Appendix H. Stormwater Assessment

Stormwater Assessment
for Proposed Solar Farm
at 380 SH 7, Waipara, Canterbury
for Far North Solar Farm Ltd

Haigh Workman reference 23 185

21 November 2023 – FINAL

Phone: +64 9 407 8327 • Fax: +64 9 407 8378 • info@haighworkman.co.nz • www.haighworkman.co.nz

Revision History

Revision №	Issued By	Description	Date
Draft	Alan Collins	Final	21 November 2023

Prepared by	Reviewed by	Approved By
Alan Collins	Sean Kelly	John McLaren
Senior Civil Engineer	Senior Civil Engineer	Senior Civil Engineer
MEngSt, MEngNZ	CPEng, IntPE(NZ)	CPEng, IntPE(NZ)

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Executive Summary

Haigh Workman Ltd was commissioned by Far North Solar Farm Ltd to undertake a stormwater assessment and subsequent management plan for a proposed solar farm (the Site) in Waipara. The proposed development would see the erection of photovoltaic (PV) modules and ancillary infrastructure across 180.8 ha of existing sheep pastureland. In addition, 4.8 ha of existing pastureland near the southern end of the Site is to be planted with a vineyard for community aesthetics. Grass growth will not be impeded by the PV modules and grazing of the land will continue.

Because the ground has high soakage, stormwater runoff only occurs in low probability rain events. Modelling with the rational method supported that the proposed development maintains stormwater neutrality. Concurrently, the partial shading from the PV modules will reduce evapotranspiration in the summer months, reducing potential demand for irrigation. This is an external positive effect on the Waipara catchment water resource.

Negative effects on stormwater quality are not foreseen. The ground infiltration provides adequate hydraulic retention time to absorb heat transferred from the PV modules. Long-term sediment yield into the Weka Creek will decrease. Erosion prone ridge faces are to be stabilised with native flora for visual aesthetics. There is potential for short-term sediment yield during construction. An Erosion Sediment Control Plan in accordance with GD05 is recommended as a consent condition.

1 Introduction

Haigh Workman Ltd was commissioned by Far North Solar Farm Ltd (the Client) to undertake a stormwater assessment for consent application. The proposed development is a 135 MWp Solar Farm. The site is accessed from 380 State Highway 7, Waipara, Canterbury.

The proposed development will occupy the following parcels:

Lot 2 DP 19025
Lot 1 DP 320376
Section 4 SO 17514
Section 3 SO 17514

Herein referred to as 'the Site'.

