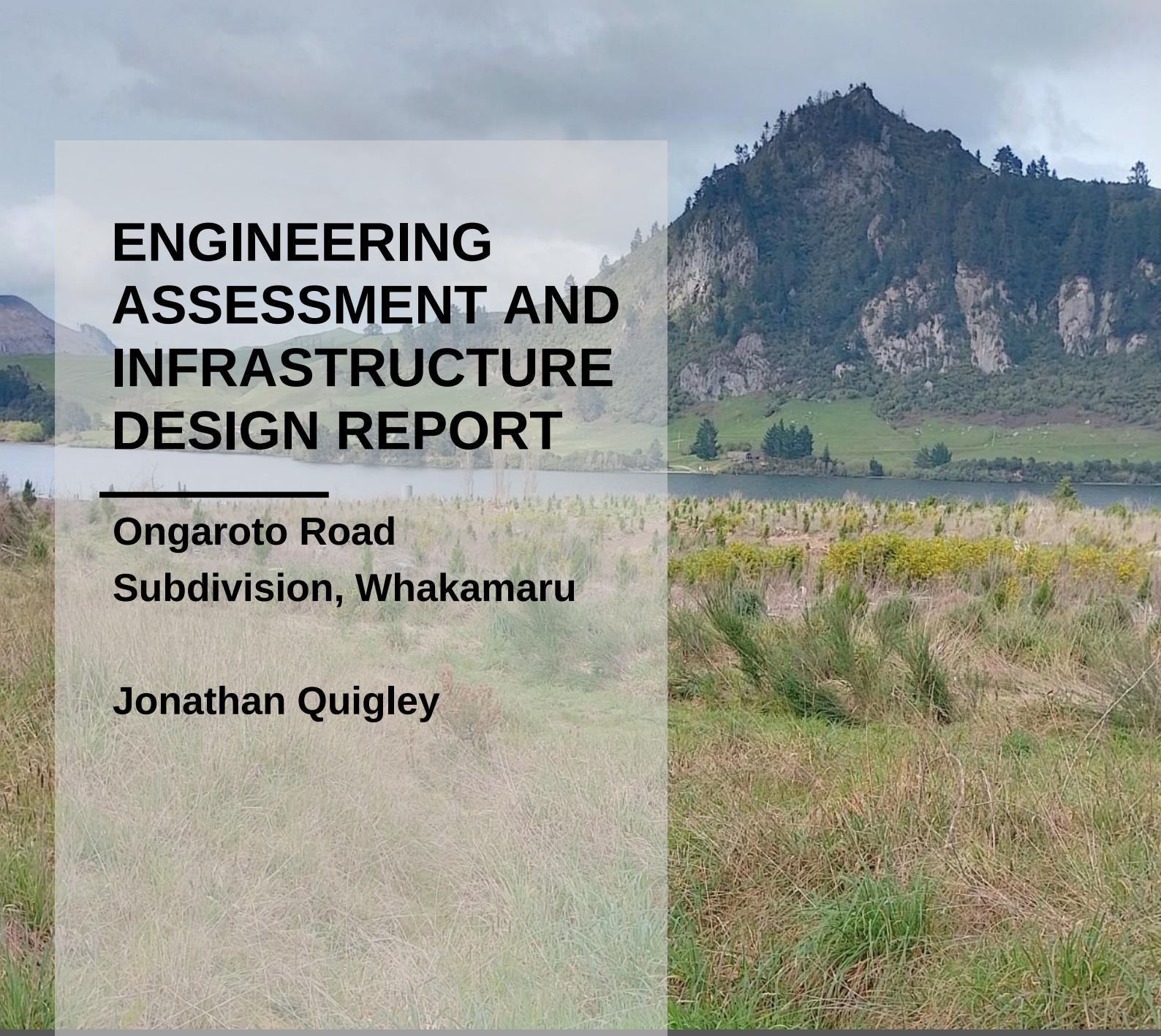

ENGINEERING ASSESSMENT AND INFRASTRUCTURE DESIGN REPORT

Ongaroto Road Subdivision, Whakamaru

Jonathan Quigley

19 FEBRUARY 2023

PROJECT NO. C2131

TITUS

CONSULTING ENGINEERS

Approved for issue by:

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RECORD OF REVISION CHANGES

Revision A: First Issue.

Revision B: Updated as per Client markup.

Revision C: Sections 3.2.3, and 7.2.2 updated.

Revision D: Section 3.2 and 7.2 updated based on District Council Comments and Flood levels from Mercury as follows:

The AEE does reference natural hazards and refers to Council Planning maps, which Mercury has not reviewed for this purpose. Given the managed nature of flows and levels associated with Lake Whakamaru and the Waikato Hydro System. With no building platform for habitable structures identified, Mercury seeks a minimum freeboard for all habitable structures and dwellings is 0.5m above Probable Maximum Flood 228.67m RL, which result in a level of 229.17m RL minimum freeboard.

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1 INTRODUCTION

Titus Consulting Engineers has been engaged by Jonathan Quigley to prepare a preliminary 'Engineering Assessment and Infrastructure Design Report' for land at Ongaroto Road (SH30), Whakamaru for the subdivision of Lot 9 DP 425239 into approximately 66 Lots. It is understood this report will be used to support a plan change and subsequent resource consent application for the proposed development.

Requirements detailed within the South Waikato District Council Plan, Waikato Regional Council Plan and Site Suitability and Natural Hazard Subdivisional Reports have been duly considered in the report and its recommendations.

The report includes the following:

- Section 2: Site and Soils Assessment
- Section 3: Stormwater Assessment
- Section 4: Wastewater Assessment
- Section 5: Water Assessment
- Section 6: Roading Assessment
- Section 7: Flood Assessment

The assessments and recommendations meet the requirements of the local regional authority, South Waikato District Council, and the following technical documents:

- South Waikato Council District Plan
- Waikato Local Authority Shared Services (RITS)
- Waikato Regional Council Plan

The report is subject to revision based on any unsighted planning requirements.

2 SITE AND GEOTECHNICAL INVESTIGATION

2.1 Site Description

The site is located on the northern bank of the Waikato River near Whakamaru, above the Whakamaru lake. The site is currently a forestry block that has been recently felled and re-planted. The site is bordered by State Highway 30 to the northeast and Crown Land on the remaining side. The Waikato River encloses the Crown Land on its remaining boundaries. The site is predominantly gently to moderately sloping. Most of this slope is towards the lake with undulations from forestry earthworks near SH30. There are some steep to very steep sections of slope near the existing access way on the boundary nearest the lake. Much of the site is covered in stumps from the prior land usage. These have been removed from the eastern portion of the site.

It is noted that on a site walkover on the 28th of September 2022 much of the site had been cleared and new pine saplings had been planted. The clearing of the site highlighted areas used as skids for forestry and showed the metal at the surface. It also showed that at the surface in some locations are boulders and rock outcrops. The lower south-eastern portion of the site directly adjacent to the lake and local reserve had shown areas of recontouring.

Figure 1: Site Photo

2.2 Proposed Site Development

The proposed site development is in relation to the proposed conceptual subdivision of an area of 31.6749 ha into approximately 66 lots with two roads within the subdivision.

A plan showing the proposed lots can be found in Appendix A. The proposed lots range in size but are each predominantly over 2500m^2. It is understood that lot sizes have the potential to change, as well as their numbers and locations.

It is proposed that access to the subdivision will be from a new road network which is to connect to SH30 at new intersection approximately halfway along the development road frontage.

2.3 Geotechnical Investigation

Refer to Titus Consulting Engineers C2131 – Site Suitability and Natural Hazard Report for the site geotechnical testing data and recommendations.

