WHENUAPAI GREEN

98-102 Totara Road, Whenuapai

Site-Specific

STORMWATER MANAGEMENT PLAN

Ver 2 - 15 Dec 2022

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Approval

Author of the Stormwater Management Plan			
Prepared by	Brian Jones BE CMEngNZ CPEng		Date: 15/12/2022

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Executive summary

The proposed Whenuapai Green development is located on existing properties at 98-100 and 102 Totara Road, Whenuapai and occupies a total area of 16.36 hectares. The site is currently predominantly in pasture and has been used for cattle farming. McCaw Avenue is on the southern boundary of the site, Totara Road to the west and northwest and the NZDF Whenuapai Air Force Base is to the east. There are recent new housing developments to the south of the site.

The site is currently zoned “future urban”. The proposed development will provide a total of 349 residential houses as part of a comprehensive consent for development of terrace units, duplex units, and standalone houses. An area of 2.79 ha (lot 800) will be developed into a proposed school which will service the surrounding area.

The location of the site (from Auckland Council GeoMaps) with respect to the surrounding area is shown below:

Fig 1 Location Plan (AC GeoMaps)

The existing and proposed stormwater catchments for the site flow to the Ratara Stream to the west of Totara Road and to the Rarawaru Creek to the east. The two streams discharge into the upper reaches of the Waitemata Harbour.

There is limited existing stormwater reticulation apart from several small culverts from the site extending under Totara Road. The Rarawaru Creek flows through a 2300mm culvert under Totara Road to the northeast of the site.

The Whenuapai 2 Stormwater Management Plan was prepared in 2016 for developments to the south of the site and included consideration of the full catchment of the Rarawaru Creek including the eastern part of this proposed development site. This site-specific stormwater management plan refers to the Whenuapai 2 SMP but has been updated to meet the current requirements of the AUP-OIP and Schedules 2 and 4 of the Regionwide Network Discharge Consent.

The stormwater management principles and objectives of this development will meet the SMAF 1 requirements of the AUP-OIP as follows:

- Retention / reuse of the first 5mm of runoff from new impervious areas.
- Detention of runoff from the 95th percentile rainfall event with controlled release over 24 hours to prevent stream erosion.
- Water quality treatment of runoff from high contaminate generating activities, namely high use roads and carparks.
- A piped stormwater network with capacity to convey up to the 10% AEP rainfall event.
- Attenuation of stormwater flood flows for 10% AEP and 1% AEP rainfall events to minimise flooding of downstream properties.

1 Existing site appraisal

1.1 Summary of data sources and dates

Existing site appraisal item	Source and date of data used
Topography	• Neil Construction Ltd Topographical Survey. • Auckland Council GIS LIDAR
Geotechnical / soil conditions	• CMW Preliminary Geotechnical Assessments 18 May 2018 & 16 August 2019 • CMW Geotechnical Investigation Report AKL2018-0085AF rev 1- 7 Dec 2022
Existing stormwater network	• Auckland Council GeoMaps Data • Neil Construction Ltd Topographical Survey.
Existing hydrological features	• Auckland Council GeoMaps Data • Bioresearches – Watercourse Classification, 9 Nov 2020 • Bioresearches – 98, & 100-102 Totara Road, Whenuapai – Wetland Assessment,17 Nov 2021 • Cato Bolam – Survey of Stream Beds 1 July 2022.
Stream, river, coastal erosion	• Auckland Council GeoMaps Data
Flooding and flowpaths	• Bioresearches – Watercourse Classification 9 Nov 2020 • Auckland Council GeoMaps Data • AECOM Memorandum Whenuapai Rapid Flood Hazard Assessment 03 Jun 2016. • Whenuapai 2 Stormwater Management Plan, March 2016.
Coastal Inundation	• Auckland Council GeoMaps Data
Ecological / environmental areas	• Geosciences Ltd Environmental Due Diligence Investigation 24 Sept 2019

Existing site appraisal item	Source and date of data used
Cultural and heritage sites	• Clough & Associates Ltd Archaeological Assessment Jan 2021. • Te Kawarau Iwi Tiaki Trust - Cultural Impact Assessment Sept 2021
Contaminated land	• Geosciences Ltd Environmental Due Diligence Investigation 24 Sept 2019

1.2 Location and general information

See Appendix A for Location Plan prepared by Construkt Architects.

Existing site element	
Site address	• 98-100 & 102 Totara Road, Whenuapai
Legal description	• Lot 2 DP81411, Lot 1 DP53062
Current Land Use	• Rural farmland – cattle holding
Current building coverage	• 3 dwellings with garages, outbuildings. Total area is approximately 800m2.
Historical Land Use	• Farming

1.3 Topography

The site is of irregular shape and currently consists of relatively flat undeveloped farmlands which generally slopes from south to north, falling from RL25m to RL16m over 600m. The overall slope is 1.5 percent, although it increases where the site slopes towards the western boundary in the middle of the site. The site is bounded in the south by McCaw Avenue which forms the northern extent of a recent housing development. Totara Road runs along the western and north-western boundaries. The NZ Defence Force Whenuapai airbase is located on the eastern boundary with a private residence (94 Totara Road) to the north-east.
In the eastern “panhandle” there are steeper slopes which fall to the tributaries of the Rarawaru Creek that run through this area.

1.4 Geotechnical

CMW Geosciences have prepared Geotechnical Investigation Report dated 7 December 2022 (AKL2018-0085AF Rev1) which confirm that the site will be generally suitable for the development.

The final report confirms the general suitability of the site for development and provides parameters for the design of building foundations and retaining walls, along with designs for slope reinforcement with geogrids.

CMW Geosciences will also be involved in the detailed design of the retaining structures, as well as to provide construction monitoring. At the completion of earthworks CMW will prepare a Geotechnical Completion Report.

A copy of the CMW Geotechnical Investigation Report is included in the resource consent application package.

1.5 Existing drainage features and stormwater infrastructure

Auckland Council GeoMaps Data and the Bioresearches Memorandum – Watercourse Classification 9 Nov 2020 provide information on the existing drainage features and stormwater infrastructure. GeoMaps gives the main stream names as Rarawaru Creek on the eastern side of the site and Ratara Stream on the western side, although tributaries are unnamed, along with overland flow paths and watercourses within and adjacent to the site.
Note that the overland flow paths from GeoMaps are based on modelled flows from the Maximum Probable Development (MPD) of the catchment with allowance for climate change.

Drainage on the existing site is primarily by way of overland flow paths conforming to the natural contours of the site. The western side of the site flows by way of several minor overland flow paths, including ephemeral overland flow paths (labelled “C.1 and C.2 on Bioresearches Fig 3) and the table drains beside Totara Road. These combine at a low point adjacent to the western boundary. This corresponds to a sag point in Totara Road where there is a 450mm diameter stormwater pipe beneath the road carriageway. This discharges into a stream / overland flow path on the western side of Totara Road which is a tributary of the Ratara Stream.

On the eastern side of the site there is an intermittent stream (labelled ‘A’ on Fig 3) which originates from a stormwater detention basin at the end of McCaw Road that serves a housing development immediately to the south of the site. This flows through the south-eastern corner of the site before going into the neighbouring NZDF airbase where it is piped. It emerges again (labelled ‘B’ on Fig 3) to flow through the eastern “panhandle” of the site, before again re-entering NZDF land.
Several smaller overland flow paths from the eastern part of the site also flow to this stream, some by way of the neighbouring property at 94 Totara Road.
All these overland flow paths and streams discharge into the Rarawaru Creek which then flows through a 2300mm diameter culvert under Totara Road approximately 140m from the north-eastern corner of the site. The culvert outlet has been surveyed as having an invert level of RL1.41m. This level is similar to the existing Mean High Water Springs (MHWS) tide level of RL 1.39 and below the MHWS tide level of RL 1.89 to be used for MPD (maximum probable development) as required by the Auckland Council Stormwater Flood Modelling Specifications November 2011.
There are also three 300mm diameter stormwater culverts under Totara Road to the west of the site which connect the table drains on each side of the road.

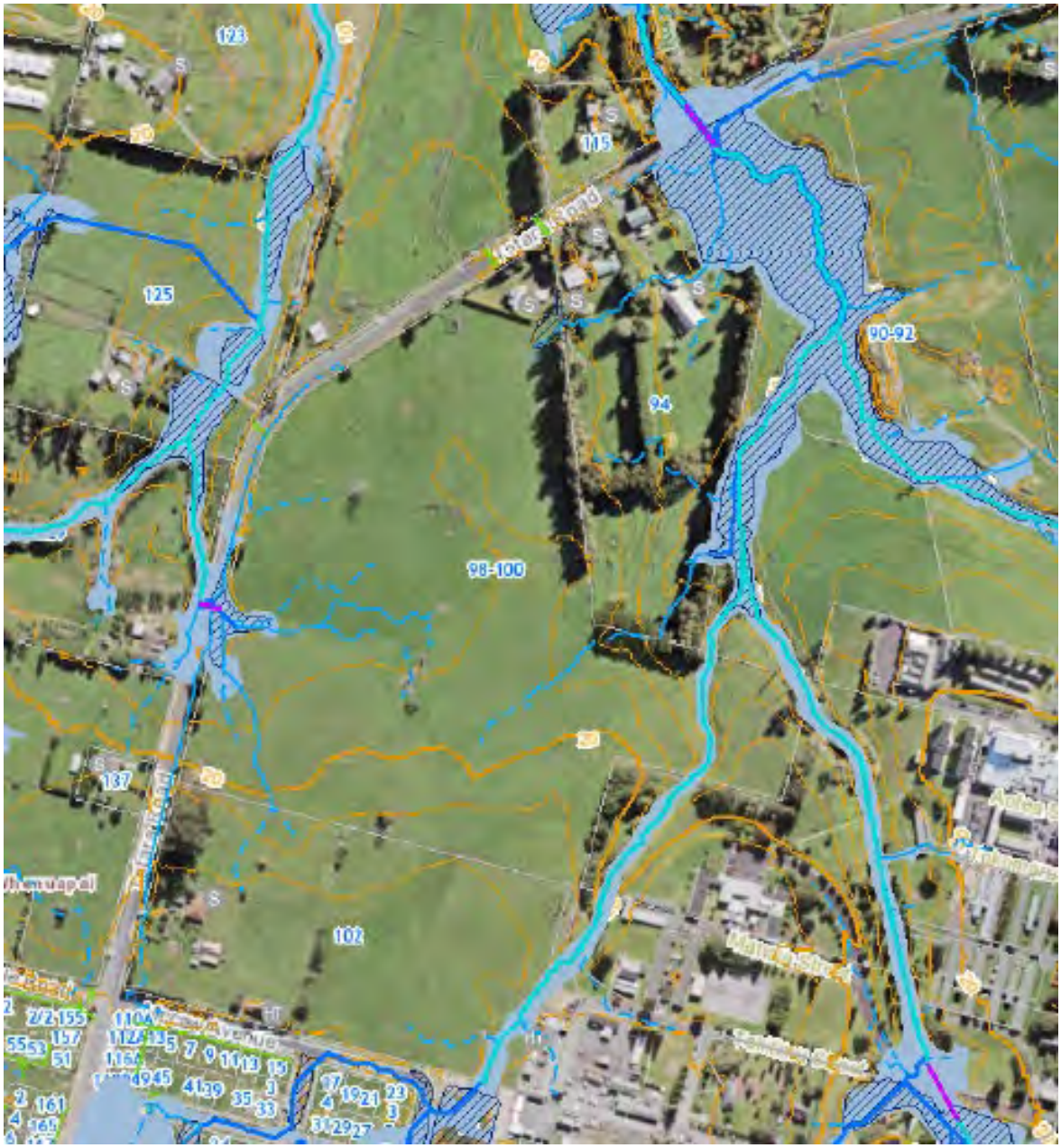


Fig 2 Overland Flow Paths (AC GeoMaps)

See Appendix A for GeoMaps Overland Flow Paths for the wider area.

A survey and report on existing stream bed widths has been undertaken by Cato Bolam Consultants (Ref 46739 7 July 2022) as part of a stream width assessment to investigate the Esplanade Qualifying Status of the watercourses. This was done in conjunction with Bioresearches to provide ecological assessment of the extent of the stream bed. The report has determined that the tributaries of the Rarawaru Creek forming sections A, B & C (as shown on Bioresearches Figure 3) has a weighted width of 2.47m and is therefore not qualifying in terms of the requirements for the vesting of Esplanade Reserve under section 230 of the Resource Management Act.

Figure 3. Classified and ground-truthed watercourses at 98 and 100-102 Totara Road.

1.6 Receiving environment

Downstream of the 2300mm diameter culvert under Totara Road, the Rarawaru Creek connects to the upper tidal reaches of the Waitemata Harbour. This area is shown in the Auckland Unitary Plan as a Significant Ecological Area – Marine 2. Auckland Council GeoMaps Data shows this area to include an Ecosystem Code of SA1.2 and being mangrove forest and scrub in an estuarine hydrosystem.
The Ratara Stream to the west of the site also connects with the upper tidal reaches of the Waitemata Harbour approximately 400m downstream of the Totara Road culvert.

1.7 Existing hydrological features

Existing hydrological features on the site have been identified using Auckland Council GeoMaps Data, with a detailed report prepared by Bioresearches entitled Watercourse Classification dated 9 Nov 2020.
The attached Figure 3 "Classified and ground-truthed watercourses at 98 and 100-102 Totara Road" from the Bioresearches report shows the nature of watercourses on the property and the report includes the following summary:
"Watercourses A and B were classified as modified intermittent streams under the AUP OP as they contained standing water 48 hours after a rain event, natural pools and no rooted terrestrial vegetation within the watercourse channel. Some portions of the three watercourses had well-defined channels, however due to bank damage from livestock had flattened these channels in places. Watercourse C was classified as ephemeral overland flow paths due to meeting only two intermittent stream criteria and was not classified as a wetland as it contained a dominance of terrestrial pasture species. Watercourse D was classified as an ephemeral artificial watercourse for the purpose of farm drainage as it contained no characteristics of a natural watercourse. Watercourse E was classified as a permanent stream. All other overland flow paths, as indicated by Auckland Council's GIS viewer (Figure 1) were ephemeral or absent."

Following on from the above Watercourse Classification, Bioresearches have also completed a Wetland Assessment dated 17 Nov 2021 to provide a more detailed assessment of potential wetlands within the site.
In summary, all features within the site (A, B, C-1, C-2, D&E as shown on Bioresearches Figure 3) were considered ***not to be*** "natural wetlands" as per the NPS-FM.

Cato Bolam Consultants Ltd have been engaged to survey the existing streams to investigate the Esplanade Qualifying status of the existing streams on the site. This was done in conjunction with the project ecologists Bioresearches Ltd to assist with identification of the banks of the watercourses by inspecting the physical channel characteristics and the associated vegetative cover. Following agreement on their location, the banks were surveyed, cross sections derived, and a weighted average stream width calculated.
It was determined that the tributary forming watercourses A & B (as identified on Bioresearches Figure 3 above) had a weighted average width of 2.47m and the section of the Rarawaru Creek (Watercourse E) a width of 1.5 – 2.5m.

Therefore, the watercourses are not qualifying in terms of the requirements for the vesting of Esplanade Reserve under section 230 of the Resource Management Act 1991.
Watercourses A, B & E will, however, have riparian margins of 10m each side as required by the Auckland Council Unitary Plan – E3 Lakes, rivers, streams and wetlands. These will be planted using native species.

The following reports are included in the full resource consent application package:

- Bioresearches Report – Stream Classification.
- Cato Bolam Consultants report on existing stream beds (Ref 46739 7 July 2022).

1.8 Flooding and flowpaths

Auckland Council GeoMaps does not show the *existing* areas of flooding, but does show predicted future flood plains and flood prone areas, along with overland flow paths as shown for the site. These areas have been established by modelling the 1% AEP rainfall event (Maximum Probable Development (MPD)) and 2.1 degrees climate change scenario using 2013 LiDAR data. Reference AECOM Memorandum Whenuapai Rapid Flood Hazard Assessment 03 Jun 2016 for details of the assessment.

Existing overland flow paths on the western side of the site combine to discharge from the site through a 450 diameter culvert under Totara Road which in turn discharges into the upper end of a tributary of the Ratara Stream. On the eastern side of the site, several small overland flow paths discharge to the Rarawaru Creek or tributaries.

The extent of flooding is confined to areas adjacent to the existing streams and overland flow paths through the site, being primarily to a small area on the western side of the site where flows leave the site by way of the existing culvert (assumed blocked in the analysis) under the embankment formed to construct Totara Road.
GeoMaps also shows flooding of Totara Road itself on the western side of the site adjacent to 129 Totara Road, where there is a sag in the road, along with flooded areas on the properties at 125 & 129 Totara Road where driveways and farm tracks cross the stream.
To the northeast of the site there is a larger area of flooding behind the Totara Road embankment across the Rarawaru Creek where there is an existing 2300mm diameter culvert.

The Whenuapai 2 Stormwater Management Plan has addressed flood flows and flooding extents, including within the tributaries of the Rarawaru Creek which flow through the proposed development site. It has also addressed the capacity of the existing 2300mm diameter Totara Road culvert and the extent of flooding behind it.

Additional modelling using HEC-RAS has been down to confirm the areas of flooding through the site. These have largely confirmed the flooding extents for the MPD flows with climate change as shown on GeoMaps and the findings of the Whenuapai 2 SWMP.

1.9 Coastal inundation

While the AUP OIP Coastal Inundation 1 percent AEP plus 1m Control applies to the downstream receiving environment, it does not extend to the development site which is well above coastal inundation levels. The minimum proposed site level varies between RL16m and RL25m, meaning the site itself is not at risk from coastal inundation.

1.10 Biodiversity

The Auckland Unitary Plan Geomaps Significant Ecological Area (SEA) overlay shows there are no SEA's within the site, however there is a 'Marine 2' overlay applied to the downstream receiving environment of the Rarawaru Creek to the north of Totara Road.
The site itself is mainly covered in pasture that has been used for cattle grazing and has low biodiversity value.
The Watercourse Classification Memorandum prepared by Bioresearches addresses the ecology in the vicinity of the streams and overland flow paths and states that the riparian yard and channel banks are dominated by terrestrial exotic pasture grass. This has been followed up by a Wetland Assessment dated 17 Nov 2021 also prepared by Bioresearches.

The report states that Feature C, which includes the flood prone area in the west of the site, does not meet the definition of a natural wetland.
The report concludes that all features within the site were considered not to be 'natural wetlands' as per the NPS-FM.

1.11 Cultural and heritage sites

Te Kawerau Iwi Tiaki Trust has been engaged and has prepared a Cultural Impact Assessment and report for the site and the proposed development.
The Conclusion of the report dated September 2021 states:

'The proposal is to develop 16.36ha into several hundred residential lots, roading and other infrastructure, amenities, and potentially a school catering for up to 1200 children. The site sits on relatively productive soils within a cultural landscape focused on coastal settlements and resource extraction around the upper Waitematā harbour. The site is in very close proximity to Te Rarawaru historic kāinga site and the Rarawaru, Waionoke, and Ratara streams. A total of five impacts are noted in relation to the development (not including individual potential animal impacts which are not covered in this report), most of which could be minor to moderate beneficial (one would be negligible adverse) if mitigations discussed are incorporated, which would be a net benefit from a cultural perspective. Without mitigation minor (but not less than minor) adverse cultural effects would occur. Mitigations include a mixture of stream restoration, native planting, stormwater treatment, and place-naming/interpretation.'

An Archaeological Assessment has been undertaken by Clough & Associates Ltd and a report prepared dated Jan 2021.
The Conclusions to the report include the following statement:

'*no archaeological sites have been identified within the property boundaries and the potential for any unidentified subsurface remains to be exposed during development is very low.'*

1.12 Contaminated land

Geosciences Ltd has conducted preliminary site investigations (PSI) of the sites for the proposed development and two reports have been prepared by as follows:

Geosciences Ltd – Preliminary Site Investigation of 98-100 Totara Road, Whenuapai – 9 May 2018 (revised 10 November 2021)

Geosciences Ltd – Environmental Due Diligence Investigation of 102 Totara Road, Whenuapai – 24 September 2019.

98-100 Totara Road

The report Conclusions state:

This investigation has identified potential sources of contamination on site to be the discrete area surrounding the existing residential dwelling in the northern portion of the site. Due to the age of the dwelling which was relocated onto the site in the 1990s, GSL considers that the following potential sources of contamination will require further investigation should any change in landuse, subdivision, or development works be proposed in that area:

- Historical use of lead based paints; and
- Potentially asbestos containing building materials utilised in the residential dwelling and garage on site.

Additionally, plans held within the property file identify the location of the onsite domestic waste water treatment systems (septic tank and effluent disposal field), which Auckland Council have considered to be encompassed by Items G.5 and G.6 on the MfE HAIL. GSL concludes that should any change in landuse, subdivision, or development of that portion of the land be proposed, then these small scale, localised points will require further investigation and likely require localised remedial works.

With regards to the wider site area, GSL did not identify any evidence for any potentially contaminating activity included on the MfE Hazardous Activities and Industries List having been undertaken on the site. GSL therefore concludes that the risk for actual or potential contamination on the site to be low, and concludes that with respect to the wider site area that any future change in landuse, subdivision, or development would be highly unlikely to result in a risk to human health or the environment.

The report Recommendations state:

In order to address the requirements of the NES and Chapter E.30 of the AUP(OP) a site management plan will be required to document the controls to be in place for the protection of human and environmental health from the potential mobilisation of contaminants in soil during soil disturbance works.

102 Totara Road

The report Conclusions state:

This investigation has identified potential sources of contamination on site to be the discrete area surrounding the original 1960's residential dwelling and former shed locations along the norther site boundary. Due to the age of the original dwelling, which was constructed in 1969, GSL considers that the following potential sources of contamination will require further investigation should any change in landuse, subdivision, or development works be proposed in that area:

- Historical use of lead based paints; and
- Potentially asbestos containing building materials utilised in the residential dwellings and sheds on site.

Additionally, plans held within the property file identify the location of the onsite domestic wastewater treatment systems (septic tank and effluent disposal field) associated with the two residential dwellings, which Auckland Council have considered to be encompassed by Items G.5 and G.6 on the MfE HAIL. GSL concludes that should any change in landuse, subdivision, or development of that portion of the land be proposed, then these small scale, localised points will require further investigation and likely require localised remedial works.

With regards to the wider site area, outside of the commentary above, GSL did not identify any evidence for any potentially contaminating activity included on the MfE Hazardous Activities and Industries List having been undertaken on the site. GSL therefore concludes that the risk for actual or potential contamination on the site to be low and concludes that with respect to the wider site area that any future change in landuse, subdivision, or development would be highly unlikely to result in a risk to human health or the environment.

Geosciences Ltd have also prepared a Site Management Plan which is included with the resource consent application.

2 Development summary and planning context

2.1 Regulatory and design requirements

Requirement	Relevant regulatory / design to follow
Unitary Plan – SMAF hydrology mitigation	• The site is not currently within a SMAF zone in the AUP Controls, however SMAF 1 requirements will apply as the Whenuapai 2 SWMP. • The SMAF 1 hydrological mitigation requirements given in AUP Table 10.6.3.1.1 are as follows: - Retention (volume reduction) of at least 5 mm of runoff depth from new impervious surfaces. - Detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff from impervious surfaces in the 95th percentile 24-hour rainfall event minus retention volume.
High Contaminant Generating Areas	• AUP E9 – High contaminant generating car parks and high use roads.
Natural Hazards	• Overland flow paths, with flooding occurring in identified flood prone areas.
Auckland Unitary Plan Precinct	• Not applicable.
Existing Catchment Management Plan	• Whenuapai 2 Stormwater Management Plan 2016, which was prepared for the development immediately to the south of the site. Part of the proposed Whenuapai Green development site is downstream but included within the same overall catchment. • Healthy Waters have accepted that the Whenuapai 2 SMP requirements can be applied.
Auckland Council Regionwide Network Discharge Consent	• Although the site consists entirely of green fields, under the NDC requirements the site would be classified as a large brown fields site due to its previous use for farming. • SMAF 1 requirements will be applied.

3 Mana whenua matters

3.1 Identification and incorporation of mana whenua values

Initial meetings have been held with the local Te Kawerau Iwi Tiaki Trust to discuss the proposed development. Further meetings will be held, if required, to discuss details of the proposed stormwater management proposals once the design is sufficiently advanced.
Te Kawerau Iwi Tiaki Trust have prepared a Cultural Impact Assessment and report for the site and the proposed development.

The design for the proposed subdivision has been developed in compliance with the recommendations in Auckland Council Guidance Documents GD01 and GD04 to reflect mana whenua values.

The revival and enhancement of mauri will be a focus during the design and construction phases through:

- *A holistic approach to resource management*
- *Protection of habitat of edible plants and native aquatic life which are traditional sources of food for local Māori*
- *Restoring a buffer of native vegetation alongside water ways*
- *Water conservation*
- *Avoiding mixing waters from different sources.*

A copy of the Cultural Impact Assessment is included with the resource consent application.

4 Stakeholder engagement and consultation

Stakeholders	What is the reason for interest?	What engagement has been completed?	Feedback and response
New Zealand Defence Force	Neighbour on eastern side.	Discussions held regarding various issues. Memorandum provided to NZDF outlining the proposed stormwater management on the site.	NZDF have provided draft conditions in relation to stormwater: • No standing water • Dry ponds to empty within 48 hours of end of 2% AEP storm event. • No platforms which may allow perching sites for birds.
Healthy Waters	Stormwater management.	A draft initial stormwater management plan was submitted with the application for consideration of the development under for Covid-19 Recovery Act. Oct 22 Draft SWMP was sent to Healthy Waters for comment. Comments received from Danny Curtis 19 Oct 22. Meeting held 3 Nov. and further comments received email of 7 Nov. Final SWMP updated.	Initial feedback from Katja Huls, Healthy Waters: The stormwater management proposed is generally aligned with the requirements of Schedules 2 and 4 of the Region-wide NDC. The site is downstream of the Whenuapai 2 SHA area which has a draft Stormwater Management Plan (SMP). The applicant should develop in accordance with this SMP. Healthy Waters (Danny Curtis) have accepted that the Whenuapai 2 SMP requirements can be applied. Although not required by the SMP, an assessment of water quality treatment measures will be provided.
Auckland Transport	Upgrading on Totara Road. New road connections with Totara Road	Various correspondence with Auckland Transport by consultants Dave Smith of Abley Transportation and Eric Hebner of Team Traffic.	Integrated Traffic Assessment prepared by Abley. Upgrade requirements for Totara Road confirmed, including use of raingardens for water quality treatment. New road connections confirmed. Intersection layouts and controls confirmed.

Watercare Services Ltd	Wastewater network including pump station.	Meeting held with Lars Fog, Program Lead, Major Projects, Watercare	Wastewater is to be drained northwards by gravity to a proposed pump station at the end of McKean Road which will also serve other future development sites in the area. Wastewater will then be pumped to the existing 225 diameter gravity main at the corner of Dale Road and Totara Road which drains to the existing Whenuapai Village pump station which has capacity for the proposed development.
Iwi	Various including stormwater	Consultation has been undertaken with the local Te Kawerau Iwi Tiaki Trust.	Te Kawerau Iwi Tiaki Trust has prepared a Cultural Impact Assessment for the project. Riparian planting to be approved by iwi.

5 Proposed development

5.1 General development information

The proposal will provide residential housing as part of a comprehensive consent for development of terrace units, duplex units, and standalone houses.
An area will also be set aside to allow for the development of a proposed school to service the surrounding community.

5.2 Location and area

The proposed development site will be located on existing properties at 98-100 and 102 Totara Road, Whenuapai and occupies a total area of 16.36 hectares. The site is currently predominantly in pasture and has been used for cattle farming. McCaw Avenue is on the southern boundary of the site, Totara Road to the west and northwest and the NZDF Whenuapai Air Force Base to the east. There are recent new housing developments to the south of the site.

Refer to Appendix A for Location Plan prepared by Construkt Architects.

5.3 Purpose of the development

The purpose of the development is to provide residential housing within the Whenuapai area.

The site is currently zoned as Future Urban in the Auckland Council Unitary Plan.
An application has been made to allow the proposed development under the Covid-19 Recovery (Fast-track Consenting) 2020 Act.

The proposal will provide a total of 349 residential houses including terrace units, duplex units, and standalone houses.
An area of 2.79 ha (lot 800) will be developed into a proposed school which will service the surrounding area.

Totara Road will be upgraded with two traffic lanes and a new cycleway and footpath on the side of the proposed development.
There will be limited road access into the site and no direct vehicle access from Totara Road to any of the proposed lots.

5.4 Site layout and urban form

The site layout and urban form has been determined in consultation with Construkt Architects to produce a comprehensive development that provides connectivity between dwellings, the proposed primary school and reserves. The typology of proposed dwellings ranges from 2-bedroom terraced houses to 4-bedroom standalone dwellings.

See Appendix B for:

- Scheme Plan 4520-00-RC-01 Rev7
- Stormwater Plans – Resource Consent Application

5.5 Earthworks

The existing site is gently sloping from the south to north with an average slope of 1.7 percent, although there is a low point on the western boundary adjacent to Totara Road to which the larger part of the site drains. Earthworks are proposed over 15.69 hectares of the site area to create roads, general building platforms and stormwater detention basins. The expected earthworks volume is in the order of 60,000 cubic metres of balanced cut and fill.
Sediment and erosion controls to mitigate the effects of stormwater runoff on the adjacent streams and downstream receiving environment will be implemented during earthworks operations. These will be in accordance with Auckland Council document GD05 “Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region”.

A resource consent for earthworks will be obtained prior to any earthworks commencing on site.
The proposed earthworks plans are included in the resource consent application.

6 Stormwater management

6.1 Principles of stormwater management

6.1.1 Original principles

The stormwater principals to be incorporated on the site are based on the requirements of Auckland Council document GD04 “Water Sensitive Design for Stormwater”. This provides guidance for the application of water sensitive design (WSD) to land use planning and land development, with a specific focus on stormwater and freshwater management.
WSD applies a set of principles to land development to reduce or minimise negative effects on the environment. The emphasis is on the appropriate location, layout and design of development, including its context within the broader catchment and region. WSD can be applied at multiple scales, for structure planning, subdivision and site development, and is appropriate for both greenfield sites and brownfield redevelopment.

A WSD approach considers the multiple objectives influencing project outcomes, including urban design, landscape amenity, and community issues and aspirations. In this way, stormwater management is targeted to where the greatest benefit can be achieved, both for the community and the land developer, and is an integral component of good urban design.

This will include:

- Promoting inter-disciplinary planning and design with consideration of a WSD approach in the early stages of design. This requires the input of a range of disciplines such as engineering, landscape architecture, urban design, community engagement, planning and ecology, and is normal best practice in this regard.

- Protect and enhance the values and functions of natural ecosystem such as mature vegetation, aquifers, watercourses and wetlands for their stormwater management function.

- Address stormwater effects as close to source as possible. This involves treating and mitigating the effects of runoff prior to it leaving the site.

- Mimic natural systems and processes for stormwater management.

6.1.2 Updated principles

Not applicable as no changes have been made to the original principles.

6.2 Proposed stormwater management

6.2.1 General

The stormwater management for the proposed development will generally comply with the requirements of the Auckland Region-wide Network Discharge Consent (NDC) and the Auckland Unitary Plan (AUP).

Following an application for referral of the development proposal under the COVID-19 Recovery (Fast Track Consenting) Act 2020, initial comments were received from Katja Huls of Healthy Waters, Auckland Council. The comments included pointing out that the site is downstream of the Whenuapai SHA which has a draft Stormwater Management Plan (SMP) and that the proposed development should develop in accordance with this SMP.
Another comment was "There is a culvert under Totara Road that will need to be upgraded to convey the flows without causing flooding. This development triggers the need for this upgrade to be undertaken by the developer."

The Whenuapai 2 Stormwater Management Plan has been reviewed and will generally be followed with the following exceptions:

- The SMP was prepared prior to finalisation of the AUP and requires 10mm of retention / reuse. This will be changed to 5mm of retention / reuse in line with AUP Table 10.6.3.1.1 and the NDC.
- The SMP does not require the attenuation of the 10% or 1% AEP storm events. This has resulted in potential downstream flooding issues arising from any further development, particularly in the vicinity of the culvert under Totara Road. For the proposed development, flood attenuation will however be provided to help mitigate the effects of downstream flooding to within the requirements of the AUP, AC SW CoP and NDC.

6.2.2 Stormwater Basins

A major component of the stormwater management for the proposed development will be the provision of two stormwater 'dry' basins. These have been designed generally to the requirements of Auckland Council Guidance Document GD01, Chapter 9 Technical Guidance: Ponds. The stormwater basins help provide detention and attenuation for stormwater runoff for the 95th percentile, 10% AEP and 1% AEP rainfall events. Contributing catchments to each basin are shown on drawing SW-433 for piped flows up to the 10% AEP and SW-431 for overland flows up to the 1% AEP rain event. The catchment shown for Area "C" cannot be piped or flow to either SW basin because of the typography of the site, so at source tanks will be provided to provide detention of the 95th percentile rainfall, while runoff from the 10% AEP and 1% AEP events will be discharge direct to the adjacent stream. This is further considered in Section 6.2.5 Flooding.

The following tables provide summary data for each SW basin.