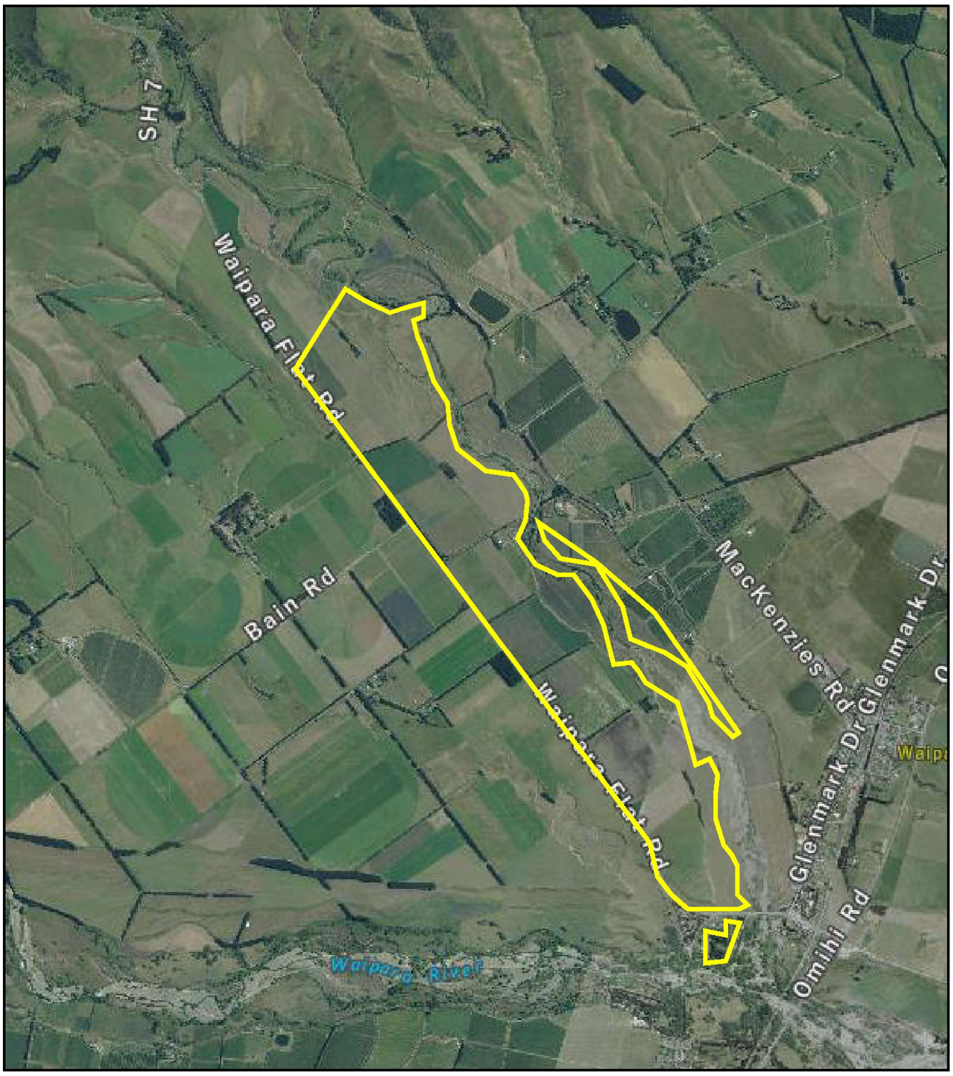

Figure 1: Site Outline

1.1 Objective and Scope

The objectives of this investigation are to:

- Undertake a site visit and make observations of stormwater flow paths, catchments, hazards, and other features.
- Review the regulatory framework for rules, policies, and objectives as it relates to stormwater.
- Assess the runoff effects from the proposed development.
- Assess water quality effects from the proposed development.
- Assess the necessity for water quantity control.
- Prepare a compliant stormwater assessment report for consent application.

1.2 Limitations

This report is intended to support a consent application with the Hurunui District Council. It is to be used by the Council when considering the application for the proposed development. The information and opinions expressed in this report shall not be used in any other context without prior approval from Haigh Workman Ltd.

All details and the scheme plan for the proposed development have been given to Haigh Workman Ltd by the Client. If the design diverges from the conceptual brief, the recommendations of this report will need to be revisited.

Haigh Workman Ltd does not take responsibility for the engineering aspects of the proposed development that are not covered in the agreed brief.

2 Site Description

2.1 Site Location

Site Address: 380 State Highway 7, Waipara, Canterbury

Area to be developed: 180.8 hectares

2.2 Site Features

2.2.1 *Site Topography*

The Site is elongated along the southwestern bank of the Weka Creek – a braided river. Inclines on the site are mostly flat to 5%. However, there are several ridges running near parallel with Weka Creek. The ridge faces are facing towards the north-east and have vertical heights up to 8m and inclines up to 70 degrees. The steepest area of the ridge is undercut by Weka Creek and has led to toppling failure.

Figure 2: Instability near Weka Creek flood plain. The Creek has undercut the hillside leading to toppling.

2.2.2 *Site Geology*

The Site is sub-par farming land with free draining gravel soils.

Geological mapping by GNS indicates that the upper plateau of theSite is arranged in low-lying river terraces with river deposits for the Late Pleistocene. Soil is described as unweathered, brownish-grey, gravels/sands/silts.

The low-lying areas of the Site within the flood plain of Weka Creek are described as active river bed deposits (Holocene). The sediments are unweathered, rounded-subangular variable gravels with greywacke origins.

