Report for Selwyn District Council

Review of Mansergh Graham Landscape Architects Glint and Glare Assessment of Darfield Agrivoltaic Development by NZ Clean Energy Ltd

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Date: 19 November 2024
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1 INTRODUCTION

1.1 Overview

To review report provided by Mansergh Graham Landscape Architects for NZ Clean Energy Ltd Darfield Agrivoltaics Development and assess the accuracy of findings in terms of impact of the potential glare and glint on surrounding dwellings as well as road users and for any nearby railroad and or airfields.

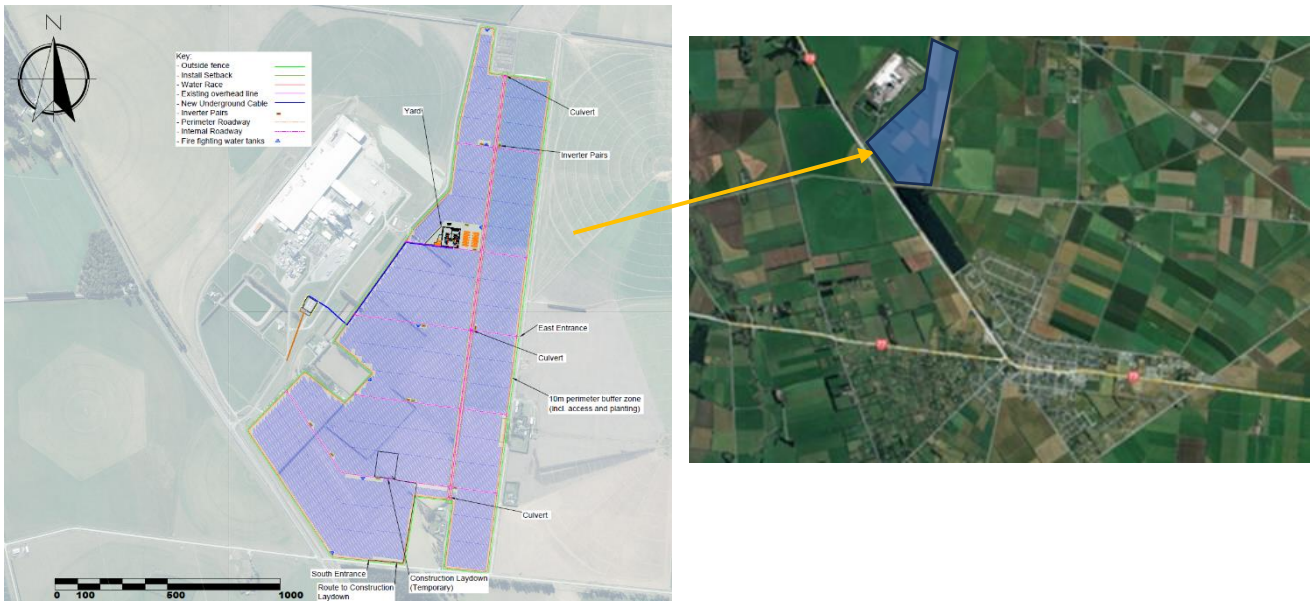


Figure 1.1 Darfield Solar Farm Location and Proposed development

1.2 Scope:

1. Fully review information provided and to set up and load associated data into modelling software for comparison purposes
2. Independent assessment to corroborate results, using same utility by ForgeSolar that Mansergh Graham Landscape Architects have used for the Single Axis tracking with 1 Solar Panel size (1P). (Solar Panels mounted in portrait arrangement about central rotating axis). Review and Comparison of results and record any differences to evaluate report conclusion offered. Dwellings as well as road and rail users to be assessed and compared. Include written review.
3. Review of mitigation measures, investigate any shortfalls and investigate additional measures against any review of landscape planning proposals
4. Review of any major impacts to both residents' dwellings and road and rail users. Consideration of specifics to any party and potential additional mitigation.
5. Conclusion outcomes and determination of potential shortfalls and associated mitigation requirements as part of any potential consent conditions. Written report follow up and clarifications.

1.3 PV Array Information

This assesment and analysis is based on the following information provided by Mansergh Graham Landscape Architect (MGLA) glint and glare report on which their modelling was based for the proposed Darfield Agrivoltaic Development.

PV Array Parameters	Mansergh Graham Glare Assessment Parameters Used	Comment
1. Solar Array type	Single Axis Tracking (SAT) system with Shade Backtracking	Noted in assessment
2. Orientation	7.546°	This is understood to be used instead of true north (0 degs) as it better suits the site terrain profile according to the Applicant.
3. Rotation Axis Height above aground	1.4m	**NOTE:** There were no diagrams of the actual solar panel layout on the rotation axis in the Mansergh Graham glare assessment Further feedback from Applicant indicates that height may vary from 1.4m (as used by Mansergh Graham Assessment) and 2.07m as indicated in Figure 1.3 provided by Applicant.
4. Max tilt angle	60 °	Noted in assessment
5. Max Height above ground.	2.8m	Ref: AEE Final, 6 September 2024, 3.2.1 The Solar array. **NOTE:** There was no consideration of this in the Mansergh Graham glare assessment. Follow up correspondence with applicant indicated that minumum height would be 2.45m and maximum height 3.1m as per Figure 1.3.
6. Solar Panels Type	With anti reflective coating	Noted in assessment

Table 1.3 Mansergh Graham Landscape Architects (MGLA) Parameters used for modelling

Apart from the comments made in table 1.3, the modelling carried out by MGLA was however based on the parameters as indicated in the table.

This report review by Velden Aviation Consulting Ltd (VACL) has also been modelled using the above parameters used by MGLA to ensure, as much as possible, a consistent comparison can be made.

The maximum height however is based on diagram provided below by the Applicant. This indicates a maximum height of 3.1m and is used to allow a more conservative consideration as it applies to minimum height mitigation screening such as possibly being proposed for new landscape planting.

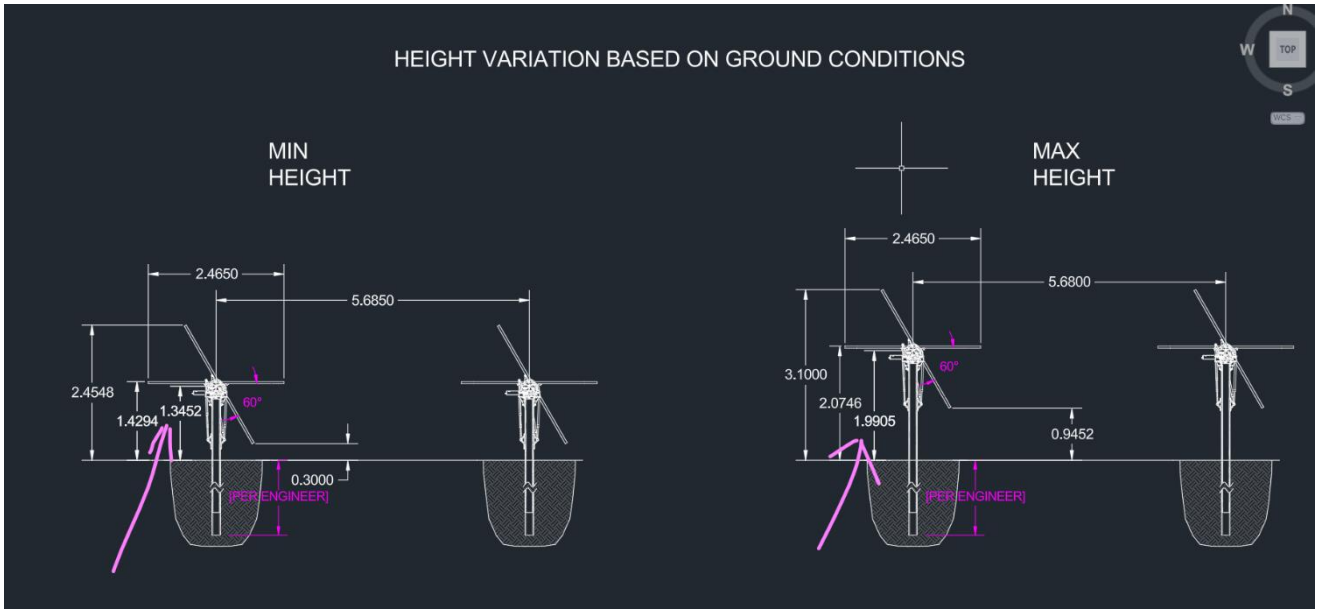


Figure 1.3 Applicants drawing of proposed solar panael layout

1.4 Solar Glint and Glare Impact Analysis

Any potential glint and glare impacts are considered using the same software utility as that used by Mansergh Graham and has also been used extensively by the author of this VACL report on other assessments both in New Zealand and internationally.

The Mansergh Graham Glare Assessment is based on use of the ForgeSolar solar glare hazard analysis software utility. This provides glare assessment associated with impact to the human eye in terms of levels of glare and its hazard potential.

Although most PV solar panels have anti-glare coatings to minimise glare as much as possible, there is always some residual glare present that has potential to create a hazard.

General Consideration

Solar glare hazard analysis (SGHA) is based on potential to cause damage to any observer's eyes.

The chart in the figure below applies a colour code of green, yellow or red depending on the hazard potential and any PV arrays causing issues to designated observation points.

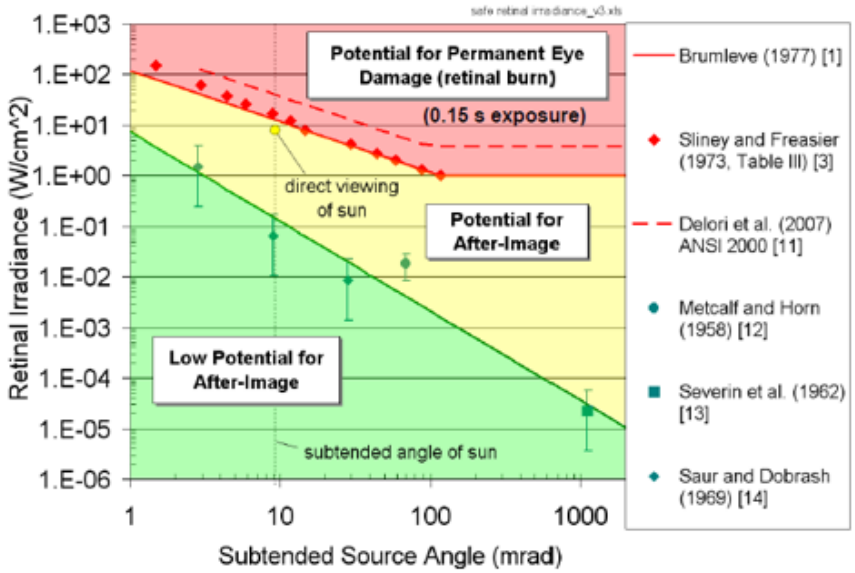


Figure 1.4 -1 . Potential Ocular Impact

"**Green zone**" glare is considered to have low potential to cause after –image (flash blindness) when observed prior to a typical blink response.

"**Yellow zone**" glare is considered to have potential to cause after image (flash blindness) when observed prior to a typical blink response time.

"**Red Zone**" glare is considered to have high potential to cause permanent eye damage.

Typically green and yellow glare are experienced from solar arrays compared to red glare which is rarely experienced from any PV reflection.