Summary – Stormwater Basin A

			Notes:
Pond type	Dry pond		NZDF Whenuapai air base restriction on ponded water.
Pond purpose	Detention of 95th percentile rainfall event with 24-hour release. Attenuation of 10% AEP rainfall event to prevent downstream flooding. Attenuation of 1% AEP rainfall event to prevent downstream flooding.		Excludes 5.0mm retention (re-use) provided within dwellings. Excludes detention and retention for school site.
1% AEP Catchment area Maximum pond volume Peak discharge:	10.56 Ha 3504m3 (RL15.61)	62% impervious 2.952 m3/s	
10% AEP Catchment area Pond volume; Peak discharge:	9.843 Ha 2773m3 (RL15.46)	62% impervious 1.503 m3/s	
Detention volume; Max. discharge:	1143m3 (RL14.64)	26.5 l/s	
Emergency spillway:	RL15.75, 13m wide		
Top of embankment:	RL16.25		
Freeboard:	0.3m		
2% AEP (50yr) drain down time:	30 hours from end of rainfall event		NZDF requires less than 48 hours.
Control structure details:	2 x 1500mm diameter MHs 120mm diam orifice for detention control (RL13.90) – one MH only. 500mm slot weir for 10% attenuation (RL14.70) – both MHs. Top of MH weir for 1% attenuation (RL15.50) – both MHs.		Outlet pipes 2 x 750diam. Top of MHs also act as primary spillway.
Internal bank slope:	Max 1 in 4 (V:H)		
External bank slope:	Max 1 in 4		

Summary – Stormwater Basin B

			Notes:
Pond type	Dry pond		NZDF Whenuapai air base restriction on ponded water.
Pond purpose	95th percentile rainfall event released to coastal discharge. Attenuation of 10% AEP rainfall event to pre-development flows. Attenuation of 1% AEP rainfall event to pre-development flows.		Excludes 5.0mm retention (re-use) provided within dwellings. Excludes detention and retention for school site.
1% AEP Catchment area Maximum pond volume; Peak discharge:	4.296 Ha 1077 m3 (RL 15.21)	54% impervious 0.801 m3/s	
10% AEP Catchment area Pond volume; Peak discharge:	4.965 Ha 741m3 (RL 15.0)	53% impervious 0.609 m3/s	
Detention volume:	Not applicable.		Discharges to tidal area.
Emergency spillway:	RL 15.40, 10 m wide		
Top of embankment:	RL 15.80		
Freeboard:	0.3m		
2% AEP (50yr) drain down time:	1 hour from end of rainfall event		NZDF requirement is less than 48 hours.
Control structure details:	1500 mm diameter MH 250 mm diam low flow outlet (RL13.70) 300 mm slot weir for 10% attenuation (RL14.10) 1500 mm slot weir for 1% attenuation (RL15.20) Top of MH (RL 15.30)		600mm diam outlet pipe. Top of MH also acts as primary spillway.
Internal bank slope:	Max 1 in 4 (V:H)		
External bank slope:	Max 1 in 4		

6.2.3 Water quality

The receiving environment for runoff from the site is to the upper reaches of the Waitemata Harbour by way of the Ratara Stream to the west and the Rarawaru Creek to the east. The receiving environment is shown in the Auckland Unitary Plan as a Significant Ecological Area – Marine 2 which has an Ecosystem Code of SA1.2 and being mangrove forest and scrub in an estuarine hydro-system. This type of environment is sensitive to sediments, heavy metals and other contaminants. To improve the water quality of the runoff from the development a water sensitive design approach will be adopted to maintain or enhance the quality of water discharged to the receiving environment.

AUP E9. Stormwater quality – High contaminant generating car parks and high use roads:
AUP E9.6.1.3 requires that the stormwater runoff from an impervious area (>1000m2, <5000m2) used for a high contaminant generation car park (ie designed for a total of more than 30 vehicles) must be treated by a stormwater treatment device(s).
Within the proposed development, the only site that may possibly have car parking for more than 30 vehicles is Lot 800, which is 2.79ha of land that will be developed into a proposed primary school.
Details of the school development are not yet available, but a private on-site treatment device such as a raingarden may be required.

AUP E9.6.2.2 requires that the stormwater runoff from the impervious area of a high use road (ie designed for more than 5000 vehicles per day), greater than 5000m2 must be treated by a stormwater treatment device(s).
Totara Road is a high use road and will have future traffic volumes greater than 5000vpd. The proposed new roads within the development will have traffic volumes less than 5000vpd. This has been confirmed by Eric Hebner of Team Traffic Consultants.

Therefore, stormwater quality treatment is **only** required for Totara Road, with no water quality treatment required for the internal roads.

Rain gardens will be used along Totara Road to provide the required stormwater quality treatment. These will also be used to meet the retention/detention requirements for the runoff from Totara Road.
The above approach is consistent with that required by the Whenuapai 2 Stormwater Management Plan, where water quality treatment has been provided for major roads only, such as Totara Road.
Sizing of the raingardens will be in accordance with Auckland Council document GD01 Stormwater Management Devices in the Auckland Region.
The controlling rainfall for determination of water quality effects will be the runoff from the 90th percentile rainfall event, that being a 24-hour rainfall of 25.3mm for the site location, resulting in a runoff of 17.24mm (per m2) from the applicable impervious area.
The governing requirement for the size of the raingardens will be to provide a surface area of 2 percent of the applicable impervious catchment.

Although stormwater quality treatment will not be required for the internal roads, some treatment will still occur. Stormwater catchpits will help catch gross pollutants and will allow some grit and sediment to be removed. In addition to the catchpits, most of the stormwater from the internal roads will be discharged into the stormwater basins. These will have gabion walls to collect litter and gross pollutants, plus the bottom of the basins will be suitably planted, which will provide some water quality treatment. In SW basin A, runoff will also be held and discharged over 24 hours to meet extended detention requirements. This will hold stormwater in the planted area for longer, increasing the amount of treatment provided.

A HEC-HMS analysis has been undertaken with the 90th percentile rainfall event applied to the 10% AEP catchment. In SW basin A this resulted in an average hydraulic residence time of approximately 6 hours during which the water quality volume (WQV) is in contact with the planted base of the SW basin.
For SW Basin B there is no orifice to retain the WQV in the base as the detention volume is released directly to the coastal discharge. The WQV does however flow across the planted base between the inlet and outlet of the basin.

See below for tables showing the Water Quality Train for the main catchment areas of the development.

See Appendix C-1 for more details and drawings of the proposed stormwater management.

Water Quality Treatment Train - AREA 'A'

(Refer to Developed Catchment 10% AEP dwg SW-433)

Item	Details	SW Quality Treatment Provided
Residential Lots	70% impervious area	• Inert Roofing Materials • 5.0mm retention for reuse, with disposal to wastewater or gardens.
Possible School Part Lot 800	40% impervious area	• Inert Roofing Materials • On-site detention (95th % rain event, 24-hr release), including: • 5.0mm retention for reuse, with disposal to wastewater or gardens.
Internal Roads	85% impervious area	• Gross pollutant traps (catchpits)
Totara Road	85% impervious area	• Rain gardens designed to GD01 provide water quality treatment and detention. • Gross pollutant traps (catchpits)
Public stormwater network	Piped conveyance.	• Gross pollutant traps formed by gabion walls prior to discharge into SW basins.
SW Basin 'A'	Dry pond provides detention and attenuation of SW. Base and side slopes fully planted.	• Stormwater flows through planted base of stormwater basin provides water quality treatment in a similar way to a planted swale. • Orifice for controlling 24-hour release of detention volume (95th % rain event) also controls release of water quality volume (90th % rain event). • Average hydraulic residence time of 6 hours provides water quality treatment in base in a similar way to a planted swale.
Ratara Stream	Slow flowing stream	• Treatment provided by vegetation on banks and in channel
Discharge to CMA	Upper reaches of Waitemata Harbour	

Water Quality Treatment Train - AREA 'B'

(Refer to Developed Catchment 10% AEP dwg SW-433)

Item	Details	SW Quality Treatment Provided
Residential Lots	70% impervious area	• Inert Roofing Materials • 5.0mm retention for reuse, with disposal to wastewater or gardens.
Possible School Part Lot 800	40% impervious area	• Inert Roofing Materials • 5.0mm retention for reuse, with disposal to wastewater or gardens.
Internal Roads	85% impervious area	• Gross pollutant traps (catchpits)
Public stormwater network	Piped conveyance system.	• Gross pollutant traps formed by gabion walls prior discharge into SW basins.
SW Basin 'B'	Dry pond provides attenuation of SW. (Detention volumes piped direct to coastal discharge) Base and side slopes fully planted.	• Stormwater flows through planted base of stormw basin provides water quality treatment in a similar way to a planted swale.
Rarawaru Creek	Discharge to tidal area.	
Discharge to CMA	Upper reaches of Waitemata Harbour .	

Water Quality Treatment Train - AREA 'C'

(Refer to Developed Catchment 10% AEP dwg SW-433)

Item	Details	SW Quality Treatment Provided
Residential Lots	70% impervious area	• Inert Roofing Materials • 5.0mm retention for reuse, with disposal to wastewater or gardens. • On-site detention with 24-hour release
Internal Road	85% impervious area	• Rain gardens • Gross pollutant traps (catchpits) • Detention with 24-hour release
Public stormwater network	Piped conveyance system.	• Discharge into tributary of Rarawaru Creek.
Rarawaru Creek	Slow flowing stream becoming tidal downstream of Totara Road.	• Treatment provided by vegetation on banks and in channel
Discharge to CMA	Upper reaches of Waitemata Harbour.	

6.2.4 Stream hydrology

Existing Streams

Riparian Planting

The existing streams on the site (A, B and E on Bioresearches' Figure 3) will be enhanced by removing the existing culverted farm crossings and reinstating the stream to match adjacent reaches. Riparian planting, with appropriate species, will also be undertaken to at least 10m either side of all existing streams. This planting will help provide removal of sediment and water quality treatment of direct stormwater runoff from adjacent areas, both during the construction phase and at completion.

For details of the planting, see landscape drawings 1395/01 to 12 prepared by Greenwood Associates. Copies included with drawings for resource consent application.

Proposed Road 9 Culvert

As part of the development, Road 9 in Stage 3 will need to cross existing stream 'B' which will require culverting. While a fish habitat assessment has not been done, Bioresearches have advised that stream B will most likely provide habitat to some fish species, therefore the fish passage requirements of the National Environmental Standards – Freshwater (NES-F) will apply. It is proposed to provide a culvert that will meet the permitted activity requirements of Section 70 of the NES-F. This has conditions so that the culvert will provide for the same passage of fish upstream and downstream as would exist without the culvert.
Conditions include that the culvert width is greater than 1.3 times the bed width and that at least 25% of the culvert's diameter is below the bed level.

Concept design options have been prepared for the proposed culvert with capacity for the 1 % AEP rainfall event, assuming the culvert is 50% blocked. Either a concrete box culvert or steel pipe arch (or steel arch) culvert laid at the gradient of the existing stream base and embedded below the stream bed will meet the requirements of the NES-F.

While the existing stream is not rock lined, rock riprap will be placed at the entry and outlet to the culvert. These will allow the existing stream profile to be replicated within the culvert once sedimentation has occurred over time. In the meantime, the shape of the culvert and the rocks will provide suitable fish passage for the species expected to be encountered in the stream.

Details of the Fish Passage Concept Design for the proposed culvert are shown on drawing SW-440 – see Appendix B.
Detailed design will be completed at the stage of Engineering Plan Approval.

A Fish Re-location Plan and a Stream-works Construction Management Plan will be prepared prior to construction works commencing.

Site Development Requirements

The requirements for the proposed development to meet stream hydrology requirements are as follows:

- The SMAF 1 hydrological mitigation requirements given in AUP Table 10.6.3.1.1 apply as follows:
  Retention (volume reduction) of at least 5 mm (per m2) of runoff depth from new impervious surfaces.

Where re-use of the retention volume is not possible, this will be included in the detention volume. An alternative is disposal by way of in-ground soakage if soil perviousness exceeds 2mm/hr. The CMW Geotechnical Investigation Report shows that soakage is available in test locations of natural ground, however, the use of soakage will have to be confirmed by the Geotechnical Completion Report.

- Detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff from new impervious surfaces in the 95th percentile 24-hour rainfall event minus retention volume.
  Runoff for detention has been calculated as 23mm (per m2) of impervious area.

  See Appendix C-1 for calculation of the runoff for Detention and WQV using TP108.

The above requirements will be achieved as follows:

Residential lots – Retention and Detention

For all residential lots, retention will be done by requiring private stormwater tanks for water reuse to be used for toilet flushing, watering gardens and similar uses where non-potable water is permitted.
Storage of 500 litres per 100m2 of total impervious area will be required, with minimum tank storage of 1000 litres.
Above ground or in-slab tanks will generally be required to enable connection to the public stormwater pipe network. Additional collection from roof areas is to be made to account for impervious surface areas, eg driveways, not able to be connected to the tank.
Design of the retention tanks is to be to the requirements of GD01 and will be part of the Building Consent approval.
Except for some Stage 3 lots as noted below, the detention volume will be taken to the stormwater basins, where it will be released over a 24-hour period using an orifice outlet in the case of stormwater basin A. For SW basin B the detention volume will be piped directly to a coastal discharge, removing the possibility of stream bed erosion.

Stage 3 Residential lots numbered 288 to 328 inclusive and COALs 516 & 517.

See drawing SW-403 for layout of SW network in this area.
Due to the topography of the site these lots and COALs are not able to be piped to either of the stormwater basins.
Lots 288 -328 inclusive will require individual private on-site stormwater tanks to provide both retention (reuse) and detention. These will be designed with a minimum size of 4500 litres to the requirements of GD01 and will be part of the Building Consent approval.
COALs 516 & 517 will require private communal stormwater tanks to provide detention, with 24-hour release, again designed to GD01.

The requirements will be enforced by a Consent Notice entered on the title and will require building consent approval.

For Stage 3 – Road 9, see below.

Lot 800 – Proposed School Site

No details are currently available for the 2.79 hectare proposed school site, although it has been assumed to have an impervious coverage of 40%.
Retention, detention, and water quality treatment (if required) will need to be undertaken on-site.
As the layout of the school is not known, two potential connections to the public stormwater pipe network will be provided.
The requirements will be enforced by a Consent Notice entered on the title and will require building consent approval.

Internal Roads 1 to 8

All internal roads will require storage for the detention volume.
Reuse will not be possible, nor is infiltration since the soakage capacity of the ground is less than 2.0mm/hr.
Except for Road 9 as below, runoff from the internal roads will be piped to the stormwater basins. In stormwater basin A, the detention volume will be stored and released over 24 hours.
In stormwater basin B, detention is not required as flows can be piped to discharge directly to a coastal outfall.

Stage 3 – Road 9
Road 9 will require a public stormwater tank to provide the detention, with 24-hour release, again designed to GD01.
At completion, ownership of this tank will be vested in Auckland Council as a roading asset.

Totara Road

The eastern side of Totara Road which is adjacent to the development will be widened to allow for a cycle path and footpath.
As Totara Road has a daily traffic volume exceeding 5,000 vpd, stormwater runoff from the carriageway will require treatment for stormwater quality.
Additionally, stormwater runoff for the difference between pre and post development impervious areas will also need to meet the detention requirements as above.
To meet the stormwater detention and treatment requirements, raingardens will be provided within the Totara Road berm. These will discharge to the stormwater basins where site levels make this possible, otherwise to the basin discharge point.
Design of the raingardens will be done to the requirements of GD01.

Best Practical Option:

Initially, consideration was given to piping all the road surface runoff to the stormwater basins or other separate area and providing a bottom of catchment bioretention device (BCBRD). This, however, was not possible due to area and

level constraints caused by the existing topography, particularly achieving outflow to the Ratara Stream.
The use of tree pits was also considered but rejected due to potential conflict with other services required in the berm. Swales were also considered, but the required continuous lengths could not adequately be achieved.
In this instance, the best practical option for providing stormwater treatment for Totara Road is therefore to use raingardens.

See Appendix B for drawings which show proposed details of the stormwater management devices.

6.2.5 Flooding

An analysis of the flooding potential of the Whenuapai Stormwater Catchment has been undertaken for Auckland Council by AECOM Consulting Services. Details of the assessment methodology are included in a Memorandum dated 03 June 2016 and included a rapid flood hazard assessment (RFHA) based on 2013 LiDAR data to determine the 100-year ARI floodplain extent used to inform the Whenuapai Stormwater Management and Structure Planning Process. The results are also used in the Auckland Council GeoMaps system.
The RFHA used a 24-hour 100-year ARI rainfall for the simulation. This was based on the TP108 rainfall-runoff model generated runoff depths using the 24-hour 100-year ARI future design rainfall with climate change (227.8mm) and 80% impervious land development scenario.
An extract from Auckland Council GeoMaps shows overland flow paths and the extent of the potential flooding on the site and the surrounding area – see Appendix A.

The Whenuapai 2 Stormwater Management Plan also analyses flooding in the Rarawaru Creek catchment which includes the eastern side of the proposed Whenuapai Green development. The SMP does not require attenuation of 10% AEP or 1% AEP flood flows.
The SMP has considered the capacity constraints of the existing 2300mm diameter Totara Road culvert, with the recommendation made for upgrading should the catchment be further developed.

Neil Group have also undertaken a rapid flood hazard assessment incorporating more detail relating to the proposed development and the downstream receiving environment. This has been done using the HEC-HMS and HEC-RAS flood computational analysis programs.
The Rapid Flood Hazard Assessment as updated by Neil Group Limited has shown that the proposed development will not be subject to flooding. It has also shown that the additional runoff resulting from increased impervious areas can be managed to minimise the effects on streams and downstream areas. Any increases in flood volumes have been attenuated sufficiently to prevent any flooding of neighbouring properties.
The need to upgrade the 2300mm diameter Totara Road culvert has been avoided by innovative design including provision of on-site attenuation – see section 6.2.7 below.

See Appendix C-1 for a copy of the AECOM RFHA and the Neil Group Rapid Flood Assessment.

The tables below provide a summary of the pre and post development flows from the development into the Ratara Stream and the Rarawaru Creek.

Summary – SW Discharge to Ratara Stream
(Western side, includes part Totara Road and SW basin A)

	Pre-Development	Post Development	
10% AEP			
Total Catchment Area	9.980 Ha	10.150 Ha	
Impervious area	0.501 Ha (5.0%)	6.37 Ha (62.8%)	
Reference dwg:	SW-432 rev A	SW-433 rev A	
Peak Discharge to Ratara Stream	**1.379 m3/s**	**1.551 m3/s**	
1% AEP	Pre-Development	Post Development	
Total Catchment Area	10.807 Ha	11.573 Ha	
Impervious area	1.163 Ha (10.8%)	7.418 Ha (64%)	
Refer dwg:	SW-430 rev A	SW-431 rev A	
Peak Discharge to Ratara Stream	**2.543 m3/s**	**3.243 m3/s**	

For the 10% AEP rainfall event, post development peak flows exceed pre-development flows by 0.17 m3/s.

For the 1% AEP rainfall event, post development peak flows exceed the pre-development flows by 0.70 m3/sec.

A flood analysis does however show that the total post development flows in the Ratara Stream do not cause flooding and hence compliance with the Auckland Council Stormwater Code of Practice.

See Appendix C-1 for Neil Group Rapid Flood Hazard Assessment.

Summary - Discharge to Rarawaru Creek
(Eastern side, includes part Totara Road, SW basin B & direct flows from Area 'C')

	Pre-Development	Post Development
10% AEP		
Catchment Area	7.120 Ha	6.801 Ha
Impervious area	0.086 Ha (1.2%)	3.598 Ha (52.8%)
Refer dwg	SW-432 rev A	SW-433 rev A
Peak Discharge to Rarawaru Creek	**0.977 m3/s**	**0.931 m3/s**
1% AEP	Pre-Development	Post Development
Catchment Area	7.120 Ha	6.232 Ha
Impervious area	0.086 Ha (1.2%)	3.41 Ha (54.7%)
Refer dwg	SW-430 rev A	SW-431 rev A
Peak Discharge to Rarawaru Creek.	**1.627 m3/s**	**1.351 m3/s**
Catchment Area C - 1%AEP (panhandle)	5.250 Ha	1.517 Ha
Peak Discharge from Area C to Rarawaru Creek.	1.184 m3/s	0.801 m3/s

For the both the 10% and 1% AEP rainfall events, post development peak flows are less than pre-development flows.

6.2.6 Overland flowpath and floodplain management

As detailed above, the Auckland Council Geomaps shows the overland flow paths and flooding that would occur in the catchment for the 1% AEP rainfall event. These are based on the maximum probable development (80% impervious) of the entire catchment and include allowance for climate change.

Floodplain - Western Side

There are several small overland flow paths shown across the existing site, with those on the western side concentrating in an existing low area beside Totara Road where a 450mm diameter concrete pipe culvert conveys stormwater under the road to the west to discharge into a tributary of the Ratara Stream. Geomaps show the low area as a flood plain and flood prone area.
As part of the proposed development there will be a stormwater dry basin (Basin A) located in the area of the existing flood plain. This will be designed to provide detention and 24-hour release of the runoff for the 95th percentile detention volume, plus partial attenuation of the runoff from the 10% AEP and 1% AEP rainfall events.

The existing 450mm pipe under Totara Road does not have sufficient capacity, even for existing pre-development flows, so will be upgraded to twin 750mm diameter outflow pipes with a new stabilised outlet to the tributary of the Ratara stream. The outlet pipes have design capacity for the 1% AEP outflow from SW basin A.

See drawings SW-401, 402, 470 & 471. Copies included with drawing sets included in the resource consent application.

Overland Flow Paths

In general, overland flow paths will convey secondary stormwater flows along the roads to discharge into either stormwater basin A or B. Overland flows from a small portion of the site will, however, discharge onto Totara Road. The outlet pipes from the stormwater basins have been sized to convey at least the attenuated runoff from the 10% AEP storm event. Secondary flows exceeding the capacity of the pipe system will discharge onto the road reserve. In the case of SW Basin A, the probability of overland flow across Totara Road has been minimised by providing twin 750mm outlet pipes designed with capacity for the attenuated 1% AEP flood flows. Should these become totally blocked or for storm events exceeding 1% AEP, the resultant overland flows will cross Totara Road to discharge into the upper tributary of the Ratara Stream. For SW basin B, overland flow will be along the southern side of Totara Road before discharging into the Rarawaru Stream.

An analysis of the overland flow has been undertaken using the HEC-RAS flow analysis program and results are shown on the drawings included in the Neil Group Rapid Flood Hazard Assessment – see Appendix C-1.
Overland flows internal to the site and for Totara Road have been prepared.

See drawings SW-480-481 for overland flow on roads. Copies included with drawing sets included in the resource consent application.

Auckland Transport Requirements

Auckland Transport requirements for stormwater flows on roads are provided in the Transport Design Manual – Engineering Design Code – Road Drainage and Surface Water Control (version 1.2).

Serviceability requirements for the 10% AEP storm event are provided in TDM Table 2. The proposed design will meet these requirements by providing suitably placed road catchpits connected into the public stormwater system.

Requirements for overland flow during a major event (1% AEP) are provided in TDM Table 3: Mayor Event – Roadway Flow Limitations.

- Floor levels – in all cases the total flow will be contained within the road reserve and the floor levels of adjacent building will be at least 350mm above flood levels.

See roading drawings for further details. Copies included with drawing sets included in the resource consent application.

6.2.7 Totara Road Culvert

In the comments received from Healthy Waters following the application made for referral under the Covid-19 Recovery (Fast-track consenting) Act 2020, Healthy Waters have raised an issue regarding the upgrade of the existing 2300 diameter culvert under Totara Road, as follows:

> *There is a culvert under Totara Road that will need to be upgraded to convey the flows without causing flooding. This development triggers the need for this upgrade to be undertaken by the developer.*
>
> *Installing an additional culvert is the best option to mitigate the risk of inundation for the nearest dwelling to the culvert. The invert of the existing culvert is located at a narrow section of the stream therefore installing a new culvert at a slightly higher invert level is a constructible solution.*
> *The best practical option is to install a 0.9m diameter culvert at an invert of 1.8mRL, which is 0.6m above the invert of the existing 2.3m diameter culvert. This additional culvert, together with the existing culvert, will provide sufficient freeboard to the nearest dwelling to meet current Auckland Council standards.*
>
> *The implementation of the culvert upgrade can be aligned with the progressive development within the catchment. An assessment as to when the culvert upgrade would be required with respect to the percentage of imperviousness or area of impervious coverage within the catchment occurs has been undertaken and concludes that the Totara Road culvert will require upgrading once 109ha, or 63%, of impervious coverage is undertaken with the catchment.*

The culvert upgrade works as outlined by Healthy Waters would involve considerable costs and disruption to traffic flows on Totara Road because of the depth of excavation (approximately 8.5m). It is also considered unreasonable that the upgrade works should be required as part of this development when previous upstream developments have not been required to limit increases in flows caused by intensification. The Whenuapai 2 SW Management plan has no requirements for the attenuation of flood flows and no attenuation has been provided in adjacent developments that also flow into the Rarawaru Creek.

To obviate the requirement to upgrade the culvert as part of the Whenuapai Green development, it is proposed that post-development flows to the Rarawaru Creek be limited to no more than pre-development flows. This has been done by providing sufficient storage within stormwater basin B and releasing flows at a controlled rate. The full catchment flowing towards the culvert has been analysed using HEC-HMS for pre and post development flows modelled to the upstream end of the existing culvert. In addition, 10% AEP flows will be piped into the tidal zone at the downstream end of the culvert.

Details of the HEC-HMS output for the pre & post-development catchments are provided in Appendix C-1.

Peak flow discharges to the 'Eastern Stream' are summarised below:

	10% AEP	**1% AEP**
Pre-development	0.977 m3/s	**1.627** m3/s
Post-development	0.931 m3/s	**1.351** m3/s

This clearly shows that with suitable attenuation provided, post-development flows do not exceed pre-development flows, thus removing the need to upgrade the culvert as a requirement for this development.

Best Practical Option

Providing attenuation storage within SW basin B to maintain post-development flows leaving the site at less than pre-development flows is considered the best practical option for this catchment. The space which is to be used for SW basin B is within the area covered by Auckland Council Designation 4311 – Whenuapai Airfield Approach and Departure Path Protection which effectively limits the construction of dwellings in this area. The additional costs attributable to providing attenuation within the SW basin would be considerably less than the cost of upgrading the culvert.

6.2.8 NZDF Conditions

NZDF Conditions

Following initial consultation, the New Zealand Defence Force has issued Draft Conditions relating to the proposed Whenuapai Green development, including conditions relating to Bird Strike and stormwater management as follows:

6) *Any new stormwater detention pond must be designed by a suitably qualified person, with experience in stormwater management systems, to the following standards:*
   a. *Stormwater infiltration basins shall be designed to fully drain within 48 hours of the cessation of a 2% AEP storm event; and*
   b. *Sufficient rapid soakage overflow capacity shall be provided to minimise any ponding of stormwater outside the infiltration area(s); and*
   c. *Side slopes shall be at least as steep as 1V:4H except for:*
      i. any side slope treated with rock armouring; or
      ii. any area required for vehicle access
   d. *No permanent island features shall be included, that could provide perching sites for birds.*

7) *Stormwater management devices resulting in a permanent waterbody, should be avoided where possible, but where necessary, designed by a suitably qualified person, with experience in stormwater management systems, to the following standard:*
   a. *Fitted with a device to prevent bird access (such as a net). It is expected that such a device will be maintained to ensure continuous exclusion of birds; or*
   b. *An equally acceptable solution identified in the bird management plan.*

The proposed stormwater basins to be utilised within the site will be “dry” basins which will be able to fully drain after rainfall events. A HEC-HMS analysis using the 2% AEP, with climate change being a 210mm 24-hour TP108 storm event, has been done for both stormwater basins A & B in the proposed developed catchment. The drain down period in both cases is less than 48 hours, as follows:

Stormwater Basin A – drain down period = 30 hours

Stormwater Basin B – drain down period = 1 hour

Note that SW basin A detention of the 95th percentile rainfall event with slow release over a 24-hour period through an orifice control. No extended detention is required for SW basin B as it includes discharge direct to the coast.

HEC-HMS time-series output is provided in Appendix C-1.

A “scruffy dome” grated screen is normally used over the top of the control manholes, but the standard dome may provide a perch for certain birds. In this case a modified screen of conical shape will be used, which with sloping sides should deter larger birds from roosting on the screen.

Also, because of the requirement to avoid standing water in the SW basin, it will not be possible to incorporate a sediment forebay. Instead, it is proposed to provide a trash screen constructed using Gabion baskets to trap gross pollutants, while still being able to allow water to drain through in the basin.

6.2.9 Development staging

Design and resource consenting will be undertaken for the whole of the proposed development at the same time.
Construction will initially commence with bulk earthworks over the entire site as cut and fill areas are separated. This will include platforming and some retaining walls for the proposed dwelling blocks.

Civil construction of the subdivision will be split into three stages as shown on drawing 4520-00-RC-01-rev7.
Staging of the stormwater network and management is shown on drawing 4520-01-SW-413.

Stage 1 will include the upgrading of Totara Road and the construction of Road 1, being the main road though the development. The two stormwater dry basins will also be constructed as part of stage 1.
Construction of the dwellings will also be done on a staged basis, with building consents obtained for smaller blocks of dwellings within each stage.

Copies of the above staging plans are included with the drawings submitted for the resource consent application.

6.3 Hydraulic connectivity

Stormwater runoff from the lots will be collected from all impervious surfaces by private drainage pipelines. The runoff from roofs will initially be directed to an on-site private storage tank which will provide stormwater retention for non-potable on-site reuse requirements, for example toilet flushing, gardens, etc. The storage tanks will be sized to requirements of GD01 Chapter 5: Technical Guidance Rainwater Tanks and will include compensation for those impervious areas, e.g. driveways, unable to be connected to the tank.

In the “panhandle” area of Stage 3, some lots 288-328 inclusive will also require private on-site storage to meet extended detention requirements. COALs 516 & 517 and Road 9 will need extended detention storage to meet both retention and detention requirements as they will discharge directly to the stream since the topography prevents reticulation to SW Basin B.

See section 6.2.3 for details.
The requirements will be enforced by a Consent Notice entered on the title and will require building consent approval.

Stormwater runoff from roads and public footpaths will be captured by catchpits and conveyed by a public stormwater pipe network to the stormwater dry basins. A public connection will be provided to connect with the on-site private drainage on all lots and COALs. The future school site will be provided with two connections as it is not yet known where building development will take place.

The public pipe network will have a design capacity to transport runoff from the 10% AEP rainfall event, including allowance for climate change.
Where possible, the public stormwater pipe network will discharge into one of the two stormwater basins which will provide retention and detention as outlined in Section 6.2.3 above.
Outflows from the stormwater basins will again be through the new public stormwater pipe system with discharge either to the Ratara Stream or the Rarawaru Creek. Discharge locations will have concrete and rock rip-rap outfalls to prevent localised stream erosion. These sections

of the public network will require pipes under or along Totara Road and will be designed to cater for at least the runoff from the 10% AEP rainfall event.
Flows exceeding the pipe capacity of the public network will be conveyed as overland flows down the public roads. The public road network will be designed, where possible, so that overland flows from runoff up to the 1% AEP rainfall event will be conveyed to the stormwater basins. Although flood attenuation is not required by the Whenuapai 2 SWMP, some attenuation of outflows will be able to be provided. This also reduces overland flows across and along Totara Road, helping to meet Auckland Transport requirements.

Copies of drawings showing the proposed public stormwater network are included with the resource consent application.

6.4 Asset ownership

On completion of the subdivision and on the issue of titles, the ownership of all stormwater assets, including the two Local Reserves – Stormwater, will vest in Auckland Council.

Discharge consents will be transferred to Auckland Council after satisfactory completion of maintenance periods.

6.5 Ongoing maintenance requirements

After completion of construction, Neil Construction Ltd will be responsible for the maintenance requirements of those SW assets for which Auckland Council requires a maintenance bond. Auckland Council - Parks maintenance bond requirements are likely to include street trees plus planting within the stormwater reserves, raingardens, stream and riparian planting.
At completion of the maintenance periods and after a final inspection, the responsibility for the ongoing maintenance of the stormwater assets will transfer to Auckland Council.

See Appendix C3 for a copy of the Draft SW Operation and Maintenance Plan covering the Stormwater Basins, Drainage Reserves, Raingardens and Stream Riparian Planting.

The Operation and Maintenance Plan is to be updated, as required, at Engineering Plan Approval and at Completion of Works.

6.6 Implementation of stormwater network

Site works will commence with bulk earthworks to establish the overall contour of the proposed development. During the bulk earthworks operations stormwater runoff will be controlled to the requirements of GD05 using diversion channels, sediment ponds and decanting earth bunds. Works will be staged with areas topsoiled, grassed and mulched as they are completed. The bulk earthworks will include the general shaping of the stormwater basins and these may be used in part as temporary sediment ponds.

Stream and riparian planting will occur before or in conjunction with bulk earthworks to allow early establishment and to help with sediment control. This will depend on being able to meet seasonal planting requirements.

Construction of the public stormwater pipe network will follow the overall staging as outlined in section 6.2.9 above. The piped outfalls to the adjacent streams will be constructed in the initial stages to ensure that overland flows are minimised. Because of the locations of the stormwater basins, the piped network will necessarily extend beyond the initial stages. Where pipes extend through future stages, lot connections will be installed to minimise future excavations and breaking into pipes.

