Tonkin+Taylor

Memo

To:	Gene Sams, Nick Bowmar, Lynley Fletcher (Meridian Energy)	Job No:	1016884.1000
From:	Pushpaka Rabel (T+T)	Date:	7 September 2023
cc:	Maurice Mills (T+T), Nick Peters (T+T), Hayden Sander (T+T), Tom Anderson (Incite)		
Subject:	Mt Munro Wind Farm Stormwater S92 Responses		

1 Introduction

The purpose of this memorandum is to provide responses to the S92 additional information requests and intended stormwater design philosophy. Please refer to the Mt Munro Wind Farm Civil Engineering Report (T+T ref: 1016884.1000 v6 dated May 2023) for the site description.

2 Responses to S92 Additional Information Requests

2.1 Request 87

"87. We note that no technical or planning assessment has been undertaken regarding the long term effects of the discharge of contaminants. Much of the infrastructure (i.e. the roads, substation and some of the laydown areas) will remain on site after the construction phase has been completed, yet an assessment of the water quality effects of this infrastructure on the receiving environment has not been undertaken. Ongoing maintenance activities, vehicles on the roads, and the roads and associated hardstand areas all have the ability to negatively affect the quality of stormwater discharges in the long term. Additionally, since the road pavement will be an unsealed granular pavement, ongoing discharge of sediments could occur. Furthermore, the creation of table drains in cut areas could concentrate flows and it is unclear if any of these table drains would discharge directly to streams within the site.

a. *Please provide an assessment of the effect on water quality from impervious surfaces which will be created by the project, along with a description of and design information for the necessary mitigation measures (e.g. stormwater treatment devices) to manage these effects.*
b. *Please also demonstrate how the proposal meets the Regional Council rules as a Permitted Activity, or alternatively apply for a resource consent and assess against the relevant planning documents (including the potential for the proposal to support Te Mana o te Wai in the long term, as required in the NPS-FM)."*

An assessment of the water quality effects of the new unsealed, granular surfaces will be carried out during the detailed design stage of this project. It is expected that construction areas typically comprising access roads and laydown areas will comprise of unsealed gravels and are likely to generate suspended sediment from run-off. While this has the potential to discharge into existing watercourses, it will be managed through the design by incorporating measures such as table drains to collect the run-off, scour protection within the drains, and treatment devices to treat sediment

prior to discharge. The sediment from these unpaved areas can be further minimised through maintenance of these surfaces and drainage systems during construction and over their design life.

Regarding cut slopes, it is expected that table drains will be provided at the toe of the cut slopes. The table drains will have velocity control devices and treatment devices installed if required before discharging to natural watercourses within the site. A design specific to each location will be required for these (and other areas where concentrated flows are expected) which will consider aspects such as erosion risk, water quality, and effects on the downstream watercourses. These items will be resolved during the detailed design stage. It is assumed that these roads will be used sparsely by maintenance vehicles once construction has been completed and the roads are fully operational. Therefore, the contaminants will predominantly comprise of suspended sediment due to run-off from the unsealed gravel road. The majority of the roads and hardstand areas are on the ridges at the upstream end of catchments, which means that there will be minimal upstream flow to divert around developed areas reducing the potential for water contamination, and providing adequate level space to install treatment devices where required.

During detailed design, options to treat the sediment to minimise its discharge will be considered using primarily GWRC guidelines supplemented by NZTA standards, and Auckland Council standards where required to ensure the design solution is appropriate for the site conditions and frequency of traffic expected on a rural maintenance access road. Options for treatment include (but are not limited to): planted swales, vegetated filter strips, and sediment retention ponds.

Nonetheless, a preliminary qualitative assessment of the changes in pervious areas within the project area was undertaken which is summarised in Table 1 below to help quantify potential effects to water quality and peak flows after development. Based on this high level assessment, the total area impacted by a change in imperviousness per catchment ranges from 3% to 7%. The additional run-off generated from these unpaved areas will be accommodated by the design of new treatment and velocity control devices where required.