Although any PV arrays that create issues that fall in the green zone have low potential for after-image, and less chance of ocular damage over time, this is seen as less of a problem for dynamic or moving receptors such as vehicles, trains or aircraft.

Use of SGHA comes with the following assumptions applied;

1 Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

2 Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints.

3 The subtended source angle (glare spot size) is constrained by the PV array footprint size.

4 Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

5 Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

6 The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

7 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.

It should be added that solar glare is experienced every day, however static occupational observation points such as for residents of dwellings does not necessarily mean that solar glare impacts the predominant direction the observer is looking.

Most dwellings have blinds as well as tinted windows that limit glare. This should not be seen as a precursor for mitigating glare however.

These are considerations that can be taken into account when deciding overall impact of solar glare from proposed PV arrays.

1.5 Solar Glare Standards and Mitigation

VACL agrees with the standards applied by Mansergh Graham and in particular glare limits, as shown in Table 1.5- 1 below, which is based on the Australia New South Wales Government Guidelines for glare impact on Dwellings and is considered in this report to compare the results obtained.

The author agrees with the MGLA approach in utilising the Australian NSW standard as it provides a more conservative approach in relation to mitigation of potential glare.

High glare impact	Moderate glare impact	Low glare impact
> 30 minutes per day > 30 hours per year	< 30 minutes & > 10 minutes per day < 30 hours & > 10 hours per year	< 10 minutes per day < 10 hours per year
Significant amount of glare that should be avoided.	Implement mitigation measures to reduce impacts as far as practicable.	No mitigation required.

Table 1.5-1 Australia NSW Government Guidelines for glare impacts on Dwellings

As noted in the guidelines, glare should ideally be reduced to a point where less than 10 mins per day and less than 10 hours per year is considered. As such, any mitigation measures being considered should be such that it reduces potential glare to dwellings to meet low glare impact durations. This should ideally apply to both green and yellow levels of glare not just yellow.

For road users, the MGLA report includes the standards for road users from the same Australian guidelines which are noted in the table below.

	Scope	Methodology	Performance objective
Road and rail	All roads and rail lines within 1km of the proposed solar array.	Solar glare analysis to identify whether glint and glare are geometrically possible within the forward looking eyeline of motorists and rail operators.	If glare is geometrically possible then measures should be taken to eliminate the occurrence of glare. Alternatively, the applicant must demonstrate that glare would not significantly impede the safe operation of vehicles or the interpretation of signals and signage.

Table 1.5-2 Australian Solar Farm Guidelines on Glint and Glare Assessment Approach for Road Users

It is noted that the MGLA report only uses a 1.6m observer eye level height for dwellings or residences as based on the reports attached in the appendix of their report.

This is contrary to the bullet point on page 11 of its report (noted below) where it states 1.8m above ground level is recommended for Dwellings.

- *An additional height should be added to the ground level at a dwelling to represent a viewing height.*
- *For dwellings, a recommended additional height of 1.8 metres above ground level should be added to account for eye level on the ground floor, with additional floors being assessed as required. Additional heights should be considered where a receptor is higher than a first floor. Modelling is recommended for ground floor receptors because it is typically the most occupied during daylight hours.*

The MGLA glare assessment does not consider observer eye level heights for two or more storey dwellings which should also have been assessed where applicable. As such VACL also consider 2 storey dwellings and applies a 3.6m receptor eye level height for occupants on the second storey. This also provides a conservative approach which allows for mitigation planning for residents with 2 storey dwellings.

For road users, while there are no definite limits with regard to glare duration constraints as for dwellings, the distinction is to demonstrate that glare would not significantly impact on safe operation of vehicles.

In normal circumstances the duration of exposure to glare from vehicles may be very short due to the dynamics of the moving vehicle and passing any potential glare zones quickly as not to be unduly affected.

The MGLA report indicates that glare originating in front of the road user requires mitigation.

While this is correct, it needs to further define that the ForgeSolar utility takes into account ±50 degree angle for assumed peripheral vision about the driver's direction of travel.

The author disagrees with MGLA report consideration of road user viewer height for the smaller vehicles eye level where it uses levels of 1.1m for passenger cars. This is also at odds with page 11 of its report where it states (see bullet point below) a recommended height for drivers eye level for cars as 1.5m

- *An additional height should be added to the ground level height to represent the typical viewing height from a road user. For road users, a height of 1.5 metres is recommended;*

For larger vehicles such as tractors, haulage vehicles etc a 2.4m driver eye height has been used by MGLA.

This should be considered acceptable as it is close to a standard typically used which considers a height for 2.5m for larger vehicle driver eye height and is considered worst case and would also cover the 1.5m driver eye level as well as buses etc and most large vehicles. As such this is also believed to provide safer consideration of mitigation requirements for road transport.

For railways and train drivers eye levels VACL is agrees with MGLA using 3m as this will also present a more conservative value which should provide safer consideration mitigation for rail transport. Typical driver eye level receptor heights for rail vary from 2.5m to 3m.

1.6 Mitigation Measures and Modelling

Mitigation measures should include landscape plantings of vegetation suited to the local environment as well as being suitably dense and high enough to obscure any view of the solar PV arrays that may potentially cause glare. Modelling in the analysis is based on dimensions of height and length of such screens and for full obstruction of any view and glare from the arrays.

Existing vegetation and structures are also considered where they indicate significant screening impact.

2 Executive summary

There is general overall agreement by the Velden Aviation Consulting Limited (VACL) peer review with the results obtained by Mansergh Graham Landscape Architects Ltd (MGLA) in their Glint and Glare report.
However, some differences and discrepancies were noted in the report with regard to parameters used and further descriptions needed to help clarify standards and mitigation considerations.

The MGLA report considers driver eye level heights for road users of 1.1m for small vehicles and 2.4m for the larger vehicles such as farm vehicles or haulage vehicles etc.

Also, it only considered dwelling observer eye levels of 1.5m and did not consider dwellings that may have been two or more storeys high.

The reviewer of the MGLA report considers driver eye levels for worst case scenario and as such a driver eye level height of 2.5m is used in consideration of larger vehicles expected to be found on most rural roads in New Zealand such as tractors, haulage trucks, school busses etc. to ensure consequential mitigation considerations provide greater safety margin against potential glare.

For dwellings, a more usual standard of 1.8m is considered for receptor eye level rather than 1.5m. Also , where it is expected that some dwellings are 2 storey, a 3.6m receptor eye level has been modelled.

For rail this report agrees with the eye level height used by MGLA of 3m as well as largely agreeing with the results obtained for assessment of potential glare impacts on nearby railways.

Results of this peer review assessment were found to be mostly consistent with results obtained by MGLA where minimal glare could be expected for dwellings, fitting within the constraints of less than 10 hours year and less than 10 minutes per day.

Although peer review results are also largely in agreement with those obtained by MGLA for the road users, further measures have been recommended in this report with regard to mitigation to ensure potential glare does not impact on road user safety.

Of particular importance is consideration of mitigation measures near or around major road intersections where potential glare has been predicted and is consistent with mitigation measures using landscape plantings as proposed by the applicant. As such, it has been recommended that some interim glare mitigation measures are included.

Overall, there is mostly agreement that the potential glare impacts from the proposed Darfield Agrivoltaic Development should mostly be minor to less than minor once considered mitigation measures have been implemented.

3 ASSESSMENT MODELLING COMPARISONS

3.1 Observer Height Modelling Considerations

The Photovoltaic array layout being considered is as per the MGLA report using the same data set for coordinates for the solar array as well as dwellings and road and rail routes. **Appendix 1** provides the data sets used for modelling and analysis for the glare assessment.

The only differences are with regard to the heights of the observers eye levels with the differences as shown in the table 3.1 below.

Receptor eye level heights used for Assessment	MGLA	VACL
For Dwelling	1.6m for all dwellings	1.8m for one storey dwellings and 3.6m for two storey dwellings.
For Road Users	1.1m for cars and 2.4m for large vehicles such as trucks	2.5m driver level eye height. Only large vehicles considered to capture worst case scenario.
For Rail	3m	3m (concur with MGLA)

Table 3.1 Differences in receptor eye heights used in peer review assessment

Rationale for Observer Height Differences

Dwellings

The majority of residents expected to be occupying first floor and lounge, kitchen and bedroom areas are more likely to suffer potential glare impacts. The heights of the foundations of the dwellings need to be taken into account and then the heights of the eye levels of the occupants. This is generally taken to be around 1.8m as a general standard. (As noted previously, this is also mentioned in the MGLA report, but it appears that their modelling is still based on a receptor eye level of 1.6m).

Roads

2.5m is considered a general standard eye level height for drivers of large vehicles. Although there is expected to always be some variation about this level, it offers a conservative value and is used in this peer review analysis. This also provides a worst case scenario for which any mitigation

measures that may be required to screen impacts to drivers of larger vehicles with eye levels at heights of 2.5m will also mitigate potential glare impact for drivers of smaller vehicles.

Rail

A train driver eye level of 3m is used by MGLA and the peer reviewer agrees with this receptor eye level as it also provides a worst case scenario and hence allows for safer margins to be considered when applying vegetation landscape mitigation measures (or other means) to eliminate potential glare to train drivers.

4 Solar Glare Analysis Results

4.1 Dwelling Results Comparison

Receptor ID	Type/Address	MGLA Predicted Potential Glare Results(With existing vegetation screening)	VACL Results and Comment (Predicted glare noted in hours annually)
OP1	Dwelling,1352 Homebush Road Darfield.	Predicted Green (0.4 hours/pa) and Yellow Glare (0.1 hours/pa).	Predicted Green (24.6 hours/pa) and Yellow Glare (6.4hours/pa).
OP2	Dwelling,1/3792 West Coast Rd, Darfield	Predicted Green (0.6 hours/pa) and Yellow Glare (0.3hours/pa).	No glare predicted
OP3	Workplace,1/3792 West Coast Road, Darfield	No potential glare predicted	No potential glare predicted
OP4	Fonterra,1/3792 West Coast Road, Darfield	No potential glare predicted	Predicted Green (0.3 hours/pa)
OP5	Dwelling,1/3792 West Coast Road, Darfield	No potential glare predicted	Predicted Green (0.3 hours/pa)
OP6	Dwelling,32 Loes Road, Darfield	No potential glare predicted	Concur with MGLA. No glare predicted
OP7	Dwelling, 68 Loes Road, Darfield	No potential glare predicted	Concur with MGLA. No glare predicted
OP8	Forest Park	Predicted Green (0.4 hours/pa)	No potential glare predicted
OP9	Forest Park	Predicted Green (0.6 hours/pa) and Yellow Glare (0.1hours/pa).	Predicted Green (2.3 hours/pa)
OP10	Future LLRZ	Predicted Green (0.4 hours/pa)	No potential glare predicted
OP11	Future LLRZ	No potential glare predicted	Concur with MGLA. No glare predicted
OP12	Future LLRZ	No potential glare predicted	Concur with MGLA. No glare predicted
OP13	Future LLRZ	No potential glare predicted	Concur with MGLA. No glare predicted
OP14	Future LLRZ	No potential glare predicted	Concur with MGLA. No glare predicted
OP15	Workshop or Shed	No potential glare predicted	Concur with MGLA. No glare predicted
OP16	Dwelling, 165 Kimberley Road	No potential glare predicted	Concur with MGLA. No glare predicted
OP17	Dwelling, 38 Whitcombe Place,	No potential glare predicted	Concur with MGLA. No glare predicted
OP18	Dwelling, 47 Landsborough Drive	No potential glare predicted	Concur with MGLA. No glare predicted