6.7 Dependencies

There are no dependencies relating to stormwater issues involved with this proposed development.

The stormwater management will only need to cater for the proposed development as upstream properties have been developed in recent years with stormwater management provided in accordance with the Whenuapai 2 Stormwater Management Plan.
Similarly, attenuation of flood flows from the development has been provided in the stormwater basins so that downstream properties will not be subjected to flooding due increased runoff.

6.8 Risks

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	What other management / mitigation could be used?	When does this risk need to be addressed?	What is the resultant level of risk?
Inaccuracies in the base information including that obtained from GeoMaps.	Full topographical survey of the site. Modelling and calculations to assess site and downstream flooding.		During the design phase.	Low.
Errors made during the design process.	Thorough review of all design elements.		During the design phase.	Low
Errors made during the construction phase.	Construction monitoring. Preparation of “as-built” drawings.		During the construction phase.	Low.
Stormwater management devices on lots not installed or maintained correctly.	Provision of consent notices on titles with installation and maintenance requirements.		During the consenting and 224c processes.	Low.

7 Departures from regulatory or design codes

There are no departures from regulatory or design codes.

8 Conclusions and recommendations for future work

8.1 Conclusions

The proposal for the Whenuapai Green development will provide a total of 346 residential houses as part of a comprehensive consent for development of terrace units, duplex units, and standalone houses. The total site area is 16.36 hectares, with an area of 2.79 ha (lot 800) to be developed into a proposed school which will service the surrounding community. The proposed residential subdivision will provide all the required infrastructure to serve the development, including roading, water supply, wastewater, stormwater drainage and other private utility services such as power and telecoms.

The stormwater management principles proposed for this development will provide for effective control of the increased runoff arising from the expected increase in impervious areas. This will include on-site retention providing for the re-use of rainwater, along with detention to limit downstream stream erosion.
Two stormwater dry basins will be constructed to provide the detention and attenuation of larger flood flows thus minimising increases in downstream flooding. SW basins will not have standing water to avoid encouragement of bird roosting in the area, as this is not compatible with flight operations on the adjacent NZDF airbase. Treatment of runoff from high contaminant generation activities will be provided in raingardens where required.
The stormwater basins will also provide amenity with extensive planting as well as paths for passive recreation.

All the existing permanent or intermittent streams will be retained within the proposed drainage reserves which will vest to Auckland Council on issue of titles. The riparian areas will also be replanted. These works will further contribute to the long-term water quality of the streams and their riparian habitat.

In summary, the proposal to discharge stormwater to the streams on site would have no appreciable adverse effects on the water quality of the streams and the physical integrity of the stream beds and riparian margins.

See below for a summary of the stormwater management requirements as they pertain to lots, COALs and Roads:

SUMMARY of Site SW Management Requirements

Location	Retention **5.0mm** (/m2 impervious area)	Detention **23mm** **24 hr release** (/m2 impervious area)	Attenuation (10% AEP and 1% AEP)	Treatment
Residential Lots				
1 to 287 and 329 to 346	On-site for reuse	In SW basins	In SW basins	GPTs & SW Basins
288 to 328 (Stage 3)	On-site for reuse	On-site	NA (Offset provided)	GPTs
Proposed school				
Lot 800	On-site for reuse	On-site	In SW basins	If Carpark >30 vehicles
COALs				
501 to 515	NA	In SW basins	In SW basins	GPTs & SW Basins
516 & 517 (Stage 3)	NA	Communal SW tank	NA (Offset provided)	GPTs
Roads	NA			
Roads 1 to 8	NA	In SW basins	In SW basins	GPTs & SW Basins
Road 9	NA	Public SW tank	NA (Offset provided)	GPTs
Totara Road	NA	Rain Gardens	80% in SW basins	Rain Gardens

NA – Not applicable or Not Available.
GPT – gross pollution trap, eg catchpit, leaf trap.

8.2 Recommendations

The detailed design for Engineering Plan Approval is to be in accordance with the principles as outlined in this Site-specific Stormwater Management Plan.

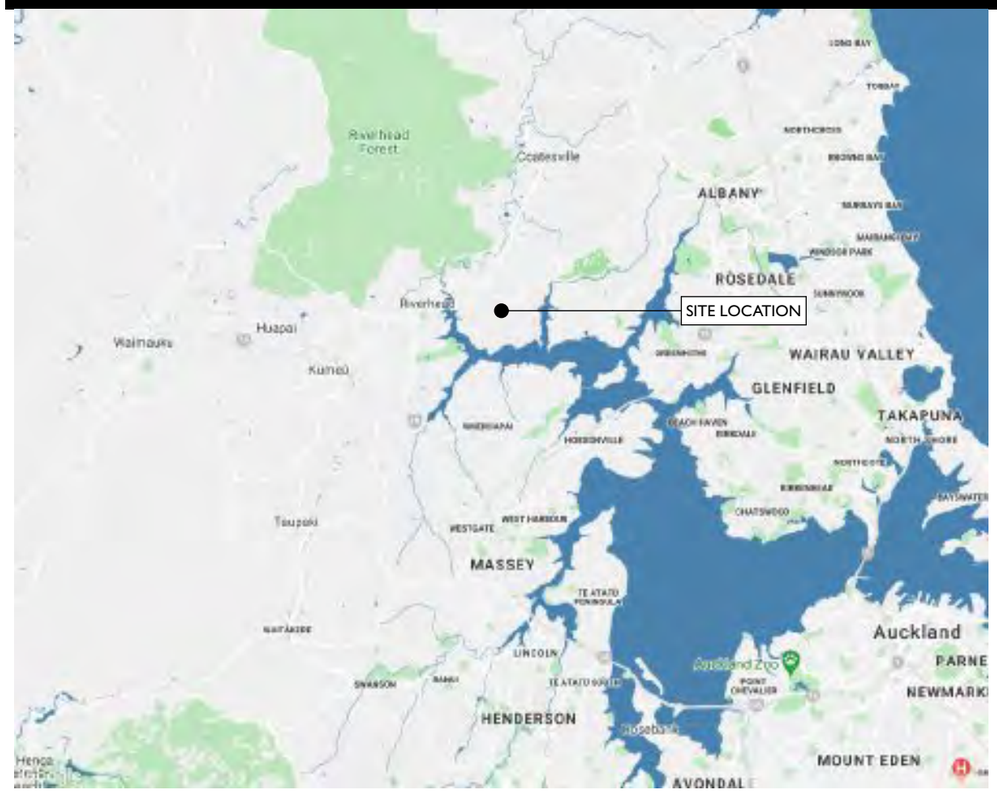
On-site stormwater management requirements to be implemented by way of Auckland Council consent notices on titles, requiring the recommended stormwater mitigation measures be applied during the design of the proposed dwellings.

Construction works be monitored to ensure that the stormwater management requirements are implemented to the design requirements.

Appendix A – Plans of existing site features

- Location Plan – Construkt
- Auckland Council GeoMaps SW Overland Flow Paths
- Bioresearches Figure 3

LOCATION PLAN



1 REGIONAL SITE LOCATION

2 LOCAL SITE LOCATION

3 Site Location Plan

0 20 120 1:2500 @A3

SITE ASSESSMENT

Legal description:	LOT 2 DP 81411, LOT 1 DP 53062
Address:	98 - 102 TOTARA RD, WHENUAPAI
Site Area:	163,646m^2
Zone:	FUTURE URBAN

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construkt

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Height datum: Auckland 1946.

AC Geomaps Overland Flow Paths

0 50 100 150
Meters

Scale @ A3
= 1:5,000

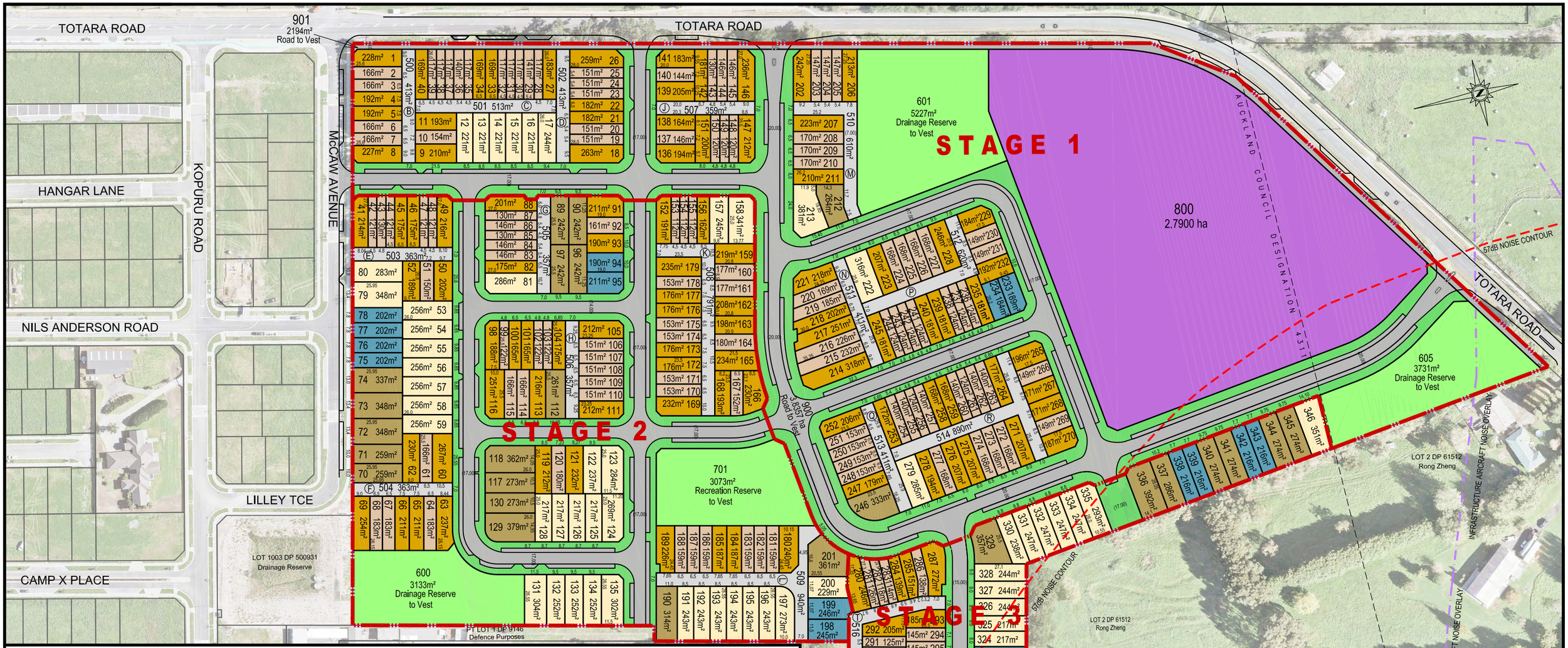
Date Printed:
29/08/2022

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Figure 3. Classified and ground-truthed watercourses at 98 and 100-102 Totara Road.

Appendix B – Proposed development plans

- **Scheme plan 4250-00-RC-01 rev7**
- **Stormwater drawings 4250-00-SW-400 to 491**
- **For other drawings see submission for resource consent application.**



TYPOLOGY SCHEDULE

	STAGE 1	STAGE 2	STAGE 3	Total
ZERO LOT BDY	9	32	14	55
END TERRACE	52	44	12	108
TERRACE	69	45	12	126
DUPLEX	2	8	18	28
STAND ALONE	2	16	11	29
Total	134	145	67	346

Territorial Authority:
Auckland Council

Comprised in:
RT NA4A/1477 &
RT 1036727

NOTE - All areas and dimensions are subject to final Survey

SCHEDULE OF AREAS

Description		Area
Residential Lots	Lots 1-346	6.8257 ha
Road to Vest	Lot 900	3.8357 ha
Road Widening	Lot 901	0.2194 ha
JOAL's	Lots 500-514,516 & 517	0.8988 ha
Recreation Reserve to Vest	Lot 701	0.3073 ha
Drainage Reserves to Vest	Lots 600-605	1.4928 ha
Proposed School Site	Lot 800	2.7900 ha
		16.3697 ha

Rev	Description	By	Date
7	SCHED OF AREAS AMENDED, LOT 515 REMVD	DP	12/12/22
6	LOTS REVISED	CK	21/11/22
5	LOTS 180-201 & 701 REVISED	MA	12/10/22

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Job Title
WHENUAPAI GREEN
98-102 TOTARA ROAD
WHENUAPAI

Drawing Title
PROPOSED SUBDIVISION OF
LOT 1 DP 53062 & LOT 2 DP 81411

	By	Date	Scale	Job No.	
Surveyed:			1:1000 @ A1 1:2000 @ A3	Drawing No.	Rev
Designed:				4520-00-RC-01	7
Drawn:	MDC	18/11/21			
Approved:					
CAD FILE					

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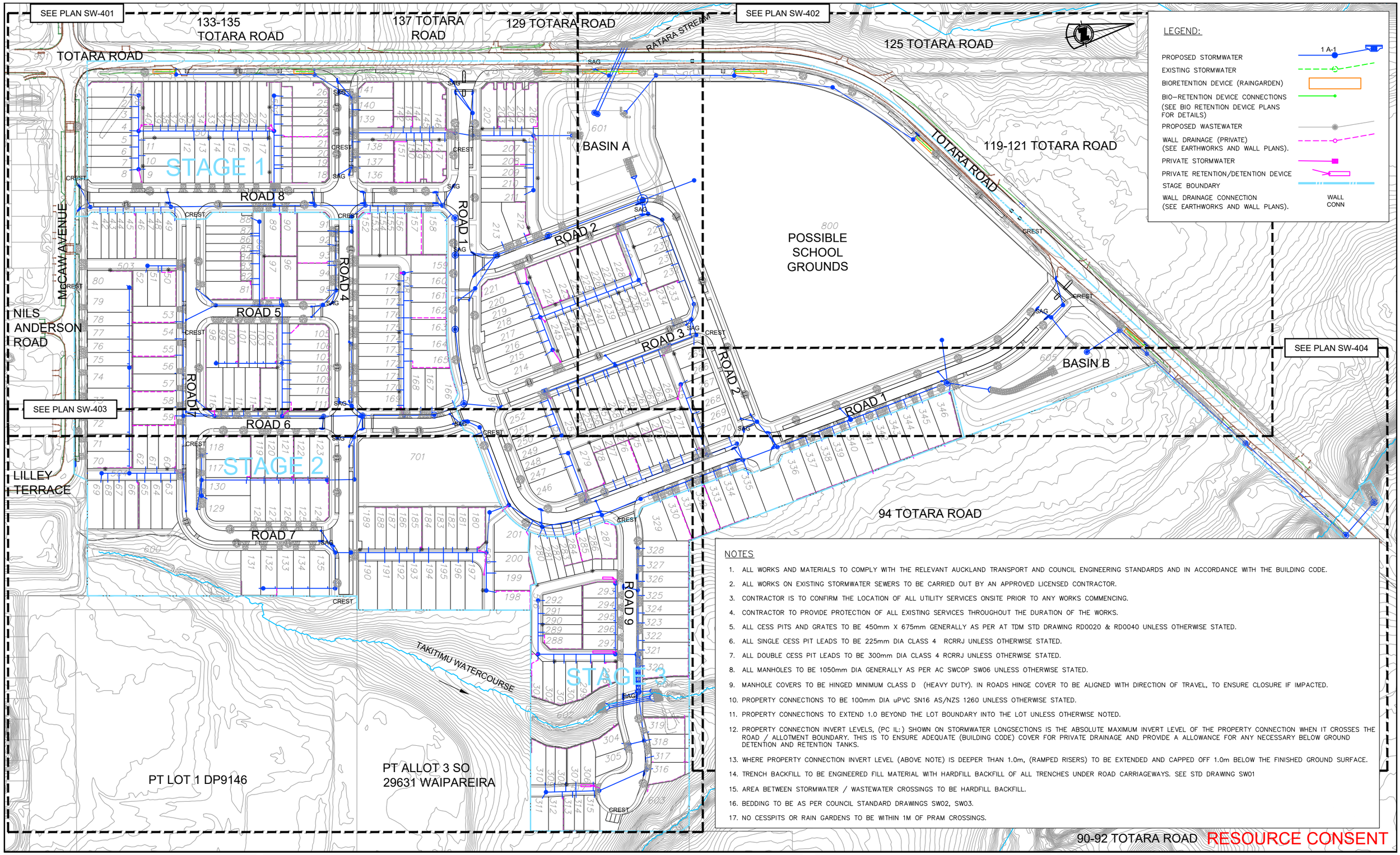

LEGEND:

- PROPOSED STORMWATER (1 A-1)
- EXISTING STORMWATER
- BIORETENTION DEVICE (RAINGARDEN)
- BIO-RETENTION DEVICE CONNECTIONS (SEE BIO RETENTION DEVICE PLANS FOR DETAILS)
- PROPOSED WASTEWATER
- WALL DRAINAGE (PRIVATE) (SEE EARTHWORKS AND WALL PLANS).
- PRIVATE STORMWATER
- PRIVATE RETENTION/DETENTION DEVICE
- STAGE BOUNDARY
- WALL DRAINAGE CONNECTION (SEE EARTHWORKS AND WALL PLANS). — WALL CONN

NOTES

1. ALL WORKS AND MATERIALS TO COMPLY WITH THE RELEVANT AUCKLAND TRANSPORT AND COUNCIL ENGINEERING STANDARDS AND IN ACCORDANCE WITH THE BUILDING CODE.
2. ALL WORKS ON EXISTING STORMWATER SEWERS TO BE CARRIED OUT BY AN APPROVED LICENSED CONTRACTOR.
3. CONTRACTOR IS TO CONFIRM THE LOCATION OF ALL UTILITY SERVICES ONSITE PRIOR TO ANY WORKS COMMENCING.
4. CONTRACTOR TO PROVIDE PROTECTION OF ALL EXISTING SERVICES THROUGHOUT THE DURATION OF THE WORKS.
5. ALL CESS PITS AND GRATES TO BE 450mm X 675mm GENERALLY AS PER AT TDM STD DRAWING RD0020 & RD0040 UNLESS OTHERWISE STATED.
6. ALL SINGLE CESS PIT LEADS TO BE 225mm DIA CLASS 4 RCRRJ UNLESS OTHERWISE STATED.
7. ALL DOUBLE CESS PIT LEADS TO BE 300mm DIA CLASS 4 RCRRJ UNLESS OTHERWISE STATED.
8. ALL MANHOLES TO BE 1050mm DIA GENERALLY AS PER AC SWCOP SW06 UNLESS OTHERWISE STATED.
9. MANHOLE COVERS TO BE HINGED MINIMUM CLASS D (HEAVY DUTY). IN ROADS HINGE COVER TO BE ALIGNED WITH DIRECTION OF TRAVEL, TO ENSURE CLOSURE IF IMPACTED.
10. PROPERTY CONNECTIONS TO BE 100mm DIA uPVC SN16 AS/NZS 1260 UNLESS OTHERWISE STATED.
11. PROPERTY CONNECTIONS TO EXTEND 1.0 BEYOND THE LOT BOUNDARY INTO THE LOT UNLESS OTHERWISE NOTED.
12. PROPERTY CONNECTION INVERT LEVELS, (PC IL:) SHOWN ON STORMWATER LONGSECTIONS IS THE ABSOLUTE MAXIMUM INVERT LEVEL OF THE PROPERTY CONNECTION WHEN IT CROSSES THE ROAD / ALLOTMENT BOUNDARY. THIS IS TO ENSURE ADEQUATE (BUILDING CODE) COVER FOR PRIVATE DRAINAGE AND PROVIDE A ALLOWANCE FOR ANY NECESSARY BELOW GROUND DETENTION AND RETENTION TANKS.
13. WHERE PROPERTY CONNECTION INVERT LEVEL (ABOVE NOTE) IS DEEPER THAN 1.0m, (RAMPED RISERS) TO BE EXTENDED AND CAPPED OFF 1.0m BELOW THE FINISHED GROUND SURFACE.
14. TRENCH BACKFILL TO BE ENGINEERED FILL MATERIAL WITH HARDFILL BACKFILL OF ALL TRENCHES UNDER ROAD CARRIAGEWAYS. SEE STD DRAWING SW01
15. AREA BETWEEN STORMWATER / WASTEWATER CROSSINGS TO BE HARDFILL BACKFILL.
16. BEDDING TO BE AS PER COUNCIL STANDARD DRAWINGS SW02, SW03.
17. NO CESSPITS OR RAIN GARDENS TO BE WITHIN 1M OF PRAM CROSSINGS.

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A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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Job Title
98-102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
LOCATION PLAN

	By	Date
Surveyed:	MS	
Designed:	KLP	
Drawn:	KLP	12/2022
Approved:	BJ	

Scale: 1:2000@A3

Job No. 4520

Drawing No. 4520-01-SW-400

Rev A

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FOR LEGEND AND NOTES
REFER TO PLAN 4520-01-SW-400

133-135 TOTARA ROAD

137
TOTARA
ROAD

129 TOTARA ROAD

TOTARA ROAD

McCAW AVENUE

ROAD 1

ROAD 2

ROAD 3

ROAD 4

ROAD 5

ROAD 6

ROAD 7

ROAD 8

POND A-1

POND A-2

REFER TO PLANS
4520-01-GN-470 TO 472 FOR
BASIN LEVELS & DETAILS

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Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER NETWORK
LAYOUT PLAN

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Drawn:	KLP	12/2022			
Approved:	BJ				

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129 TOTARA ROAD

125 TOTARA ROAD

119-121 TOTARA ROAD

FOR LEGEND AND NOTES
REFER TO PLAN 4520-01-SW-400

REFER TO PLANS
4520-01-GN-470 TO 472 FOR
BASIN LEVELS & DETAILS

RIPRAP OUTLET PROTECTION

EX. SW CULVERT & OUTLET TO BE REMOVED

EX. SW CULVERT & OUTLET TO BE REMOVER

TOTARA ROAD

ROAD 1

ROAD 2

ROAD 3

POND A-1

POND A-2

POND B-5

POND B-6

POND B-7

CREST

WALL CONN

RIPRAP OUTLET PROTECTION

RESOURCE CONSENT

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WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
LAYOUT PLAN

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Approved:	BJ				

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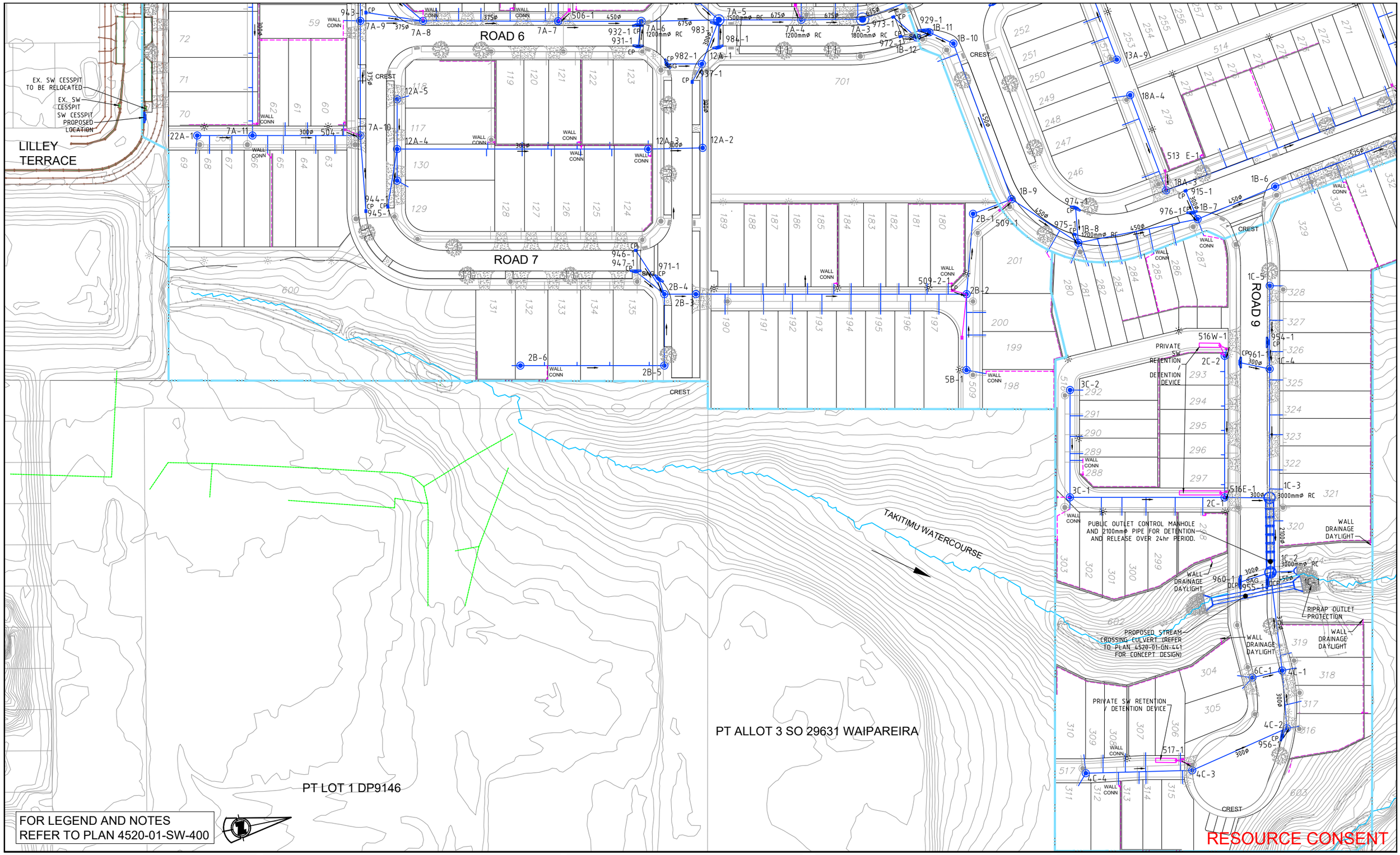

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LAYOUT PLAN

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Drawing No. 4520–01–SW–403
Rev A

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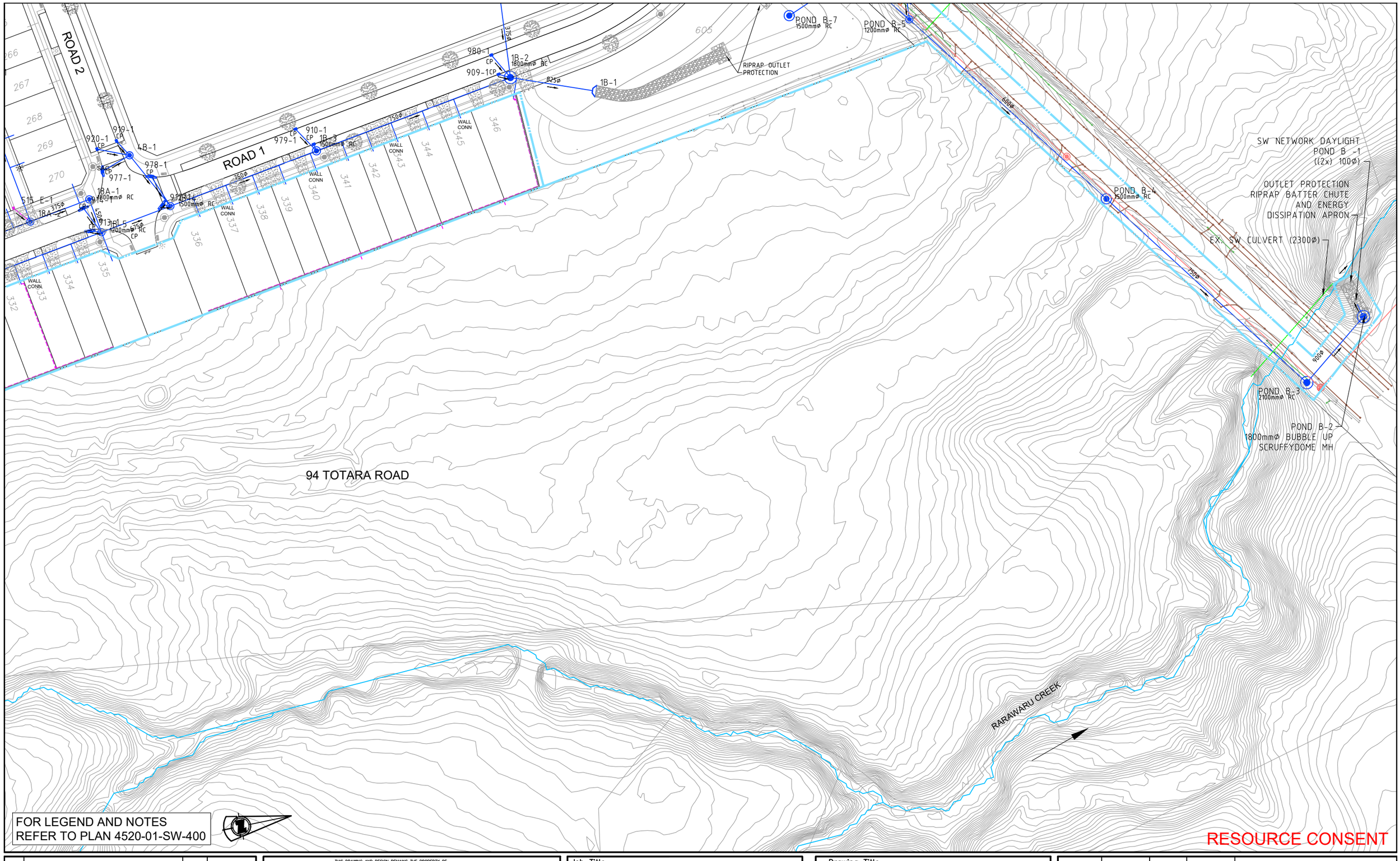

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Drawing Title
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LAYOUT PLAN

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Approved:	BJ				

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133-135 TOTARA ROAD

137 TOTARA ROAD

129 TOTARA ROAD

RATARA STREAM

125 TOTARA ROAD

901 TOTARA ROAD

LEGEND:

PROPOSED STORMWATER

EXISTING STORMWATER

DEVELOPMENT STAGING

119-121 TOTARA ROAD

TOTARA ROAD

BASIN A

STAGE 1

ROAD 8

ROAD 1

ROAD 2

800
POSSIBLE
SCHOOL
GROUNDS

McCAW AVENUE

ROAD 4

ROAD 5

ROAD 3

ROAD 2

BASIN B

ROAD 7

ROAD 6

ROAD 1

STAGE 2

94 TOTARA ROAD

ROAD 7

ROAD 9

TAKITIMU WATERCOURSE

RARAWARU CREEK

STAGE 3

PT LOT 1 DP9146

PT ALLOT 3 SO
29631 WAIPAREIRA

90-92 TOTARA ROAD

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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LAND DEVELOPERS

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Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
DEVELOPMENT STAGING

	By	Date	Scale	Job No. 4520	
Surveyed:	MS		1:500@A3	Drawing No. 4520–01–SW–405	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

CAD FILE C:\12dS\data\NGSQL01\Whenuapai Green – 4520_61\Design\DWG\ENG\RESOURCE CONSENT\4520–01–SW–400.dwg

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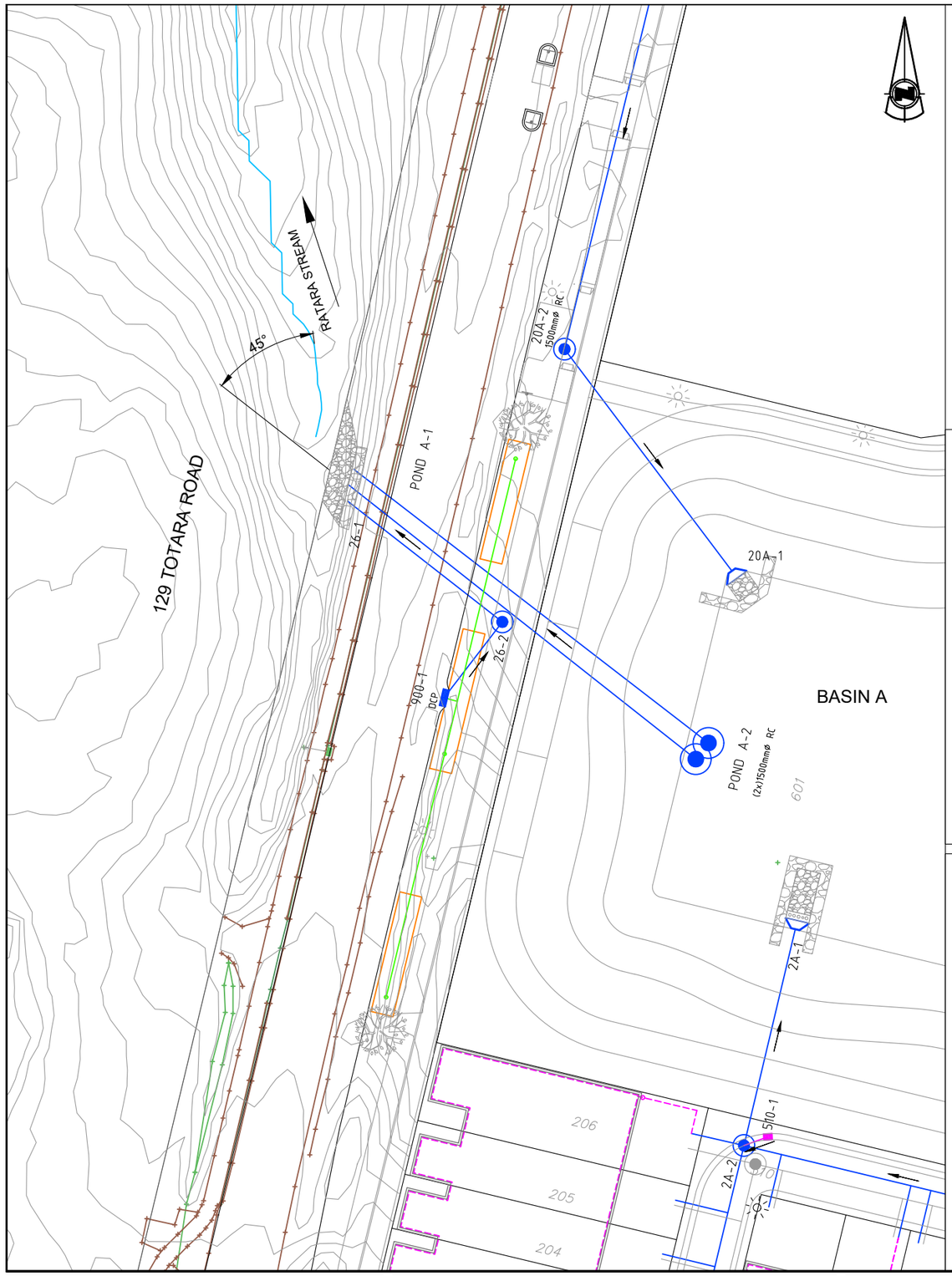


