

APPENDIX 3

BUCKLEYS ROAD SOLAR FARM

GRAPHIC SUPPLEMENT

AUGUST 2023



Table of Contents

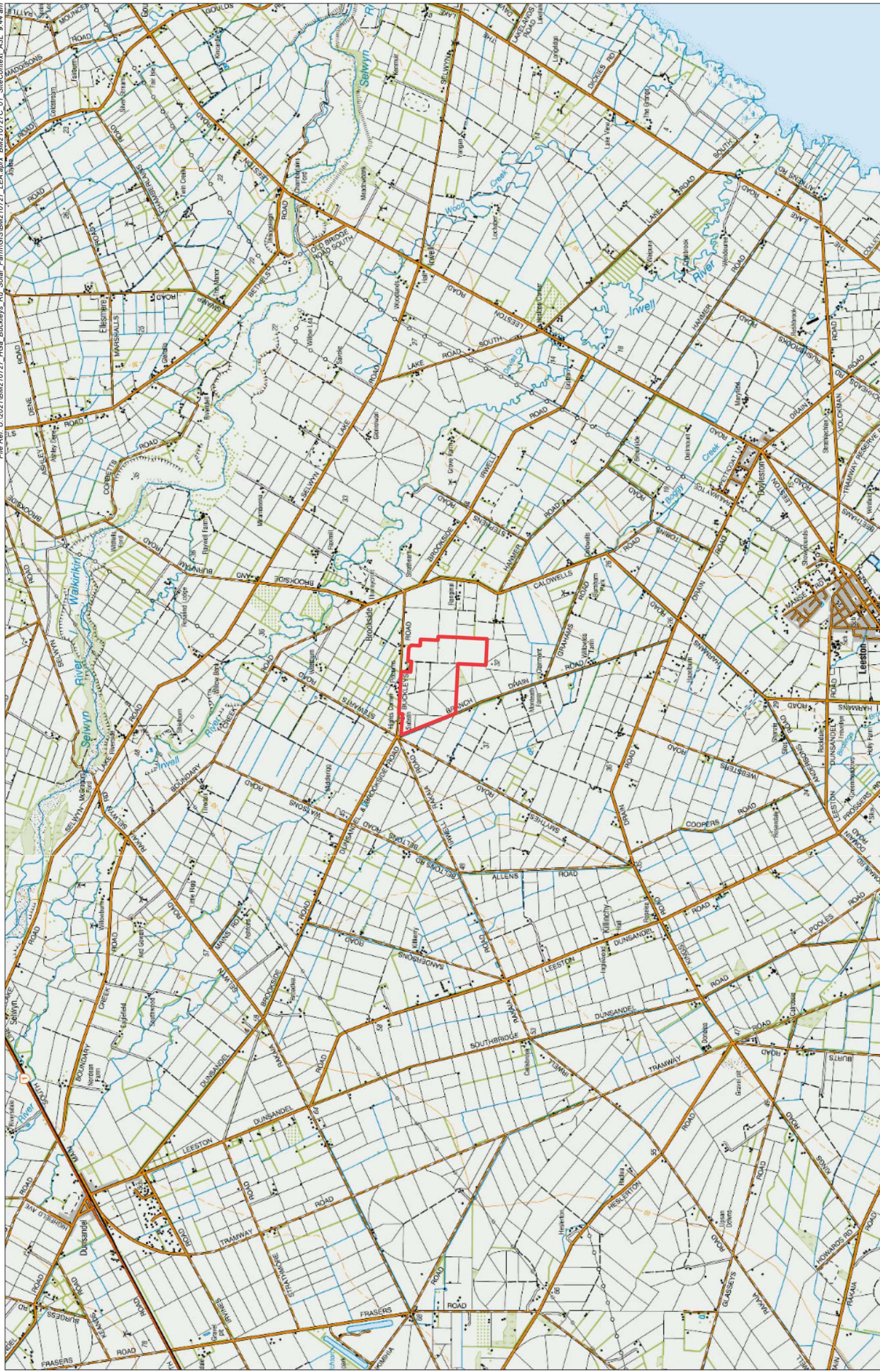
FIGURE 1: Site Context
FIGURE 2: Viewpoint Location Map
FIGURE 3: Landscape Mitigation Plan
FIGURE 4: Northern Vegetation
FIGURE 5: Southern Vegetation
FIGURES 6 - 7: Sections
FIGURES 8- 17: Viewpoints
FIGURE 18: Potential Glare Map
FIGURE 19: Planting Plan
FIGURE 20: Plant Tables
FIGURE 21: Visual Simulation Methodology

PRINT A3 landscape double-sided

COVER IMAGE: View from within the Site, looking at the north-westerly direction towards the existing substation at the corner of Branch Drain and Buckleys Roads.

LEFT IMAGE: View of existing solar panels on Buckleys Road, north of the Site.





