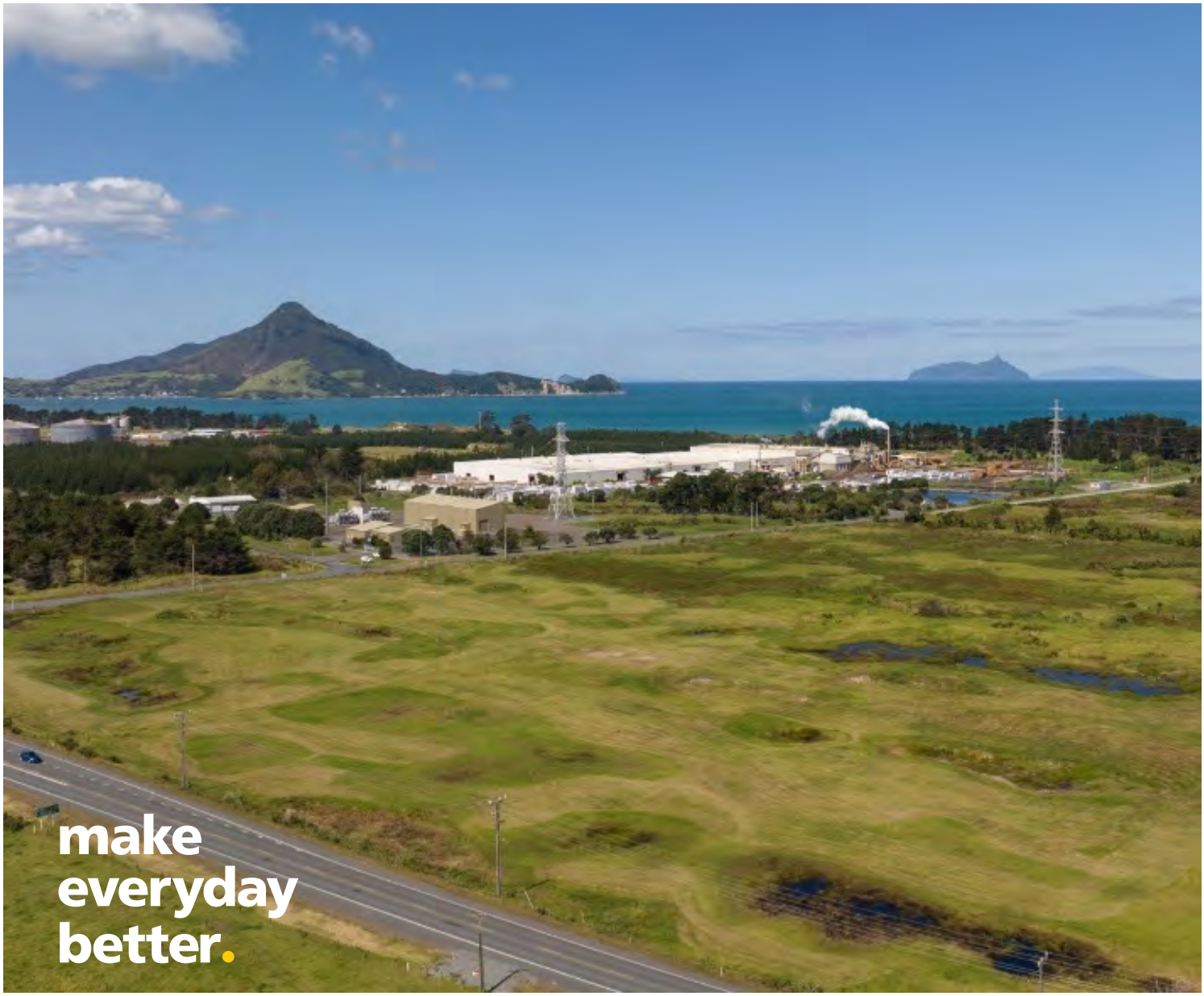
APPENDIX 8

Civil Design Report

Ruakākā Energy Park Solar Farm Consent Design

Prepared for Meridian Energy Ltd
Prepared by Beca Limited

28 August 2023



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Revision History

Revision Nº	Prepared By	Description	Date
A	Justin Kirkman	Issue for Client Review	01/06/2023
B	Victoria Whyte	Issue for Resource Consent	07/07/2023
C	Justin Kirkman	Issue for Resource Consent	04/08/2023
D	Justin Kirkman	Updated with client comments	15/08/2023
E	Isaac Kenny	Updates to Table 2	28/08/2023

Document Acceptance

Action	Name	Signed	Date
Prepared by	Justin Kirkman		15/08/2023
Reviewed by	Jacob Steenkamp		15/08/2023
Approved by	Alex Aramakutu		28/08/2023
on behalf of	Beca Limited		

Executive Summary

Meridian Energy Ltd has plans to develop three sites in the Ruakākā area with solar generation, maintenance, and energy transmission infrastructure. The civil infrastructure works associated with the development are discussed within this report. The development comprises three sites, each are located to the south of Marsden Point and are situated within the Northland Regional Council and Whangārei District Council local government jurisdictions.

Each site comprises solar arrays with supporting infrastructure such as power inverters, internal roads, underground cables, perimeter planting, fencing, culverts, drainage channels and wetlands for ecological offset mitigation. The sites have been designed to balance the project goal of constructing arrays of solar panels on three sites, with the environmental impact and best use of land within each site's unique constraints and opportunities.

Site 1 is close to the previously consented Battery Energy Storage Site (BESS) and the Bream Bay Substation (BBS). The Site 1 area has been mapped by the project ecologist and contains areas of wetland vegetation, open water and Kanuka Trees.

Site 2 is relatively flat land and on high ground, with the majority being at or above RL 8.0m. This site is the least flood prone of the three sites with minimal wetlands identified by the ecologist. The solar coverage on this site is not impeded by overhead lines, underground pipes or wetlands. The site does have important open channels to maintain for regional stormwater management.

Site 3 is a mostly flood prone land block with the lowest elevation being RL 1.5m. The southern part of Site 3 is the deepest and the most flood prone, making it the most ideal location for a wetland to offset the affected wetland areas from Site 1. Additionally, overhead power lines in Site 3 occupy the southern end. The northern part of Site 3 is available for solar if the deep flood waters can be accommodated in the solar panel supporting structure design.

All three sites will require full site earthmoving activity to flatten the terrain and make it suitable for solar infrastructure. This earthmoving will be carried out with erosion and sediment controls in place. An indicative erosion and sediment control plan has been prepared as separate from this report.

The development sites will remain fully pervious to rainfall infiltrating into the ground as the majority of internal roads will be made from compacted gravel material, with the solar panels elevated off the ground on a support rack for mounting. As a result, no additional retention, detention and attenuation has been allowed for in the consent design. A rationale for this conclusion is discussed in detail within this report.

Water quality effects are not expected as a result of the new solar infrastructure as the surfaces will not produce contaminants for mobilisation. Furthermore, the runoff will flow overland as sheet flow across shallow grades and flat grassed land. This process will filter and entrain any atmospheric sediments suspended in the stormwater runoff.

An ecological offset wetland will be constructed in the southern part of Site 3 where the deepest flooding is expected, this wetland will offset the loss of wetland features on all 3 sites and enhance the natural amenity of the Bream Bay College and the Ruakākā Town Centre adjacent land. Another offset wetland will be included on Site 1 enhancing the current open water wetland in the southern corner.

Operation erosion effects have been considered in this design and indicative countermeasures are proposed at culvert inlets and outlets. Rainfall dripping off the panels along the dripline presents a minor risk of erosion where the ground beneath the dripline is not protected. The establishment of grass is expected to cushion the impact of dripping water and prevent erosion from taking place. As an adaptive measure, a regular

inspection of the driplines may be adopted as part of routine maintenance and gravel may be placed in areas showing signs of erosion.

All required infrastructure (wastewater, potable water, electricity) are located within connection distance to the site where needed, although this development will have low demand on these services.

1 Introduction

1.1 Background

This report provides supporting information for a resource consent application on behalf of Meridian Energy Ltd (**"Meridian"**) for a Solar Farm development in Ruakākā, New Zealand (**"The Project"**). The civil infrastructure works associated with the development are discussed within this report.

The Project covers three sites, referred to as Site 1, Site 2 and Site 3 as shown in Figure 1. Site 1 is located to the south of Marsden Point and Sites 2 and 3 are further south of Site 1. All three sites are located within the Northland Regional Council (**"NRC"**) and Whangārei District Council (**"WDC"**) jurisdictions. Each site comprises solar arrays with supporting infrastructure such as power inverters, internal roads, underground cables, perimeter planting and/or bunding where required by the district plan, culverts, drainage channels and wetlands for ecological offset mitigation. The sites are surrounded by emerging developments including Ruakākā town centre enhancements and new residential areas. The sites are considered greenfield and undeveloped in their present states.

Figure 1: Site Location

1.2 Project Description

The three sites have been designed to enable a range of solar array types, based on the environmental impact and best use of land within each site's unique constraints and opportunities. Site 1 is close to the previously consented Battery Energy Storage Site (BESS) and the Bream Bay Substation (BBS). The BESS is currently under construction, as stage 1 of the Ruakākā Energy Park development. Construction of a solar

farm, through The Project, forms stage 2 of the same Ruakākā Energy Park with the solar farm utilising the same operations and maintenance facility, switching station, and grid connection as the BESS. This site is therefore the most ideal for electricity generation to minimise transmission losses. The Site 1 area has been mapped by the project ecologist and contains areas of wetland vegetation, open water and Kanuka Trees. The solar layout developed has:

1. Avoided disturbing a grove of Kanuka Trees
2. Retained and enhanced the largest connected open water wetland.
3. Constructed new wetland habitat within the southern part of Site 3 (detail to follow) where this can be integrated with the Ruakākā River blue-green corridor.