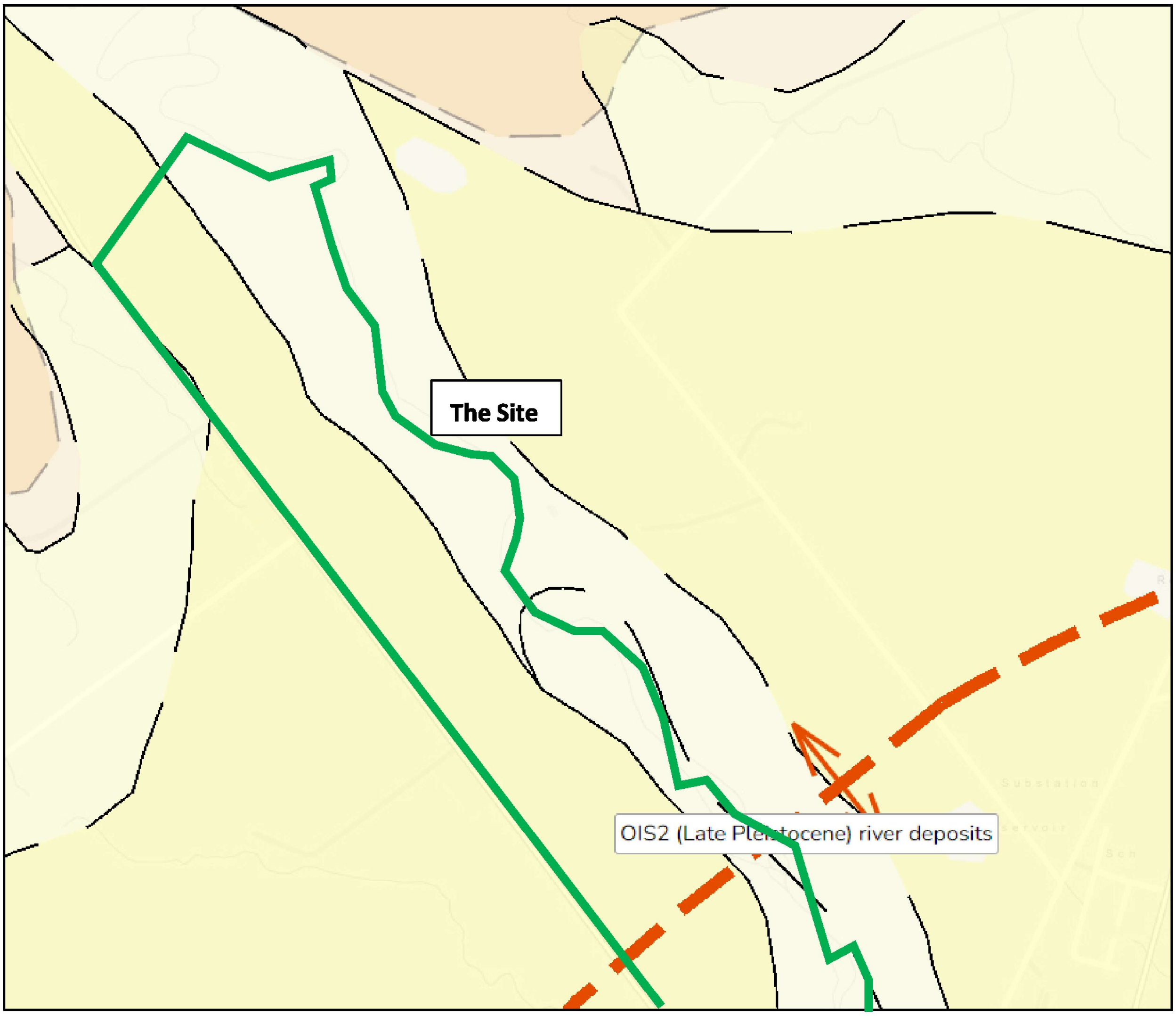

Figure 3: GNS Geological mapping of Site.

Site Observations confirmed the mapped geology. There is 0-50mm of topsoil. Grass growth is patchy in places. Chalky grey, rounded, gravel particles are seen throughout the Site. There is negligible evidence of overland flowpaths for a very large area of the catchment. This indicates that precipitation infiltrates into the ground rather than moving as surface runoff.

Figure 4: Patchy grass cover and exposed gravels were found throughout the Site. However, bare patches were more concentrated in the low-lying flood plain.