BUCKLEYS ROAD SOLAR FARM, BROOKSIDE

Site Context

Date: 09 August 2023 | Revision: 0

Plan prepared for Keax Limited by Boffa Miskell Limited

Project Manager: Amanda Anthony@boffamiskell.co.nz | Drawn: AAn | Checked: EMc

Figure 1

LEGEND



0 1,000 m

1:50,000 @ A3

Data Sources: Eagle Technology, Land Information New Zealand

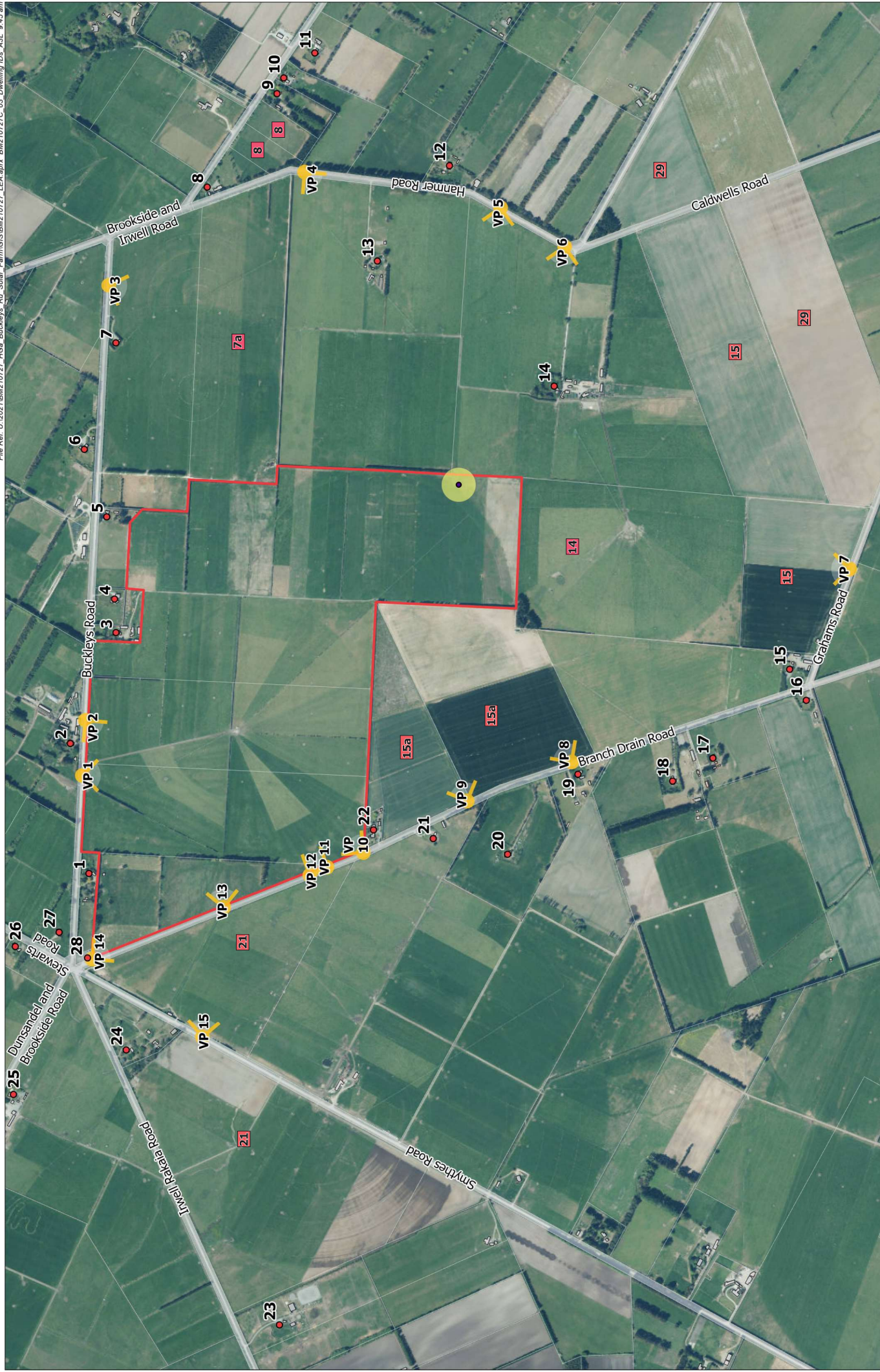
Projection: NZGD 2000 New Zealand Transverse Mercator

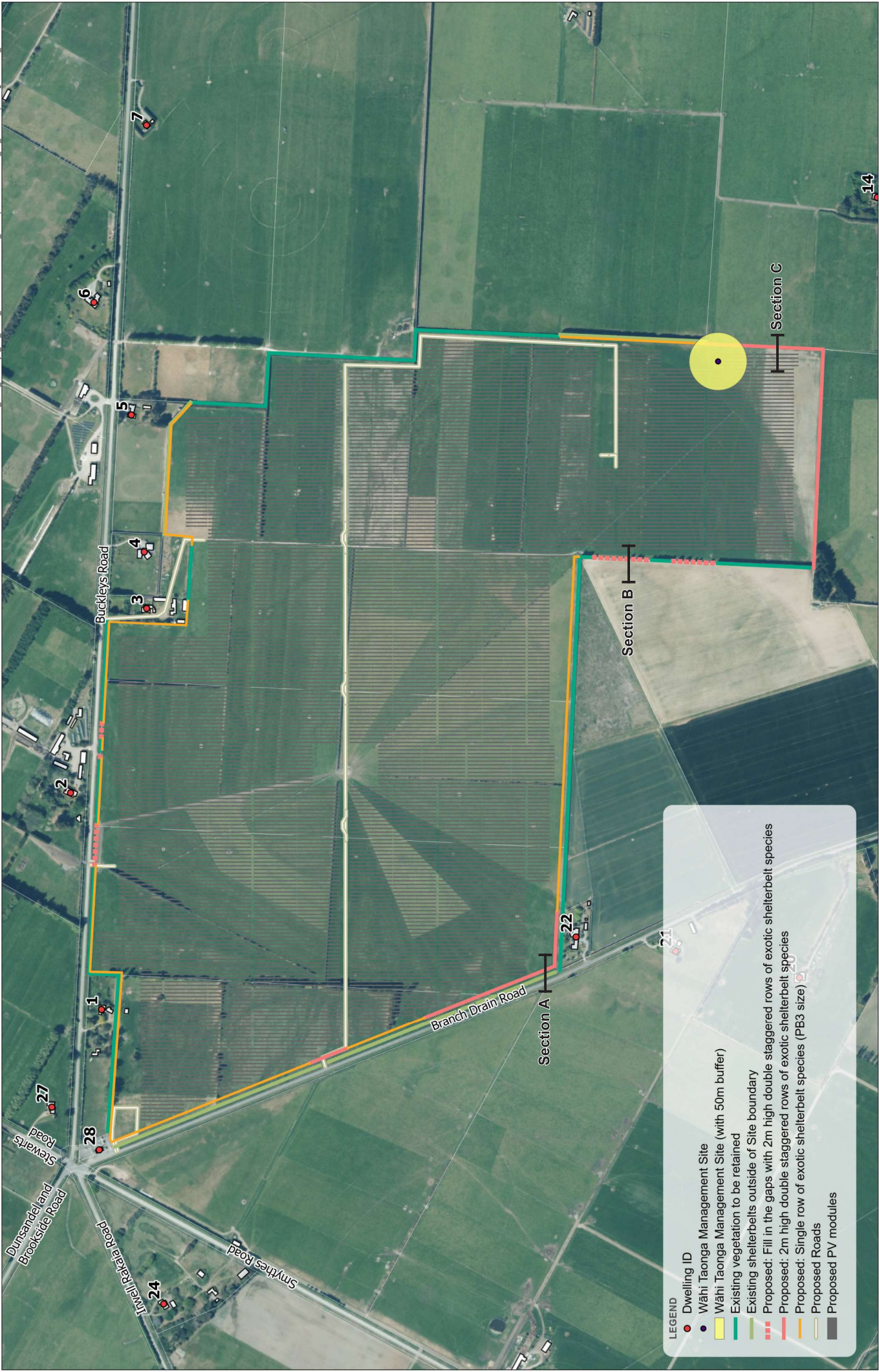
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- LEGEND**
- Dwelling ID
 - Existing shelterbelts outside of Site boundary
 - Proposed: Fill in the gaps with 2m high double staggered rows of exotic shelterbelt species
 - Proposed: 2m high double staggered rows of exotic shelterbelt species
 - Proposed: Single row of exotic shelterbelt species (PB3 size)
 - Existing vegetation to be retained
 - Proposed Roads
 - Proposed PV modules