Site 2 is the most distant from the BESS. It is relatively flat land and on high ground, with the majority being at or above RL 8.0m (NZVD 2016). This site is the least flood prone of the three sites with minimal wetlands identified by the ecologist. The solar coverage on this site is not impeded by overhead lines, underground pipes or wetlands. However, the site does have important open channels to maintain for regional stormwater management. All drains with easements will be retained. Non-easement drains/channels may be altered, consolidated, or removed as required to the more refined layout developed after consent. suit

Site 3 is a highly flood prone land block with the lowest elevation being RL 1.5m. The southern part of Site 3 is the most flood prone, making it the most ideal location for a wetland to offset the affected wetland areas from all three sites. Additionally, overhead power lines on Site 3 occupy its southern end, further reducing the viability for solar arrays in this area. The northern part of Site 3 is available for solar if the flood waters can be accommodated in the solar array supporting structure design. The general site layouts can be seen in Figure 2. Note that the sections labelled Solar Panels contain internal roads, small maintenance buildings, inverter stations, and drainage channels/culverts.

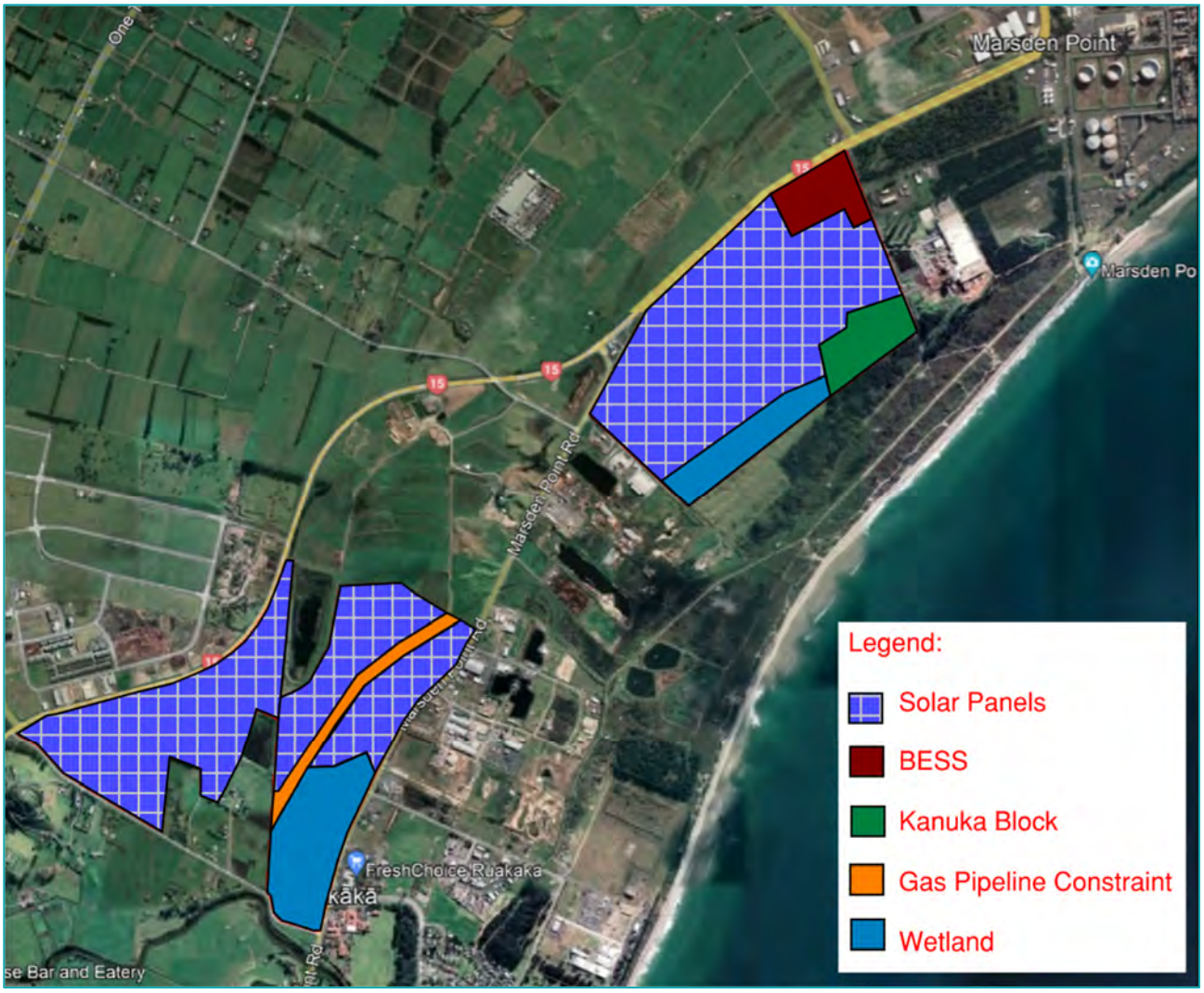

Figure 2: General Design Site Layout

The solar panel arrays may be one of two installation types:

1. Fixed Tilt (**"FT"**): Fixed tilt refers to a solar panel installation system where the panels are mounted at a fixed angle, typically optimised for the specific geographic location, in order to maximise solar energy generation. Fixed tilt systems are oriented with the solar panels fixed facing north.
2. Single Axis Tracking (**"SAT"**): Single axis tracking is a solar panel mounting system that allows the panels to move along a single axis (usually horizontal) throughout the day, following the sun's path from east to west. This dynamic movement helps increase the overall energy output by maximising exposure to sunlight during sunlight hours.

For the purposes of this consent application, the arrays are all assumed to be FT and require earthworks to suit this panel arrangement. However, all aspects of Beca's documentation for this consent application has considered effects and design for a SAT array along with a FT array. Meridian have indicated the array configuration may change depending on market supply, cost and yield considerations that will be refined post resource consent. The FT arrays require the terrain to be generally not more than 11% in grade in any direction which requires an earthworks design with gradual shallow terrain grades. However, all aspects of Beca's documentation for this consent application has considered effects and design for a SAT array along

with a FT array. All sites will have a perimeter road around the boundary for maintenance access and as a buffer to the security fence and any areas of screening planting and/or bunds.

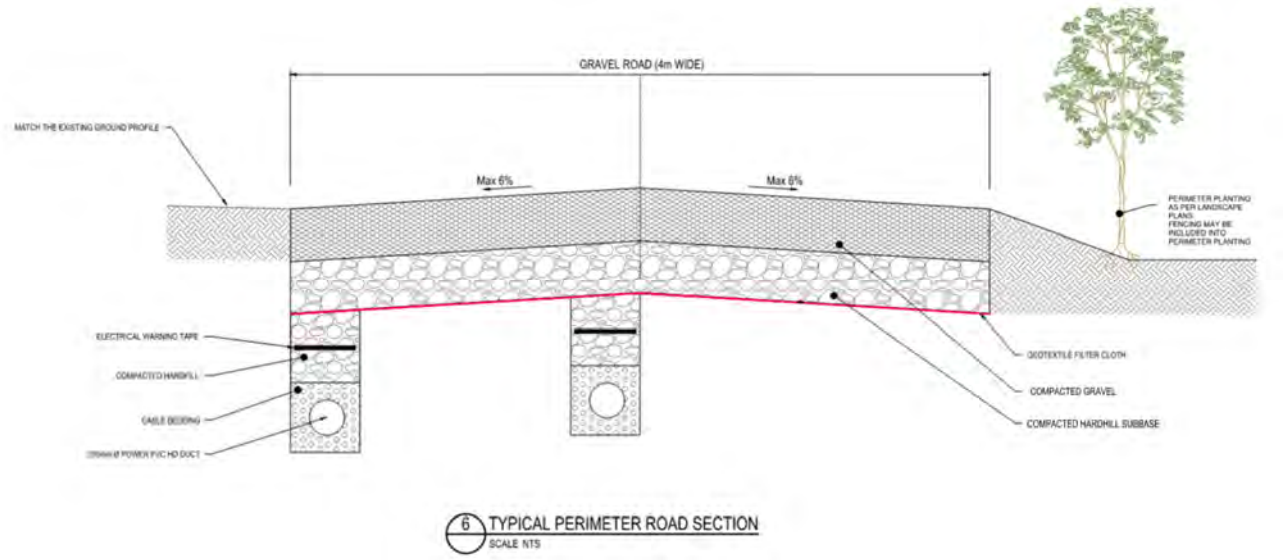

Figure 3: Typical Perimeter Detail

An ecological offset wetland is proposed in the southern corner of Site 3, the size of which was determined by the Project's ecologists based on ecological disturbance and offset multipliers. The Northpower powerlines located within the site are to be relocated to within the road boundary of McCathie Road.

Access to all three sites will be via Council roads as shown on the appended layout plans. There will be no access off SH15. These access points will be connected to an internal service road network (4m to 8m wide) with a perimeter and grid pattern to service the solar panels and associated infrastructure throughout their design life.

Open water drains with existing easements on the Sites will remain and internal roading will align with these drains to allow ease of maintenance. Minor farm drainage channels (without easements) will either remain in place or be removed, redirected and/or consolidated, where it is possible to do so without impacting the flow pattern and capacity. The internal roads will be culverted where they cross the internal drains with a capacity that maintains the same cross-sectional area of the drain. The solar panels will be on structural supports above the existing ground thus presenting as a "shield" to rain falling on the ground rather than an impervious surface. The effects of a sloping terrain, panel angle, and possible wind influences are expected to wet the shielded terrain maintaining the pervious and porous nature of the site. This is discussed more in depth in section 2.1. Site Drainage.