2.2.3 *Site Features*

The Site is currently grazed by sheep at low intensity. There is an existing 370m^2 house with residential garden and parking. There is a large livestock barn (240m^2) to the west of the house on the upper terrace. The runoff of the barn enters a 20,000L water tank with overflow. The overflow discharges directly to the ground with no evidence of flowpaths or springs downhill. This is indicative of the free-draining characteristic of the soil.

There are several windbreaks of mature pine trees on the farm, perpendicular to the predominant nor-westerly.

The ridge faces were relatively stable except for the one isolated location where toppling has occurred (shown in Figure 2). One flowpath was observed in the most southerly section of the Site (Figure 5). The flowpath exists as it takes overflow from another creek's catchment to the west. Overland flowpaths (OLFP) are not present on the Site from direct precipitation.

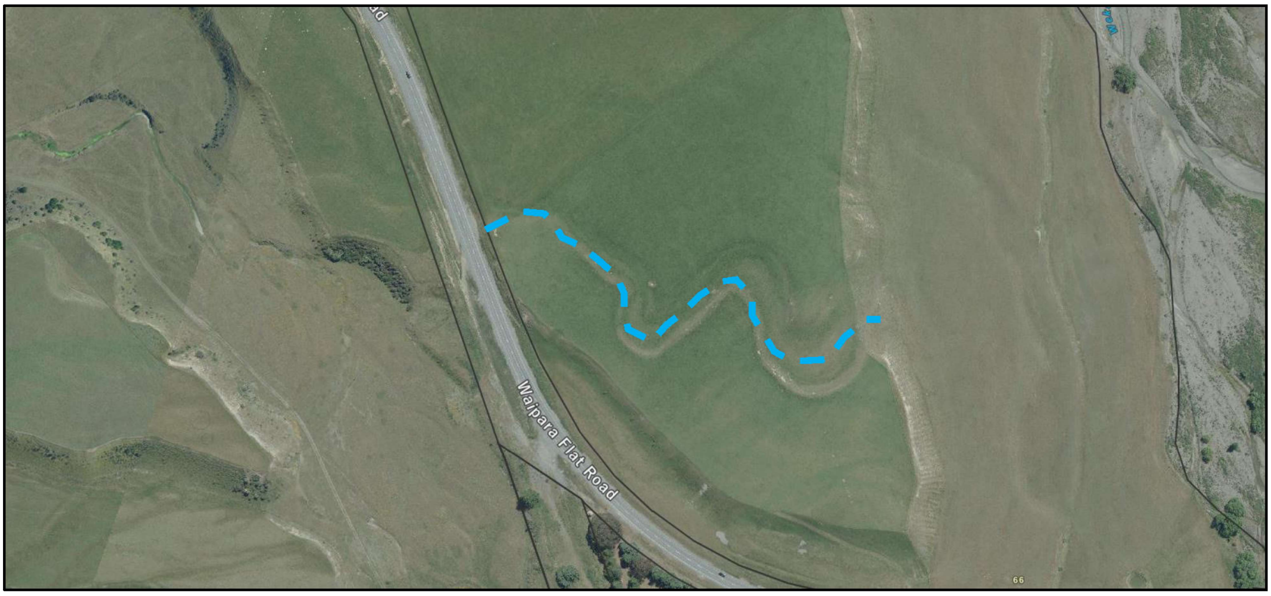

Figure 5: OLFP in southern section of Site. Carries overflow from a creek west of the Site.

2.3 Proposed Development

The proposed development will see photovoltaic panels erected across 180.8 ha of the Site. Non of the PV modules are to be erected in the Flood Assessment Overlay. The panels will be set on 2.285m wide tables orientated north-south with single axle oscillation tracking the trajectory of the sun through the day. The tables will tilt up to a 30-degree incline east and west. There is a 4m gap between table mounts, giving an overall pitch of 6.0m. The table tracking axis are to be mounted 1.5m above ground.

For visual aesthetic and planning purposes, the far south-east corner of the Site that is within view for the Waipara township, is to be developed into a vineyard, replacing gravelly and patchy pasture.

The steep east facing ridges between terraces are to be planted with 3-5m tall revegetation plants (details found in the Landscape Mitigation plan, Simon Cocker Landscape Architecture, 20 September 2023.). In total, 15.5 hectares of marginal pasture is to be revegetated apart from the 180.8 ha developed for PV modules.