3 STORMWATER ASSESSMENT

3.1 Existing Stormwater Infrastructure

There is no South Waikato District Council Stormwater infrastructure within or in the near vicinity of the proposed development.

State Highway 30 (SH30) has approximately 5 culverts that discharge upper catchments along the proposed development road frontage. The culvert locations as measured from the existing road intersection centreline at the northern end of the development (unnamed forestry road and existing Lot/Reserve entrance) are as follows:

1) Unnamed Forestry Road Centre Line = Chainage 0.0
2) Existing Culvert 1
    a. 375mmØ Culvert = Chainage 100m
3) Existing Culvert 2
    a. 300mmØ Culvert = Chainage 380m
4) Existing Culvert 3
    a. 375mmØ Culvert = Chainage 620m
5) Existing Culvert 4
    a. 300mmØ Culvert = Chainage 830m
6) Existing Culvert 5
    a. 375mmØ Culvert = Chainage 980m

Refer to Section 7 for the upper catchment assessment.

3.2 Proposed Stormwater Infrastructure

Given the proximity of the development to the existing lake and slopes running down to Lake Whakamaru below, the management of surface water runoff will be an important aspect of the proposed development that will require detailed assessment to prevent erosion of soils and potential for slips. Options would potentially include the use of soakage, attenuation storage, the inclusion of appropriate infrastructure for the collection of surface water runoff with discharge into the lake or a combination of all three. Detailed Stormwater assessment and design shall be undertaken at engineering approval stage for the proposed development.

Due to the location of the proposed subdivision development to the adjacent lake, it is anticipated that a Waikato Regional Council consent would be required.

3.2.1 Waikato Regional Council Assessment

Due to the location of the proposed subdivision development to the adjacent lake, it is anticipated that a Waikato Regional Council (WRC) Stormwater Discharge Consent may be required for this development.

Refer to WRC rules

- 3.5.11.4 – Permitted Activity Rule – Discharge of Stormwater Into Water

- c) The catchment shall not exceed one hectare for discharges that originate from urban areas.
  - *Proposed development may be considered an urban development due to the road networks and inclusion of additional housing in an otherwise rural area.*
- d) There shall be no adverse increase in water levels downstream of the discharge point which causes flooding on neighbouring properties, as a result of the discharge
  - *Proposed development may be required to restrict discharge of stormwater to pre-development volumes.*
- e) The discharge shall comply with the suspended solids standards in Section 3.2.4.6
  - *Proposed development may be required to demonstrate how this will be achieved both during construction and developed stages.*
- f) The discharge shall not contain any material which will cause the production of conspicuous oil or grease films, scums or foams, or floatable suspended materials.
  - *Proposed development may be required to demonstrate how road run-off petrol-chemicals are dealt with prior to discharge.*
- g) The discharge shall not contain concentrations of hazardous substances that may cause significant adverse effects on aquatic life or the subtility of the water for human consumption.
  - *Proposed development may be required to demonstrate how road run-off petrol-chemicals are dealt with prior to discharge.*

- 3.5.11.5 – Permitted Activity Rule – Discharge of Stormwater onto or Into Land
  - b) The discharge shall be below a rate that would cause flooding outside the design discharge soakage area, except in rain events equivalent to the 10% Annual Exceedance Probability design storm or greater. Any exceedance shall go into designated overland flow paths.
    - *Proposed development maybe required to demonstrate that sufficient soakage is achievable and secondary overland flows are catered for.*
  - c) There shall not be any overland flow resulting in a discharge to surface water, expect in rain events equivalent to the 10% Annual Exceedance Probability design storm or greater; then there shall be no adverse surface water effects as a result of the discharge.
    - Proposed *development maybe required to demonstrate that sufficient soakage is achievable and no secondary flooding and/or ponding will occur.*
  - e) The discharge shall not contain concentrations of hazardous substances that may cause significant adverse effects on aquatic life or the subtility of the water for human consumption
    - *Proposed development may be required to demonstrate how road run-off petrol-chemicals are dealt with prior to discharge.*

- 3.5.11.6 – Controlled Activity Rule – Discharge of Stormwater onto or Into Land

- *a) The discharge shall be below a rate that would cause overland flow leading to discharge to surface water, except in rain events equivalent to the 10% Annual Exceedance Probability design storm or greater. Any exceedance shall go into designated overland flow paths.*
  - *Proposed development maybe required to demonstrate appropriate measures are used to:*
    - *Control erosion or Flooding*
    - *Avoid, remedy or mitigate the discharge of groundwater quality*
    - *Avoid, remedying or mitigating the effect of maintaining stormwater treatment systems*
    - *Avoid, remedy or mitigate the effects of the discharge on surface water bodies*
    - *Avoid, remedy or mitigate adverse effects on neighbouring property.*

- 3.5.11.7 – Controlled Activity Rule – Discharge of Stormwater into Water
  - The discharge shall not contain concentrations of hazardous substances that are causing significant adverse effects on aquatic life or the subtility of the water for human consumption
    - *Proposed development may be required to demonstrate how road run-off petrol-chemicals are dealt with prior to discharge.*

- 3.5.11.8 – Discretionary Activity Rule – Discharge of Stormwater
  - The discharge of stormwater into water, and/or into land which does not comply with Rules 3.5.11.4 – 3.5.11.7 is a discretionary activity (requiring resource consent.

The overall development stormwater treatment and conveyance philosophy will need to be in accordance with any WRC Stormwater Discharge Consent.

3.2.2 Road Network Assessments

The proposed development will construct internal road networks to the Regional Infrastructure Technical Specification (RITS) standards.

Road stormwater conveyance shall predominately be via roadside swales sized to accommodate the appropriate design event, which is anticipated to be the 1 in 10-year event. Roadside swales will be designed to accommodate both conveyance of the design event, and where site contours allow treatment of the Water Quality volume.

Where Water Quality volume cannot be achieved via roadside swales, residence time and volume, then it is anticipated that the additional treatment can be achieved via appropriately sized and located soakage devices, such as Cirtex Trition or Rain Smart systems (or approved similar systems), or appropriately sized soakage swales located within the road reserves.

As identified in the Site Suitability and Natural Hazard report, the soils show susceptibility to “Rilling” and “Scouring”, as such swales on slopes will require to be appropriately designed to account for scouring. Riprap scour protection and planting (grass) may be required.

Where road gradients are prohibitive to the use of swales, internal pipe infrastructure may be required in certain areas. These areas will be piped directly to any soakage treatment devices that may be required.

Refer to Appendix A for the proposed road network layout and typical road cross-section.

3.2.3 Upstream Catchment Assessment

The existing culverts that convey and discharge the upstream catchment from the proposed development will be conveyed via either the road network swales and/or stormwater swales within reserve areas/corridors.

Based on the existing culverts identified in section 3.1 above, the associated conveyance corridors are as follows

- Culvert 1
    - Roadside swale will convey the flow to the west connecting to the roadside swales and reserve corridor A.
    - It is noted that a culvert will be required under the ROW entrance to convey this flow. This culvert will need to be sized accordingly.
- Culvert 2
    - Roadside swale will convey the flow to the west connecting to the reserve corridor E and D.
    - It is noted that a culvert will be required under the road to connect reserve area E with reserve area D. This Culvert will need to be sized accordingly.
- Culvert 3
    - Roadside swale will direct the flow to reserve corridor I connecting to the internal roadside swale, which will direct to reserve corridor J.
    - It is noted that the lower portions of the internal swale will need to be sized accordingly to accommodate this additional flow.
    - It is noted that a culvert will be required under the road to connect with reserve area J. This culvert will need to be sized accordingly.
- Culvert 4
    - Roadside swale will direct the flow to the reserve corridor K, connection to the internal roadside swale, conveying the flow to the east towards reserve corridor L.
    - It is noted that the lower portions of the internal swale will need to be sized accordingly to accommodate this additional flow.
- Culvert 5
    - Roadside swale will direct the flow to the reserve corridor L.
    - It is noted that a culvert will be required under the ROW entrance to convey this flow. Culvert will need to be sized accordingly.