LEGEND

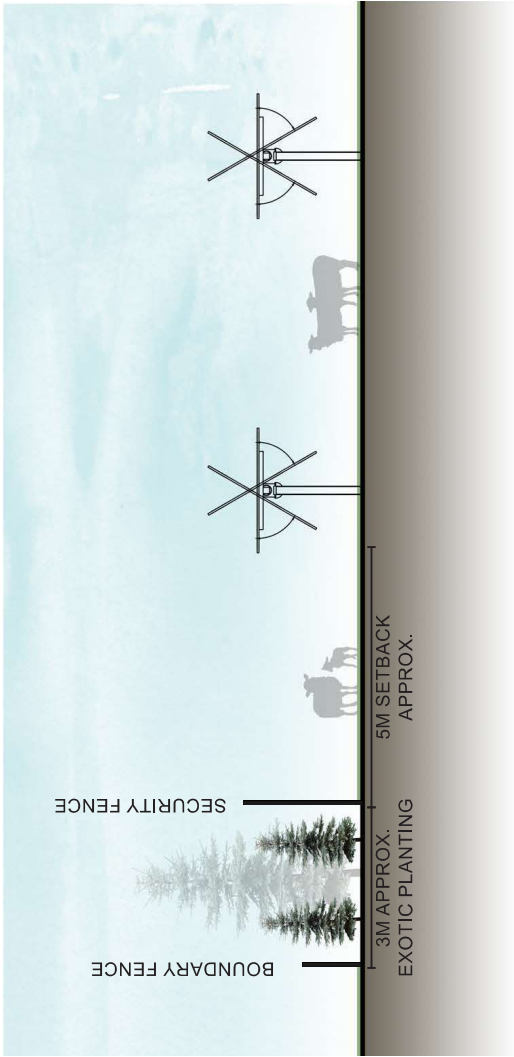
- Dwelling ID
- Wāhi Taonga Management Site
- Wāhi Taonga Management Site (with 50m buffer)
- Existing shelterbelts outside of Site boundary
- Proposed: Fill in the gaps with 2m high double staggered rows of exotic shelterbelt species
- Proposed: 2m high double staggered rows of exotic shelterbelt species
- Proposed: Single row of exotic shelterbelt species (PB3 size)
- Existing vegetation to be retained
- Proposed Roads
- Proposed PV modules



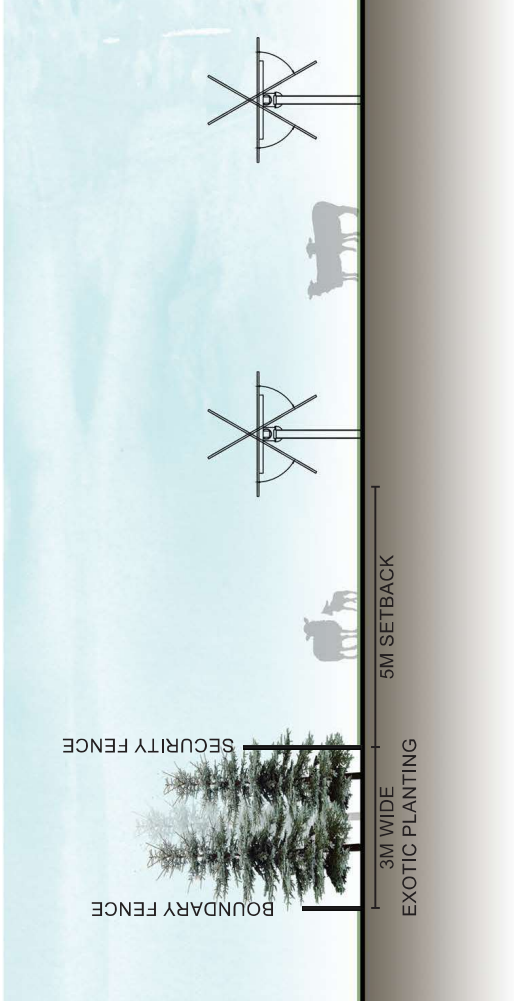
Section A: Branch Drain Road after construction