OP19	Dwelling, 45 McHugh Crescent	No potential glare predicted	Concur with MGLA. No glare predicted
OP20	Workshop or shed	No potential glare predicted	Concur with MGLA. No glare predicted
OP21	Dwelling, 1827 Clintons Road, **(2 Storey)**	No potential glare predicted	Concur with MGLA. No glare predicted
OP22	Dwelling, 1616 Homebush Road**, (2 Storey)**	No potential glare predicted	Concur with MGLA. No glare predicted
OP23	Workshop or shed	No potential glare predicted	Predicted Green (0.6 hours/pa)
OP24	Dwelling, 1433 Homebush Road,	Predicted Green (0.4 hours/pa)	No potential glare predicted
OP25	Dwelling, 2171 Clintons Road**,(2 Storey)**	No potential glare predicted	Concur with MGLA. No glare predicted
OP26	Dwelling, 3967 West Coast Road,	No potential glare predicted	Concur with MGLA. No glare predicted
OP27	Workshop or shed	No potential glare predicted	Concur with MGLA. No glare predicted
OP28	Workshop or shed	No potential glare predicted	Concur with MGLA. No glare predicted
OP29	Dwelling	No potential glare predicted	Concur with MGLA. No glare predicted
OP30	Workshop or shed	No potential glare predicted	Concur with MGLA. No glare predicted
OP31	Dwelling, 181 Bleak House Road,	No potential glare predicted	Concur with MGLA. No glare predicted
OP32	Dwelling, 245 Bleak House Road,	No potential glare predicted	Concur with MGLA. No glare predicted
OP33	Dwelling, 324 Bleak House Road	No potential glare predicted	Concur with MGLA. No glare predicted
OP34	Dwelling, 594 Kimberley Road	No potential glare predicted	Concur with MGLA. No glare predicted
OP35	Dwelling,	No potential glare predicted	Concur with MGLA. No glare predicted
OP36	Dwelling, 526 Auchenflower Road	No potential glare predicted	Concur with MGLA. No glare predicted
OP37	Cemetery	No potential glare predicted	Concur with MGLA. No glare predicted
OP38	Workshop or shed	No potential glare predicted	Concur with MGLA. No glare predicted
OP39	Dwelling, 398 Kimberley Road,	No potential glare predicted	Concur with MGLA. No glare predicted
OP40	Dwelling, 355 Kimberley Road,	No potential glare predicted	Concur with MGLA. No glare predicted

Table 4.1 Dwellings Predicted Solar Glare Impacts Comparison

General Comments on Dwelling Results

Of the dwellings predicted to be impacted by potential glare, these are all less than the 10 hours per annum as and therefore within the required guidelines of the Australia New South Wales Government Guidelines for minimum impact and no mitigation required.

Where there are some differences between the MGLA assessment and that of the peer reviewer from VACL, these are highlighted in yellow table 4.1 above. Overall, however the results from VACL are largely in agreement with those obtained by the applicants glare assessment.

Differences are expected to be attributed to the difference in observer heights by MGLA using 1.6m and that of VACL using 1.8m.

Also, for the dwellings that were simulated as 2 storey (OP21, 21 and 25) there was no difference in results with both MGLA and VACL analysis indicating that there would be no predicted glare for residents at these dwellings.

With Dwelling at 1352 Homebush Road (OP1) with the largest predicted amount of glare at 25 hours green glare and 27.4 hours per annum yellow glare, VACL concurs with the MGLA assessment that the existing vegetation surrounding this dwelling should mostly mitigate this to minor and even less than minor.

The below plots indicate the annual predicted glare occurrence and the daily duration for OP 1.

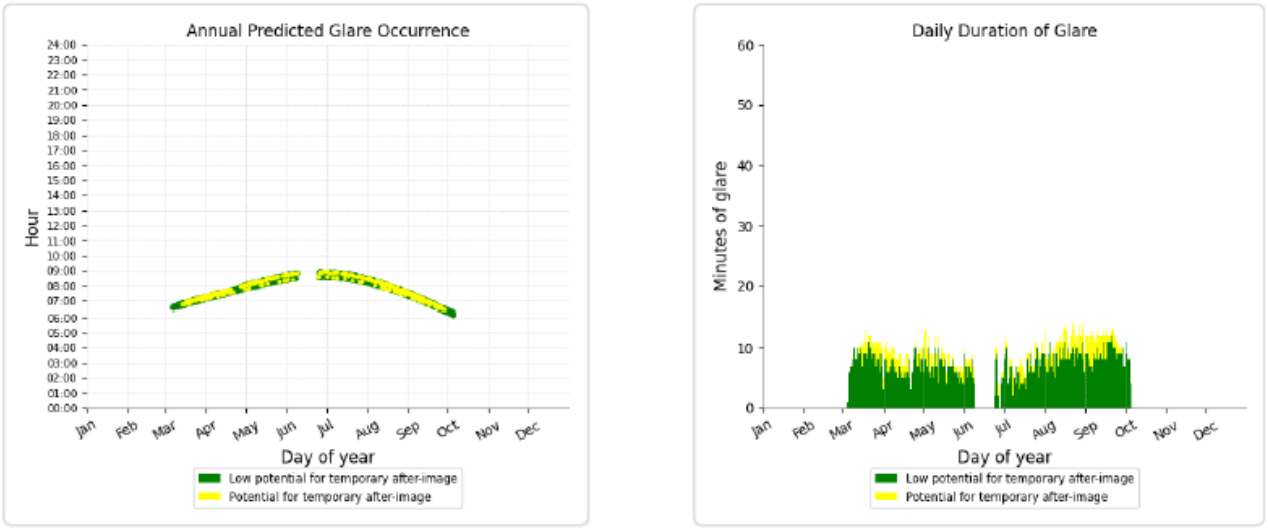


Figure 4.1 Predicted Glare Occurrence and Daily duration for 1352 Homebush Road

As noted in the ocular hazard definitions in section of 1.4, green glare is expected to have low impact compared to yellow glare which should ideally be mitigated as far as practicable where glare levels exceed 10 hours per annum for dwellings as per the Australian guidelines.

It should be noted, the simulations of existing vegetation obstruction to mitigate glare provided by both MGLA and VACL should theoretically have completely screened all potential glare based on the geometry angles between the Observation Point 1 (Dwelling at 1352 Homebush Rd), the existing vegetation and the solar array location. The mechanism for this is illustrated in **Appendix E** and the reviewer believes this to be an anomalous result as there should be complete screening of the array for this dwelling based on its existing surrounding vegetation. (The reviewer has raised this with the software developers and at time of writing of this report has not had a reply from them.)

4.2 Road Route Comparisons

Road Route	MGLA Predicted Potential Glare Results mins/yr Based on 2.4m driver Eye level and with obstructions (existing vegetation and planned landscape plantings)	VACL Results (mins/year) Based on 2.5m driver eye level and with obstructions (existing vegetation plus planned landscape plantings)
Auchenflower Road	No predicted glare	476 mins/year green glare 222 mins/year yellow glare
Auchenflower Road West of Main Highway 73	Not considered	No predicted glare
Bleak House Road	No predicted glare Concur with MGLA.	Concur with MGLA. No predicted Glare
Boultons Road	432 mins per year Green (6 mins per day green glare)*	No predicted glare
Clintons Road	90 mins per year green glare*	No predicted glare
Homebush Road East of Railway	412 mins per year green glare and 602 mins per year yellow glare*	No predicted glare
Homebush Road West of Railway	108 mins per year green glare and 307 mins per year yellow glare *	No predicted glare
Kimberley Road North	No predicted glare	Concur with MGLA. No predicted Glare
Kimberley Road South	No predicted glare	Concur with MGLA. No predicted Glare
Tramway Road east of Kimberly Rd	No predicted glare	Concur with MGLA. No predicted Glare
Tramway road West of Kimberley Rd	No predicted glare	Concur with MGLA. No predicted Glare
Landsborough Drive[1]	No predicted glare	Not Considered . See note 1
Loes Road	No predicted glare	Concur with MGLA. No predicted Glare
State Highway 73	No predicted glare	Concur with MGLA. No predicted Glare
Gunns Road[2]	Not considered	No predicted glare. See note 2

Table 4.2 Results Comparison MGLA and VACL

Notes : 1 – Landsborough road was not considered in the analysis by VACL as it did not present any predicted glare as per the MGLA report and this would be expected given it was largely obscured by residential houses and existing vegetation. See below photo of typical view along Landsborough Drive. Solar Farm at Darfield would be to the right of the of the photo and mostly outside of the drivers Field of View (FoV).

Photo 4.2-1. Landsborough Road

Note 2- Gunns Road (see below) was included in the assessment by VACL given it meets a major intersection that may potentially encounter glare from the Darfield Solar Farm.

Photo 4.2-2 Gunns Road location and intersection with State Highway 73

Rationale for inclusion of Gunns Road is due to major intersection with State Highway 73

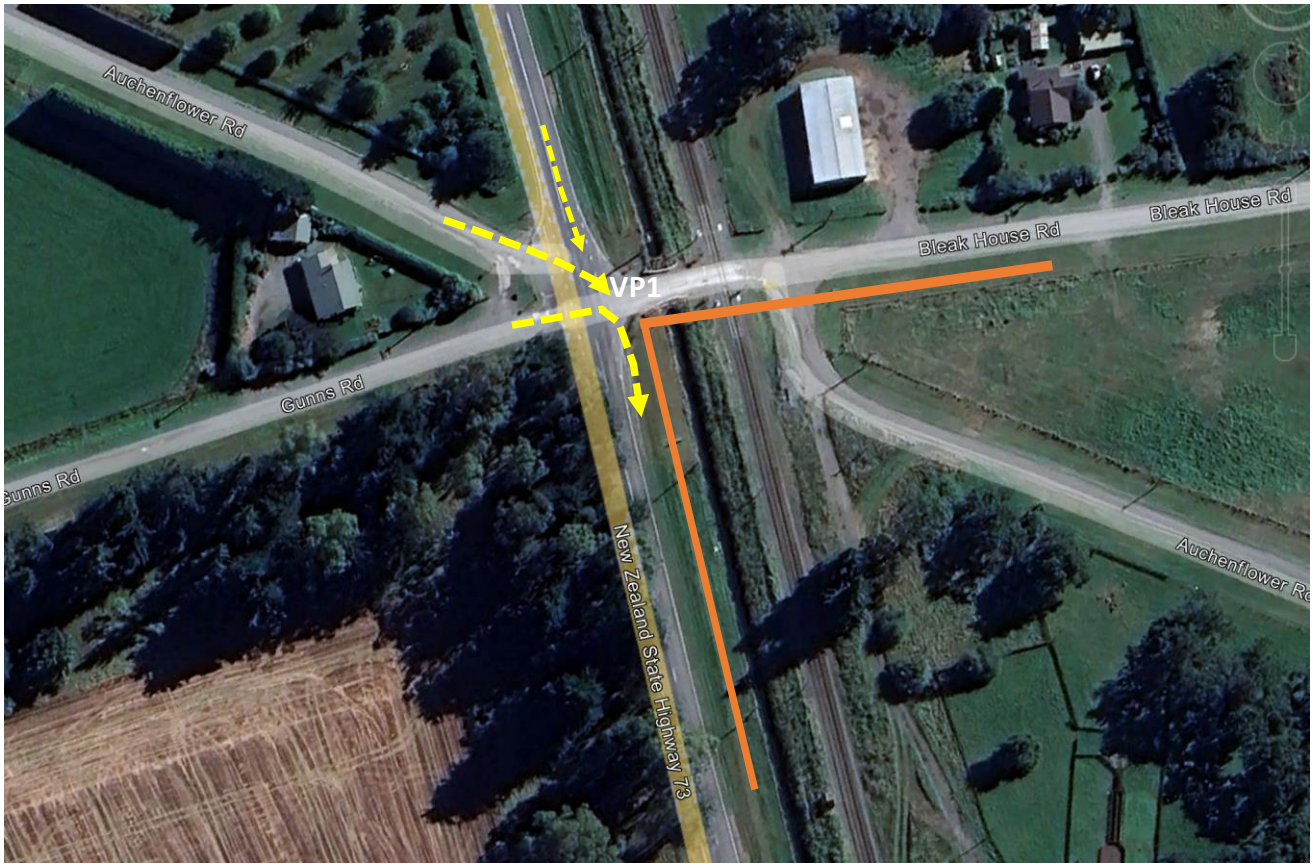


Photo 4.2-3a and b. View from Gunns Road looking at Viewpoint 1 (VP1)

While not included in the MGLA report**,** the peer reviewer from VACL considered it important to include roads at major intersections where there is potential of glare from Solar Farm developments due to potential safety issues encountered at major intersections, especially in New Zealand rural roads.