General comment is noted that the reserve locations may need to be adjusted to suit the location of the existing culverts to improve conveyance of the upper catchments flows.

All discharge points into the lakeside reserve will need to be designed and constructed in accordance with Waikato Regional Council standards and regulations.

The initial assessment of the stormwater philosophy indicates that the anticipated runoff from the upper catchments discharging through the existing culverts beneath SH30, can be managed along the north-eastern site boundary and through the proposed development via the road network and associated reserve corridors. The identified flow paths and devices will be designed during the engineering plan approval stage to either eliminate or limit any negative impact on the individual lots.

3.2.4 Individual Lot Assessment

Stormwater assessments shall be undertaken at the building consent stage for individual houses. Rainfall data is to be derived from the HIRDS data for the Whakamaru area with the appropriate climate change adjustment. Hydraulic neutrality should be provided on each lot for the addition of impervious surfaces. The disposal of stormwater should not cause a nuisance to neighbouring properties and public infrastructure.

Given the dryness and high permeability of the underlying pumice sands a high soakage rate is expected. As such it is likely that conventional soakage devices will be appropriate for much of the site. It is recommended however that this is proven with several onsite soakage tests prior to detail design of individual soakage systems. In order to prevent “rilling” and piping of the insitu pumice soils, soakage and swale systems may need to be lined with geotextile.

3.2.5 Secondary Overland Flows

The secondary overland flows will be via the road networks and associated reserve corridors. Where secondary overland flow paths for runoff from developed lots are not available to discharge to road or reserve areas, appropriate flow paths shall be designated.

4 WASTEWATER ASSESSMENT

4.1 Existing Wastewater Network

There is no South Waikato District Council Wastewater infrastructure within and/or within the near vicinity of the proposed development.

4.2 Waikato Regional Council Assessment

Depending upon the proposed method of individual lot onsite discharge, each individual lot could undertake the discharge to land as a Permitted Activity, or as a Discretionary Activity. As such it is not anticipated that a Waikato Regional Council (WRC) consent will be required for onsite wastewater disposal.

Refer to WRC rules

- 3.5.7.5 – Permitted Activity Rule – Discharge of Domestic Sewage from New On-Site Systems
  - *Volume shall not exceed 1.3m³ per day*
  - *Minimum septic tank size of 3,000 litres*
  - *No discharge direct to ground water*
  - *Minimum Area of 2,500m²*
  - *Minimum set back from Waters edge of 10m*
  - *Minimum clearance of 600mm from Water Table*
- 3.5.7.6 – Permitted Activity Rule – Discharge of Sewage from Improved On-site Domestic Sewage Treatment and Disposal Systems
  - *Pre-treatment of effluent not to exceed 20g/m³ of Biological Oxygen Demand and 30g/m³ of suspended solids*
  - *No discharge direct to ground water*
  - *Minimum set back from Waters edge of 10m*
  - *Minimum clearance of 600mm from Water Table*
- 3.5.7.7 – Discretionary Activity – Other On-Site Sewage Discharges
  - *If non-compliant with Rule 3.5.7.5 or 3.5.7.6 must provide setback of 20m from Significant Geothermal Features*

4.3 Proposed Lot Wastewater Infrastructure

The assessment has been carried out in accordance with the local authority's requirements and; AS/NZS 1547/2012: On-site Domestic Wastewater Management (AS/NZS 1547), and the Waikato Regional Plan.

The soils on the site are classified as Sandy Loams (Category 2) as determined by the preliminary soil assessment.

Primary or secondary on-site wastewater disposal methods are considered appropriate to manage wastewater for the proposed development unless the lot is less than 2500m^2 (where secondary systems will be required). Lot Specific assessments will be required at building consent stage, with particular attention being required to consider the slope on the section and the high permeability of the pumice soils on site. This may require that traditional disposal

beds / trenches are avoided and dripper lines, Wisconsin mounds or ETS beds are adopted for on lot wastewater disposal. It is recommended that the disposal fields are located away from large clusters of trees and in areas where the necessary vertical clearance between the winter water table level and base of the effluent disposal system is achieved. On proposed sites with significant slopes secondary disposal methods may be required.

It is not anticipated that flooding should occur at elevated areas of the site. However, disposal fields constructed in low-lying isolated areas should be avoided. Wastewater disposal fields must also be offset 30m from the river/lake at the base of the slope. Sufficient area is available for disposal and reserve fields on the site for the proposed development.

5 WATER ASSESSMENT

5.1 Existing Water Supply

There is no South Waikato District Council Water Supply infrastructure within and/or within the near vicinity of the proposed development.

5.2 Waikato Regional Council Assessment

It is not anticipated that any bores and/or water take from the Lake be used for potable or non-potable supply, therefore it is not anticipated that a Waikato Regional Council (WRC) consent will be required for water take and/or supply.

5.3 Proposed Water Supply

It is anticipated that each individual Lot will install onsite rainwater harvesting and storage in rainwater tanks for reuse as potable and non-potable water supply.

Fire fighting supply will be via the installation of additional water supply tanks to meet the district council requirements for Rural and Rural Residential developments.

The number, size and location of water supply tanks shall be undertaken at building consent stage for each individual house/lot.

6 ROADING ASSESSMENT

6.1 Existing Road Network Assessment

The Existing Lot has access at the Western end of the State Highway Road frontage via the council access road to the lake boat ramp and camping reserve.

6.2 Proposed Roading Infrastructure

Detailed Road network, Right of Way, Accessway, Footpath, and Pavement assessment and design shall be undertaken at engineering approval stage for the proposed development.

Detailed design of the State Highway Intersection will be undertaken at Detailed design stage and approval of any design will be subject to NZTA.

Individual Lots shall have specific driveway and/or access assessment and design undertaken at building consent stage.

6.3 State Highway Intersection

Refer to CKL report for the proposed new intersection.

6.4 Proposed Development Internal Road Layout

All internal roads will be designed to Regional Infrastructure Technical Specifications (RITS) standards and will be vested with the South Waikato District Council (SWDC).

All private Right of Ways and Accessways will be designed to the RITS standards but not vested with SWDC.

The proposed development will consist of three (3) local roads, eight (8) right of ways and three (3) accessways, as well as six (6) footpath links to the lake and council reserve area. The internal roading layout design has considered the topography to limit earthworks.

The main road off State Highway 30 will provide access to the council reserve and camping area.

Refer to Appendix A for proposed road network layout and typical road cross-section.

7 FLOOD ASSESSMENT

7.1 FLOOD RISK ASSESSMENT

7.1.1 Background Information

A review of the Waikato Regional Council Flooding maps shows no regional or local scale flooding in the area. Refer to the figure below.