The project has been designed in accordance with the following guidelines and standards:

- Whangarei District Council Engineering Standards, Issue 0.4 – Revised 2022
- Whangarei District Council Standard Operating Procedure for Environmental Engineering Standards, July 2010
- NZS 4404:2010 Land Development and Subdivision Infrastructure.
- New Zealand Building Code Clause E1 – Surface Water – 1st edition, amendment 11, November 2020

The following Beca reports form part of the resource consent application:

- "Preliminary Geotechnical Assessment Report - Ruakākā Energy Park Solar Farm", May 2023
- "Erosion and Sediment Control Plan (ESCP) - Ruakākā Energy Park Solar Farm", May 2023

- “Ruakākā Flood Modelling - Ruakākā Energy Park Solar Farm Consent Design”, May 2023
- “Ruakākā Solar Farm Traffic Impact Assessment”, May 2023

1.3 Existing Site Features

Site 1 has a relatively flat terrain across the entire site with small rolling sand dunes covered in grass and shrubs. The lowest point of the site is within the Bercich drain in the northeast of the site. All runoff from the site, including groundwater, will outlet into the Bercich drain and flow under Rama Road and past the Bream Bay Substation. The Bercich drain is a council drain, and the eastern most third of the drain is also a crown easement. The site is bordered by State Highway 15 to the north west, coastal dunes to the east and industrial land-uses (Caltex and Atlas concrete) to the south west. Site 1 contains existing wetlands scattered throughout the entirety of the site, with a block of Kanuka trees in the corner towards the east (see Figure 4). The Digital Elevation Model (DEM) for the existing Site 1 terrain has been included as Figure 5. Note that the colours denoting elevation on this Figure (and subsequent Figures) refer to highest and lowest points. Absolute elevations should not be inferred from the colours.

The utilities around Site 1 include power, communications, stormwater, potable water, and wastewater. All of these except the stormwater are within the State Highway 15 road corridor.

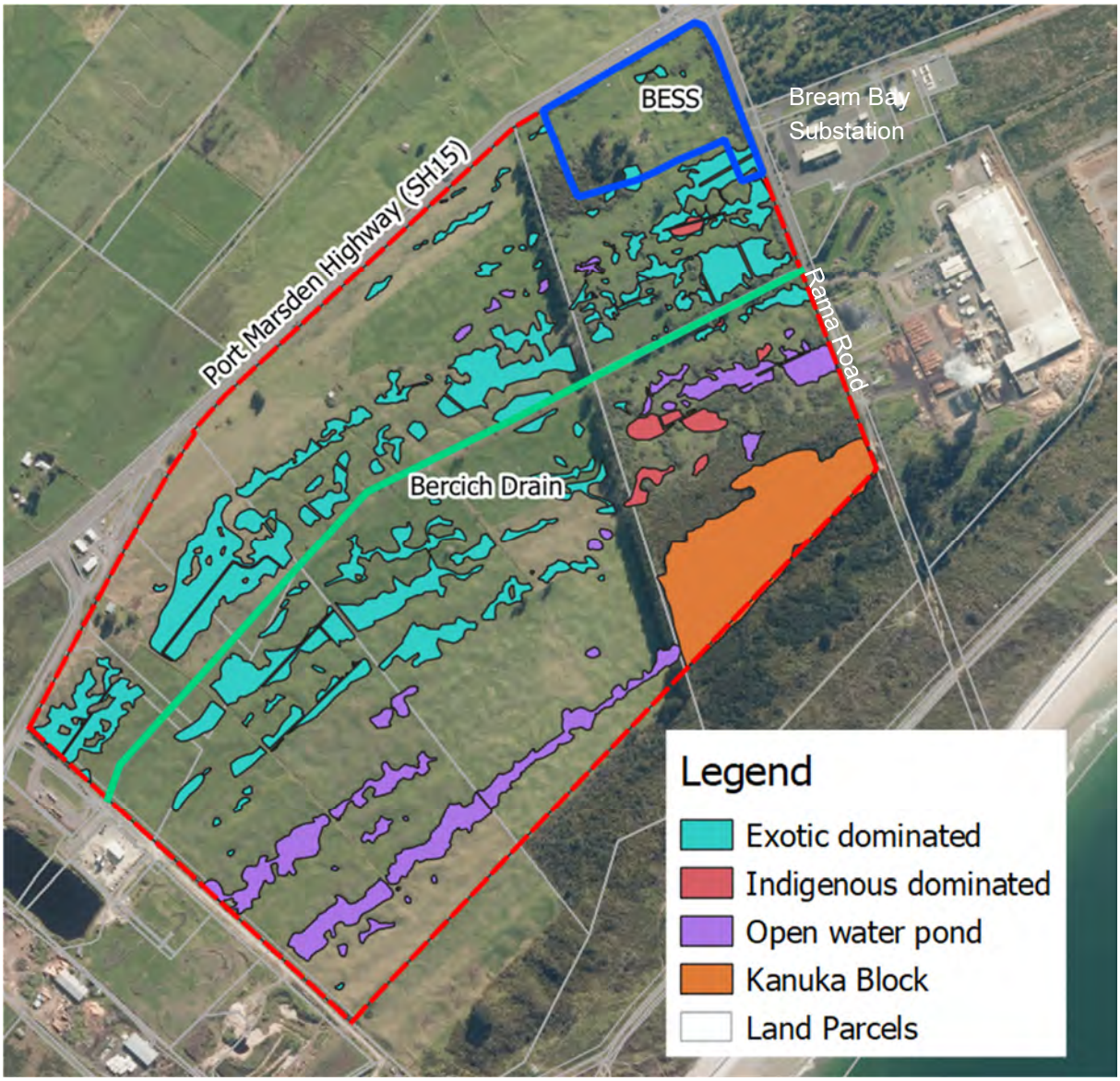

Figure 4: Site 1 Ecological features

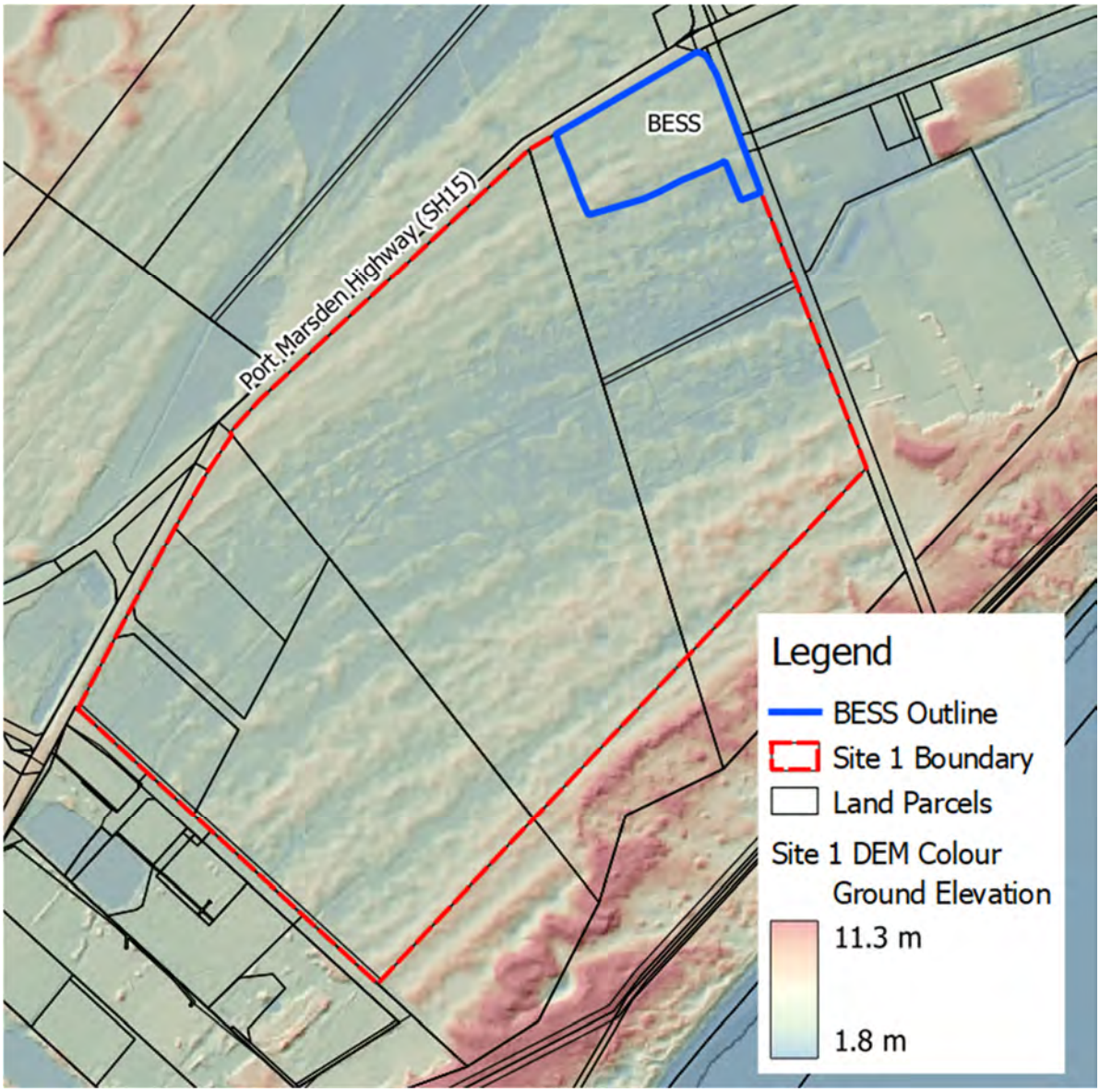

Figure 5: Site 1 Terrain

Site 2 is bounded by two main roads; north west of the site is State Highway 15 whereas on the south side of the site is McCathie Road. The existing terrain for Site 2 is relatively flat with the lowest point of the site being to the south-east. The existing terrain of Site 2 can be seen in Figure 6.

Existing power, potable water, wastewater, and communications cables run alongside the site in the road parcels. Specifically, State Highway 15 and McCathie Road. There are currently two existing retention ponds to the east of the site that perform stormwater management functions for the residential developments to the northwest of the site. Within the site there are two council drainage easements to allow for the flow of stormwater from the residential development to the retention ponds. The first easement is through the centre of the site, and the second easement is the northern most drain on the site. The ponds drain to a council drainage easement that contains an existing open drain that flows along the south-east of the site. This easement drains towards the Ruakākā River, and the river subsequently flows towards the sea. Lastly, it should be noted that an overhead 11 and 33 kV powerlines owned by Northpower intersects at the southern part of Site 2, as seen in Figure 7.

