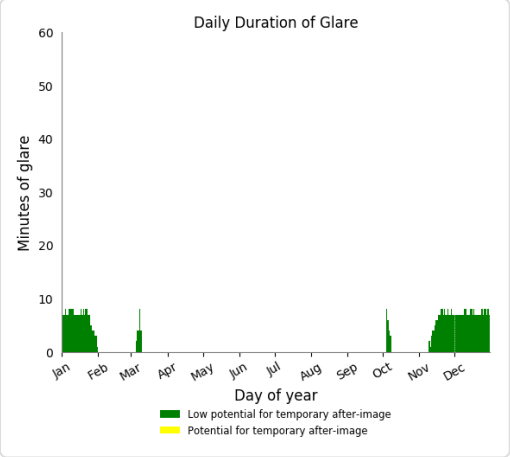
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
606 minutes of green glare



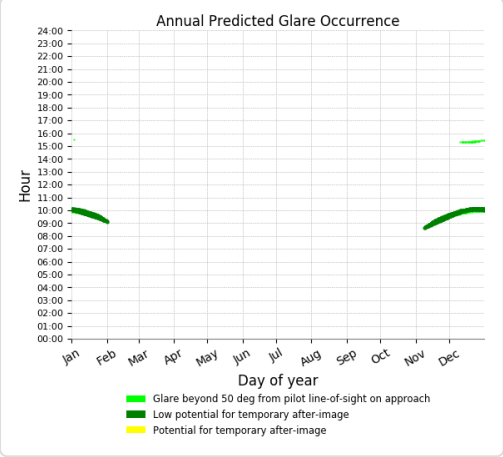


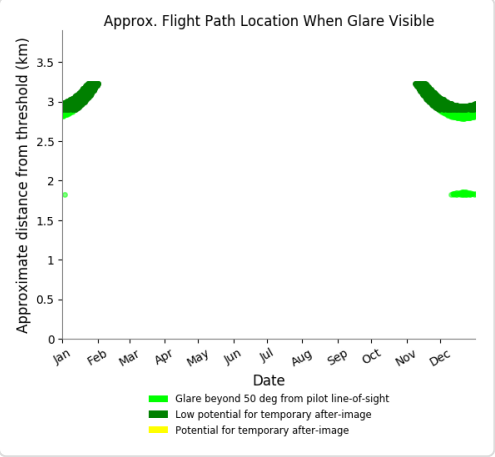


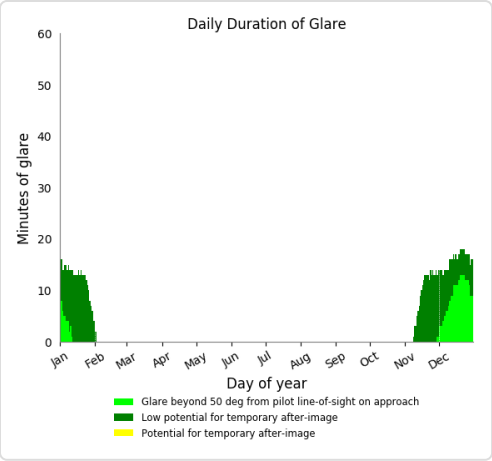
Flight Path: 10 Runway

0 minutes of yellow glare

780 minutes of green glare



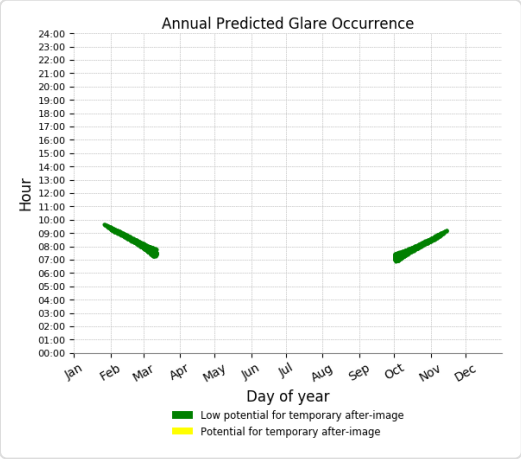


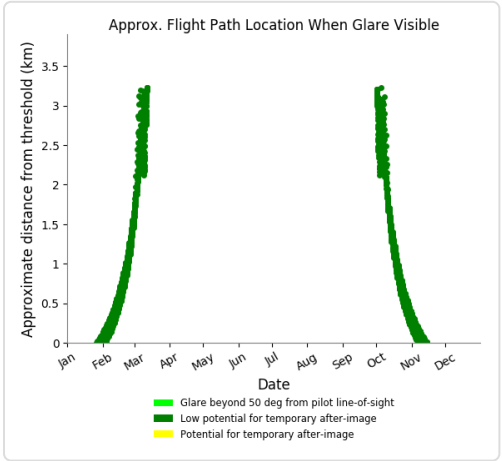


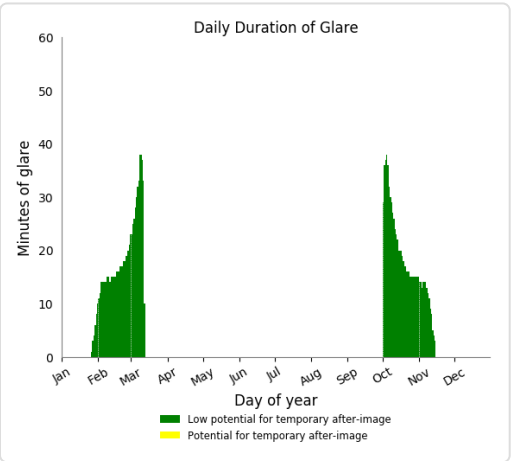
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

1669 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare

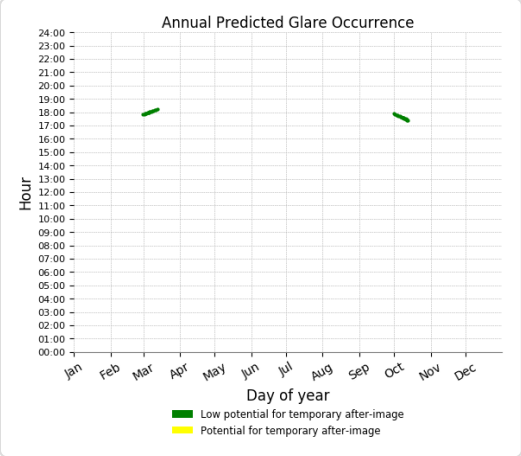
0 minutes of green glare

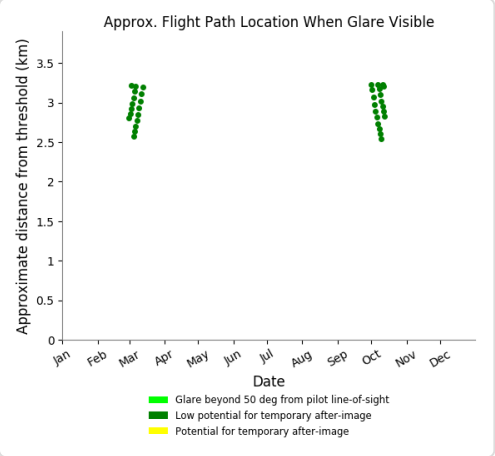
Flight Path: 16 Runway 2-4M

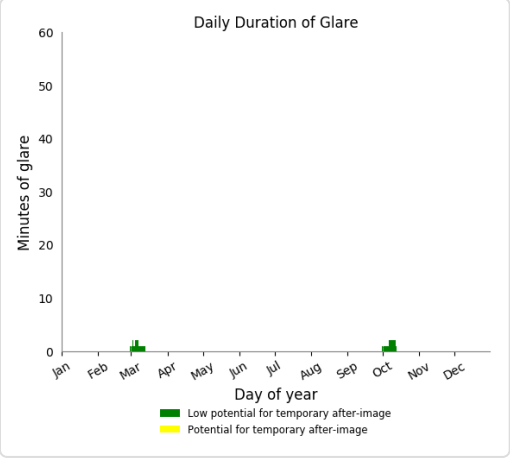
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
36 minutes of green glare





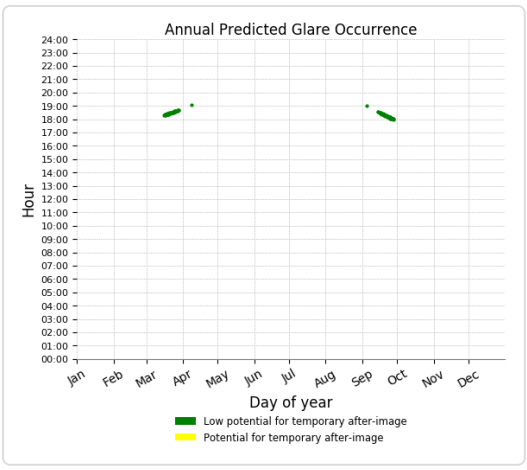


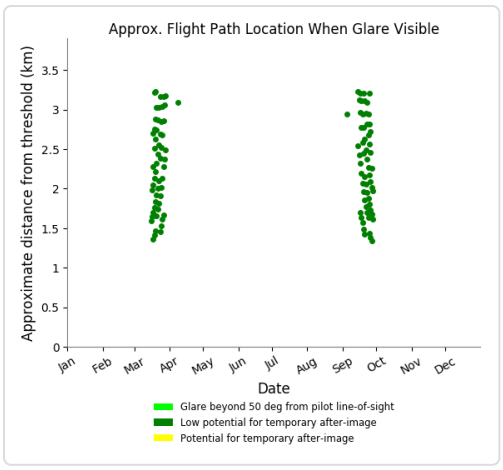
Flight Path: 28R Runway 2-4M

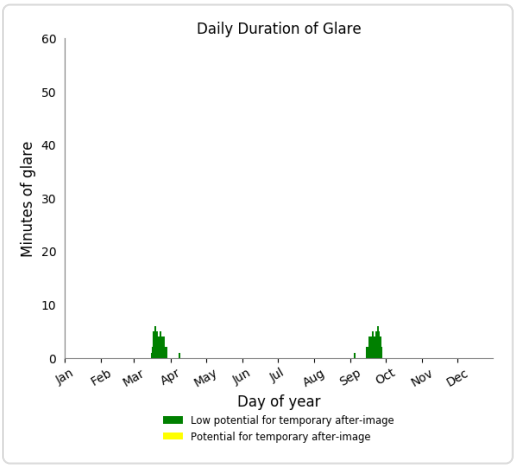
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway

0 minutes of yellow glare
113 minutes of green glare



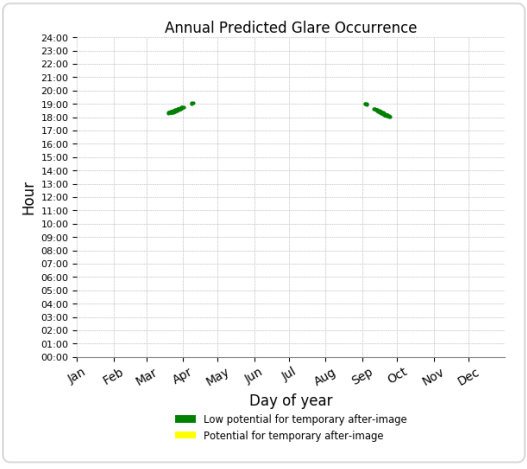


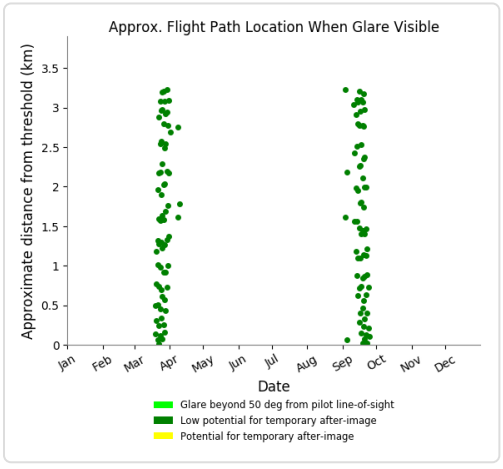


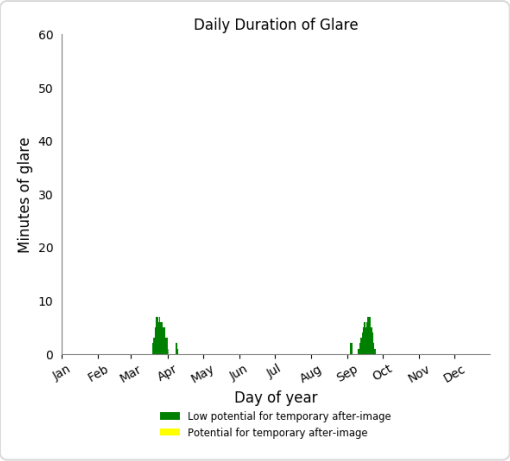
Flight Path: 28 Runway 2-4M

0 minutes of yellow glare

138 minutes of green glare



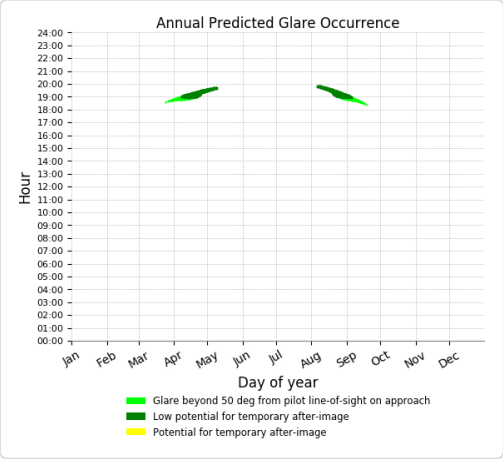


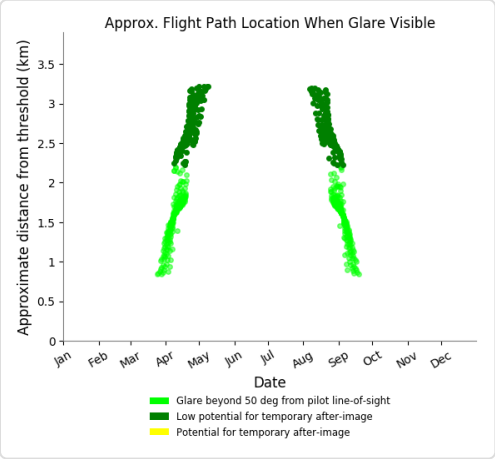


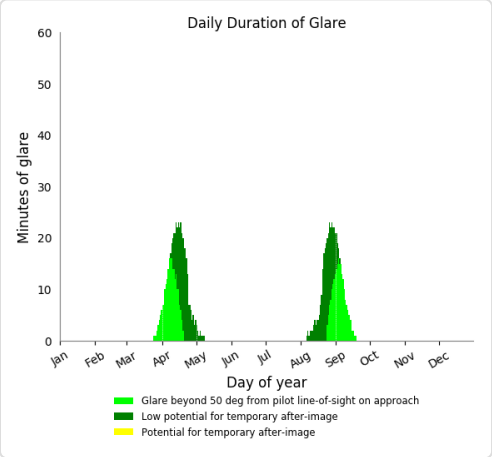
Flight Path: 34 Runway

0 minutes of yellow glare

477 minutes of green glare



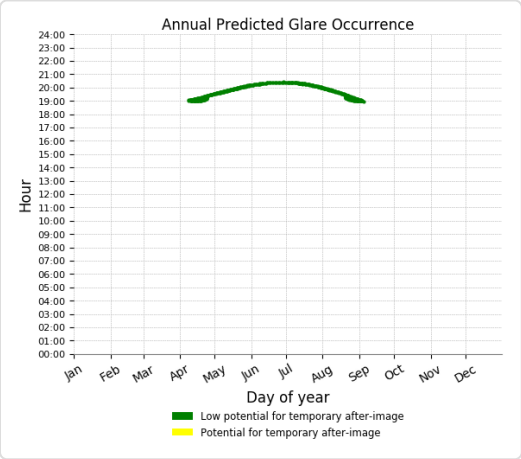


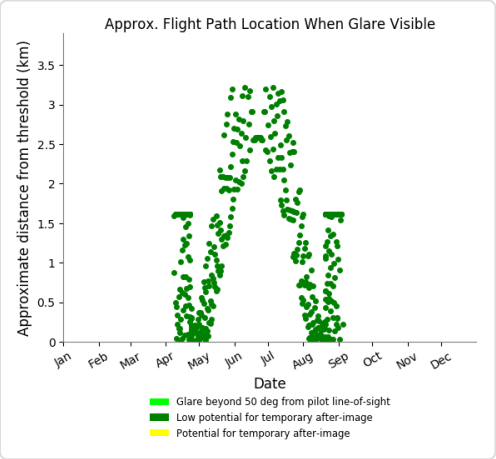


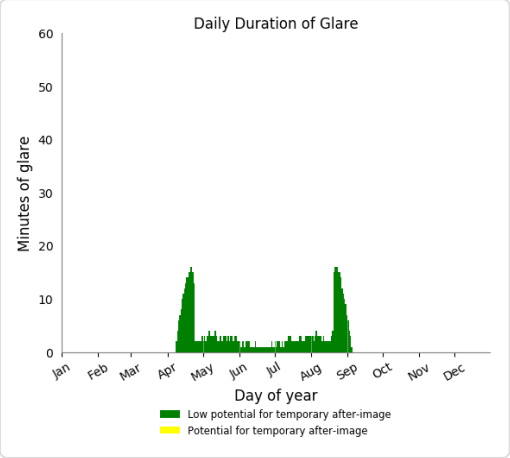
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

604 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section C

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	536	0
10 Runway	815	0
10 Runway 2-4M	1709	0

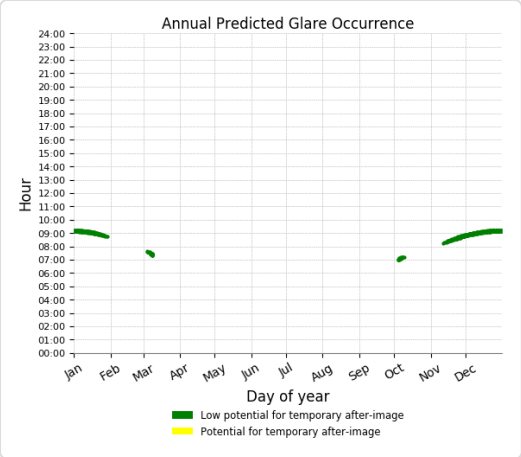
Receptor	Green Glare (min)	Yellow Glare (min)
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	35	0
28 Runway 2-4M	151	0
34 Runway	472	0
36 Runway 2-4M	615	0
ATCT 1	0	0
ATCT 2	0	0

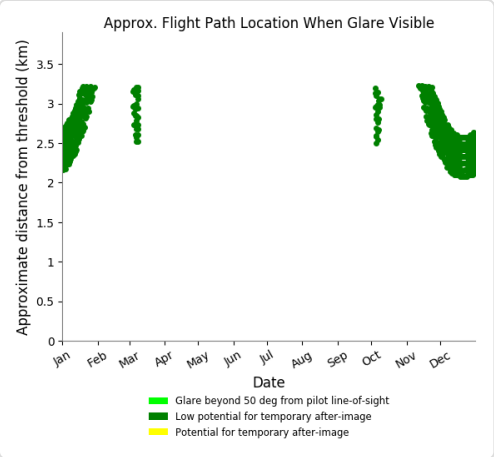
Flight Path: 10L Runway

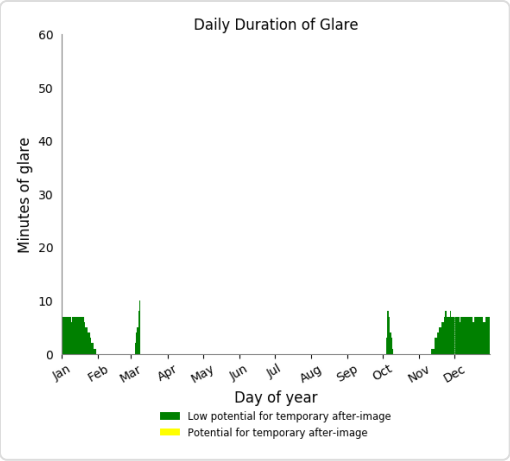
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
536 minutes of green glare



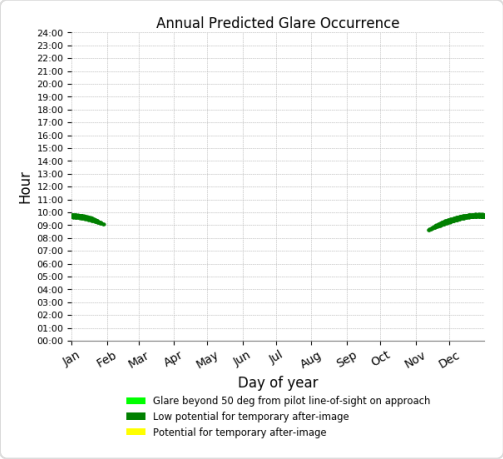


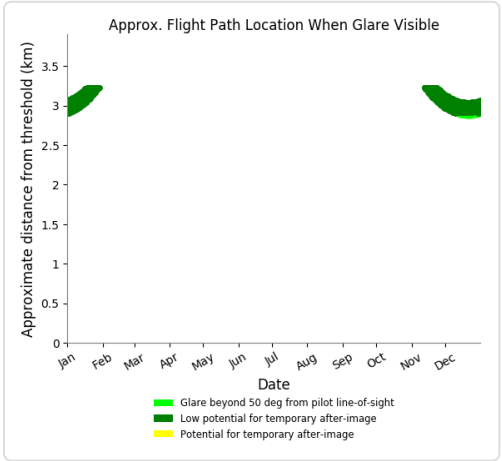


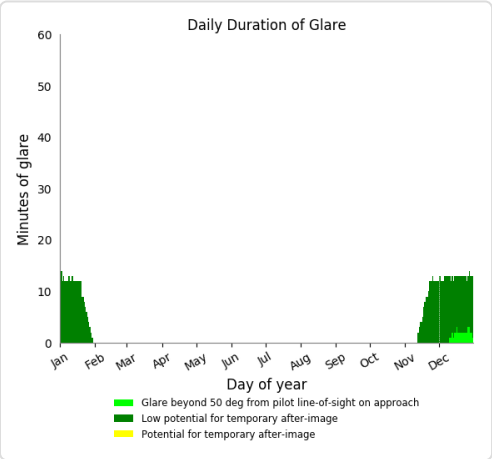
Flight Path: 10 Runway

0 minutes of yellow glare

815 minutes of green glare



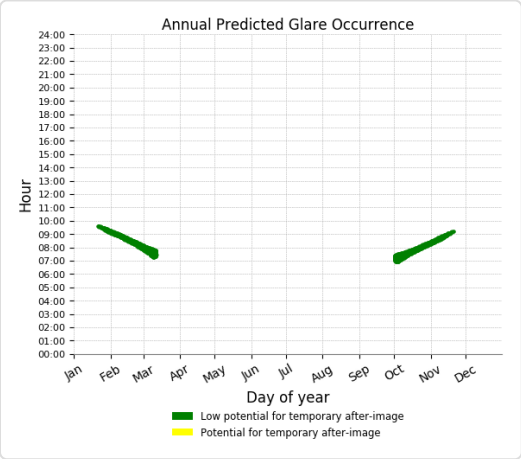


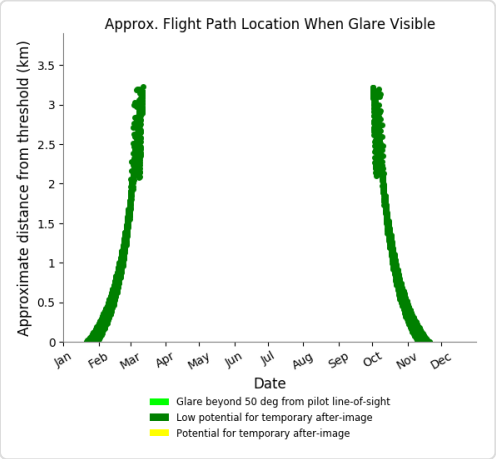


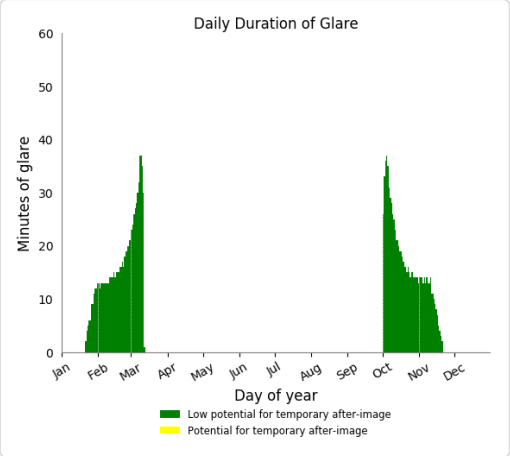
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

1709 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

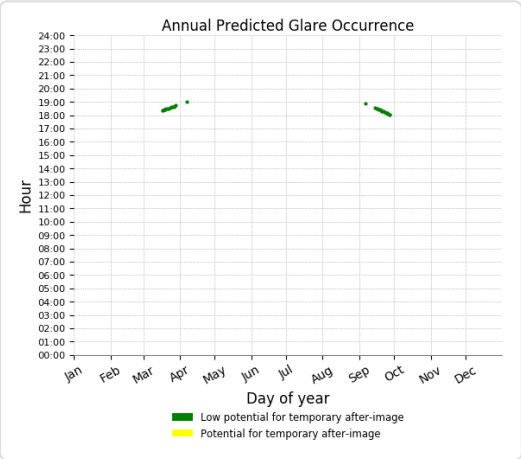
Flight Path: 28R Runway 2-4M

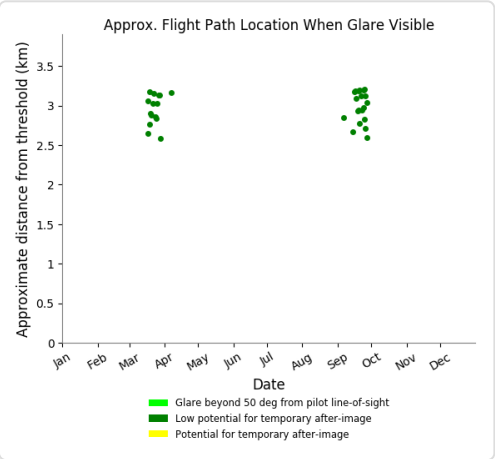
0 minutes of yellow glare
0 minutes of green glare

