STORMWATER MANAGEMENT PLAN

DRAFT

Twizel Solar Project

for Nova Energy

Rev WD - 24/03/2026

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for Nova Energy

Reviewed

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1 INTRODUCTION

This Stormwater Management Plan (SMP) has been prepared on behalf of Nova Energy (Nova) to support the resource consent applications for the proposed Twizel Solar Plant. The application site is on the property legally described as Lot 3 DP 4229201 located on State Highway 8, Twizel, being some 868 hectares and hereafter to be referred to as the 'project site'. The project site is in the General Rural Zone of the Mackenzie District Plan.

A map of the proposed project site in provided in Figure 1.1.

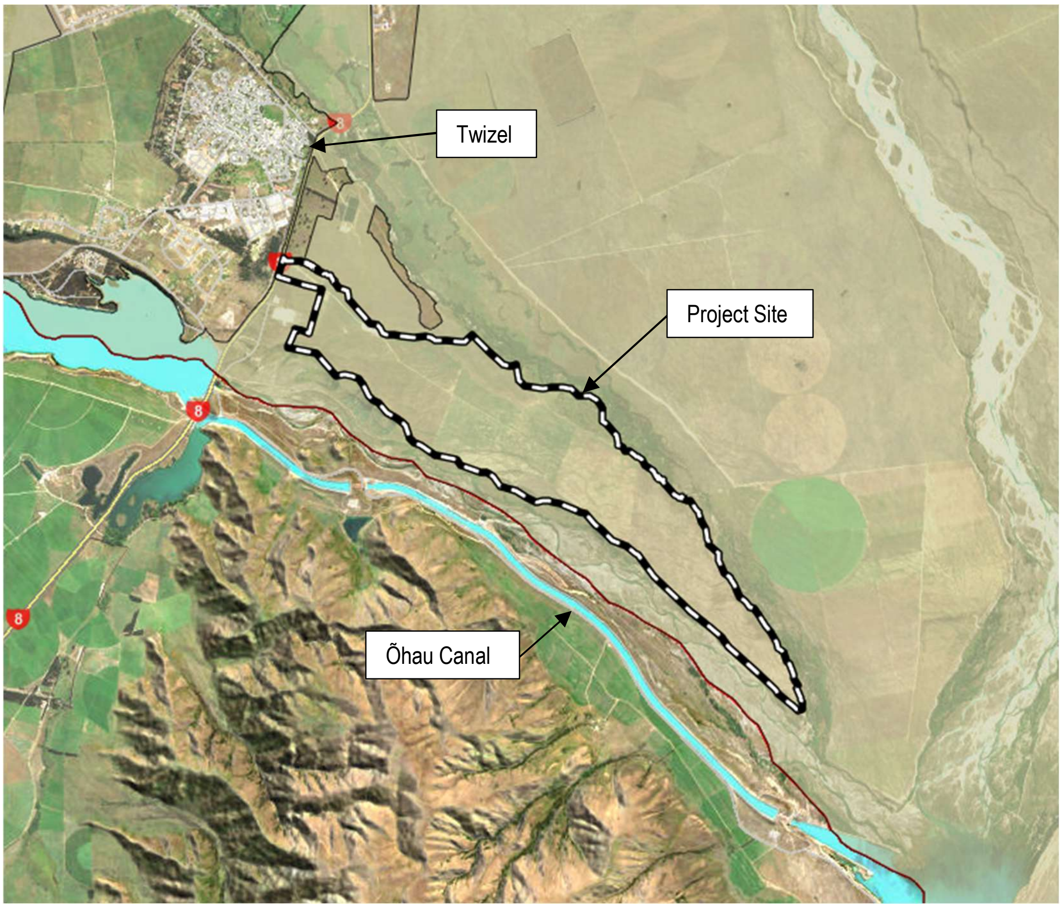


Figure 1.1: Project Site (Source MDC District Plan Maps)

This SMP outlines a technically sound and workable stormwater management strategy, that provides flood protection and stormwater management for the proposed development in accordance with the requirements of the NPS-FM and NPS-NH, the Mackenzie District Plan, the Canterbury Land and Water Regional Plan (CLWRP), and best environmental practice.

The stormwater management strategy has been developed to ensure that the proposed development gives effect to Te Mana o Te Wai by prioritising the health and well-being of the receiving waterbodies and ecosystem. The stormwater design approach has been prepared to mitigate any adverse effects on downstream waterbodies and adjacent waterways.

2 SITE CATCHMENT AND FLOOD RISK ASSESSEMENT

The site topography, geology and hydrology is documented in the BTW *Flood Hazard Risk Assessment* which provides information on the assessed flood risk across the site and recommendations.

A brief summary of key points from the report that has relevance to this SMP is provided below.

2.1 Site Description

The project site area is on the eastern side of State Highway 8, south of Twizel township on a strip of land bordered by the Twizel River to the north and the Ōhau River to the south, the two rivers confluence at the southeastern end of the site at the head of Lake Benmore and the Waitaki River.

The site is terraced at the northern end where there is a sudden drop in elevation of 7 to 10 m across the site, the existing quarry operates above the precipice on the eastern boundary with an existing access track to the quarry. At various locations along the boundary with the Twizel and Ōhau Rivers there are similar cliff faces, elevating the site well above the riverbeds.

Much of the site is flat with a gradual slope in an east to southeasterly direction, the site is situated in the General Rural Zone in the Mackenzie District Plan. The 868 ha site is presently used for dry stock grazing farming operations, with a small gravel quarry also operating (under a third party lease agreement) out of the northern end of the site. Current surface cover is approximately 85% of grasslands, red clover, and ryecorn.

Figure 2.1: Aerial image of the site boundary and location. (Source: Nova Energy Limited)

2.2 Site Catchment

The site catchment area is bounded by State Highway 8 (SH 8) and the Twizel and Ōhau Rivers which confluence at the southeastern end of the site before entering the head of Lake Benmore and the Waitaki River. The catchment area is approximately 1200 ha, and the distance from SH 8 to the bottom of the site is approximately 9 km.

The site is of low gradient without any formalised drainage system and infrastructure or watercourses. The historic river braids are embedded within the finer grain of the site topography and form the basis of the existing site drainage system. The natural gravelly soils are highly pervious with high infiltration rates and surface storage.

During light and minor rainfall events, runoff is generally captured at source and discharged directly to ground. During heavier larger periods of rainfall, it is expected stormwater runoff will follow site grading and concentrate in the low points of the historic river braids.

2.3 Receiving Environment

The site discharges into a highly valued receiving environment. Water quality is of the highest value with the rivers providing habitat for spawning salmon and trout along with wetlands that contain indigenous flora and fauna. Water quality treatment for all runoff from disturbed ground and hardstand areas should be provided.

The receiving environment is not sensitive to an increase in stormwater runoff or increased peak flows due to the hydro schemes which have resulted in significant modification to the natural hydrological regime, providing significant flood storage and reduction in stream flows.

2.4 Flood Risk Assessment

The results provided in the BTW *Flood Hazard Risk Assessment* indicate flooding on the site is generally confined to historic river braids which are located across the site. High velocity flows and elevated depths are limited to the more defined channels.

An assessment of the flood hazards on the site was undertaken against the Mackenzie District Plan (MDP) and National Policy Statement for Natural Hazards (NPS-NH). The analysis established the following

MDP: The site is generally assessed as having a low flood hazard risk. Minor areas of the proposed solar plant (< 0.1%) are identified to meet the 'high flood hazard area' classification.

NPS-NH: The flood risk of the site is generally considered to be low with small, localised areas of the site and solar array extent being of a medium to high risk.

The high flood hazard areas are localised and are generally caused by concentration of water within the historic river braids, and it is considered that natural hazard mitigation works could be undertaken within the assessed medium and high hazard areas to reduce the hazard classification.

The identified areas include a borrow pit located on the slope between upper and lower plateaus at the location of the proposed new access road to the site, and a small area within and along the periphery of the solar panel array footprint.

3 STORMWATER MANAGEMENT

Stormwater management is required to provide suitable management of surface water runoff to support and enable the proposed development and to mitigate the effects of the development on the receiving environment.

3.1 Design Objectives

The following design objectives have been a focus throughout the development of the stormwater management system:

- Develop a technically sound and workable overall stormwater management system for the proposed development that provides site drainage and flood protection.
- Give effect to Te Mana o te Wai by prioritising the health and wellbeing of the receiving water bodies and freshwater ecosystems by designing a stormwater management system that mitigates effects on the receiving environment.
- Consider water sensitive design objectives that consider stormwater management in parallel with the ecology of the site.
- Protect waterways and manage stormwater runoff during construction by implementing and maintaining erosion and sediment control practices as outlined in BTW *Erosion and Sediment Control Plan* and ECan toolbox.