In this instance, based on viewpoint 1, the results outcome of no potential predicted glare at this point is likely due to the existing vegetation and building structures I the background as seen from this point.

General Comments of Road Route Results

For Boultons Road, Clintons Road, Homebush Road East and West of Railway, the MGLA report indicates both green and yellow glare as noted in the table. From the MGLA report and Darfield NZTA Truck with Obstruction R2 Forgesolar Glare analysis Report in their appendix only existing vegetation has been considered. There are however no obstructions related to these roads based on any existing vegetation and as such the following comments are made in the Landscape and Visual Assessment Report.

Glare

The glint and glare analysis found that glare is expected to be experienced along SH73, at its intersection with Homebush Road. Glare may also be potentially experienced at the intersection of SH73 and the Fonterra Darfield site access road.

While glint and glare from the proposed PV panels was not found to be an issue from a driver safety perspective from along the remainder of SH73, or form the Midland Railway Line, there is potential for glare experienced at a wider (180-degree) FoV to draw attention to the site from this stretch ofSH73 and the Midland Railway. This is likely to have a small adverse effect on visual amenity when looking over the site.

Mitigation

Mitigation planting and/or PV tracking management is required along the southwestern site boundaries (adjacent to SH73 & Midland Railway Line and Fonterra Darfield) to mitigate the effects of glint and glare on the intersections of Homebush Road and the Fonterra access road with SH73 (for traffic safety reasons). This mitigation planting will screen views of the proposed development from these viewer locations and will also screen potential glint and glare (experienced at a wider 180-degree FoV).

VACL has considered added vegetation planting along the boundary of West Coast Rd (Statehighway 73) and Homebush road east of the intersection as indicated in Figure 4.4 below.

This also supports the comment made above from the Landscape and Visual Assessment Report. The minimum planting proposed is 4m and based on this modelling the glare, the VACL result in table 4.2 indicate that this eliminates any potential glare for Boultons Road, Clintons Road and Homebush Road East and West of Railway.

This also provides an important safety measure against any glare that may be experienced at this intersection both for road as well as rail.

Figure 4.2- 4. Recommended Obstruction landscape planting along Statehighway 73 at Homebush Road Intersection.

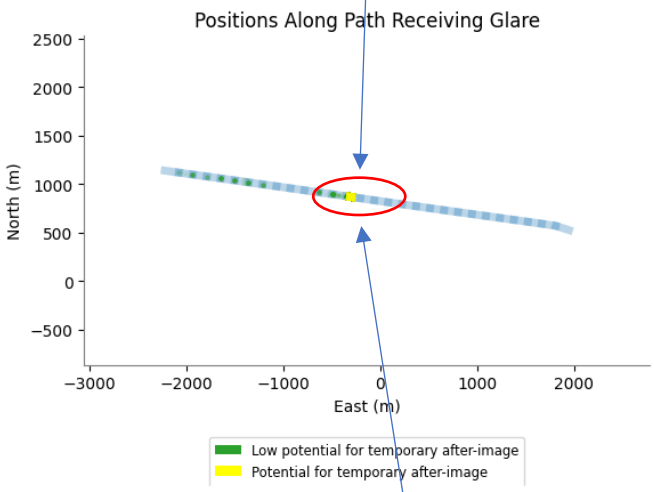
Figure 4.2-5. View towards intersection from Homebush Road West of railway and Statehighway 73

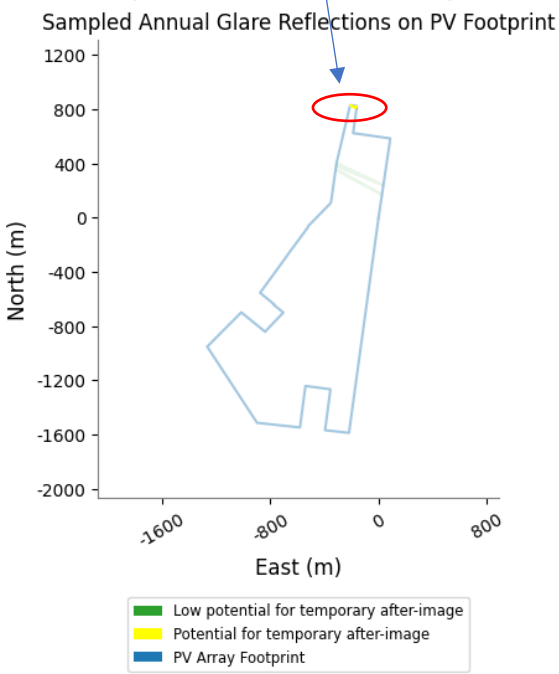
Figure 4.2-5 shows there is currently no existing vegetation that would obstruct the view of the solar arrays when approaching this intersection indicating a potential safety issue of encountering glare. As MGLA results show there are 602 mins of yellow glare for large vehicles traveling along Homebush road east of railway and 307 mins of yellow glare for large vehicles travelling along Homebush road west towards the intersection.

The schematic shows obstruction screens in the peer reviewers simulation of 4m high landscape plantings that should potentially obscure large and small vehicle driver view of the proposed solar array and hence any potential glare from it. The VACL results from table 4.2 indicate that there should be no predicted glare once incorporated. This would support the applicants Landscape and Visual Assessment report indicating its intention to consider such landscape planting.

Auchenflower Road

Auchenflower road indicates there is potential green and yellow glare of 476 mins/year and 222 mins/year respectively. The photo location correlation with the simulation glare reflection on the PV footprint shows where glare can be expected. It also shows where there is no existing vegetation along this point as shown in photo below and where the yellow line along the road indicates where yellow glare may be seen.





A 4m high obstruction simulating a landscape planting along this point has been analysed with resultant potential yellow glare being mitigated and potential green glare being reduced from 476mins to 268mins per year.

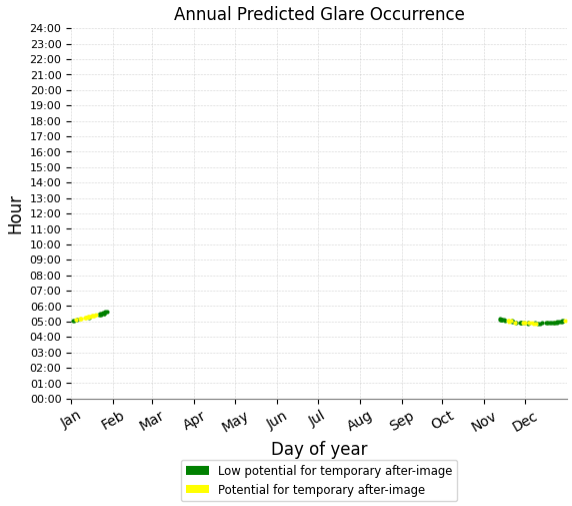
With green glare unlikely to cause any significant issue given the dynamic nature of the moving vehicle and minimum glare factor associated with green level glare, the overall impact of potential glare on road users with existing vegetation and that of planned landscape planting should be minimized to minor or less than minor.

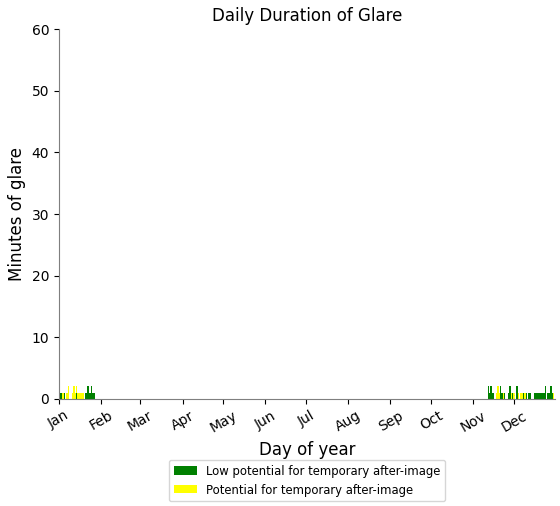
4.3 Railway Results Comparisons

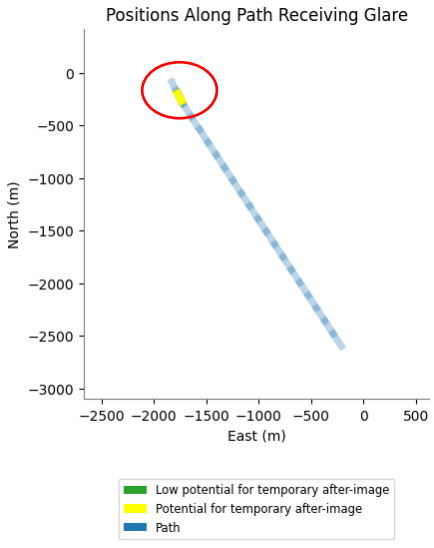
Receptor ID Type/Address	MGLA Predicted Potential Glare Results mins /yr (With existing vegetation screening). Mins /year	VACL Results min /year Comment (Predicted noted in hours annually)
Main Trunk Line	No predicted glare	50 mins/yr predicted green glare, and 26 mins/yr predicted yellow glare
Fonterra Siding	230 mins /year green glare	58mins/yr green glare and 8 mins/year yellow glare

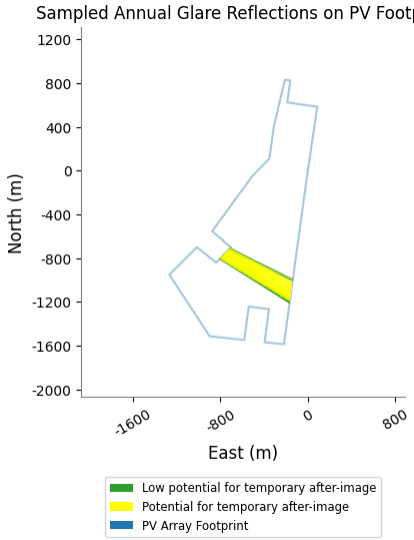
General Comment on Railway Route Results

For the Main trunk line, a minimal amount of glare can be expected with less than 3 mins per day of mostly green glare. This is likely to happen for trains travelling east in early hours of the morning as indicated form the plots below.









