Planning | Surveying | Engineering | Environmental

Stormwater Management Plan

NZ Clean Energy Ltd

1352 Homebush Road, Darfield

Agrivoltaic Facility

Document Information

Client	**NZ Clean Energy Ltd**
Site Location	1352 Homebush Road, Darfield
Legal Description	Lot 1 DP 434071, Lot 2 DP 60325
CKL Reference	A23288
Office of Origin	Auckland

Author	Joshua Raynes		
Signed	[redacted]	**Date**	3/07/2024

Reviewed & Authorised By	Bronwyn Rhynd		
Signed	[redacted]	**Date**	3/07/2024

Revision	Status	Date	Author	Reviewed By	Authorised By
1	Approved	03/07/2024	JR	BR	BR
2	Approved	12/08/2024	JR	BR	BR
3	Approved	15-089-24	GCW		

Contents

1	**Introduction**	**4**
2	**Existing Site Conditions**	**4**
2.1	Watercourse Assessment	5
3	**Proposed Development**	**7**
4	**Stormwater Management Plan - Strategy**	**8**
5	**Stormwater Management Options Assessment**	**8**
5.1	Photovoltaic arrays	8
	5.1.1 Runoff to the existing grassed areas	9
5.2	Stormwater Treatment Assessment	9
5.3	Conveyance – amenity areas	9
6	**Best Practicable Stormwater Management Option**	**10**
6.1	Proposed Culverts	10
6.2	Amenity areas	11
7	**Flood Risk Assessment**	**12**
8	**Summary**	**15**
9	**Limitations**	**15**

Figures

Figure 1: Existing site layout 5

Figure 2: Selwyn District Council, Malvern Water Race Scheme – 03/10/2018 6

Figure 3: Example photograph of ground-mounted photovoltaic arrays 7

Figure 4: Example photovoltaic arrays drawing (left and middle) & support pile cross-section (right) 8

Figure 5: Best Practicable stormwater management option 10

Figure 6: Canterbury Flood Maps, 500 Year ARI – Accessed June 2024 12

Figure 7: Proposed site layout overlaid on ECan flooding maps (All flood levels shown related to LVD1937) 13

Tables

Table 1: Existing Channel Dimensions 6

Table 2: Soakage size per 1000m^2 of impervious area 11

Table 3: Minimum Finished Floor Levels 14

Appendices

Appendix 1 CKL Site Visit Drawings and Photos

Appendix 2 CKL Design Plans

Appendix 3 NZ Clean Energy Design Plans

1 Introduction

This report outlines a stormwater management plan prepared by CKL NZ Ltd (CKL) in support of a resource consent application for the proposed agrivoltaic facility at 1352 Homebush Road, Darfield. This assessment has been undertaken based on information from the following sources:

- Selwyn District Council (SDC) Online Maps – Canterbury Maps Viewer – accessed June 2024
- Selwyn District Council, Selwyn Partially Operative District Plan (SPODP) – 3 May 2016
- Environment Canterbury Regional Council (ECan), "Canterbury Land and Water Regional Plan" – September 2023
- Environment Canterbury Regional Council, Waimakariri River Regional Plan – October 2017
- Land Information New Zealand (LINZ) Topographical Maps, LiDAR, and aerial imagery – accessed April 2024
- CKL, Proposed Site Plans – dated June 2024
- NZ Clean Energy Ltd, Proposed Site Plans – Dated May & July 2024
- Site visit undertaken by CKL Ltd on 17 April 2024

2 Existing Site Conditions

The SPODP indicates that the total 148 hectare site is situated in a General Rural zone of the outer plains approximately 1.5km north of Darfield township and directly to the east of the Darfield Fonterra Factory. Currently, the land cover is primarily grass pasture with some scattered shelter belt vegetation. Currently most of the land is used for sheep grazing which is proposed to continue post development.

The site currently contains residential buildings and farm-related structures accessed directly from Homebush Road that are excluded from this development. The land is generally flat with 17m of fall over approximately 2.4km from north to south (average 0.7% grade) and the landscape can be described as very typically Canterbury plains. The hydrological infrastructure of the site is described in a following section.

The site location and surrounding area are shown in Figure 1.

A thorough site visit was undertaken in April 2024 to identify any important features of the site that may have an impact on the proposed civil and stormwater infrastructure. Plans were produced to show the location of specific features and reference a series of photos taken while onsite. These plans and photos are contained in appendix 1.

GNS Science geology maps indicate the soils onsite are gravelly river deposits – "Unweathered, brownish-grey, variable mix of gravels/sand/silt/clay in low river terraces." S-Map Online by Manaaki Whenua (Landcare Research) indicates the soil is "well drained". This is consistent with soils observed onsite during the site visit.