Site 3 is relatively flat throughout. The site itself is accessible through McCathie Road on the southern boundary of the site and Marsden Point Road along the east side. The ground elevation varies from RL 7.6m in the north and eastern areas to RL 1.5m in the southern end. The DEM of Site 3 is shown in Figure 6.

To the east and south of Site 3, within the road parcels of Marsden Point Road and McCathie Road, lie communications, power, potable water, and some stormwater utilities. The site contains two crown drainage easements and has a council drainage easement along the western border. The crown drains flow towards the west into the council drain easement. The lowest point of the site is to southwest, where the council easement containing an open drain, carries the stormwater towards the Ruakākā River and subsequently towards the ocean. West of the site are two retention ponds, discussed in the Site 2 existing site features above, to which Site 3 additionally drains.. Two FirstGas pipelines, including the Refinery to Auckland Pipeline (“RAP”), potable water pipes, Transpower transmission lines, Northpower power lines transverse the site. Utilities that cross the site can be seen in Figure 7.

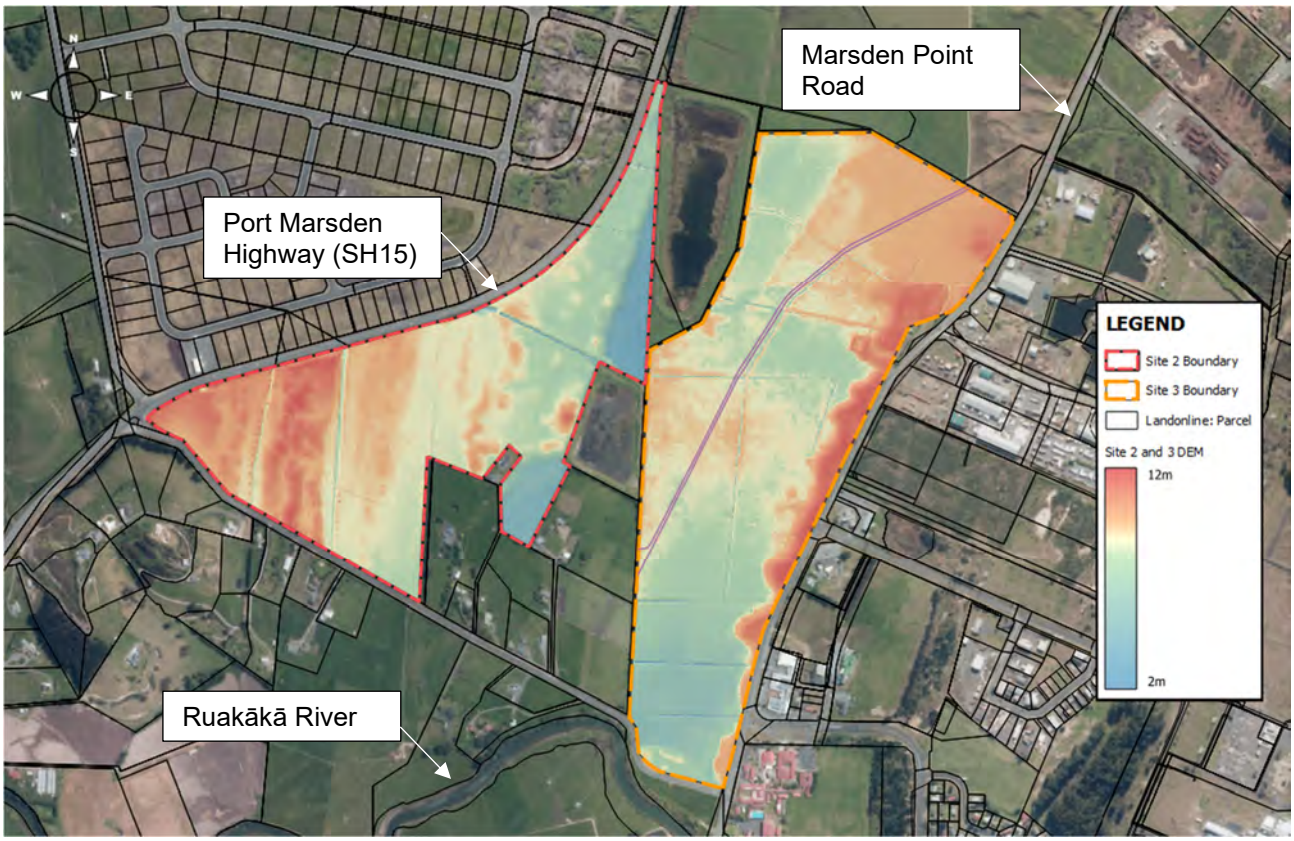

Figure 6: Site 2 and 3 Terrain

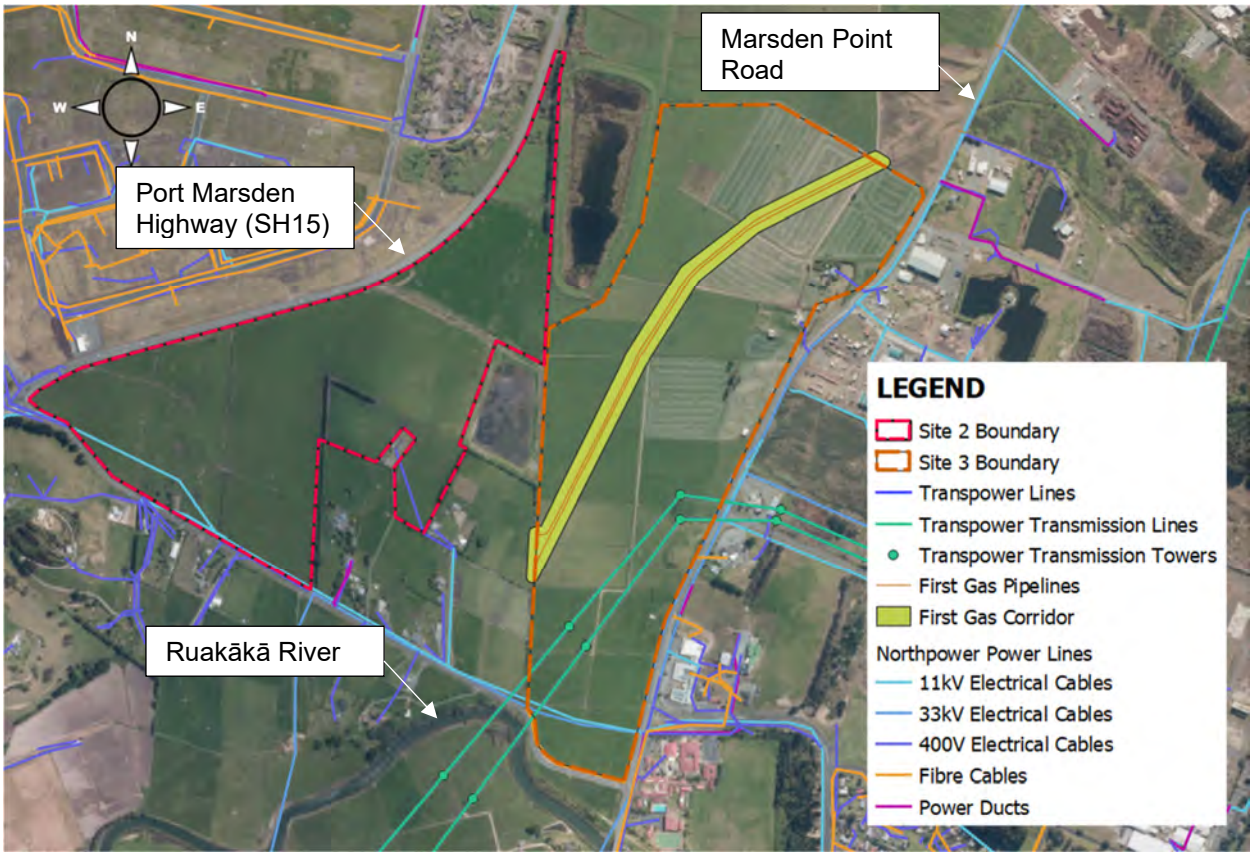

Figure 7: Site 2 and 3 Existing Utilities

A site visit was carried out on the 15th of May 2023 and a site visit report has been prepared based on observations and photos taken. This site visit report is included in Appendix B.

2 Consent Design

The proposed works for this project is to build a solar farm on all three sites. This solar farm will connect to Transpower's 33/22 kV Bream Bay Substation through stage 1 of the Ruakākā Energy Park (the BESS) which is located to the northeast of Site 1. For the fixed tracking solar energy arrays, the individual modules of photovoltaic panels (**"solar panels"** or **"panels"**) are mounted on pole and truss systems (**"racks"**) that may potentially align in the north-south direction, with the panels themselves facing the east/west direction at the most optimal angle. This alignment is subject to change at a more detailed phase and the specific technology of the racks may change to single axis tracking or remain fixed tilt post resource consent stage. The racks are grouped together (**"arrays"**) and arranged to maximise the land use of the three sites. The details of the civil design of this solar farm will be discussed further in this report.

Site 1

Site 1 will consist of an expansion of an existing wetland on the south-eastern boundary, a preserved Kanuka shrub area, the previously consented (and under construction) BESS, new solar arrays, internal gravel road, culverts, inverter stations (on elevated platforms), site security fencing and (in some places) perimeter planting and/or perimeter bunds. The BESS is located on the northern most corner of the site and has been previously designed and consented by WSP. The Kanuka block is located on the easternmost corner of the site and as part of this project will be fenced to prevent stock access and will become a protected area of existing Kanuka trees and other wildlife. The remaining area of the site will contain solar

panels and associated infrastructure. Figure 8 shows the consent layout with the required civil infrastructure elements. Layout plans in Appendix A describe the consented design in more detail.

