REPORT

Tonkin+Taylor

Stormwater Impact Assessment

Balmoral Solar Array

Prepared for
Boffa Miskell Limited
Prepared by
Tonkin & Taylor Ltd
Date
August 2022
Job Number
1020784 v1

Together we create and sustain a better world
www.tonkintaylor.co.nz

Document control

Title: Stormwater Impact Assessment					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
04-08-2022	D1	Final	KTHA	SIFR	PRC

Distribution:

Boffa Miskell Limited	1 electronic copy
Tonkin & Taylor Ltd (FILE)	1 electronic copy

Table of contents

Executive summary

Tonkin & Taylor Ltd has been engaged by Boffa Miskell Ltd to undertake a stormwater assessment for a proposed solar array at Balmoral Station in Tekapo.

Our overall assessment is that the site is suitable for the proposed development and that the risk of increased stormwater discharge, stormwater erosion and concentration of stormwater flows, resulting in adverse effects for this site are very low.

Table 1 below summarises the potential stormwater discharge risks and should be read in conjunction with the relevant details in the main body of this report.

Table 1 Summary of main findings

Issue	Assessment
Increased stormwater discharge volume	Stormwater discharge volume from pre to post development will remain unchanged
Increased erosion by stormwater	With the measures recommended in Section 4 the potential for erosion is **very low**.
Increased concentration of stormwater flow	With the measures recommended in Section 4 the potential for the concentration of stormwater flow **is low**.
Decrease in the rate of infiltration into the ground	Changes to the existing landforms will be minor, and no significant compaction of the ground is expected.

With the measures proposed by Boffa Miskell [1] and recommended in Section 4, it is unlikely that the existing natural waterbodies on the site will be affected by the construction or operation of the solar array.

1 Introduction

Tonkin & Taylor Ltd has been engaged by Boffa Miskell Ltd to undertake a stormwater assessment for a proposed solar array at Balmoral Station in Tekapo. The site location is shown in Figure 1 below.