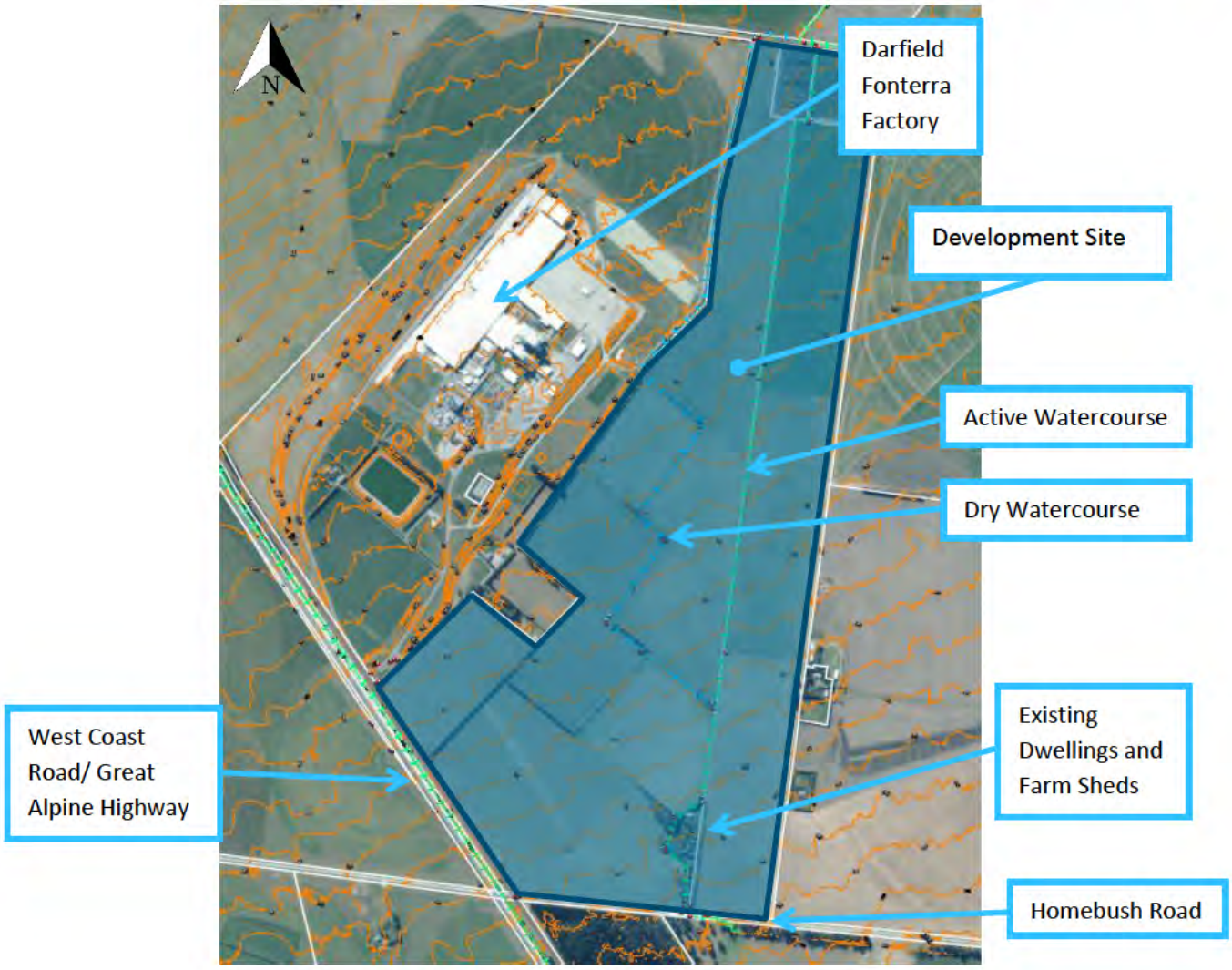

Figure 1: Existing site layout[1]

2.1 Watercourse Assessment

The site contains two formed drainage channels that flow through the site from north to south. The channels are part of the Malvern Water Race Scheme managed by the Selwyn District Council and are fed through a network of drainage races originating from the Kowai River intake just upstream of the SH73 Kowai River bridge approximately 7km west of Springfield. A map of the scheme to the property channels is presented in Figure 2.