3.2 Basis of Design

The catchment assessment has determined the following key points which inform the design criteria for the preparation of an SMP for the development.

- The historic river braids are embedded within the finer grain of the site topography and form the basis of the existing site drainage system. The natural gravelly soils are highly pervious with high infiltration rates and surface storage.
- The site discharges into highly valued receiving waters used for recreational activities on the surrounding lakes and rivers. Water quality is of the highest value with the rivers providing habitat for spawning salmon and trout along with wetlands that contain indigenous flora and fauna. Lake Benmore is identified as a critical habitat in the CLWRP.
- Groundwater is important in providing permitted water take for irrigation and hydro-electricity generation. Water quality treatment for all runoff from disturbed ground and hardstand areas should be provided.
- The receiving environment is not sensitive to an increase in stormwater runoff or increased peak flows. The Hydro schemes have resulted in significant modification to the natural hydrological regime providing significant flood storage and reduction in stream flows.

A preliminary stormwater design criteria for the proposed development has been determined from the catchment review based on the above considerations and is outlined below in Table 3.1.

Table 3.1: Stormwater Basis of Design

DESIGN OBJECTIVES	DESIGN CRITERIA	DESCRIPTION	COMMENT	REFERENCE
STORMWATER MANAGEMENT				
Flood Hazard Management	Required	The site is located in the Flood Hazard Assessment overlay. Flood hazard mitigation provided for 500-year ARI design event in accordance with NPS-NH and MacKenzie District Plan NH-S1 Provide secondary flow routes for Major design events.	Buildings located outside the High Flood Hazard Area[2]. Finished floor levels for any natural hazard sensitive building to be elevated 300 mm above 500-year ARI top water levels. Solar array infrastructure to be designed with consideration for flood levels with suitable clearance above estimated top water levels.	[1]NZS 4404 [2]MDC DP
Flood Control	Not required	Detention required limiting the post development 100-year ARI event to the pre-development 100-year ARI event flow rates	Downstream receiving environment not sensitive to an increase in stormwater.	[3]AC GD01
Flow Attenuation	Not Required	Match pre-development flow rates for the 2 and 10-year ARI events through controlled attenuation and multi-stage outlets or devices that reduce the runoff flow.	Downstream receiving environment not sensitive to an increase in stormwater.	[3]AC GD01
Water Quality Treatment	Required	Water quality treatment for all runoff from impervious surfaces prior to discharge into the natural waterways	Highly valued receiving environment. Specific consideration during construction phases.	[3]AC GD01
Extended Detention	Not Required	Provide detention and a drain-down period of 24 hours for the difference between the pre- and post-development runoff volumes from the 95th percentile (WQV x 1.2), 24-hour rainfall event minus the 5 min retention	Downstream receiving environment not sensitive to stream erosion / increase in stormwater.	[3]AC GD01 / [4]WRC TR20
Manage Cross Boundary Stormwater Flows	Required	The concept design of the drainage system should consider and allow for surrounding development areas. The drainage design should allow to receive flows from upstream catchments in major stormwater events	Upstream, adjacent and downstream development and respective catchments considered in design of stormwater system.	[1]NZS 4404
STORMWATER RETICULATION				
Primary drainage system	Conveyance capacity for a 5-year ARI design storm. (Industrial Land)	Primary infrastructure (pipelines and open channels) shall be provided to convey stormwater to an appropriate discharge using gravity flow. Infrastructure design will be undertaken using the HIRDS V4 RCP 8.5 2081 – 2100 climate change scenario for rainfall intensity.	Practical operational and maintenance requirement. Maintain existing flow capacities in channels.	[1]NZS 4404

DESIGN OBJECTIVES	DESIGN CRITERIA	DESCRIPTION	COMMENT	REFERENCE
Road Runoff	Allowance for site runoff from a 10-year ARI design storm. (Industrial Land)	Roadside collection via network of drainage channels discharging into natural water courses.	Not required.	[1]NZS 4404
Outlet Scour Protection – Energy Dissipation/Rip rap apron	10-year ARI design storm	Scour protection at reticulation outlets using energy dissipaters and rock rip rap. Design to disperse flows and/or provide hydraulic energy reduction, with consideration towards environmental, cultural, social and economic factors.	Design of inlets and outlets to be provided as per current best practice to protect against scour while also accounting for cultural, social and environmental factors, i.e. diffuse discharges into wetlands, visual amenity of proposed scour reduction techniques.	[3]AC GD01

[1] NZS 4404:2010 Land Development and Subdivision Infrastructure Standard
[2] Mackenzie District Council District Plan
[3] Auckland Council Guideline Document Stormwater Management Devices in the Auckland Region
[4] Waikato Regional Council Technical Report Waikato Stormwater Management Guideline

3.3 Design Strategy/Approach

The combination of the following elements is proposed as part of the stormwater management design to meet the requirements outlined in the design objective:

- The natural gravelly soils are highly pervious and provide high rates of infiltration. The proposal should minimise landform modifications and hardstand areas to maintain high infiltration rates.
- The historic river braids are embedded within the finer grain of the site topography and form the basis of the existing site drainage system. The stormwater management system should utilise the natural site drainage system where possible. Landform changes may be required in high hazard flood areas as identified in the *Flood Risk Hazard Assessment*.
- Provide water quality treatment for run-off from hardstand surfaces prior to discharging into the receiving environment.
- Establish clear and safe secondary flow paths to ensure safe offsite conveyance of flows during major rainfall events. Identify major flow routes and ponding areas where further assessment may be required to inform solar array design requirements such as locations and minimum levels.
- Embrace Environmentally Sustainable Design (ESD) and integrate water sensitive design principles into the site drainage system. Utilise green infrastructure to provide surface water conveyance, treating stormwater run-off via filtering and exposing the water to sunlight. Select sustainable materials and minimise grey infrastructure.
- Integrate proposed site ecological enhancement into areas which enhance stormwater management and runoff quality via filtering and treating site discharge.
- Identify high valued ecological features such as onsite natural wetlands and provide catchment controls to protect the catchment hydrology and the quality of site runoff discharging to these areas.

- Manage construction related effects of runoff throughout construction by implementing controls in accordance with the *Erosion and Sediment Control Plan*. Provide bunded containment areas and contingency plans for high-risk activities such as refuelling.
- Ensure restoration of ground cover with topsoil and vegetative growth following completed earthworks to protect subsoils and assist with stormwater discharge. The natural gravelly subsoils and existing land drainage network will be largely maintained providing a highly pervious surface with high infiltration rates and storage.

3.4 Design Features

A summary of the key design features for the project is provided in this section. Further assessment at time of detailed design may be required to detail any proposed infrastructure.

A layout plan for the proposed solar plant is shown in Figure 3.1.