Approximately 10km of deer fence around the perimeter of the Site is to be erected. 4m wide gravel access tracks will traverse the Site for 7km or 2.8 ha. As the Site geology is already free draining and gravel, the import of aggregate is expected to be negligible.

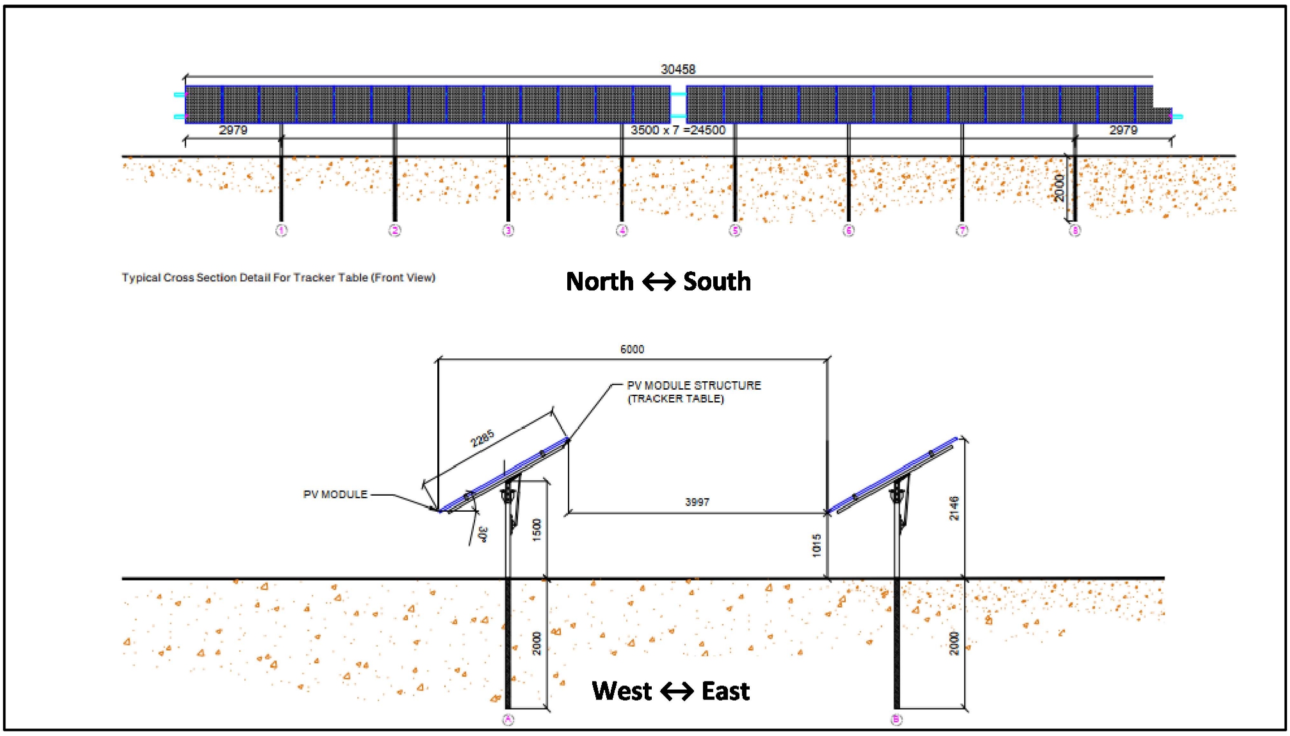

Figure 6: Proposed module arrangement

3 Stormwater Management

3.1 Regulatory Framework

3.1.1 *Huranui District Council Plan*

The Huranui District Plan zones the Site as 'Rural Zone'. A small portion of the Site in the southern end of the parcel is in the 'Flood Assessment Zone' overlay, however this area of the site is not to be developed.

Section 3 of the District Plan gives policies and rules for the Rural Zone but does not address stormwater specifically. Sediment and Stormwater runoff must be assessed for earthworks (3.4.8.9 (b)). Flood assessment only applies for development within the Flood Assessment Overlay (15.2).