[1] LINZ data, accessed April 2024

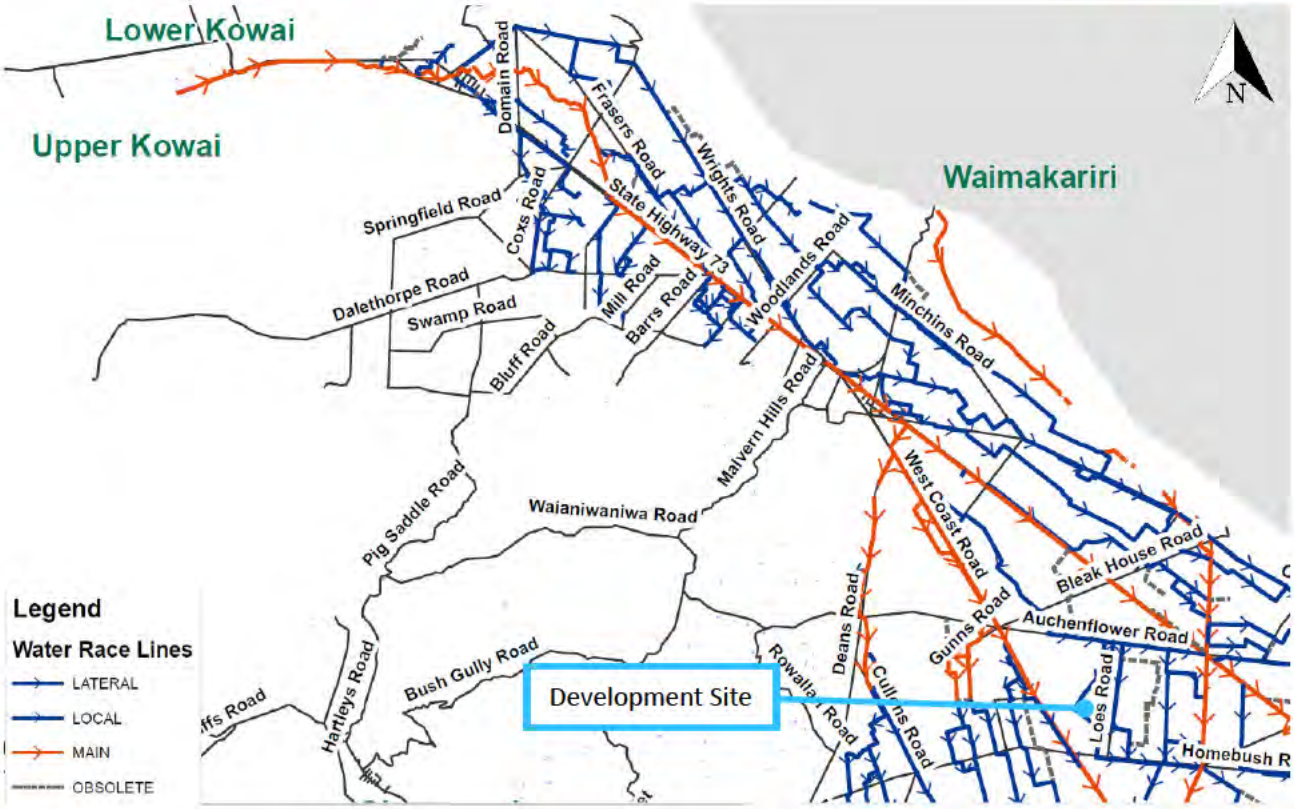

Figure 2: Selwyn District Council, Malvern Water Race Scheme – 03/10/2018

During the site visit, the eastern channel was running with clear water, and the western channel was dry. It was noted a broken weir at Auchenflower Road near the northern site boundary meant that the western channel remained dry. If this weir was to be repaired, it is assumed both channels would be active.

During the site visit, the channels were measured at various locations throughout the site, and they were found to have the following dimensions:

Table 1: Existing Channel Dimensions

	Top Width (m)	Bottom Width (m)	Depth (m)
Range	1.2 – 3.2	0.6 – 1.7	0.3 – 1.2
Average	2.0	1.1	0.5

The channels have multiple culverts throughout the property ranging in size and in various conditions. The main operational drain enters and exits the site through 225mmØ culverts, and most internal culverts within the operational drain are also 225mmØ (with the exception of a single 300mmØ). The dry disused drain has a range of culverts from 150mmØ – 300mmØ.

The locations of these culverts are shown on the site visit plans contained in appendix 1.

3 Proposed Development

The Applicant seeks to establish an approximately 148ha agrivoltaic development, also known as a solar farm, within the subject site. The project is a utility scale 117 MW renewable energy project. It will consist of 117 MW of Solar plus 106MW / 200-400 MWH of battery energy storage. This project will include erecting solar panels (photovoltaic modules), inverters, transformers, battery energy storage system (BESS), a substation, and a site office. It is proposed to continue grazing the development area for the duration of the project, although the stock will be limited to sheep. CKL design plans are contained in Appendix 2 for reference.

The project encompasses not only the photovoltaic arrays (solar panels) but also the essential supporting infrastructure, such as substations, inverters, and service paths. The civil works related to stormwater include:

- Construction of internal access tracks, site carpark and layout down area.
- Construction of new culverts for the internal access tracks.
- Construction of hard stand areas for substation and BESS units.
- Possible upgrade of existing culverts as required.
- New site entrances off Homebush Road and Loes Road.