ENERGY DISSIPATION CALCULATION

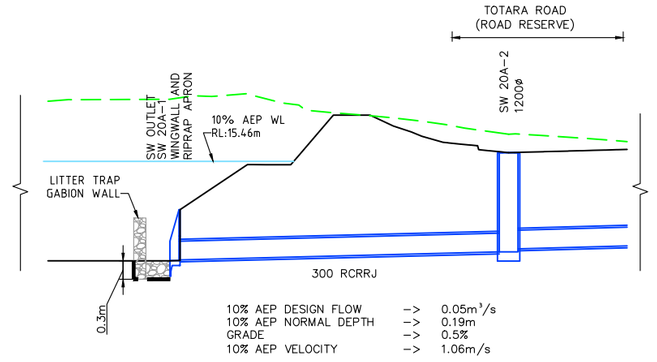
$F_o = v / (g \times d_o)^{\wedge 0.5}$
$F_o = 1.06 / (9.81 \times 0.19)^{\wedge 0.5}$

10% AEP FROUDE NUMBER = 0.78
F_o < 1.7 -> HEADWALL & APRON

RIPRAP (ROCK SIZE)
$D_{50} = 0.25 \times D_o \times F_o$
$D_{50} = 0.25 \times 0.3 \times 0.78$
$D_{50} = 0.06m$ (150mm MINIMUM)

APRON DIMENSIONS
$W_a >= 3 \times D_o$
$W_a = 0.9m$

$L_a = D_o (8+17 \log F_o)$
$L_a = 0.3 [8+17\log(0.78)]$
$L_a \approx 2m$



10% AEP DESIGN FLOW -> 0.05m³/s
10% AEP NORMAL DEPTH -> 0.19m
GRADE -> 0.5%
10% AEP VELOCITY -> 1.06m/s

ENERGY DISSIPATION CALCULATION

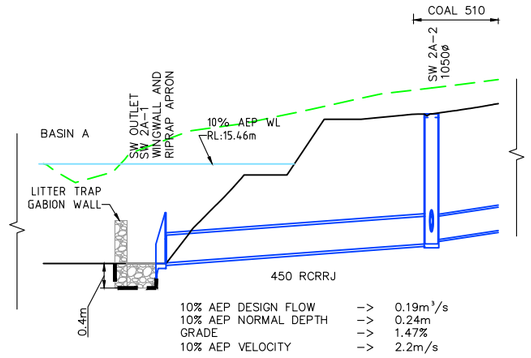
$F_o = v / (g \times d_o)^{\wedge 0.5}$
$F_o = 2.2 / (9.81 \times 0.24)^{\wedge 0.5}$

10% AEP FROUDE NUMBER = 1.4
F_o < 1.7 -> HEADWALL & APRON

RIPRAP (ROCK SIZE)
$D_{50} = 0.25 \times D_o \times F_o$
$D_{50} = 0.25 \times 0.45 \times 1.4$
$D_{50} = 0.16m$ (200mm)

APRON DIMENSIONS
$W_a >= 3 \times D_o$
$W_a = 1.35m$

$L_a = D_o (8+17 \log F_o)$
$L_a = 0.45 [8+17\log(1.4)]$
$L_a \approx 4.7m$



10% AEP DESIGN FLOW -> 0.19m³/s
10% AEP NORMAL DEPTH -> 0.24m
GRADE -> 1.47%
10% AEP VELOCITY -> 2.2m/s

RESOURCE CONSENT

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A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
ENERGY DISSIPATION &
OUTLET DESIGN

	By	Date	Scale	Job No. 4520	
Surveyed:	MS		1:500@A3 5 X VERT.	Drawing No. 4520–01–SW–406	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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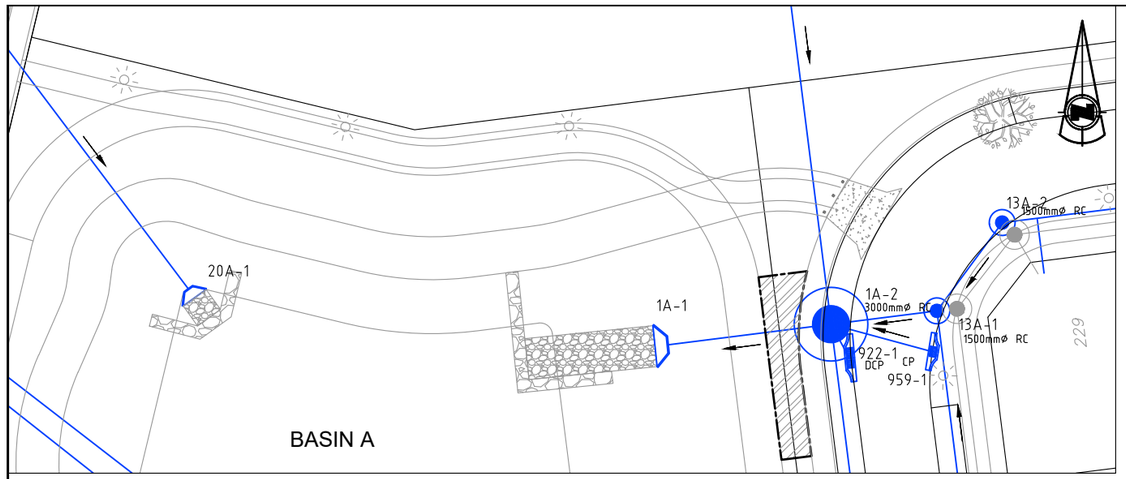
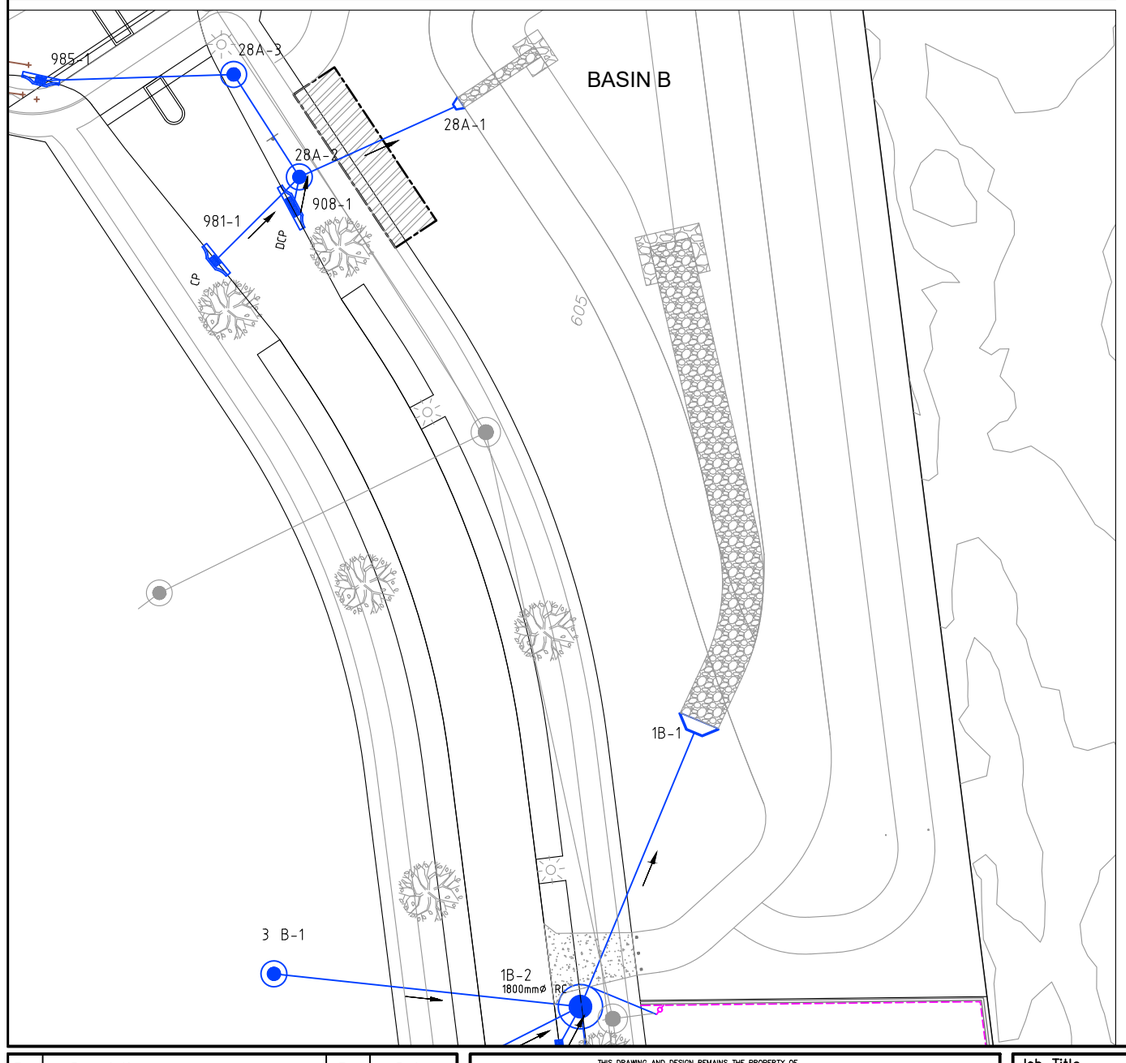




ENERGY DISSIPATION CALCULATION

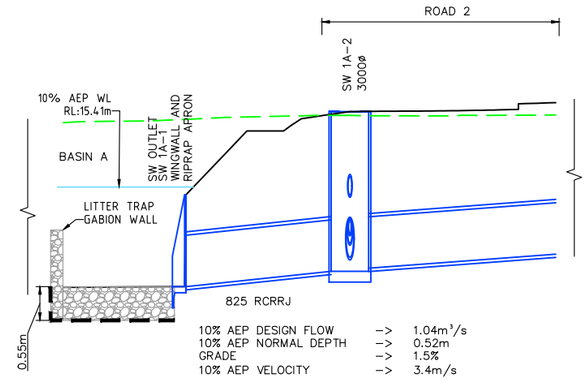
$F_o = v / (g \times d_o)^{\wedge 0.5}$
$F_o = 3.4 / (9.81 \times 0.52)^{\wedge 0.5}$

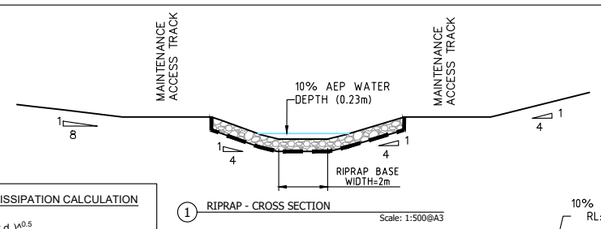
10% AEP FROUDE NUMBER = 1.5
F_o < 1.7 -> HEADWALL & APRON

RIPRAP (ROCK SIZE)
$D_{50} = 0.25 \times D_o \times F_o$
$D_{50} = 0.25 \times 0.825 \times 1.5$
$D_{50} = 0.31m$ (350mm)

APRON DIMENSIONS
$W_a >= 3 \times D_o$
Wa ≈ 2.5m

$L_a = D_o (8+17 \text{Log} F_o)$
$L_a = 0.825 [8+17\log(1.5)]$
L_a ≈ 9.1m





1 RIPRAP - CROSS SECTION
Scale: 1:500@A3

ENERGY DISSIPATION CALCULATION

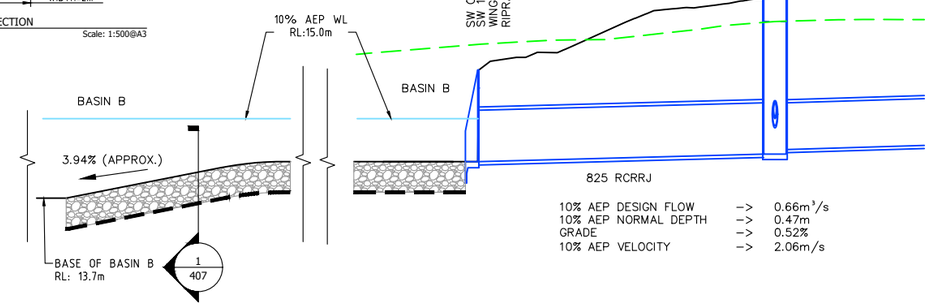
$F_o = v / (g \times d_o)^{\wedge 0.5}$
$F_o = 2.06 / (9.81 \times 0.47)^{\wedge 0.5}$

10% AEP FROUDE NUMBER = 0.96
F_o < 1.7 -> HEADWALL & APRON

RIPRAP (ROCK SIZE)
$D_{50} = 0.25 \times D_o \times F_o$
$D_{50} = 0.25 \times 0.825 \times 0.96$
$D_{50} = 0.2m$ (250mm)

APRON DIMENSIONS
$W_a >= 3 \times D_o$
Wa ≈ 2.5m

$L_a = D_o (8+17 \text{Log} F_o)$
$L_a = 0.825 [8+17\log(0.96)]$
L_a ≈ 6.4m



ENERGY DISSIPATION CALCULATION

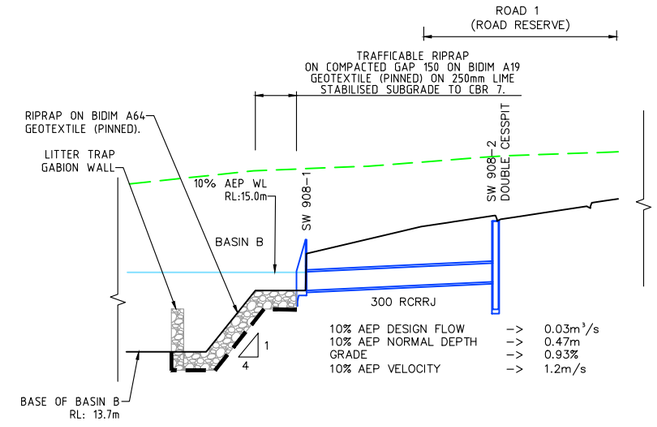
$F_o = v / (g \times d_o)^{\wedge 0.5}$
$F_o = 1.2 / (9.81 \times 0.12)^{\wedge 0.5}$

10% AEP FROUDE NUMBER = 1.11
F_o < 1.7 -> HEADWALL & APRON

RIPRAP (ROCK SIZE)
$D_{50} = 0.25 \times D_o \times F_o$
$D_{50} = 0.25 \times 0.3 \times 1.11$
$D_{50} = 0.08m$ (150mm MINIMUM)

APRON DIMENSIONS
$W_a >= 3 \times D_o$
Wa ≈ 0.9m

$L_a = D_o (8+17 \text{Log} F_o)$
$L_a = 0.3 [8+17\log(1.11)]$
L_a ≈ 2.7m



RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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WEB: www.neilgroup.co.nz

Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
ENERGY DISSIPATION &
OUTLET DESIGN

	By	Date	Scale	Job No. 4520	
Surveyed:	MS		1:500@A3	Drawing No.	Rev
Designed:	KLP		5 X VERT.	4520–01–SW–407	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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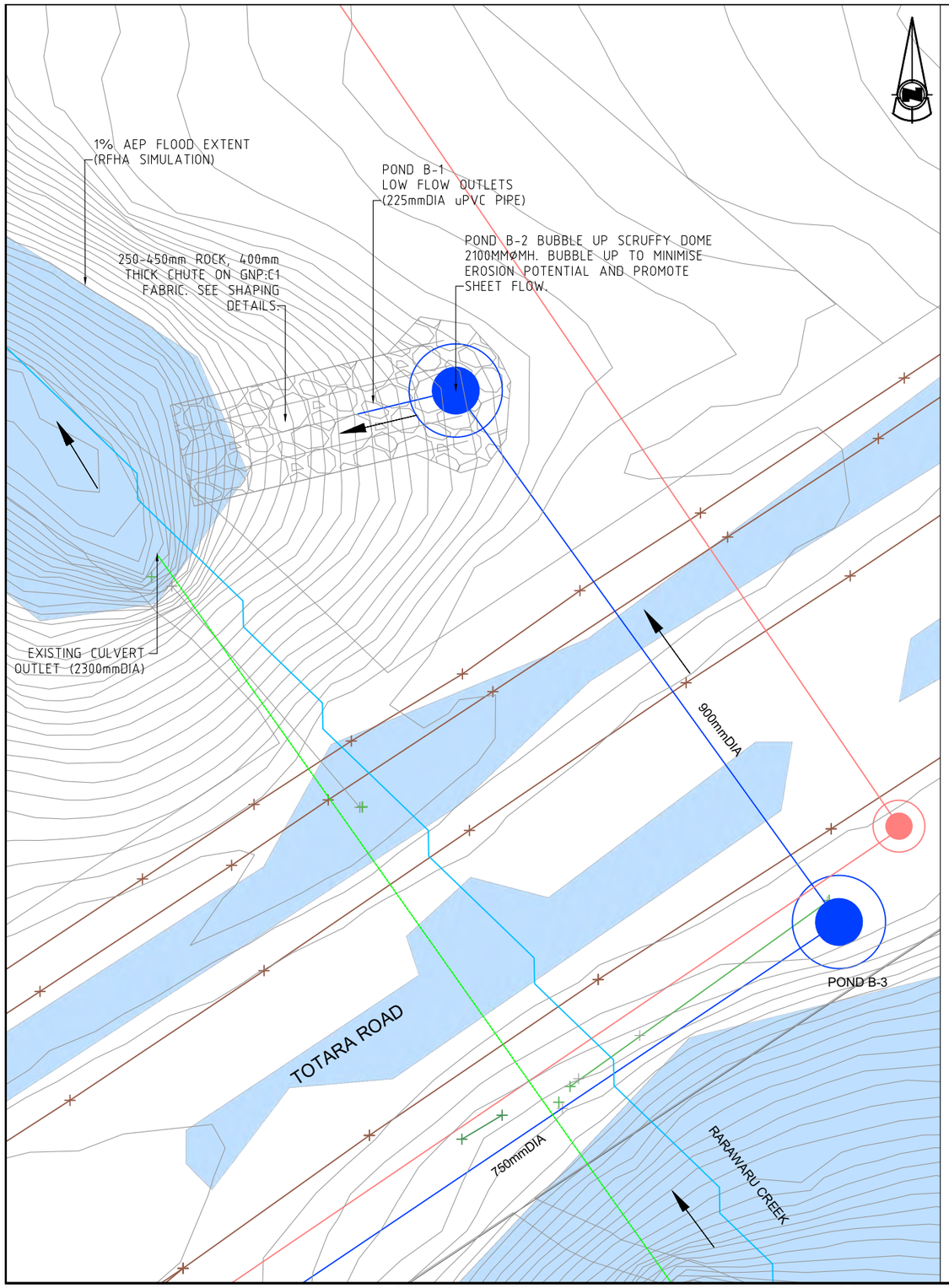
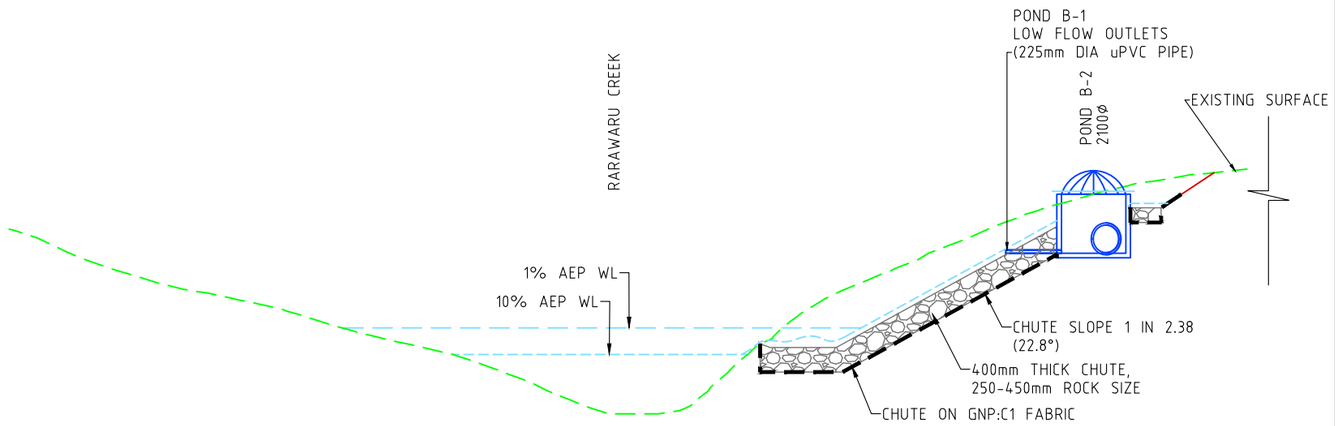
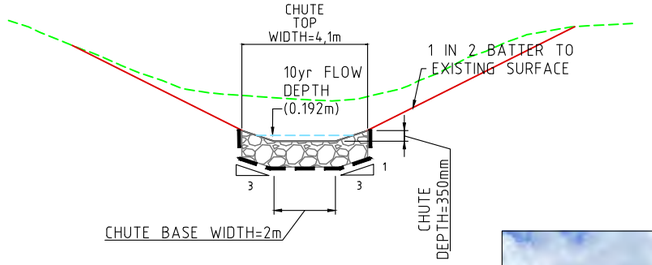
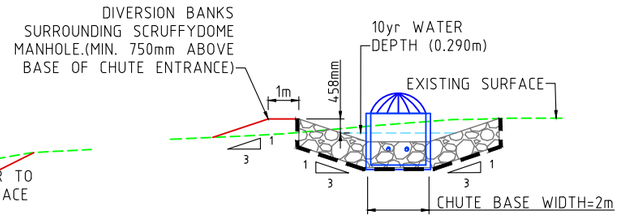




SW CHUTE
TYPICAL CROSS SECTION





EXAMPLE BUBBLE UP OUTFALL AND ROCK CHUTE.

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	01/12/2022

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FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
ENERGY DISSIPATION &
OUTLET DESIGN

	By	Date	Scale	Job No. 4520	
Surveyed:	MS		1:500@A3	Drawing No. 4520–01–SW–408	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

CAD FILE C:\12dS\data\NGSQL01\Whenuapai Green – 4520_61\Design\DWG\ENG\RESOURCE CONSENT\4520–01–SW–400.dwg

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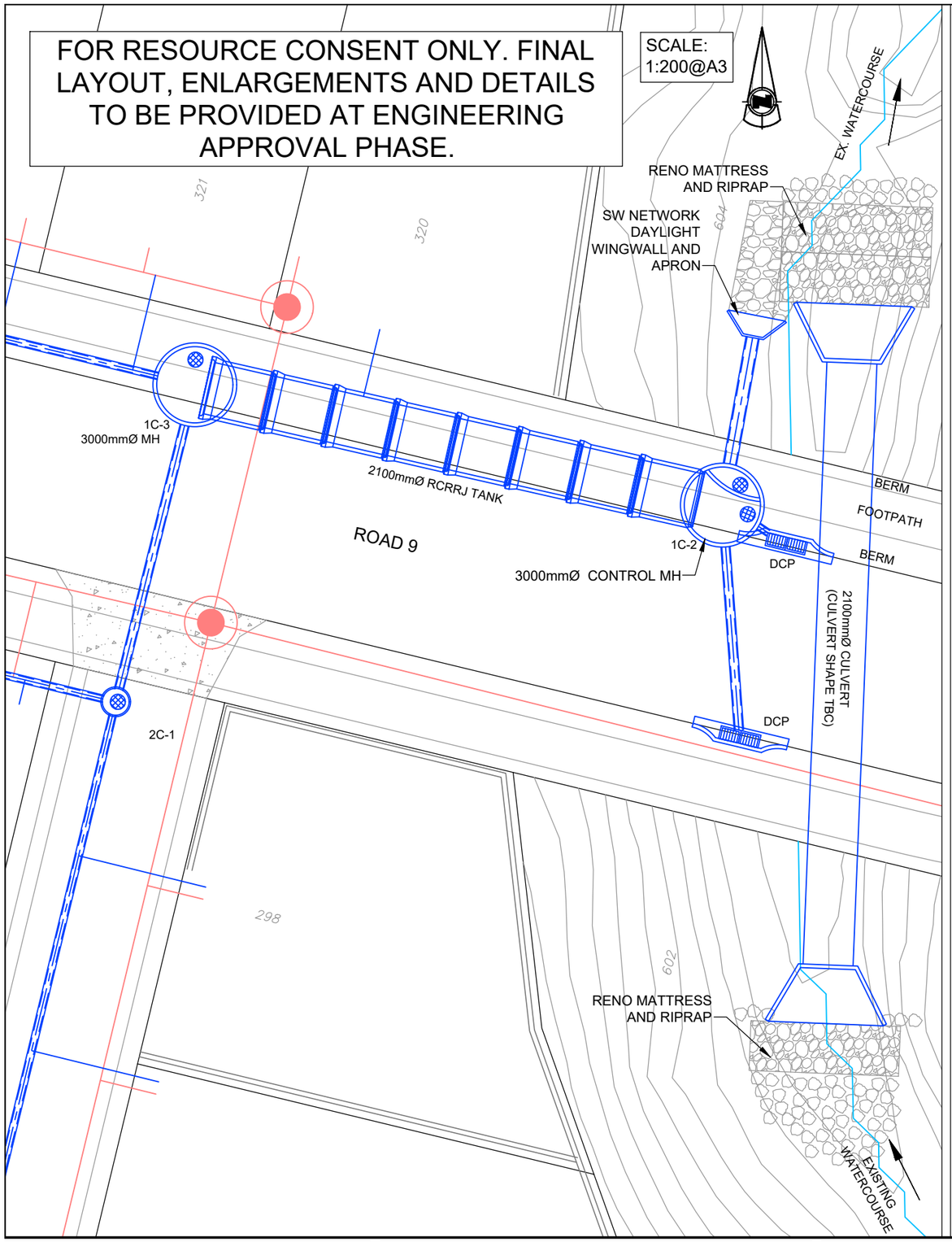
FOR RESOURCE CONSENT ONLY. FINAL LAYOUT, ENLARGEMENTS AND DETAILS TO BE PROVIDED AT ENGINEERING APPROVAL PHASE.

SCALE: 1:200@A3



ENERGY DISSIPATION CALCULATION

$F_o = v / (g \times d_p)^{0.5}$

$F_o = 2 / (9.81 \times 0.3)^{0.5}$

10% AEP FROUDE NUMBER = 1.16

F_o < 1.7 -> HEADWALL & APRON

RIPRAP (ROCK SIZE)

$D_{50} = 0.25 \times D_o \times F_o$

$D_{50} = 0.25 \times 0.45 \times 1.16$

$D_{50} = 0.13m$ (150mm MINIMUM)

APRON DIMENSIONS

$W_a >= 3 \times D_o$

$Wa \approx 1.35m$

$L_a = D_o (8+17 \log F_o)$

$L_a = 0.45 [8+17\log(1.16)]$

$L_a \approx 4.1m$

GD01 - STORMWATER DETENTION RUNOFF VOLUME CALCULATIONS

[UNDER ROAD DETENTION]

PROJECT DATA & PARAMETERS

PROJECT NO.:	4520-01(WHENUAPAI GREEN)	DATE:	Nov-22 Rev A
SITE DESCRIPTION:	98-102 Totara Road, Whenuapai	BY:	Kleber Lessa

STORMWATER SCOPE TO ACHIEVE:

1. Retention of 5mm runoff from contributing impervious areas. (as AC SW NDC / SMAF1).

2. Detention of 95th percentile contributing impervious areas. (as per AC SW NDC / SMAF1).

Total Road 9 Reserve Area (m2):	2792	Hydrological Soil Group:	C
Existing Impervious Area (m2):	0	Pre Impervious SCS curve number (CN):	74
Road 9 Impervious Area (m2):	2373	Pre Initial Abstraction Depth Ia (mm):	5
Roads Impervious Area (%):	85.0%	Post Impervious SCS curve number (CN):	98
SMAF1 95th 24hr Rainfall Depth (mm):	35	Post Initial Abstraction Depth Ia (mm):	0
SMAF Retention Depth (mm):	5.00	Orifice Calculation Coefficient of Discharge (Cd):	0.62

TP108 - PRE / POST DEVELOPMENT RUNOFF DEPTH CALCULATION (SCENARIO B)

PRE DEVELOPMENT		POST DEVELOPMENT	
Soil Storage Parameter S (mm):	89.24	Soil Storage Parameter S (mm):	5.18
Runoff Depth (mm):	7.55	Runoff Depth (mm):	30.50

Post minus Pre Runoff Depth (mm): 22.95

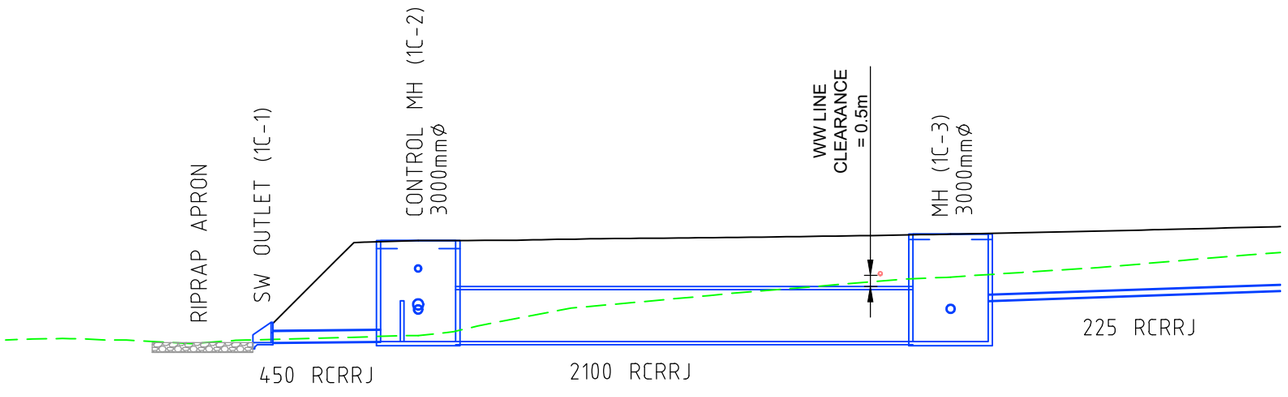
HYDROLOGY MITIGATION VOLUME CALCULATION

Hydrology Mitigation Volume (m3):	54.5	95th% Release Rate, Q_{Av95th} (l/s):	0.630
Retention Volume (m3):	11.9	Maximum Release Rate Q_{max} (l/s):	1.261
Detention Volume (m3):	42.6 TRUE		

STORMWATER DETENTION PIPE SIZING - Under road storage

Considering all site constraints:
- 1 x Underground pipe to be located under road reserve.
- Infiltration not possible due to soil conditions

Number of Tanks:	1	Orifice Diameter, $d_{(design)}$ (mm):	21
Tank Diameter, $D_{(tank)}$ (m):	2.1	Orifice Area, $A_{(design)}$ (m2):	3.46E-04
Tank Length, L (m):	18.650	Design release rate, Q_{design} (l/s):	1.226 TRUE
Tank Area (up to weir height), A (m^2):	2.937		
Pipe Volume, V_{pipe} (m^3):	54.77 TRUE		
Storage height, $h_{(95th\%Det/Ret)}$ (m):	1.66	*weir height above invert	



SCALE: 1:500@A3

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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WEB: www.neilgroup.co.nz

Job Title: WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title: STORMWATER DRAINAGE
ROAD 9 ON–SITE
STORMWATER DETENTION DEVICE