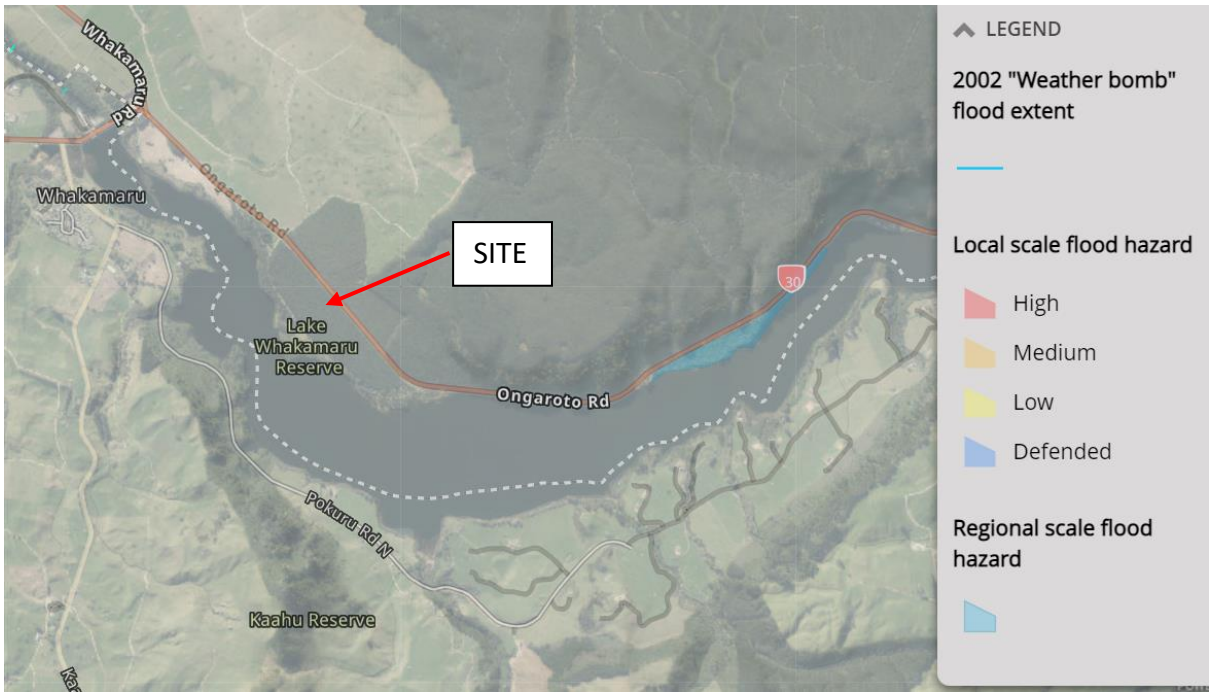


Figure 2: WRC Flooding Hazard Information (No regional scale flooding indicated)

A review of the South Waikato District Council GIS also shows no flooding for the site as shown in the figure below.

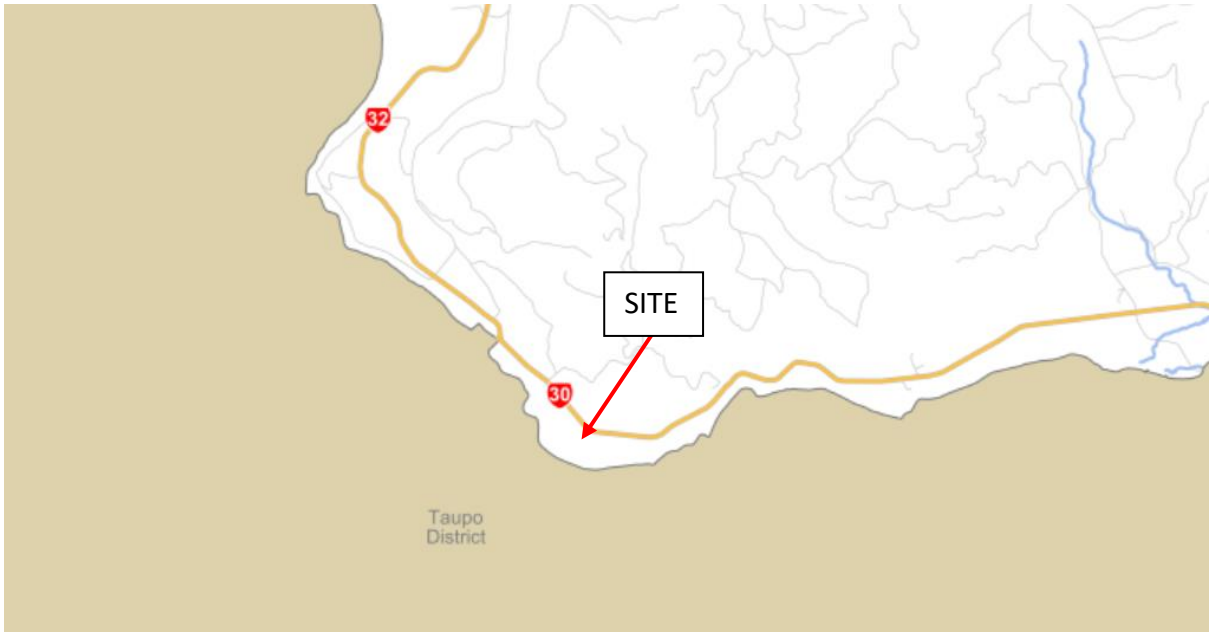


Figure 3: SWDC Flooding Hazard Information (No flooding indicated)

7.1.2 Existing Site

7.1.2.1 Topography

The topography on the site ranges from 260mRL to 230mRL. The higher lying topography levels range from 440mRL (east and northeast of the site) down to predominantly 260mRL along SH30 with the lowest part at a level of 230mRL in the southeast of the site. The site is bordered by Lake Whakamaru / Waikato River along the southwest boundary.

The existing overland flow paths are shown in the figure below.

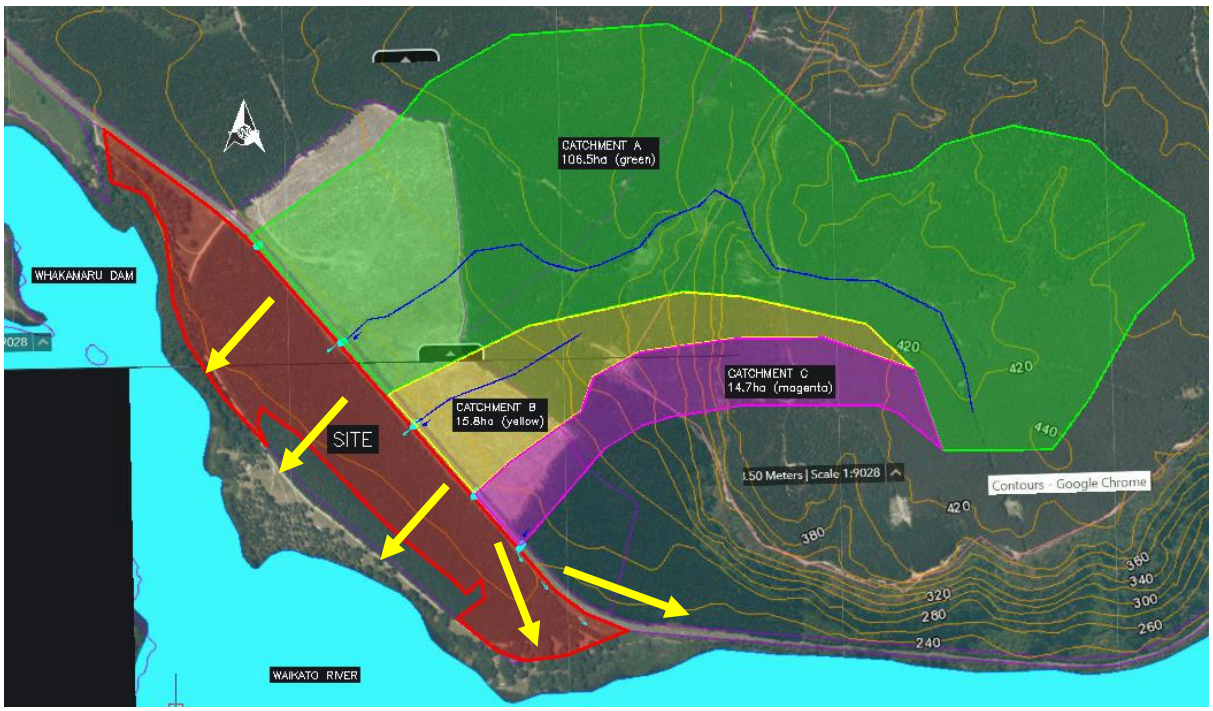


Figure 4 - Flow paths (HCC GIS)