With regard to the location highlighted in red below and its correlation point also highlighted in red on plot showing positions along path receiving glare, it is expected that train drivers are not likely to encounter any potential glare as indicated in the above plots above which already show minimal glare. This is based on likelihood that existing vegetation as well as buildings around Fonterra Plant (which have not been included in obstruction simulation) are likely to obscure the already minimal view of the Darfield solar array and hence any potential glare from it.

Photo 4.3. Path along Statehighway 73 heading East and showing Maintrunk line view toward Fonterra plant and its buildings.

Photo 4.3 also shows significant hedgerow at least 4m -5m high adjacent to the rail track that is likely to obscure most of the drivers view towards the PV array.

For the Fonterra railway siding, potential glare is predicted to be experienced very briefly in the morning only and in the direction as the train travels towards the Fonterra plant.

It is likely that parts of the tree shelter belt and Fonterra building (see plots and figure 4.3 below) will also mostly mitigate an already minimal glare 58mins/year green glare and 8 mins/per year yellow glare which can be considered minor to less than minor impact in terms of predicted glare impact to the train driver due to short duration from the moving train.

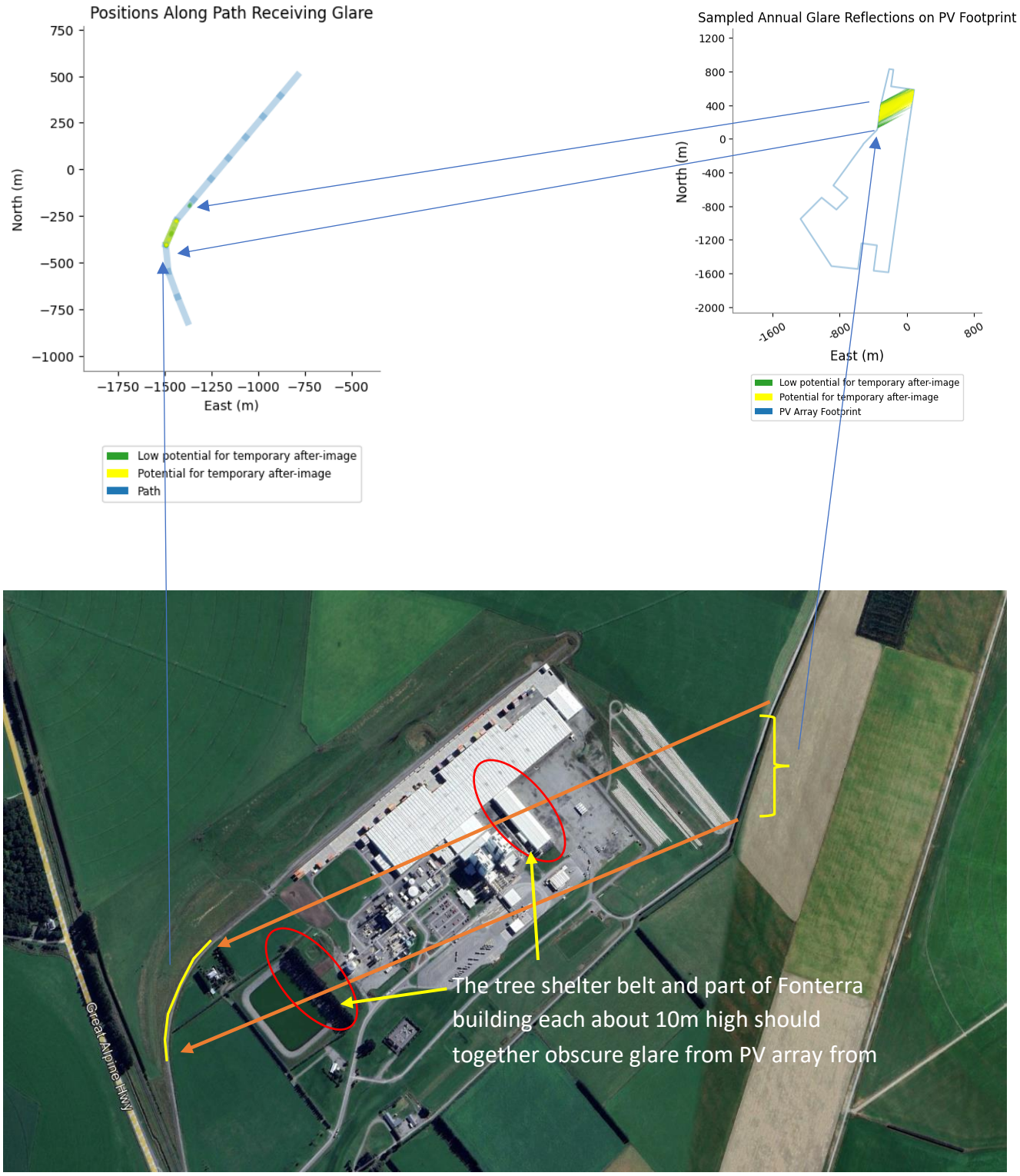


Figure 4.3 -1. Fonterra Railway Siding and site obstructions likely to mitigate potential glare from PV Array

PV array 1 and Route: Fonterra Railway Siding
Yellow glare: 8 min.
Green glare: 58 min.

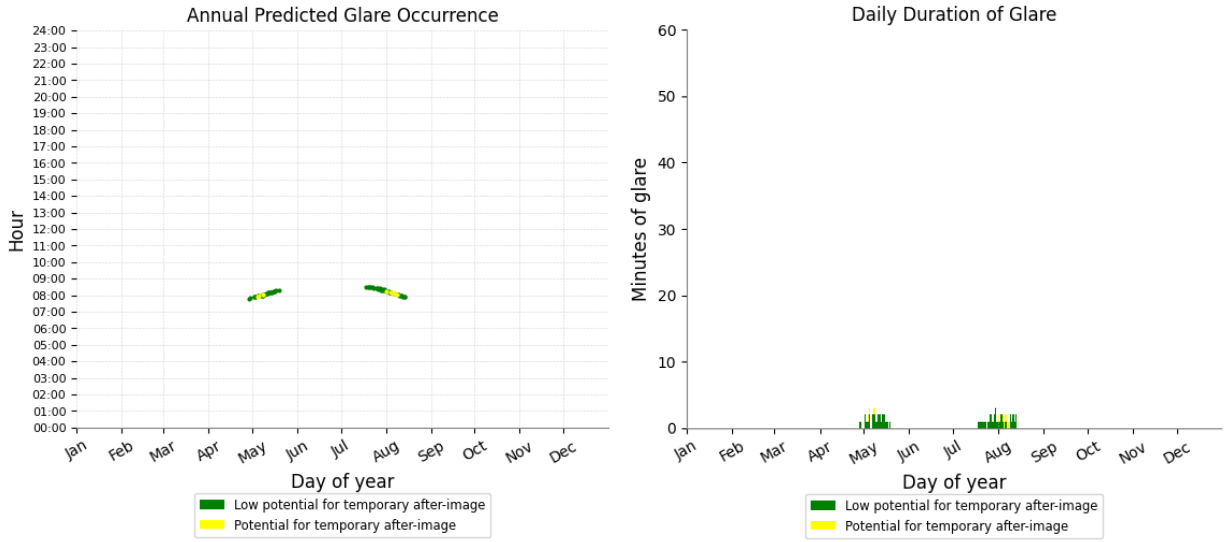


Figure 4.3-2 Annual Predicted glare and Daily duration for Railway Siding

The annual predicted glare occurrence and daily duration plots indicate minimal predicted glare which his mostly low level green glare and as such should only present minor impact. With the likelihood of further obstruction of the view to the PV array from the tree shelterbelt and Fonterra building structure as circled in red In the above photos, it is expected that any glare should be less than minor if not completely mitigated by these structures.

5. MITIGATION CONSIDERATIONS

5.1 Mitigation Requirements for Dwellings

Apart for the anomalous result for the OP1 (Dwelling at 1352 Homebush Rd) VACL is largely in agreement with MGLA that the existing vegetation should mostly mitigate potential glare from the PV array proposed by NZ Clean Energy Ltd.

This is irrespective of the higher observer eye level considered at 1.8m for single storey and also the 2 storeys at 3.6m based on recommended dwelling observer eye levels which overall have not produced significantly different results in this the peer review analysis.

5.2 Mitigation Requirements for Road Users

Due to more important and immediate safety implications associated with road traffic, VACL believes it to be more important to consider worst case scenario relating to larger vehicles and associated driver eye level height of 2.5m.

While there was largely agreement with results obtained, VACL considered it important to review impacts at and close to intersections of roads where there was predicted potential glare.

Although no mitigation measures were detailed in the MGLA report these were covered in Appendix 10 Landscape and Visual Assessment R3-240826 Document submitted by the applicant.

VACL is in agreement with what they have proposed in terms of mitigation measures especially around the Homebush and State Highway 73 intersection.

Any planned vegetation planting to provide mitigation of any predicted glare should ideally be at least 4m high and also of sufficient density to ensure full mitigation of potential yellow glare can be achieved.

5.3 Mitigation Requirements for Rail

As noted in previous section 4.3, apart from some difference in results, VACL largely concurs with MGLA assessment that existing vegetation as well as local building structures should mostly provide the mitigation required to contain any significant glare to the train drivers with a considered eye level of 3m.

6. SUMMARY AND RECOMMENDATION

Summary of Impact on Dwellings

There were some differences noted in the parameters in the MGLA report and in particular the observer eye height for dwellings which had been assessed for levels above 1.6m instead of recommended 1.8m and also consideration of 2 storey dwellings.

Even though MGLA did not take into account some differing observer eye levels for some of the dwellings that were considered, results from the MGLA and VACL review indicated that overall, there would be minor to less than minor impact to residents of the forty (40) dwellings that were assessed.

Independent analysis by VACL using the same software utility and modelling taking into account the parameter differences and any discrepancies produced results with only slight differences, and which were largely in agreement with those of MGLA glint and glare assessment.

Summary of Impact on Road Users

Again, with consideration of the above in terms of the few differences with the parameters, VACL is largely in agreement with the MGLA modelling choice related to large vehicle traffic with driver eye height of 2.4m for which there was only a minor driver eye level consideration allowing assessment for the worst case.

VACL considered it worthwhile to include an additional road (Gunns Road) for assessment of potential glare given that this connected with a major road State Highway 73 and hence could pose potential risk if glare was present. Glare simulation analysis indicated this was not the case.

Additional landscape plantings need to be considered along Statehighway 73 and along Homebush Road along paths noted to ensure glare to oncoming and approach traffic at this intersection is minimised and eliminated as far as practicable. Once achieved , VACL is in agreement with MGLA and applicant that any potential glare should be reduced to minor and less than minor impacts.

Summary of Impact on Rail Users

Apart from some differences in the results that were achieved, these were mostly not significant in terms of glare levels and or duration. VACL is therefore largely also in agreement with MGLA and the applicant that existing vegetation as well as local building structures on and around the Fonterra plant should mostly mitigate any potential glare to train drivers.

Recommendation

Overall, VACL is largely in agreement with the results that MGLA have obtained from their glint and glare assessment for the Darfield solar energy project.