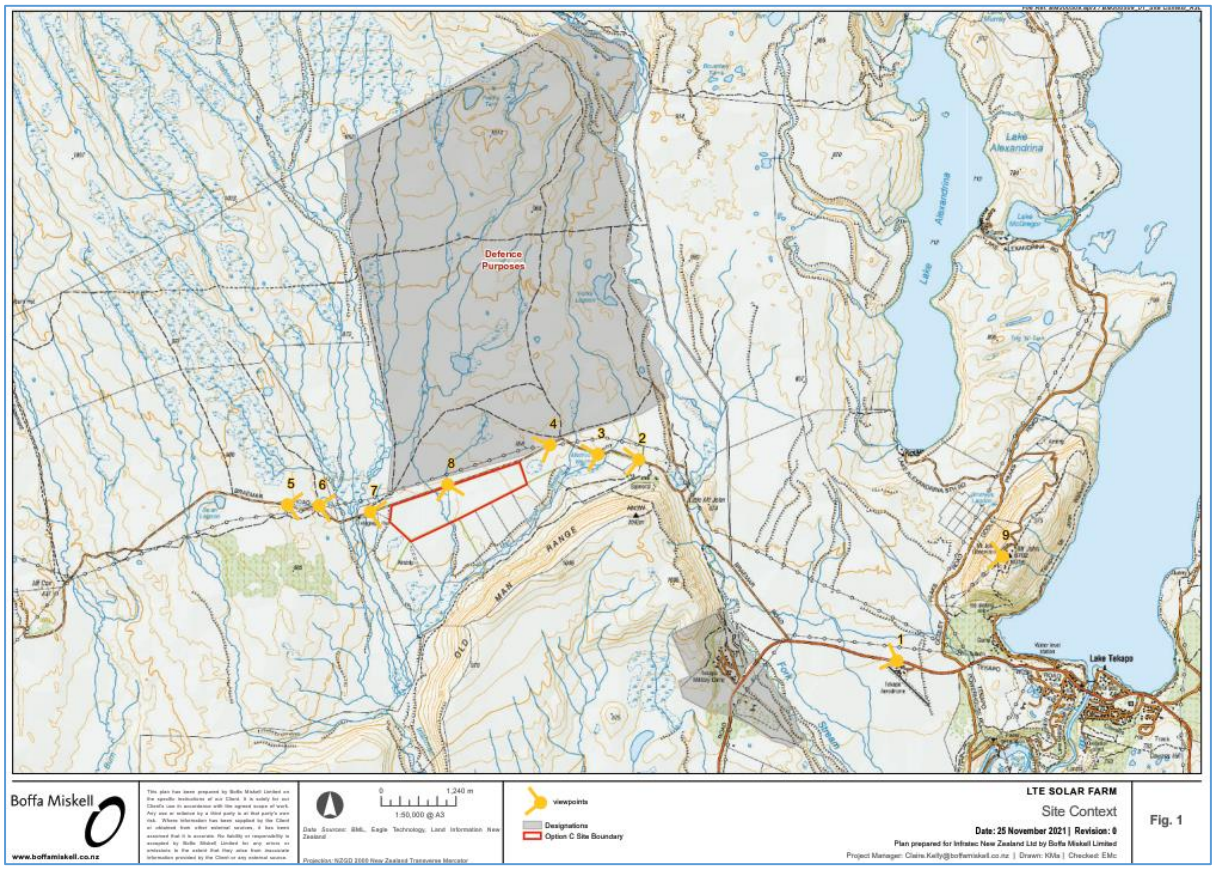


Figure 1: Proposed location of solar array

The site is located on Balmoral Station, approximately 9 km north-west of the town of Tekapo. The land is a mixture of pasture and tussock and is currently used for sheep and beef cattle grazing. The site comprises two areas, known as Cattle Yard and Tom's Paddock, and the solar farm will be established over an area of approximately 113 hectares.

The proposed solar array comprises solar panels, mounted on small diameter driven posts. There will be permanent structures on site for the inverters and transformer switchgear & general storage. Four gravel access tracks of approximately 4 m width will be constructed for maintenance of the array.

1.1 Topography

The topography is gently undulating with hummocks and low-lying areas where water is retained after heavy rainfall events. A digital terrain model provided by Boffa Miskell is shown in Figure 2. The site generally falls from east to west, from an elevation of 849 m RL to 804 m RL over approximately 2.5 km. The topography indicates a waterway near the centre of the site with a wetland and a stream that flows through and out of the site. There is a second wetland in the south-west corner of the site [2]. There are potentially severe limitations on development due to the presence of 'wetland' areas.