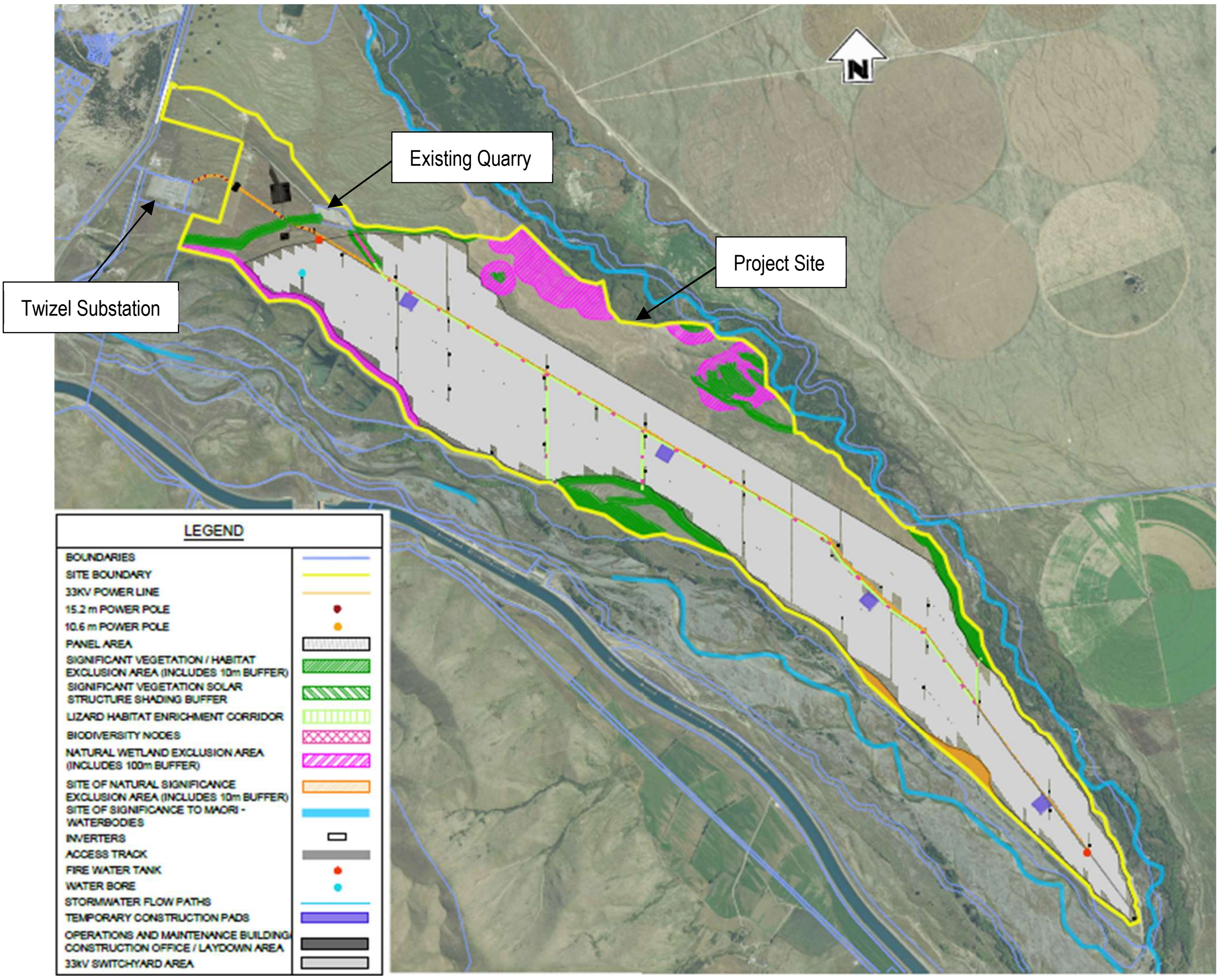


Figure 3.1: Layout Plan of proposed solar plant

3.4.1 Solar Panels

The panels are suspended off the ground surface and are an impervious material that allows water to run off them, down to what is described as the dripline.

However, the true distinction between an impervious surface and a pervious surface is determined by whether the soil is available to absorb rainfall or not. Rainfall that does not infiltrate becomes runoff and thus contributes to the surface water part of the hydrology cycle. The solar panels intercept rainfall before it comes into contact with the ground surface but does not affect the soil's ability to infiltrate water. Therefore, panels should be considered pervious, and not impervious in the same way a concrete or paved surface would.

The ability for rainfall to infiltrate in these conditions is equal to the pre-development state as the panels would not have any influence over the ponded water absorbing into the soil. The solar panels are supported by piles and result in a minor increase in impermeable surface area where natural infiltration and soakage processes take place.

The dripline location can cause concentrated erosion on sensitive materials, such as loose gravel soils. The impact of this erosion will be mitigated by maintaining grass coverage on the ground surface, discharge to ground, and the use of tilting solar arrays.

The proposed tilting solar panel arrays move from east to west with the sun. This operational mechanism allows maximum solar absorption, with the additional benefit of a moving dripline for erosion prevention. An example of the changing panel positions can be seen in photos taken from Nova's demonstration site at Rangitāiki, Figure 3.2 and Figure 3.3.

Figure 3.2: Rangitāiki Demonstration Array in the morning

Figure 3.3: Rangitāiki Demonstration Array at mid-day

On steeper areas, if some erosion occurs at the dripline, a shallow flat 'bunded' area may be utilised as velocity control to allow sediment to fall out before entering the downstream environment. This has been considered as part of the BTW *Concept Design Drawings – Preliminary Earthworks Plan - Drawing No. 210982-02 EW1* and will be monitored and modified if required, during operation of the solar plant.

The concept of the earthworks approach is to recontour areas (where required) to make gradients more gradual, rather than adjusting their overall average gradient or direction of stormwater flow paths or catchment areas. All earthworks that involve contouring work to optimise panel placement, will respect existing flow paths as much as possible. Panel array tolerance for slopes is approximately 15 degrees. In areas that are not deemed exclusions zones, earthworks may be required in some locations to reduce rate of change in gradients.

Following earthworks, rehabilitation of soils and grass strike will be monitored to ensure good coverage before stock grazing, in order to prevent degradation.

3.4.2 Site Access Track

The internal access track network will consist of a single main gravel access track central within the site. The tracks will be constructed using local gravels, sourced from the site quarry if possible, meaning that the permeability of the ground surface has similar potential for stormwater infiltration.

Furthermore, the site is located on relatively flat land with historic river braided channels and natural gravelly soils that are highly pervious with high infiltration rates and surface storage.

There are no streams or watercourses onsite that the access track will cross however it will cross many ephemeral flow paths, that although are not formalised will be embedded into the existing site topography. Further assessment is provided in Section 3.4.4 below.

Detailed design of the site access and flow path crossings will be completed at time of detailed design.

3.4.3 Operation and Maintenance Facility

The operations and maintenance facility will consist of a large single storey warehouse / workshop building and smaller office building complete with basic amenities. Figure 3.4 below shows a floor plan of the proposed buildings.

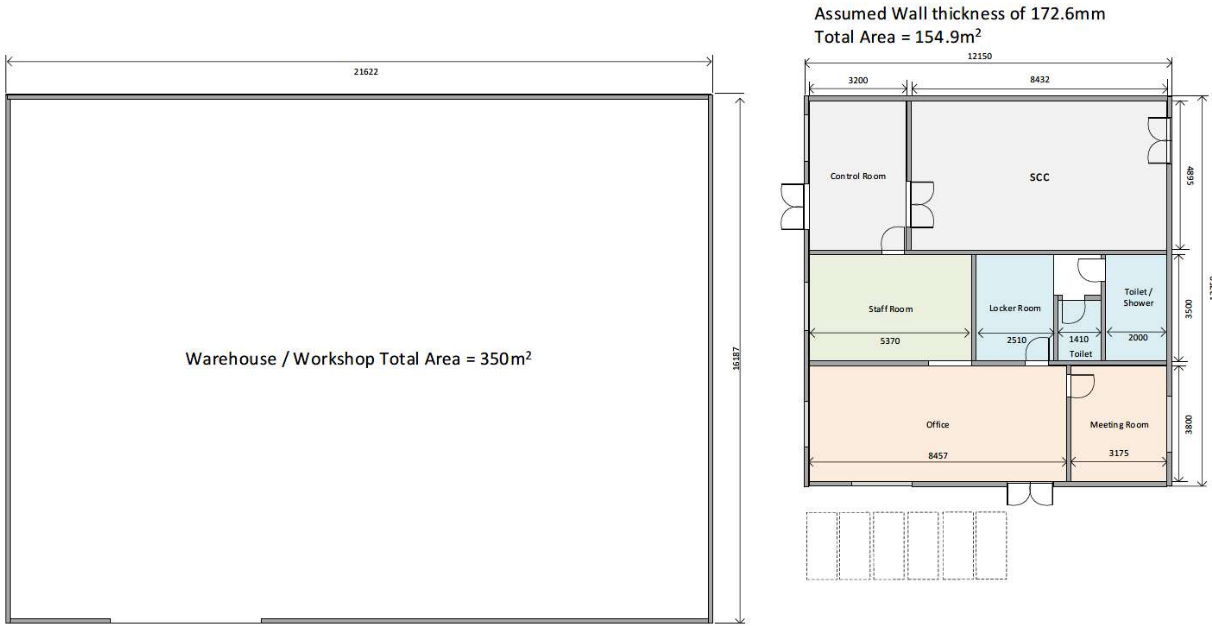


Figure 3.4: Layout plan of operations and maintenance buildings (Source: Nova)

A large gravel pavement area will also provide parking and an area in which to manoeuvre and maintain vehicles and machinery. An on-site refuelling station will be provided within a bunded area with spill containment measures to reduce the risk of accidental discharges. A hazard register will be maintained with annual recorded inspections to check that environmentally hazardous substances are stored and/or contained appropriately on the site.

Stormwater surface runoff will be directed via site grading to vegetated swale drains to provide water quality treatment prior to discharge over existing ground cover. Roof runoff will be collected in a storage tank for potable water offtake with any excess water discharged directly to existing overland flowpaths or to ground through soakage devices. The final stormwater infrastructure layout will be determined during detailed design.

3.4.4 Site Drainage

The site is without any formalised drainage system and infrastructure or watercourses.

The historic river braids are embedded within the finer grain of the site topography and form the basis of the existing site drainage system. As previously outlined, the natural gravelly soils are highly pervious with high infiltration rates and surface storage.