	By	Date	Scale	Job No. 4520	Rev
Surveyed:	MS		AS SHOWN	Drawing No. 4520–01–SW–409	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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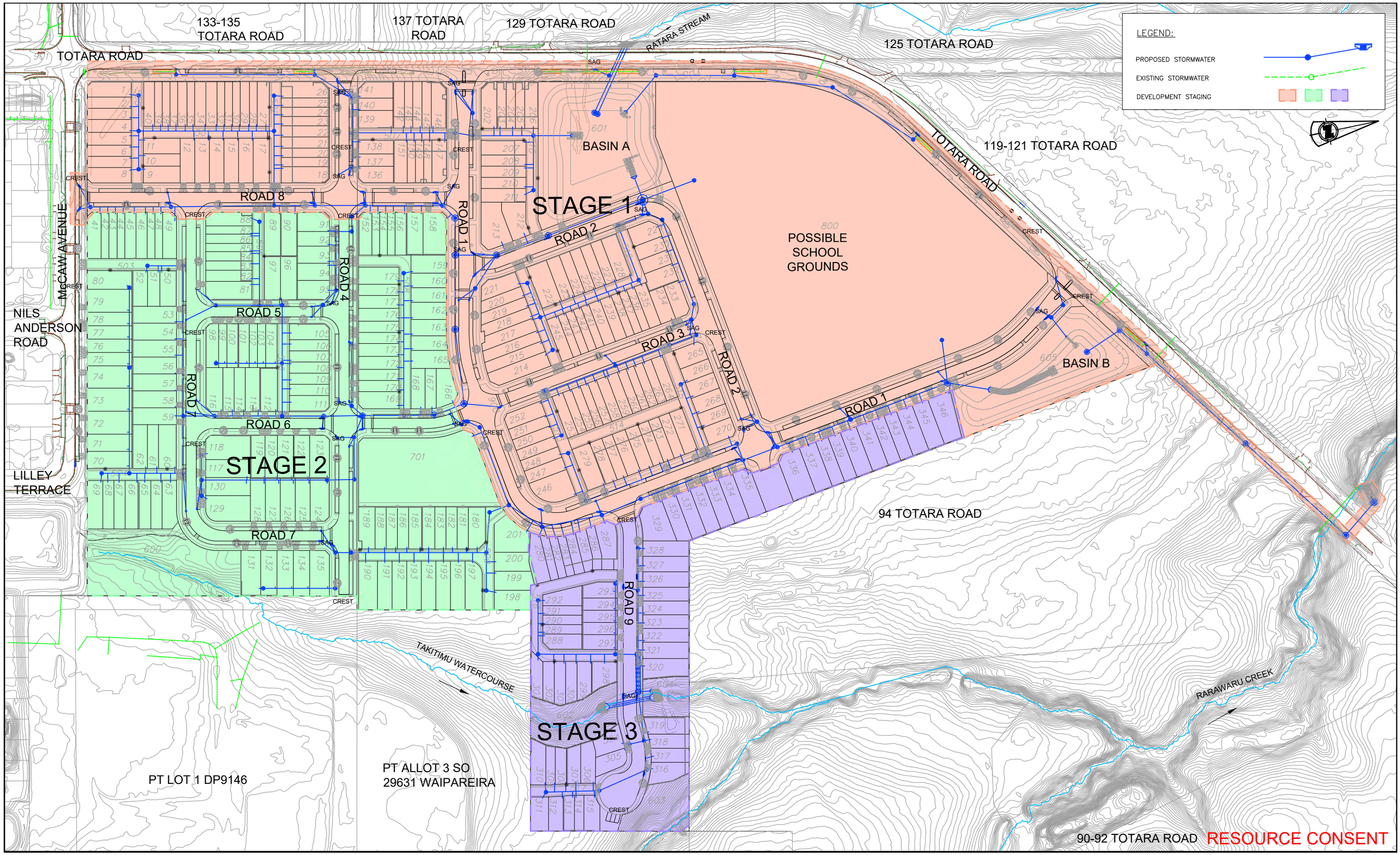

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A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
98–102 TOTARA ROAD
WHENUAPAI GREEN
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
DEVELOPMENT STAGING PLAN

	By	Date	Scale	Job No. 4520	
Surveyed:	MS		1:2000@A3	Drawing No. 4520–01–SW–413	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

CAD FILE C:\12dS\data\NGSQL01\Whenuapai Green – 4520_61\Design\DWG\ENG\RESOURCE CONSENT\4520–01–SW–400.dwg

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137 TOTARA ROAD

133-135 TOTARA ROAD

129 TOTARA ROAD

125 TOTARA ROAD

TOTARA ROAD

ROAD SAG

CREST

SUB-CATCHMENT SOUTHWEST
AREA = 1.4540ha
IMPERVIOUSNESS = 80%

KOPURU ROAD

McCAW AVENUE

CREST

NILS ANDERSON ROAD

LILLEY TERRACE

SUB-CATCHMENT WEST
AREA = 9.3532ha
IMPERVIOUSNESS = 0%

SUB-CATCHMENT EAST
AREA = 5.2503ha
IMPERVIOUSNESS = 0%

SUB-CATCHMENT NORTH
AREA = 1.7618ha
IMPERVIOUSNESS = 0%

SUB-CATCHMENT NORTHEAST
AREA = 0.1078ha
IMPERVIOUSNESS = 80%

CREST

TOTARA ROAD

119-121 TOTARA ROAD

94 TOTARA ROAD

1/5173 KUPE AVENUE

14 AIRPORT ROAD

90-92 TOTARA ROAD

LEGEND

- EXISTING CONTOURS 0.5m (AC GIS)
- 1% AEP FLOOD PLAIN EXTENT (AC GIS)
- 1% AEP FLOOD PRONE AREA (AC GIS)
- EXISTING CATCHMENTS (PRE DEVELOP.)
- EXISTING ROAD FORMATION

RESOURCE CONSENT

Rev	Description	By	Date
--	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
1% AEP EXISTING (PRE–DEVELOP.)
CATCHMENT AREAS

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		1:2000@A3	Drawing No. 4520–01–SW–430	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

CAD FILE C:\12dS\data\NGSQL01\Whenuapai Green – 4520_61\Design\DWG\ENG\RESOURCE CONSENT\4520–01–SW–430.dwg

137 TOTARA ROAD

133-135 TOTARA ROAD

TOTARA ROAD

129 TOTARA ROAD

125 TOTARA ROAD

ROAD SAG

CREST

AREA F
1.0125ha
(85% IMPERV.)

SAG

SW BASIN A

A1
481

SAG

CREST

AREA A
10.0723ha
(62.1% IMPERV.)

KOPURU ROAD

McCAW AVENUE

CREST

NILS ANDERSON ROAD

CREST

CREST

CREST

CREST

CREST

AREA B
4.7826ha
(53.5% IMPERV.)

CREST

TOTARA ROAD

B1
481

SAG

AREA E
0.0774ha
(85% IMPERV.)

B2
481

SW BASIN B

LILLEY TERRACE

EXISTING
SW BASIN

AREA D
0.3419ha
(0% IMPERV.)

CREST

94 TOTARA ROAD

AREA C
1.5168ha
(69% IMPERV.)

SAG

C1
481

1/5173 KUPE AVENUE

14 AIRPORT ROAD

90-92 TOTARA ROAD

RESOURCE CONSENT

LEGEND

- EXISTING CONTOURS 01m (AC GIS)
- PROPOSED CONTOURS (1m)
- 1% AEP FLOOD PLAIN EXTENT (AC GIS)
- 1% AEP FLOOD PRONE AREA (AC GIS)
- 1% AEP CATCHMENTS (PRE DEVELOP.)
- EXISTING ROAD FORMATION
- OVERLAND FLOW PATH
- EXISTING WATERCOURSE

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
1% AEP PROPOSED DEVELOPMENT
CATCHMENT AREAS

	By	Date
Surveyed:	CP / MS	
Designed:	KLP	
Drawn:	KLP	12/2022
Approved:	BJ	

Scale: 1:2000@A3

Job No. 4520

Drawing No. 4520–01–SW–431

Rev A

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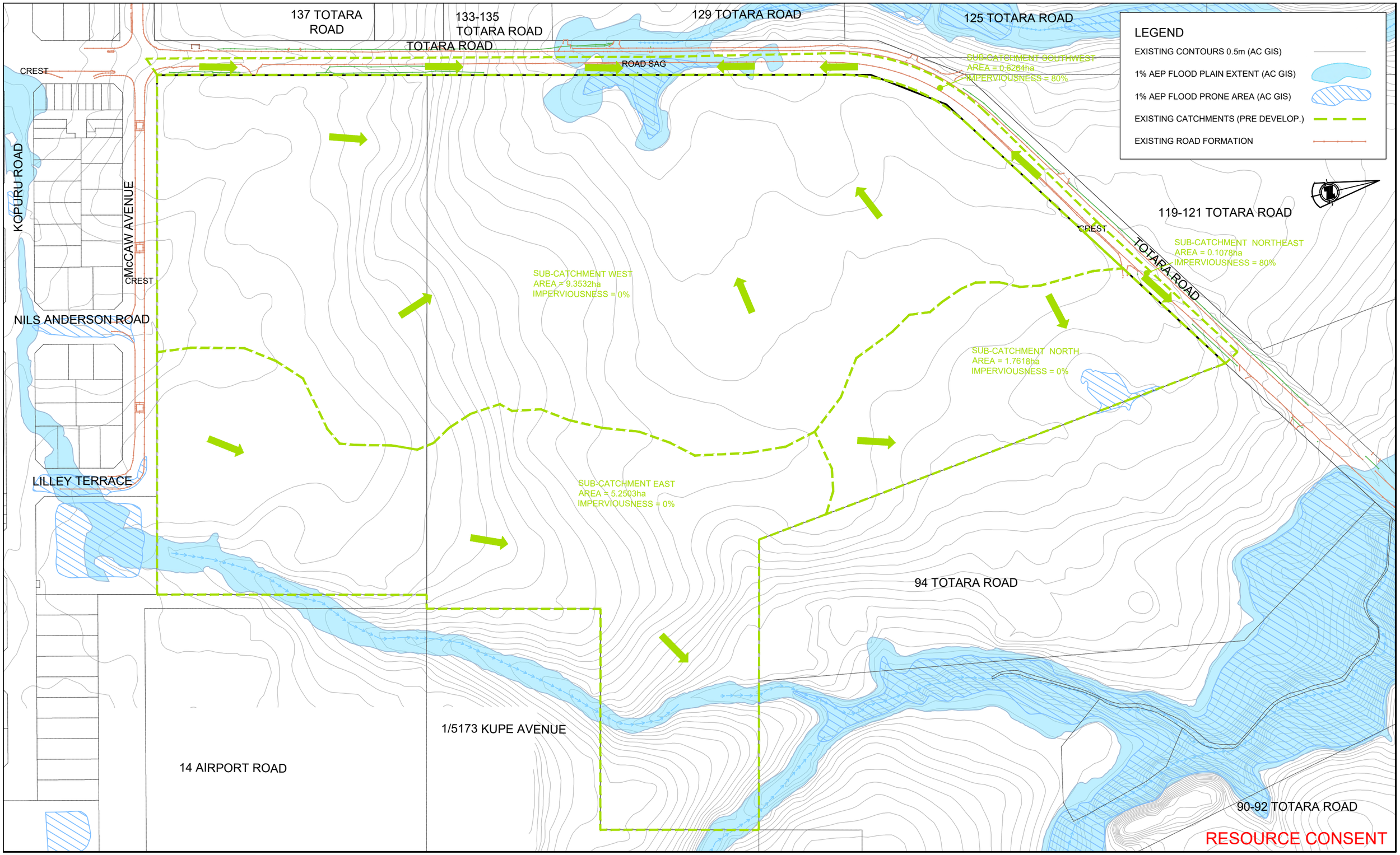

Rev	Description	By	Date
--	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
10% AEP EXISTING (PRE–DEVELOP.)
CATCHMENT AREAS

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		1:2000@A3	Drawing No. 4520–01–SW–432	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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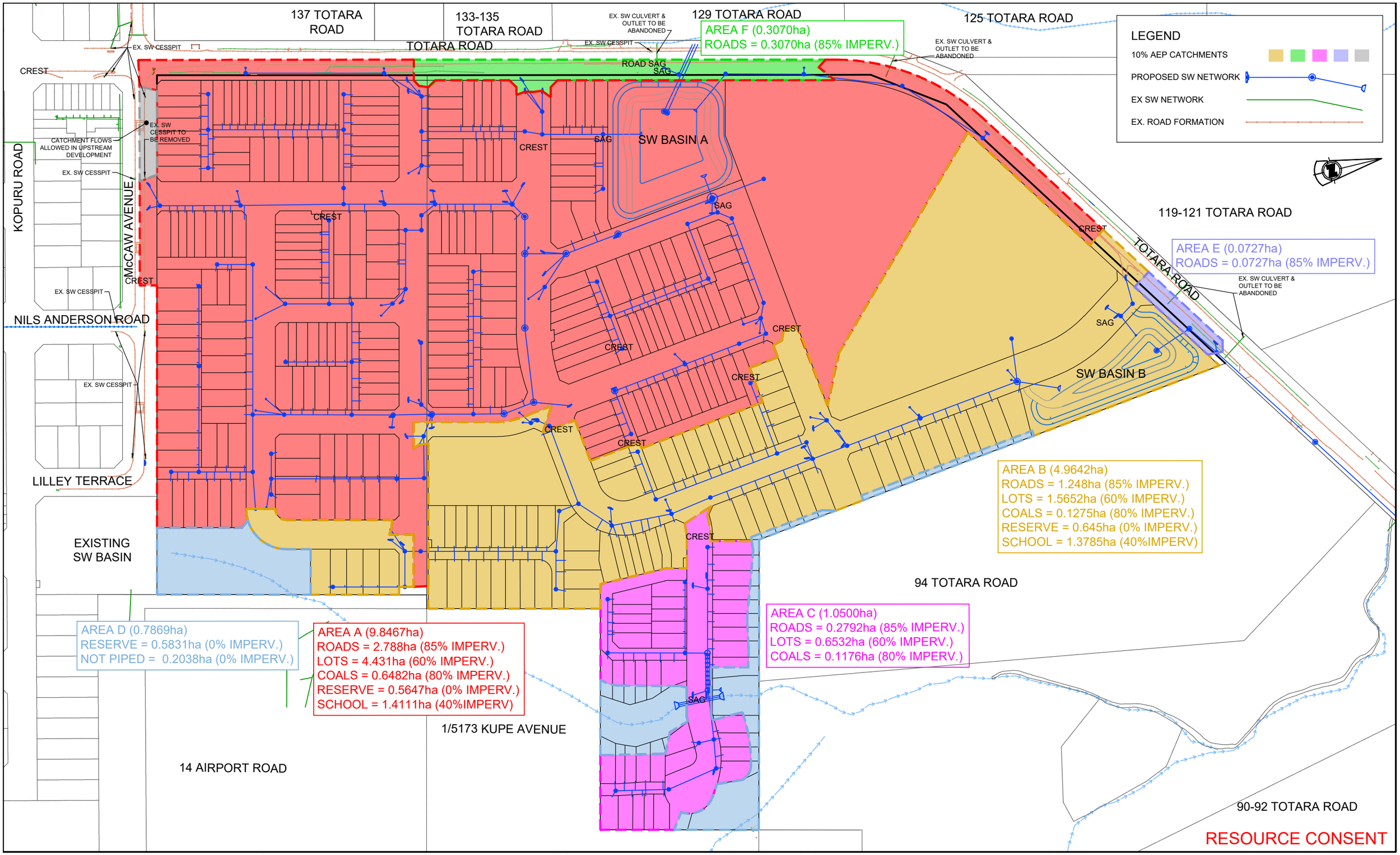

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
10% AEP PROPOSED DEVELOPMENT
CATCHMENT AREAS

	By	Date	Scale	Job No. 4520	Rev
Surveyed:	CP / MS		1:2000@A3	Drawing No. 4520–01–SW–433	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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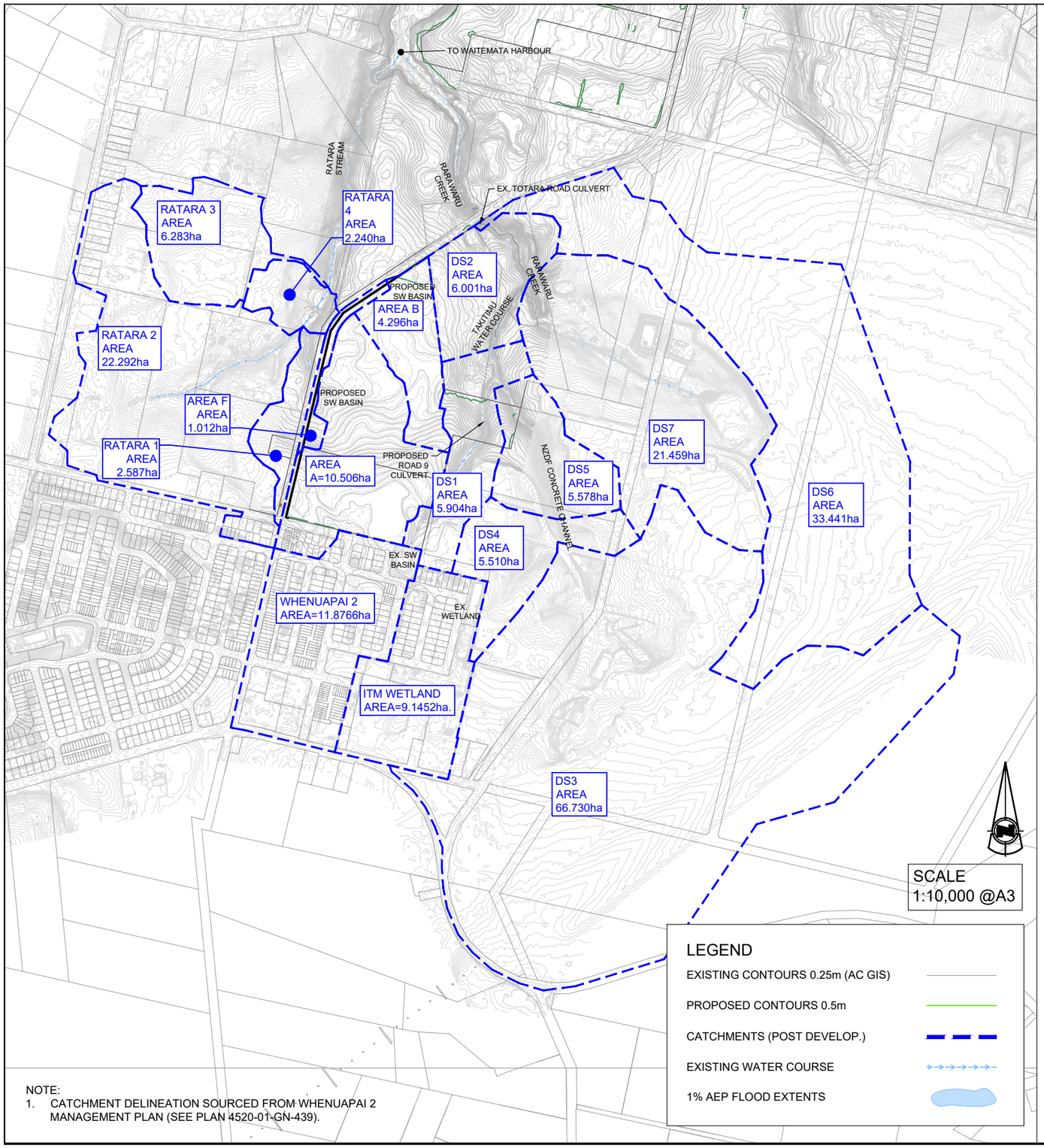

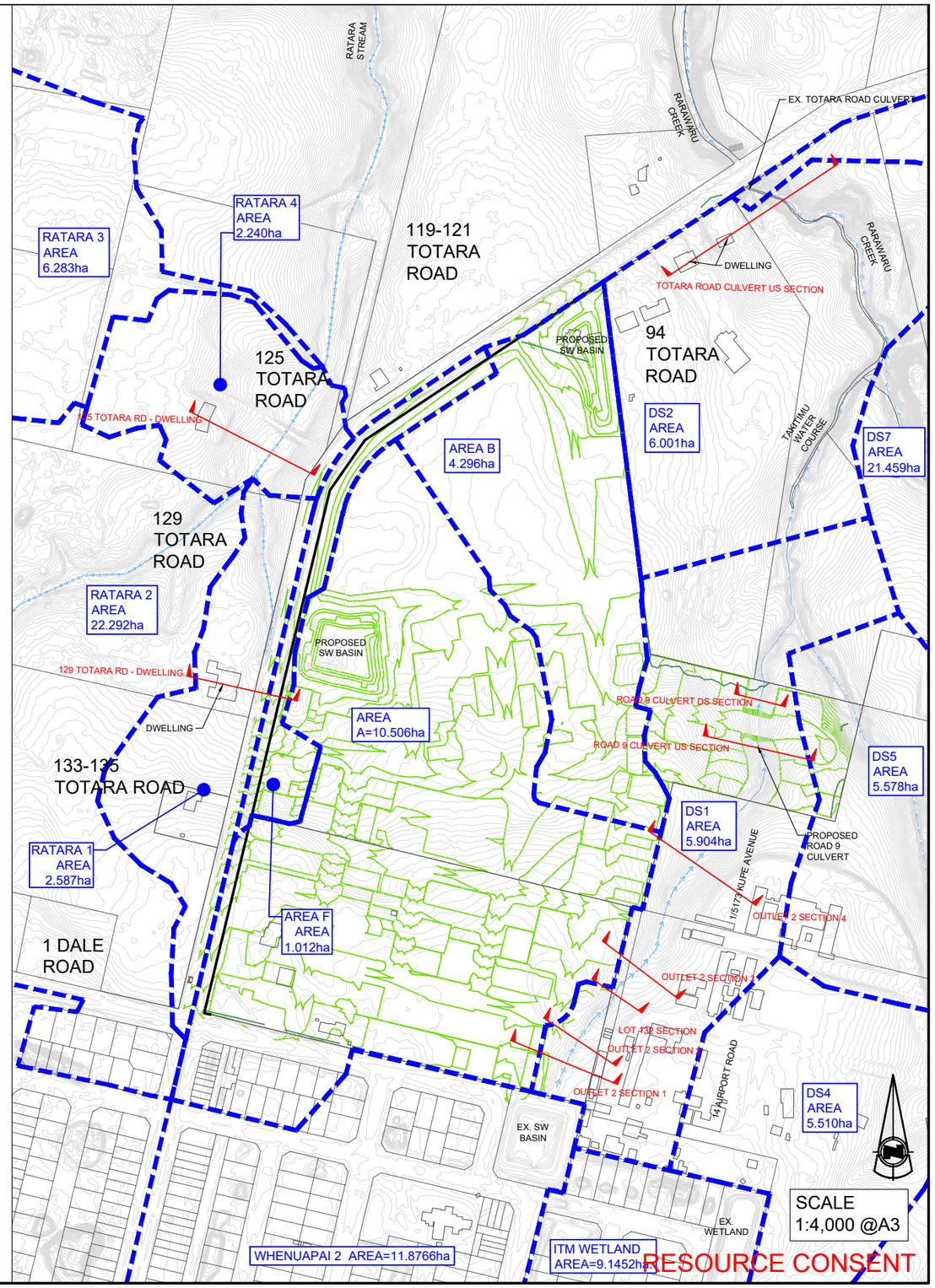

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
RAPID FLOOD HAZARD
ASSESSMENT LOCATION PLAN

	By	Date	Scale	Job No. 4520
Surveyed:	CP / MS		AS SHOWN	Drawing No. 4520–01–SW–434 Rev A
Designed:	KLP			
Drawn:	KLP	12/2022		
Approved:	BJ			

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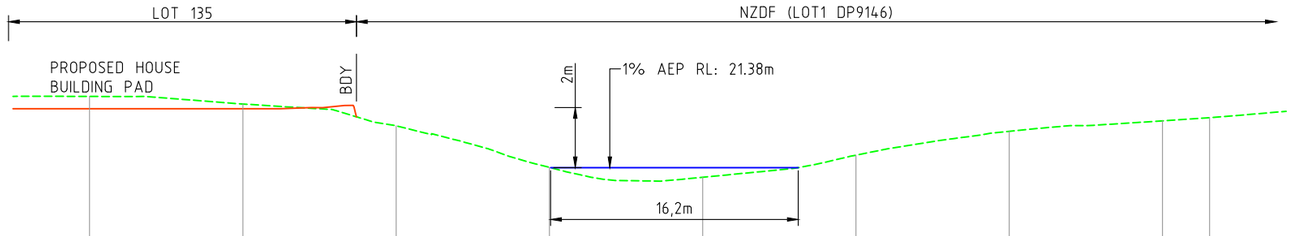
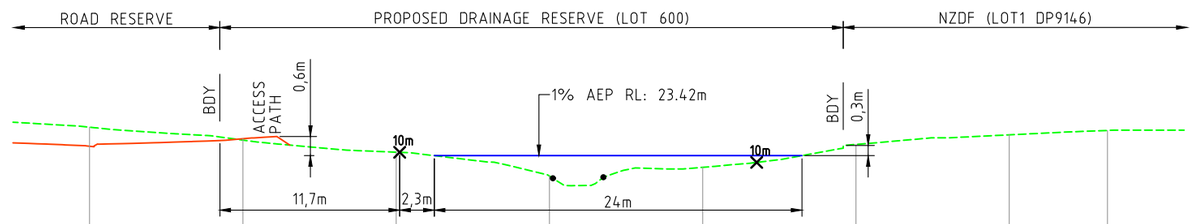


DATUM R.L.18.00

FINISHED SURFACE	23.30	23.30	22.74	21.39	21.07	21.79	22.56	22.91	23.01
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	73.07

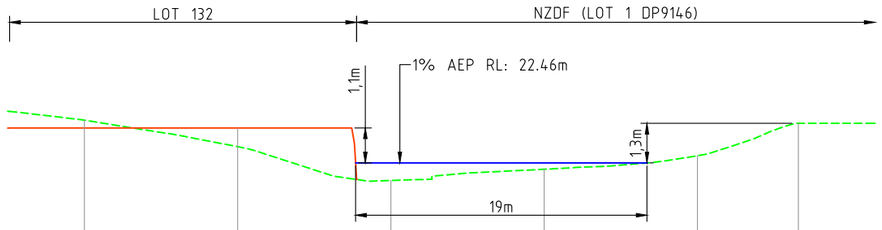
OUTLET 2 SECTION 3 (EXISTING PIPE IGNORED)



DATUM R.L.20.00

FINISHED SURFACE	23.73	23.97	23.53	22.76	23.04	23.79	24.10	24.24
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	66.41

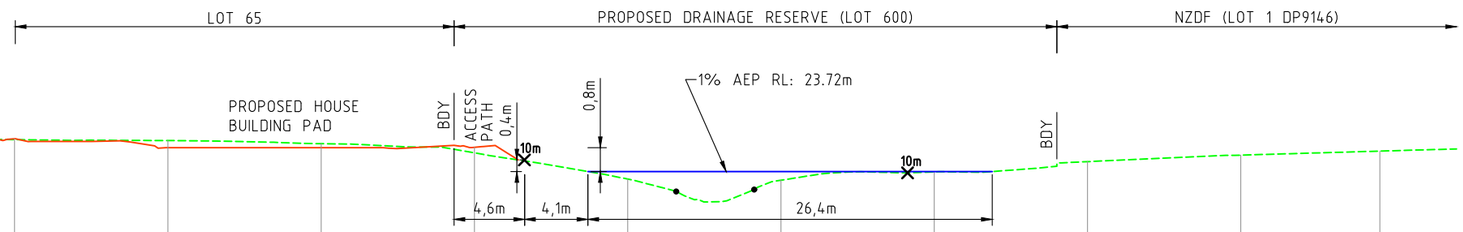
OUTLET 2 SECTION 2



DATUM R.L.19.00

23.60	23.60	21.89	22.25	22.69	23.75
0.00	10.00	20.00	30.00	40.00	46.59

LOT 132 SECTION (EXISTING PIPE IGNORED)



DATUM R.L.20.00

FINISHED SURFACE	24.79	24.50	24.50	24.51	23.48	23.44	23.71	24.04	24.26	24.39
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	89.07

OUTLET 2 SECTION 1

KEY:
FINISHED SURFACE
EXISTING SURFACE
TOP OF BANK (TOB)
10m OFFSET FROM TOB

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
RAPID FLOOD HAZARD
ASSESSMENT CROSS SECTIONS

	By	Date
Surveyed:	CP / MS	
Designed:	KLP	
Drawn:	KLP	12/2022
Approved:	BJ	

Scale: 1:400@A3 5 x VERT
Job No. 4520
Drawing No. 4520–01–SW–435
Rev A

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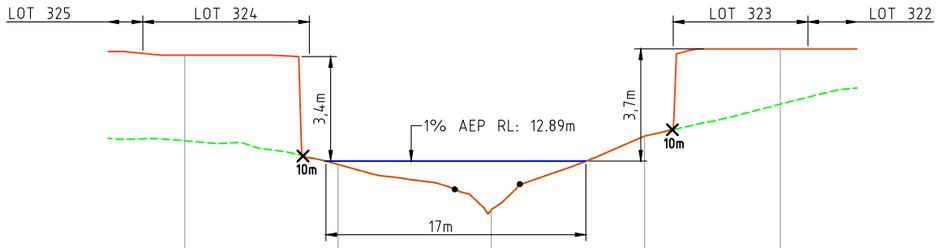
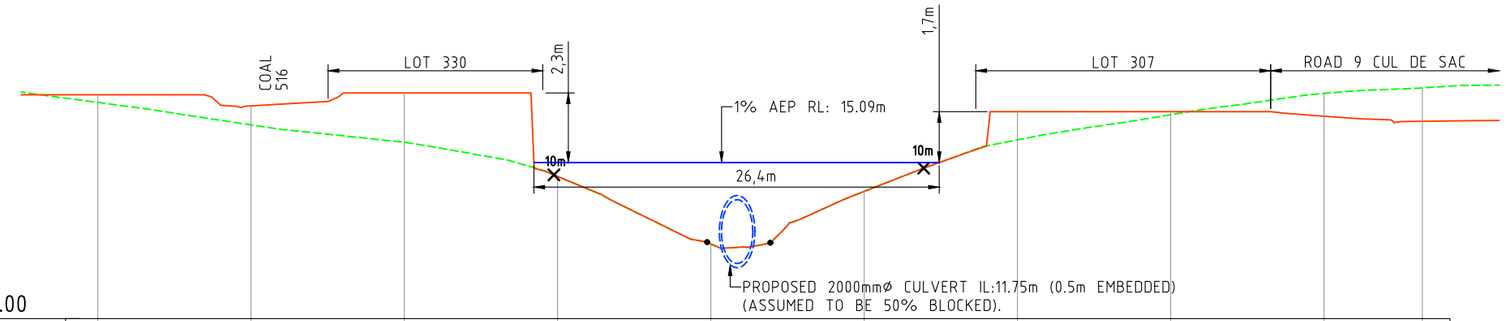


DATUM R.L.9.00

FINISHED SURFACE	16.35	12.78	11.31	13.71	16.55
CHAINAGE	0.00	10.00	20.00	30.00	38.86

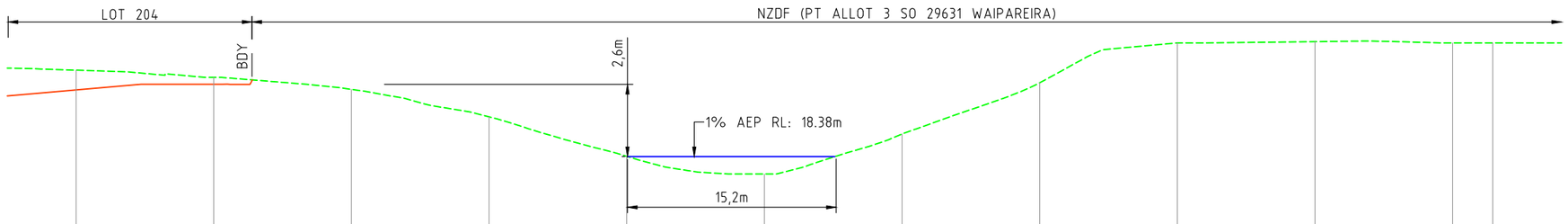
ROAD 9 CULVERT DS SECTION



DATUM R.L.10.00

FINISHED SURFACE	17.30	16.94	17.36	14.64	12.43	14.15	16.75	16.75	16.60	16.44
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	86.42

ROAD 9 CULVERT US SECTION



DATUM R.L.15.00

FINISHED SURFACE	20.80	21.00	20.82	19.82	18.39	17.75	19.20	21.05	22.50	22.55	22.50	22.50
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	102.91

KEY:
FINISHED SURFACE
EXISTING SURFACE
TOP OF BANK (TOB)
10m OFFSET FROM TOB 10m

OUTLET 2 SECTION 4

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
RAPID FLOOD HAZARD
ASSESSMENT CROSS SECTIONS

	By	Date
Surveyed:	CP / MS	
Designed:	KLP	
Drawn:	KLP	12/2022
Approved:	BJ	

Scale: 1:400@A3
5 x VERT

Job No. 4520

Drawing No. 4520–01–SW–436

Rev A

CAD FILE C:\12dS\data\NGSQL01\Whenuapai Green – 4520_61\Design\DWG\ENG\RESOURCE CONSENT\4520–01–SW–430.dwg