7.1.3 Lake Whakamaru / Waikato River

Lake Whakamaru is operated by Mercury Energy who have confirmed that the probable maximum flood (pmf) level for the ultimate flood scenario is 228.66 masl. The majority of the site levels are considerably higher than this, however the lowest portion in the southeast needs to ensure that minimum final floor levels consider this level and apply the applicable freeboard of 500mm. Refer to the figure below.

Figure 5 – Maximum Flood Level (Mercury Energy)

7.1.4 Upper Catchment Assessment

Five existing pipe culverts were identified along SH30 and although the culverts appeared to predominantly provide cross drainage for runoff from the road prism, this assessment will consider a conservative approach and assume that the upper catchment runoff will be managed through the proposed development at culverts 2, 3 & 5 which are located at low points. Refer to Figures 4 and 6.

The upstream catchments were delineated using the culverts and WRC 20m contours.

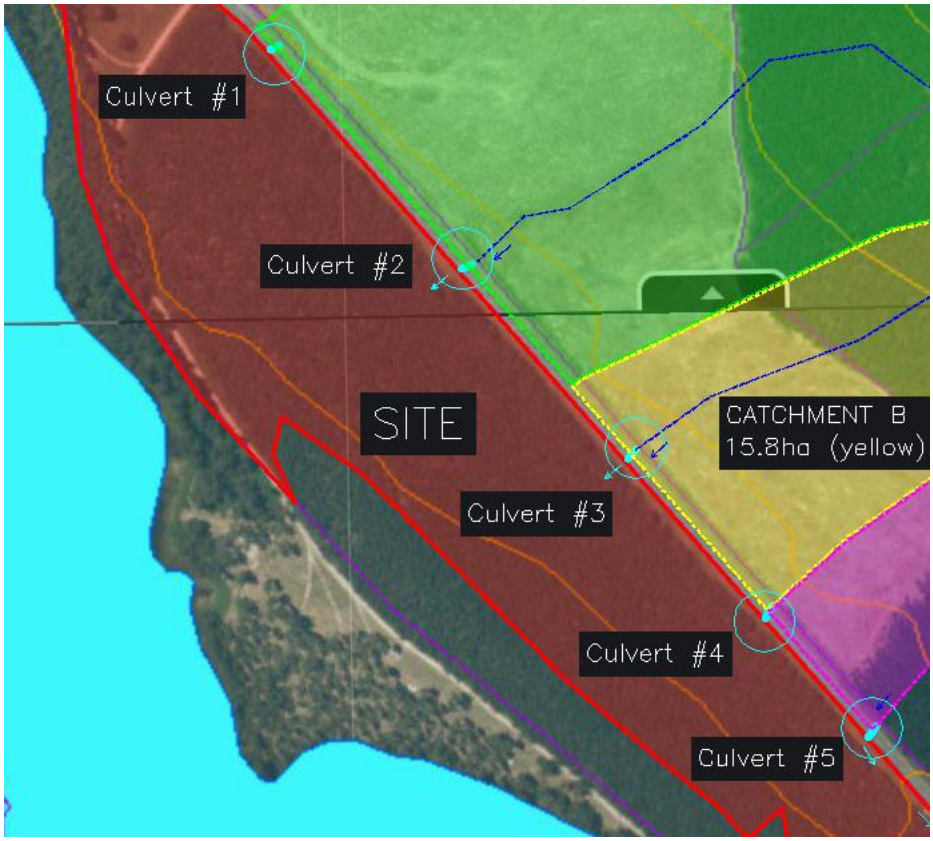


Figure 6 – Existing Pipe Culverts under SH30

Three catchments were delineated as follows;

- Catchment A (106.5ha)
- Catchment B (15.8ha), and
- Catchment C (14.7ha).

The design rainfall is based on HIRDS with 2.1 degrees climate change adjustment with rainfall data from the Tokoroa rainfall gauge. The storm intensities were fitted to a 24-hour rainfall distribution as per WRC Technical Report 2020/06 - WRC Stormwater Modelling Guidelines.

7.1.4.1 Catchment A

Stormwater runoff for Catchment A was calculated as a simple catchment area. The impervious area percentage was calculated from desktop measurements, with a value of approximately 0.5% across the catchment as concrete / sealed areas. The balance of 99.5% of the catchment area was taken as permeable. The catchment characteristics are provided in Figure 7.

A primary design storm of 1 in 100yr has been used.

FLOW & VOLUME OUTPUTS

Catchment A

Rainfall Location	Event	ARI
Tokoroa	Primary	100
	Secondary	100

Catchment	Area (m2)		C
	Existing	Proposed	
Grass	1,059,500	1,059,500	0.30
Roof			0.95
Concrete	5,500	5,500	0.90
Gravel			0.70
Other			-
TOTAL	**1,065,000**	**1,065,000**	
Composite C	0.3030986	0.30	
Adopted C	**0.30**	**0.30**	

Figure 7: Catchment A Characteristics

The catchment input parameters as derived from the WRC Technical Report 2020/06 - WRC Stormwater Modelling Guidelines are shown in the table below. The hydrological soil group (HSG) is considered Group C with tree farming in fair condition.

Table 1 – Catchment A Input Parameters

Initial Abstraction (mm)	Curve Number	Lag time (min)
4	76	24

7.1.4.1.1 Hydrological Modelling

The proposed 1 in 100yr design storm (i.e. including Climate Change) graph from HEC HMS is shown in Figure 8.