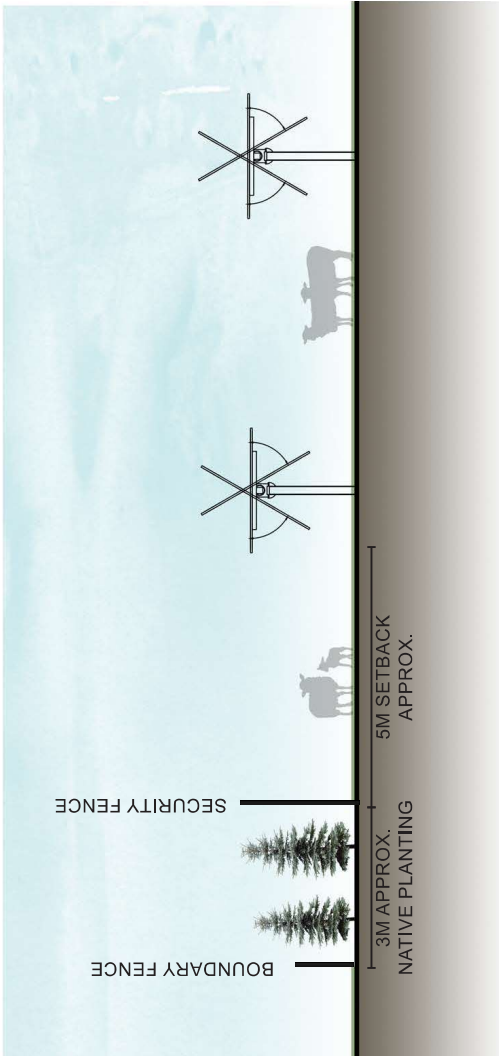
Section A: Branch Drain Road after 5 years



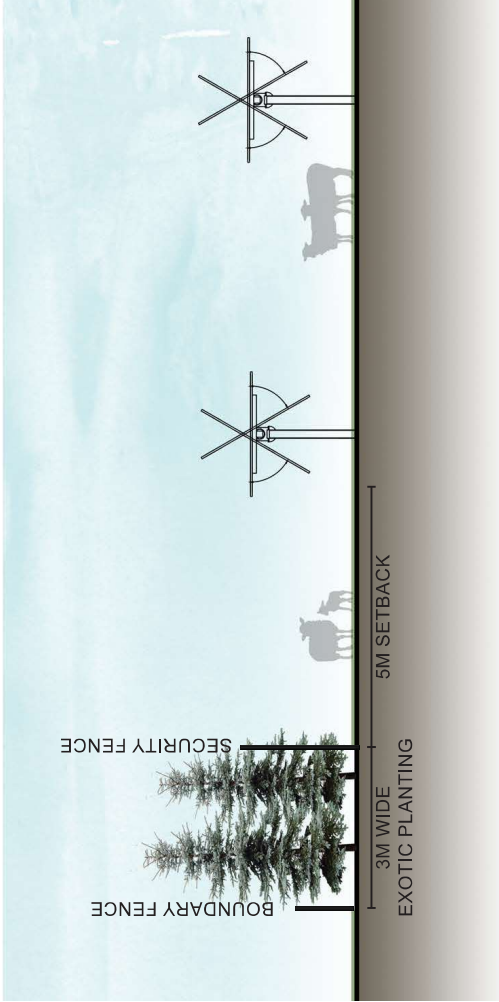
Section B: 2m high exotic shelter belt 'gap filling' between existing vegetation



Section B: 3.5m high exotic shelter belt 'gap filling' between existing vegetation after 5 years



Section C: 2m high exotic shelter belt plantings



Section C: 3.5m high exotic shelter belt plantings after 5 years

The Site (gap in existing vegetation)



Existing view

Viewpoint 1 & Visual Simulation 1 is located on Buckleys Road, north of the Site, looking in a southerly direction across the Site. This illustrates the existing view.



After construction

Visual Simulation 1 View after construction with 2m high plants in a gap between the existing vegetation on Buckleys Road.

Date of Photography: 10:00am - 2:00pm 14 June 2023 NZST	
Horizontal Field of View	: 90°
Vertical Field of View	: 30°
Projection	: Rectilinear
Image Reading Distance @ A3 is 20 cm	
NZTM Easting	: 1542261.4053 mE
NZTM Northing	: 5161085.2512 mN
Elevation/Eye Height	: 52.5m / 1.6m
Date of Photography	: 2:10pm 14 June 2023 NZST