During light and minor rainfall events, runoff is generally captured at source and discharged directly to ground. During heavier larger periods of rainfall it is expected stormwater runoff will follow site grading and concentrate in the low points of the historic river braids.

The proposed solar project minimises landform modifications and utilises the natural site drainage system where possible. Landform changes may be required in high hazard flood areas as identified in the *Flood Risk Hazard Assessment.*

Minor modifications to the landform are proposed to form suitable access to enable construction and ongoing operation and maintenance access. Where the proposed site access intercepts the natural drainage system it is expected onsite drainage infrastructure will be required to maintain a suitable level of service for the site access.

Preliminary assessment has been undertaken to define site catchments and identify notable flow paths where formalised access crossings may be required and/or ponding depths and water velocities may require further assessment with detailed design.

Larger catchment areas and corresponding peak catchment flows have been calculated and are summarised in Table 3.2 and Table 3.3 below with full calculations attached in Appendix A. Calculations demonstrate that during major rainfall events the site is subject to reasonable flows with 1% AEP peak flow rates up to 5.7 m³/s (Catchment 1) which would likely result in surface ponding and flow velocities which may require further consideration during detailed design phases. It is noted in similar upstream areas where detailed flood modelling assessment has been completed that flow depths of approximately 0.5 m depth are observed in major design storm events.

The key catchments, flow paths, crossing locations, and areas within the solar array which may be subject to ponding and high flow velocities are shown in Figure 3.5.

Table 3.2: Catchment Analysis Summary

Catchment Area	Area (km^2)	Slope (%)	Length (km)	TOC (min)	Runoff Coefficient C	Rainfall Intensity RCP 6.0 2081-2100 2 year I_2 (mm/hr)	Rainfall Intensity RCP 6.0 2081-2100 10 year I_{10} (mm/hr)	Rainfall Intensity RCP 6.0 2081-2100 100 year I_{100} (mm/hr)
1	3.187	0.5	5.8	120	0.20 – 0.25	8.6	14.7	25.8
2	0.546	0.3	2.5	90	0.20 – 0.25	10.1	17.4	31.0
3	0.520	0.3	2.1	75	0.20– 0.25	10.9	18.7	33.5

Table 3.3: Peak Flow Results for RCP 6.0 2081 - 2100

Catchment Area	Peak Flow 50% AEP (m^3/s)	Peak Flow 10% AEP (m^3/s)	Peak Flow 1% AEP (m^3/s)
1	1.53	2.60	5.71
2	0.31	0.53	1.17
3	0.31	0.54	1.21

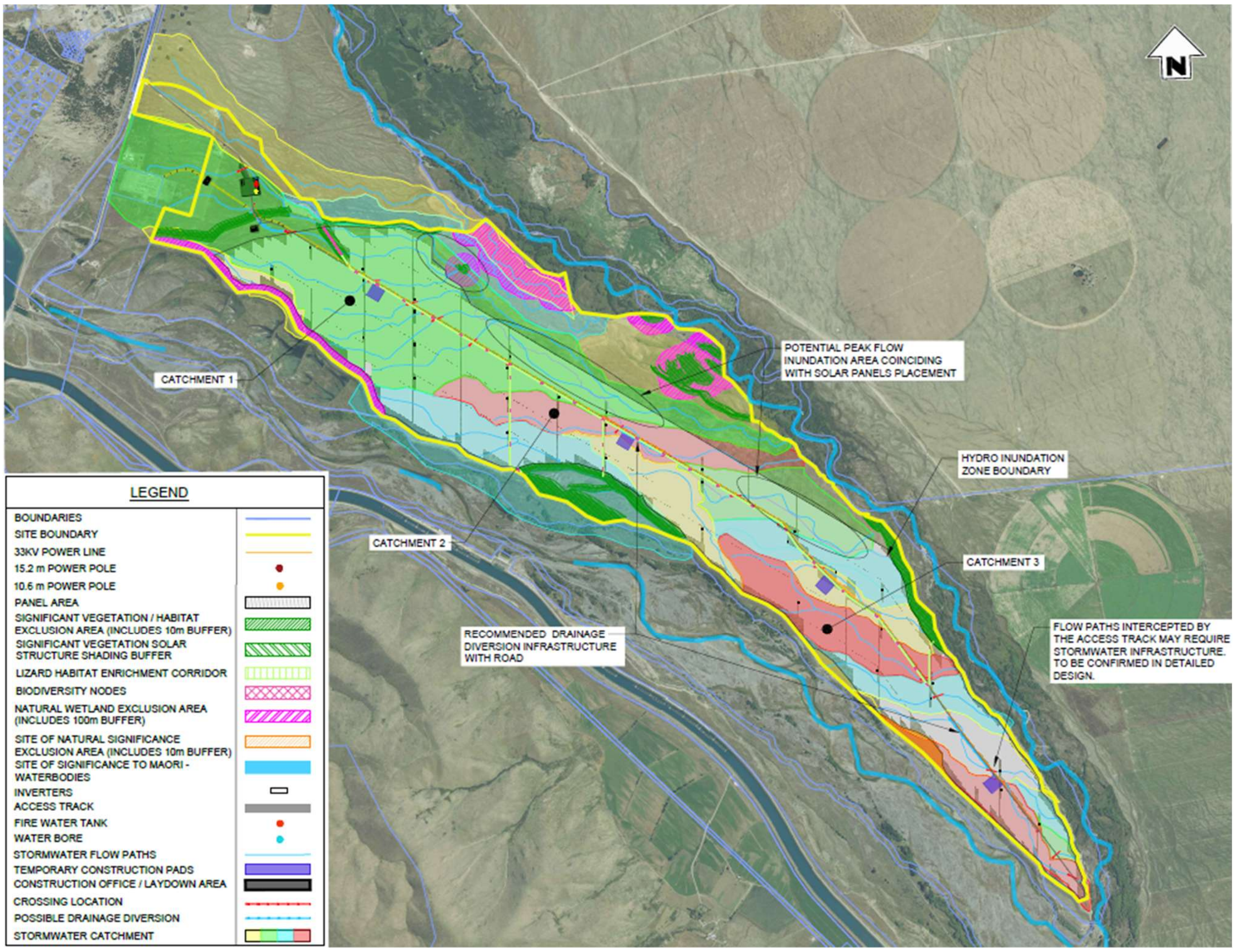


Figure 3.5: Catchment Areas and Potential Inundation Areas

It is recommended that further assessment should be undertaken during detailed design to inform the site drainage and design, define flow depths and velocities to determine any impacts on the solar array design.

3.4.5 Laydown Areas

Temporary construction facilities and laydown areas are required as part of the panel installation. Minor stripping of topsoils and minor regrading may be necessary to provide an all-weather functional surface. The existing subgrade soils may be adequate for all weather access or improvement layers from locally sourced materials will be added.

Runoff from laydown areas will be managed throughout construction with temporary erosion and sediment controls to ensure stormwater discharge is free of sediment and contaminants when discharging into the receiving environment. The proposed laydown areas shown in the BTW *Concept Design Drawings* are setback an appropriate distance away from sensitive receiving environments, including waterbodies and wetlands to provide opportunity for further filtering of site discharge through onsite vegetation.

3.4.6 Temporary Earthworks

Minor earthworks including trenching to run power cables from solar panels to inverters and transformers will be completed as panel arrays are installed. Works will be completed concurrently so that disturbed soils are rehabilitated as soon as practicable. Cut materials are to be stockpiled nearby and reused as fill, minimising bulk earthwork transportation and maintaining the hydrology of the soils. Grass seeding shall be completed at earliest opportunity and monitored to ensure successful germination.

Other temporary earthworks may include piling, temporary earth bunds and diversion channels.

All temporary earthworks shall be managed via an approved Erosion and Sediment Control Plan, which will include details of handling hazardous materials such as when refuelling, and contingency plans for potential spills.

3.4.7 Existing Natural Inland Wetland

A natural inland wetland has been identified on the northeastern and western edge of the site. The wetlands and upstream catchments are shown in Figure 3.6.