For visual reference, Figure 3 showcases a photograph of a comparable operational agrivoltaic facility, while Figure 4 provides a detailed schematic representation of the planned agrivoltaic solar array and support structure.

Figure 3: Example photograph of ground-mounted photovoltaic arrays

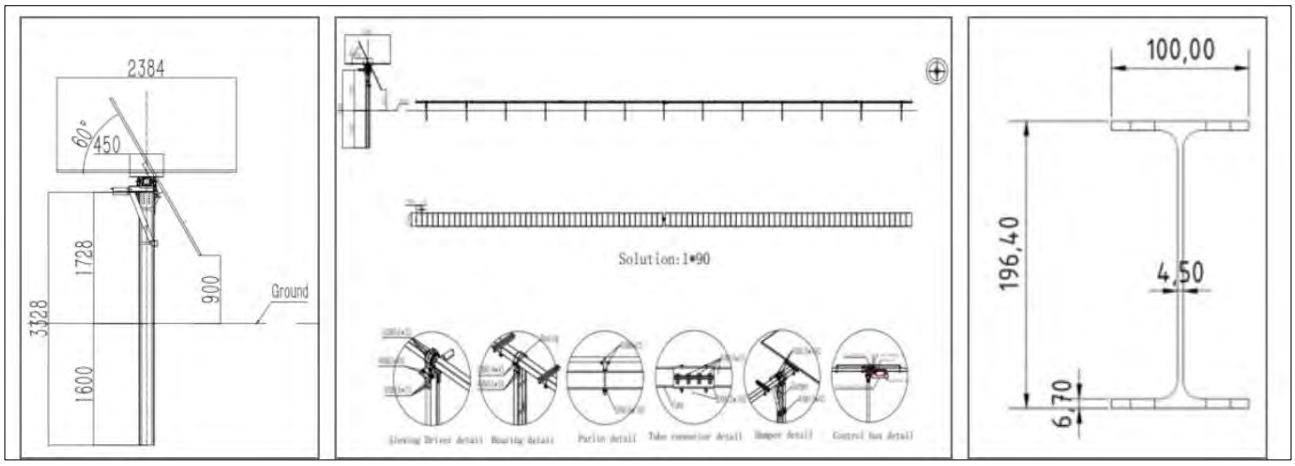

Figure 4: Example photovoltaic arrays drawing (left and middle) & support pile cross-section (right)

A noteworthy feature of the (panel) design is the inclusion of adjustable mounting frames, which will enable the photovoltaic arrays to pivot for optimal solar engagement throughout the day.

4 Stormwater Management Plan - Strategy

The primary objective of a stormwater management plan is to manage stormwater runoff in such a way as to minimise flood damage and adverse effects on both the built and natural environments. The site is located under the SDC territorial authority and the ECRC authority. The proposed development, with respect to stormwater management, in this area is guided by the following documents and standards:

- Selwyn District Council, Selwyn Partially Operative District Plan (SPODP) – 3 May 2016
- Environment Canterbury Regional Council (ECRC), "Canterbury Land and Water Regional Plan" – September 2023
- Canterbury Regional Council, Waimakariri River Regional Plan – October 2017
- Selwyn District Council, Malvern Water Race Scheme – 2018
- NZS 4404:2010 Land development and subdivision infrastructure
- Acceptable Solutions and Verification Methods for New Zealand Building Code Clause E1 Surface Water, 1st Edition, amendment 11, dated 5 November 2020.

5 Stormwater Management Options Assessment

An options assessment has been undertaken to assess the management of stormwater runoff from three main areas and/or aspects; photovoltaic arrays, treatment, and conveyance of runoff.

5.1 Photovoltaic arrays

The proposed photovoltaic array installation will alter the rainfall pattern prior to the runoff entering the site ground surface. As such whilst there is an alteration in the rainfall arriving to the site the runoff regime across the surface itself remains the same as existing scenario. This is discussed further in the following subsection.

5.1.1 Runoff to the existing grassed areas

Whilst the panels themselves are considered impermeable, the ground below remains vegetated and permeable. Rainfall (stormwater) will runoff from the panels and fall to the ground, where it will either infiltrate into the soil or runoff as overland flow when the soils infiltration capacity is exceeded, or the soils are saturated. No infiltration testing has been completed for the site, however the assumed infiltration value based on a United States Soil Conservation Service (SCS) Type A soil is 19mm[2] (assuming a curve number of 40).

An example photograph of an agrivoltaic facility is presented in Figure 3. This shows the gaps between photovoltaic arrays allow the water (rainfall) to runoff onto the ground, and that the natural groundcover can remain. Based on current estimates provided by the applicant, it is anticipated the spacing between photovoltaic arrays will be approximately 3.2 m.

Given the site is very flat, only minor earthworks associated with the access tracks are proposed for the development. No major grading or contouring of the site is proposed.