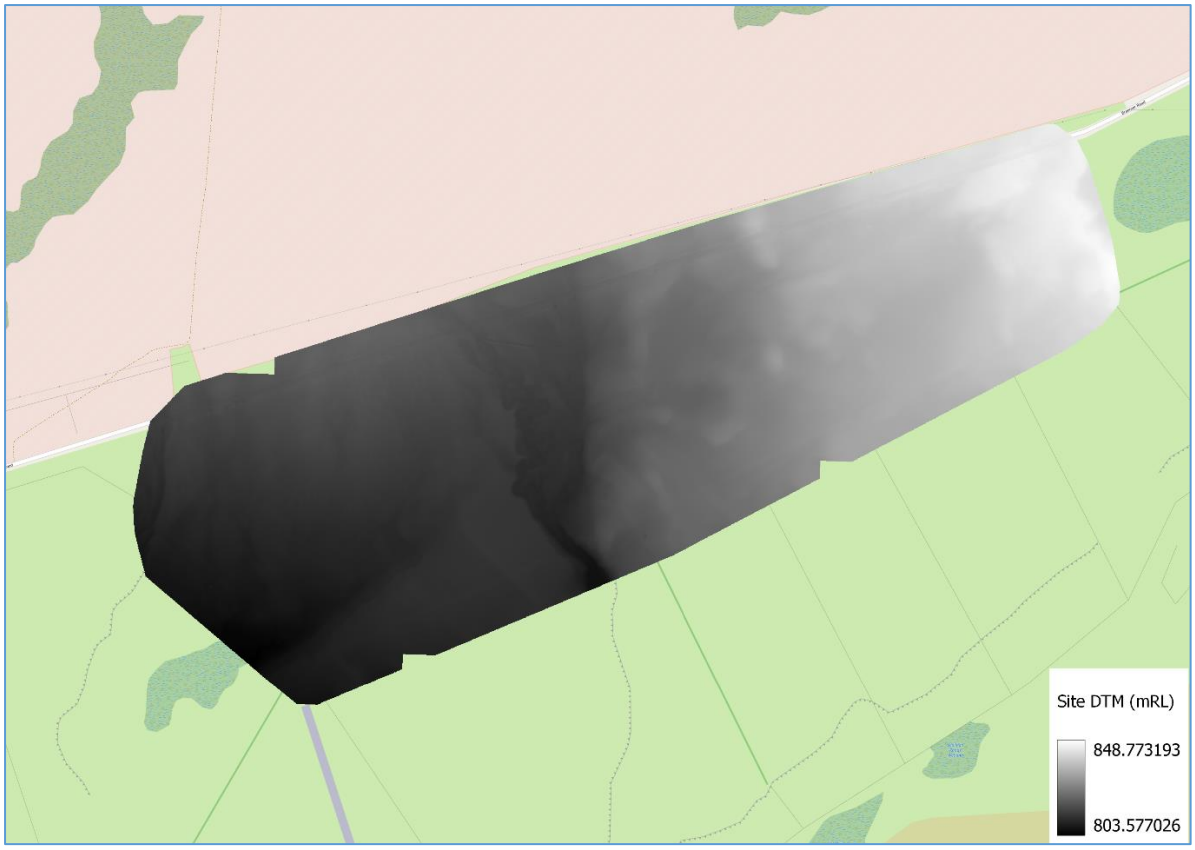


Figure 2: Digital Terrain Model (DTM) of the site

1.2 Climate and weather

Climate at the site is relatively cool and dry. Average annual rainfall at the Lake Tekapo climate station is less than 600mm, with rainfall occurring on 74 wet days[1] each year [5], and with snow expected every 12 days per year on average [5]. There is little seasonal variation in rainfall in the area, with between five and seven wet days occurring each month.

Climate change projections for the Canterbury region predict that annual rainfall in Tekapo will increase by 6% (RCP8.5) by 2040 and 11% (RCP8.5) by 2090 [6]. Both the annual mean temperature and winter mean temperature are predicted to increase, likely reducing the number of snow days on site.

1.3 Hydrology

The site is in the upper reaches of the Irishman Creek Catchment, with Irishman Creek crossing through the centre of the site. Irishman Creek is broad and shallow, with a wetland located in the centre of this area (Figure 3). NIWA River Maps[2] suggest that Irishman Creek is a permanent watercourse with an estimated mean annual flow of 0.18 m^3/s and a median flow of 0.098 m^3/s. NIWA River Map flow statistics suggest that the stream flow is relatively consistent and not subject to significant high flow events brought about by rainfall runoff.

[1] The number of days where at least one mm of rainfall is measured.
[2] NZ River Maps (niwa.co.nz)

Figure 3: Irishman Creek, as seen from the centre of the site (from Boffa Miskell 2022).

1.4 Soils/drainage

The geology of the site comprises glacial and fluvial deposits, mostly gravels with some boulders, sand, silt and clay. Surface soils are mapped as brown soils with variable quantities of silt across the northwest and central part of the site, and with more stony soils in the southwest of the site.

It is likely that these soils are moderately well drained, with shallow overlying glacial deposits of variable permeability.

1.5 Assessment methodology

A desktop review of the proposal was undertaken to assess stormwater management required on site. The amount of rainfall and the soakage potential of soils on site were assessed to determine the amount of rainfall and the increase in runoff that could be generated post development.