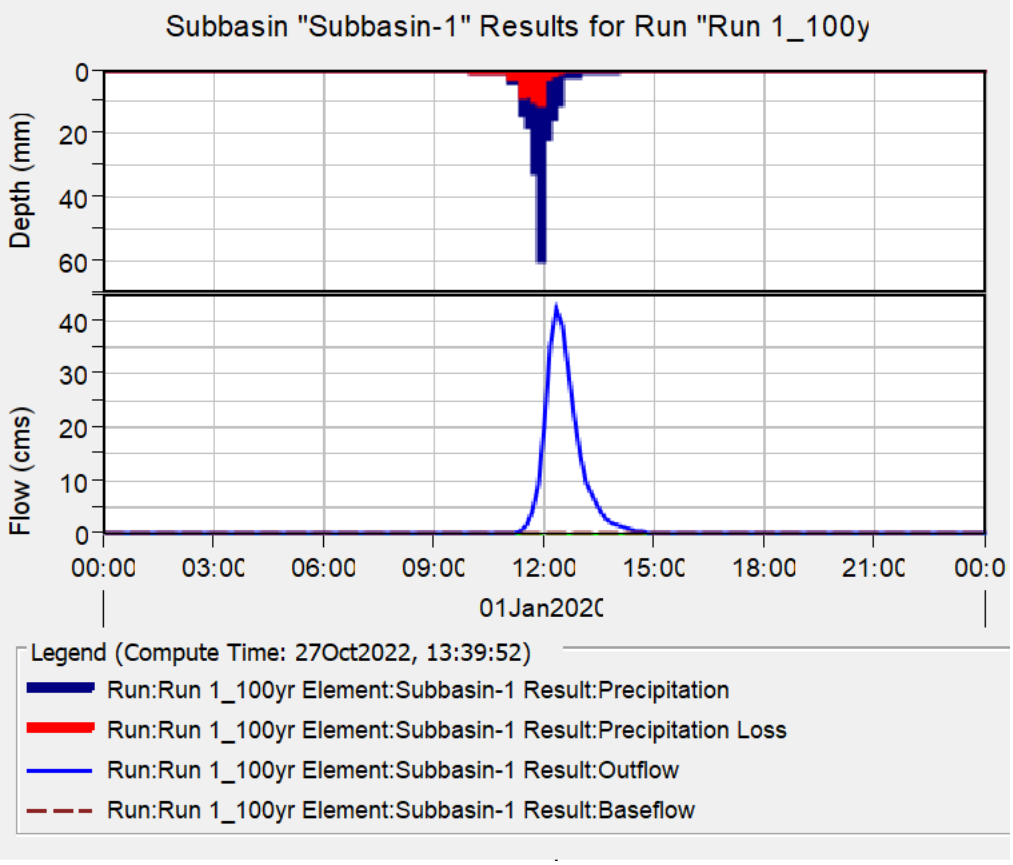


Figure 8: HEC HMS Precipitation Depth and Runoff Volume (Catchment A)

The distribution in the above figure summarises the following:

- *Precipitation total depth of 207.8mm with a direct runoff total depth of 146.5mm.*
- *Peak depth: 59.9mm.*
- *Precipitation volume of 221 307m³ with a direct runoff volume of 155 987m³.*
- *Peak Discharge: 42.13m³/s.*

7.1.4.2 Catchment B

Stormwater runoff for Catchment B was calculated as a simple catchment area. The impervious area percentage was calculated from desktop measurements, with a value of approximately 2.2% across the catchment as concrete / sealed areas. The balance of 97.8% of the catchment area was taken as permeable. The catchment characteristics are provided in Figure 9.

A primary design storm of 1 in 100yr has been used.

FLOW & VOLUME OUTPUTS

Catchment B

Rainfall Location	Event	ARI
Tokoroa	Primary	100
	Secondary	100

Catchment	Area (m2)		C
	Existing	Proposed	
Grass	154,500	154,500	0.30
Roof	-		0.95
Concrete	3,500	3,500	0.90
Gravel			0.70
Other			-
TOTAL	**158,000**	**158,000**	
Composite C	0.3132911	0.31	
Adopted C	**0.31**	**0.31**	

Figure 9: Catchment B Characteristics

The catchment input parameters as derived from the WRC Technical Report 2020/06 - WRC Stormwater Modelling Guidelines are shown in the table below. The hydrological soil group (HSG) is considered Group C with tree farming in fair condition.

Table 2 – Catchment B Input Parameters

Initial Abstraction (mm)	Curve Number	Lag time (min)
4	76	19

7.1.4.2.1 Hydrological Modelling

The proposed 1 in 100yr design storm (i.e. including Climate Change) graph from HEC HMS is shown in Figure 10.

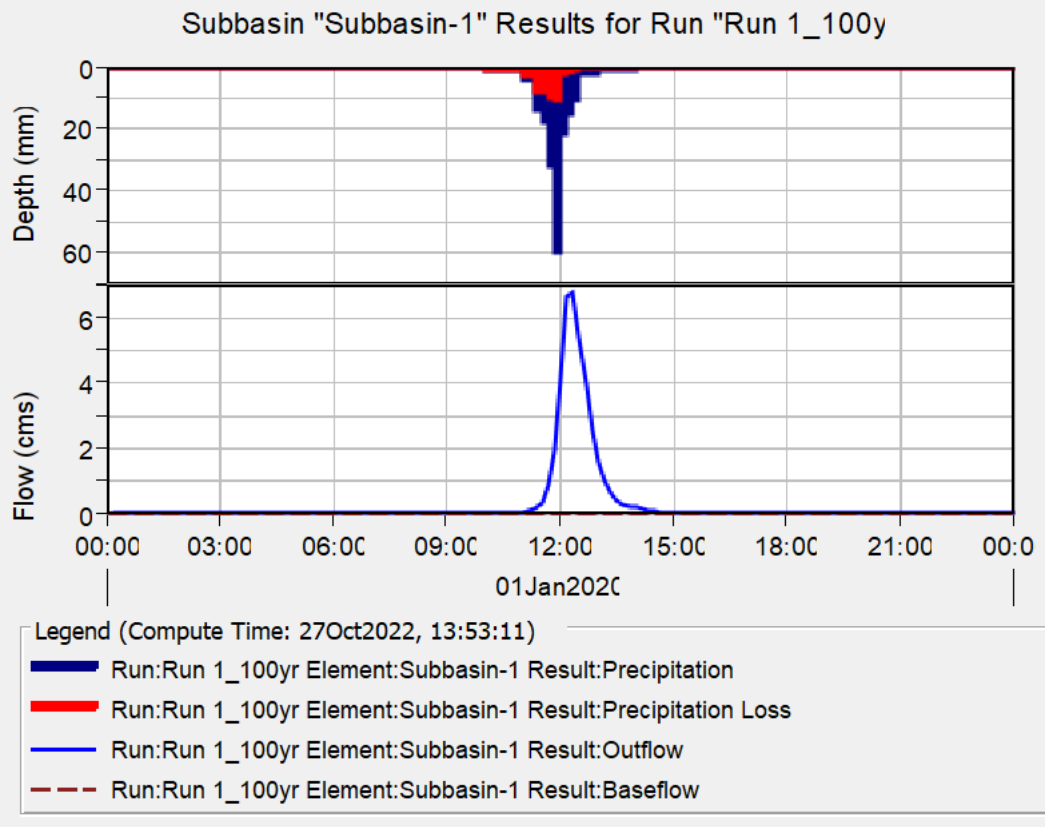


Figure 10: HEC HMS Precipitation Depth and Runoff Volume (Catchment B)

The distribution in the above figure summarises the following:

- *Precipitation total depth of 207.8mm with a direct runoff total depth of 147.5mm.*
- *Peak depth: 59.9mm.*
- *Precipitation volume of 32 832m³ with a direct runoff volume of 23 311m³.*
- *Peak Discharge: 6.77m³/s.*

7.1.4.3 Catchment C

Stormwater runoff for Catchment C was calculated as a simple catchment area. The impervious area percentage was calculated from desktop measurements, with a value of approximately 1.0% across the catchment as concrete / sealed areas. The balance of 99.0% of the catchment area was taken as permeable. The catchment characteristics are provided in Figure 11.

A primary design storm of 1 in 100yr has been used.

FLOW & VOLUME OUTPUTS

Catchment C

Rainfall Location	Event	ARI
Tokoroa	Primary	100
	Secondary	100

Catchment	Area (m2)		C
	Existing	Proposed	
Grass	145,500	145,500	0.30
Roof	-		0.95
Concrete	1,500	1,500	0.90
Gravel			0.70
Other			-
TOTAL	**147,000**	**147,000**	
Composite C	0.3061224	0.31	
Adopted C	**0.31**	**0.31**	

Figure 11: Catchment C Characteristics

The catchment input parameters as derived from the WRC Technical Report 2020/06 - WRC Stormwater Modelling Guidelines are shown in the table below. The hydrological soil group (HSG) is considered Group C with tree farming in fair condition.