The following assumptions were made in relation to this assessment:

- The five catchments are representative of the site wind turbine access road and hardstand areas (i.e., within the project area);
- Only permanent works have been considered at this stage;
- Fill embankments will be constructed using permeable materials and cut slopes will be stabilised post construction;
- Access roads are 10m wide;
- Assumes all hardstand areas are approximately 5000m^2 in area;
- Where the unsealed areas replace existing pervious surfaces, the run-off co-efficient (when assessing peak flows using the Rational Method) is assumed to change from 0.35 to 0.55.

Table 1: Summary of changes to catchment areas in project area

Catchment	Catchment Area (km^2)	Increase in impervious areas (gravel) from access road (km^2)	Increase in impervious areas (gravels) from hardstand areas (km^2)	Total increase in impervious areas (km^2)	Approximate percentage reduction in pervious areas (grassed) in overall catchment (%)
1	0.976	2.72km*10 m = 0.0272	0.005sq.km*7 =0.035	= 0.0272 + 0.035 = 0.0622	= (0.976 – 0.0622) – 0.976 / 0.976 = 6%
2	0.734	2.63km*10 m = 0.0263	0.005sq.km*5 = 0.025	= 0.0263 + 0.025 = 0.0513	= (0.734 – 0.0513) – 0.734 / 0.734 = 7%
3	0.194	0.9km*10m = 0.009	0 (no hardstand areas located in this catchment)	= 0.009	= (0.194 – 0.009) – 0.194 / 0.194 = 5%
4	0.254	0.3km*10m = 0.003	0.005sq.km*1 = 0.005	= 0.003 + 0.005 = 0.008	= (0.254 – 0.008) – 0.254 / 0.254 = 3%
5	0.255	0.8km*10m = 0.008	0.005sq.km*1 = 0.005	= 0.008 + 0.005 = 0.013	= (0.255 – 0.013) – 0.255 / 0.255 = 5%

The project Planner is currently preparing a response to Request 87b.

2.2 Request 88

"88. Please provide an assessment of the efficacy of the proposed mitigation measures to reduce increased pH levels which could result from discharges from the concrete batching plant. We note that sediment retention ponds are generally not effective at mitigating the effects of pH on downstream freshwater receiving environments."

A CBP (concrete batching plant) management plan will be developed and approved prior to construction activities containing further details as part of an overall CEMP (Construction Environmental Management Plan). At this stage, it is anticipated that the plan may consider strategies such as:

1. Designing the CBP such that all water generated within the site is confined and re-used on-site. Water shall be treated for sediment and pH prior to re-use or discharge.
2. Standards for pH and suspended sediment for any water that may require discharge to land or water.
3. Design of erosion and sediment control measures.
4. No operations during a severe weather event (to be agreed with Council).
5. Design of the drainage system to dissipate any water flow.
6. The requirement to provide monitoring reports.
7. The requirement to provide pH analysis of water discharge.

2.3 Request 89

"89. No technical or planning assessment has been undertaken regarding effects related to stormwater quantity, including flooding, overland flow paths and erosion (both erosion arising from concentrated discharges as well as channelized stream erosion). Please provide an assessment of effects in relation to the risks indicated below, and associated stormwater quantity mitigation systems proposed to manage these risks:

a. *Increased peak flows;*
b. *Increased runoff volumes;*
c. *Punctual / concentrated discharges;*
d. *Channelized stream erosion risks;*
e. *Modifications to natural flow patterns and overland flow paths, including flow diversions resulting from the construction of road corridors and other works; and*
f. *Impact of the proposed works on downstream floodplains including the Makākahi River and Bruce Stream."*

A full assessment of the stormwater quantities including assessment of peak flows and volumes, erosion risk, flow paths, and downstream effects will be undertaken during detailed design. This assessment will be undertaken in line with GWRC guidelines and Wellington Water standards.

As discussed earlier in our response to RFI #87, peak flows are expected to increase albeit minimally due to the small increase in imperviousness of the project area. Attenuation devices will be considered to minimize the impact on the downstream receiving environment where required. An overall pre – and post-development assessment will be undertaken, that will consider potential changes to existing flow paths (both channelised and overland), and appropriate measures will be considered to ensure that these are maintained (such as level spreaders to disperse concentrated flows and maintain the original flow regimes) in detailed design.