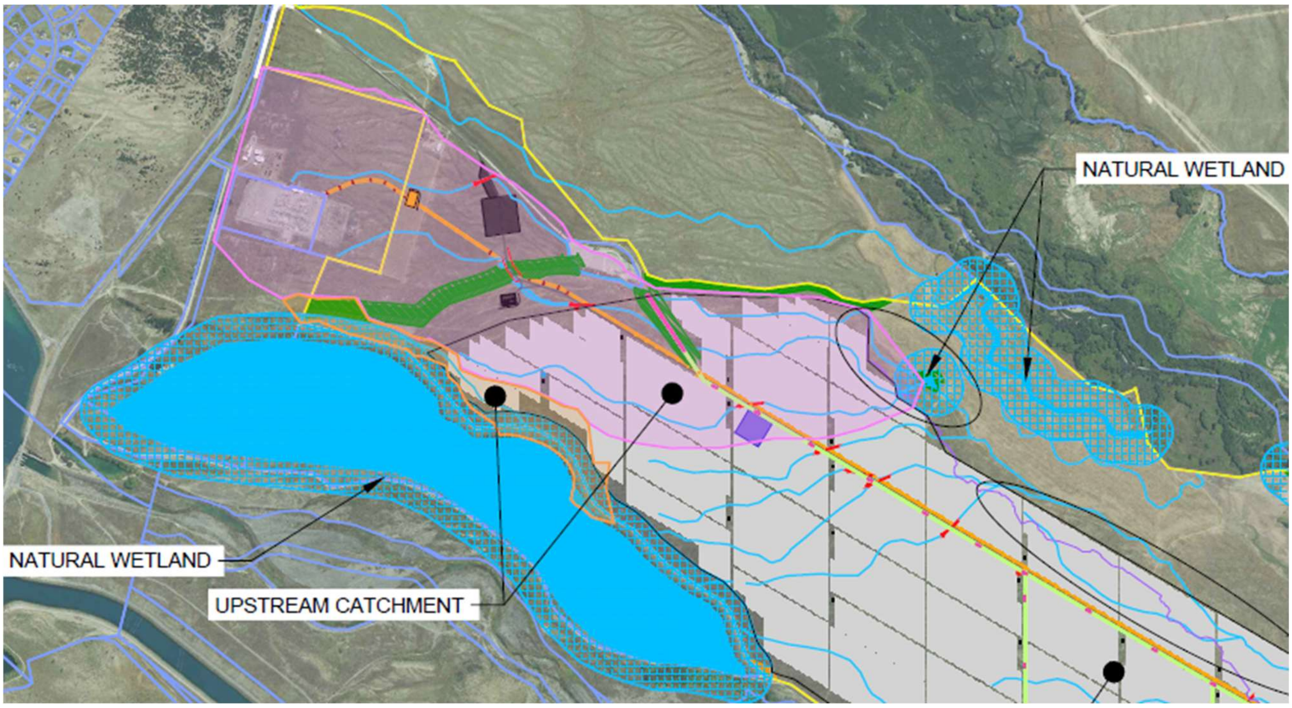


Figure 3.6: Natural Inland Wetland and upstream catchment area

The Project proposes minimum 100 m setbacks from natural wetlands. Site development works within the catchment of the natural wetland should protect the existing site hydrology. Detailed design of any roads, culverts and drainage infrastructure should ensure that the existing hydrology is maintained to ensure there are no adverse effects on the wetland.

There is opportunity for riparian planting and ecological enhancement works around the upstream reaches of these wetlands to further enhance water quality.

3.4.8 Flood Hazard Protection

Where the Flood Hazard Risk Assessment has identified high flood hazard areas, natural hazard mitigation works could be undertaken to reduce flow depths and velocities, stabilise the landform and reduce the hazard classification. A combination of the following mitigation works is proposed within the *Flood Hazard Risk Assessment* (BTW, 2026) and is duplicated below:-

Design of the solar infrastructure to be resilient to flood hazard as far as is practicable.

- Solar panels are elevated on piles with a minimum ground clearance of 800 mm. They can be remotely tracked to increase ground clearance to up to 1.85 m in a severe weather event.
- Inverters, the workshop and the operations and maintenance buildings will be elevated at least 300 mm above the 500-year ARI flood level.
- Scour is anticipated to be negligible on the site as the modelled flow velocities on the site are less than 2.0 m/s.
- Undertake physical works and engineering interventions to reduce flow depths and velocities and reduce the hazard classification to ensure the protection of structures, the stability of the landform and to improve safety of access for people and vehicles. Example works include:
  - Minor earthworks to level the historic river braids, spreading concentrated flows and reducing flood depths and velocities.
  - Install drainage infrastructure such as pipes and channels reducing flood depths and velocities.
  - Install culverts, drainage channels and regrading of land at proposed new access road location through borrow pit. This would decrease flow depths and velocities on the road itself.

The site is located within the MDP - Flood Hazard Assessment Overlay. To comply with NH-S1 of the Plan it is proposed that the workshop and operations and maintenance building floor levels (natural hazard sensitive buildings) are elevated to a height of 300 mm above the assessed 500-year ARI flood water levels.

Stormwater infrastructure shall comply with Clause E1 - Surface Water of the New Zealand Building Code to safeguard people from injury or illness, and other property from damage caused by surface water, and protect the outfalls of drainage systems. This includes:-

- Surface water, resulting from a 10% AEP storm event which is collected or concentrated by the buildings or sitework, shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property.
- Drainage systems for the disposal of surface water shall be constructed to convey surface water to an appropriate outfall using gravity flow where possible, and avoid the likelihood of blockages or leakage, penetration by roots, or the entry of ground water where pipes or lined channels are used.
- Provide reasonable access for maintenance and clearing blockages, avoid the likelihood of damage to any outfall, in a manner acceptable to the network utility operator, and avoid the likelihood of damage from superimposed loads or normal ground movements.

3.4.9 Site Restoration

Rapid stabilisation and restoration of ground cover following construction activities will be undertaken. The grass seeding mix and application shall be determined from site analysis to match pre-existing vegetative ground cover.

4 CONCLUSIONS

This SMP outlines a technically sound and workable stormwater management strategy, that provides flood protection and stormwater management for the proposed development in accordance with the requirements of the NPS-FM, the NES-F, the MDP, the CLWRP, and best environmental practice.

The stormwater management strategy has been developed to ensure that the proposed development gives effect to Te Mana o Te Wai by prioritising the health and well-being of the receiving waterbodies and ecosystems.

Throughout the construction phase all works will be undertaken under a ECan certified ESCP to mitigate effects of the works on the environment.

Throughout the operational phase the pasture cover within the footprint of the solar plant should be maintained. The natural gravelly soils will remain highly pervious with high infiltration rates and surface storage. The existing land drainage network will largely be maintained and any onsite effects of modifications to flow paths (from roads or other infrastructure) and associated risk of erosion and sediment deposition shall be addressed in the detail design phase through specification of appropriate drainage infrastructure.

Drainage infrastructure that may be used at the site includes:

- Minor earthworks to level the historic river braids, spreading concentrated flows and reducing flood depths and velocities
- Installation of pipes and channels to reduce flood depths and velocities.
- Installation of culverts, drainage channels and regrading of land at proposed new access track location through the borrow pit.
- Vegetated swales to capture runoff from hardstand areas and provide water quality treatment
- Rip rap structures to reduce velocities and provide erosion protection.

Overall, the site general hydrology and drainage network will undergo minimal change. The proposed solar plant minimises landform modifications and utilises the natural site drainage system where possible. Recommendations from the Flood Risk Hazard Assessment is that any floor levels of natural hazard sensitive buildings and solar panel infrastructure should be elevated to a height of 300 mm above the assessed 500-year ARI flood water levels.

Identified High Hazard Flood Areas will be largely avoided with any risk to infrastructure able to be addressed through site grading to lower water depths and velocities to an acceptable risk level.

Site catchments, internal flow paths and associated drainage infrastructure, as well as possible ponding areas are indicated on BTW Stormwater Catchment Plan, provided in Appendix B, for further consideration during detailed design phases.

5 RECOMMENDATIONS

The following recommendations are provided:

- Controls are required throughout the construction phase to mitigate construction effects on the receiving environment. The BTW Erosion and Sediment Control Plan addresses runoff management and sediment discharge mitigation during construction, and should be read alongside this report, along with the supporting plans and reports referenced. All construction works should be undertaken in accordance with the ECan certified Erosion and Sediment Control Plan.
- At detailed design phase the appropriate drainage infrastructure should be specified to mitigate any onsite effects of modifications to flow paths (from roads or other infrastructure) and the associated risk of erosion and sediment deposition during a design storm.
- Site development works within the catchment of the natural wetlands should maintain the existing site hydrology. Detailed design of any roads, culverts and drainage infrastructure should ensure that the existing hydrology is maintained.
- Opportunities should be explored for riparian planting and ecological enhancement in the upstream reaches of the natural wetlands which may provide improvements to runoff quality via additional water quality treatment and filtering.