Figure 7: District Plan - Flood Hazard Assessment Overlay

3.1.2 *Operative Environment Canterbury Land and Water Regional Plan 2018*

The Regional Plan gives policies, rules, and targets for various Canterbury catchments for the ecological conservation of river systems. Policy 4.3 states that the natural variability of flowrates, including floods, is to be maintained. The natural colour of water in a river is not to be altered. Developments are to consider how sedimentation of rivers is to be avoided or minimized (4.22). The discharge of stormwater into a river is a permitted activity so long as the river is not a wetland and not in a natural state (5.95). The discharge is not to increase the 20% AEP flowrate by more than 1% from pre-development. In addition, the discharge is to meet the water quality standards found in Schedule 5.

Schedule 5 gives the parameters for water quality. The Total Suspended Solids (TSS) of the stormwater discharge is not to exceed 50g/m3. Temperature changes of inflows are not to exceed 2.0 °C. The water quality testing flowrate for design purposes is to be the seven-day mean annual low flow rate (7DMALF).

3.1.3 *Waipara Catchment Environmental Flow and Water Allocation Regional Plan*

The specific catchment plan for protecting the environmental values of the Waipara River became operative in 2012. The plan mostly deals with outtake management for the purpose of irrigation. The Waipara River catchment includes Weka Creek which is a tributary.

Issue 4 states the river has particular volume sensitivity and that changes to runoff within the catchment are to be carefully managed and restricted.

Part 7 of the plan gives specific rules for the management of surface water and groundwater within the catchment. The maximum amount of surface water that can be diverted as a permitted activity is $10m^3/d$ (7.1.2(a)). Water is not to be diverted out of the riverbed and surface flow is to remain continuous (7.1.3(a)(b)).

To protect the runoff volume into the river, the plan has controls for minimising the planting of woody exotic plants that retain runoff within the catchment (Policy 3.6).

3.1.4 *New Zealand Building Code*

Section 2.1 of E1/VM1 recommends the rational method for estimating the effects on runoff from changes in land use. Appropriate runoff coefficients for a variety of surfaces are given. The Building Code also provides helpful guidance in determining the Time of Concentration for catchments for hydrological modelling.

3.2 Stormwater Quantity Control

3.2.1 *PV modules*

The combination of a high panel height, low angles, array spacing, and the ridgeline gap allow for adequate direct and diffused lighting to allow grass to grow. Site observations showed that partially shaded areas had Crop growth being improved (Figures 8 and 9). It is reasonable to assume that the ground will continue to have grass growth post-development, and that the runoff properties will remain close to pre-development.

Figure 8: Site Observations showed areas with partial shading had greater grass growth.

Figure 9

The justification for the runoff coefficient of the PV module area remaining the same as, or better than, predevelopment is as follows:

1. The experience of other NZ Solar farms has shown than stormwater runoff remains largely unchanged between pre and post development. (See Figures 10 and 11).
2. Rainwater Distribution: rain will fall through the spacing of the PV modules along 1.1m spaced lines. Surface sheet runoff will distribute from these lines, so that no patch of the ground will become unirrigated.
3. Reduced evapotranspiration: The partial shading provided by the PV modules can reduce evapotranspiration of the grass during dry summer months. This means that the grass cover may increase in dry seasons when there is a risk of greater stormwater and sediment runoff.
4. The Site already has fast infiltration with minimal evidence of surface flowpaths or sheet runoff resulting from precipitation. Once precipitation passes through the PV module spacing it will soak into the ground as it has always done. Soakage may improve because of increased grass coverage.

Figure 10: A similar PV module arrangement at the Kapuni Solar Farm, Taranaki. The photo shows that grass coverage over the ground is practically unchanged because of the PV modules.

Figure 11: Another NZ Solar Farm - Keswick Farm Dairies Ltd, Rangiora. The photo shows grass coverage over the ground does not diminish because of the PV modules.

3.2.2 *Runoff Effects*

Runoff Effects were assessed for the 10% AEP event. The rainfall intensity used the RCP 8.5 data from the NIWA HIRDS dataset for a 10min duration.

Runoff Coefficients for different surfaces were derived from Table 1 in E1 AS1/VM1 of the NZ Building Code. The pre and post development scenarios were determined using the Rational Method as detailed in the building code.