The suite of erosion and sediment control, treatment, and velocity control devices is expected to include (but is not limited to):

- Check dams
- Vegetated or lined swales/table drains
- Silt fences and socks
- Silt traps and bunding
- Sediment retention ponds
- Riprap aprons, linings and basins and,
- Level spreaders.

Furthermore, diversion bunds and/or table drains will be proposed at the top of the cut slopes to convey run-off that is obstructed by the proposed road alignment and minimize the number of culverts required across the project. It is likely that there may be some inter sub-catchment transfer as a result of these diversions. However, they will not be proposed where there may be a scour risk to an existing stream. Catchment transfer across the wider catchment will be avoided where possible. These items will be developed further during detailed design.

It is also expected that some areas of existing stream will need to be re-aligned where conflicting with the proposed road alignment, in order to maintain existing flow paths, and minimize culvert lengths.

Concentrated discharges and channelized erosion may occur at culvert inlet and outlet locations, table drains and piped reticulation. Appropriate erosion and scour protection measures will be provided where required as outlined in our response to RFI #92 below (riprap aprons).

2.4 Request 90

"90. Based on observation on site and a desktop review of the available LiDAR information, there is likely to be a number of additional culvert crossings which are not indicated in the application. For example, east of Culvert 3, there appears to be an additional stream crossing that hasn't been mentioned in the application (as indicated with the red circle in the screenshot below). More detailed maps should be provided showing the topography with contours and identifying any other culvert crossings that may be required for the project, within the road alignments or other areas where land modification is proposed."

Appendix A contains a map which shows the main catchments within the project area, ground contours at 10m intervals, flow paths, the proposed road design alignment along with associated areas of cut and fill, the location of a potential bridge, the locations of the major culverts (Culvert 1, 2 and 3) and locations of potential additional smaller culverts. These are indicative only at this stage of the design and are to be confirmed during detailed design.

Note the following:

- A bridge may be required at the north-west area and be suitably sized to service the large catchment area anticipated and satisfy structural and fish passage requirements;
- Culverts 1, 2, and 3 are expected to service large catchments and maintain existing stream flows and/or flow paths and fish passage;
- The rest of the culverts identified service relatively small to medium-sized catchments (refer our response to RFI #91 below) and maintain existing stream flows and/or flow paths and fish passage, or are required to maintain overland flow paths.

2.5 Request 91

"91. Please provide hydrological and hydraulic calculations to understand the flows generated within the various sub catchments that will be affected by the works, both for a pre and post development"

A preliminary assessment of the hydrology and culvert sizing for culverts 1, 2, 3 and a typical "small" and "medium" sized culverts was undertaken and summarised in Table 2 and Table 3 below. An indicative pre- and post-development peak flow comparison is provided for information in Table 4 below.

Please note the following:

- The hydrological and hydraulic design and associated design requirements are to be progressed and confirmed during the detail design stage;
- The small and medium sized culverts have not been designed at this stage, however an estimation of peak flow and culvert size was carried out based on catchment size.
- Peak flows for the 10% AEP CC (Annual Exceedance Probability adjusting for climate change) were assessed using the Rational Method (Q = CiA / 360):
    - C = run-off co-efficient = 0.35 based on the guidance from the Building Code Clause E1 for Surface Water
    - I = rainfall intensity based on NIWA HIRDS V4 rainfall data accounting for climate change (upscaled by 20% as per guidance from Wellington Water Reference Guide for Design Storm Hydrology) based on a time of concentration of 10 minutes.
    - A = catchment area, as delineated for each culvert.
- Culvert sizes were estimated using the HY-8 Culvert Hydraulic Analysis Program.
- Culverts with catchment areas between 0 – 1 hectares were considered a "small culvert", culverts with catchment areas 1 – 5 hectares were considered a "medium culvert", and culverts with catchment areas > 5 hectares were considered a "large culvert". The culverts along with associated size are shown in Appendix A.

    - For the small and medium culverts – the largest catchment area from each of these categories was used when assessing peak flows (taken as 0.8 hectares for "small" culverts and 4.6 hectares for "medium" culverts).
- A 1% stream bed slope was assumed for the small and medium culverts. If installed steeper, a smaller culvert may suffice.
- No fish passage assessment has been completed for the smaller culverts but is expected to be completed during the detailed design as required.
- It is anticipated that there may be a bridge to the south-west of Culvert 3, which will be further understood and designed during the detailed design stage.
- A 300mm diameter and a 600mm diameter culvert was deemed to be sufficient for small and medium catchments respectively based on achieving a minimum freeboard of 0.5m to the access track which the culvert crosses.