APPENDIX A CALCULATIONS

HIRDS V4 Intensity-Duration-Frequency Results
Sitename: TWIZEL SUBSTATION
Site ID: H40212
Coordinate system: NZGD1949
Longitude: 170.098
Latitude: -44.277

DDF Model Parameter:	c	d	e	f	g	h	i
Values:	-0.013229	0.59938	-0.008859	-0.0065	0.307256	-0.008797	2.157719
Example:	Duration (h	ARI (yrs)	x	y	Rainfall Rate (mm/hr)		
	24	100	3.178054	4.600149	5.054435		

Rainfall intensities (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	17.9	13.4	11.4	8.65	6.51	3.95	2.74	1.8	1.1	0.797	0.622	0.508
2	0.5	20.2	15.1	12.8	9.67	7.25	4.38	3.03	1.98	1.21	0.873	0.681	0.555
5	0.2	28.8	21.3	18	13.4	9.98	5.93	4.05	2.62	1.59	1.14	0.884	0.719
10	0.1	36	26.5	22.2	16.5	12.2	7.15	4.86	3.12	1.88	1.34	1.04	0.842
20	0.05	44.3	32.3	27	19.9	14.6	8.49	5.73	3.66	2.18	1.55	1.2	0.971
30	0.033	49.6	36	30.1	22.1	16.1	9.33	6.27	3.99	2.37	1.68	1.3	1.05
40	0.025	53.6	38.9	32.4	23.8	17.3	9.95	6.67	4.23	2.51	1.78	1.37	1.11
50	0.02	56.9	41.2	34.3	25.1	18.2	10.4	6.99	4.43	2.62	1.86	1.43	1.15
60	0.017	59.7	43.1	35.8	26.2	19	10.9	7.26	4.59	2.71	1.92	1.47	1.19
80	0.013	64.3	46.3	38.5	28	20.3	11.5	7.69	4.85	2.85	2.02	1.55	1.25
100	0.01	68.1	48.9	40.6	29.5	21.3	12.1	8.04	5.05	2.97	2.1	1.61	1.3
250	0.004	85	60.6	50	36.1	25.8	14.5	9.53	5.94	3.46	2.43	1.86	1.49

Intensity standard error (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	3.8	2.6	1.9	1.7	1.2	0.81	0.64	0.26	0.16	0.12	0.09	0.048
2	0.5	4.3	2.9	2.2	1.9	1.3	0.89	0.7	0.29	0.17	0.13	0.1	0.054
5	0.2	6.4	4.2	3.2	2.5	1.7	1.2	0.91	0.4	0.24	0.18	0.14	0.075
10	0.1	8.4	5.6	4.4	3.1	2.2	1.4	1.1	0.49	0.29	0.21	0.16	0.094
20	0.05	11	7.5	6	3.8	2.7	1.7	1.3	0.59	0.35	0.25	0.2	0.12
30	0.033	13	9	7.2	4.4	3.1	1.9	1.4	0.65	0.39	0.28	0.22	0.13
40	0.025	15	10	8.3	4.8	3.5	2.1	1.5	0.7	0.42	0.3	0.23	0.15
50	0.02	16	11	9.2	5.2	3.8	2.2	1.6	0.75	0.45	0.32	0.25	0.16
60	0.017	18	12	10	5.6	4	2.3	1.7	0.78	0.47	0.33	0.26	0.17
80	0.013	20	14	12	6.2	4.5	2.5	1.8	0.84	0.51	0.35	0.28	0.18
100	0.01	22	16	13	6.7	4.9	2.7	2	0.89	0.54	0.37	0.3	0.19
250	0.004	33	25	20	9.6	7	3.6	2.5	1.1	0.69	0.47	0.38	0.26

Rainfall intensities (mm/hr) :: RCP6.0 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	19.3	14.5	12.3	9.35	7	4.2	2.89	1.88	1.14	0.825	0.642	0.524
2	0.5	21.9	16.3	13.8	10.5	7.83	4.67	3.2	2.08	1.26	0.906	0.705	0.573
5	0.2	31.3	23.2	19.5	14.6	10.8	6.35	4.31	2.76	1.66	1.19	0.919	0.745
10	0.1	39.3	28.8	24.2	18	13.2	7.68	5.17	3.29	1.96	1.4	1.08	0.874
20	0.05	48.3	35.2	29.4	21.7	15.9	9.13	6.1	3.86	2.29	1.62	1.25	1.01
30	0.033	54.1	39.3	32.8	24.1	17.6	10	6.69	4.21	2.49	1.76	1.35	1.09
40	0.025	58.5	42.4	35.3	25.9	18.8	10.7	7.12	4.47	2.63	1.86	1.43	1.15
50	0.02	62.2	44.9	37.4	27.4	19.8	11.3	7.46	4.68	2.75	1.94	1.49	1.2
60	0.017	65.2	47.1	39.1	28.6	20.7	11.7	7.75	4.85	2.84	2.01	1.54	1.24
80	0.013	70.3	50.6	42	30.6	22.1	12.4	8.21	5.13	3	2.11	1.62	1.3
100	0.01	74.4	53.4	44.3	32.2	23.2	13	8.59	5.35	3.12	2.2	1.68	1.35
250	0.004	92.9	66.2	54.6	39.4	28.1	15.6	10.2	6.29	3.64	2.55	1.94	1.56

Rainfall intensities (mm/hr) :: RCP6.0 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	75min	90min	2h	6h	12h	24h	48h	72h
1.58	0.633	21.4	16	13.6	10.3	9.65	9	7.7	4.55	3.09	2	1.21	0.864
2	0.5	24.2	18.1	15.3	11.6	10.86	10.12	8.64	5.08	3.44	2.21	1.33	0.952
5	0.2	34.8	25.7	21.7	16.3	15.225	14.15	12	6.94	4.66	2.96	1.76	1.25
10	0.1	43.7	32.1	27	20	18.675	17.35	14.7	8.41	5.61	3.53	2.09	1.48
20	0.05	53.8	39.3	32.8	24.3	22.65	21	17.7	10	6.63	4.15	2.44	1.72
30	0.033	60.4	43.9	36.6	27	25.125	23.25	19.5	11	7.27	4.53	2.65	1.87
40	0.025	65.4	47.3	39.5	29	26.975	24.95	20.9	11.8	7.75	4.81	2.81	1.98
50	0.02	69.5	50.2	41.8	30.6	28.475	26.35	22.1	12.4	8.12	5.03	2.93	2.06
60	0.017	72.9	52.6	43.7	32	29.75	27.5	23	12.9	8.44	5.22	3.03	2.13
80	0.013	78.6	56.6	47	34.3	31.875	29.45	24.6	13.7	8.94	5.52	3.2	2.25
100	0.01	83.2	59.7	49.5	36.1	33.525	30.95	25.8	14.4	9.36	5.76	3.33	2.33
250	0.004	104	74	61.1	44.1	40.9	37.7	31.3	17.2	11.1	6.78	3.89	2.71

CATCHMENT 1 - VERIFICATION METHOD E1/VM1 - RURAL STORMWATER DESIGN

Calculate the Slope
Modified Taylor-Schwarz Method

Elevation (m)	Length (m)	Slope (S_i)	$L_i/\sqrt{S_i}$
416.00			
417.30	200	0.01	2,481
418.80	200	0.01	2,309
420.10	200	0.01	2,481
421.20	200	0.01	2,697
422.10	200	0.00	2,981
423.10	200	0.01	2,828
423.90	200	0.00	3,162
424.70	200	0.00	3,162
425.70	200	0.01	2,828
426.60	200	0.00	2,981
427.50	200	0.00	2,981
428.60	200	0.01	2,697
428.80	200	0.00	6,325
430.00	200	0.01	2,582
430.80	200	0.00	3,162
432.30	200	0.01	2,309
433.00	200	0.00	3,381
433.50	200	0.00	4,000
434.90	200	0.01	2,390
435.80	200	0.00	2,981
437.10	200	0.01	2,481
438.50	200	0.01	2,390
447.20	200	0.04	959
448.30	200	0.01	2,697
450.00	200	0.01	2,169
451.50	200	0.01	2,309
453.30	200	0.01	2,108
455.70	200	0.01	1,826
458.10	200	0.01	1,826
	5,800		79,486

Slope = 0.005 m/m

Time of Concentration

Length	5.8	Km
Area	3.187	Km²
ΔH	42.10	m
Slope	0.005	m/m

Bransby-William Formula (Up to 500ha)
T_c 199 minutes

Ramser-Kirpich
T_c 116 minutes

U.S. Soil Conservation Service
T_c 103 minutes

RATIONAL METHOD:

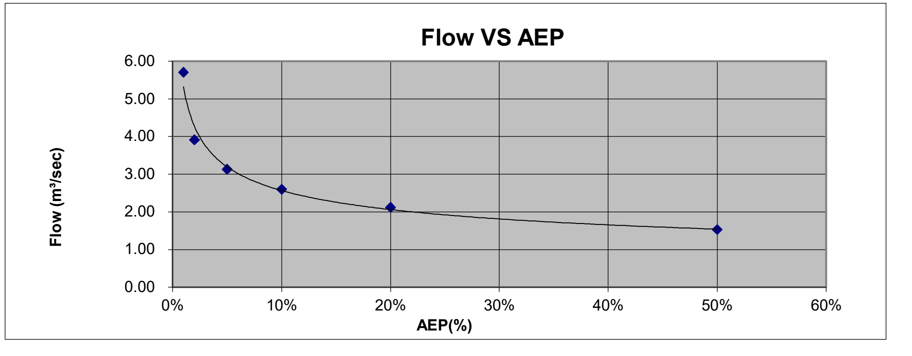
Q_c = $CIA_c/360$
where
Q_c = catchment run-off (m³/s).
C = run-off coefficient (see Table 1).
I = rainfall intensity (mm/hr).
A_c = area (hectares) of catchment above the point being considered.