Also, where consideration of further landscape mitigation planting has been proposed, VACL offers the following recommendations for further consideration.

1. That given the maximum height of the proposed solar arrays are potentially 3.1m based on the drawings provided by the applicant NZ Clean Energy Ltd, that any proposed landscape mitigation planting be at least 4m high to ensure adequate screening from any potential view by observer points.

2. That landscape planting along Auchenflower Road and towards and around the Homebush Road and Statehighway 73 intersection be at least 4m high to ensure it is above any potential view of the solar arrays and be sufficiently dense enough to eliminate potential glare from the solar array.

3. In relation to the above, to provide interim screening where plants still need to reach expected established heights to ensure mitigation of glare towards road traffic and so provide margins of safety to road traffic until planned established heights of plants can be reached.

4. To ensure that the planned mitigation landscape plantings themselves do not create any hazard by obscuring any view towards oncoming traffic especially at the road intersections being considered.

7. IMPORTANT NOTES

While care is taken on the input data accuracy, it is based on what information has been provided by the client and any noted assumptions.

While the overall results from the ForgeSolar glare analysis simulation generally provide an accurate analysis of potential glare based on comparison of simulation against actual installations, these are based on implementation of PV arrays as per tilts and orientations provided.

The algorithm 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 as well as very localised significant undulations in nearby terrain and roads are difficult to capture and hence may impact on glare results.

8. REFERENCE DOCUMENTS

[1]: Mansergh Graham Landscape Architects Report , Appendix 09 , Solar Glare Analysis Memo R2-240625
[2]: Appendix 05, Scheme Plans DAR -001 to 004 Rev 10
[3]: Appendix 10. Landscape & Visual Assessment R3_240826
[4]: Appendix 12A . Engineering Drawings, Agrivoltaic Facility, 1352 Homebush Road, Darfield, Darfield Solar and Energy Ltd.
[5]: Email Correspondence

APPENDIX A: Site Location and Component Data (Map and Satellite View)

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 7.546718°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.434
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	-43.451667	172.097071	231.90	1.40	233.30
2	-43.465951	172.094370	221.20	1.40	222.60
3	-43.465778	172.092183	221.10	1.40	222.50
4	-43.463059	172.092676	223.80	1.40	225.20
5	-43.462839	172.090390	224.50	1.40	225.90
6	-43.465596	172.089889	222.20	1.40	223.60
7	-43.465287	172.085972	223.20	1.40	224.60
8	-43.460230	172.081414	229.00	1.40	230.40
9	-43.457955	172.084528	230.10	1.40	231.50
10	-43.459237	172.086705	228.40	1.40	229.80
11	-43.457965	172.088370	229.40	1.40	230.80
12	-43.457442	172.087479	229.80	1.40	231.20
13	-43.457410	172.087512	229.80	1.40	231.20
14	-43.456653	172.086246	230.60	1.40	232.00
15	-43.454706	172.088200	232.30	1.40	233.70
16	-43.453924	172.088971	232.60	1.40	234.00
17	-43.452312	172.090606	233.40	1.40	234.80
18	-43.452239	172.090630	233.60	1.40	235.00
19	-43.450710	172.092674	234.00	1.40	235.40
20	-43.450660	172.092704	234.00	1.40	235.40
21	-43.450585	172.092739	233.90	1.40	235.30
22	-43.447953	172.093245	236.10	1.40	237.50
23	-43.447856	172.093289	236.10	1.40	237.50
24	-43.444192	172.094476	238.40	1.40	239.80
25	-43.444256	172.095094	237.70	1.40	239.10
26	-43.446052	172.094744	237.20	1.40	238.60
27	-43.446405	172.098146	235.30	1.40	236.70

APPENDIX B : Discrete Observation Point Receptors (Dwellings)

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-43.464387	172.091797	222.80	1.60
OP 2	2	-43.458671	172.086307	229.40	1.80
OP 3	3	-43.456912	172.084893	230.80	1.80
OP 4	4	-43.456103	172.083137	232.10	1.80
OP 5	5	-43.454771	172.079477	234.00	1.80
OP 6	6	-43.457656	172.096367	228.00	1.80
OP 7	7	-43.460258	172.096295	225.30	1.80
OP 8	8	-43.465873	172.089187	222.00	1.80
OP 9	9	-43.465961	172.090847	221.40	1.80
OP 10	10	-43.466551	172.093262	220.30	1.80
OP 11	11	-43.466745	172.095720	219.90	1.80
OP 12	12	-43.466939	172.098178	219.40	1.80
OP 13	13	-43.467133	172.100636	218.50	1.80
OP 14	14	-43.467714	172.108010	215.70	1.80
OP 15	15	-43.468240	172.116054	213.70	1.80
OP 16	16	-43.473094	172.115783	210.30	1.80
OP 17	17	-43.474994	172.103772	211.80	1.80
OP 18	18	-43.474423	172.101117	212.10	1.80
OP 19	19	-43.476828	172.099929	210.70	1.80
OP 20	20	-43.478120	172.084550	213.10	1.80
OP 21	21	-43.478109	172.071468	214.60	3.60
OP 22	22	-43.465628	172.059271	229.30	3.60
OP 23	23	-43.464938	172.068560	226.90	1.80
OP 24	24	-43.466480	172.081114	225.70	1.80
OP 25	25	-43.454336	172.074992	236.10	3.60
OP 26	26	-43.446973	172.069888	246.00	1.80
OP 27	27	-43.442225	172.067733	250.50	1.80
OP 28	28	-43.441146	172.071761	250.30	1.80
OP 29	29	-43.438282	172.074647	250.80	1.80
OP 30	30	-43.436611	172.084236	246.90	1.80
OP 31	31	-43.434756	172.086878	246.80	1.80
OP 32	32	-43.432439	172.094054	244.90	1.80
OP 33	33	-43.430610	172.103736	241.70	1.80
OP 34	34	-43.436036	172.123475	230.60	1.80
OP 35	35	-43.439780	172.122011	229.50	1.80
OP 36	36	-43.444801	172.106926	233.20	1.80
OP 37	37	-43.448283	172.120202	226.00	1.80
OP 38	38	-43.450926	172.118838	224.60	1.80
OP 39	39	-43.453415	172.121308	222.30	1.80
OP 40	40	-43.456588	172.117357	220.90	1.80

APPENDIX C : Road Routes

Name: Auchenflower Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.446950	172.121125	226.70	2.50	229.20
2	-43.446557	172.119438	227.60	2.50	230.10
3	-43.446355	172.117663	227.80	2.50	230.30
4	-43.446175	172.115884	228.00	2.50	230.50
5	-43.445995	172.114104	229.70	2.50	232.20
6	-43.445815	172.112325	230.50	2.50	233.00
7	-43.445635	172.110545	231.50	2.50	234.00
8	-43.445456	172.108766	232.10	2.50	234.60
9	-43.445276	172.106987	233.00	2.50	235.50
10	-43.445096	172.105207	233.70	2.50	236.20
11	-43.444914	172.103428	234.20	2.50	236.70
12	-43.444732	172.101649	235.20	2.50	237.70
13	-43.444549	172.099870	236.50	2.50	239.00
14	-43.444365	172.098091	236.80	2.50	239.30
15	-43.444178	172.096313	237.60	2.50	240.10
16	-43.443990	172.094535	238.20	2.50	240.70
17	-43.443803	172.092757	239.40	2.50	241.90
18	-43.443617	172.090979	240.30	2.50	242.80
19	-43.443433	172.089200	240.60	2.50	243.10
20	-43.443250	172.087422	241.00	2.50	243.50
21	-43.443066	172.085643	242.50	2.50	245.00
22	-43.442883	172.083864	243.30	2.50	245.80
23	-43.442700	172.082085	244.00	2.50	246.50
24	-43.442516	172.080306	245.90	2.50	248.40
25	-43.442333	172.078528	244.00	2.50	246.50
26	-43.442152	172.076748	247.70	2.50	250.20
27	-43.441972	172.074969	248.20	2.50	250.70
28	-43.441792	172.073190	249.20	2.50	251.70
29	-43.441611	172.071410	249.90	2.50	252.40
30	-43.441431	172.069631	250.30	2.50	252.80

Name: Auchenflower Rd West of Main Highway 73
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.439186	172.052739	253.00	2.50	255.50
2	-43.439607	172.055754	252.00	2.50	254.50
3	-43.439965	172.058211	250.00	2.50	252.50
4	-43.440184	172.059949	250.00	2.50	252.50
5	-43.440355	172.061151	249.00	2.50	251.50
6	-43.440526	172.062331	248.00	2.50	250.50
7	-43.440698	172.063554	247.00	2.50	249.50
8	-43.441025	172.065839	245.00	2.50	247.50

Name: Bleak House Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.441027	172.066132	250.80	2.50	253.30
2	-43.440555	172.067806	250.70	2.50	253.20
3	-43.440072	172.069475	250.90	2.50	253.40
4	-43.439588	172.071143	251.40	2.50	253.90
5	-43.439104	172.072812	251.20	2.50	253.70
6	-43.438623	172.074482	250.70	2.50	253.20
7	-43.438144	172.076153	249.90	2.50	252.40
8	-43.437664	172.077824	249.60	2.50	252.10
9	-43.437185	172.079495	249.10	2.50	251.60
10	-43.436705	172.081165	249.00	2.50	251.50
11	-43.436220	172.082833	247.70	2.50	250.20
12	-43.435732	172.084499	246.70	2.50	249.20
13	-43.435244	172.086166	246.60	2.50	249.10
14	-43.434757	172.087832	246.70	2.50	249.20
15	-43.434269	172.089498	246.30	2.50	248.80
16	-43.433781	172.091165	245.50	2.50	248.00
17	-43.433310	172.092840	246.00	2.50	248.50
18	-43.432840	172.094516	244.80	2.50	247.30
19	-43.432370	172.096192	244.00	2.50	246.50
20	-43.432338	172.096305	243.90	2.50	246.40

Name: Boultons Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.468097	172.119544	213.00	2.50	215.50
2	-43.467599	172.121205	211.40	2.50	213.90
3	-43.467090	172.122860	211.70	2.50	214.20
4	-43.466581	172.124514	211.80	2.50	214.30
5	-43.466073	172.126168	211.60	2.50	214.10
6	-43.465564	172.127823	211.60	2.50	214.10
7	-43.465056	172.129477	211.30	2.50	213.80
8	-43.464547	172.131132	211.20	2.50	213.70
9	-43.464039	172.132786	210.80	2.50	213.30
10	-43.463530	172.134440	210.00	2.50	212.50
11	-43.463022	172.136095	209.50	2.50	212.00
12	-43.462513	172.137749	209.40	2.50	211.90
13	-43.462005	172.139403	208.20	2.50	210.70
14	-43.461496	172.141058	208.40	2.50	210.90
15	-43.460987	172.142712	207.40	2.50	209.90
16	-43.460469	172.144360	207.30	2.50	209.80
17	-43.460079	172.144939	207.30	2.50	209.80