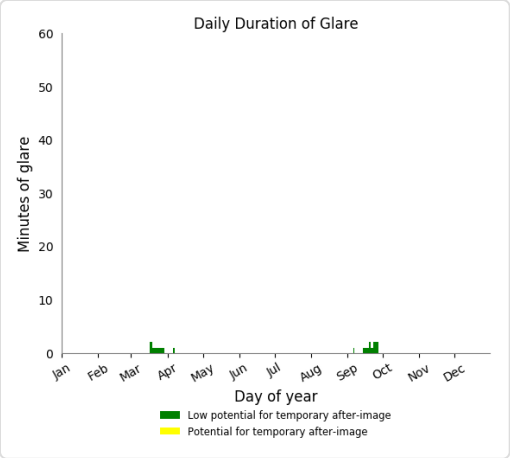
Flight Path: 28 Runway

0 minutes of yellow glare

35 minutes of green glare



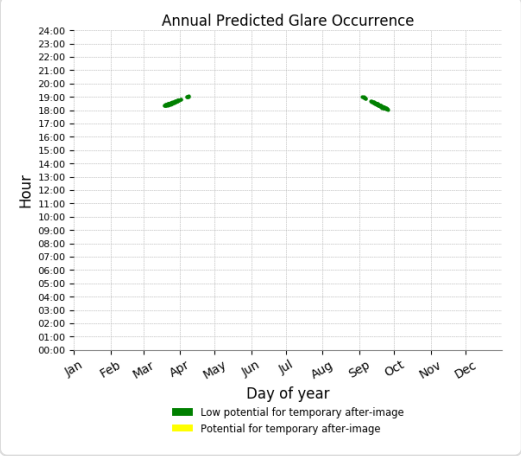


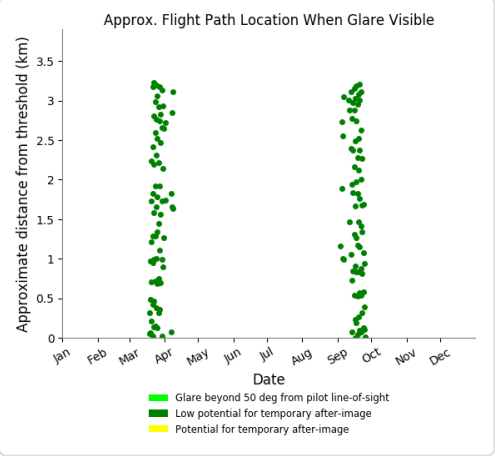


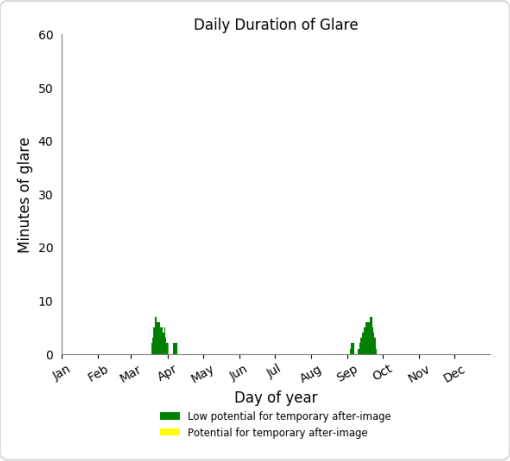
Flight Path: 28 Runway 2-4M

0 minutes of yellow glare

151 minutes of green glare



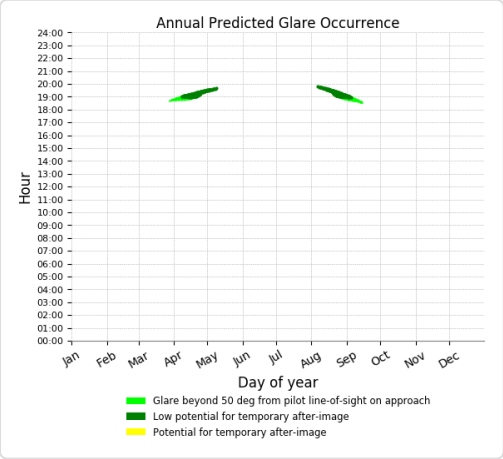


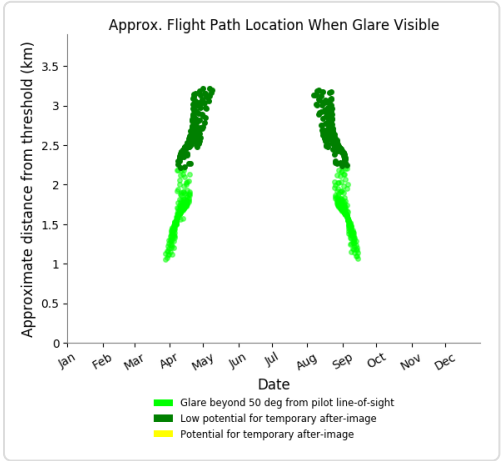


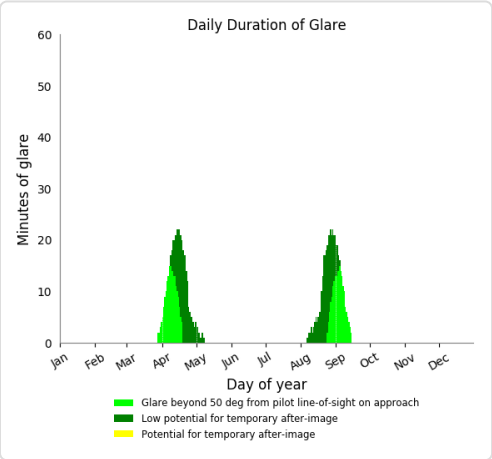
Flight Path: 34 Runway

0 minutes of yellow glare

472 minutes of green glare



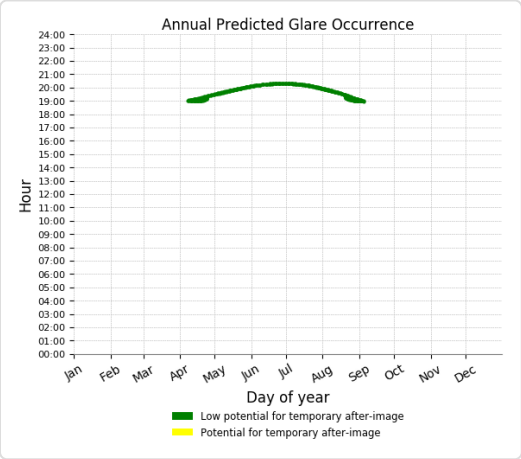


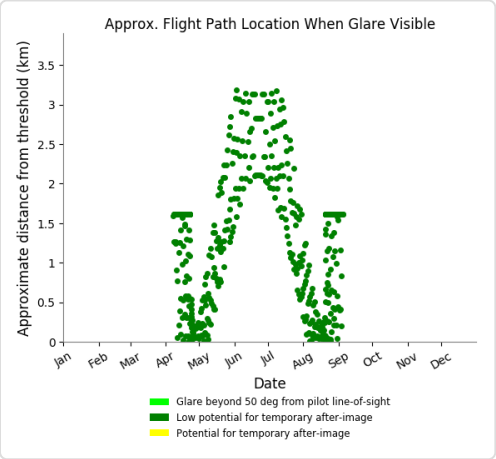


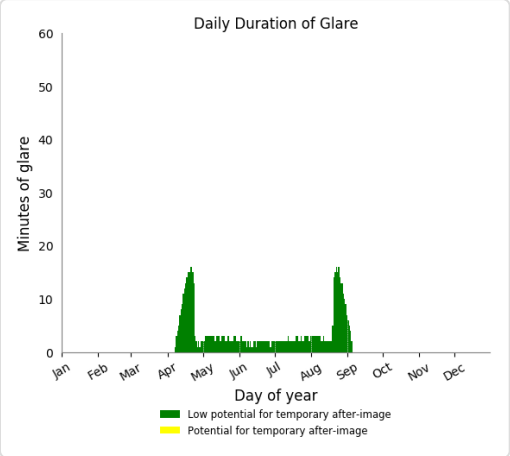
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

615 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section D

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	455	0
10 Runway	652	0
10 Runway 2-4M	1725	0

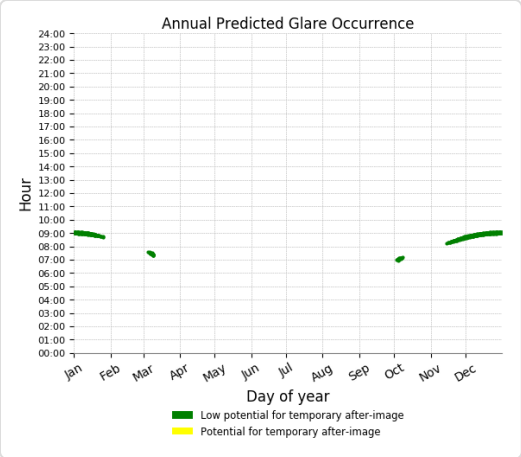
Receptor	Green Glare (min)	Yellow Glare (min)
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	0	0
28 Runway 2-4M	93	0
34 Runway	474	0
36 Runway 2-4M	592	0
ATCT 1	0	0
ATCT 2	0	0

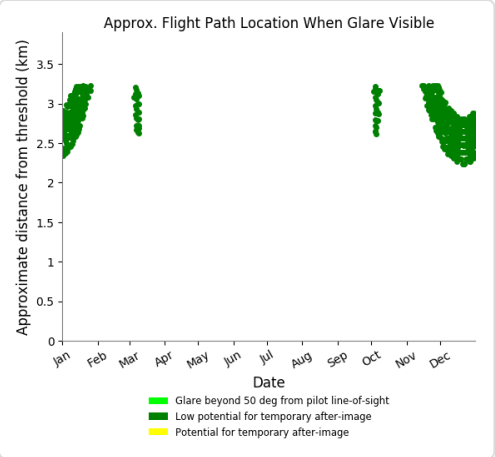
Flight Path: 10L Runway

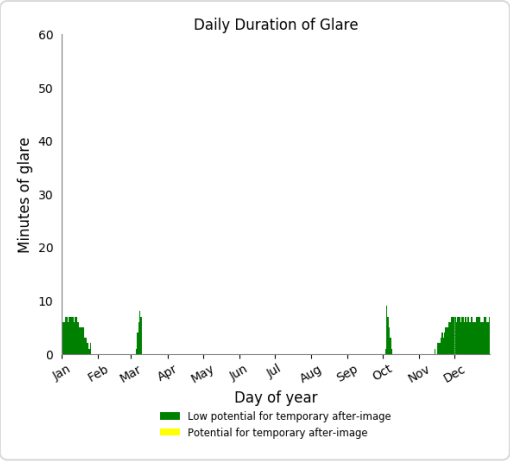
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
455 minutes of green glare



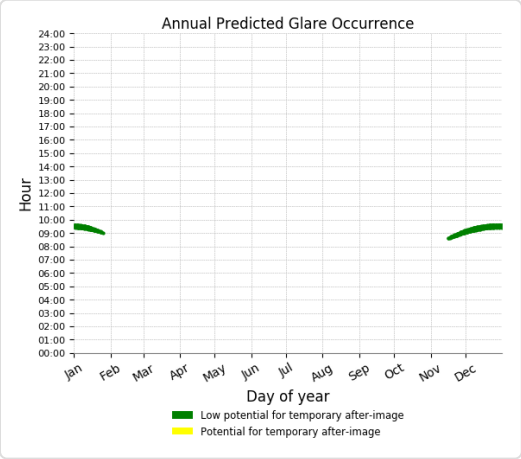


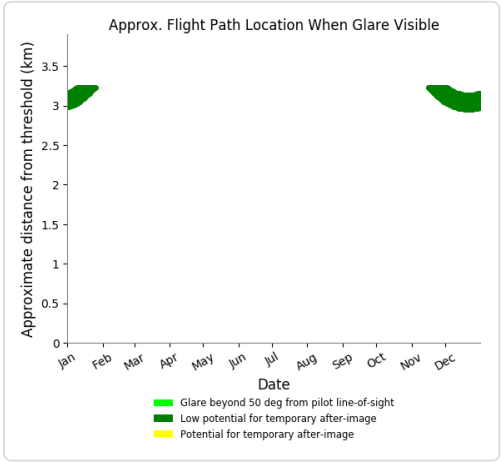


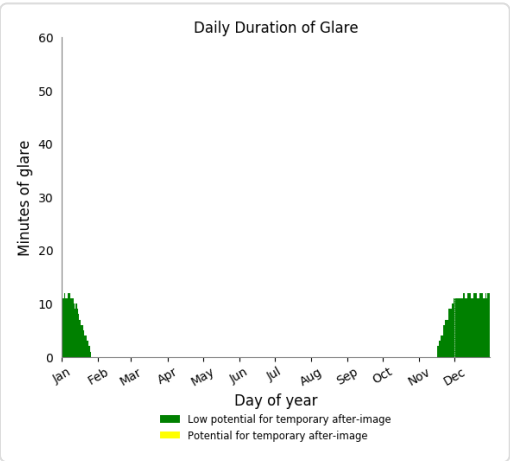
Flight Path: 10 Runway

0 minutes of yellow glare

652 minutes of green glare



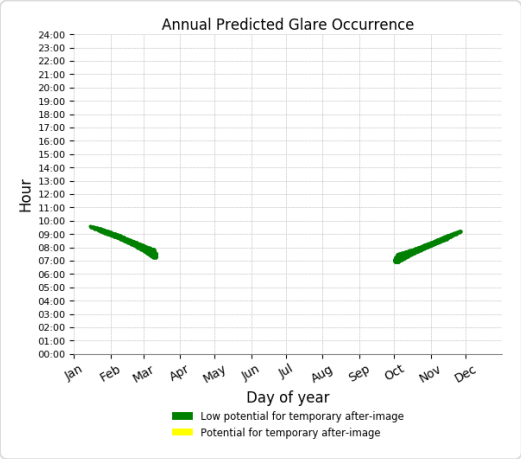


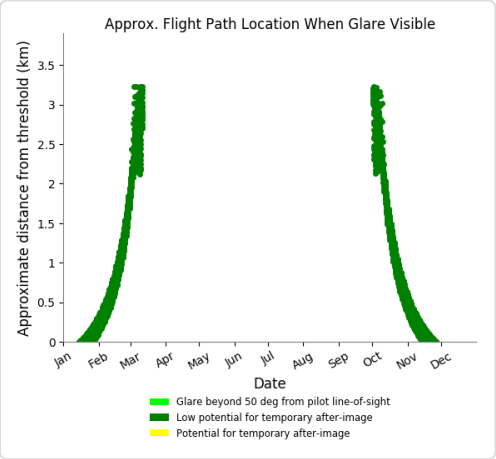


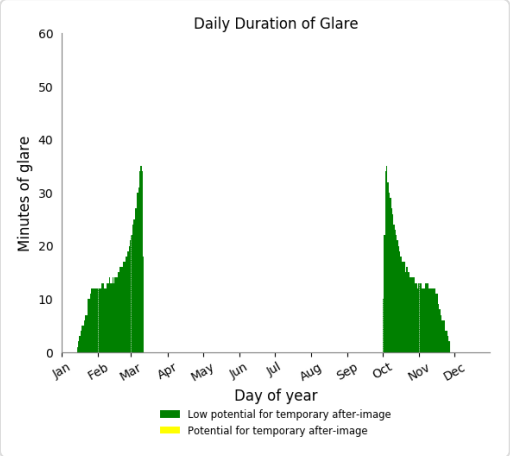
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