The consent design for Site 1 requires a site-wide earthworks undertaking to reduce the height of the dunes and fill in the trapped depressions. The result of the earthworks profile proposed for consent achieves a profile that is suitable for solar panel construction and operation, typically not more than 11% slope. The layout will result in not more than 1V in 4H batters at the perimeter when interfacing with adjacent land. The wetland is battered at 1V in 5H and has an invert level of RL 3.3m. The final bathymetry of the wetland will be completed in detailed design and based on a sinusoidal pattern with varying marsh zones. As part of site preparation works, the Bercich drain will also be cleared of debris and modified to improve drainage. This and ongoing clearance once the site is operational is included in the consent application.

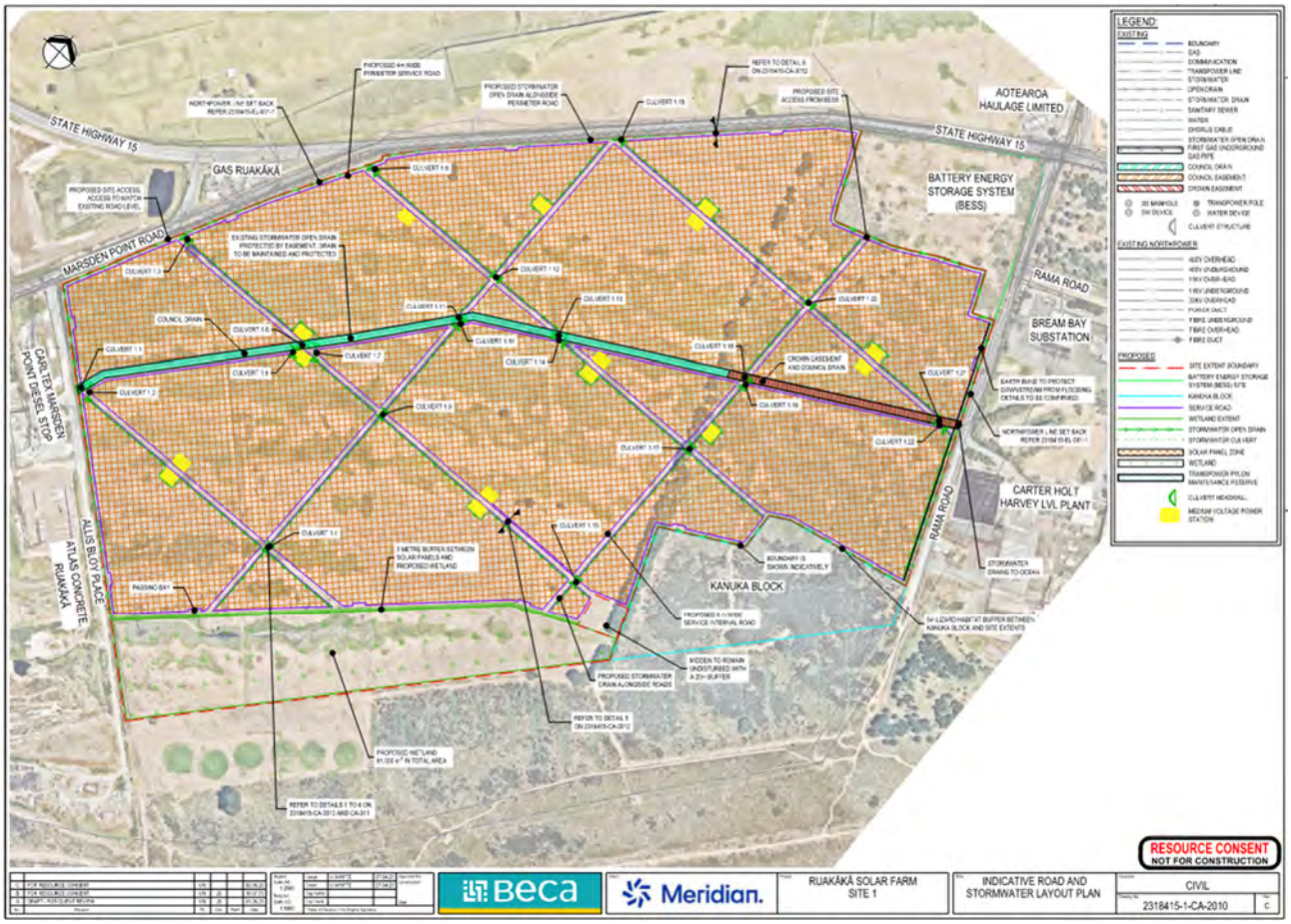

Figure 8: Site 1 Concept Design

Site 2

The Site 2 consent design is covered in solar panels as the site is relatively flat in its existing state, is not prone to flooding from the Ruakākā River, does not contain any large areas of ecological significance and is largely free of utility services. The same solar approach in Site 1 has been applied to Site 2 for the orientation of the racks, panels, roads and culverts. Open water drains with existing easements on the site will remain unchanged and internal roading will align with these drains, where possible, to allow regular maintenance. Open water drains without easements will either remain unchanged or be consolidated, where it is possible to do so without impacting the flow pattern and capacity.

All cabling may be installed along the racks and under the internal roads as shown on the details in Appendix A. Transmission from Site 2 may be via underground cables beneath the internal road that connects Site 2 to Site 3. Site 2 conveys stormwater flows from the residential/commercial development to the north (on the

other side of SH15) and through to the existing stormwater pond to the southeast of Site 2. This drainage path will remain in place and a new culvert may be installed under the internal road that crosses it. The capacity of the new culvert may be the same as that upstream (3 x Ø1500mm pipe culverts). Secondary flows will continue as per pre-development design and overtop the culverts and access road placed in existing drains.

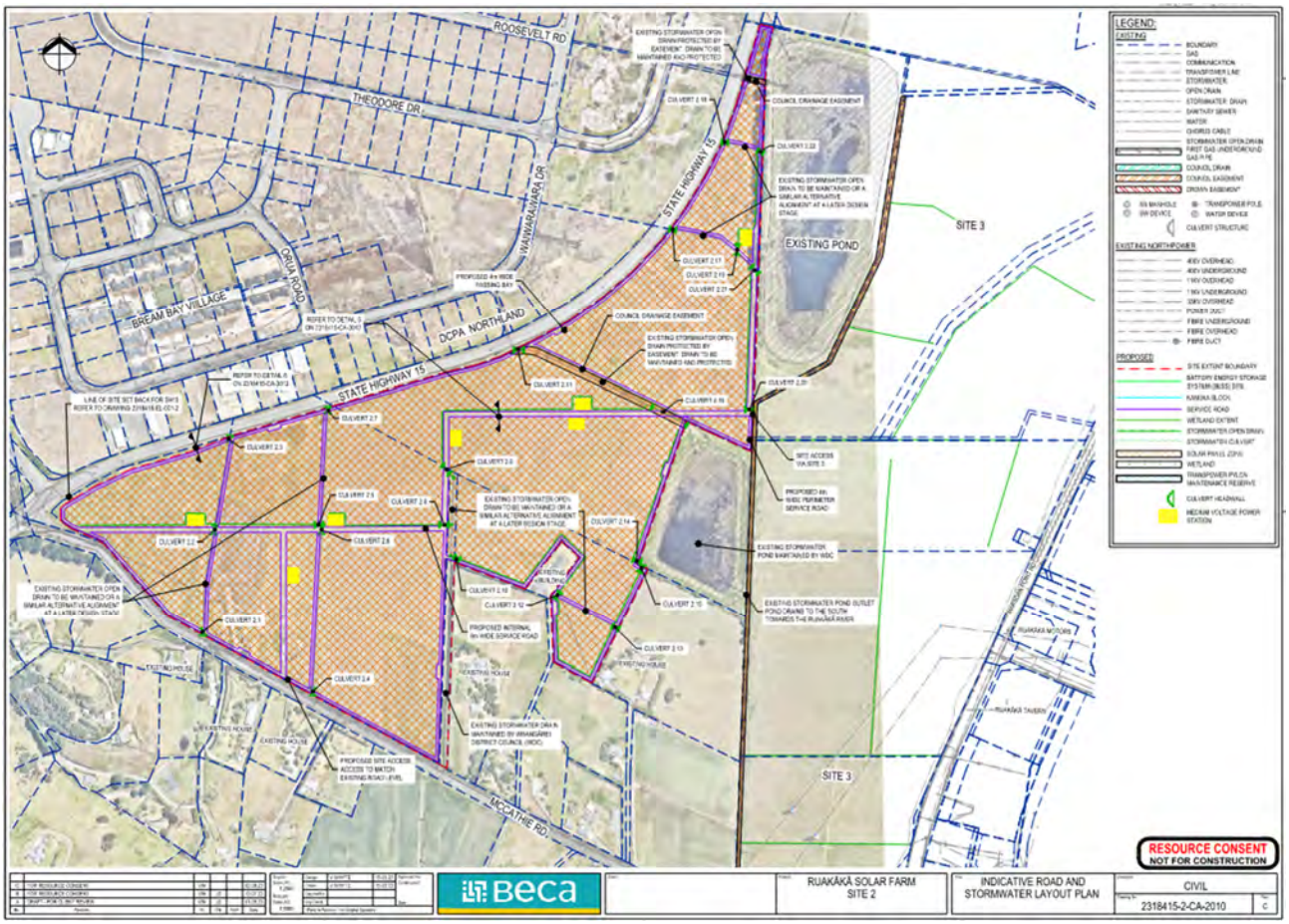

Figure 9: Site 2 Concept Design

Site 3

The Site 3 consent design contains a wetland to offset the removal of wetlands from Site 1. The wetland is located in the south of the site where the flood depths are greatest and where the blue-green corridor is best connected to the Ruakākā River. The wetland is located opposite the Bream Bay College and the Ruakākā Town Centre, enhancing the natural amenity to a high use area. The RAP corridor will remain untouched except where internal roads will cross perpendicularly. Conversations with Firstgas have resulted in a 6m wide buffer between the underground pipelines and solar panels. The rest of the site will contain solar arrays, internal roads, culverts, inverter stations and a satellite control room / operation and maintenance facility as shown in Figure 10.