1.5.1 Design management guidelines

Guidelines for the management of stormwater have been published and help inform our assessment and our recommendations[3].

Key factors to be considered in managing stormwater include:

- Solar panels located on slopes less than 5% generally would not require erosion control beneath the lower edge or drip line.
- Solar panels located on slopes with an average slope greater than 5% are generally likely to require erosion control beneath the lower edge. The use of spreaders, terraces or berms could also be considered to avoid concentration of flow.
- Soils should be undisturbed during installation of the array.
- Groundcover vegetation must be maintained in good condition.
- Keeping the bottom edge of the solar panels to less than 3m above the ground surface to avoid erosion of soil under the drip line of the panel, or alternatively reinforcing the ground to protect soil beneath the drip line from erosion.

2 Proposal

The background to the proposal is fully set out by Boffa Miskell in its assessment of effects on the environment [1]. In summary a solar array will be established over an area of approximately 113 hectares as shown in Appendix A. The array will be set back 20m from Irishman Creek and the

[3] Refer to references [1] to [4].

wetland in the centre of the site and from the wetland located on the southwest of the site, in accordance with the recommendations set out by Boffa Miskell [2].

2.1 Solar Panels

The solar panels are to be arranged as indicated on the drawings in Appendix A.

The panels are approximately 2.4 m long and 1.3 m wide. The panels will sit in pairs within a frame, with each panel physically separated from each other. Panels are arranged in rows, 4.6 m wide with each row separated by 4.9 m. The panels will cover approximately 40% of the gross site area.

The solar panel frames are to be mounted on steel piles that will be driven into the ground. The height of the panels above the ground will vary but generally be at least 1 m above ground level.

2.2 Inverters, switchgear & general storage

It is proposed that the inverters will be installed in weather resistant housings, sitting on container skids on a reinforced concrete slab. It is expected that there will be 17 of these required, located across the site.

The MV export switchgear and storage facility will be a prefabricated structure, approximately 5 m width by 12 m length. This will also sit on a reinforced concrete slab.

A permanent site storage facility may also be installed on site. This would be a 20 ft or 40 ft container or pre-fabricated unit.

2.3 Earthworks

In total, approximately 13,100 m^3 of earthworks is required, covering 2.74 hectares or 2.4% of the site.

Earthworks will be carried out in two Phases:

- Phase 1 comprising approximately 3,100 m^3 of earthworks over an area of approximately 6,300 m^2. Phase 1 will start in 2023 and take about 9 months to complete.
- Phase 2 comprising approximately 10,000 m^3 of earthworks over 21,000 m^2. Timing for the start of Phase 2 is uncertain because this is dependent on network upgrades by others. However, once it does start it will take approximately 18 months to complete.

Earthworks are required to:

- Provide flat platforms for structures, parking for cars and a laydown areas of approximately 25 m x 50 m.
- To build internal unsealed roads with roadside swale drains to manage stormwater flows and enable disposal via soakage to ground.
- Provide minor levelling works within the array area.
- Create trenches for reticulation of DC and AC cables between modules, inverters, transformers and to the grid connection. These will be backfilled once work is complete and allowed to revegetate.

3 Assessment of pre and post development stormwater flow and behaviour

3.1 Pre-development

Currently, the site area is pasture with the land receiving rainfall across the entire site area.

There is no artificial collection or disposal of stormwater run-off and all rainfall infiltrates to the ground.

Stream flow statistics suggest that the rate of runoff to Irishman Creek (when it does occur) is relatively minor.

3.1.1 Erosion by stormwater

Photos of the site show no evidence that erosion by natural rainfall is currently a feature of this site.

3.2 Post-development

In the post-development scenario, the site will remain in pasture with very little change in the landform pattern.

Most of the rainfall will infiltrate to the ground, as per the existing condition. The remainder, the of the run-off from access tracks and the site facilities will also drain to ground using swales or similar features. The presence of these structures, if appropriately designed, is unlikely to result in the concentration of stormwater flows.