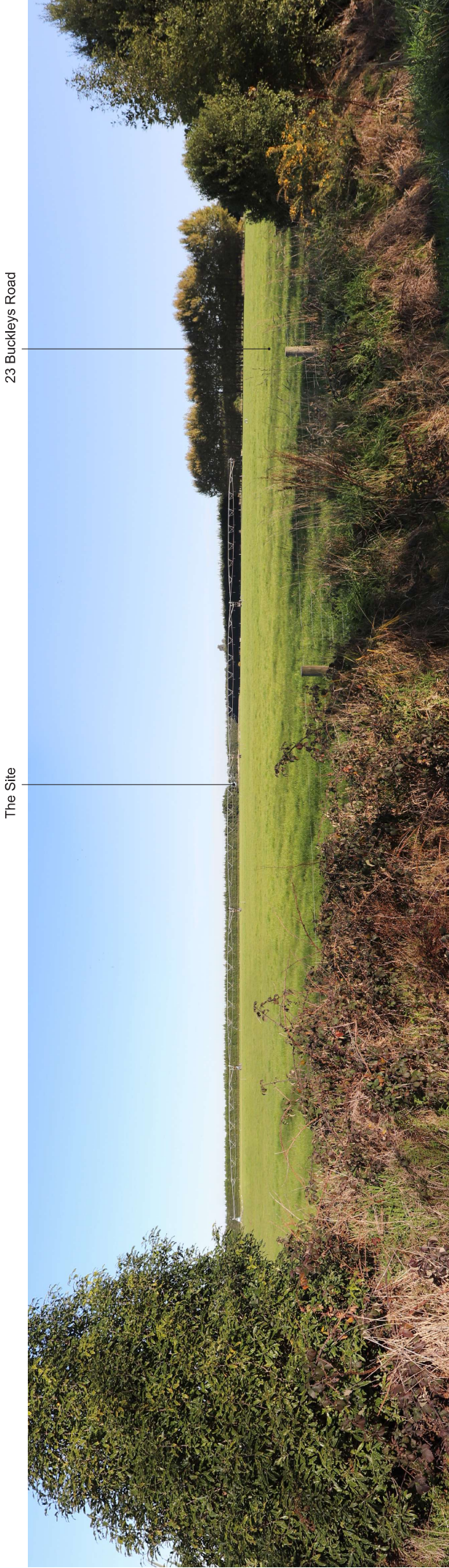


Visual Simulation 1 View after 5 years with 3.5m high plants in a gap between the existing vegetation on Buckleys Road.
The Site (gap in existing vegetation)



Viewpoint 2 is located on Buckleys Road, north of the Site, looking in a south-westerly direction towards the Site.

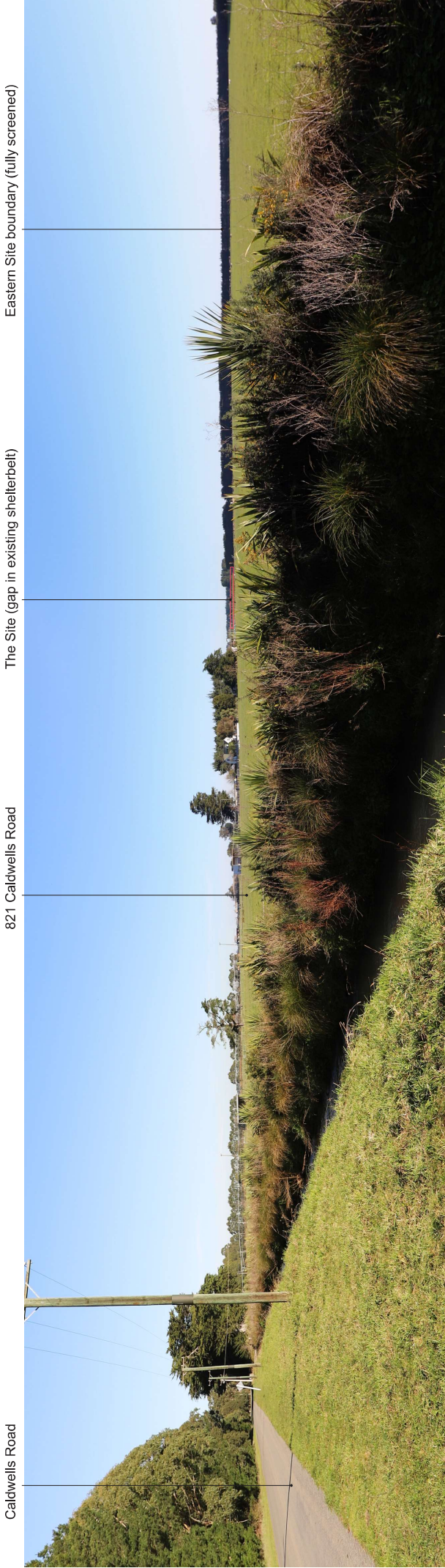
Viewpoint Details			
Date of Photography: 10:00am - 2:00pm 14 June 2023 NZST			
Horizontal Field of View	: 90°	NZTM Easting	: 1542261.4053 mE
Vertical Field of View	: 30°	NZTM Northing	: 5161085.2512 mN
Projection	: Rectilinear	Elevation/Eye Height	: 52.5m / 1.6m
Image Reading Distance @ A3 is 20 cm		Date of Photography	: 2:10pm 14 June 2023 NZDT



The Site

23 Buckleys Road

Viewpoint 3 is located on Buckleys Road, approximately 605m north-east of the Site, looking in a south-westerly direction towards the Site.



Caldwells Road

821 Caldswells Road

The Site (gap in existing shelterbelt)

Eastern Site boundary (fully screened)

Viewpoint 4 is located on Caldswells Road, approximately 970m north-east of the gap in existing shelterbelt, looking in a south-westerly direction towards the south-eastern Site corner.



Viewpoint 5 is located on Caldwell's Road, approximately 775m east of the Site, looking in a westerly direction towards the south-eastern corner of the Site.