Name: Clintons Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.485350	172.075213	208.50	2.50	211.00
2	-43.484132	172.074572	209.40	2.50	211.90
3	-43.482915	172.073931	210.30	2.50	212.80
4	-43.481697	172.073290	211.50	2.50	214.00
5	-43.480442	172.072814	212.50	2.50	215.00
6	-43.479171	172.072412	213.80	2.50	216.30
7	-43.477898	172.072026	214.70	2.50	217.20
8	-43.476624	172.071640	215.90	2.50	218.40
9	-43.475356	172.071228	216.90	2.50	219.40
10	-43.474084	172.070831	218.10	2.50	220.60
11	-43.472813	172.070434	219.30	2.50	221.80
12	-43.471541	172.070037	220.40	2.50	222.90
13	-43.470269	172.069640	221.50	2.50	224.00
14	-43.468998	172.069243	223.30	2.50	225.80
15	-43.467726	172.068846	224.30	2.50	226.80
16	-43.466454	172.068449	225.20	2.50	227.70
17	-43.465183	172.068052	226.40	2.50	228.90
18	-43.463911	172.067654	227.60	2.50	230.10
19	-43.462641	172.067250	228.70	2.50	231.20
20	-43.461370	172.066848	230.00	2.50	232.50
21	-43.460099	172.066445	231.00	2.50	233.50
22	-43.458828	172.066043	232.40	2.50	234.90
23	-43.457557	172.065641	233.70	2.50	236.20
24	-43.456286	172.065239	235.20	2.50	237.70
25	-43.455025	172.064944	236.50	2.50	239.00
26	-43.454868	172.066674	236.10	2.50	238.60
27	-43.454816	172.068469	236.10	2.50	238.60
28	-43.454765	172.070264	236.30	2.50	238.80
29	-43.454713	172.072059	236.30	2.50	238.80
30	-43.454661	172.073855	236.30	2.50	238.80

Name: Fonterra Railway Siding
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.459032	172.080040	231.20	3.00	234.20
2	-43.457823	172.079373	232.20	3.00	235.20
3	-43.456598	172.078758	232.80	3.00	235.80
4	-43.455313	172.078588	233.30	3.00	236.30
5	-43.454129	172.079293	233.90	3.00	236.90
6	-43.453124	172.080437	234.40	3.00	237.40
7	-43.452121	172.081587	234.50	3.00	237.50
8	-43.451119	172.082736	234.50	3.00	237.50
9	-43.450116	172.083885	234.50	3.00	237.50
10	-43.449114	172.085034	234.60	3.00	237.60
11	-43.448111	172.086184	234.60	3.00	237.60
12	-43.447126	172.087313	234.50	3.00	237.50

Name: Gunns Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.444600	172.058233	245.00	2.50	247.50
2	-43.444086	172.059241	246.00	2.50	248.50
3	-43.443619	172.060303	249.00	2.50	251.50
4	-43.443152	172.061355	250.02	2.50	252.52
5	-43.442661	172.062395	249.00	2.50	251.50
6	-43.442201	172.063468	247.00	2.50	249.50
7	-43.441726	172.064530	245.94	2.50	248.44
8	-43.441104	172.065898	245.00	2.50	247.50

Name: Homebush Rd East of Railway
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.465355	172.084639	224.00	2.50	226.50
2	-43.465498	172.086425	223.00	2.50	225.50
3	-43.465636	172.088211	222.40	2.50	224.90
4	-43.465774	172.089998	222.10	2.50	224.60
5	-43.465913	172.091784	221.60	2.50	224.10
6	-43.466051	172.093571	221.00	2.50	223.50
7	-43.466200	172.095355	220.50	2.50	223.00
8	-43.466356	172.097139	220.20	2.50	222.70
9	-43.466493	172.098926	219.20	2.50	221.70
10	-43.466630	172.100712	218.90	2.50	221.40
11	-43.466767	172.102499	218.00	2.50	220.50
12	-43.466904	172.104286	217.80	2.50	220.30
13	-43.467041	172.106072	217.00	2.50	219.50
14	-43.467182	172.107858	216.40	2.50	218.90
15	-43.467323	172.109645	215.60	2.50	218.10
16	-43.467463	172.111431	215.40	2.50	217.90
17	-43.467604	172.113217	215.20	2.50	217.70
18	-43.467745	172.115003	214.30	2.50	216.80
19	-43.467886	172.116789	213.80	2.50	216.30
20	-43.468028	172.118575	212.70	2.50	215.20
21	-43.468164	172.120362	211.70	2.50	214.20
22	-43.468302	172.122148	210.90	2.50	213.40
23	-43.468444	172.123934	210.40	2.50	212.90
24	-43.468586	172.125720	210.10	2.50	212.60
25	-43.468729	172.127506	209.30	2.50	211.80
26	-43.468871	172.129292	209.00	2.50	211.50
27	-43.469013	172.131078	208.40	2.50	210.90
28	-43.469035	172.131348	208.20	2.50	210.70

Name: Homebush Road West of Railway
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.468385	172.045917	226.70	2.50	229.20
2	-43.468088	172.047667	226.30	2.50	228.80
3	-43.467788	172.049415	226.20	2.50	228.70
4	-43.467495	172.051166	228.00	2.50	230.50
5	-43.467201	172.052916	229.20	2.50	231.70
6	-43.466908	172.054667	229.00	2.50	231.50
7	-43.466615	172.056418	228.50	2.50	231.00
8	-43.466321	172.058168	228.60	2.50	231.10
9	-43.466028	172.059919	228.50	2.50	231.00
10	-43.465734	172.061669	228.30	2.50	230.80
11	-43.465441	172.063420	228.20	2.50	230.70
12	-43.465148	172.065170	227.70	2.50	230.20
13	-43.464854	172.066921	227.30	2.50	229.80
14	-43.464555	172.068669	227.00	2.50	229.50
15	-43.464259	172.070419	227.40	2.50	229.90
16	-43.464093	172.072184	227.70	2.50	230.20
17	-43.464269	172.073965	227.60	2.50	230.10
18	-43.464444	172.075745	227.50	2.50	230.00
19	-43.464619	172.077525	226.70	2.50	229.20
20	-43.464794	172.079305	226.40	2.50	228.90
21	-43.464970	172.081086	225.40	2.50	227.90
22	-43.465154	172.082864	224.60	2.50	227.10
23	-43.465355	172.084639	224.00	2.50	226.50

Name: Kimberley Rd North
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.446387	172.121175	230.00	2.50	232.50
2	-43.445576	172.121218	230.00	2.50	232.50
3	-43.444735	172.121304	231.00	2.50	233.50
4	-43.443598	172.121390	231.00	2.50	233.50
5	-43.442476	172.121476	231.00	2.50	233.50
6	-43.441588	172.121518	232.00	2.50	234.50
7	-43.440279	172.121626	232.00	2.50	234.50
8	-43.439002	172.121733	233.00	2.50	235.50
9	-43.438270	172.121776	233.00	2.50	235.50
10	-43.437288	172.121862	234.00	2.50	236.50
11	-43.436447	172.121883	234.00	2.50	236.50
12	-43.434857	172.122033	235.00	2.50	237.50
13	-43.433408	172.122162	235.00	2.50	237.50
14	-43.432099	172.122227	235.00	2.50	237.50
15	-43.431242	172.122291	236.00	2.50	238.50
16	-43.430494	172.122334	236.12	2.50	238.62
17	-43.429263	172.122420	237.00	2.50	239.50
18	-43.428281	172.122505	238.00	2.50	240.50
19	-43.427471	172.122548	237.98	2.50	240.48
20	-43.426302	172.122656	237.00	2.50	239.50
21	-43.424947	172.122763	235.00	2.50	237.50

Name: Kimberley Road South
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.483167	172.110196	208.00	2.50	210.50
2	-43.481205	172.111355	209.00	2.50	211.50
3	-43.478371	172.113157	210.00	2.50	212.50
4	-43.475880	172.114788	211.00	2.50	213.50
5	-43.474136	172.115818	212.00	2.50	214.50
6	-43.471209	172.117577	213.00	2.50	215.50
7	-43.468250	172.119423	213.00	2.50	215.50
8	-43.466475	172.119637	215.00	2.50	217.50
9	-43.465291	172.119766	216.00	2.50	218.50
10	-43.462768	172.119938	220.00	2.50	222.50
11	-43.461335	172.120066	221.00	2.50	223.50
12	-43.459341	172.120195	222.00	2.50	224.50
13	-43.458033	172.120195	222.00	2.50	224.50
14	-43.457005	172.120281	222.00	2.50	224.50
15	-43.455323	172.120453	223.00	2.50	225.50
16	-43.454482	172.120539	224.00	2.50	226.50
17	-43.453609	172.120539	224.00	2.50	226.50
18	-43.452799	172.120710	225.00	2.50	227.50
19	-43.452270	172.120710	226.00	2.50	228.50
20	-43.451709	172.120710	226.00	2.50	228.50
21	-43.451179	172.120753	227.00	2.50	229.50
22	-43.450525	172.120796	227.00	2.50	229.50
23	-43.449996	172.120839	227.00	2.50	229.50
24	-43.449524	172.120875	227.52	2.50	230.02
25	-43.449181	172.120875	227.69	2.50	230.19
26	-43.448870	172.120939	228.00	2.50	230.50
27	-43.448589	172.120961	228.00	2.50	230.50
28	-43.447920	172.121046	228.00	2.50	230.50

Name: Loes Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.466130	172.094587	221.10	2.50	223.60
2	-43.464839	172.094834	221.60	2.50	224.10
3	-43.463547	172.095081	222.80	2.50	225.30
4	-43.462255	172.095328	223.70	2.50	226.20
5	-43.460964	172.095575	225.10	2.50	227.60
6	-43.459672	172.095822	225.80	2.50	228.30
7	-43.458380	172.096069	226.80	2.50	229.30
8	-43.457089	172.096316	227.80	2.50	230.30
9	-43.455797	172.096563	228.90	2.50	231.40
10	-43.454505	172.096810	229.80	2.50	232.30
11	-43.453213	172.097057	230.80	2.50	233.30
12	-43.451921	172.097304	231.70	2.50	234.20
13	-43.450629	172.097551	232.80	2.50	235.30
14	-43.449337	172.097798	233.60	2.50	236.10
15	-43.448045	172.098045	234.20	2.50	236.70
16	-43.446753	172.098292	234.80	2.50	237.30
17	-43.445461	172.098539	235.90	2.50	238.40
18	-43.444433	172.098736	236.70	2.50	239.20

Name: Main Trunk Line
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.475051	172.094494	214.10	3.00	217.10
2	-43.473960	172.093510	215.10	3.00	218.10
3	-43.472870	172.092525	216.10	3.00	219.10
4	-43.471779	172.091541	217.20	3.00	220.20
5	-43.470688	172.090557	218.20	3.00	221.20
6	-43.469597	172.089573	219.20	3.00	222.20
7	-43.468506	172.088588	220.30	3.00	223.30
8	-43.467415	172.087604	221.50	3.00	224.50
9	-43.466325	172.086620	222.70	3.00	225.70
10	-43.465234	172.085636	223.80	3.00	226.80
11	-43.464143	172.084652	225.10	3.00	228.10
12	-43.463052	172.083667	226.50	3.00	229.50
13	-43.461961	172.082683	227.80	3.00	230.80
14	-43.460870	172.081699	229.00	3.00	232.00
15	-43.459779	172.080715	230.40	3.00	233.40
16	-43.458688	172.079730	231.50	3.00	234.50
17	-43.457597	172.078746	232.80	3.00	235.80
18	-43.456506	172.077762	234.10	3.00	237.10
19	-43.455416	172.076776	235.30	3.00	238.30
20	-43.454313	172.075817	236.70	3.00	239.70
21	-43.453157	172.074986	237.80	3.00	240.80
22	-43.452425	172.074469	238.70	3.00	241.70