Table 3 – Catchment C Input Parameters

Initial Abstraction (mm)	Curve Number	Lag time (min)
4	76	19

7.1.4.3.1 Hydrological Modelling

The proposed 1 in 100yr design storm (i.e. including Climate Change) graph from HEC HMS is shown in Figure 12.

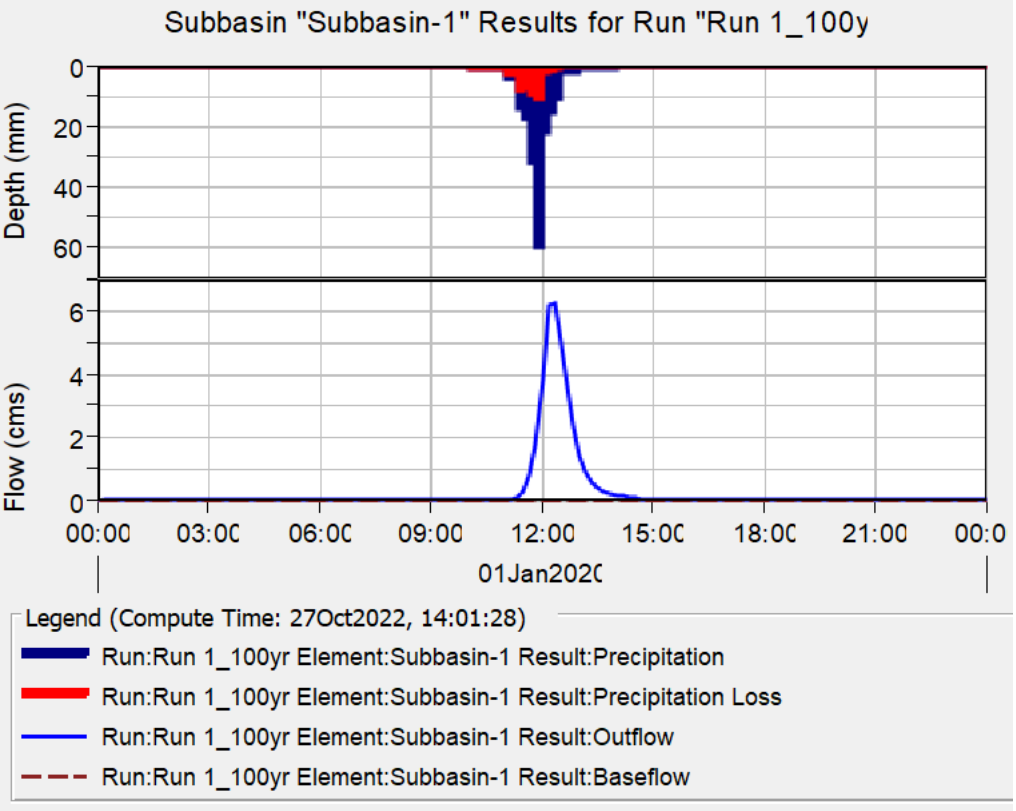


Figure 12: HEC HMS Precipitation Depth and Runoff Volume (Catchment C)

The distribution in the above figure summarises the following:

- *Precipitation total depth of 207.8mm with a direct runoff total depth of 146.8mm.*
- *Peak depth: 59.9mm.*
- *Precipitation volume of 30 547m³ with a direct runoff volume of 21 579m³.*
- *Peak Discharge: 6.28m³/s.*

7.1.4.4 Summary of Analysis

Apart from a small portion of the site in the southeast, the proposed development is above the probable maximum flood level expected for Lake Whakamaru / Waikato River.

The results for the stormwater runoff from the upper catchment northeast of SH30 have produced substantial runoff volumes. During the onsite visit, there was no evidence of any overtopping of the road or large-scale erosion from any runoff discharging from the upper catchment, indicating that there may be channels further upstream in the catchments which could be diverting the runoff and that the existing roadside drains and culverts are managing the runoff adequately. For the purpose of this assessment, the maximum capacity of the existing culverts has been used as the runoff volumes which need to be managed through the proposed development for the primary storm.

7.2 Recommendations

7.2.1 Lot Specific Effects

Cut and Fill and localised landscaping of the proposed lots shall provide for unimpeded overland flows across the site and shall not concentrate runoff towards any buildings. Where cut into the existing ground is anticipated for the construction of the building platforms, it is to be ensured that stormwater runoff can be drained off the surrounding areas.

In accordance with the risks assessed in this report the minimum Final Floor Levels (FFL) to the underside of the floor slabs / joists, whichever is applicable, is to be a minimum of 229.17mRL (228.67 + 0.5m) or the requirements of the Building Code with respect to adjacent ground.

Note that the above levels are based on levels provided by Mercury Energy and WRC.

7.2.2 Secondary flows across subdivision

For the purpose of this assessment, the maximum capacity of the existing culverts has been used as the runoff volumes which need to be managed through the proposed development for the primary storm. The road network and associated reserve corridors of the proposed development will be aligned with the secondary overland flow paths. The flow paths and devices will be designed during the engineering plan approval stage to either eliminate or limit any negative impact on the individual lots. The reserve strips may potentially need to be shaped and planted in order to prevent excess secondary flows from affecting adjacent sections.

8 LIMITATIONS

This report does not assess risk of contamination of soils. This report does not provide a foundation design. An assessment of flood risk has been done but does not provide a flood analysis.

Testing portrays a limited percentage of ground conditions at Ongaroto Road (SH30), Whakamaru and may not be representative of all soils present on site.

Assessment of the water table depth and moisture content is subject to seasonal variation.

During excavation and construction, the site should be examined by a suitably qualified engineer in order to assess whether the exposed subsoils are compatible with the inferred soil conditions on which the recommendations have been based and potentially further investigation and design rationalisation may be required.