1725 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway 2-4M

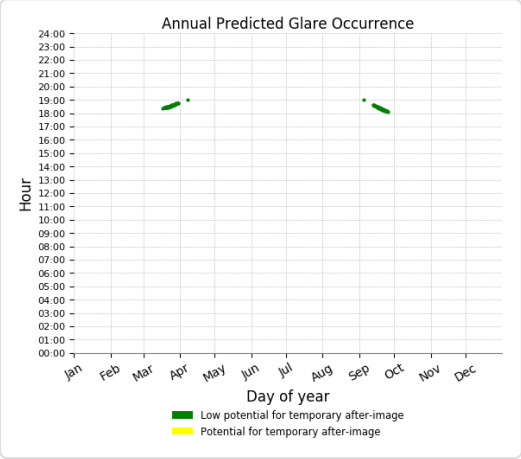
0 minutes of yellow glare
0 minutes of green glare

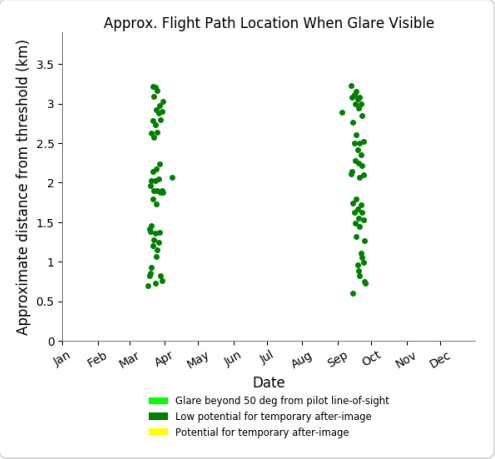
Flight Path: 28 Runway

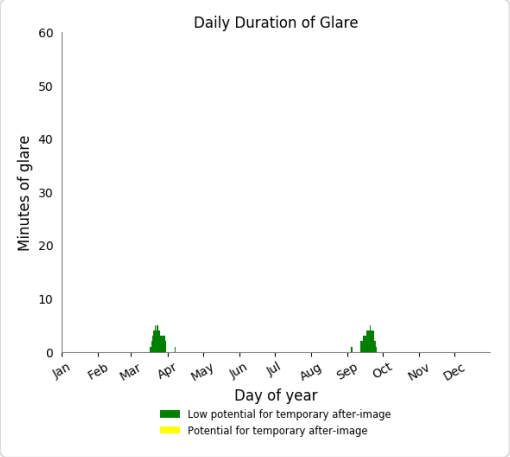
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway 2-4M

0 minutes of yellow glare
93 minutes of green glare

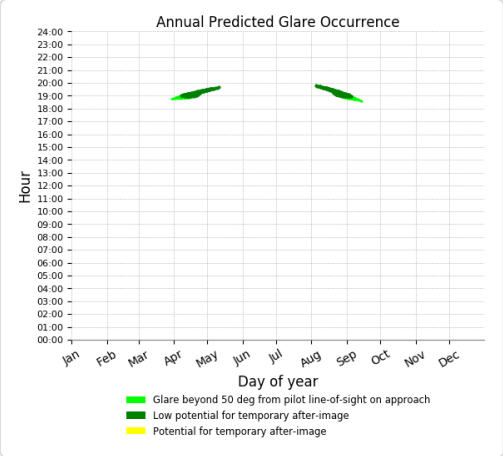


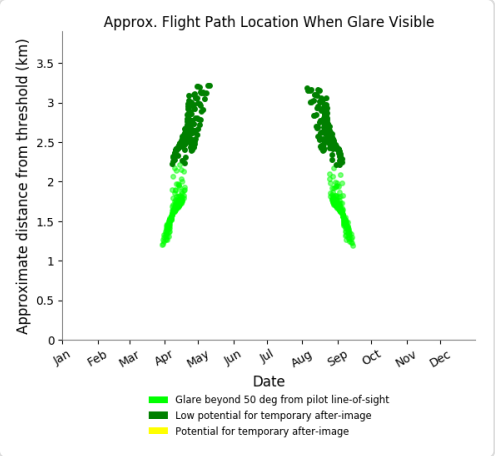


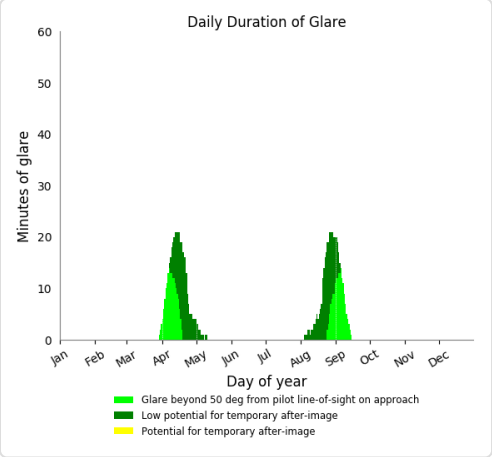


Flight Path: 34 Runway

0 minutes of yellow glare
474 minutes of green glare



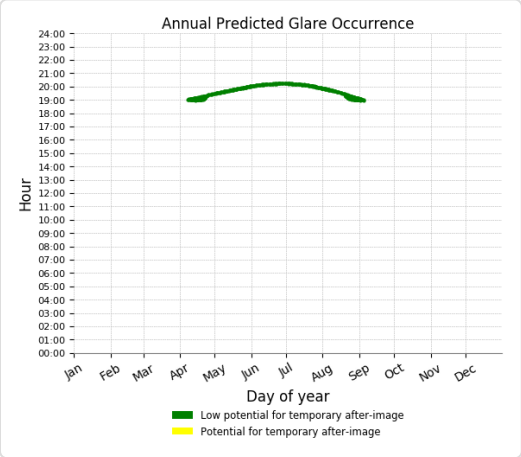


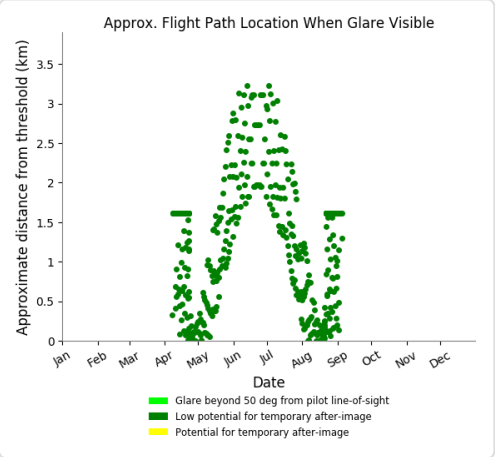


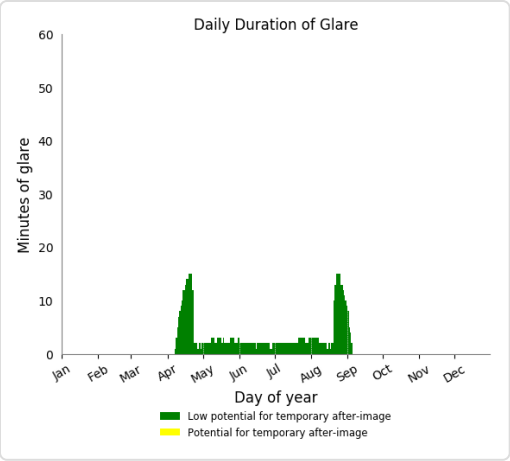
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

592 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section E

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	396	0
10 Runway	478	0
10 Runway 2-4M	1824	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	0	0
28 Runway 2-4M	24	0
34 Runway	485	0
36 Runway 2-4M	602	0
ATCT 1	0	0
ATCT 2	0	0

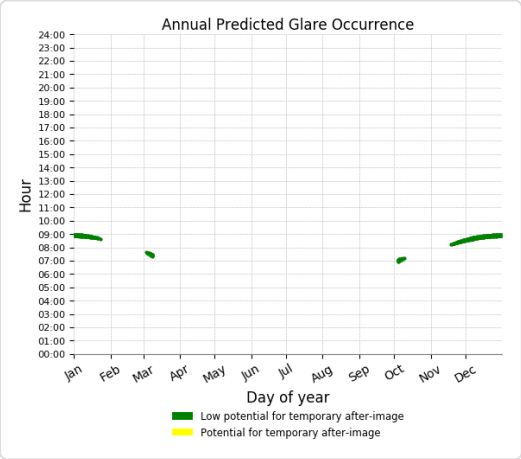
Flight Path: 10L Runway

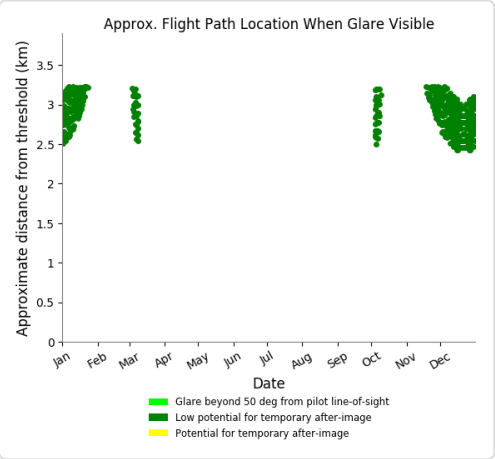
0 minutes of yellow glare

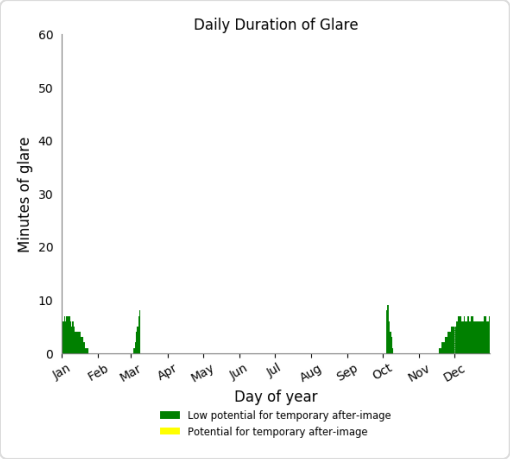
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
396 minutes of green glare