Table 2: Summary of Culvert Catchment Hydrology – 10% AEP CC pre-development scenario

Culvert	Run-off coefficient [C]	Time of concentration (mins)	Rainfall intensity[1], I (mm/hr)	Catchment Area, A (ha)
1	0.35	19	50.3	66.1
2	0.35	14	74.0	41.8
3	0.35	18	64.9	25.3
4 (Small)	0.35	10	83.0	0.8
5 (Medium)	0.35	10	83.0	4.6

Notes
1: Historical rainfall intensity was multiplied by 1.2 to allow for climate change as recommended by WWL Reference Guide for Design Storm Hydrology.

Table 3: Summary of Culvert Hydraulics – 10% AEP CC pre-development scenario

Culvert	Peak Flow (m^3/s) [=CiA/360]	Indicative Required Culvert Diameter (mm)	Culvert length (m)	Culvert slope (%)	Surcharge above soffit[1] (mm)
1	3.9	1200	110	4.4	1100
2	3.0	1050	100	7.0	1200
3	1.6	900	30	12.5	500
4 (Small)	0.06	300	30 - 100	1.0	0
5 (Medium)	0.37	600	25 - 80	1.0	50

Notes
1: Where the upstream water level is above the top of the pipe, this is measured as the distance between the upstream water level of the culvert (headwater level) to the top of the pipe. If the upstream water level is below the top of the pipe, this is zero. In all cases, the headwater level is expected to be contained below the crest level of the access track and achieve at least 0.5m freeboard.

Table 4: Comparison of pre and post development peak flows in 10% AEP CC design storm event

Culvert	Pre-development catchment run-off coefficient	Pre-development Peak Flow (m^3/s)	Post-development weighted run-off coefficient	Post-development Peak Flow (m^3/s)
1	0.35	3.9	0.36	4.0
2	0.35	3.0	0.36	3.1
3	0.35	1.6	0.36	1.6
4 (Small)	0.35	0.06	0.36	0.07
5 (Medium)	0.35	0.37	0.36	0.38

2.6 Request 92

92 *Similarly, please provide information (calculations and details) on proposed scour and erosion protection measures where concentrated discharges will be generated (e.g. culvert outlets or other piped or channelled outlets or runoff diversion drains).*

- Design of proposed scour and erosion protection measures will be developed further during detailed design. At this stage, it is expected that the design will follow local and regional council guidelines in the first instance to be in line with industry best practice. For the purposes of the consent design, the culvert rip rap aprons were sized using the guidance from HEC-14.
- For the detailed design - we will consider the requirements of Wellington Water, Auckland Council, and GWRC's "Stormwater Management" and "Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region" and other supplementary guidance such as HEC-14 to select the most appropriate erosion protection measures and will be designed for the 10% AEP + CC (Annual Exceedance Probability adjusted for climate change). Requirements for fish passage will be included during detailed design and incorporate NES-FM requirements.
- Erosion protection is expected to comprise either grass or planted surfaces, and rip rap, concrete, and erosion protection mattresses where velocities are expected to be high (i.e., exceed the maximum permissible velocities of the existing stream bed / bank material).
- It is expected that erosion protection will be provided for all concentrated discharges from culvert outlets, piped reticulation, and channelised flows due to the steep topography of the site. Wing walls and headwall flow transition structures, and erosion protection / energy dissipation will be provided at the inlet and outlet of culverts and piped reticulation. Channelised flows may need specific erosion protection measures such as grassed / planted surfaces, rip rap lining, and/or erosion protection mattresses.

  Where rip rap is proposed, the interstitial voids between inlet and outlet rip rap clasts will be filled with finer substrate material (matched to the existing stream bed material where appropriate) to minimize loss of flow and increase low flow depths to provide for fish passage.

2.7 Request 93

"93. We note that no information has been provided on proposed operation and maintenance or other plans during the operational phase of the project to ensure that the proposed primary and secondary drainage systems and any associated mitigation systems are regularly inspected, monitored and maintained to ensure they remain effective for the life of the project. Please provide this."