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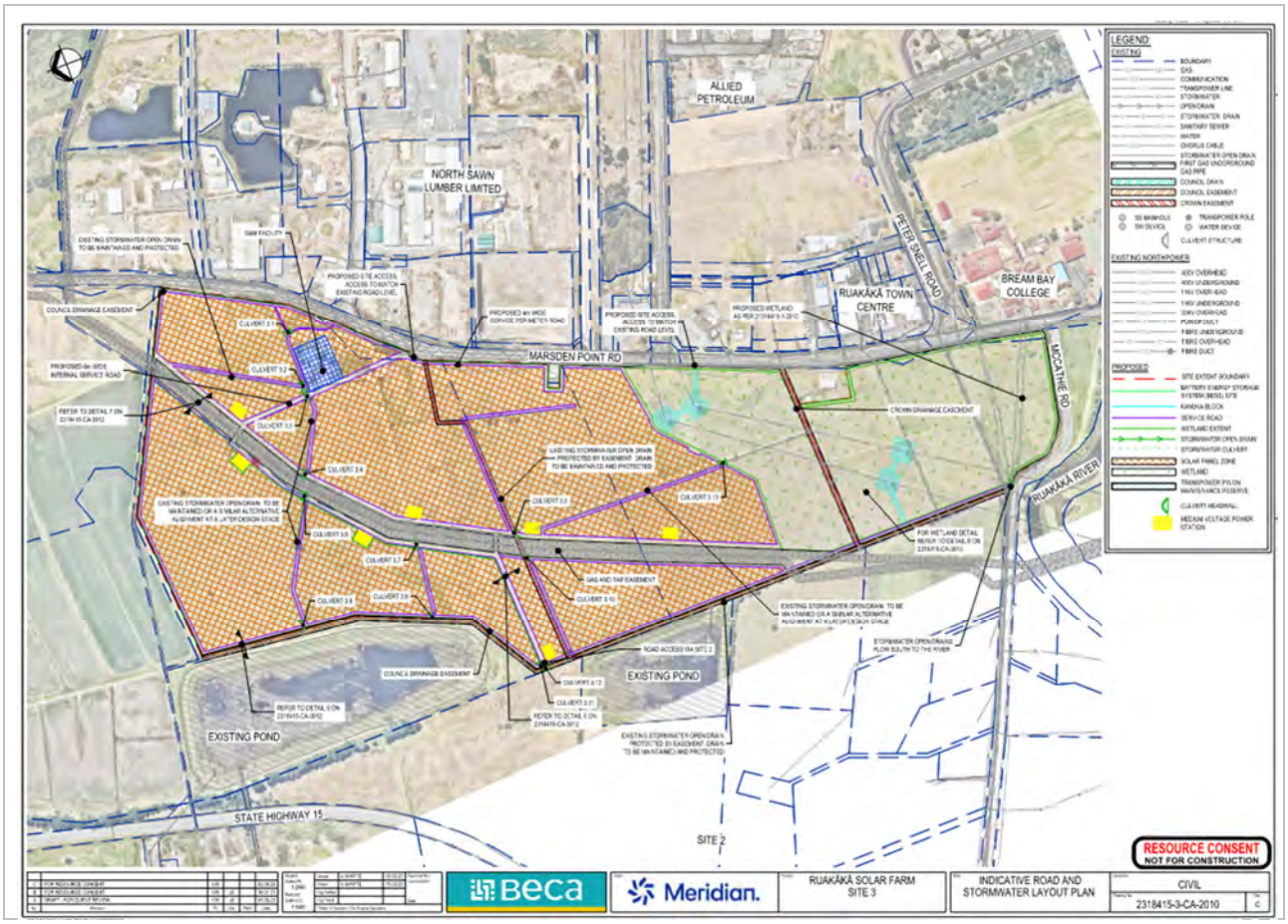

Figure 10: Site 3 Concept Design

2.1 SITE DRAINAGE

The drainage on all 3 sites may continue to drain in the same fashion as the observed existing case. Existing channels on Site 3 will be maintained where possible. However, some drains on site 3 may need to realign to accommodate the solar and internal road layout. The racks will not traverse the open channels and instead will leave space for the drains. Where required by existing easements, open channels may have an internal gravel road that running alongside the drains for maintenance purposes.

The panels will shield rainfall from interacting with the ground surface in the typical way and consideration for this effect has been given some thought. The concept of the ground becoming effectively impervious needs to consider the following factors:

1. Is rainfall prevented from soaking into the soil; and

2. Will runoff from the non-shielded parts of the site still flow overland and come into contact with the shielded parts of the site; and

3. Is the soil any less capable of soaking and storing rainfall.

Rainfall will change direction according to wind patterns and depending on the strength of the wind and changes in direction, may not result in a fully shielded area as illustrated in the sketch in Figures 11a and 11b.

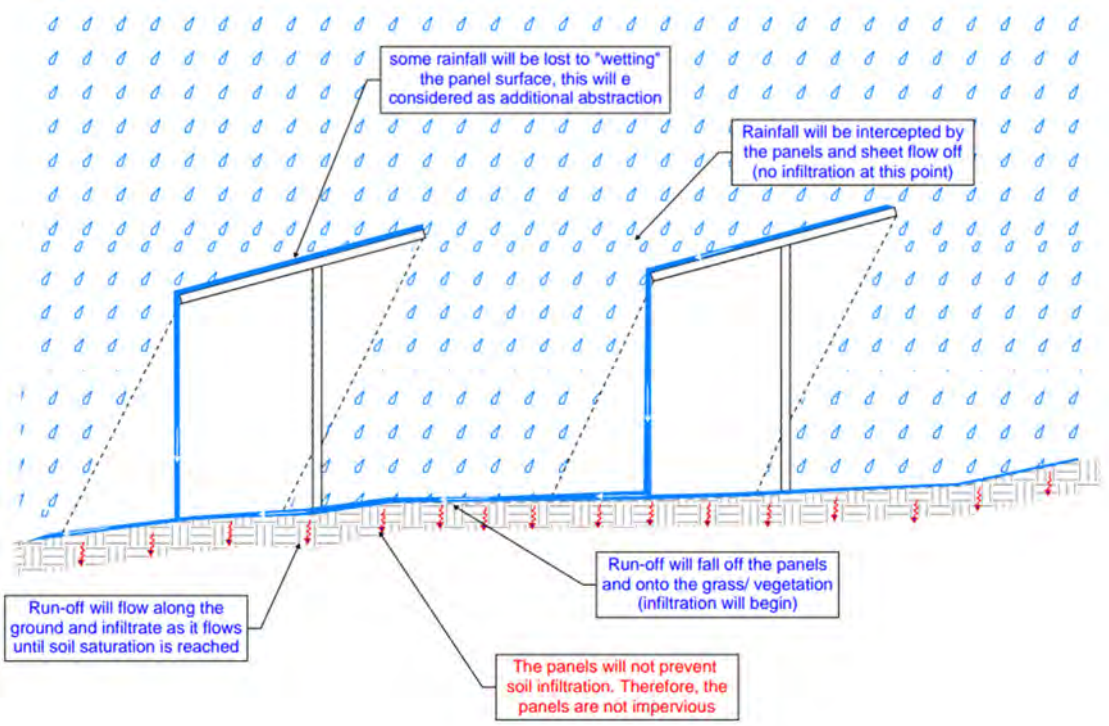

Figure 11a: Sketch of wind affected rainfall and the reduced effect of ground shielding

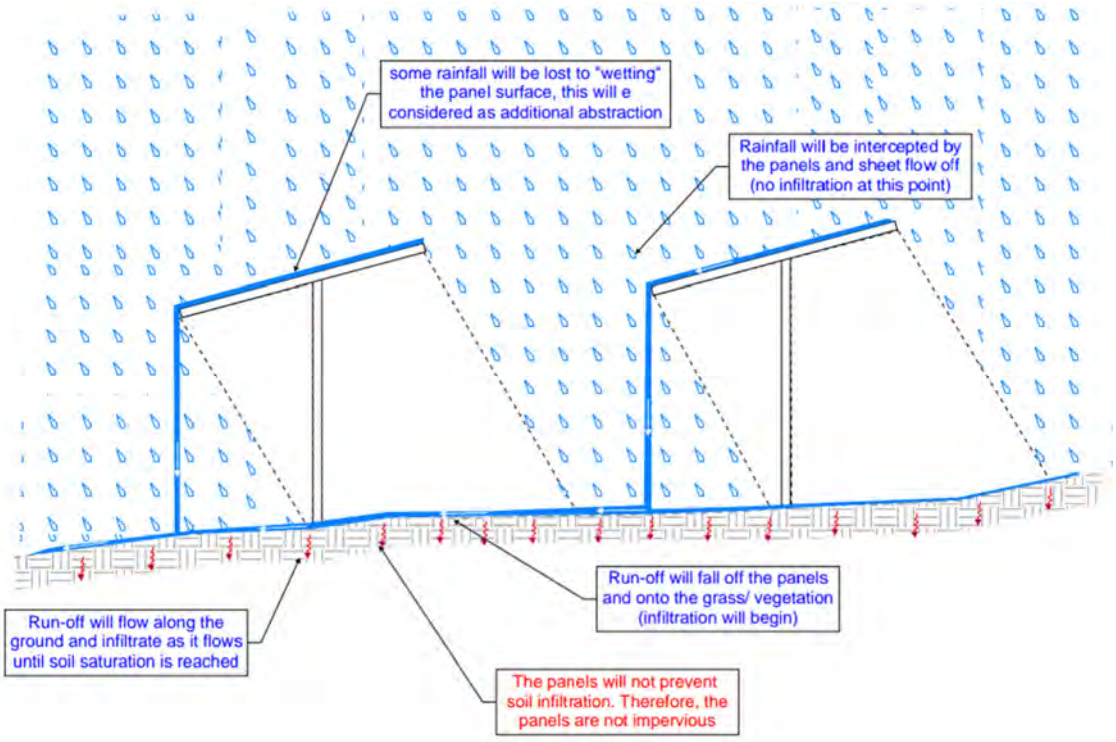

Figure 11b: Sketch of wind affected rainfall and the reduced effect of ground shielding

Further to the potential for wind adjustment to the shielding effects, the runoff will flow overland when it comes into contact with the ground surface at the panel dripline. The runoff will follow the ground contours in a sheet flow pattern and come into contact with the ground surface including all shielded parts. The ground will be vegetated and graded at flat gradients, the velocity of runoff will therefore be very slow and infiltration at the same rate as the predevelopment case is expected.