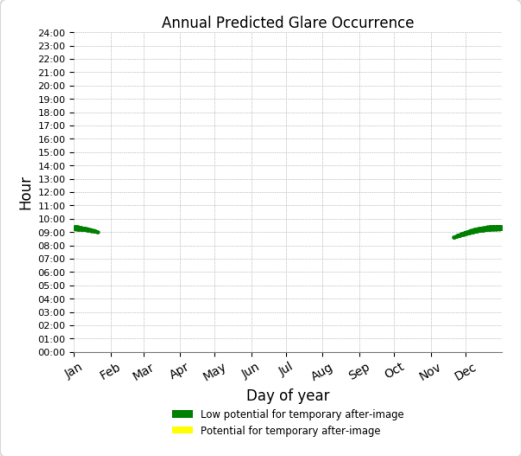


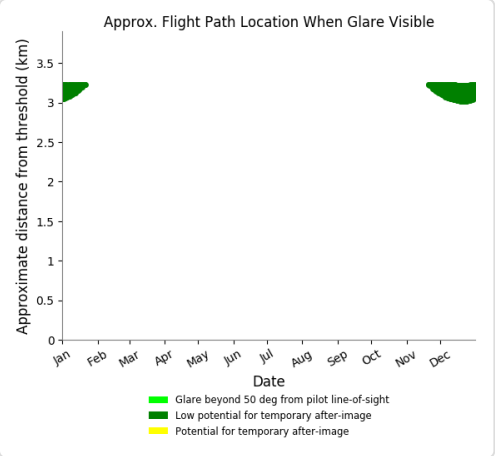


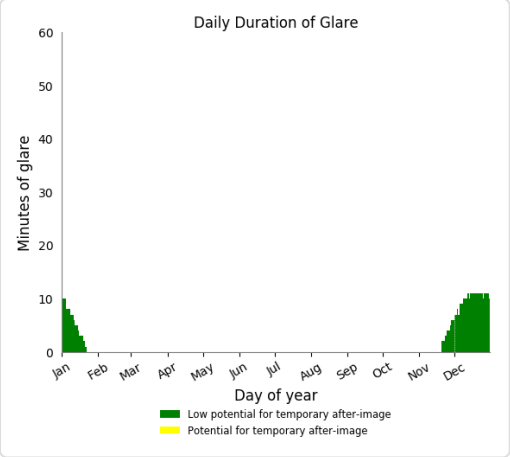


Flight Path: 10 Runway

0 minutes of yellow glare
478 minutes of green glare



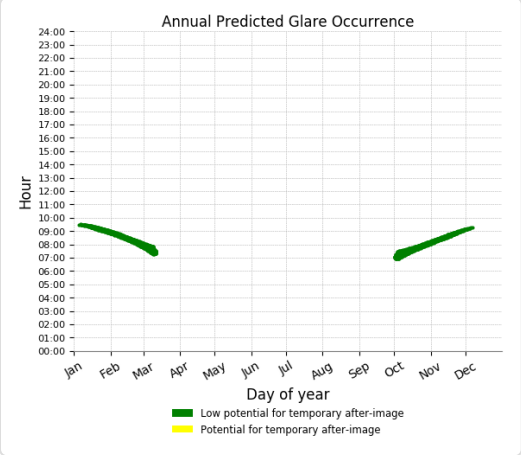


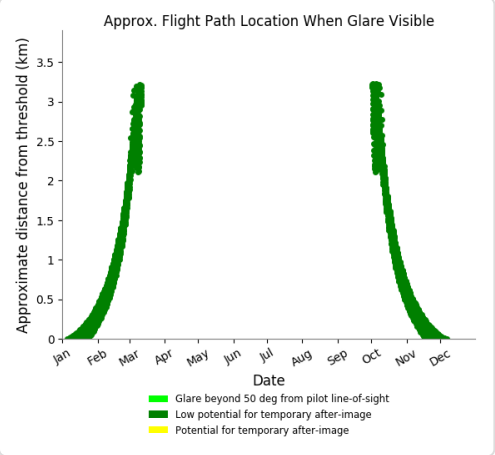


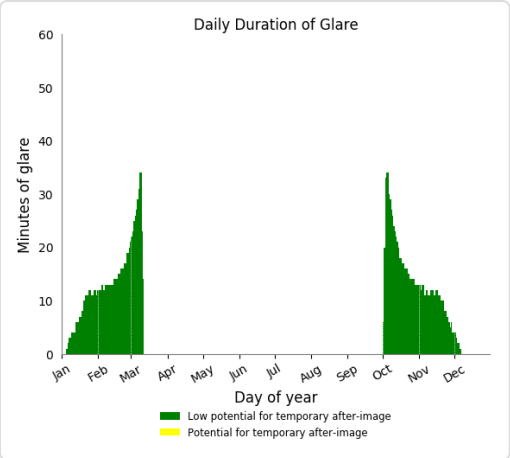
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

1824 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway 2-4M

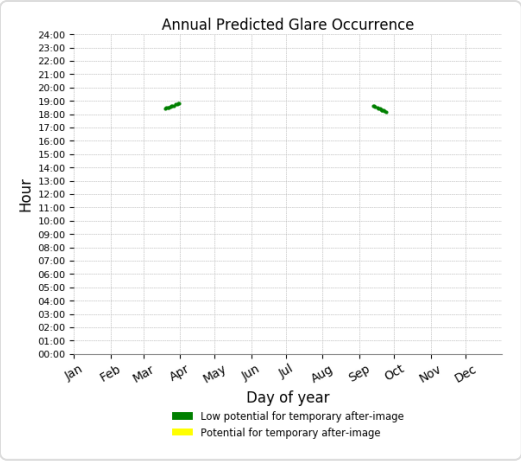
0 minutes of yellow glare
0 minutes of green glare

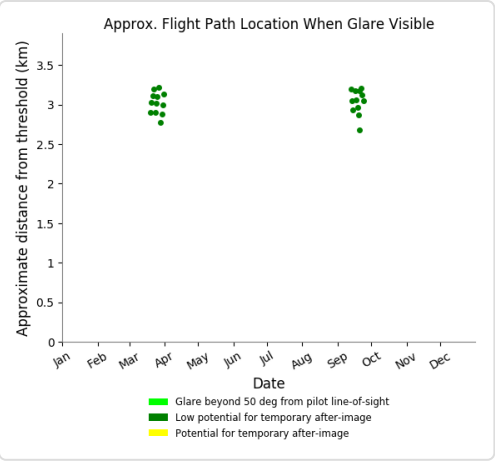
Flight Path: 28 Runway

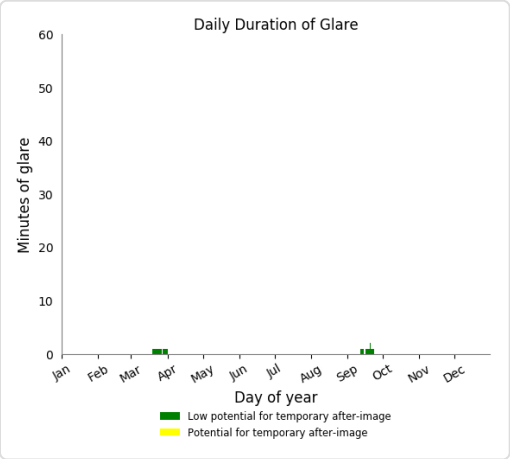
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway 2-4M

0 minutes of yellow glare
24 minutes of green glare



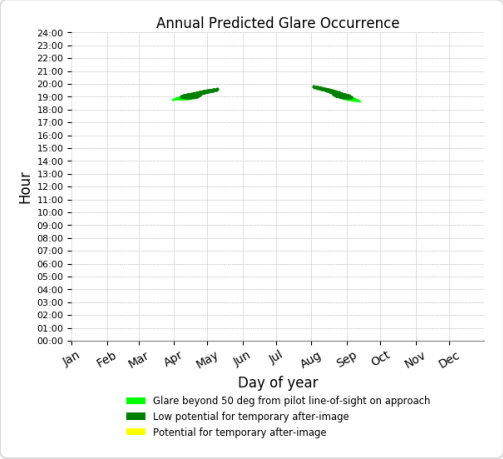


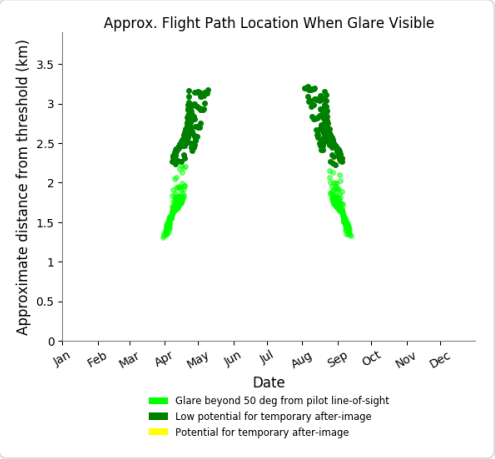


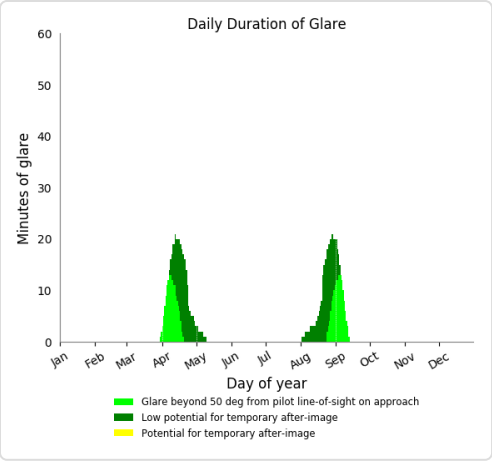
Flight Path: 34 Runway

0 minutes of yellow glare

485 minutes of green glare



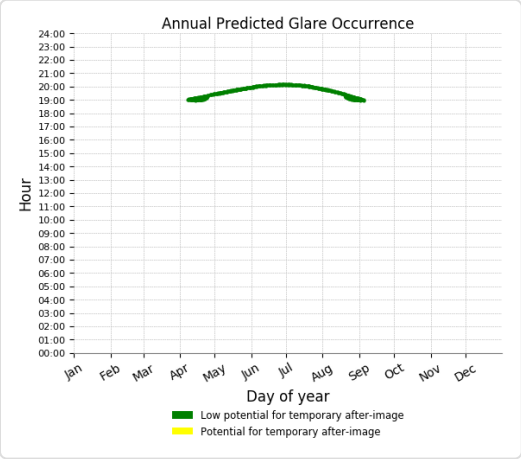


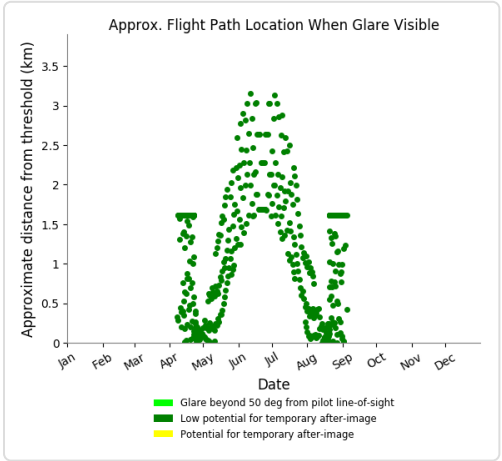


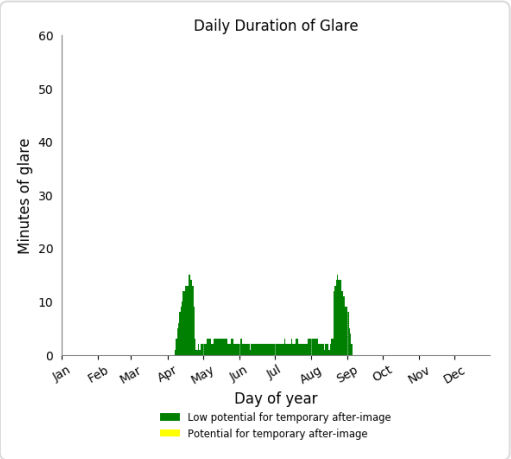
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

602 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section F

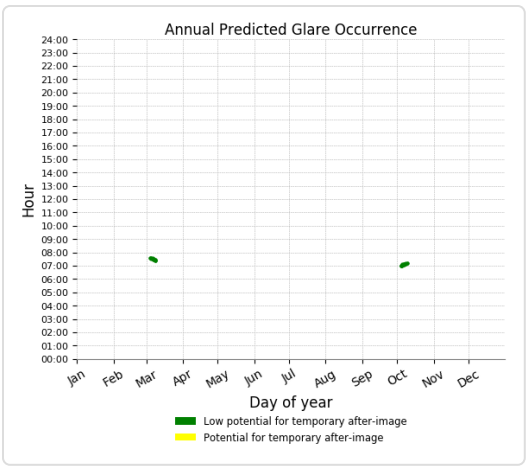
Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	44	0
10 Runway	140	0
10 Runway 2-4M	2060	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	0	0
28 Runway 2-4M	0	0
34 Runway	472	0
36 Runway 2-4M	589	0
ATCT 1	0	0
ATCT 2	0	0

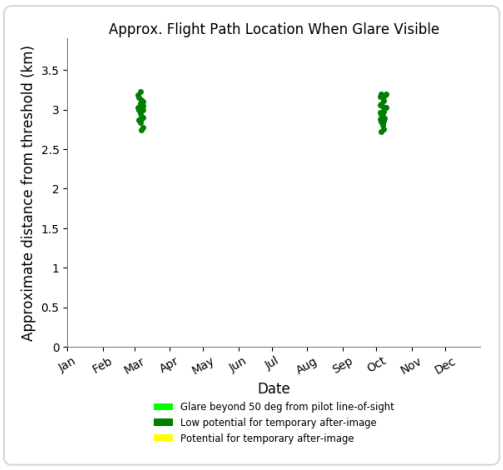
Flight Path: 10L Runway

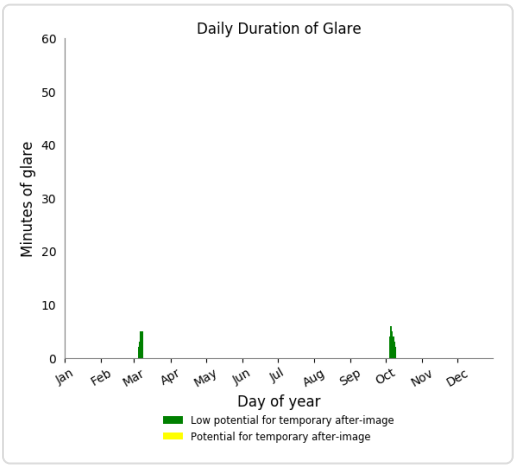
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
44 minutes of green glare