An Operations and Maintenance (O&M) plan has not been completed for this stage of design. It is envisaged that the O&M plan be developed during the construction phase of the project. O&M requirements may include the following:

- Undertaking visual inspections at an agreed frequency;
- Undertaking visual inspections after large storms;
- Maintenance of access roads;
- Maintenance of laydown areas as part of the permanent works, and any which are to be de-commissioned following the completion of construction works; and
- Unblocking drains and culverts when required, clearing out ponds and drains of sediment, correctly maintaining any stormwater treatment devices, and maintaining stormwater drains and culverts.

The requirements will be further investigated based on drainage infrastructure specified during detailed design.

2.8 Request 94

"94. Section 11 of the Tonkin & Taylor engineering report indicates that there will be surplus fill arising from the works, which will be disposed within the Turbine Envelope, and Turbine Exclusion Zones. It mentions that fill sites will be identified where catchment areas above them are minimised, however there is no information provided in the application on where these sites will be located. Please provide information to show how any potential impact of the fill sites on local catchments will be managed to ensure that natural drainage patterns are unchanged wherever possible and overland flow paths and natural floodplains are protected."

The final locations of the fill disposal areas will be confirmed at detailed design stage. The fill disposal areas will be located as much as possible long the tops of ridges where there are no catchment areas above the fill sites. Where fill disposal areas are not located at the tops of ridges and surface water flows are anticipated above the fill disposal area, a cut off / perimeter drain will be constructed around the fill area to allow surface water to pass around the fill site and return to its natural overland flow path immediately downslope of the fill area. The natural overland drainage pattern will therefore only be altered around the footprint of the fill disposal area. This fill sites will be stabilised and maintained as required by the regional councils. This may include water quality monitoring and visual inspection of the fill site to ensure the impacts on the natural flow paths and water quality are minimised.

2.9 Request 95

"95. Please also demonstrate how the proposal meets the Regional Council rules as a Permitted Activity, or alternatively apply for a resource consent and assess against the relevant planning documents."

The project planner is currently preparing a response to this request.

3 References used

Table 5 below contains examples of references which are anticipated to be used during detailed design:

Table 5: Summary of references

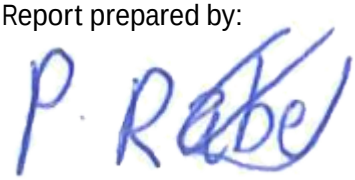
Standard or Guideline	Source	Version
Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region GD05	Auckland Council	June 2016
Stormwater Management Devices in the Auckland Region	Auckland Council	Dec 2017
Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14 (HEC-14)	Federal Highway Administration	Oct 2012
Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region	Greater Wellington Regional Council	Feb 2021
Acceptable Solution and Verification Methods for New Zealand Building Code Clause E1 Surface Water	Ministry of Business, Innovation and Employment	Jan 2017
Erosion and Sediment Control Guidelines for State Highway Infrastructure	Waka Kotahi	Sep 2014
Stormwater Treatment for State Highway Infrastructure	Waka Kotahi	May 2010
Wellington Water Regional Standard for Water Services	Wellington Water	Dec 2021
Reference Guide for Design Storm Hydrology	Wellington Water	Apr 2019

4 Applicability

We understand and agree that our client Meridian Energy Limited will submit this memorandum as part of an application for resource consent and that Masterton District Council, Tararua District Council, Greater Wellington Regional Council and Horizons Regional Council as the consenting authorities, will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:



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Pushpaka Rabel
Civil Engineer

Authorised for Tonkin & Taylor Ltd by:

PP 

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Nick Peters
Project Director
(PP'd by Maurice Mills)