The ability for runoff to infiltrate into the soil will depend on changes to soil material, compaction, and antecedent moisture content. The soil material will remain as predominantly fine to medium sand with a layer of organic topsoil, compaction is not expected to significantly reduce the soil's ability to infiltrate rainwater. Refer to the findings with the Beca report "Preliminary Geotechnical Assessment Report - Ruakākā Energy Park Solar Farm", May 2023.

The antecedent moisture content of the soil would theoretically increase as the ground beneath the panels will be in shade for more of the time and therefore evaporation will reduce. The low density of panels, panel movement and sun movement throughout the day will cast a changing shadow on the land and only small areas beneath the panels are expected to be shielded for the whole of the day. On this basis, shading effect influence on soil moisture content is expected to be minor.

With all these elements considered, the effects from the solar panel infrastructure on stormwater runoff rates are not expected to change compared to the predevelopment case.

Site 1 will continue to drain to the central Bercich drain that runs from the south-east to the north-east. Drainage will be improved with modification and regular clearance of debris from the drain. This drain no longer receives runoff from the adjacent land, as it historically did before the Atlas Concrete land was developed, so it is required to convey Site 1 generated runoff only. The site's new internal roads will form barriers to the runoff so channels on the uphill side of the road will be constructed to intercept runoff and convey it to the Bercich drain. These drains are also spaced such that the sheet flow will have not more the 200m of flowpath length and avoid transforming into rills and gullies. Figure 12 shows a typical detail of the internal roads and channels designed for Site 1, 2 and 3.

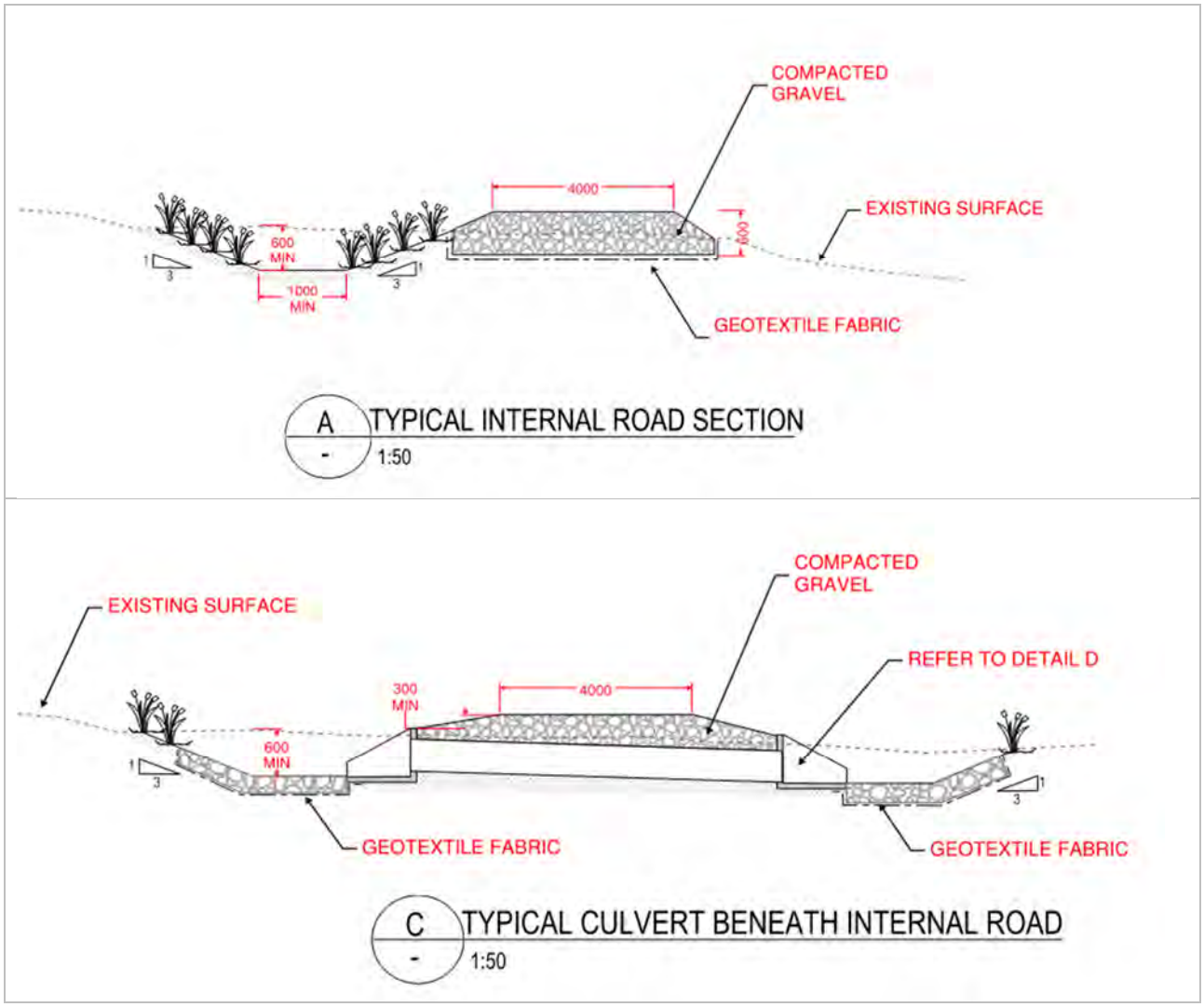

Figure 12: Sketch of internal roads, channels, and culverts

Culverts have been placed in all areas where the roads cross drainage paths. Where an inverter station blocks a road channel, the channel will re-direct around the perimeter and re-join the roads edge. Runoff volumes and peak flow rates from the site will remain unchanged meaning no on-site attenuation required. In the event that culvert capacity is exceeded, the secondary flow will over top the road and continue down the drains where the culvert is located.

The earthworks profile adopted for the site will remove depression storages and alter the runoff from the site. This effect has been modelled and is discussed in the Beca report “Ruakākā Flood Modelling - Ruakākā Energy Park Solar Farm Consent Design”, May 2023. To mitigate downstream effects, an earthen bund will be constructed along Rama Road to the north east north-east of the site. The size and dimensions of the bund have been modelled to achieve a no worsening outcome for the downstream environment.

The surface runoff in Site 2 will follow the same drainage approach as that adopted for Site 1. All existing drainage channels with an easement will be maintained, and all roads intercepting sheet flow will have a new channel constructed on the uphill side. The configuration of the open channels may be optimised at a later stage of design. As a result of the unchanged nature of drainage on site 2, runoff volumes and peak flow rates from the site will remain similar to the predevelopment state. This means the development on Site 2 will place no additional pressure on the downstream infrastructure.Development on Site 3 will follow the same philosophy as Site 1 by maintaining existing channels and constructing new roadside drains where possible with no increase in impervious area. Site 3 contains a new wetland which will manage stormwater for the

majority of the development area and the earthworks planned to construct the wetland will provide more floodplain storage for the Ruakākā floodplain. This will have a net benefit for flood depths in the area as described in the flood effects report. The northern portion of the site that does not drain towards the wetland will drain towards the west of the site and then towards the Ruakākā River via the drainage channel flowing south between Sites 2 and 3.

2.1.1 Culverts

Culverts have been indicatively shown on all sites to accommodate the internal road layout and site access points. These internal roads may change in a more detailed stage of design to suit the optimisation of the site's energy generation potential. There are two existing culverts on Site 1, eight on site 2 and six on Site 3, these culverts are within the existing channels and are proposed to be kept in place in the consent design. New culverts will be placed in all existing and proposed drains where an internal roadway crosses the flowpath. Table 1 outlines the different culverts and if they are located in an easement as defined by the National Environmental Standard for Freshwater (NES:FW).

All culverts have been included indicatively and will be sized in more detail at a future design stage. Culvert sizing will be based on a confirmed and detailed internal road layout plan, detailed survey, hydraulic calculations and the resource consent conditions.

Table 1. Culvert Information

Site	Culvert Name	Culvert Location Description
1	1.1	Existing council drain, Bercich drain
	1.2	Proposed roadside drain
	1.3	Proposed roadside drain
	1.4	Proposed roadside drain
	1.5	Proposed roadside drain
	1.6	Existing council drain, Bercich drain
	1.7	Proposed roadside drain
	1.8	Proposed roadside drain
	1.9	Proposed roadside drain
	1.10	Proposed roadside drain
	1.11	Existing council drain, Bercich drain
	1.12	Proposed roadside drain
	1.13	Existing council drain, Bercich drain
	1.14	Proposed roadside drain
	1.15	Proposed roadside drain
	1.16	Proposed roadside drain
	1.17	Proposed roadside drain
	1.18	Existing council drain, Bercich drain, crown easement
	1.19	Proposed roadside drain
	1.20	Proposed roadside drain
	1.21	Existing council drain, Bercich drain, crown easement
	1.22	Proposed roadside drain

Site	Culvert Name	Culvert Location Description
2	2.1	Existing drain
	2.2	Existing drain
	2.3	Existing drain
	2.4	Existing drain
	2.5	Proposed roadside drain
	2.6	Existing drain
	2.7	Existing drain
	2.8	Proposed roadside drain
	2.9	Proposed roadside drain
	2.10	Proposed roadside drain
	2.11	Existing council drainage easement
	2.12	Proposed roadside drain
	2.13	Existing drain
	2.14	Proposed roadside drain
	2.15	Proposed roadside drain
	2.16	Existing council drainage easement
	2.17	Existing drain
	2.18	Existing drain
	2.19	Proposed roadside drain
	2.20	Proposed roadside drain
	2.21	Existing drain
	2.22	Existing drain
3	3.1	Proposed roadside drain
	3.2	Existing drain
	3.3	Existing drain
	3.4	Existing drain
	3.5	Proposed roadside drain
	3.6	Existing drain
	3.7	Existing drain
	3.8	Existing drain
	3.9	Existing drain, crown easement
	3.10	Existing drain, crown easement
	3.11	Proposed roadside drain
	3.12	Existing drain, council easement
	3.13	Existing drain

2.1.2 Erosion

As seen in Figure 11, the water will fall in the same location underneath the lower edge of the solar panel whenever it rains at the site, referred to as the dripline. Directly after construction the site will require a period for vegetation establishment to allow time for the grass to grow, monitoring for erosion and ground stabilisation may be required, especially under the lower edge of the solar panels. During operation, the

repetitive effect of water falling in the same spot may cause erosion directly under the solar panel edge. If this is left unaddressed soil material will be transported from the site, causing pollution. As an adaptive management approach, dense fibre grass is proposed to be grown on the soil underneath all the solar panels as part of re-establishing vegetation post-construction. The grass will prevent erosion by intercepting, and cushioning the impact of, dripping water with the root structures binding the soil particles and stabilizing the soil. The panel drip lines may then be monitored and where localised erosion is noticed, it may then be back filled with a gravel material (AP20 or equivalent) to prevent the scour from worsening.