Catchment Characteristics	Runoff-Producing Characteristics					
Rainfall Intensity	(0.05) Rainfall intensity less than 25 mm/hr					
Relief	(0.0) Relatively flat land with average slope 0 - 5%					
Surface Retention	(0.00) Poorly defined & meandering stream courses; large surface storage					
Infiltration	(0.05) Deep sands or well aggregated soils;					
Cover	(0.10) About 50% of area with improved pasture; not more than 50% cultivation, open scrub					
Modified C Value	0.20	0.20	0.20	0.20	0.20	0.25

Waugh, J.R. 1972. Report on the use of Technical Memorandum No. 61 (3rd Rev.) For estimating flood peak discharge for small rural catchments in the Northland-Auckland area. Water and Soil Diversion, Ministry of Works and Development, 10p.

AEP	50%	20%	10%	5%	2%	1%
I (mm/hr)	8.6	12.0	14.7	17.7	22.1	25.8
Modified C Value	0.20	0.20	0.20	0.20	0.20	0.25
Catchment Area (m²)	3187000	3187000	3187000	3187000	3187000	3187000
Q (m³/sec) = CIA	1.53	2.12	2.60	3.13	3.91	5.71

Hirds Data using Tc = 120mins



PROJECT: Twizel Solar
JOB NUMBER: 210982
LOCATION: Twizel
SITE: Solar Farm

DESIGNED: G.Hale DATE: 1/11/24
CHECKED: S.Husband DATE: 1/11/24

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CATCHMENT 2 - VERIFICATION METHOD E1/VM1 - RURAL STORMWATER DESIGN

Calculate the Slope
Modified Taylor-Schwarz Method

Elevation (m)	Length (m)	Slope (S_i)	$L_i/\sqrt{S_i}$
415.80			
416.80	100	0.01	1,000
417.30	100	0.01	1,414
418.10	100	0.01	1,118
418.11	100	0.00	10,000
418.70	100	0.01	1,302
419.30	100	0.01	1,291
419.50	100	0.00	2,236
420.50	100	0.01	1,000
421.00	100	0.01	1,414
421.20	100	0.00	2,236
421.50	100	0.00	1,826
422.20	100	0.01	1,195
422.80	100	0.01	1,291
423.20	100	0.00	1,581
423.70	100	0.01	1,414
423.80	100	0.00	3,162
424.50	100	0.01	1,195
424.90	100	0.00	1,581
425.40	100	0.01	1,414
425.90	100	0.01	1,414
426.70	100	0.01	1,118
427.30	100	0.01	1,291
428.30	100	0.01	1,000
428.70	100	0.00	1,581
429.00	100	0.00	1,826
	2,500		45,902

Slope = 0.003 m/m

Time of Concentration

Length	2.5	Km
Area	0.546	Km²
ΔH	13.20	m
Slope	0.003	m/m

Bransby-William Formula (Up to 500ha)
T_c 109 minutes

Ramser-Kirpich
T_c 76 minutes

U.S. Soil Conservation Service
T_c 61 minutes

RATIONAL METHOD:

$Q_c = CIA_c/360$

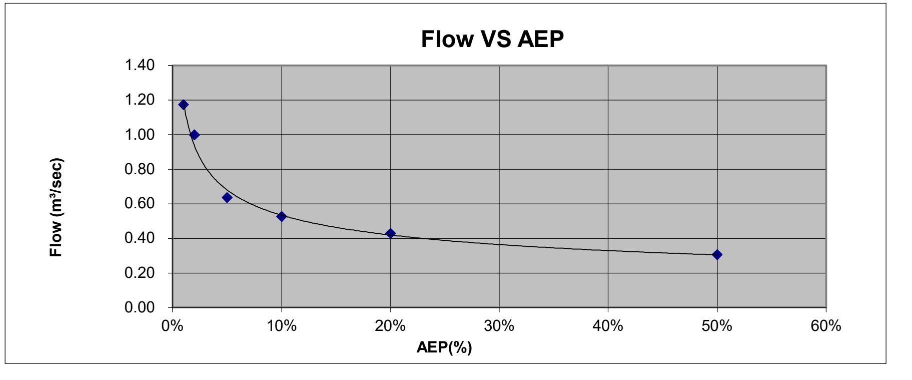
where

Q_c = catchment run-off (m³/s).
C = run-off coefficient (see Table 1).
I = rainfall intensity (mm/hr).
A_c = area (hectares) of catchment above the point being considered.

Catchment Characteristics	Runoff-Producing Characteristics					
Rainfall Intensity	(0.05) Rainfall intensity less than 25 mm/hr					
Relief	(0.0) Relatively flat land with average slope 0 - 5%					
Surface Retention	(0.00) Poorly defined & meandering stream courses; large surface storage					
Infiltration	(0.05) Deep sands or well aggregated soils;					
Cover	(0.10) About 50% of area with improved pasture; not more than 50% cultivation, open scrub					
Modified C Value	0.20	0.20	0.20	0.20	0.25	0.25

Waugh, J.R. 1972. Report on the use of Technical Memorandum No. 61 (3rd Rev.) For estimating flood peak discharge for small rural catchments in the Northland-Auckland area. Water and Soil Diversion, Ministry of Works and Development, 10p.

AEP	50%	20%	10%	5%	2%	1%	
I (mm/hr)	10.1	14.2	17.4	21.0	26.4	31.0	Hirds Data using Tc = 90mins
Modified C Value	0.20	0.20	0.20	0.20	0.25	0.25	
Catchment Area (m²)	546000	546000	546000	546000	546000	546000	
Q (m³/sec) = CIA	0.31	0.43	0.53	0.64	1.00	1.17	



PROJECT: Twizel Solar
JOB NUMBER: 210982
LOCATION: Twizel
SITE: Solar Farm

DESIGNED: G.Hale DATE: 1/11/24
CHECKED: S.Husband DATE: 1/11/24

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CATCHMENT 3 - VERIFICATION METHOD E1/VM1 - RURAL STORMWATER DESIGN

Calculate the Slope
Modified Taylor-Schwarz Method

Elevation (m)	Length (m)	Slope (S_i)	$L_i/\sqrt{S_i}$
403.40			
404.10	100	0.01	1,195
404.25	100	0.00	2,582
404.26	100	0.00	10,000
405.40	100	0.01	937
406.00	100	0.01	1,291
406.60	100	0.01	1,291
407.90	100	0.01	877
408.10	100	0.00	2,236
408.70	100	0.01	1,291
409.50	100	0.01	1,118
410.20	100	0.01	1,195
410.40	100	0.00	2,236
411.80	100	0.01	845
412.50	100	0.01	1,195
412.80	100	0.00	1,826
413.50	100	0.01	1,195
413.80	100	0.00	1,826
414.10	100	0.00	1,826
414.60	100	0.01	1,414
415.20	100	0.01	1,291
415.90	100	0.01	1,195
	2,100		38,863

Slope = 0.003 m/m

Time of Concentration

Length	2.1	Km
Area	0.520	Km²
ΔH	12.50	m
Slope	0.003	m/m

Bransby-William Formula (Up to 500ha)
T_c 90 minutes

Ramser-Kirpich
T_c 67 minutes

U.S. Soil Conservation Service
T_c 51 minutes

RATIONAL METHOD:

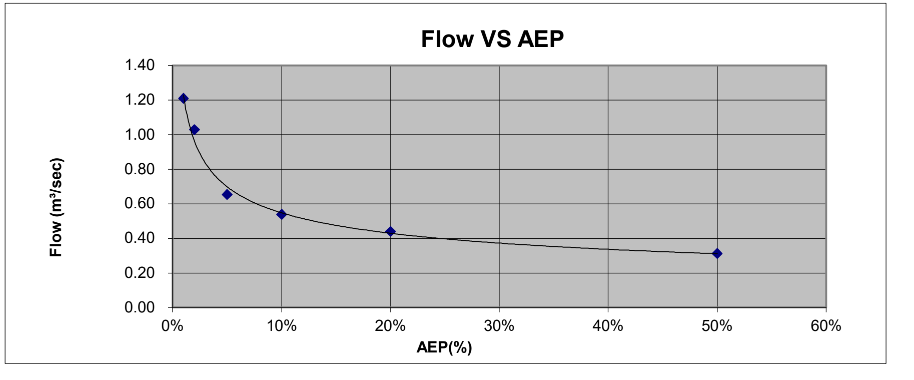
Q_c = $CIA_c/360$
where
Q_c = catchment run-off (m³/s).
C = run-off coefficient (see Table 1).
I = rainfall intensity (mm/hr).
A_c = area (hectares) of catchment above the point being considered.