Modelled results are as follows:

Pre-Development Runoff

	Area	C	I_{10}	Q
	m²		mm/hr	L/s
metal access road	5000	0.5	47.28	32.8
roof area	610	0.9	47.28	7.2
high soakage grass paddocks	2418790	0.2	47.28	6353.4
Total	**2424400**			**6393.4**

Post-Development Runoff

	Area	C	I_{10}	Q
	m²		mm/hr	L/s
metal access road (2.8 new & 0.5ha existing)	33000	0.5	47.28	216.7
roof area	610	0.9	47.28	7.2
PV table	603000	0.2	47.28	1583.9
proposed native shrubbery	155000	0.15	47.28	305.4
proposed vineyard	48000	0.15	47.28	94.6
high soakage grass paddocks	1584790	0.2	47.28	4162.7
Total	**2424400**			**6370.4**
Excess Runoff	**2424400**			**-23.0**

The model shows that the proposed development. will decrease peak stormwater runoff by 23 L/s in a 10% AEP flood event. In the context of a 242 hectare land parcel, the reduction in runoff is miniscule and well within the margins of error for modelling stormwater neutrality.

Directions of stormwater runoff and groundwater will not change because of the proposed development. Stormwater volumes will not change as no volume is to be retained or detained. Stormwater will continue to enter the Weka Creek and tribute into Waipara River.

3.2.3 *Effects on Water Allocation in the Waipara Catchment*

The partial shading of the PV modules will decrease evapotranspiration in the summer months – when irrigation demand in the catchment is at its highest. The partial shading will put downward pressure on water demands for the Site's farm. This is a positive external effect for the Waipara Catchment Flow and Water Allocation Plan.

3.3 Erosion and Scour Effects

Entry points into Weka Creek is primarily by groundwater ingress. The southern overland flowpath (Figure 5) has adequate energy dissipation at its outlet into Weka Creek by natural riverbed armouring.

Currently, the highest likelihood of erosion is from localised shallow slumping on the steep ridge faces. The proposed development would see these areas planted with deep rooted native flora that will stabilize the inclines in the long-term.

Minimal aggregate is expected to be imported for construction as the existing near-surface gravel is suitable for access road pavement. Erosion and sediment deposition is a risk during the construction of the Solar Farm when grass coverage may be temporarily reduced. While earthworks have minimal volume, they cover a large area. We recommend that and Erosion Sediment Control Plan in accordance with GD05 guidelines be required as a condition of consent.

3.4 Water Quality Effects

3.4.1 *Livestock Pollutants*

The proposed solar farm will continue to allow sheep grazing to manage pasture in the solar farm. Sheep grazing will be at a similar intensity as pre-development. The proposed development may have long-term water quality benefits by inhibiting future intensification of the farm and greater use of fertilisers.

3.4.2 *Soil and Sediment*

The PV modules are not expected to inhibit grass coverage (section 3.2.1). Bare ground during the construction of the Solar Farm can lead to higher sediment yields for the construction period. A GD05 Erosion Sediment Control Plan is recommended as a consent condition.

3.4.3 *Temperature*

PV modules can reach temperatures upwards of 40 degrees Celsius. The detention time of rain runoff on PV modules is not more than 5 seconds before it reaches the ground and infiltrates. The small length of time that precipitation runs off a hot PV module is more than offset by the extended hydraulic retention time in the groundwater system.

4 Conclusions

The high-soakage capability of the soil means that there are few overland flow paths on the Site. Precipitation infiltrates directly into the ground in most rain events. For extreme rain events, sheet runoff towards Weka Creek is to be expected. The proposed solar farm is not expected to affect the water quality or water quantity of stormwater discharged from the Site.

The PV modules themselves will not inhibit grass growth or ground infiltration. Runoff in heavy rain events is affected by the proposed creation of several gravel access tracks. But the effect is offset by the proposed planting of a vineyard and native shrubbery on the ridge faces for amenity.

Long term stormwater quality will remain the same or improve. Livestock pollutant yield will remain the same as pre-development. Heat is a common water pollutant for solar farms, but the ground infiltration ensures that heat transferred from the PV modules will be absorbed by the ground before the water reaches Weka Creek.

Long term sediment yield is expected to decrease because of the proposed native planting in erosion-prone areas. Short term sediment yield during construction can be effectively managed with an Erosion Sediment Control Plan.