The photovoltaic array tables will be raised above the ground, there will be no significant change in impermeable surface cover across the site (at ground level). Therefore, the increase in stormwater generation (or change to the rainfall pattern) will be no more than minor.

5.2 Stormwater Treatment Assessment

Stormwater treatment could be required, due to contaminant generation, of the runoff generated from the amenity areas. The proposed site office cladding (for roof and walls) is to be non-contaminant generating material. As a result, the site office is considered a low contaminant generating area/activity and as such the standard collection and cladding choice will provide sufficient treatment mitigation for this site.

The impervious areas of the hardstand areas are 20,700m². The parking areas are considered as low traffic volume areas and as such no additional treatment devices are proposed. Anti-clogging measures such as sediment chambers and catchpits are sufficient to minimise maintenance requirements and ensure long-term operation of the soakage device, with respect to discharge to ground.

Soakage devices for discharge to ground of treated runoff may be located under parking areas, in adjacent grass areas, within the swales, or other areas as deemed appropriate.

5.3 Conveyance – amenity areas

Runoff from paved/gravel areas can be conveyed to discharge points via swales/channels and runoff from roofs can be conveyed via spouting, downpipes and a private pipe system, or an overland swale/channel system.

[2] Waikato Regional Council, Technical Report 2020/06, Waikato Stormwater Runoff Modelling Guideline, Table 5-1

6 Best Practicable Stormwater Management Option

Based on the options assessment, the best practicable options to manage stormwater runoff from the fully developed site are presented below.

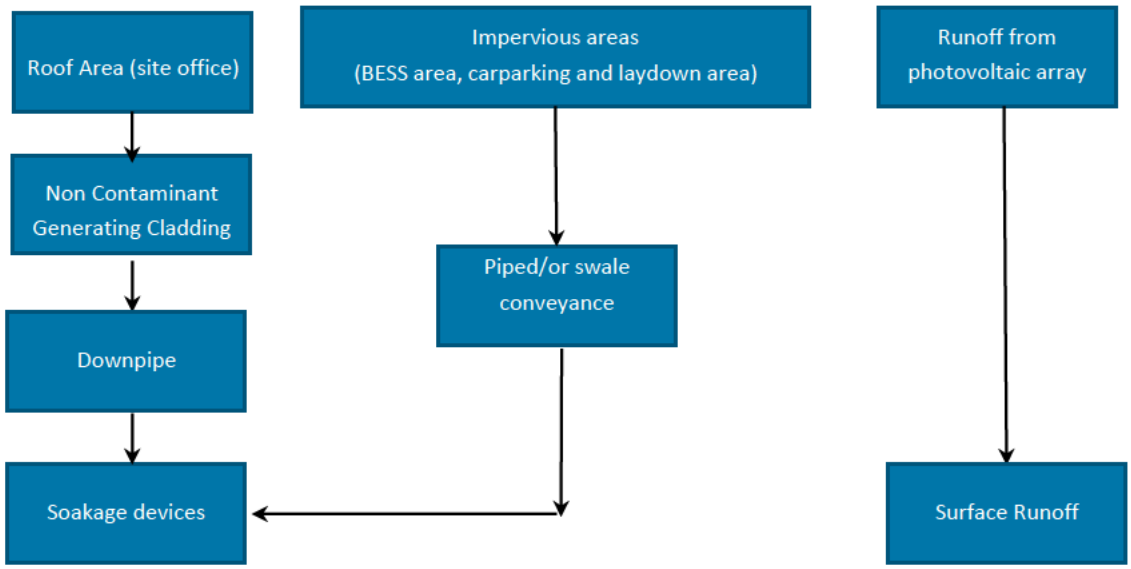

Figure 5: Best Practicable stormwater management option

The stormwater runoff volumes, flows, and discharge regime from the site are expected to be equivalent to the predevelopment scenario. Therefore the effects on the existing channels, receiving environment, are considered less than minor and the potential risk to the agrivoltaic facility of flooding from the watercourse will be avoided.

6.1 Proposed Culverts

As per the CKL Engineering & Infrastructure Report, two new culverts will be installed to create two independent crossing points separate from the existing farm crossings. It is anticipated that new pipes and wingwalls will be constructed along with compacted suitable fill over the pipes to form an embankment crossing. These two culvert crossings are proposed to be 300mm diameter equivalent to the existing upstream and downstream culverts.

As the channels are artificial, created for irrigation purposes, and the flow in the channels is controlled by upstream weirs and the overlying drainage scheme operators, the flows in the channels will not usually exceed a specified flow rate. Therefore, to match the existing onsite culvert sizes is considered adequate.

6.2 Amenity areas

The outcome of the options assessment resulted in the soakage and sheet flow discharge regimes are considered as potential options for the site, as there is no public reticulation available.