Name: SH 73 North of Homebush Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.465209	172.085024	224.00	2.50	226.50
2	-43.464120	172.084037	225.30	2.50	227.80
3	-43.463031	172.083049	226.40	2.50	228.90
4	-43.461942	172.082060	227.70	2.50	230.20
5	-43.460853	172.081072	229.00	2.50	231.50
6	-43.459763	172.080084	230.10	2.50	232.60
7	-43.458674	172.079096	231.30	2.50	233.80
8	-43.457582	172.078113	232.60	2.50	235.10
9	-43.456487	172.077138	234.00	2.50	236.50
10	-43.455392	172.076162	235.00	2.50	237.50
11	-43.454228	172.075354	236.20	2.50	238.70
12	-43.453073	172.074519	237.90	2.50	240.40
13	-43.451918	172.073684	239.30	2.50	241.80
14	-43.450763	172.072849	240.80	2.50	243.30
15	-43.449608	172.072015	243.00	2.50	245.50
16	-43.448447	172.071195	244.90	2.50	247.40
17	-43.447287	172.070375	246.10	2.50	248.60
18	-43.446126	172.069554	246.20	2.50	248.70
19	-43.444966	172.068734	248.00	2.50	250.50
20	-43.443805	172.067914	249.60	2.50	252.10
21	-43.442645	172.067094	250.50	2.50	253.00
22	-43.441484	172.066273	250.70	2.50	253.20
23	-43.440343	172.065403	250.80	2.50	253.30
24	-43.439215	172.064502	251.00	2.50	253.50
25	-43.438087	172.063599	251.30	2.50	253.80
26	-43.436960	172.062695	251.80	2.50	254.30
27	-43.435830	172.061795	252.70	2.50	255.20
28	-43.434702	172.060893	253.80	2.50	256.30
29	-43.433743	172.060124	254.70	2.50	257.20

Name: Tramway Road East of Kimberley Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.446656	172.121311	229.72	2.50	232.22
2	-43.447279	172.122502	228.50	2.50	231.00
3	-43.447715	172.123221	228.00	2.50	230.50
4	-43.448174	172.124025	227.00	2.50	229.50
5	-43.448743	172.125077	226.00	2.50	228.50
6	-43.449023	172.125517	225.00	2.50	227.50
7	-43.449351	172.126150	225.00	2.50	227.50
8	-43.449943	172.127169	224.00	2.50	226.50
9	-43.450488	172.128113	223.00	2.50	225.50
10	-43.451173	172.129336	221.00	2.50	223.50
11	-43.452123	172.130978	220.00	2.50	222.50
12	-43.452980	172.132469	218.03	2.50	220.53
13	-43.453868	172.134014	217.00	2.50	219.50
14	-43.455387	172.136664	214.00	2.50	216.50
15	-43.456485	172.138584	213.00	2.50	215.50
16	-43.458011	172.141310	210.00	2.50	212.50
17	-43.459211	172.143380	209.00	2.50	211.50
18	-43.459989	172.144775	208.00	2.50	210.50

Name: Tramway Road West of Kimberley Bush Rd
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-43.432628	172.096799	244.00	2.50	246.50
2	-43.433220	172.097829	243.00	2.50	245.50
3	-43.433890	172.099074	243.00	2.50	245.50
4	-43.434653	172.100383	242.00	2.50	244.50
5	-43.435370	172.101563	242.00	2.50	244.50
6	-43.435993	172.102636	241.00	2.50	243.50
7	-43.436601	172.103773	241.00	2.50	243.50
8	-43.437333	172.104996	240.00	2.50	242.50
9	-43.438393	172.106970	239.00	2.50	241.50
10	-43.439437	172.108815	237.84	2.50	240.34
11	-43.440153	172.110103	237.00	2.50	239.50
12	-43.441524	172.112335	235.00	2.50	237.50
13	-43.442553	172.114287	234.00	2.50	236.50
14	-43.443596	172.116090	233.00	2.50	235.50
15	-43.444453	172.117484	232.00	2.50	234.50
16	-43.444765	172.118085	231.00	2.50	233.50
17	-43.445232	172.118922	231.00	2.50	233.50
18	-43.445637	172.119609	230.12	2.50	232.62
19	-43.446463	172.121003	230.00	2.50	232.50

APPENDIX D: Obstructions Components : Existing Vegetation and Planned Landscaping

Name: Amenity Planting OP1
Top height: 8.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.465829	172.091864	227.36
2	-43.464766	172.091971	228.22
3	-43.464415	172.092110	228.47
4	-43.463968	172.092194	228.88
5	-43.463514	172.091472	229.63
6	-43.464303	172.091134	228.36
7	-43.464698	172.091842	228.33
8	-43.464760	172.091901	228.27
9	-43.465330	172.091848	227.76
10	-43.465714	172.091805	227.64

Name: Fonterra Boundary Planting
Top height: 4.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.460148	172.081222	229.00
2	-43.457827	172.084548	230.00
3	-43.459120	172.086673	230.00
4	-43.457944	172.088164	230.00
5	-43.456667	172.086082	231.00
6	-43.452476	172.090310	234.00
7	-43.452227	172.090406	234.00
8	-43.450592	172.092584	235.00
9	-43.447873	172.093110	237.00
10	-43.444197	172.094344	239.00

Name: Fonterra Building
Top height: 10.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.447954	172.087282	237.00
2	-43.449075	172.085994	237.00
3	-43.448951	172.085704	237.00
4	-43.451568	172.082743	236.00

Name: FonterraEntry to Homebush Statehighway73 Int
Top height: 4.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.460159	172.081212	229.00
2	-43.460640	172.081636	228.93
3	-43.461230	172.082159	228.00
4	-43.461898	172.082741	227.00
5	-43.463153	172.083894	226.00
6	-43.464146	172.084798	225.00
7	-43.465367	172.085879	224.00

Name: Fonterra Siding Mitigation Screening
Top height: 5.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.456024	172.078761	233.00
2	-43.456569	172.078847	232.00
3	-43.457808	172.079490	231.00
4	-43.458789	172.080070	230.00
5	-43.459498	172.080649	230.00

Name: Homebush East of State Highway73 to Op1 Obs 8
Top height: 4.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.465367	172.085906	224.00
2	-43.465464	172.087073	223.00
3	-43.465544	172.088020	223.00
4	-43.465614	172.088948	223.00
5	-43.465694	172.090053	222.01
6	-43.465840	172.091718	222.00

Name: Main Trunk Line - State-highway 73 Obs 9
Top height: 6.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.454029	172.075850	234.00
2	-43.455310	172.076837	233.00
3	-43.456143	172.077593	233.00
4	-43.456852	172.078221	232.00
5	-43.456984	172.078328	232.00

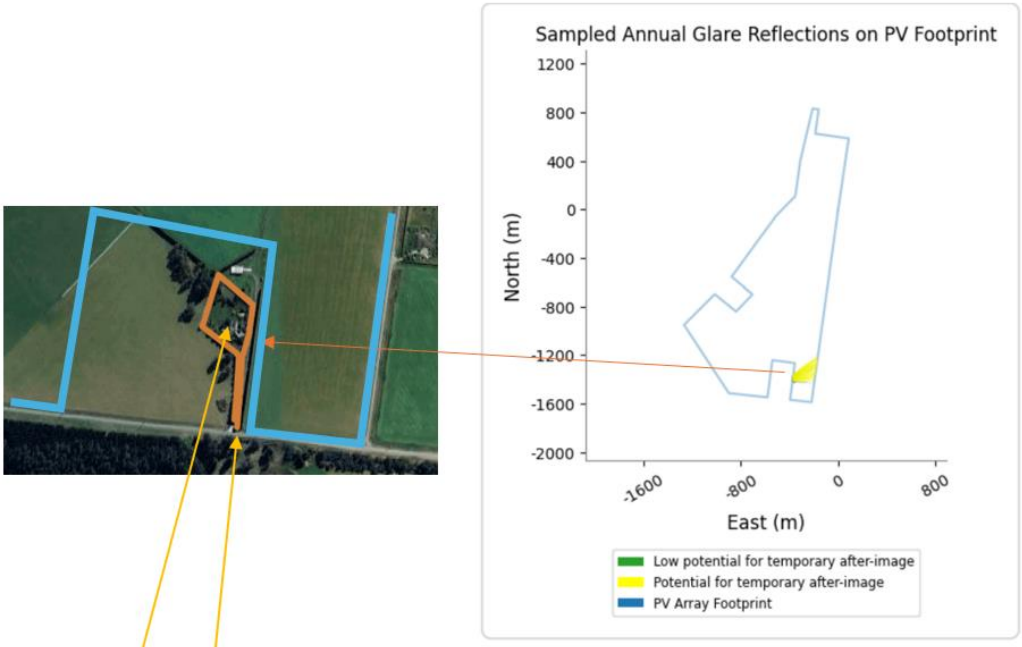
Name: McHughs Forest Park
Top height: 20.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.477312	172.096710	212.00
2	-43.465721	172.086307	223.00
3	-43.466009	172.090738	222.00
4	-43.472526	172.096574	216.00
5	-43.473188	172.096874	215.00
6	-43.473858	172.097615	215.00
7	-43.475999	172.099224	213.00

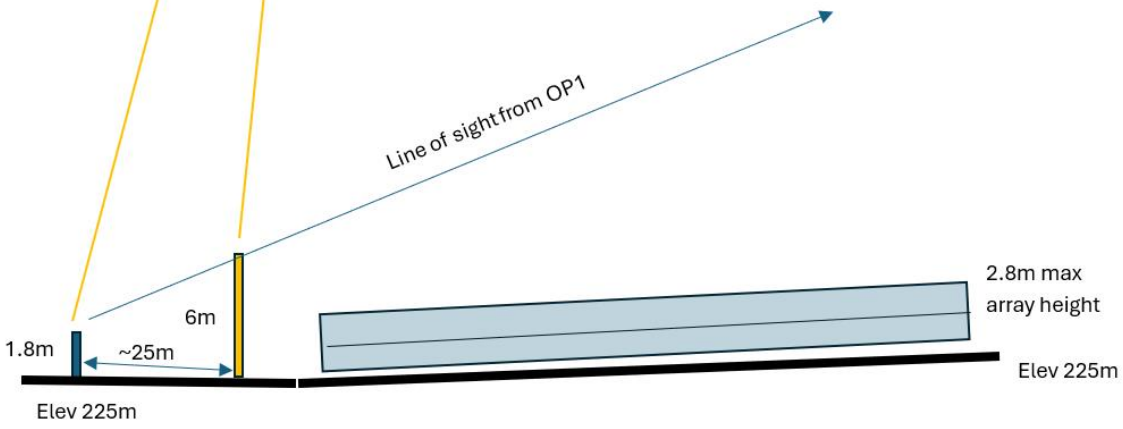
Name: OP1 to Loes Rd Obs 10
Top height: 4.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-43.465846	172.092008	222.00
2	-43.466056	172.094468	221.00

APPENDIX E : Obstruction Observer Point 1 Anomalous Result



OP 1 Green glare 25 hours per annum and yellow glare 27.4 hours per annum



Existing Vegetation obstruction should obscure any view of solar array from observer point 1 and hence any glare.