Swale drains along the proposed access roads will follow the natural contour of the property, and any stormwater that happens to be concentrated in these drains will flow downslope and be directed away from the natural water bodies located in the centre and southwest of the site.

Rainfall runoff from the panels themselves will infiltrate into the ground at, and around, the drip line. The configuration of the panels over the site, and natural topography means that there is no mechanism for the concentration of run-off.

3.2.1 Erosion by stormwater

3.2.1.1 Facilities

The inverter housings, switchgear and storage facilities are all sufficiently small that the rainfall that lands on these will simply runoff and infiltrate into the ground, without the need for specific erosion control.

3.2.1.2 Access tracks

The rainfall that lands on the access tracks will not infiltrate into the ground but will runoff to the swale drains where it will be conveyed and soak to ground.

Grades along the access tracks are generally low as shown in Table 2, and apart from localised sections where grades exceed 5%, no specific flow or erosion control measures are considered necessary. There may however be a requirement for minor grade control structures (such as gravel weirs, channel armouring in swales) where these exceed 5% for distances greater than 20 m.

Table 1. Access track grades

Access track	1	2	3	4
Average grade (%)	2.2%	2.2%	2.7%	2.3%
Median grade (%)	1.8%	1.7%	2.0%	1.7%
95th percentile grade (%)	5.3%	6.1%	7.6%	6.6%

3.2.1.3 Solar panel arrays

The rainfall that lands on the solar panels will concentrate and drip off the bottom edge of the panel onto the ground, where is will soakaway or run on to adjacent areas and soak away.

Grades across the site and along the rows of solar panels in the north-east section of the site are low (Table 2) and it is unlikely that any specific measures would be required to manage stormwater runoff and erosion.

The panel configuration in in the southwest part of the site generally follows the ground contour and it is unlikely that this would result in the concentration of flow.

Table 2. Grades along rows of solar panels in the north-east section

Line	1	2	3	4
Average grade (%)	2.3%	2.1%	2.1%	2.8%
Median grade (%)	1.9%	1.8%	1.8%	2.3%
95th percentile grade (%)	6.1%	5.3%	5.1%	7.4%

Should any panels have a bottom edge higher than 3 m, some form of erosion control may be required.

4 Management and mitigation measures

The potential for the concentration of stormwater flow or erosion from the solar array, site facilities or access tracks is low. With the adoption of the management or mitigation measures outlined below the effects of this development on erosion, and on natural water bodies on the site will be very low.

In addition to what is proposed by Boffa Miskell [1][2], to avoid adverse effects on soil and water, we recommend the following:

- The preparation and implementation of an erosion and sediment control plan, developed in accordance with Environment Canterbury's Erosion and Sediment Control Toolbox[4]. The plan should include:
  - Consideration of flow control structures on swale drains with grades greater than 5% for distances over 20 m to avoid the potential for erosion of the swale drain.
  - Inspection and maintenance of swale drains for erosion and repair as necessary.
  - Maintenance of pasture or other vegetation cover where possible.
  - Periodic inspection of the drip line of solar panels (particularly after a period of wet weather or in the event of a significant snow melt), to check for signs of soil erosion and where necessary repair or install a protection layer.

[4] Starting Point - First Steps in Managing Erosion and Sediment Control

5 References

[1] Boffa Miskell Ltd 2022: Undertake Earthworks. Resource consent application and assessment of environmental effects. Assessment of effects report dated 5 May 2022.

[2] Boffa Miskell Ltd 2022: Balmoral Station Solar Farm. Ecological impact assessment. Report dated 26 April 2022.