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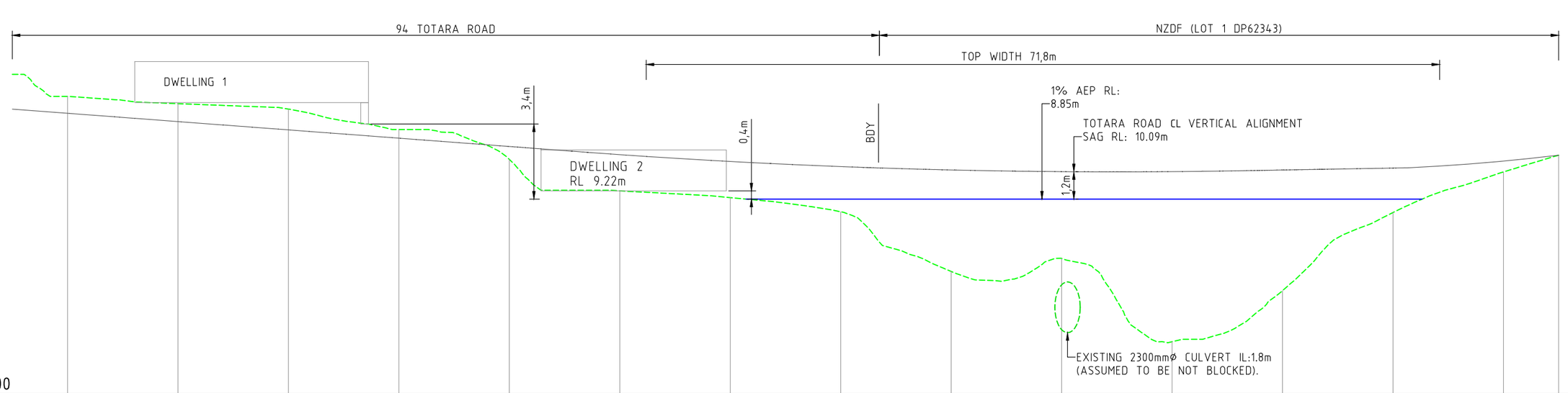
KEY:
FINISHED SURFACE
EXISTING SURFACE
TOP OF BANK (TOB)
10m OFFSET FROM TOB



DATUM R.L.0.00

FINISHED SURFACE	13.50	13.17	12.93	12.00	10.65	9.22	8.92	8.28	5.57	6.16	2.39	4.70	8.24	10.08	10.84
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	135.00

TOTARA ROAD CULVERT US SECTION

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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AUCKLAND, NEW ZEALAND
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FACSIMILE: +64 9 918 6567
WEB: www.neilgroup.co.nz

Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
RAPID FLOOD HAZARD
ASSESSMENT CROSS SECTIONS

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		1:400@A3 5 x VERT	Drawing No. 4520–01–SW–437	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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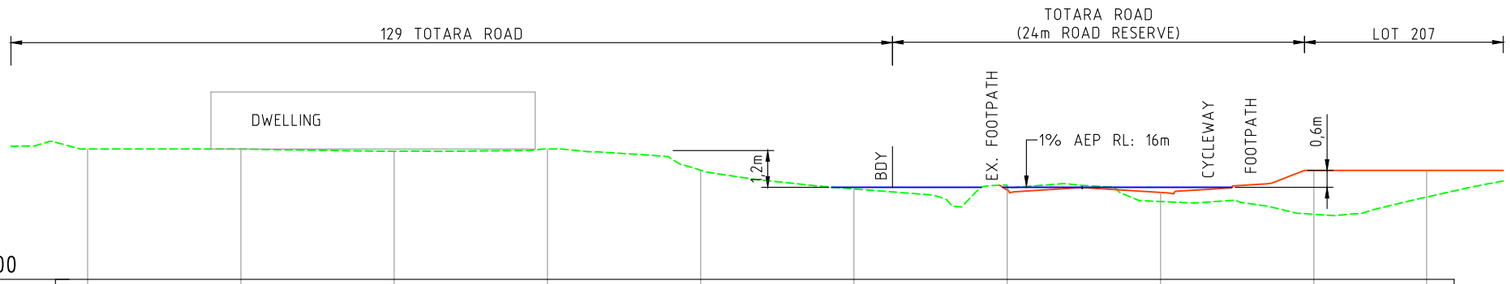
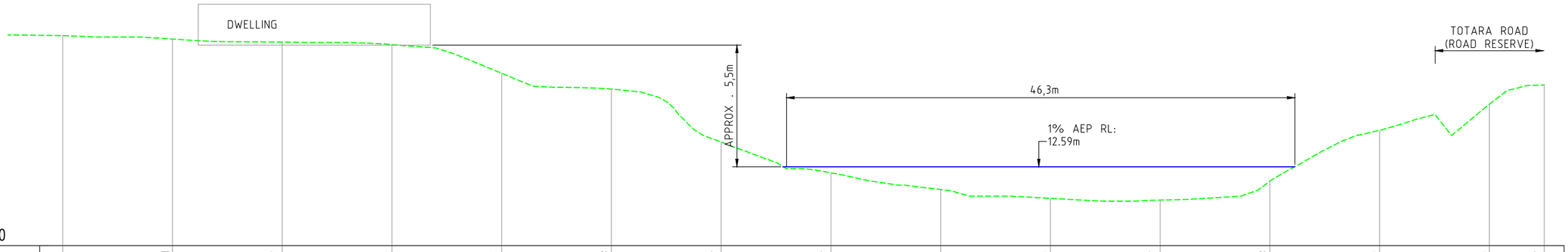
KEY:
FINISHED SURFACE
EXISTING SURFACE
TOP OF BANK (TOB)
10m OFFSET FROM TOB 10m



DATUM R.L.13.00

FINISHED SURFACE	17.25	17.25	17.17	17.25	16.56	15.95	15.91	15.83	16.55	16.55
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	87.36

SECTION 129 TOTARA ROAD



DATUM R.L.9.00

FINISHED SURFACE	18.56	18.41	18.27	18.15	16.85	16.13	13.72	12.32	11.56	11.15	11.07	11.93	14.25	15.44	16.32
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	135.00

SECTION 125 TOTARA ROAD

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
RAPID FLOOD HAZARD
ASSESSMENT CROSS SECTIONS

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		1:400@A3 5 x VERT	Drawing No. 4520–01–SW–438	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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RAINFALL TO RUNOFF ROUTING SUMMARY

PROJECT DATA

PROJECT NO.:	4520	**BY:**	KLP
DATE:	Dec-22 **Rev A**	**SITE DESCRIPTION:**	98-102 TOTARA ROAD, WHENUAPAI

1% AEP STORM EVENT CATCHMENT FLOWS CALCULATIONS (TP108):

Note: - Rainfall data from TP108 - Appendix A - Figure A.6 (WITH CLIMATE CHANGE as per Auckland CoP 4.2.10)
- Catchment data as per Whenuapai 2 Stormwater Management Plan (March 2016)

ID		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19	
CATHMENTS		**DS1**		**DS2**		**DS3**		**DS4**		**DS5**		**DS6**		**DS7**		**WHENUAPAI 2**		**ITM WETLAND**		**AREA B**		**RATARA 1**		**RATARA 2**		**RATARA 3**		**RATARA 4**		**RATARA 5**		**RATARA 6**		**RATARA 7**		**AREA A**		**AREA F**	
		(perv & imperv)		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**		**(perv & imperv)**	
Catchment Area	ha		5.904		6.001		67.700		5.510		5.580		33.440		21.460		12.740		3.9400		4.296		2.547		22.140		6.280		2.220		5.948		5.589		3.755		10.560		1.013
Perv/Imperv		Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv	Perv	Imperv
		1.181	4.723	1.200	4.801	13.540	54.160	1.102	4.408	1.116	4.464	6.688	26.752	4.292	17.168	2.548	10.192	0.788	3.152	0.859	3.437	0.509	2.037	4.428	17.712	1.256	5.024	0.444	1.776	1.190	4.758	1.118	4.471	0.751	3.004	4.002	6.558	0.152	0.861
Catchment slope	m/m		0.03		0.03		0.02		0.03		0.03		0.02		0.02		0.00569		0.03		0.04		0.04		0.01		0.025		0.05		0.05		0.1		0.1		0.035		0.03
Catchment length	km		0.5		0.332		1.138		0.37		0.427		1.38		0.875		0.50		0.30		0.4		0.35		1.2		0.4		0.2		0.4		0.35		0.3		0.4		0.5
Imperviousness	%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%		80%
Channel factor		0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8
SVS Curve Number	mm	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98	74	98
Weighted CN	mm		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		93.2		88.9		94.4
Weighted Ia	mm	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0
Runoff C	--	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.87	0.00	0.80	0.00	0.89
Tc	min	12.2min	12.4min	10.0min	10.0min	23.8min	24.2min	10.0min	10.2min	11.0min	11.2min	27.0min	27.5min	20.0min	20.3min	20.1min	20.5min	10.0min	10.0min	10.0min	10.0min	10.0min	10.0min	30.3min	30.8min	11.2min	11.3min	10.0min	10.0min	10.0min	10.0min	10.0min	10.0min	10.0min	10.0min	10.1min	10.3min	12.2min	12.4min
tp	min	8.2min	8.3min	6.7min	6.7min	15.9min	16.1min	6.7min	6.8min	7.4min	7.5min	18.0min	18.3min	13.3min	13.6min	13.4min	13.7min	6.7min	6.7min	6.7min	6.7min	6.7min	6.7min	20.2min	20.6min	7.4min	7.6min	6.7min	6.7min	6.7min	6.7min	6.7min	6.7min	6.7min	6.7min	6.7min	6.8min	8.2min	8.3min
Storage S	mm	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2	89.2	5.2
10yr P24hr rainfall	mm		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		227.8		212.8		212.8
c*=(P24-2Ia)/ (P24-2Ia+2S)		0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.55	0.96	0.53	0.95	0.53	0.95
q* (from fig.5.1)	*Approx!!*	0.126	0.158	0.133	0.167	0.100	0.129	0.133	0.166	0.130	0.162	0.095	0.122	0.108	0.138	0.108	0.138	0.133	0.167	0.133	0.167	0.133	0.167	0.090	0.116	0.129	0.162	0.133	0.167	0.133	0.167	0.133	0.167	0.133	0.167	0.130	0.166	0.123	0.158
q peak	m^3/s	0.339	1.704	0.364	1.825	3.089	15.934	0.334	1.668	0.330	1.652	1.450	7.465	1.058	5.398	0.626	3.196	0.239	1.198	0.261	1.306	0.154	0.774	0.911	4.678	0.370	1.853	0.135	0.675	0.361	1.809	0.339	1.699	0.228	1.142	1.110	2.314	0.040	0.290
Q24	mm	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	159	223	145	208	145	208
V24	m^3	1878	10520	1909	10693	21539	120631	1753	9818	1775	9943	10639	59585	6828	38239	4053	22701	1254	7021	1367	7655	810	4538	7044	39449	1998	11190	706	3956	1892	10599	1778	9959	1195	6692	5818	13623	221	1788
Combined Runoff Volume	m^3	12398		12602		142171		11571		11718		70224		45066		26754		8274		9022		5348		46493		13187		4662		12491		11737		7886		19442		2009	

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
RAPID FLOOD HAZARD
ASSESSMENT FLOW SUMMARY

	By	Date	Scale	Job No. 4520	
Surveyed:	--		--	Drawing No.	Rev
Designed:	KLP			4520–01–SW–439	A
Drawn:	--	12/2022			
Approved:	BJ				

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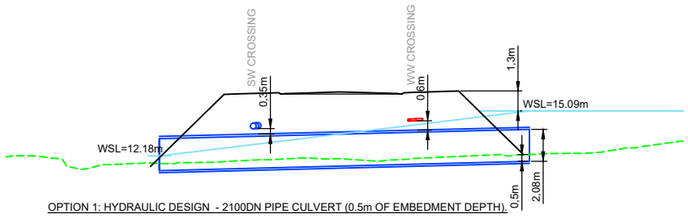
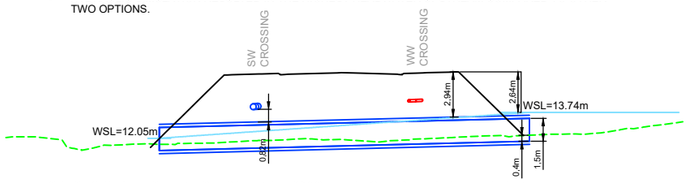


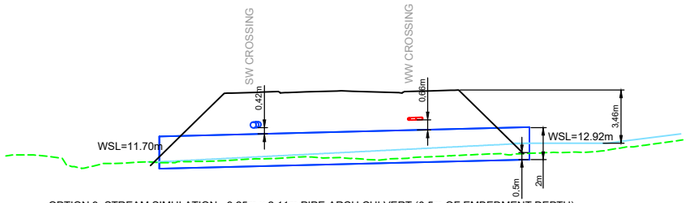
OPTION 1: HYDRAULIC DESIGN - 2100DN PIPE CULVERT (0.5m OF EMBEDMENT DEPTH).

- SPECIFIC HYDRAULIC PERFORMANCE (VELOCITY/DEPTH/TURBULENCE TO TARGET FISH).
- NOT POSSIBLE TO UPSIZE PIPE DUE TO NOT HAVING ENOUGH CLEARANCE FROM SW & WW CROSSINGS.
- PIPE DIAMETER SMALLER THAN STREAM BANKFULL WIDTH (NOT SUITABLE FOR STREAM SIMULATION).
- HYDRAULIC SIMULATION RESULTED IN THE HIGHEST HEADWATER UPSTREAM COMPARED TO OTHER TWO OPTIONS.



OPTION 2: STREAM SIMULATION - 3.5m x 1.5m BOX CULVERT (0.4m OF EMBEDMENT DEPTH)

- SPECIFIC DESIGN DUE TO FILL HEIGHT (>2000mm).
- HYDRAULIC SIMULATION RESULTED IN THE SECOND HIGHEST HEADWATER UPSTREAM COMPARED TO OTHER TWO OPTIONS.



OPTION 3: STREAM SIMULATION - 3.25m x 2.11m PIPE-ARCH CULVERT (0.5m OF EMBEDMENT DEPTH)

- STEEL PIPE (LIGHTER / STRAIGHT FORWARD INSTALLATION).
- POSSIBLY NOT AS EASILY AVAILABLE TO BE SOURCED FROM.
- HYDRAULIC SIMULATION RESULTED IN THE LOWEST HEADWATER UPSTREAM COMPARED TO OTHER TWO OPTIONS.

OPTION 4: STREAM SIMULATION - 3.35m x 1.75m ARCH CULVERT (0.5m OF EMBEDMENT DEPTH)

- STEEL ARCH FRAME (LIGHTER / STRAIGHT FORWARD INSTALLATION)
- CONCRETE FOOTING (POSSIBLY MORE COMPLEX DESIGN / INSTALLATION).
- HYDRAULIC SIMULATION RESULTED IN SIMILAR HEADWATER UPSTREAM COMPARED TO PIPE-ARCH CULVERT (OPTION 3).

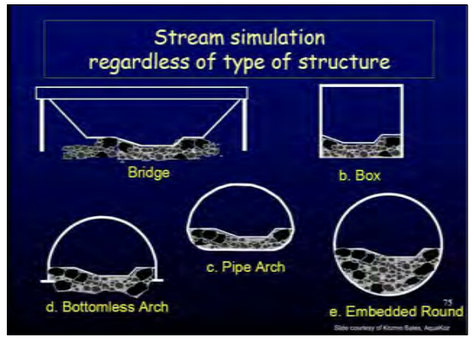
OPTION 1 - PIPE CULVERT

OPTION 2 - BOX CULVERT

OPTION 3 - PIPE-ARCH CULVERT

OPTION 4 - ARCH CULVERT

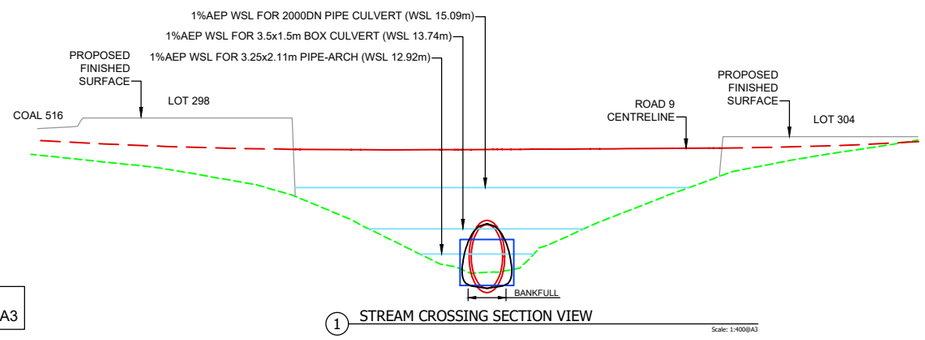
PHOTO A - TAKITIMU WATERCOURSE (LOOKING NORTH)



STREAM CROSSING DESIGN PARAMETERS:

- EMBANKMENT HEIGHT = 4.3m±
- EXISTING STREAM BED GRADE = 2.5%
- CALCULATED WEIGHTED STREAM BANKFULL WIDTH = 2.47m (CATO BOLAM, JULY / 2022).
- CULVERT SPAN TO BE 1.3 x BANKFULL WIDTH = 3.2m±
- CROSSING LENGTH = 25m±
- 1% AEP PEAK FLOW = 5.31m³/s
- CULVERT ASSUMED TO BE 50% BLOCKED

SCALE 1:400@A3

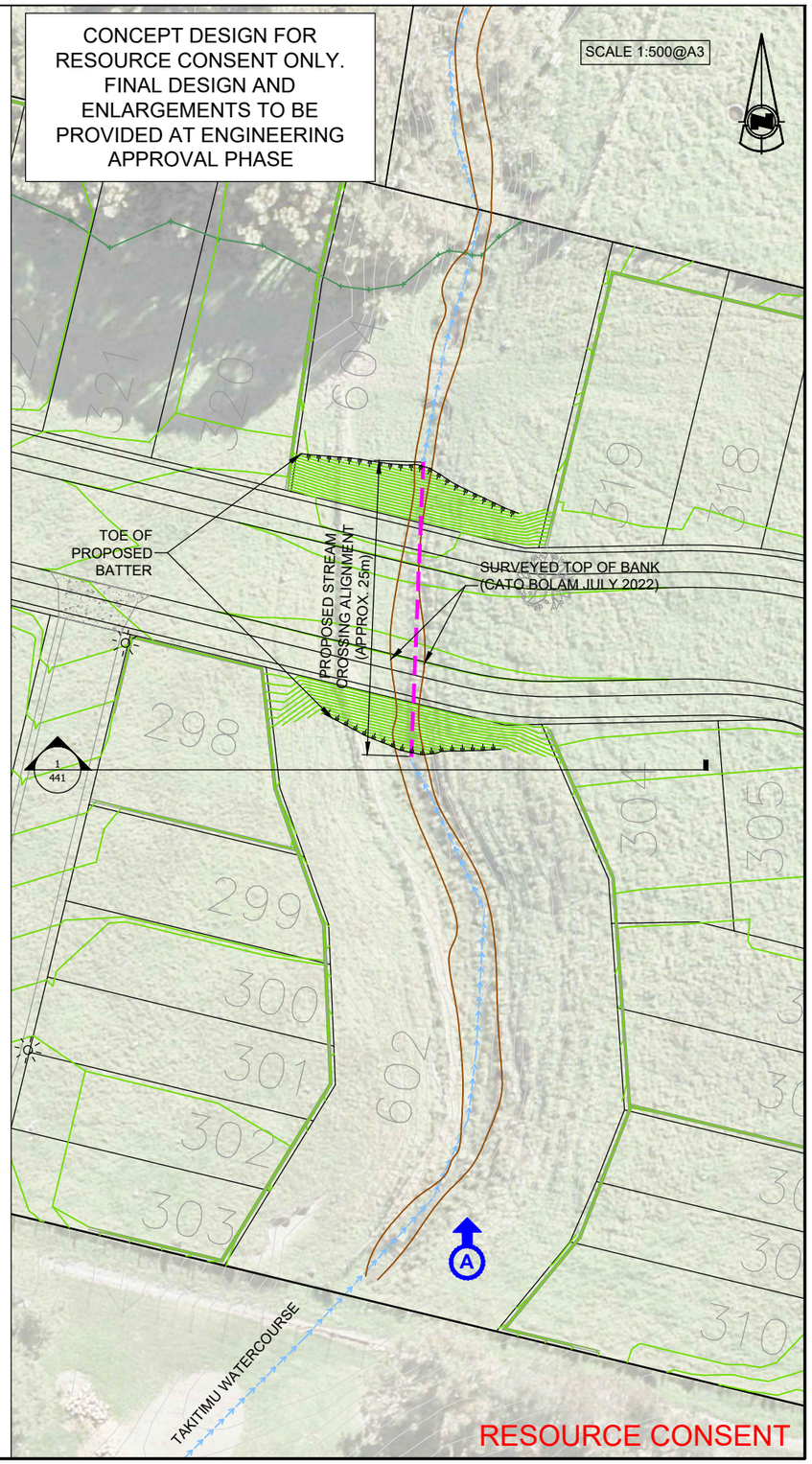


1 STREAM CROSSING SECTION VIEW

Scale: 1:400@A3

CONCEPT DESIGN FOR RESOURCE CONSENT ONLY. FINAL DESIGN AND ENLARGEMENTS TO BE PROVIDED AT ENGINEERING APPROVAL PHASE

SCALE 1:500@A3



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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
STREAM CROSSING
FISH PASSAGE CONCEPT DESIGN

	By	Date	Scale	Job No. 4520	Rev
Surveyed:	MS		AS SHOWN	Drawing No. 4520–01–SW–440	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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STORMWATER MANAGEMENT OBJECTIVES - (QUALITY AND QUANTITY):

THE STORMWATER MANAGEMENT OBJECTIVES ARE APPLICABLE TO THIS SITE, AS DEFINED BY:

- AUCKLAND COUNCIL CODE OF PRACTICE CHAPTER 4 - STORMWATER (VERSION 3 JAN 2022)
  (WHICH REFERS TO:)

AUCKLAND COUNCIL REGIONAL STORMWATER NETWORK DISCHARGE CONSENT - SCHEDULE 4.
(WHICH REFERS TO:)
AUCKLAND UNITARY PLAN SECTION E10 STORMWATER MANAGEMENT AREA - FLOW 1 (SMAF 1).

ARE SUMMARIZED AS:

STORMWATER MANAGEMENT OBJECTIVES:					
Contributing catchment		*Public Road Reserve (Roads 1 to 8) & COALs (500 to 515)*	*Public Road Reserve (Roads 9) & COALs 516 and 517*	*Private Dwellings*	*Totara Road Reserve (half road)*
10% AEP - Primary pipe drainage capacity adjusted for climate change.		*10% AEP / 10min time of concentration / 2.1degrees climate change adjusted rainfall intensity of 106.1mm/hr used for pipe calculations and sizing.*			
At source management and control of stormwater runoff		*Dry Basin - 2 Stormwater Basins are proposed, providing detention (Basins A & B)*	*Underground storage pipe - Appropriated sized public storage pipe located under road reserve, providing detention from road runoff. Appropriataed sized private storage pipe located under COAL, providing detention from COALs runoff.*	*Rain water tanks would be the most appropriately suited device to achieve this outcome. (subject to final house design and build).*	*Rain garden - bioretention device (due to existing topography), providing detention and treatment.*
Stormwater Management Area Flow 1 (SMAF 1)	**Retention (volume reduction) of a minimum of 5mm runoff from impervious surfaces.**	*Retention included with detention volume.*	*Retention included with detention volume.*	*Rain water tanks for garden and internal water toilet reuse(subject to final house design and build).*	*Retention included with detention volume.*
	Detention (temporary storage) of modified (pre vs post minus retention volume) 95th percentile 24hr event (35mm) from impervious surfaces calculated as 17.94mm. [being TP108 post runoff depth of 30.49mm minus TP108 pre development runoff depth of 7.55mm minus Flow 1 retention of 5mm].	*Detained within the proposed stormwater basinss with 24hrs draw down release through an orifice controlled outlet.*	*Detained within the storage pipe under road reserve, drawing down over 24 hour period through an orifice controlled chamber*	*Lots 288-238 inclusive. SMAF 1 detention volume managed by a rainwater tank with drawn down via an outlet orifice over 24hrs period. (subject to final house design and build). All other Lots piped to SW basins.*	*Rain garden - at source appropriately sized device allowing for SMAF 1 detention volume to be stored and released over 24hrs period.*
Provision for overland flow paths for secondary flow.		*All roads and COALs are used for secondary overland flow. Road 1 and Road 2 sags provides overland flow entry to stormwater basins respectively and Road 9 sag provides overland flow exit to existing watercourse (Takitimu)*			
At source water quality treatment of high contaminant generating areas.		*No Treatment required. (Not considered as high use road)*			*Water quality met by SMAF 1 detention / retention volume requirements using proposed raingardens.*

Notes:

- It should be noted that only Totara Road is considered to be high used road (> 5000 vehicles per day) and therefore requires stormwater runoff treatment.

- No infiltration is provided due to existing underlying soils.

DRAFT

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A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
MANAGEMENT SUMMARY

	By	Date	Scale	Job No. 4520	
Surveyed:	--		AS SHOWN	Drawing No. 4520–01–SW–450	Rev A
Designed:	KLP/CK				
Drawn:	KLP	12/2022			
Approved:	BJ				
CAD FILE					

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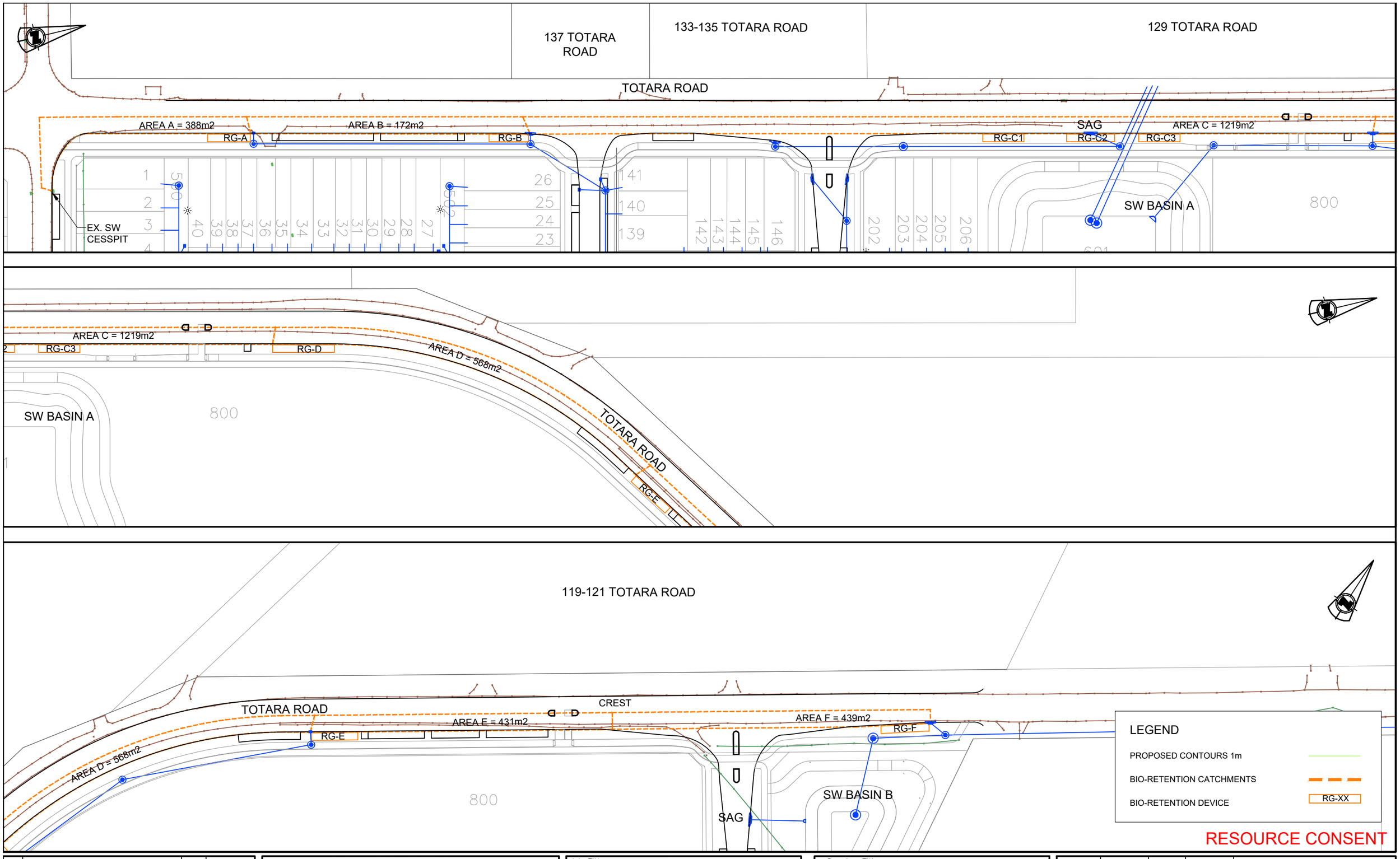

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER QUALITY
BIO–RETENTION CATCHMENTS &
LOCATION PLAN

	By	Date	Scale	Job No.	Rev
Surveyed:	MS		1:1000@A3	Drawing No. 4520–01–SW–460	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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GD01 - STORMWATER DETENTION & RETENTION RUNOFF VOLUME CALCULATIONS

[ON-STREET BIO RETENTION]

PROJECT DATA & PARAMETERS

PROJECT NO.:	4520-01 (whenuapai green)	**DATE:**	Sep-22	Rev A
SITE DESCRIPTION:	**98-102 Toatara road - Road Reserve**	**BY:**	KLP	

STORMWATER SCOPE TO ACHIEVE:

1. Retention of 5mm runoff from contributing impervious areas. (as AC SW NDC / SMAF1).

2. Detention of 95th percentile contributing impervious areas. (as per AC SW NDC / SMAF1).

Total Site Area (m2):	3354	FALSE	**Hydrological Soil Group:**	C
Existing Impervious Area (m2):	1656		**Pre Impervious SCS curve number (CN):**	74
Developed Impervious Area (m2):	3354	100%	**re Initial Abstraction Depth Ia (mm):**	5
SMAF1 90th 24hr Rainfall Depth (mm):	25.3		**Post Impervious SCS curve number (CN):**	98
Soil Infiltration Rate (mm/hr):	2.0		**Post Initial Abstraction Depth Ia (mm):**	0
Evapotranspiration Rate (mm/day):	3.0		**Aggregate Void Space (%):**	35%
SMAF Retention Depth (mm):	5.00		**Media Void Space (%):**	30%
			Infiltration Time (hrs):	72

TP108 - PRE DEVELOPMENT RUNOFF DEPTH CALCULATION (SCENARIO B)

PRE DEVELOPMENT		POST DEVELOPMENT	
Soil Storage Parameter S (mm):	89.24	**Soil Storage Parameter S (mm):**	5.18
Runoff Depth (mm):	**3.76**	**Runoff Depth (mm):**	**21.00**

Post minus Pre Runoff Depth (mm): **17.24**

GD01- APPLICABLE DESIGN CRITERIA

Depth Soil Infiltration (mm):	144
Depth Evaporation (mm):	9

DEVICE SELECTION

Considering all site constraints:

Berm located open battered raingarden with 1 in 1 (45 degrees)side slopes.

Device Size and Area Details:		Bioretention Layer Details:		
		All Devices:		
		Ponding Layer (mm):	200	*Min 200mm*
Media top width, a (m):	2.190	**Media Depth (mm):**	500	*Min 500mm*
Media bottom width,b (m):	1.190	**Transition Layer (mm):**	100	*Min 100mm*
		Drainage Layer (mm):	200	*Min 200mm*
		Storage Layer (mm):	450	*Min 450mm*

Note:
1.Due to existing underlaying soil composition (alluvial deposits overlaying clayey sandstone and siltstone of the Waitemata Group), no runoff infiltration is provided. Calculated storage volume to be release over 72 hrs period.