As per Section 2 the underlying soils are gravelly river deposits with a high infiltration potential. Therefore it is assumed that soakage is viable, and it is expected a reasonable soakage rate can be achieved. It is important to note that no onsite soakage tests have been performed; thus, the assessment relies on a presumed soakage rate of 500 mm/hour. It is strongly advised to conduct actual soakage testing to verify these assumptions and, if necessary, to recalibrate the assessment accordingly.

In the unlikely event that the soakage capacity is found to be inadequate, investigation of alternative discharge methods will be needed. Examples of viable alternative discharge methods include discharging via swales (as per the existing site drainage regime), or surface discharge such as a level spreader.

As indicated in the proposed site plan, the proposed development includes the construction of a site office, carparks, and layout down area, and hard stand areas for substation and BESS units. An assessment has been conducted to size the soakage device. The size of the soakage trench/device per 1000m^2 of impervious area is shown in Table 2.

Table 2: Soakage size per 1000m^2 of impervious area

Location	Contributing Catchment	Number of soakage trenches	Trench Base Area (m^2)	Soakage Trench Depth (m^2)	Drainage Metal Void Ratio (%)
Amenity areas (hardstand/roof etc) *	1000 m^2	1	50 m^2	1 m^2	38%

*Anti-clogging measures such as sediment chambers, catchpits, litter traps or leaf separators should be incorporated in the design of all soakage devices to minimise maintenance requirements and ensure the long-term operation of soakage devices.

7 Flood Risk Assessment

A review of the Environment Canterbury Regional Council's Flood modelling[3], available online, has been undertaken and is shown in Figure 6. The flood modelling is for 200 and 500 Year ARI events with a climate change increase based on RCP 8.5 for 2081-2100.