Catchment Characteristics	Runoff-Producing Characteristics
Rainfall Intensity	(0.05) Rainfall intensity less than 25 mm/hr
Relief	(0.0) Relatively flat land with average slope 0 - 5%
Surface Retention	(0.00) Poorly defined & meandering stream courses; large surface storage
Infiltration	(0.05) Deep sands or well aggregated soils;
Cover	(0.10) About 50% of area with improved pasture; not more than 50% cultivation, open scrub

Modified C Value	0.20	0.20	0.20	0.20	0.25	0.25

Waugh, J.R. 1972. Report on the use of Technical Memorandum No. 61 (3rd Rev.) For estimating flood peak discharge for small rural catchments in the Northland-Auckland area. Water and Soil Diversion, Ministry of Works and Development, 10p.

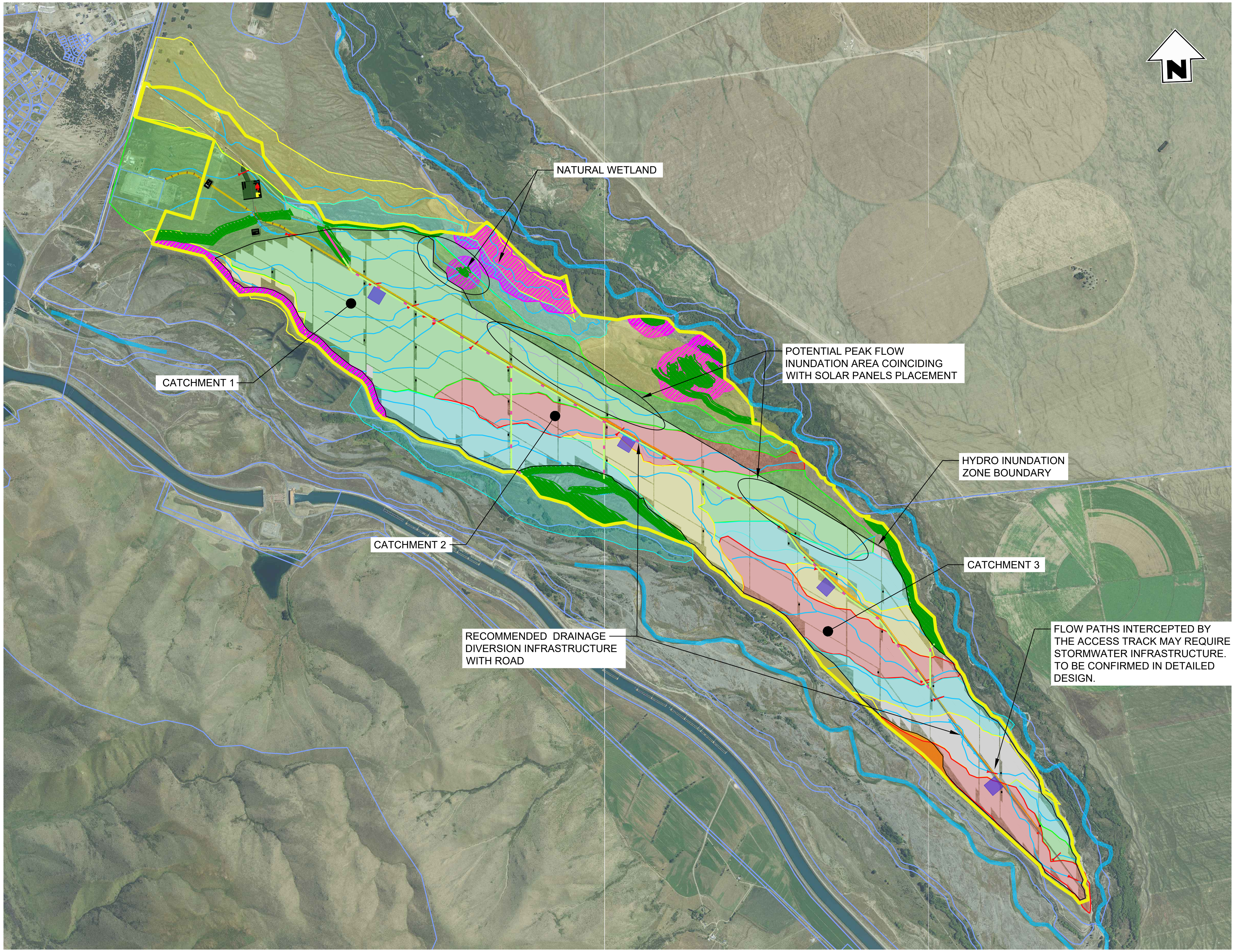
AEP	50%	20%	10%	5%	2%	1%	
I (mm/hr)	10.9	15.2	18.7	22.7	28.5	33.5	Hirds Data using Tc = 75mins
Modified C Value	0.20	0.20	0.20	0.20	0.25	0.25	
Catchment Area (m²)	520000	520000	520000	520000	520000	520000	
Q (m³/sec) = CIA	0.31	0.44	0.54	0.65	1.03	1.21	



APPENDIX B CATCHMENT PLAN

LEGEND

- BOUNDARIES
- SITE BOUNDARY
- 33KV POWER LINE
- 15.2 m POWER POLE
- 10.6 m POWER POLE
- PANEL AREA
- SIGNIFICANT VEGETATION / HABITAT EXCLUSION AREA (INCLUDES 10m BUFFER)
- SIGNIFICANT VEGETATION SOLAR STRUCTURE SHADING BUFFER
- LIZARD HABITAT ENRICHMENT CORRIDOR
- BIODIVERSITY NODES
- NATURAL WETLAND EXCLUSION AREA (INCLUDES 100m BUFFER)
- SITE OF NATURAL SIGNIFICANCE EXCLUSION AREA (INCLUDES 10m BUFFER)
- SITE OF SIGNIFICANCE TO MAORI - WATERBODIES
- INVERTERS
- ACCESS TRACK
- FIRE WATER TANK
- WATER BORE
- STORMWATER FLOW PATHS
- TEMPORARY CONSTRUCTION PADS
- CONSTRUCTION OFFICE / LAYDOWN AREA
- CROSSING LOCATION
- POSSIBLE DRAINAGE DIVERSION
- STORMWATER CATCHMENT



DRAFT

300 0 300 600 900 1200 1500m

SCALE 1 : 30,000

PLAN
SCALE 1:30000

Disclaimer:
Areas and dimensions may be subject to scale error.
Scaling from this drawing is at the users risk.

BTW COMPANY

SURVEYING
ENGINEERING
PLANNING
ENVIRONMENT

NO	DATE	BY	CHKD.	APPR.	OPER.	DESCRIPTION
WD1	19.02.26	GH	SH	.	.	ISSUED FOR COMMENT

REVISIONS

NUMBER	TITLE

REFERENCE DRAWINGS

GENERAL NOTES
1. Coordinates in terms of : New Zealand Transverse Mercator Projection
2. Elevations in terms of : NA
3. Contour interval is : NA

LOCATION	TWIZEL	
PROJECT No.	210982	
A3 SCALE	1:30000	
SURVEYED	-	-
DRAWN	J.STEPHENSON	09/2024
CHECKED	-	-

TITLE
NOVA ENERGY LTD
SOLAR FARM - LOT 3 DP 422901
STORMWATER CATCHMENT PLAN

ORIGINAL SIZE	DRAWING No	SHEET	REVISION
A3	210982-03	01	WD

File Name: C:\12d\S\data\BTW12D\210982 - Todd Generation Taranaki Ltd_3679\07 Drawings\210982.00-02 Base drawing.dwg - CATCHMENT PLAN Plot Date: 03/06/2026 Plot Time: 08:45