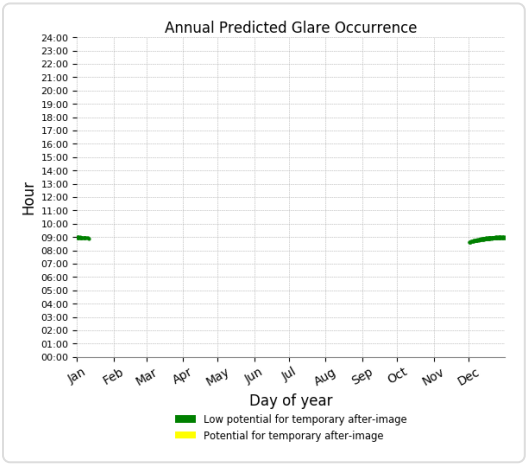


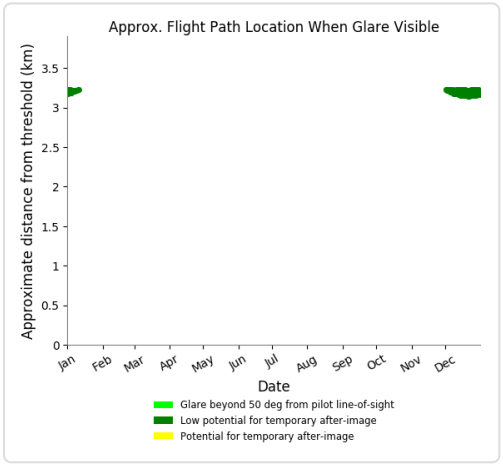


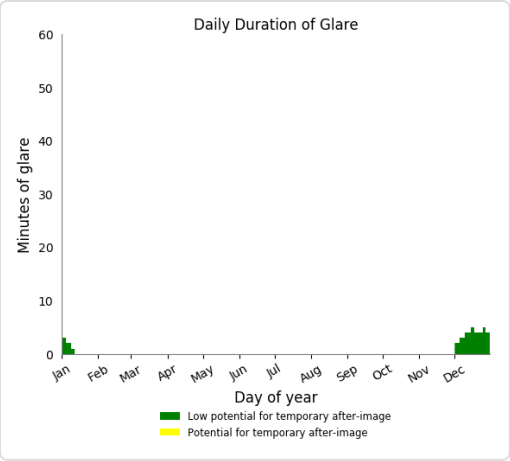
Flight Path: 10 Runway

0 minutes of yellow glare

140 minutes of green glare



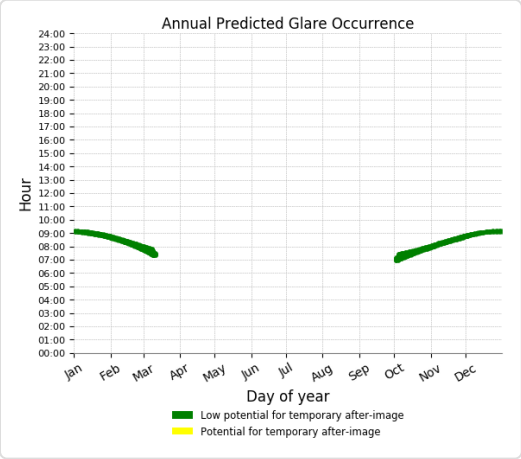


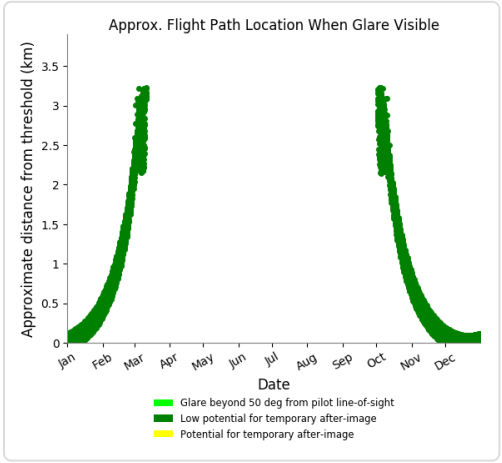


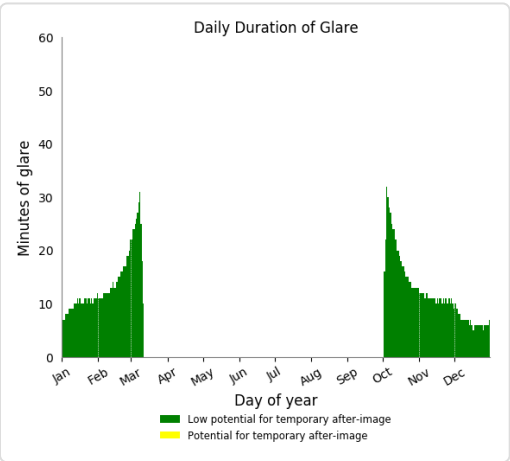
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

2060 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare

0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway

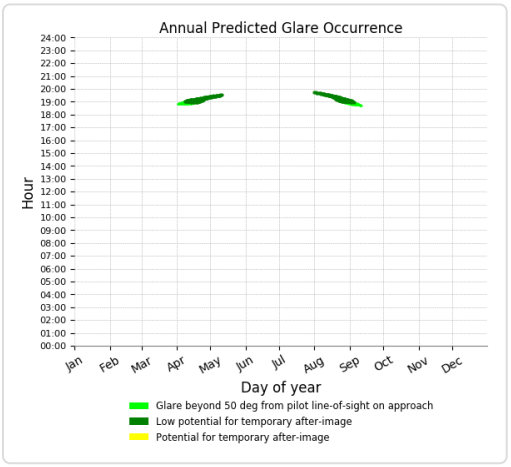
0 minutes of yellow glare
0 minutes of green glare

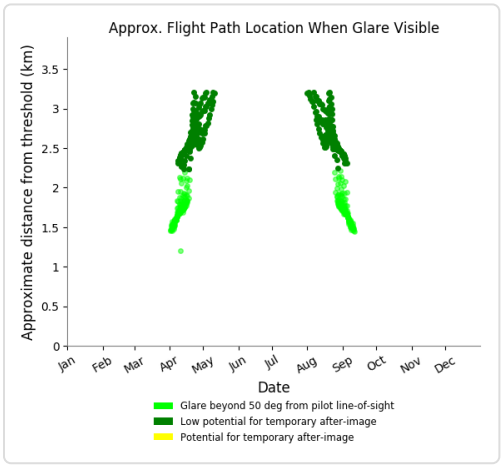
Flight Path: 28 Runway 2-4M

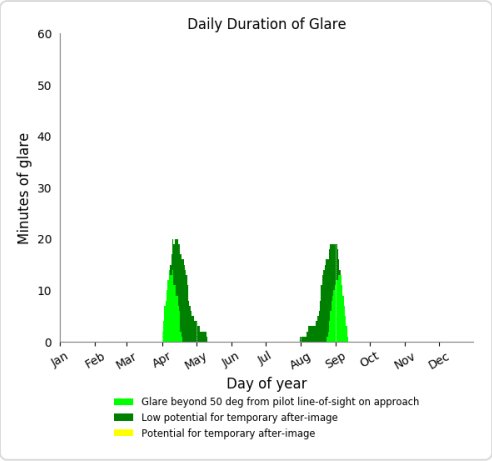
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
472 minutes of green glare



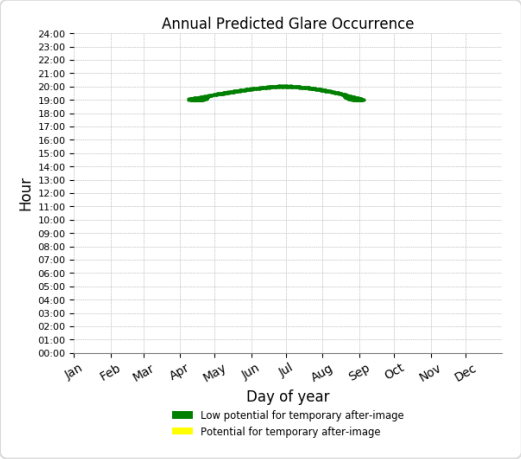


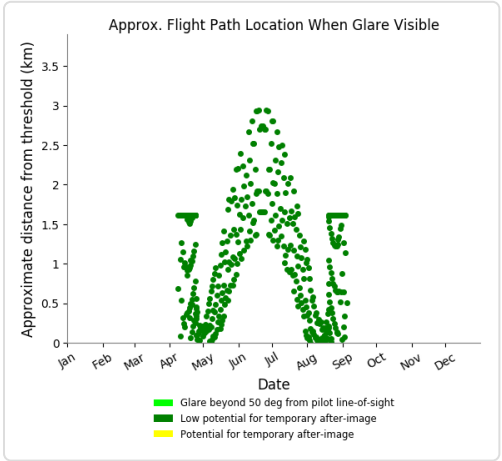


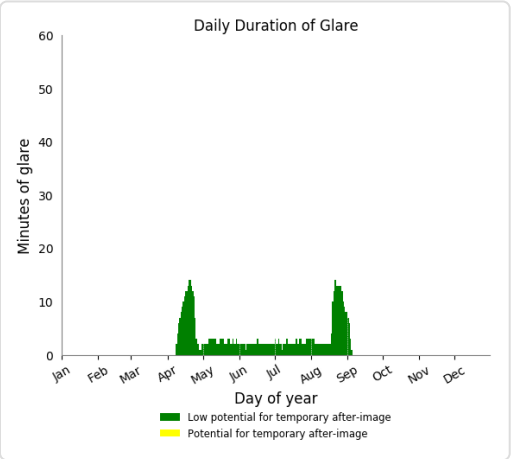
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

589 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section G

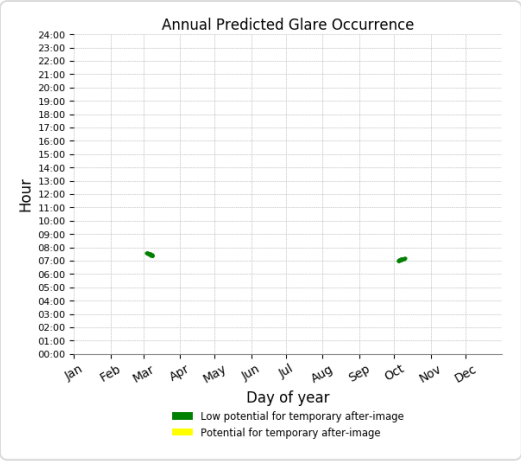
Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	44	0
10 Runway	44	0
10 Runway 2-4M	2073	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	0	0
28 Runway 2-4M	0	0
34 Runway	477	0
36 Runway 2-4M	591	0
ATCT 1	0	0
ATCT 2	0	0

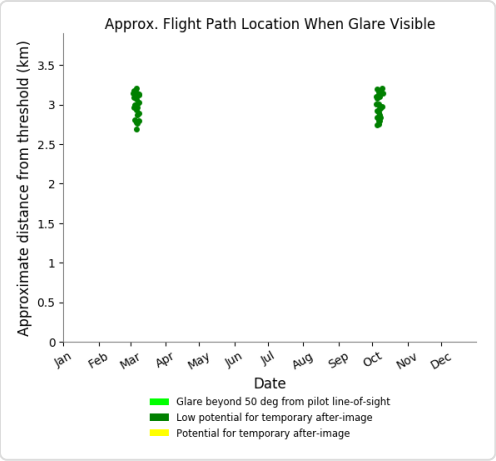
Flight Path: 10L Runway

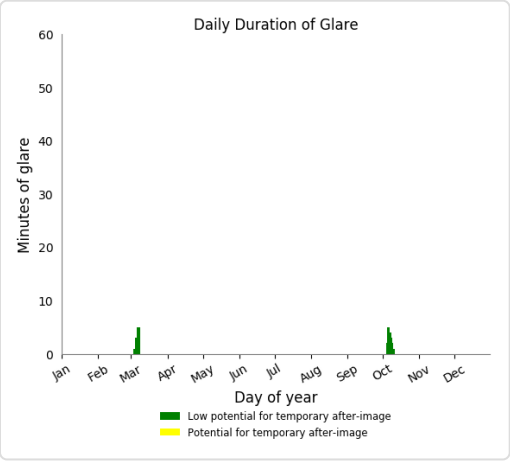
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
44 minutes of green glare