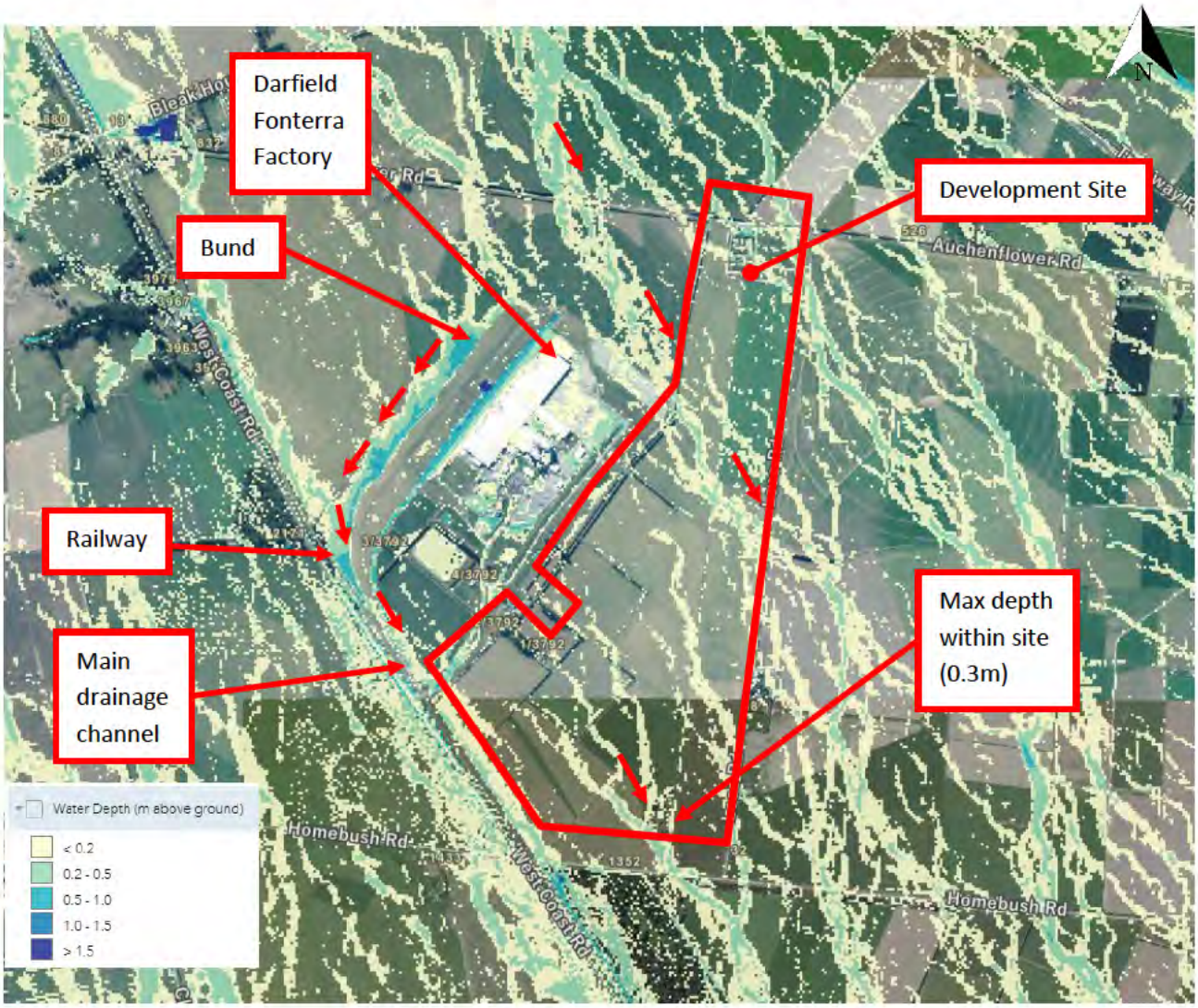

Figure 6: Canterbury Flood Maps, 500 Year ARI – Accessed June 2024

The flood modelling shows relatively scattered flooding across the site, which is expected given the site has a relatively flat surface with only a very slight grade from north west to south east and is located approximately half way between the Waimakariri and Waikirikiri/Selwyn Rivers. There is a large bund in place upstream, to the north west of the Fonterra factory which appears to block some surface flows and divert them to the main channel adjacent the railway.

The deepest flooding on the site is at the existing entrance from Homebush Road with a depth of 0.3m. As the entrance is existing and is to remain as is, this is considered acceptable. The layout and placement of

[3] November 2019, DHI, Regional Policy Statement Modelling for Selwyn District Council - District Plan https://www.selwyn.govt.nz/__data/assets/pdf_file/0014/324131/DHI-Regional-Policy-Statement-Modelling.pdf

the photovoltaic arrays mean that the flows along the surface (ground level) in a flooding event will not be diverted or changed from the existing situation.

The imperviousness, infiltration, and soil type will not be altered, and therefore the runoff (pattern/volume) from the site will remain the same. Therefore it is considered the effects from flooding on the site development and any adverse effects on adjacent/downstream flooding are negligible.

The location of the site office, substation, and BESS units are shown in Figure 7 overlaid on the ECan flooding maps. The annotations show the flood levels (relative to LVD1937) and flood depths above ground level for the 500 Year and 200 Year ARI flood events.

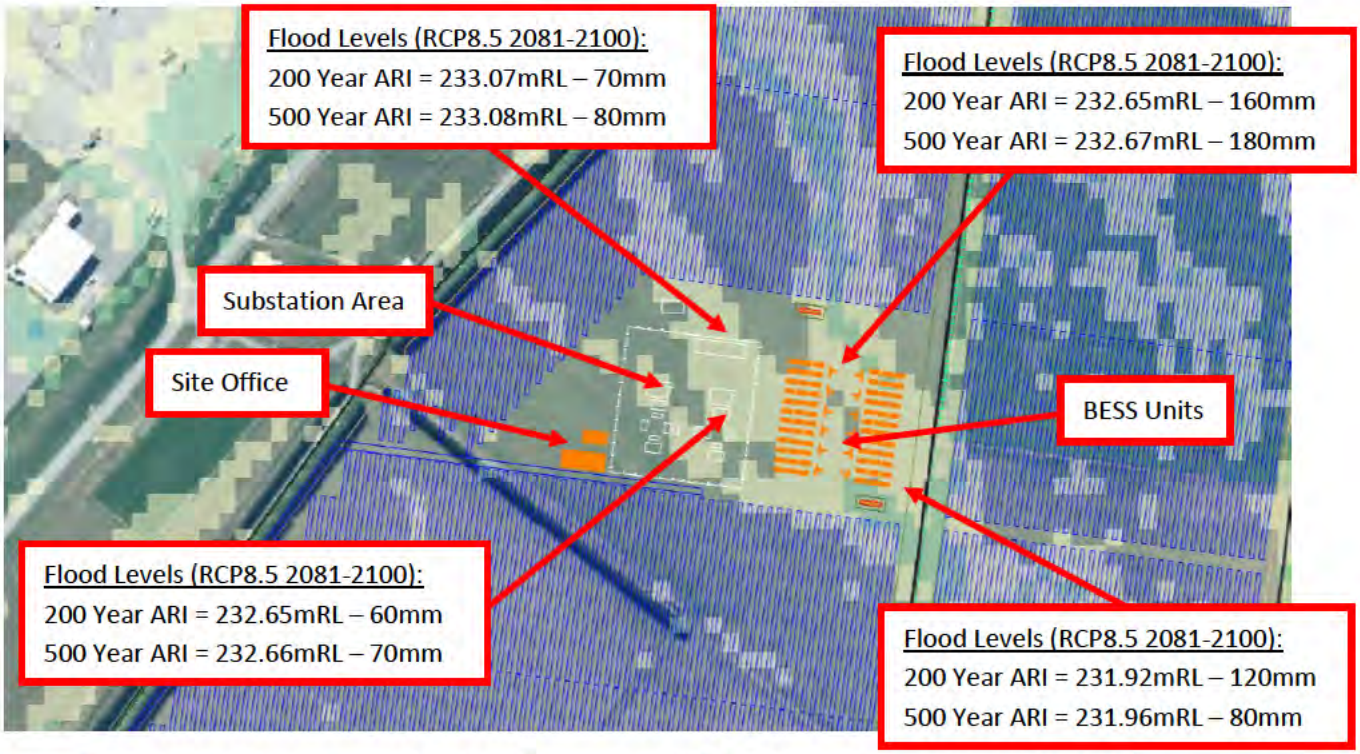

Figure 7: Proposed site layout overlaid on ECan flooding maps (All flood levels shown related to LVD1937)