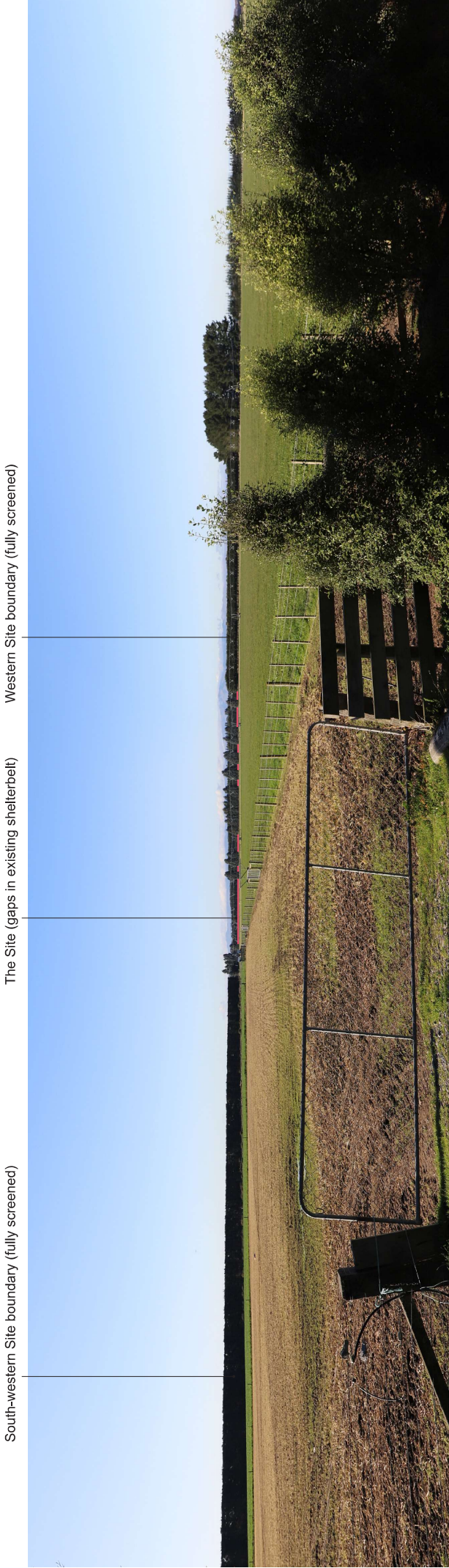
Viewpoint 6 is located on Caldwell's Road, approximately 685m south-east of the Site, looking in a north-westerly direction towards the south-eastern corner of the Site.



Viewpoint 7 is located on Grahams Road, approximately 960m south of the Site, looking in a northerly direction towards the Site.



Viewpoint 8 is located on Branch Drain Road, approximately 570m south-west of the 'gaps' in the shelterbelt along the western Site boundary, looking in a north-easterly direction towards the Site.



Viewpoint 9 is located on Branch Drain Road, approximately 565m west of the 'gaps' in the shelterbelt along the western Site boundary, looking in a north-easterly direction towards the Site.

South-western Site boundary (fully screened)

The Site (gap in existing vegetation)



Viewpoint 10 is located on Branch Drain Road, near the south-western corner of the Site, looking in a north-easterly direction across the Site.



Visual Simulation 2 View after construction with 2m high plants in a gap between the existing vegetation on Buckleys Road.



Viewpoint 10 View after 5 years with 3.5m high plants in a gap between the existing vegetation on Branch Drain Road.

Viewpoint Details

Date of Photography: 10:00am - 2:00pm 14 June 2023 NZST	
Horizontal Field of View	: 90°
Vertical Field of View	: 30°
Projection	: Rectilinear
Image Reading Distance @ A3 is 20 cm	
NZTM Easting	: 1542048.4046 mE
NZTM Northing	: 5160273.5173 mN
Elevation/Eye Height	: 43.1 m / 1.6m
Date of Photography	: 2:28pm 14 June 2023 NZDT



Viewpoint 11 is located on Branch Drain Road, west of the Site, looking in a north-easterly direction toward the Site and Branch Drain Road.



Viewpoint 12 is located on Branch Drain Road, west of the Site, looking in a south-easterly direction toward the Site and Branch Drain Road.

The Site (gap in existing vegetation)



Viewpoint 13 is located on Branch Drain Road, west of the Site, looking in an easterly direction across the Site.

Brookside Substation

The Site (gap in existing vegetation)

Existing vegetation

Branch Drain Road



Viewpoint 14 is located on Branch Drain Road, near the north-western corner of the Site, looking in a south-easterly direction towards the Site.



Viewpoint 15 is located on Smythes Road, approximately 360m west of the Site, looking in an easterly direction toward the Site.



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 0 400 m
1:15,000 @ A3
Data Sources: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors
Projection: NZGD 2000 New Zealand Transverse Mercator

- LEGEND**
- Low potential for glare (Green dot)
 - Potential for glare (Yellow dot)
 - No glare identified (Blue dot)
 - No panel backtracking to avoid glare (Hatched area)

- Wāhi Taonga Management Site (Black dot)
- Wāhi Taonga Management Site (with 50m buffer) (Yellow area)
- Site Boundary (Red line)
- Primary Parcels (White area)

Figure 18



2M HIGH FILL IN THE GAPS

AREA	LENGTH (M)	HEIGHT (M)	SPACING (M)	QTY
A	70m	2m	1.5	93
B	12m	2m	1.5	16
C	24m	2m	1.5	32
D	100m	2m	1.5	133
E	75m	2m	1.5	100

*All plants shall be approximately 2m high at the time of planting.
*3m wide strip consisting of two rows of trees that are double staggered.
*All plants shall be maintained to a height of at least 3.5m for the life of the solar farm.

2M HIGH NEW EXOTIC SHELTERBELT SPECIES

AREA	LENGTH (M)	HEIGHT	SPACING (M)	QTY
A	67m	2m	1.5	89
B	335m	2m	1.5	446
C	380m	2m	1.5	506
D	140m	2m	1.5	186

*All plants shall be approximately 2m high at the time of planting.
*3m wide strip consisting of two rows of trees that are double staggered.
*All plants shall be maintained to a height of at least 3.5m for the life of the solar farm.