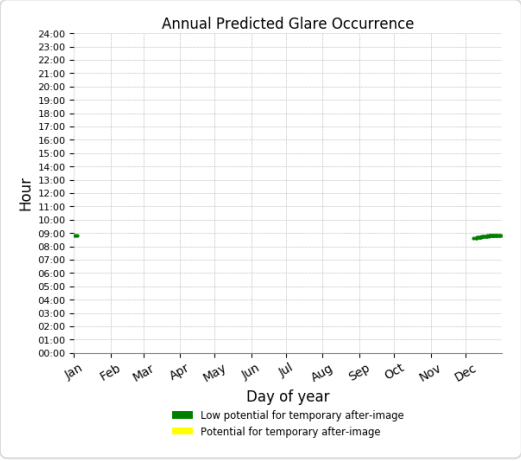


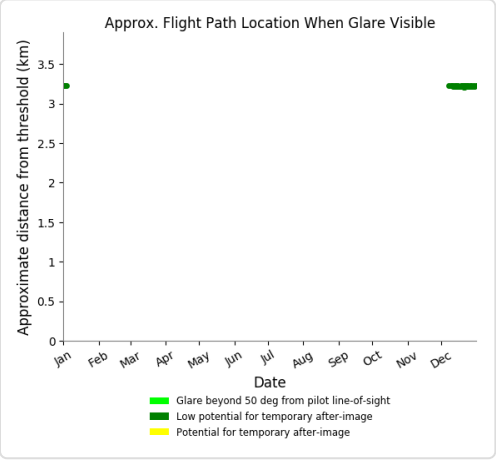


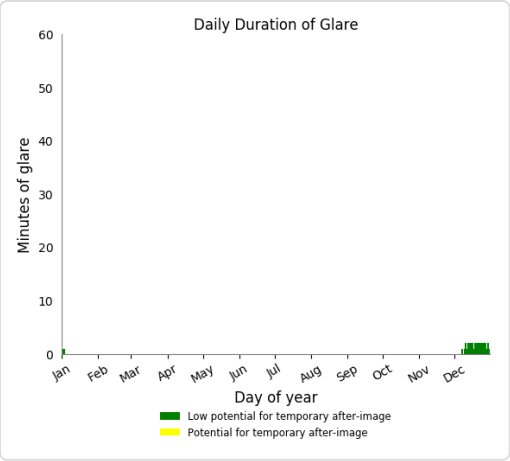
Flight Path: 10 Runway

0 minutes of yellow glare

44 minutes of green glare



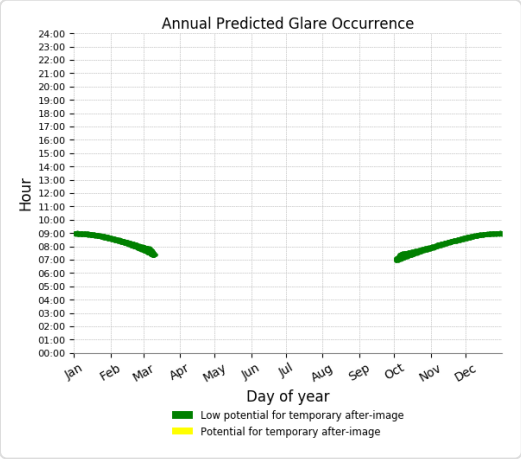


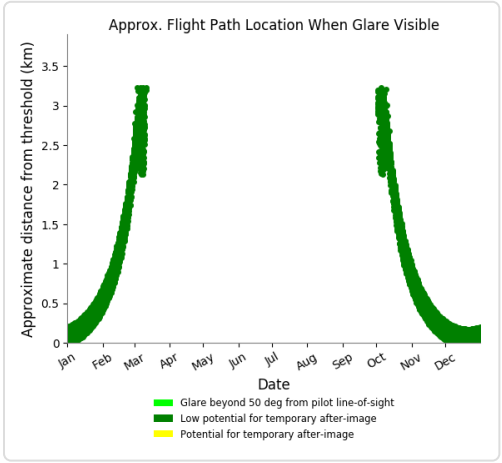


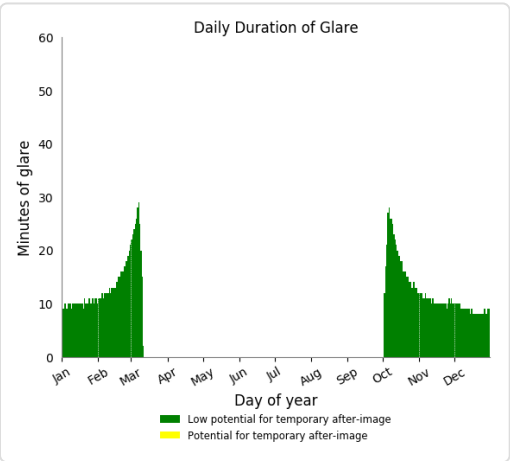
Flight Path: 10 Runway 2-4M

0 minutes of yellow glare

2073 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare

0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway

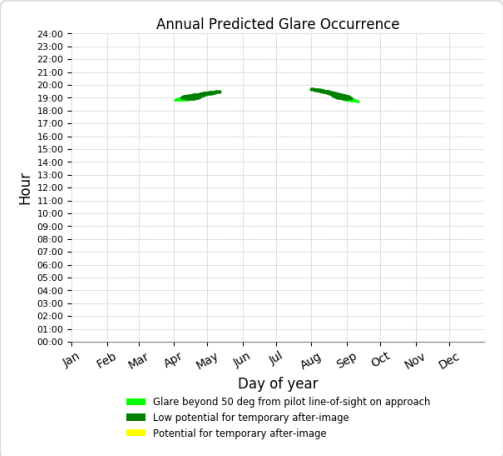
0 minutes of yellow glare
0 minutes of green glare

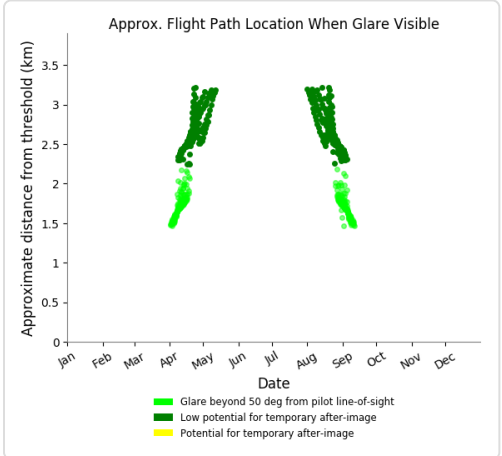
Flight Path: 28 Runway 2-4M

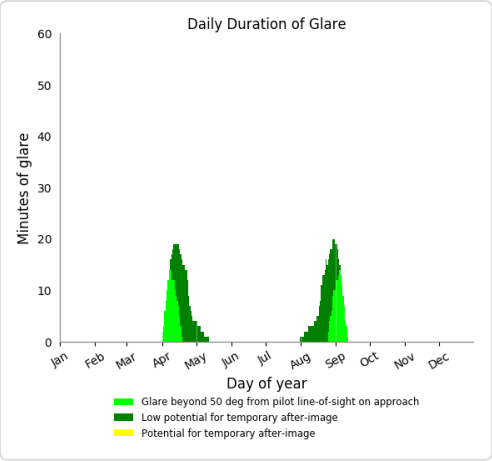
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
477 minutes of green glare



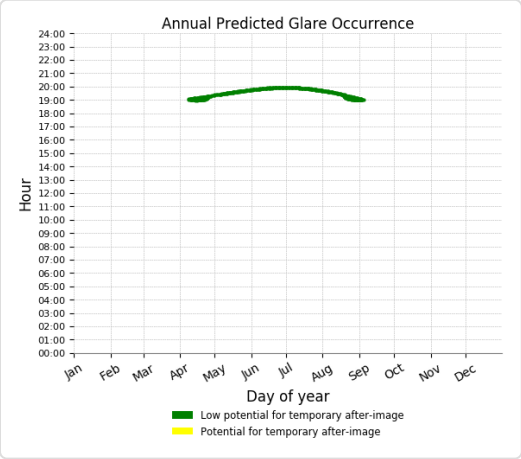


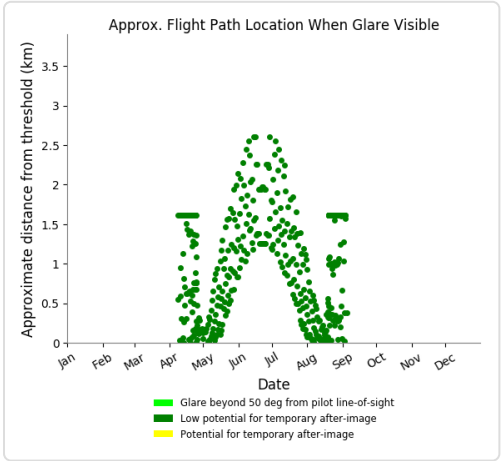


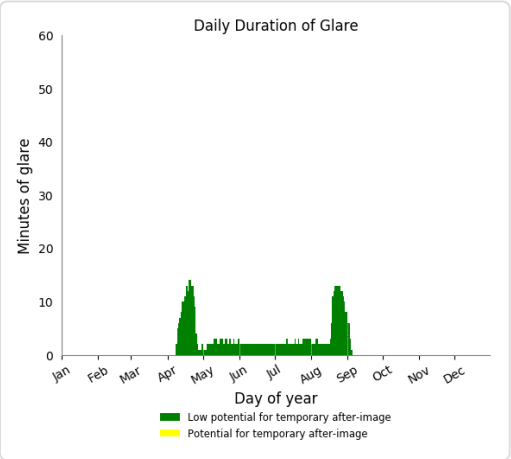
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

591 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section H

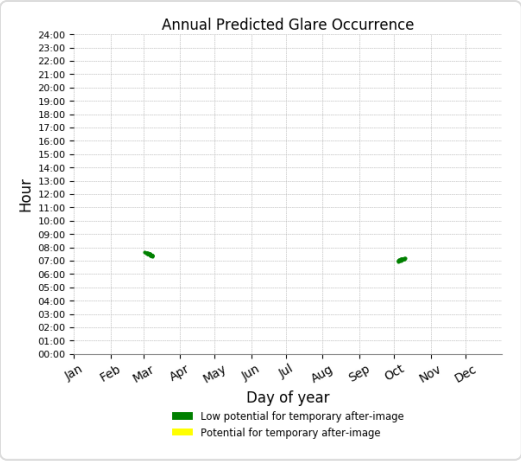
Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	58	0
10 Runway	0	0
10 Runway 2-4M	2002	0
16 Runway	0	0
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	0	0
28 Runway 2-4M	0	0
34 Runway	483	0
36 Runway 2-4M	591	0
ATCT 1	0	0
ATCT 2	0	0

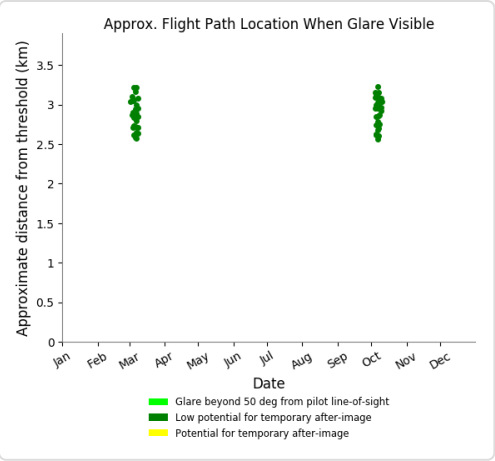
Flight Path: 10L Runway

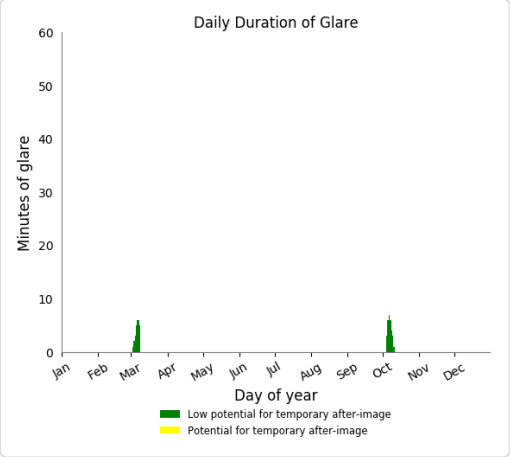
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
58 minutes of green glare





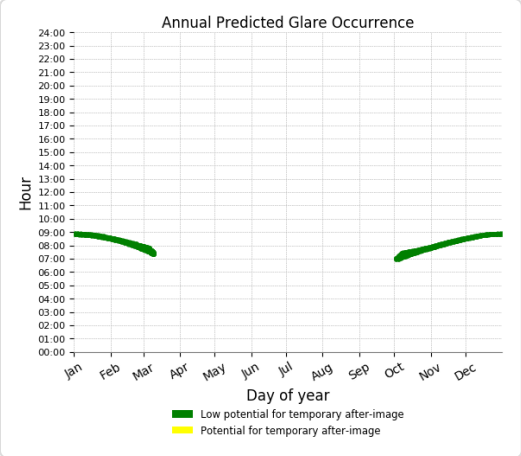


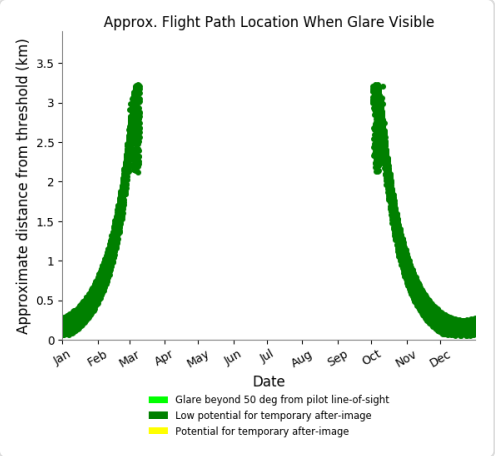
Flight Path: 10 Runway

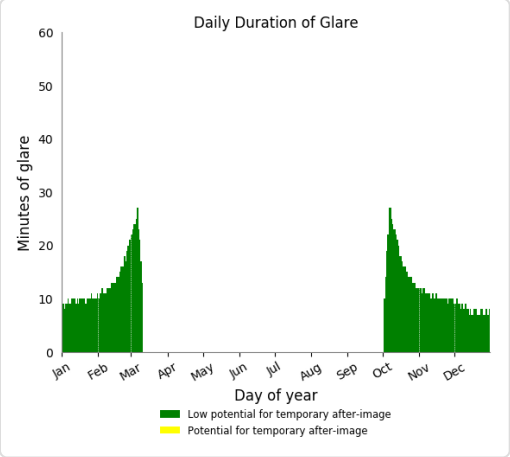
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10 Runway 2-4M

0 minutes of yellow glare
2002 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway

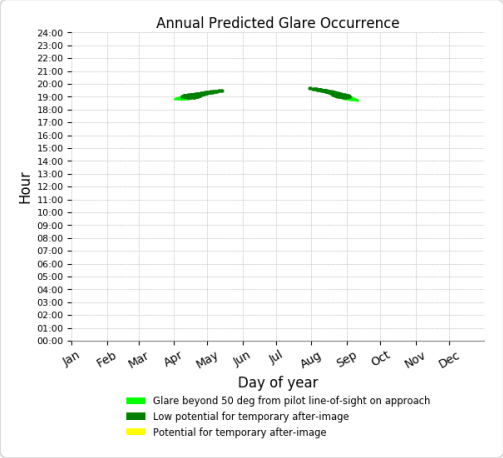
0 minutes of yellow glare
0 minutes of green glare

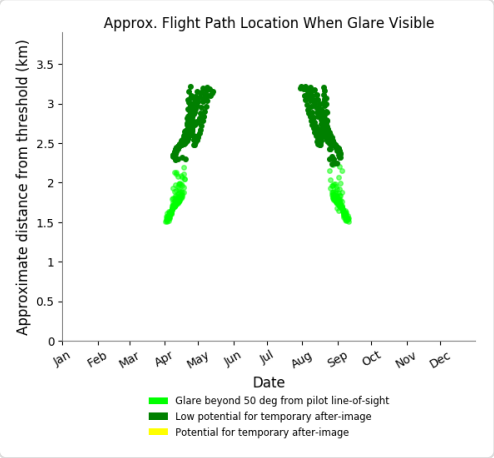
Flight Path: 28 Runway 2-4M

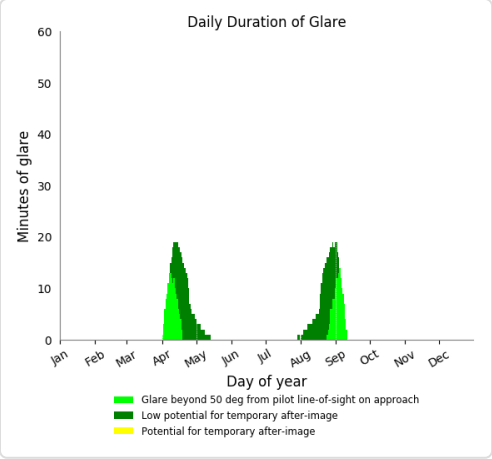
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
483 minutes of green glare