The applicable SPODP standards according to NH-SCHED1 state the following:

NH-SCHED1 Flood Assessment Certificates

A Flood Assessment Certificate will be issued by the Selwyn District Council (that is valid for 2 years from the date of issues) which specifies:

1. whether or not the site or activity is located on land that is within a High Hazard Area; and
2. whether or not the site or activity is likely to be subject to inundation in a 200-year Average Recurrence Interval (ARI) flood event and;
3. where the site or activity is not located on land that is within a High Hazard Area but is likely to be subject to inundation in a 200-year ARI flood event, a minimum finished floor level for any new building or structure (or part thereof) that is 300mm above the 200-year ARI flood level.

The minimum finished floor level will be determined with reference to:

a. the most up to date models and maps held by Selwyn District Council or Canterbury Regional Council;
b. any relevant field information; and
c. any site-specific flood assessment prepared by a suitably and experienced person

A freeboard of 300mm above the 200 Year ARI floodplain must be applied to the site office, substation buildings, and BESS units. With the information from Figure 7 the minimum finished floor levels in Table 3 for any new structure will apply. The finished floor levels are given in relation to both LVD1937 and NZVD2016. Note that the minimum finished floor levels below are in relation to the current design as per the NZ Clean Energy Ltd Proposed Site Plans – Dated May & July 2024, in particular the BESS & Switchyard plan, Dwg # DAR-004 dated 30/05/2024. If there are changes to the location of the buildings from this revision, a revised minimum finished floor level will need to be provided.

Table 3: Minimum Finished Floor Levels

Building	Freeboard	Adjacent Upstream Flood Level (LVD1937)	Minimum Finished Floor Level (LVD1937)	Adjacent Upstream Flood Level (NZVD2016)	Minimum Finished Floor Level (NZVD2016)
Site Office	300mm	233.07	233.37	232.73	233.03
Substation	300mm	233.07	233.37	232.76	233.03
BESS Units	300mm	232.65	232.95	232.31	232.61

8 Summary

This report, prepared by CKL NZ Ltd, supports a resource consent application for a proposed agrivoltaic facility at Homebush Road, Darfield, Canterbury and includes a stormwater management plan to support the operation of the site. The site is 148 hectares in a General Rural Zone, currently used for stock grazing, and features a two channels/races and minimal structures. The proposed agrivoltaic facility will include adjustable photovoltaic arrays panels and essential accessory infrastructure such as access routes, hardstand areas and buildings.

The stormwater management strategy has the overarching aim to minimise adverse environmental effects. The site's stormwater runoff conveyance is managed by sheet flow/overland flow and existing culverts within the channels/races. Two new culverts are proposed in the existing channels and are sized to be equivalent with existing infrastructure. Soakage devices are considered adequate for managing stormwater discharge, with the design including anti-clogging measures, associated with the amenity facilities such as roof areas and carparks.

The photovoltaic arrays, whilst interrupting the rainfall deposition to the ground surface will not result in the change in surface flow patterns. As such the runoff crosses the ground surface and results in minimal change in runoff to the receiving environment, which it will either infiltrate into the soil or runoff as overland flow when the soils infiltration capacity is exceeded, or the soils are saturated. The photovoltaic array tables will be raised above the ground and there will be no significant change in impermeable ground surface cover across the site, and the existing site watercourses will remain. Therefore, the increase in stormwater generation will be no more than minor.

The proposed building cladding is proposed to be non-contaminant generating, and parking areas are considered low traffic, requiring no additional treatment devices. There is considered to be no flood risk to the agrivoltaic facility given the topography of the site and there is considered to be no adverse effects to the existing watercourses.

Minimum Floor Levels have been determined for the proposed site office, substation, and BESS units to incorporate a 300mm freeboard above the 200 YEAR ARI flood level.

9 Limitations

This report has been prepared solely for the benefit of our client with respect to the particular brief and it may not be relied upon in other contexts for any other purpose without the express approval by CKL. Neither CKL nor any employee or sub-consultant accepts any responsibility with respect to its use, either in full or in part, by any other person or entity. This disclaimer shall apply notwithstanding that the report may be made available to other persons including Council for an application for consent, approval or to fulfil a legal requirement.