[3] Cook, L. M., & McCuen, R. H. (2013). Hydrologic response of solar farms. Journal of Hydrologic Engineering, 18(5), 536-541. https://doi.org/10.1061/(asce)he.1943-5584.0000530

[4] Maryland Department of the Environment. Stormwater Design Guidance – Solar Panel Installations. ESDMEP Design Guidance – Solar Panel Installations (maryland.gov)

[5] Minnesota Pollution Control Agency. Stormwater management for solar projects and determining compliance with the NPDES construction stormwater permit. Stormwater management for solar projects and determining compliance with the NPDES construction stormwater permit - Minnesota Stormwater Manual (state.mn.us)

[6] Connecticut Government. Guidance for Construction of Solar Array Projects. 200108GuidanceforConstructionofSolarArrayProjects.pdf

[7] NIWA (2016). The Climate and Weather of Canterbury. NIWA Science and Technology Series, Number 68. https://niwa.co.nz/static/web/canterbury_climatology_second_ed_niwa.pdf

[8] NIWA (2020). Climate change projection for the Canterbury Region. https://niwa.co.nz/sites/niwa.co.nz/files/ClimatechangeprojectionsfortheCanterburyRegionNIWA.PDF

6 Applicability

This report has been prepared for the exclusive use of our client Boffa Miskell Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

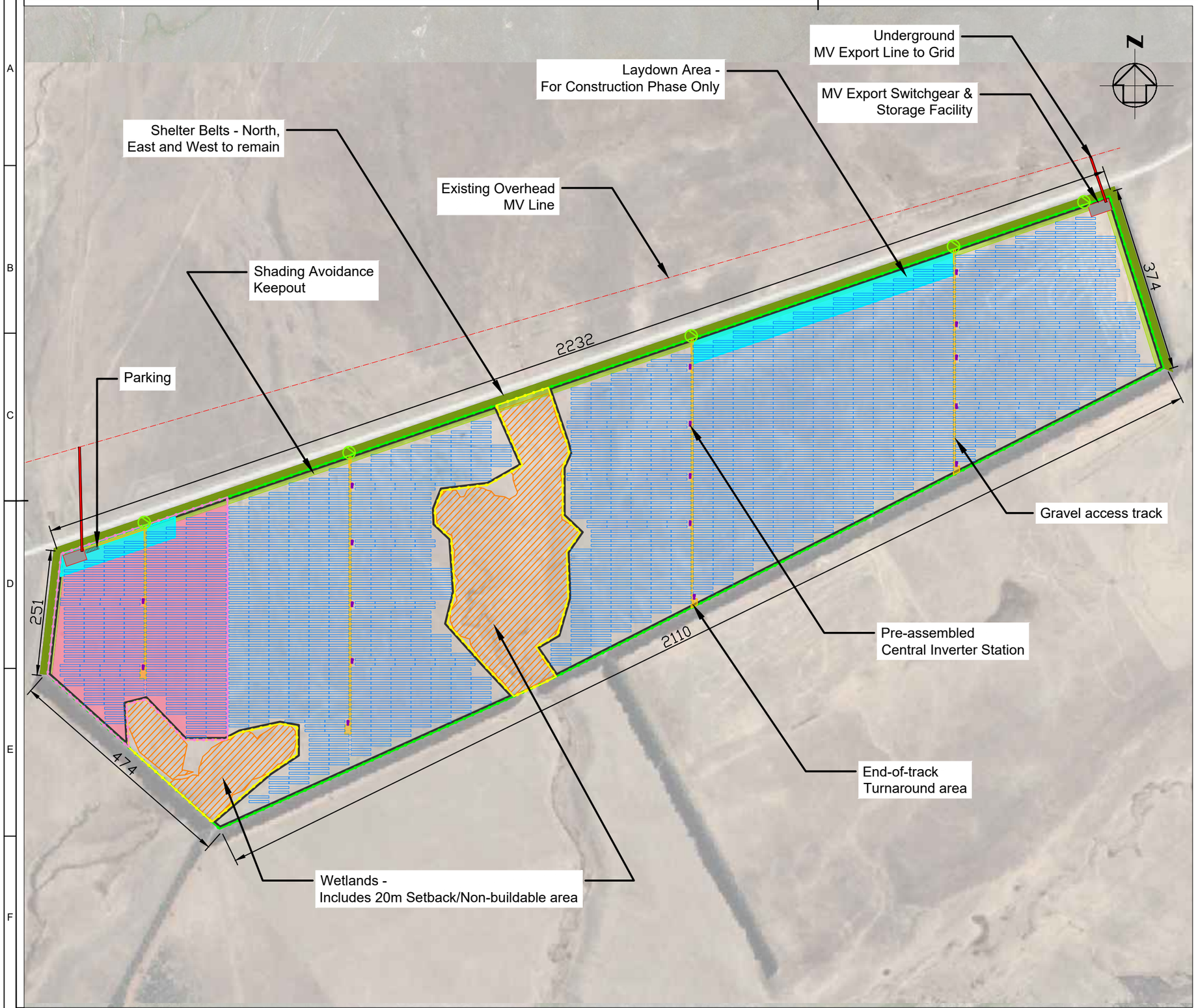
We understand and agree that our client will submit this report as part of an application for resource consent and that the McKenzie District Council and Environment Canterbury as the consenting authority will use this report for the purpose of assessing that application.