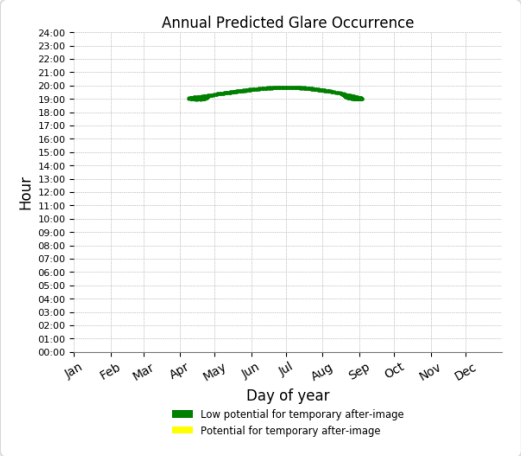


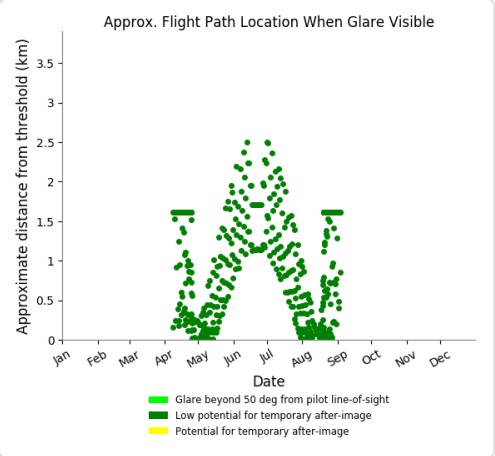


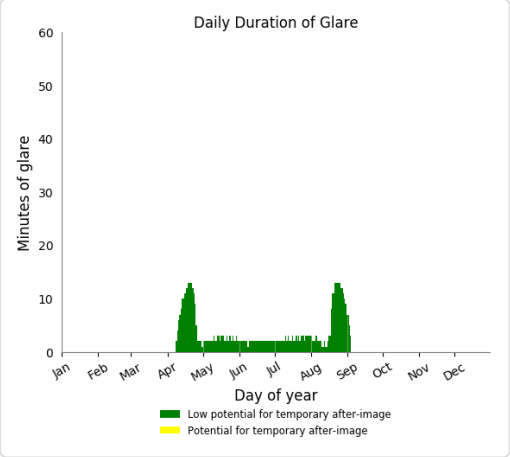


Flight Path: 36 Runway 2-4M

0 minutes of yellow glare
591 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Results for: Section I

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10L_Runway 2-4M	49	0
10 Runway	0	0
10 Runway 2-4M	1669	0
16 Runway	0	0

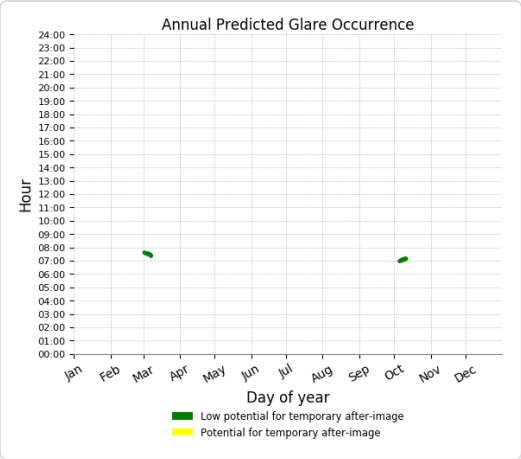
Receptor	Green Glare (min)	Yellow Glare (min)
16 Runway 2-4M	0	0
28R Runway	0	0
28R Runway 2-4M	0	0
28 Runway	0	0
28 Runway 2-4M	0	0
34 Runway	490	0
36 Runway 2-4M	586	0
ATCT 1	0	0
ATCT 2	0	0

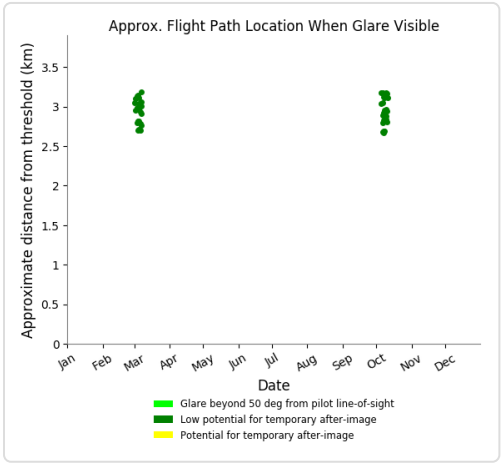
Flight Path: 10L Runway

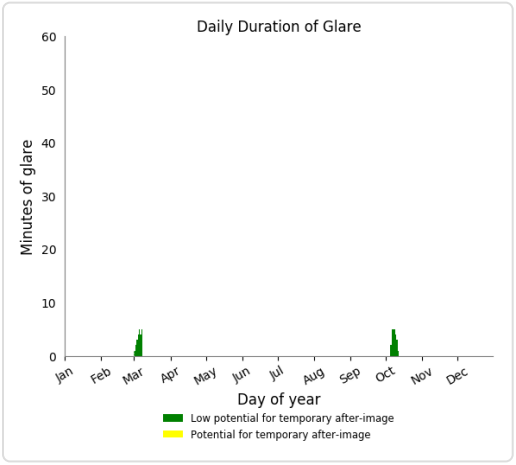
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10L_Runway 2-4M

0 minutes of yellow glare
49 minutes of green glare





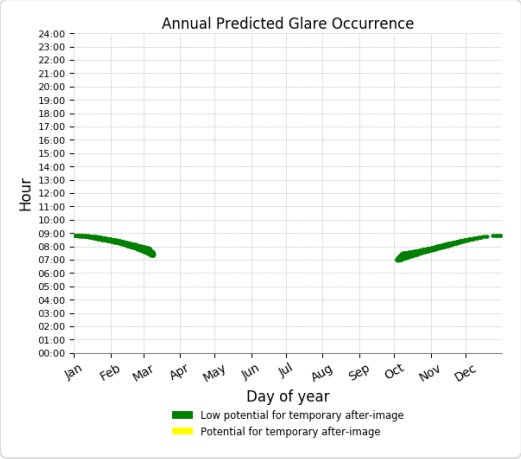


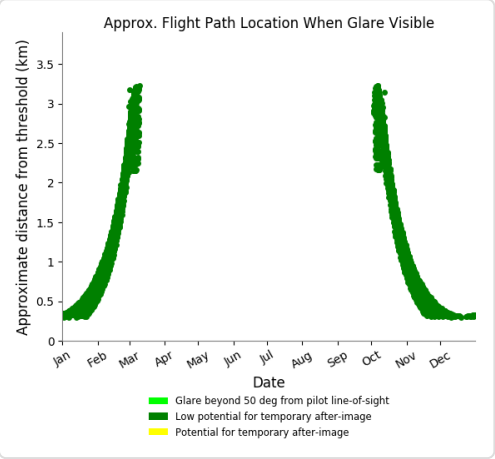
Flight Path: 10 Runway

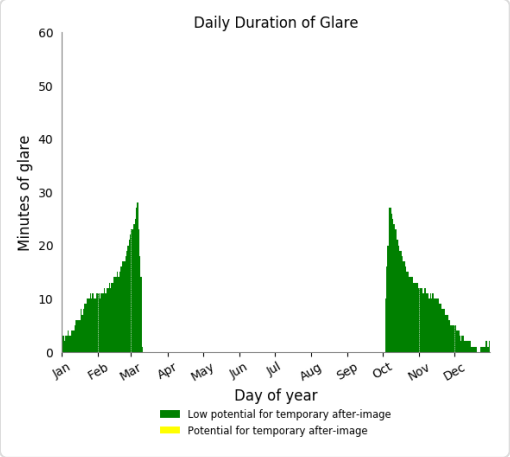
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10 Runway 2-4M

0 minutes of yellow glare
1669 minutes of green glare







Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway 2-4M

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28 Runway

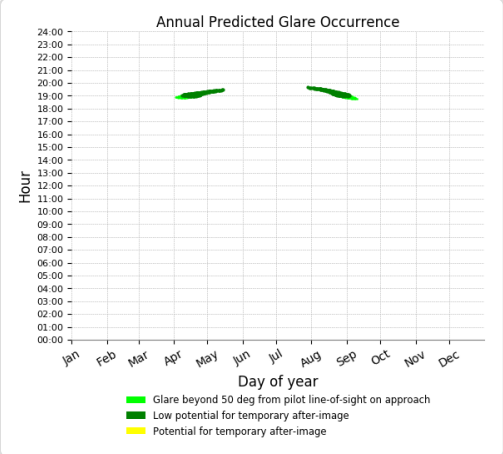
0 minutes of yellow glare
0 minutes of green glare

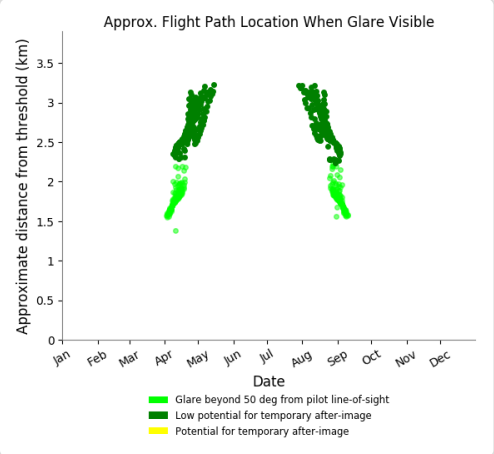
Flight Path: 28 Runway 2-4M

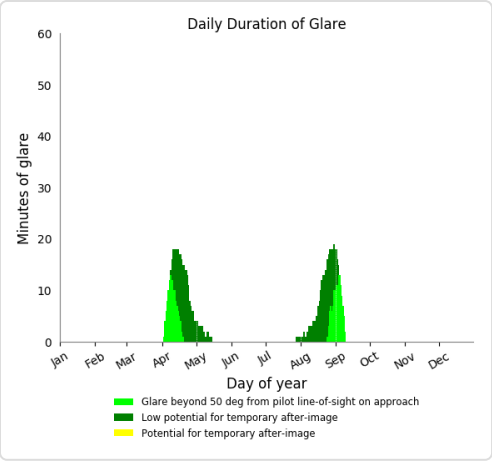
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
490 minutes of green glare



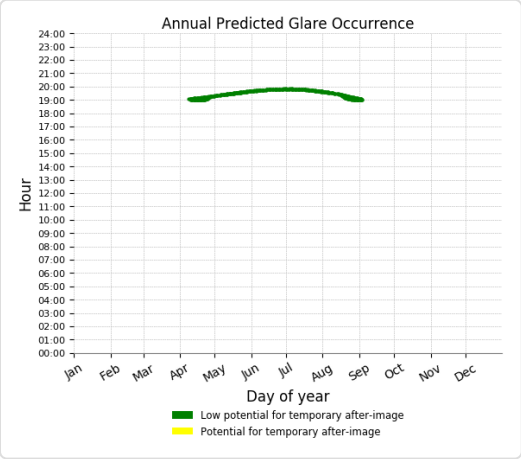


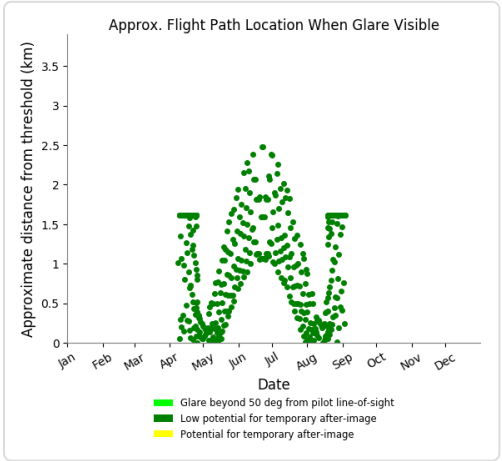


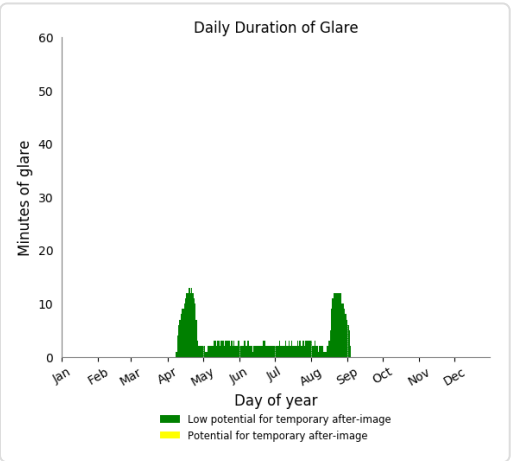
Flight Path: 36 Runway 2-4M

0 minutes of yellow glare

586 minutes of green glare







Point Receptor: ATCT 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: ATCT 2

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
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 based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Appendix 17A RGD EIAR Outline CEMP

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Weekly Environmental Inspection Record Sheet

Contractor/ Sub-contractor:	Contract Area:
Inspection Reference/ Number:	Date:
Inspected by:	Role:
Other Attendees (Role)	
Weather Condition: Temperature: Rainfall: Wind speed and direction:	
Inspection Notes:	