SINGLE ROW OF EXOTIC SHELTERBELT SPECIES

AREA	LENGTH (M)	BAG SIZE	SPACING (M)	QTY
A	533m	PB 3	1.5	355
B	116m	PB 3	1.5	77
C	24m	PB 3	1.5	16
D	354m	PB 3	1.5	236
E	302m	PB 3	1.5	201
F	233m	PB 3	1.5	155
G	620m	PB 3	1.5	413
H	145m	PB 3	1.5	96
I	370m	PB 3	1.5	246

*All plants shall be approximately PB3 grade and consist of a single row along the fence line.
*All plants shall be maintained to a height of at least 3.5m for the life of the solar farm.

VISUALISATIONS - METHODOLOGY

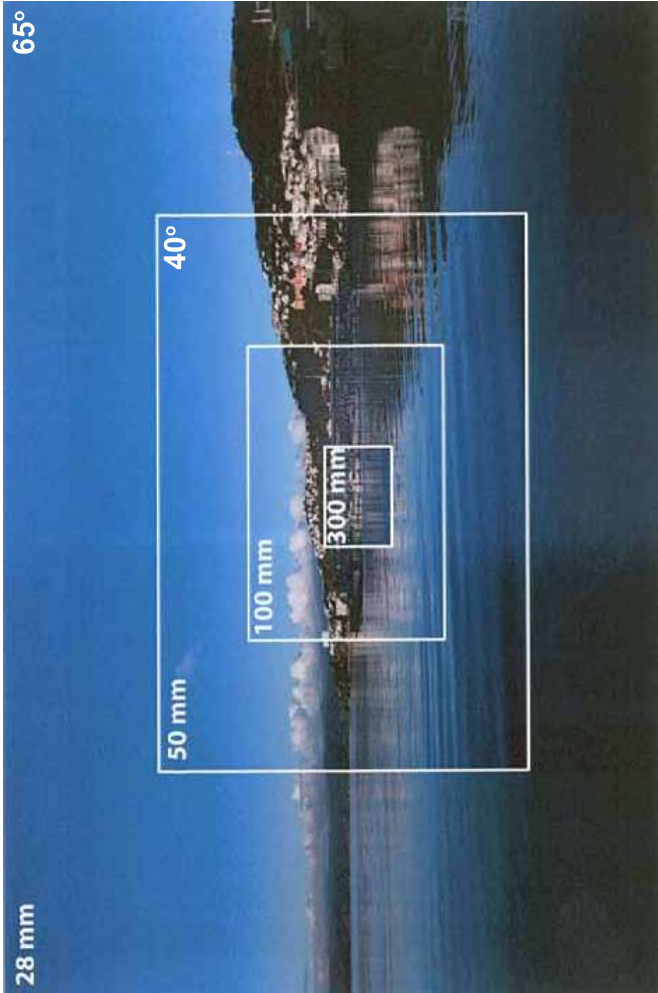
SITE VISIT & PHOTOGRAPHY

Site photographs were taken with a Canon digital SLR camera fitted with a 24mm focal length lens. A series of photos were taken at predetermined viewpoints, situated on roads surrounding the Site at publicly accessible locations. The locations of each viewpoint were fixed by GPS units built in to the camera.

NZILA GUIDELINES & PANORAMA PREPARATION

The visual simulations have been produced in accordance with the NZILA Best Practice Guidelines for Visual Simulations (BPG 10.2) and also adhere to Boffa Miskell's internal Visualisation Guidelines.

Camera lenses with different focal lengths capture images with differing fields of view. As can be seen below (derived from Fig 9 of the NZILA BPG), a photo taken with a 28mm lens will provide a horizontal field of view of 65°. Using a 50mm lens will provide a “cropped” (40°) version of the same view. So, the coverage obtained with a 28mm lens can also be achieved by taking multiple 50mm photos (in “portrait” mode), and using digital stitching software to merge and crop to 65° (or in the case of these visual simulations, to create a 90° panorama).

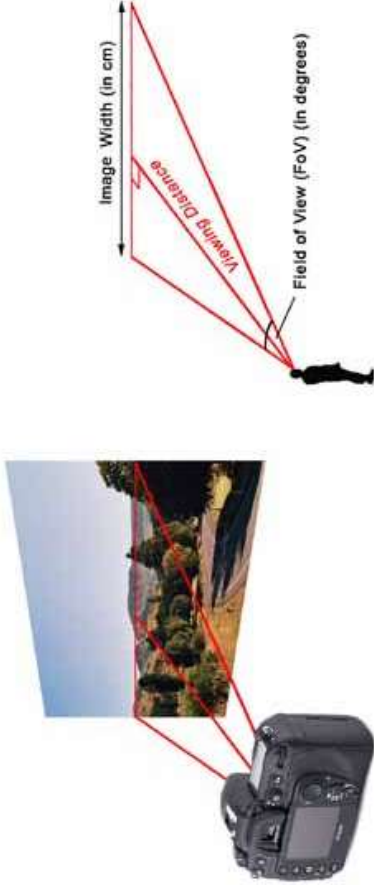


3D MODELLING

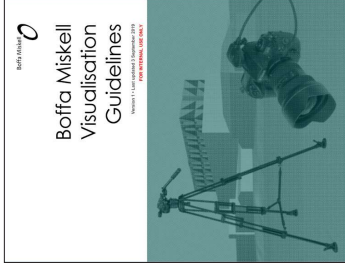
Virtual camera views were then created in 3D modelling software, and a combination of 3D contour data and 3D engineering drawings turned on in each of these views. These were then matched to the corresponding photographic image, using identifiable features in the landscape and the characteristics of the camera to match the two together. The visual simulations were then assembled using graphic design software.