7-Sep-23
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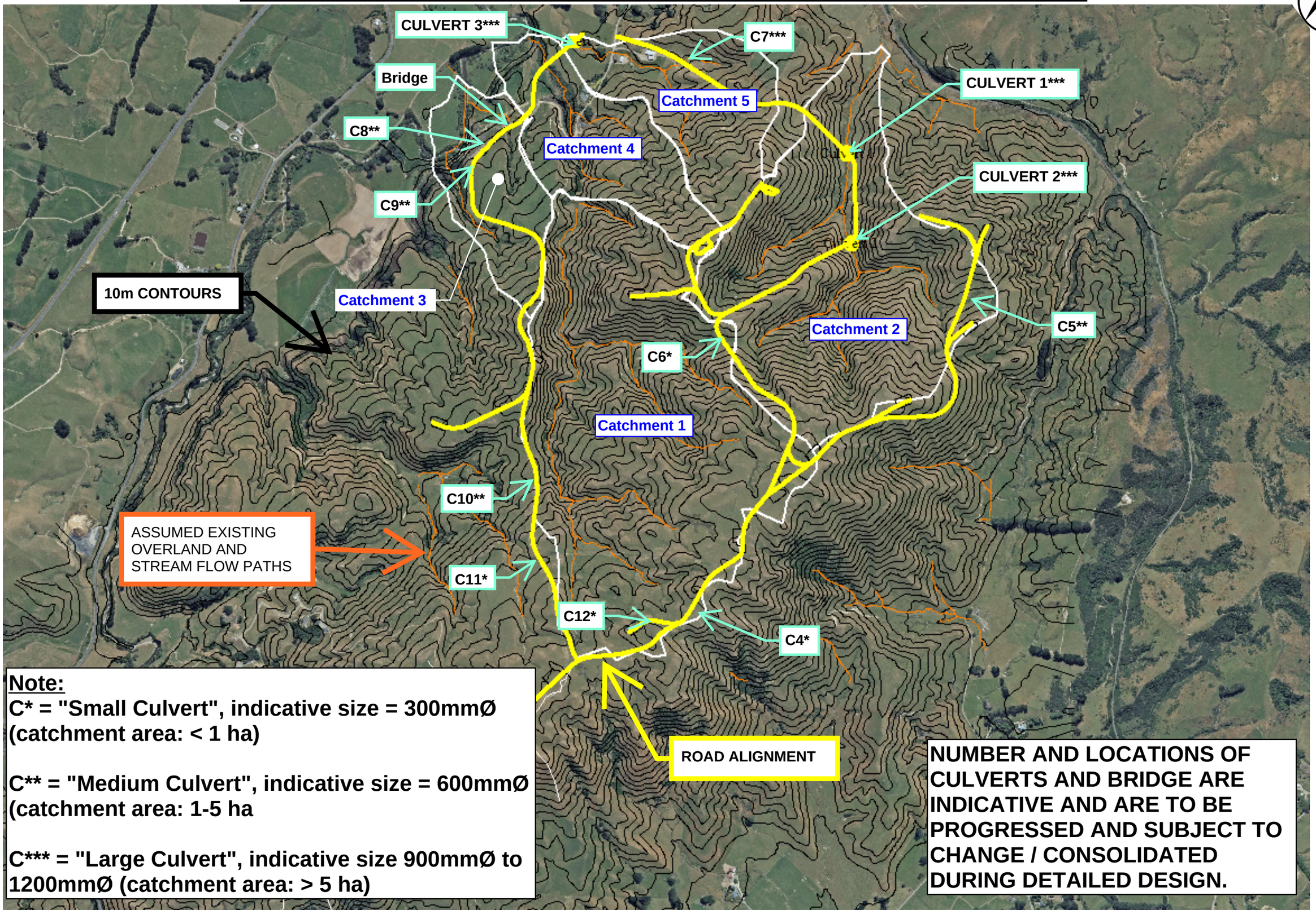
Appendix A – Request 90: Plan

MOUNT MUNRO CONCEPT DESIGN POTENTIAL CULVERT LOCATIONS



Note:
C* = "Small Culvert", indicative size = 300mmØ (catchment area: < 1 ha)

C = "Medium Culvert", indicative size = 600mmØ (catchment area: 1-5 ha**

C* = "Large Culvert", indicative size 900mmØ to 1200mmØ (catchment area: > 5 ha)**

NUMBER AND LOCATIONS OF CULVERTS AND BRIDGE ARE INDICATIVE AND ARE TO BE PROGRESSED AND SUBJECT TO CHANGE / CONSOLIDATED DURING DETAILED DESIGN.

0 m 250 m 500 m 750 m 1250 m