The slopes of all parts of Sites 1, 2 and 3 will be suitably graded and expected to be vegetated when fully established. The erosion risk in channels will be low. Furthermore, all culvert inlet and outlets may have rock riprap aprons as shown on the details and plans in Appendix A.

2.1.3 Water Quality

The site will be covered in solar panels with associated infrastructure, gravel roads, grassed land, wetlands and a building on Site 3. These surfaces are not pollutant generating surfaces traditionally as no pollutants will be generated by these surfaces. The mechanical devices that allow the panels to rotate (if SAT framing system are used) may require some lubricant to function, this would be on the underside of the solar panels and will not come into contact with rainfall. These instances are not expected to happen often, if at all, and in the event of damage, the panels will be replaced, and any pollutants exported from the panels will be captured in the surrounding grassed areas. No water quality improvement devices have been included in this design, although it should be noted that the wetland on Site 1 and Site 3 will have some water quality improvement outcomes.

2.1.4 Flooding

The solar panels will be elevated above the 1% AEP floodwater elevation such that the only the support racks will interact with floodwaters. Power inverters will be lifted out of the floodplain to protect from flood damage. The project consideration of flood waters and effects are addressed in a separate report by Beca entitled “Ruakākā Flood Modelling - Ruakākā Energy Park Solar Farm Consent Design”, May 2023.

2.2 EARTHWORKS

Significant volumes of earthworks materials are expected to be generated during the construction of the proposed Solar Farm development. The project will aim for zero balance cut and fill with unsuitables potentially being used for bunds, wetland creation, and plantings. It will be the responsibility of the main contractor to provide a staged Erosion and Sediment Control Plan (ESCP), Silt Fence, Earth Bund, and Earth Drain in advance of any earthworks being undertaken. The approximate earthworks/land disturbance areas are listed in Table 2.

Table 2. Earthworks/Land Disturbance Area

Location	Area (m^2)
Site 1	937,600
Site 2	415,500
Site 3	553,400
Total	1,906,400

The controls outlined in the following sections may be put in place by the contractor during the construction-related earthworks activities. Earthworks cut and fill plans for each site have been included in Appendix A.

2.2.1 DUST CONTROL PROCEDURES

To avoid dust generation during dry conditions and to mitigate against dust generation associated with vehicular movement, the following control and monitoring systems may be put in place by the contractor.

- Frequent spraying of water over the excavation and truck loading so that the working surfaces remain damp.
- When necessary, wetting of the loaded material once placed on the truck.
- Use of a water truck or portable water sprays in trafficked areas to dampen dust.
- Reduction of vehicle speeds through the site.
- Minimising drop heights during lifting operations.

2.2.2 CONTAMINATION

If contaminated ground is encountered during earthworks, actions are to be undertaken by the contractor to minimise the exposure of contaminated materials, which are to include but not limited to a Job Safety and Environmental Analysis (JSEA) to identify the appropriate methodology and Personal Protective Equipment (PPE) required to undertake the task. Contaminated fill will be cut to waste at an appropriate hazardous waste disposal facility.

2.3 INTERNAL ROADS

2.3.1 PROPOSED SITE INGRESS/EGRESS

These access points are shown on the layout plans in Appendix A. As Site 1 is relatively a large site, the site will have two additional access points. Site access will be from Rama Road , and off Marsden point Rd in southern corner. Two construction accesses will be required, directly off Rama Rd, and the third off Marsden point Rd in southern corner. The current BESS operational access will remain in use. Site 2 access will be from McCathie Rd as well as an internal access road internally between Site 2 and 3. Site 3 will have an access point from Marsden Point Rd and an internal access from Site 2.

2.3.2 PAVEMENT DESIGN

The roads that are designed to be situated within Sites 1, 2 and 3 will serve as a service road. These service roads will be compromised of an unpaved (GAP 65 compacted hardfill or similar). The road will be between 4m and 8m wide and run a pattern as best suited to maintain the solar panels and racking system. The indicative service roads will run along the boundary on the interior side of the sites and cross the site in a grid-like pattern. Details of the road sections and typical details of the pavement design is shown in Appendix A.

2.4 BUILDINGS

A single building is proposed on Site 3, this building will operate as a satellite control room and operation and maintenance centre. The building will be constructed on piles and sit above the 2% AEP floodplain with 150mm freeboard to comply with the Building Code Section E1. This building will have a rooved surface and discharge to the adjacent channels on Site 3 and flow to the Ruakākā River. Additionally, inverter stations may be constructed throughout the 3 sites adding a small increase to the site's impervious percentage. No attenuation or flow management has been proposed for this development as the wetland provides a large flood level compensation for the site and the building / inverters will have a negligible effect on the site's overall impervious percentage.

2.5 GAS PIPELINE

The First Gas pipeline and Refinery to Auckland Pipeline (RAP) running centrally through Site 3 will be avoided through construction with only 2 perpendicular crossings proposed. Consultation with Firstgas has resulted in the pipeline being surveyed and confirmed on site The confirmed location has been included on the drawings in Appendix A. Firstgas have also requested the pipeline not be driven over in a longitudinal direction to prevent disjointing forces on the pipeline.

Requirements for internal access roads over the RAP and the gas main were received from a stakeholder engagement advisor from Firstgas (Brad Moore) on 23/06/2023. The requirements are:

"New vehicle access (temporary or permanent)

1. *vehicles travelling over the pipeline have the potential to cause load stress to the pipeline. To manage this, we assess new vehicles crossings to ensure the construction and use does not pose a risk to the pipeline.*
2. *Generally speaking, we ask that vehicle crossing cross the pipeline easement corridor perpendicular to the pipeline and a minimum of 300mm compacted material is laid. However, this does depend on the depth of the pipeline and vehicles loads. We can speak more on this as details become available.*
3. *Consider also crossing the pipeline during establishment/construction of the solar farm."*

A detail has been included in the consent drawing set to reflect the above requirements from Firstgas.

2.6 WASTEWATER

Wastewater pipes are not required for activities on Site 1 and 2 as part of this consent. However, the satellite control room will require a sanitary sewer connection from the northern boundary of Site 3 from the 50mm HDPE pipe. This connection will contribute a minor change in sewerage demand on the line. This is an existing connection and will continue to remain in commission.

2.7 POTABLE WATER

Similar to the wastewater demand/connection requirement, a potable water supply will be required for Site 3 but not for Sites 1 and 2. The Ø250mm AC watermain on Marsden Point Road is available for connection to the satellite control room. A 50mm offtake is assumed to be suitable for the supply of potable water to the building. In the event of fire, extinguishers are recommended for use at the inverters and the satellite control room. Firefighting flows in the potable supply have not been confirmed.

2.8 ELECTRICAL INFRASTRUCTURE

Electrical ducting will be installed beneath the site's internal roads and connect to the inverter stations, the inverter stations will transmit electricity to the BESS via below ground and overhead cables based on the findings of an electricity transmission specialist. Energy will be supplied to the Site 3 satellite control room via the power cables on Marsden Point Road. Sites 1 and 2 do not require any additional electricity connections, however the connection may need upgrading for construction works.

3 Erosion and Sediment Control

A separate report has been prepared for the erosion and sediment control plans by Beca entitled “Erosion and Sediment Control Plan (ESCP) - For Resource Consent”, May 2023. Refer to this report for details of the indicative plans for each of the three sites.

4 Safety in Design and Maintenance

A safety in design workshop, including maintenance strategy will be held post resource consent between the designers and Meridian. The risks identified will be addressed in detailed design with elimination, mitigation and controls reviewed through this process.

5 Conclusion

The solar farm development proposed will require extensive earthworks to the Ruakākā area with the land being largely levelled with an expansion to an existing wetland and one new wetland being constructed. Erosion and sediment control practices will mitigate the effects of the land disturbance as outlined in a separate erosion and sediment control report that form part of the consent application.

The pervious internal roads and raised nature of the solar arrays will maintain infiltration capability for rainfall to soak into the soil profile of the site once fully constructed. On this basis the volume of runoff will not be altered from that of the pre-development state. A flood modelling report that considers the effects of the changed earthworks profile forms part of the consent application as a separate document. The potential for water quality effects have been assessed and the surfaces exposed to rainfall will not have pollutants available for transport.

After consideration of the available information and assessments, it has been determined that the impact of a solar farm and its associated infrastructure on the land and surrounding environment is less than minor. All required services to operate the satellite control building are available at the site perimeter and a very small demand will be placed on these existing services.

A

Appendix A – Consent Design Drawings

B

Appendix B – Site Visit Report from 15/05/2023