IMAGE READING DISTANCES

These visual simulations have a field of view of 90° and so should be viewed from a distance of 20 cm when printed at A3. This will ensure that each simulation is viewed as if standing on-site at the actual camera location, and is in accordance with Section 7.11 of the NZILA BPG. Users are encouraged to print these pages on A3 transparency, go to the viewpoint and hold at the specified reading distance in order to verify the methodology.



Geometry of Image Reading Distance





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Appendix 4: Solar Glint and Glare Methodology

August 2023

Introduction

Glint is defined as a small flash of bright light, especially a reflected one. An example of glint is a momentary solar reflection from the windscreen of a moving car. Glare is a sustained reflection of strong and dazzling light. An example of this is direct reflected sunlight off a stationary object. The difference between glint and glare is duration.

The objective of this methodology is to assess the effects of solar glint and glare associated with solar energy installations and their potential impact on the surrounding environment.

Identifying Glint and Glare Effects

The duration of glint and glare effects can be calculated using the geographical location and layout of the proposed solar farm, the geometry of the solar panels and the relative locations of the panels, the viewer and the sun. The likelihood of the effect occurring, and the duration and intensity of such an effect depends upon several factors:

- the distance of the dwelling/road from the solar panels
- the orientation of the dwelling/road relative to the solar panels
- the area of the solar panels, their angle and whether they are static panels or part of a solar tracking system
- the time of day and time of the year
- the nature of the intervening terrain between the dwelling/road and panels; and
- the impact of any intervening vegetation and/or structures.

Boffa Miskell uses Forge Solar as a modelling tool to undertake Glint and Glare modelling for analysis. Forge Solar employs an interactive Google map where the user can quickly locate a site, draw an outline of the proposed PV array(s), and specify observer locations or paths. Latitude, longitude, and elevation are automatically queried from Google, providing necessary information for sun position and vector calculations. Additional information regarding the orientation and tilt of the PV panels, reflectance, environment, and ocular factors are entered by the modeller.

Identifying the viewing audience

The Landscape Effects Assessment will identify the areas from which the solar farm may be visible and the specific viewing audience(s) affected. For the purposes of identifying residential and road users who will have views of the proposed solar site, and therefore may be impacted by glint and/or glare, the assessment generally considers residents within 1km of the proposed site boundary, and road users where roads align within the identified viewing area. For analysis of the potential visibility of glare for road users, a series of points located every 100m along the road corridor are generated using Arc GIS and these points are used for the modelling within the Forge Solar software.

Identifying Glare and limits

If glare is found, the Forge Solar tool calculates the retinal irradiance and subtended angle (the size/distance) of the glare source. This can be used to inform the potential for glare in the assessment.

Forge Solar identifies two potential levels of glare:

- Green: Low Potential for glare
- Yellow: Potential for glare

For other areas outside these, it is identified that glare is not geometrically possible.

The limit for glint/glare which creates unreasonable nuisance has been defined in several international guidelines. In Germany the Light-Guideline (Licht-Leitlinie) issued by the Ministry of Environment defines the limits for glare duration at 30 minutes per day and 30 hours per year. In Austria the same values were determined in their national guidelines OVE R11-3. Australian guidance¹ defines glare of high impact as that which is greater than 30 minutes per day and 30 hours per year. Table 1 has been adapted from these guidelines with reference to effects of solar glare.

In the United Kingdom, photovoltaic glint and glare guidance² states that if visible glint and glare is predicted for a surrounding dwelling for longer than 60 minutes per day, for three or more months of the year, then the impact should be considered significant with respect to residential amenity. For the purposes of this assessment, limits for glare duration greater than 30 minutes per day and 30 hours per year have been defined as high impact. This duration of effect has been chosen as it is in line with international best practice for solar glare, but also aligns with the limits defined by international guidelines for addressing the effects of shadow flicker caused by wind turbines. Table 1 below outlines the level of impact in relation to glare for residential dwellings.

Table 1: Glare Impact in relation to residential dwellings

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

Solar Glare for road users

A review of international best practice guidance for assessing effects of solar glare from roads finds that reflections which originate in front of the road user require mitigation. Internationally, local roads are generally considered to not require mitigation, however as the majority of roads in New Zealand would qualify for what internationally would be considered a 'local road', the assessment has considered all roads.

A road user travelling on surrounding roads where a solar reflection is geometrically possible would experience a solar reflection that is fleeting in nature. The nature of the view is dependent on the speed of the road user travelling past the solar farm at a time when a solar reflection is geometrically possible. Therefore, the location of the solar reflection is more significant than its duration because the road user is moving. Because of this, the length of time a solar reflection is

¹ New South Wales Department of Planning and Environment. Large-Scale Solar Energy Guidelines, August 2022.

² Pager Power Ltd. Solar Photovoltaic and Building Development Glint and Glare Guidance, Fourth Edition, September 2022.

present is not considered when determining its significance. Instead, the location of the solar reflection and road type are considered. Major roads such as State Highways would be considered more sensitive to the effects of glare than local roads where the speed of travel is reduced.

Mitigation is considered necessary for all roads where the road user is aligned directly with the area of glare. For glare which is oblique to the road user's direction of travel, mitigation can also be considered but is not necessary.

Mitigation measures

If the assessment reveals potential glint and/or glare, the following mitigation measures can be considered to reduce or remove these effects:

- Layout adjustment and programming: Removal of panels from layout, adjustments to panel layout or programming of the panels to adjust tilt angles to minimise the potential for glint/glare (such as removal of backtracking). This mitigation is effective immediately.
- Vegetation screening: Planted mitigation to screen views of potential glint/glare. This mitigation is effective once planting has been established.
- Communication/warning systems: Installation of signage or warning systems to warn people of potential glint/glare hazards. This form of mitigation does not remove the hazard but provides an alert system.