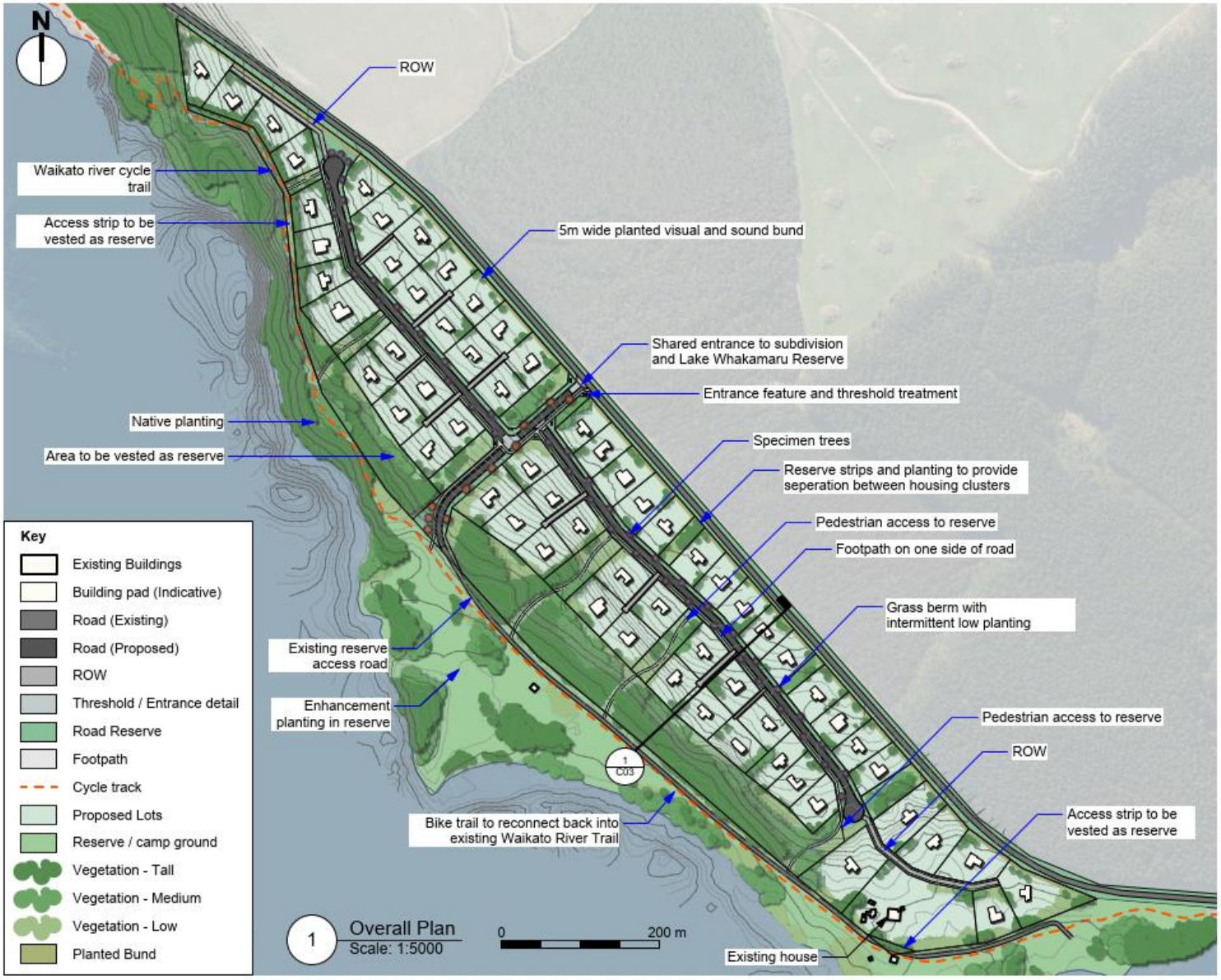
This report has been prepared solely for Jonathan Quigley, its professional advisors and local authorities in relation to Ongaroto Road (SH30), Whakamaru. No liability is accepted for its use for any other purpose or by any other entity. Reliance by other parties or future owners of the property on the information or opinions contained in the report shall be verified with Titus Consulting Engineers.

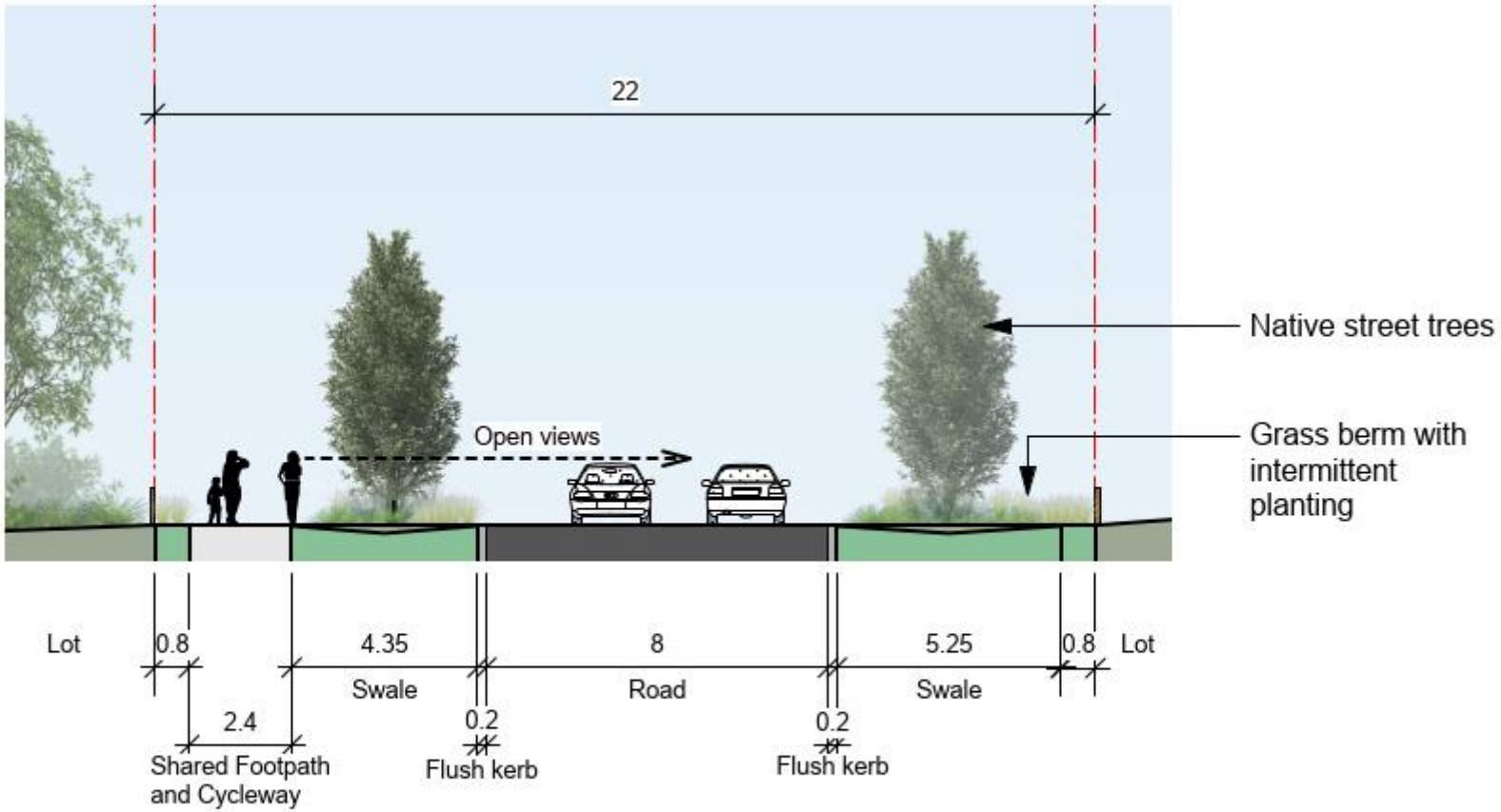
Should you be in any doubt as to the recommendations of this report it is essential that you discuss these issues with Titus Consulting Engineers prior to proceeding with any work based on this report.

The recommendations in this report do not supersede recommendations of other engineering reports and shall be considered in conjunction with all other information available for the site.

APPENDICES

APPENDIX A – SITE LAYOUT PLANS


N
ROW
Waikato river cycle trail
Access strip to be vested as reserve
5m wide planted visual and sound bund
Shared entrance to subdivision and Lake Whakamaru Reserve
Entrance feature and threshold treatment
Native planting
Area to be vested as reserve
Specimen trees
Reserve strips and planting to provide seperation between housing clusters
Pedestrian access to reserve
Footpath on one side of road
Grass berm with intermittent low planting
Existing reserve access road
Enhancement planting in reserve
Pedestrian access to reserve
ROW
Access strip to be vested as reserve
Bike trail to reconnect back into existing Waikato River Trail
Existing house
Key
Existing Buildings
Building pad (Indicative)
Road (Existing)
Road (Proposed)
ROW
Threshold / Entrance detail
Road Reserve
Footpath
Cycle track
Proposed Lots
Reserve / camp ground
Vegetation - Tall
Vegetation - Medium
Vegetation - Low
Planted Bund
1
Overall Plan
Scale: 1:5000
0
200 m



2 Typical Road Section
Scale: 1:200