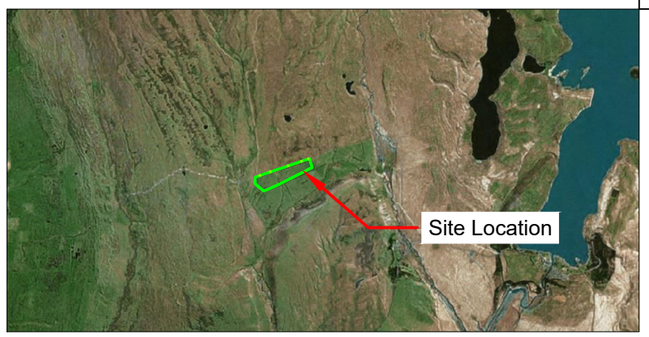
Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
Kate Hand	Peter Cochrane
Water Resources Engineer	Project Director

KTHA
t:\christchurch\tt projects\1020784\issueddocuments\20220804 ktha balmoral solar array stormwater assessment.docx

Appendix A Site layout plan





SYSTEM SPECIFICATIONS:

Total number of modules: 134,940

Total DC System Size: 88.386 MWp

Number of Central Inverter Skid Units: 17

Total AC System Size: 74.63 MWac approx.

Site area: 113 Hectares

Total length of Access Tracks: approx. 2000m

Total Graveled Area: approx. 8500m^2

LEGEND:

- Boundary Security Fence
- Phase 1 Security Fence
- Wetlands Rabbit & Stock Proof Fence
- Site Entrance Gate
- PV Array Tables
- Pre-Assembled Central Inverter Station
- MV Export Switchgear & Storage Facility
- Underground MV Line, to Grid
- Wetland (includes 20m setback) / Non-buildable Area
- Clearance for egress
- Gravel access track - 4m wide
- 12MW West Section for Phase 1

RVN	DATE	DRAWING TITLE	DRN	APP
4	28/02	Fence designation and boundaries updated	EA	RN
3	18/02	Shading keepouts reduced and annotations updated	EA	RN
2	16/02	Shading Keepout added & Access Roads Redesigned	EA	RN
1	23/12	12MW West Section added	HL	RN
0	22/12	Concept including wetland exclusions	HL	RN

INFRATEC LTD
Level 13, Pencarrow House,
58-66 Jervois Quay,
Wellington
6142
New Zealand

DRAWING TITLE:
CONCEPT LAYOUT 1
IRISHMAN PADDOCKS
FULL EXTENT

DESIGNED: EA	DATE: 17/02/2022	SIZE: A3	CLIENT: Lake Tekapo Enterprises Limited
DRAWN: EA	DATE: 28/02/2022	SCALE: 1:8000	
CHECKED: RN	DATE: 28/02/2022	UNITS: m	DRAWING NUMBER: 000285-D401-M-4
APPROVED: RN	DATE: 28/02/2022		REVISION 4

www.tonkintaylor.co.nz