DEVICE SIZING

Bio retention ID:	**RG A**	**RG B**	**RG C**	**RG D**	**RG E**	**RG F**	
Catchment Area (m2):	388.39	404.36	1219.42	568.31	431.55	441.34	
RUNOFF VOLUME DEPTH CALCULATION							
Hydrology Mitigation Volume (m3):	6.69	6.97	21.02	9.80	7.44	7.61	
Retention Volume (m3):	1.94	2.02	6.10	2.84	2.16	2.21	
Detention Volume (m3):	4.75	4.95	14.92	6.95	5.28	5.40	
INFILTRATION							
Min Infiltration Area (m2):	12.69	13.21	39.85	18.57	14.10	14.42	**Min for Soil Infiltration and Evap*
Min Infiltration Area (m2):	13.59	14.15	42.68	19.89	15.10	15.45	**3.5% of Impervious Catchment*
DIMENSIONS							
Media top width, a (m):	2.19	2.19	2.19	2.19	2.19	2.19	
Media bottom width,b (m):	1.19	1.19	1.19	1.19	1.19	1.19	
Length (m):	12.50	13.00	38.00	18.00	13.50	14.00	
Footprint area (m2):	27.375	28.47	83.22	39.42	29.565	30.66	**Min. 20m2 (AT DTM)*
CALCULATED AREA AND VOLUMES							
Ponding depth volume (m3):	5.48	5.69	16.64	7.88	5.91	6.13	
Media Volume (m3):	3.17	3.30	9.63	4.56	3.42	3.55	**Including transition layer*
Drainage volume (m3):	1.04	1.08	3.17	1.50	1.12	1.17	
Storage Volume (m3):	2.01	2.09	6.10	2.89	2.17	2.25	**To be released over 72hr period*
CHECKS AGAINST REQUIREMENTS							
Total Infiltration Surface Area (m2):	**14.88**	**15.47**	**45.22**	**21.42**	**16.07**	**16.66**	
Total Retention Volume (m3):	**2.01**	**2.09**	**6.10**	**2.89**	**2.17**	**2.25**	
Total Detention Volume (m3):	**11.69**	**12.16**	**35.55**	**16.84**	**12.63**	**13.10**	
Infiltration Area Achieved > Min Infiltration Area	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	
difference	2.18	2.26	6.37	2.85	1.96	2.24	
Retention Vol. Achieved > Min Retention Vol.	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	
difference	0.07	0.07	0.01	0.05	0.01	0.04	
Detention Vol. Achieved > Min Detention Vol.	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	
difference	6.94	7.21	20.63	9.88	7.35	7.70	

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER QUALITY
BIO–RETENTION (RAINGARDEN)
CALCULATIONS

	By	Date	Scale	Job No.	
Surveyed:	MS		--	Drawing No.	Rev
Designed:	KLP			4520–01–SW–461	A
Drawn:	KLP	12/2022			
Approved:	BJ				

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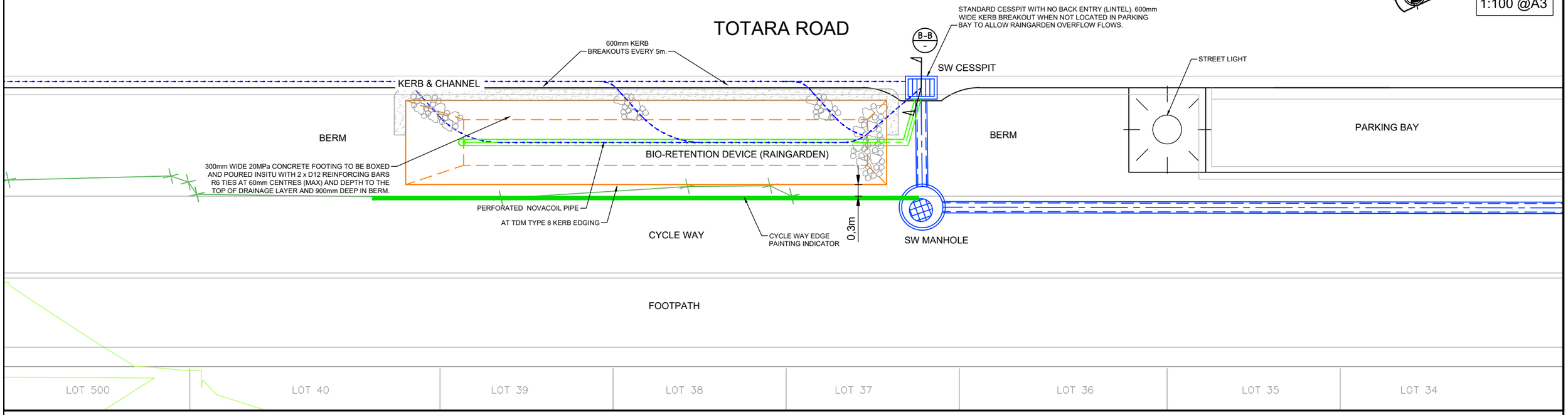
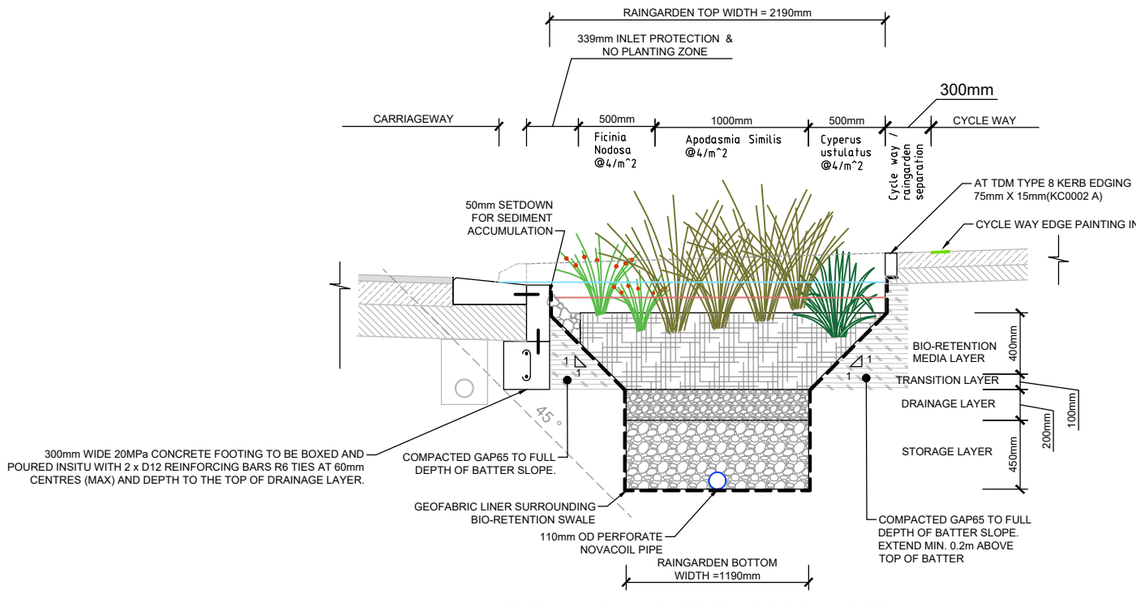
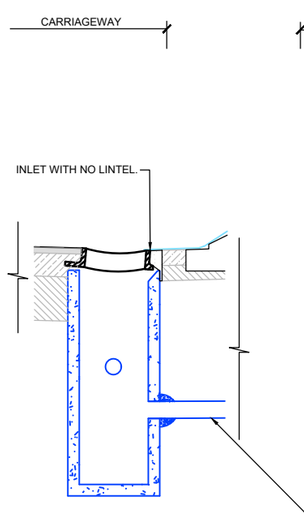
SCALE
1:100 @A3

TOTARA ROAD

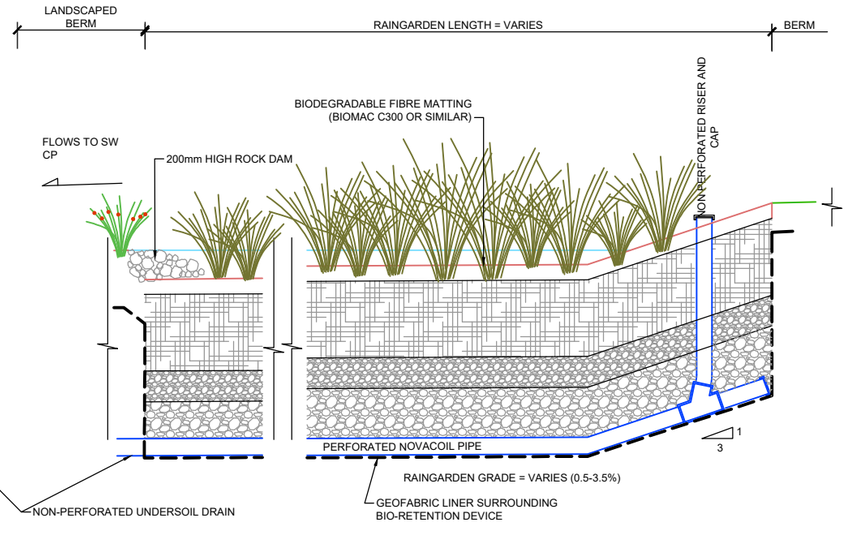




TYPICAL RAINGARDEN CROSS SECTION
(NOT TO SCALE)



SECTION B-B
(NOT TO SCALE)



RAINGARDEN TYPICAL LONG SECTION
(NOT TO SCALE)

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A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER QUALITY
BIO–RETENTION (RAINGARDEN)
DETAILS & SECTIONS

	By	Date	Scale	Job No.	Rev
Surveyed:	MS		AS SHOWN	Drawing No. 4520–01–SW–462	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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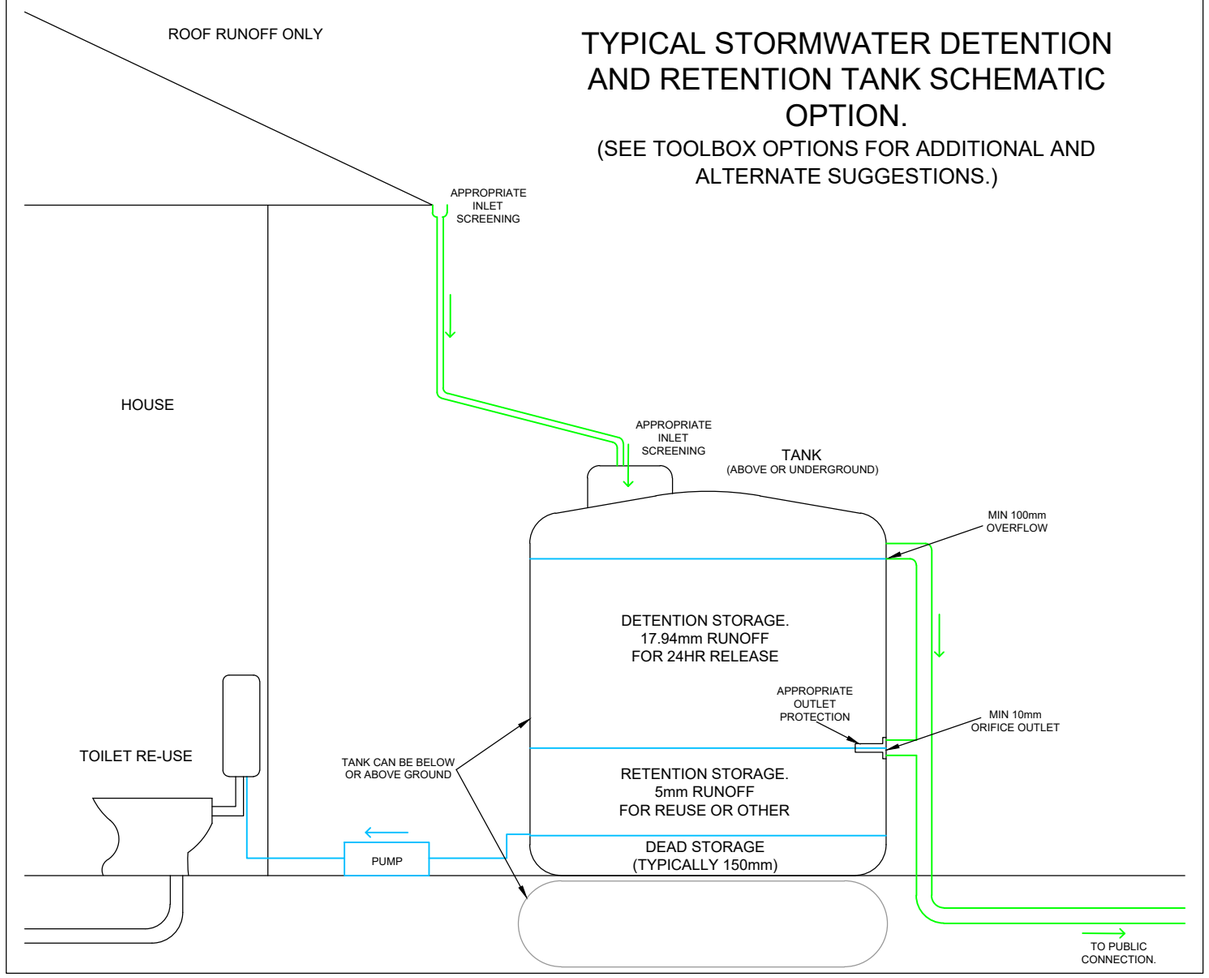
PRIVATE ALLOTMENT STORMWATER RETENTION AND DETENTION REQUIREMENTS (SMAF1 AREA):

- **TO RETAIN 5mm OF RUNOFF FROM ALL IMPERVIOUS AREAS, AND**
- **TO DETAIN FOR 24HR, 17.94mm OF RUNOFF FROM ALL IMPERVIOUS AREAS.**
- **TO PROVIDE THE ABOVE RETAINED AND DETAINED RUNOFF IN COMPLIANT STORMWATER MANAGEMENT DEVICES AS OUTLINED IN AUCKLAND COUNCIL GUIDELINE DOCUMENT 2017/01 (GD01).**



TYPICAL STORMWATER DETENTION AND RETENTION TANK SCHEMATIC OPTION.

(SEE TOOLBOX OPTIONS FOR ADDITIONAL AND ALTERNATE SUGGESTIONS.)

(SMAF1) INDICATIVE ALLOTMENT STORMWATER RETENTION & DETENTION VOLUMES

NOTE: Final tank size selection subject to final house design and landscaping impervious area.
Detention orifice to be selected to draw down over 24hrs period

STORMWATER FACTORS

95th percentile runoff depth (P24): (mm)	22.94
SMAF1 Minimum Stormwater Retention (volume reduction) value: (mm)	5
SMAF1 Stormwater Detention value: (mm)	17.94

ALLOTMENT RETENTION & DETENTION VOLUMES

Total Lot Area (A)	% Impervious Area (%IP)	Minimum Site Retention Volume	Site Detention Tank Volume	Total Stormwater Management Volume
(m2)	%	(l)	(l)	(l)
120	60%	360	1292	1652
140	60%	420	1507	1927
160	60%	480	1722	2202
180	60%	540	1938	2478
200	60%	600	2153	2753
250	60%	750	2691	3441
300	60%	900	3229	4129
350	60%	1050	3767	4817

NOTE:

1. **INDIVIDUAL ALLOTMENT RETENTION AND DETENTION TANKS TO BE SPECIFICALLY DESIGNED, APPROVED AND BUILT WITH ALLOTMENT BUILDING WORK AND CONSENT. ABOVE PROVIDED FOR INFORMATION ONLY.**
2. **DETENTION TANK LOW LEVEL OUTLET TO BE CONTROLLED BY A SPECIFICALLY SIZED (BUT MIN 10mm) ORIFICE TO BE RELEASED OVER A 24HR PERIOD.**
3. **LOTS 288-328 INCLUSIVE REQUIRE BOTH RETENTION AND DETENTION.**
4. **LOT 800 (POSSIBLE SCHOOL SITE) REQUIRES SPECIFIC DESIGN FOR RETENTION, DETENTION AND WATER QUALITY.**
5. **ALL OTHER LOTS REQUIRE ON-SITE RETENTION ONLY.**

TOOLBOX OPTIONS FOR STORMWATER RETENTION AND DETENTION DEVICES ON ALLOTMENTS.

(TYPICALLY ALL DESIGNED TO AC GD01)

- **PERVIOUS PAVING (LINED OR UNLINED).**
- **BIO RETENTION DEVICE (RAINGARDEN OR TREE PIT).**
- **BELOW OR ABOVE GROUND RETENTION AND/OR DETENTION RAINWATER TANKS.**
- **LIVING ROOFS.**
- **PLANTER BOXES.**

RESOURCE CONSENT

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER MANAGEMENT
EXAMPLE RESIDENTIAL ON–SITE
RETENTION & DETENTION DEVICE

	By	Date	Scale	Job No.	Rev
Surveyed:	MS		1:1000@A3	Drawing No. 4520–01–SW–464	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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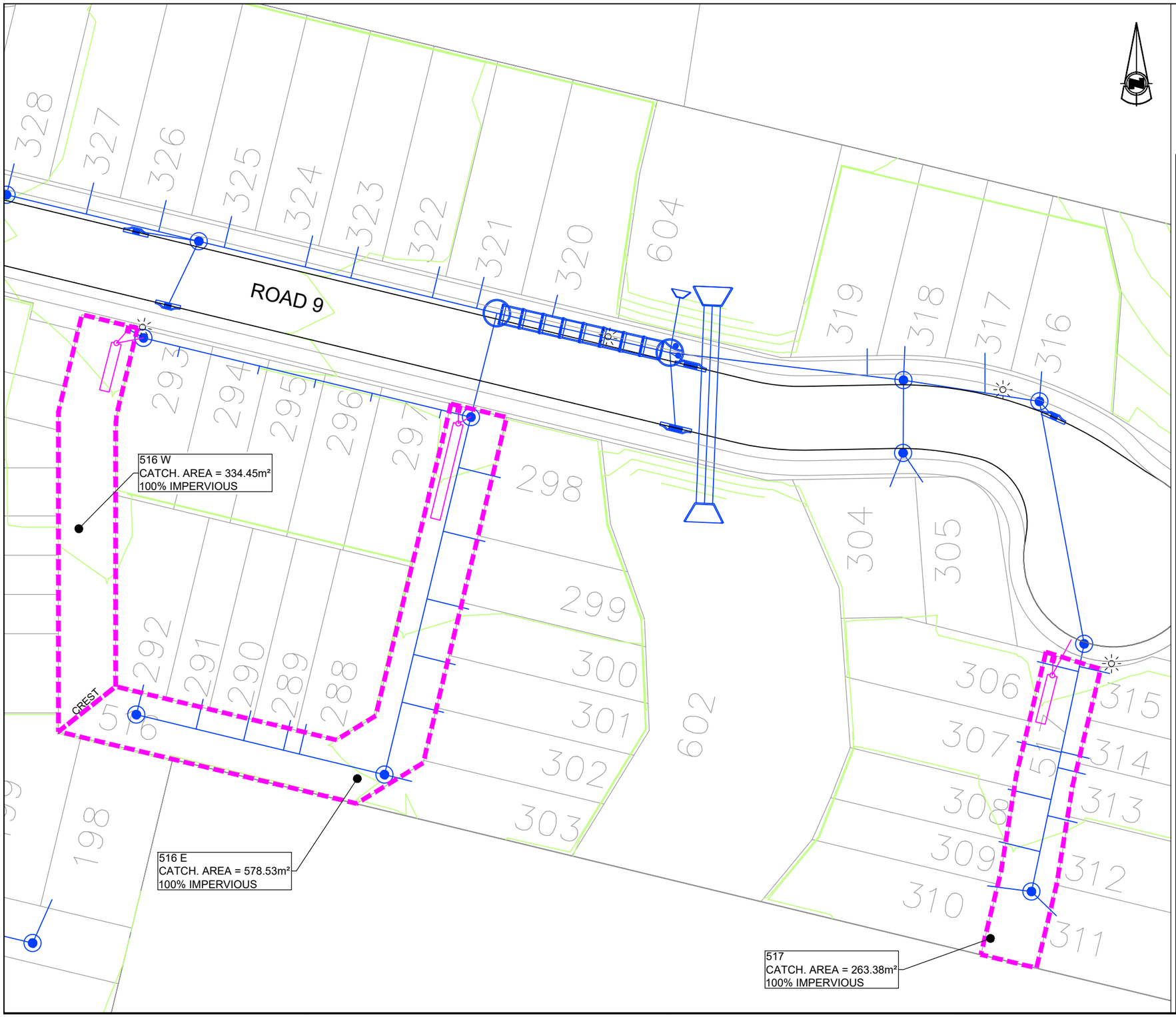

LEGEND

PROPOSED CONTOURS 1m

COAL's CATCHMENTS

ON-SITE RETENTION / DETENTION DEVICE

GD01 - STORMWATER DETENTION & RETENTION RUNOFF VOLUME CALCULATIONS
[UNDERGROUND DETENTION TNAK]

PROJECT DATA & PARAMETERS

PROJECT NO.:	4520-01 (whenuapai green)	**DATE:**	Dec-22 Rev A
SITE DESCRIPTION:	98-102 Toatara road - Road Reserve	**BY:**	KLP

STORMWATER SCOPE TO ACHIEVE:

1. Retention of 5mm runoff from contributing impervious areas. (as AC SW NDC / SMAF1).

2. Detention of 95th percentile contributing impervious areas. (as per AC SW NDC / SMAF1).

Total Site Area (m2):	1176	**Hydrological Soil Group:**	C
Existing Impervious Area (m2):	1656	**Pre Impervious SCS curve number (CN):**	74
eveloped Impervious Area (m2):	1176 100%	**itial Abstraction Depth Ia (mm):**	5
1 90th 24hr Rainfall Depth (mm):	35	**Post Impervious SCS curve number (CN):**	98
Soil Infiltration Rate (mm/hr):	2.0	**Post Initial Abstraction Depth Ia (mm):**	0
apotranspiration Rate (mm/day):	3.0	**Aggregate Void Space (%):**	35%
SMAF Retention Depth (mm):	5.00	**Media Void Space (%):**	30%
		Infiltration Time (hrs):	72

TP108 - PRE DEVELOPMENT RUNOFF DEPTH CALCULATION (SCENARIO B)

PRE DEVELOPMENT		POST DEVELOPMENT	
Soil Storage Parameter S (mm):	89.24	**Soil Storage Parameter S (mm):**	5.18
Runoff Depth (mm):	7.55	**Runoff Depth (mm):**	30.49

Post minus Pre Runoff Depth (mm): 22.94

DEVICE SIZING

Storage Tank ID:	516-W	516-E	517	
Catchment Area (m2):	334.45	578.53	263.38	
RUNOFF VOLUME DEPTH CALCULATION				
Hydrology Mitigation Volume (m3):	7.67	13.27	6.04	26.98
Retention Volume (m3):	1.67	2.89	1.32	
Detention Volume (m3):	6.00	10.38	4.72	
DEVICE DIMENSIONS				
Storage tank diameter, D (m):	1.20	1.20	1.20	
Storage tank length/height, L (m):	7.00	12.00	6.00	
Storage depth, d (m):	1.20	1.20	1.20	** Outlet pipe height*
Storage Volume, V (m3):	7.92	13.57	6.79	**Volume Capacity up to overflown outl*
Volume check:	OK	OK	OK	

Note:

1.Due to existing underlaying soil composition (alluvial deposits overlaying clayey sandstone and siltstone of the Waitemata Group),

2. Private on-site detention only required for COAL's 516 & 517. All other COALs drain to stormwater basins.

RESOURCE CONSENT

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A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER MANAGEMENT
COAL's PRIVATE ON–SITE
STORMWATER DETENTION DEVICE

	By	Date	Scale	Job No.	Rev
Surveyed:	MS		1:1000@A3	Drawing No. 4520–01–SW–465	A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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RATARA STREAM TRIBUTARY

BUS STOP

THREE BOLLARD (MIDDLE PADLOCK REMOVABLE) VEHICULAR ENTRY CONTROL.

ENKAMAT 7018 TOPSOILED AND LANDSCAPED PROTECTION. REVERSE GRADE ON BERM AND FOOTPATH TO ALLOW SECONDARY FLOW TO DISCHARGE TO BASIN. INSTALLED TO MANUFACTURERS SPECIFICATIONS.

COMMERCIAL VEHICLE CROSSING

GABION WALL & RIPRAP REACH PROTECTION

PROPOSED CULVERT ALIGNMENT (2 x 750mmØ)

PROPOSED CULVERT ALIGNMENT (1 x 300mmØ)

RAINGARDEN

RL:15.0m

BASIN INLET

SEE DETAILS FOR BASIN INLET

OVERLAND FLOW

(RD SAG)

(RD SAG) DCP

CYCLE WAY

FOOTPATH

(2x 1500Ømm) CONTROL MANHOLE

BASIN A

3.5M WIDE MAINTENANCE ACCESS TRACK.

WHERE AT RL:15.0m 150mm COMPACTED GAP65 COVERED WITH 200mm TOPSOIL GRASSED. ENTRY RAMPS AS SHOWN: 150mm 20MPa CONCRETE ON 100mm GAP 40. SAW CUTS AT 3m CENTERS.

EMERGENCY SPILLWAY BASE
RL: 15.75m
TOP RL:16.25m
13m WIDE BASE WITH 1:20
SIDE TRANSITION BATTERS.

BASIN INLET

RL:15.0m

3.5m MAINTENANCE ACCESS TRACK

3m WIDE TOP OF EMBANKMENT. RL 16.25m

PARKING BAYS

FOOTPATH

(ROAD SINGLE WAY CROSSFALL - SEE ROADING DESIGN)

THREE BOLLARD (MIDDLE PADLOCK REMOVABLE) VEHICULAR ENTRY CONTROL.

COMMERCIAL VEHICLE CROSSING

TOTARA ROAD

RAINGARDEN

206 205 204 203 202 207 208 209 210 211 212 510 601

EMERGENCY SPILLWAY
BASE RL: 15.4m
TOP RL:15.8m
10m WIDE BASE WITH 1:10
SIDE TRANSITION BATTERS.

3m WIDE TOP OF EMBANKMENT

(1500Ømm) CONTROL MANHOLE

INLET RIPRAP APRON.200mmØ ROCK RIPRAP ON BIDIM A64 GEOTEXTILE (PINNED). WHERE TRAFFICABLE, PLACE ROCK RIPRAP ON 375COMPACTED GAP 150 ON BIDIM A19 GEOTEXTILE (PINNED) ON 250mm LIME STABILISED SUBGRADE TO CBR 7.

BASIN B

RL: 14.7m

RL: 15.8m

3.5m MAINTENANCE ACCESS TRACK

OVERLAND FLOW

(RD SAG) DCP

ENKAMAT 7018 TOPSOILED AND LANDSCAPED PROTECTION. REVERSE GRADE ON BERM AND FOOTPATH TO ALLOW SECONDARY FLOW TO DISCHARGE TO BASIN. INSTALLED TO MANUFACTURERS SPECIFICATIONS.

FOOTPATH

3.5m MAINTENANCE ACCESS TRACK

COMMERCIAL VEHICLE CROSSING

3.5M WIDE MAINTENANCE ACCESS TRACK. WHERE AT RL:14.7m 150mm COMPACTED GAP65 COVERED WITH 200mm TOPSOIL GRASSED. WHERE ABOVE RL:14.7m 150mm 20MPa CONCRETE ON 100mm GAP 40. SAW CUTS AT 3m CENTERS.

THREE BOLLARD (MIDDLE PADLOCK REMOVABLE) VEHICULAR ENTRY CONTROL.

605

RESOURCE CONSENT

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
DRY BASINS
LAYOUT PLAN

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		1:500@A3	Drawing No. 4520–01–SW–470	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				

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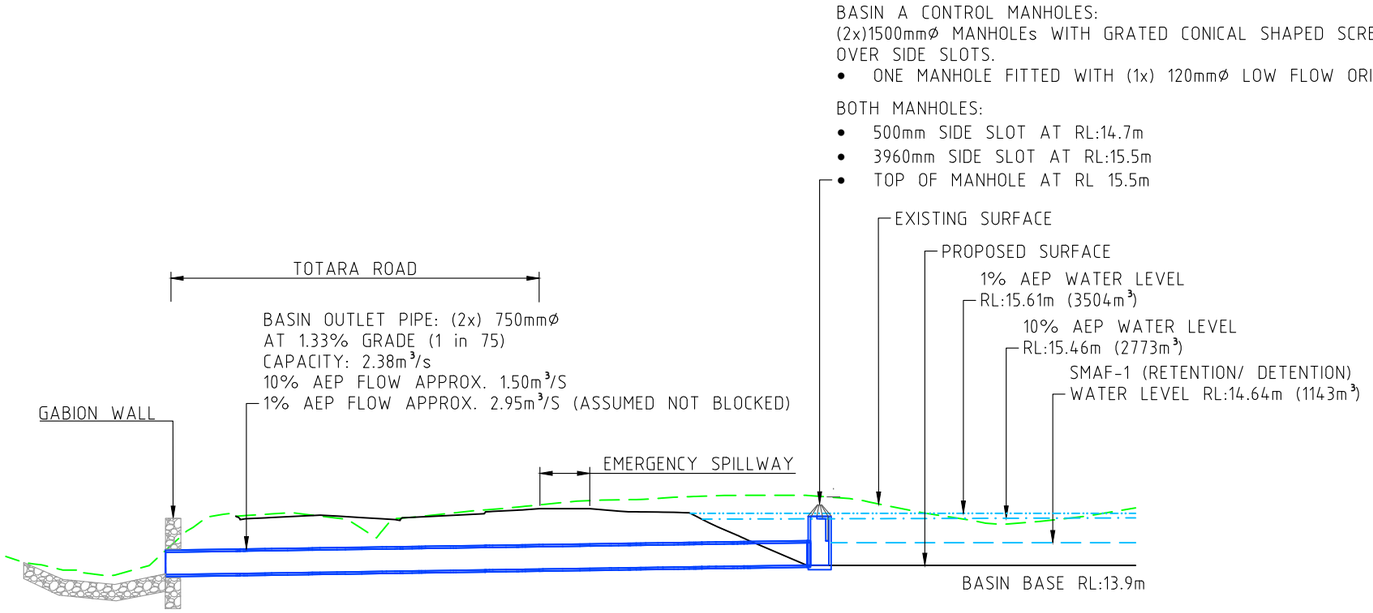
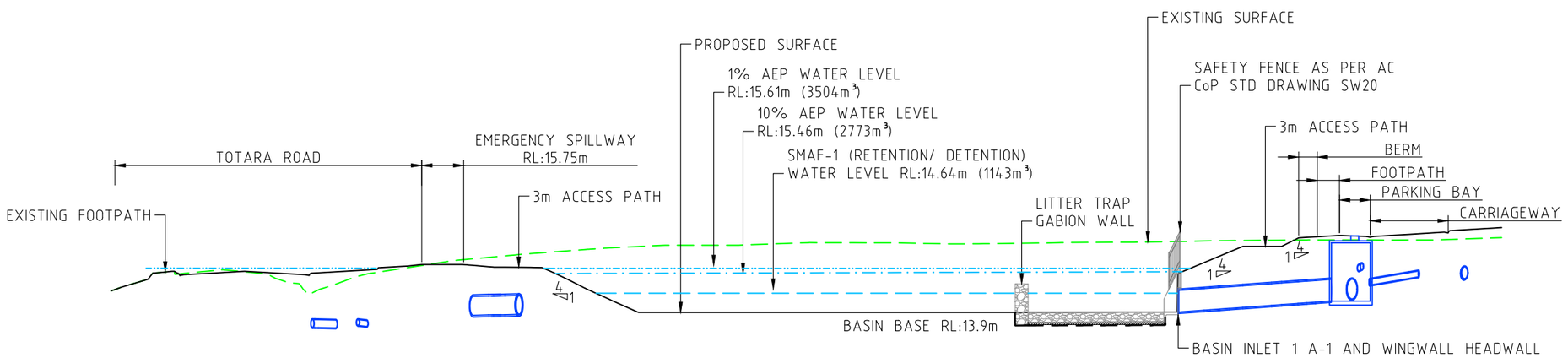


2 BASIN A CROSS SECTION (DATUM RL:11.0m)

Scale: 1:500@A3 (2.5 x VERTICAL EXAGGERATION)



1 BASIN A CROSS SECTION (DATUM RL:11.0m)

Scale: 1:500@A3 (2.5 x VERTICAL EXAGGERATION)

RESOURCE CONSENT

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A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
DRY BASINS
SECTIONS AND DETAILS

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		AS SHOWN	Drawing No. 4520–01–SW–471	Rev A
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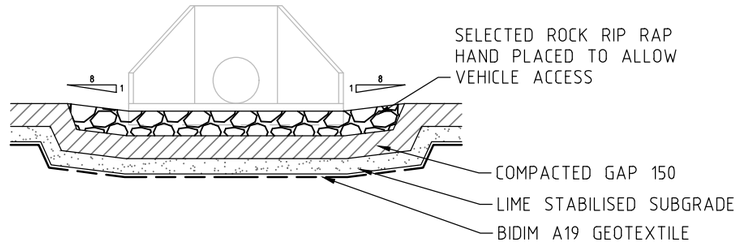
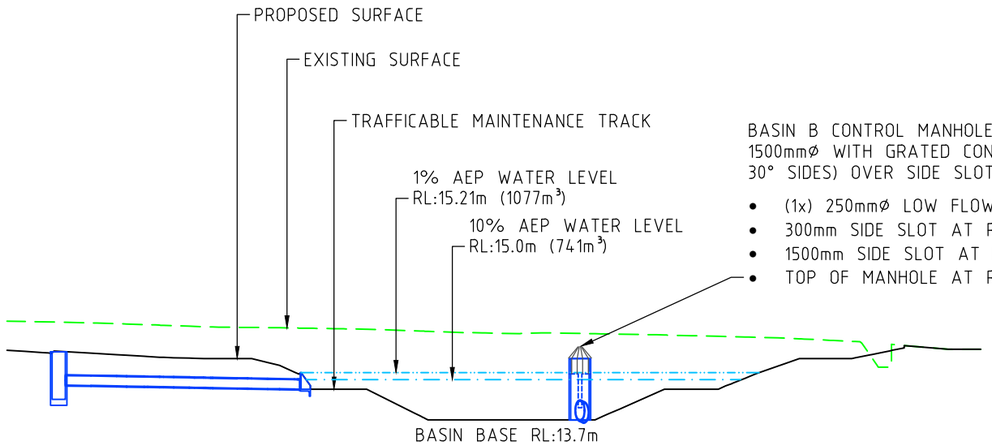
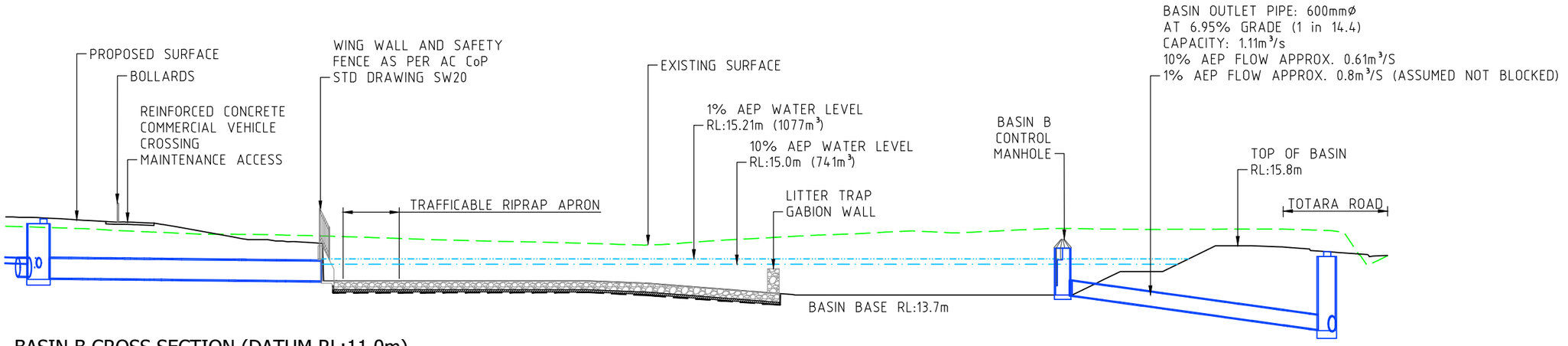


TRAFFICABLE MAINTENANCE TRACK
TYPICAL SECTION (N.T.S)



4 BASIN B CROSS SECTION (DATUM RL:11.0m)

Scale: 1:500@A3 (2.5 x VERTICAL EXAGGERATION)



3 BASIN B CROSS SECTION (DATUM RL:11.0m)

Scale: 1:500@A3 (2.5 x VERTICAL EXAGGERATION)

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
DRY BASINS
SECTIONS AND DETAILS

	By	Date	Scale	Job No. 4520	
Surveyed:	CP / MS		AS SHOWN	Drawing No. 4520–01–SW–472	Rev A
Designed:	KLP				
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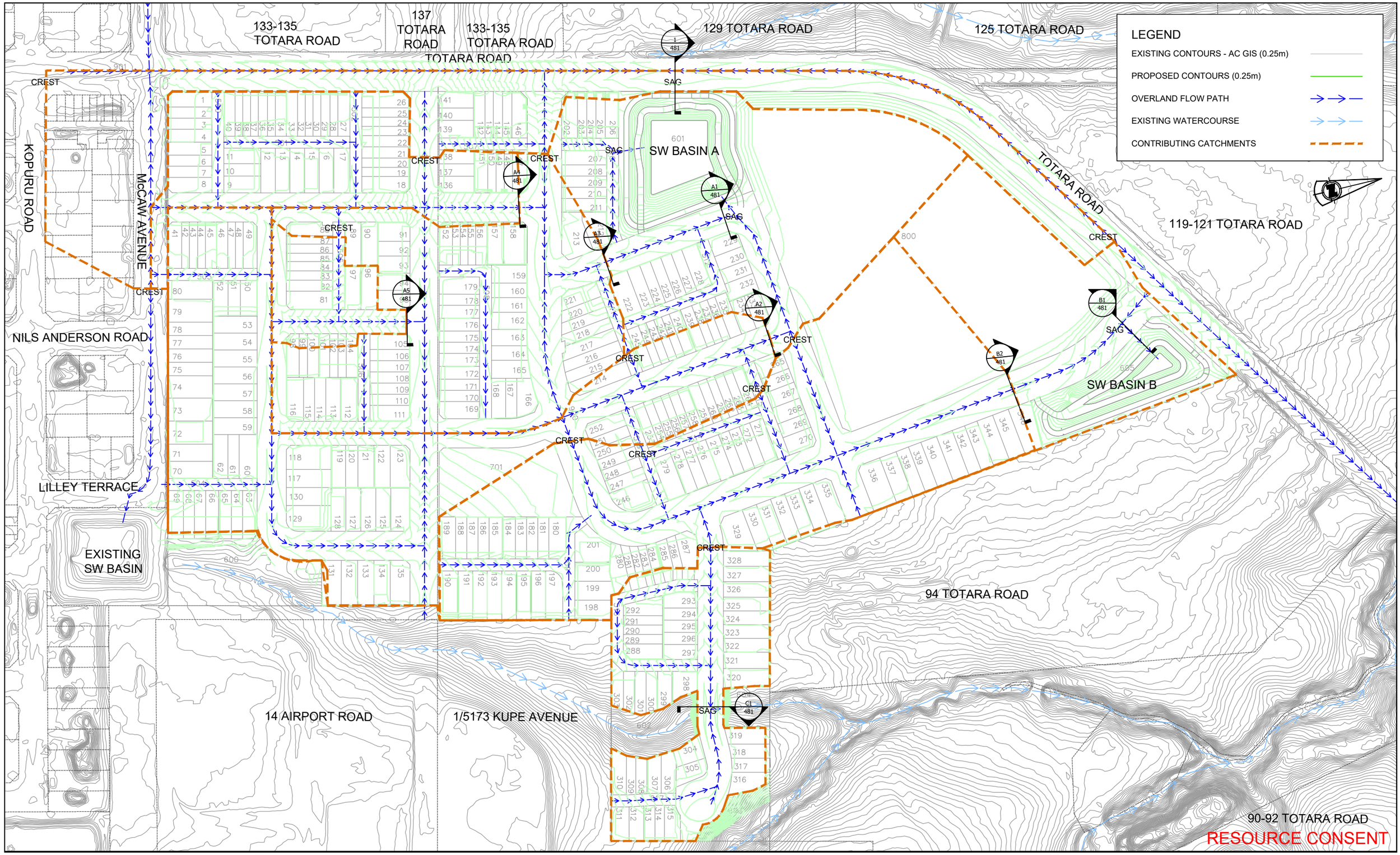

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Job Title

WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title

STORMWATER DRAINAGE
1% AEP OVERLAND FLOW PATH
LOCATION PLAN

	By	Date	Scale	Job No. 4520	
Surveyed:	MS/CP		1: 2000@A3	Drawing No. 4520–01–SW–480	Rev A
Designed:	KLP				
Drawn:	KLP	12/2022			
Approved:	BJ				
CAD FILE					

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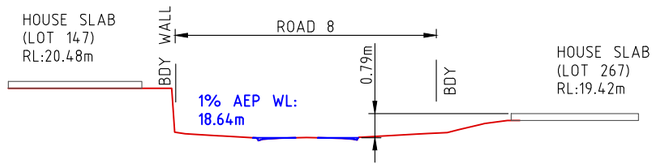
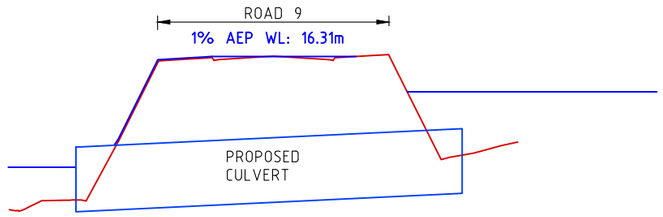
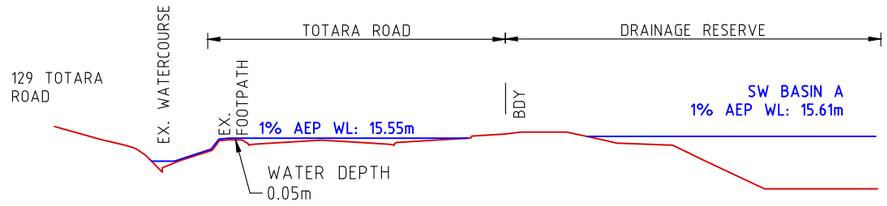


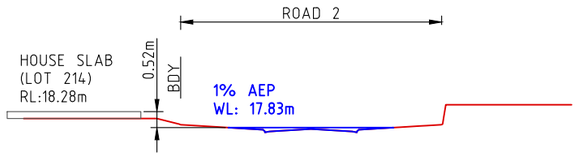
A4 1% AEP SECTION - ROAD 8 CH.215 (DATUM 16m)



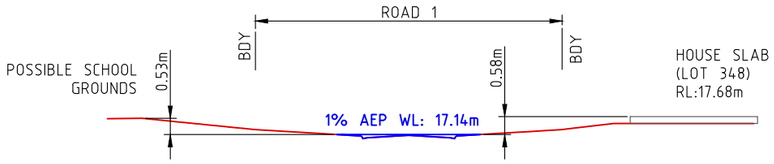
C1 1% AEP SECTION - ROAD 1 CH.520 (DATUM 9m)



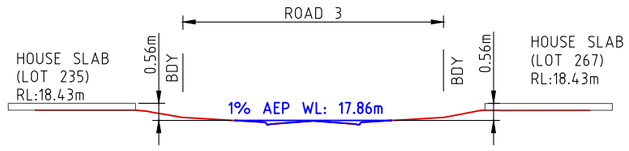
1 1% AEP SECTION - TOTARA RD CH.769 (DATUM 11m)



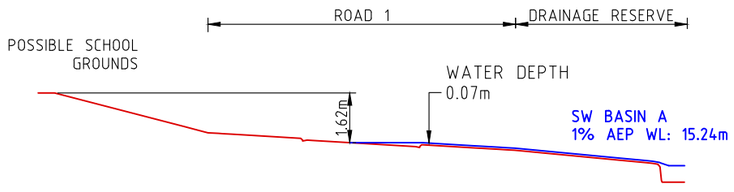
A3 1% AEP SECTION - ROAD 2 CH.40 (DATUM 15m)



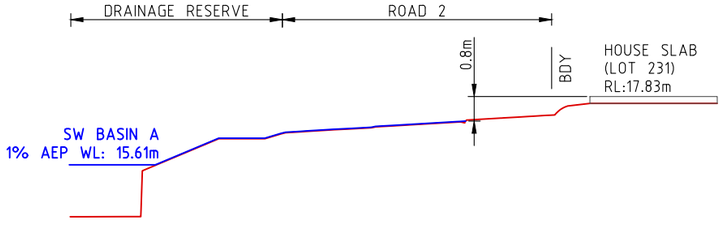
B2 1% AEP SECTION - ROAD 1 CH.520 (DATUM 14m)



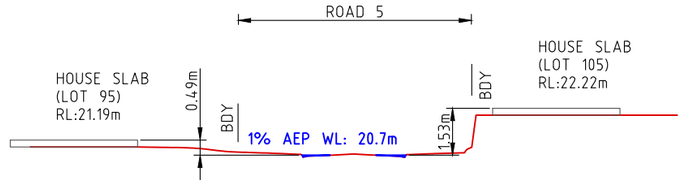
A2 1% AEP SECTION - ROAD 3 CH.13 (DATUM 15m)



B1 1% AEP SECTION - ROAD 1 CH.597 (DATUM 12m)



A1 1% AEP SECTION - ROAD 2 CH.116 (DATUM 11m)



A5 1% AEP SECTION - ROAD 5 CH.11 (DATUM 18m)

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
1% AEP OVERLAND FLOW PATH
SECTIONS

	By	Date
Surveyed:	MS/CP	
Designed:	KLP	
Drawn:	KLP	12/2022
Approved:	BJ	
CAD FILE		

Scale: 1:200@A3
5 x VERT.

Job No. 4520
Drawing No. 4520–01–SW–481
Rev A

100 Year Flood Level Calculations

PROJECT DATA

PROJECT NO.:	4520 - 01 Whenuapai Green
DATE:	Oct-22 REV A
BY:	KLP
SITE DESCRIPTION:	98-100 TOTARA ROAD, WHENUAPAI

TP108 rainfall data:	
Return Period	**Depth**
24hr 10 year ARI =	135 mm
24hr 100 year ARI =	195 mm

Intensity for 10min storm duration	
Return Period	**Intensity**
10min 10 year ARI =	91.125 mm/hr
10min 100 year ARI =	131.625 mm/hr

CLIMATE CHANGE ALLOWANCE OF 2.1°C	
Return Period	**Intensity**
10min 10 year ARI =	106.06 mm/hr
10min 100 year ARI =	158.07 mm/hr

100YR FLOW CALCULATIONS - RATIONAL METHOD

100 Year flow calculations assuming full pipe network blockage.

Section ID. / Location:	ROAD 2 CH.116 (SAG)		ROAD 3 CH.13		ROAD 2 CH.40		ROAD 8 CH.215		ROAD 5 CH.11		ROAD 1 CH.597 (SAG)		ROAD 1 CH.520		ROAD 9 CH.110 (SAG)		TOTARA ROAD CH.769 (SAG)	
	SECTION A1		SECTION A2		SECTION A3		SECTION A4		SECTION A5		SECTION B1		SECTION B2		SECTION C1		SECTION 1	
Catchment Area (A) Ha:	10.5603		3.3179		3.7852		1.2603		0.3827		4.2956		2.8502		1.1980		2.0387	
	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious
	3.4849	7.0754	1.0949	2.2230	1.2491	2.5361	0.4159	0.8444	0.1263	0.2564	1.8471	2.4485	1.1401	1.7101	0.2982	0.8998	0.3058	1.7329
Imperviousness (%)	67%		67%		67%		67%		67%		57%		60%		75%		85%	
Runoff Coefficient, C:	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9	0.3	0.9
Weighted Runoff Coefficient (C):	0.70		0.70		0.70		0.70		0.70		0.64		0.66		0.75		0.81	
Simulation event (AEP):	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%
Rainfall Intensity (i) mm/hr:	106.06	158.07	106.06	158.07	106.06	158.07	106.06	158.07	106.06	158.07	106.06	158.07	106.06	158.07	106.06	158.07	106.06	158.07

TP108 10min 10yr/100yr with climate change.

Q_{AEP}:	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%	10%	1%
Catchment Runoff (m3/s):	2.184	3.255	0.686	1.023	0.783	1.167	0.261	0.388	0.079	0.118	0.812	1.211	0.554	0.826	0.265	0.395	0.486	0.725

Q(i) = CiA/360

Q_{10yr}, Network Blockage (%):	100%		100%		100%		100%		100%		100%		100%		100%		100%	

As Per SWCOP 4.3.5.6

Q_{100yr}, Secondary Flow (m3/s):	3.255		1.023		1.167		0.388		0.118		1.211		0.826		0.395		0.725	

100YR ROAD FLOW CALCULATION - MANNINGS

Section ID. / Location:	ROAD 2 CH.116 (SAG)	ROAD 3 CH.13	ROAD 2 CH.40	ROAD 8 CH.215	ROAD 5 CH.11	ROAD 1 CH.597 (SAG)	ROAD 1 CH.520	ROAD 9 CH.110 (SAG)	TOTARA ROAD CH.769 (SAG)
	SECTION A1	SECTION A2	SECTION A3	SECTION A4	SECTION A5	SECTION B1	SECTION B2	SECTION C1	SECTION 1
Road Slope OR Basin entry slope(S):	3.0%	0.5%	0.5%	4.0%	4.3%	3.0%	0.5%	3.0%	3.0%
Depth of Flow above kerb top (m):	**0.085**	**0.149**	**0.156**	**0.092**	**0.061**	**0.068**	**0.135**	**0.039**	**0.053**
Flow Area (A) (m2):	2.0871	1.0810	1.1538	0.2417	0.1026	0.8922	0.9354	0.4219	0.9838
Wetted Perimeter (P) (m):	36.8322	10.3780	10.3780	5.1064	3.6688	19.6808	10.3780	16.2274	28.3792
Mannings n (n):	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Flow Velocity (m/s):	1.597	0.978	1.022	1.635	1.194	1.376	0.888	0.950	1.151
***Flow Depth x Velocity (m^2/s):**	**0.136**	**0.146**	**0.159**	**0.150**	**0.073**	**0.094**	**0.120**	**0.037**	**0.061**
	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Channel Flow Q(a) (m3/s):	3.333	1.059	1.181	0.396	0.123	1.228	0.832	0.401	0.748

*Qa = A(A/P)^2/3*SQRT(S)/n*

** Maximum flow x depth of: 0.6m2/s no obvious danger and 0.4m2/s obvious danger. (Austroads 2013 Part 5A-table 5.1) & AC Stormwater CoP-4.3.5.6 (e)*

CAPACITY CHECK:

Catchment ID. / Location:	ROAD 2 CH.116 (SAG)	ROAD 3 CH.13	ROAD 2 CH.40	ROAD 8 CH.215	ROAD 5 CH.11	ROAD 1 CH.597 (SAG)	ROAD 1 CH.520	ROAD 9 CH.110 (SAG)	TOTARA ROAD CH.769 (SAG)
	SECTION A1	SECTION A2	SECTION A3	SECTION A4	SECTION A5	SECTION B1	SECTION B2	SECTION C1	SECTION 1
100yr Capacity > 100yr flow:	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**	**TRUE**

RESOURCE CONSENT

Rev	Description	By	Date
A	ISSUED FOR RESOURCE CONSENT	BJ	16/12/2022

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Job Title
WHENUAPAI GREEN
98–102 TOTARA ROAD
WHENUAPAI

Drawing Title
STORMWATER DRAINAGE
1% AEP OVERLAND FLOW PATH
CALCULATIONS

	By	Date	Scale	Job No. 4520	Rev
Surveyed:	--		--	Drawing No. 4520–01–SW–482	A
Designed:	KLP				
Drawn:	--	12/2022			
Approved:	BJ				
CAD FILE					

Appendix C1 – Proposed stormwater management

- Rainfall Data
- TP108 95%ile & 90%ile runoff.
- Catchment Data for HEC-HMS
- HEC-HMS Output (TP108) for pre- and post-development.
- NZDF requirements for drawdown in SW Basins.
- AECOM ID_67 WHENUAPAI Rapid Flood Hazard Mapping Memo 2016
- Neil Group Rapid Flood Assessment – see stormwater drawings 4520-01-SW-434 to 439 inclusive in Appendix B.

Whenuapai Green SWMP

Rainfall Data Existing and with Climate Change

Using Auckland Council SW CoP Table 4.1 Percentage Increase in 24-Hour Rainfall Depth

HIRDS V4

ARI yrs	**AEP %**	Existing 24 hr rainfall (mm)	2.1 deg CC increase (%)	**2.1 deg CC 24 hr Rainfall (mm)**	Existing Rainfall Intensity (10min) (mm/hr)	2.1deg CC %	2.1 deg CC Intensity (10min) (mm/hr)
2	**50**	80.9	9.0	**88.2**		9.0	0.0
5	**20**	104.0	11.3	**115.8**	63.3	11.3	70.5
10	**10**	122.0	13.2	**138.1**	93.1	13.2	105.4
20	**5**	140.0	15.1	**161.1**	106.0	15.1	122.0
50	**2**	164.0	16.8	**191.6**	122.0	16.8	142.5
100	**1**	182.0	16.8	**212.6**	135.0	16.8	157.7

TP108

ARI yrs	**AEP %**	Existing 24 hr rainfall (mm)	2.1 deg CC increase (%)	**2.1 deg CC 24 hr Rainfall (mm)**	
2	**50**	85.0	9.0	**92.7**	
5	**20**	112.0	11.3	**124.7**	
10	**10**	135.0	13.2	**152.8**	
20	**5**	155.0	15.1	**178.4**	
50	**2**	180.0	16.8	**210.2**	NZDF time to empty
100	**1**	195.0	16.8	**227.8**	

STORMWATER RUNOFF - USING METHOD OF TP 108

Values in red require input

Worksheet 1: Runoff Parameters and Time of Concentration

Project: **Whenuapai Green** **By:** **BJ** **Date:** May-22

Location: **Totara Road, Whenuapai** **Checked:** **Date:**

Select one : **Present:** **Yes** **Developed:** **No**

1. Runoff Curve Number (CN) and Initial Abstration(Ia)

Soil Name and Classification	Cover desciption (cover type, treament and hydrologic condition)	Curve Number CN (*)	Area (km2)	Product of CN x area
	Existing PERVIOUS	74	0.00100	0.074
	Existing IMpervious	98	0.00000	0.000
				0.000
				0.000
				0.000
				0.000
				0.000
				0.000
* from Appendix B		Totals =	0.00100	0.074

CN (weighted) = total product / total area = 0.074 / 0.001 = **74**

Ia (weighted) = 5 x pervious area / total area = 0.00100 / 0.00100 = **5.00 mm**

2. Time of Concentration

Channelisation factor .... C = 0.8 (from Table 4.2)
Catchment length .... L = 0.5 km (along drainage path)
Catchment slope .... Sc = 0.05 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74 / 126 = 0.5873

tc = $0.14\ C\ L^{0.66}\ (CN / 200 - CN)^{-0.55}\ Sc^{-0.30}$ = 0.233 hrs
(min 10min) = **0.233 hrs**
= **14.000 mins**

SCS Lag for HEC-HMS tp= 2/3 tc = 9.333 **mins**

Table 4.2 - Channelisation factors	
Piped stormwater system	C = 0.6
Engineered grass channels	C = 0.8

STORMWATER RUNOFF - USING METHOD OF TP 108

Values in red require input

Worksheet 1: Runoff Parameters and Time of Concentration

Project: **Whenuapai Green** **SMAF 1** **By:** **BJ** **Date:** May-22

Location: **Totara Road, Whenuapai** **Checked:** **Date:**

Select one : **Present:** **No** **Developed:** **Yes**

1. Runoff Curve Number (CN) and Initial Abstration(Ia)

Soil Name and Classification	Cover desciption (cover type, treament and hydrologic condition)	Curve Number CN (*)	Area (km2)	Product of CN x area
	Developed PERVIOUS	74	0.00000	0.000
	Developed IMpervious	98	0.00100	0.098
				0.000
				0.000
				0.000
				0.000
				0.000
				0.000
* from Appendix B		Totals =	0.00100	0.098

CN (weighted) = total product / total area = 0.098 / 0.001 = **98**

Ia (weighted) = 5 x pervious area / total area = 0.00000 / 0.00100 = **0.00 mm**

2. Time of Concentration

Channelisation factor .... C = 0.6 (from Table 4.2)
Catchment length .... L = 0.5 km (along drainage path)
Catchment slope .... Sc = 0.05 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 98 / 102 = 0.9608

tc = $0.14\ C\ L^{0.66}\ (CN / 200 - CN)^{-0.55}\ Sc^{-0.30}$ = 0.133 hrs
(min 10min) = **0.167 hrs**
= **10.000 mins**

SCS Lag for HEC-HMS tp= 2/3 tc = 6.667 **mins**

Table 4.2 - Channelisation factors	
Piped stormwater system	C = 0.6
Engineered grass channels	C = 0.8

Worksheet 2: Graphical Peak Flow Rate PRESENT

Project: **Whenuapai Green** **By:** **BJ** **Date:**

Location: **Checked:** **Date:**

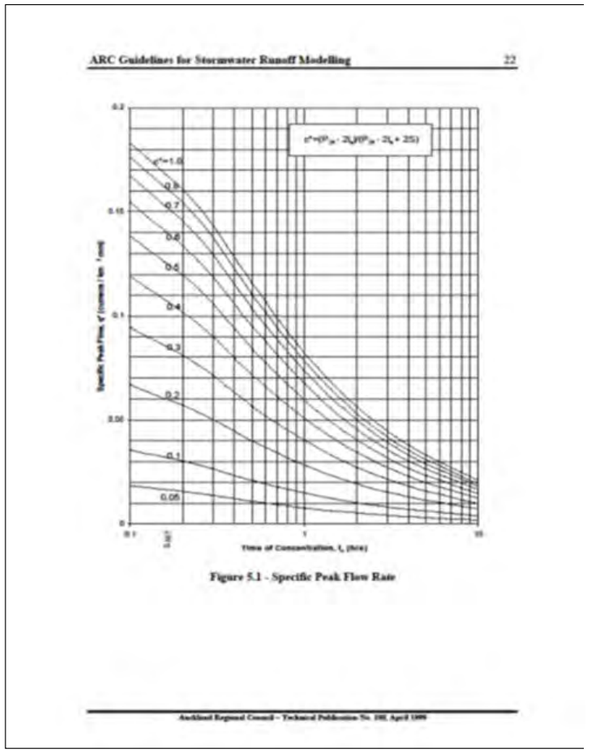
Select one : **Present:** **Y** (all pervious) **Developed:**

1. Data

Catchment area …	A =	0.00100 km2	(From Worksheet 1)
Runoff curve number …	CN =	74.00	(From Worksheet 1)
Initail Abstraction …	Ia =	5.00 mm	(From Worksheet 1)
Time of concentration …	tc =	0.233 hrs	(From Worksheet 1)

2. Calculate storage, S = [(1000/CN) - 10] x 25.4 = 89.24 mm

				Storm #1	Storm #2	Storm #3	
3. Average recurrence interval				95%	90%		**SW Treatment (Storm #2)**
4. 24 hour rainfall depth			(mm)	35.0	25.3		Fig 6, 5 GD01
5. Compute c* =	$\frac{P_{24} - 2Ia}{P_{24}-2Ia+2S}$			0.123	0.079		
6. Specific peak flow rate, q* (from fig 5.1)				0.045	0.025		
7. Peak flow rate,	$q_p = q^* A P_{24}$		(m3/s)	0.0016	0.0006		
8. Runoff depth,	$\mathbf{Q_{24}} =$	$\frac{(P_{24} - Ia)^2}{(P_{24}-Ia)+S}$	(mm)	**7.55**	**3.76**		
9. Runoff volume,	$\mathbf{V_{24}} =$	$1000 \times Q_{24} A$	(m3)	**8**	**4**		



Worksheet 2: Graphical Peak Flow Rate DEVELOPED

Project: **Whenuapai Green** **By:** **BJ** **Date:**

Location: **Checked:** **Date:**

Select one : **Present:** **Developed:** **Y - now all impervious**

1. Data

Catchment area …	A =	0.00100 km2	
Runoff curve number …	CN =	98.00	
Initail Abstraction …	Ia =	0.00 mm	
Time of concentration …	tc =	0.167 hrs	

2. Calculate storage, S = [(1000/CN) - 10] x 25.4 = 5.18 mm

				Storm #1	Storm #2	Storm #3	
3. Average recurrence interval				95%	90%		**WQ Storm - Storm #2**
4. 24 hour rainfall depth (Fig 14 95th percentile 24hr rainfall depth)			(mm)	35.0	25.3		Fig 6, 5 GD01
5. Compute c* =	$\frac{P_{24} - 2Ia}{P_{24}-2Ia+2S}$			0.771	0.709		
6. Specific peak flow rate, q* (from fig 5.1)				0.16	0.154		
7. Peak flow rate,	$q_p = q^* A P_{24}$		(m3/s)	0.0056	0.0039		
8. Runoff depth,	$\mathbf{Q_{24}} =$	$\frac{(P_{24} - Ia)^2}{(P_{24}-Ia)+S}$	(mm)	**30.49**	**21.00**		
9. Runoff volume,	$\mathbf{V_{24}} =$	$1000 \times Q_{24} A$	(m3)	**30**	**21**		For 1000m2 new impervious area

SMAF 1 **Runoff depth for Detention from 95% Storm (Whenuapai Green)**

Q24(EDV) = Q24 (post-development) - Q24 (pre-development) - Q (retention)
= 30.49 - 7.55 - 5.00
= **17.94** mm

Runoff depth for WQV from 90% Storm (Whenuapai Green)

Q24(WQV) = Q24 (WQ post-development) - Q24 (WQ pre-development)
= 21.00 - 3.76
= **17.24** mm

EXISTING (Pre-development) Catchment - 1% AEP

REV N - RC issue 30/11/2022

1% AEP Catchment based on original contours and outfalls.
Dwg 4520-01-GN-430 rev A

Sub-Catchment		Impervious	Impervious		Pervious	
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)
SOUTH-WEST	1.4540	80.00	11632	0.011632	2908.0	0.002908
WEST	9.3532	0.00	0	0	93532.0	0.093532
NORTH-EAST	0.1078	80.00	862.4	0.000862	215.6	0.000216
NORTH	1.7618	0.00	0	0	17618.0	0.017618
EAST	5.2503	0.00	0	0	52503.0	0.052503
Totals	17.9271		12494.4	0.0124944	166776.6	0.1667766

7.1199

EXISTING (Pre-development) Catchment - 10% AEP

10% AEP Catchment based on original contours and outfalls.
Dwg 4520-01-GN-432 rev A

Sub-Catchment		Impervious	Impervious		Pervious	
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)
SOUTH-WEST	0.6264	80.00	5011.2	0.005011	1253	0.001253
WEST	9.3532	0.00	0	0	93532	0.093532
NORTH-EAST	0.1078	80.00	862.4	0.000862	215.6	0.000216
NORTH	1.7618	0.00	0	0	17618	0.017618
EAST	5.2503	0.00	0	0	52503	0.052503
Totals	17.0995		5873.6	0.0058736	165121.4	0.1651214

Rainfall (24hr existing - no CC) **TP108**

24hr - 10% AEP	135	mm
24hr - 1% AEP	195	mm

DEVELOPED Catchment - 1% AEP

REV N - RC issue

1% AEP Developed Catchment based on proposed road and site contours.

Dwg 4520-01-SW-431 rev A

Updated 30/11/22

Flows to SW Basin A

Sub-Catchment		Impervious	Impervious		Pervious	
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)
AREA A	10.5603	62.10	65579.463	0.065579463	40024	0.040023537

Flows to SW Basin B

Sub-Catchment		Impervious	Impervious		Pervious	
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)
AREA B	4.2956	53.50	22981.46	0.02298146	19975	0.01997454

Flows direct to eastern stream

Sub-Catchment		Impervious	Impervious		Pervious	
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)
AREA C (Eastern panhandle)	1.5168	69.00	10465.92	0.01046592	4702	0.00470208
AREA D (Drainage reserve)	0.3420	0.00	0	0	3420	0.00342
AREA E (Totara Rd NE)	0.0774	85.00	657.9	0.0006579	116	0.0001161

Flows direct to western stream

Sub-Catchment		Impervious	Impervious		Pervious	
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)
AREA F (Totara Rd West)	1.0125	85.00	8606.25	0.00860625	1519	0.00151875

DEVELOPED Catchment - 10% AEP

REV N - RC issue

10% AEP Developed Catchment based on proposed stormwater pipe network.

Dwg 4520-01-SW-433 rev A
Updated 30/11/22
Retn for all lots on-site
Detn from lots in SW basin A & flow thru basin B

Detn & Retn from COALs and Roads in SW basin A & flow thru basin B
EAST sub-catchment (Area C) - Detn & Retn on Lots, COALs & Road reserve
Totara Road only -WQ, Retn & Detn in raingardens.

Flows to SW Basin A

Sub-Catchment		Impervious	Impervious		Pervious		In SW Basin: 5.0mm Retn	18.0mm Detn		Notes
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)	(m3)	(m3)		
AREA A - Roads	2.7880	85.00	23698.0	0.02370	4182.0	0.00418	118.5	426.6		
AREA A - lots	4.4310	60.00	26586.0	0.02659	17724.0	0.01772	na	478.5		Retn on site
AREA A - COALs	0.6482	80.00	5185.6	0.00519	1296.4	0.00130	25.9	93.3		
AREA A - Reserve	0.5647	0.00	0.0	0.00000	5647.0	0.00565	0	0.0		
AREA A - School	1.4111	40.00	5644.4	0.00564	8466.6	0.00847	na	na		Retn & Detn on site
Area A - Totals:	9.8430	62.09	61114.0	0.06111	37316.0	0.03732	144.4	998.5	1142.9	

Flows to SW Basin B

Sub-Catchment		Impervious	Impervious		Pervious		To SW Basin: 5.0mm Retn	18.0mm Detn		Notes
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)	(m3)	(m3)		
AREA B - roads	1.2480	85.00	10608.0	0.01061	1872.0	0.00187	53.0	190.9		
AREA B - lots	1.5652	60.00	9391.2	0.00939	6260.8	0.00626	na	169.0		Retn on site
AREA B - COALs	0.1270	80.00	1016.0	0.00102	254.0	0.00025	5.1	18.3		
AREA B - Reserve	0.6450	0.00	0.0	0.00000	6450.0	0.00645	0.0	0.0		
AREA B - School	1.3785	40.00	5514.0	0.00551	8271.0	0.00827	na	na		Retn & Detn on site
Area B - Totals:	4.9637	53.45	26529.2	0.02653	23107.8	0.0231	58.1	378.3	436.4	

Note: Detn in Basin B not required as discharge is piped direct to tidal part of stream

Flows direct to eastern stream

Sub-Catchment		Impervious	Impervious		Pervious		5.0mm Retn	18.0mm EDV		Notes
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)	(m3)	(m3)		
AREA C - roads	0.2792	85.00	2373.2	0.00237	418.8	0.00042	11.9	42.7		Retn & Detn on site
AREA C - lots	0.6532	60.00	3919.2	0.00392	2612.8	0.00261	19.6	70.5		Retn & Detn on site
AREA C - COALs	0.1170	80.00	936.0	0.00094	234.0	0.00023	4.7	16.8		Retn & Detn on site
Area C - Totals:	1.0494	68.88	7228.4	0.00723	3265.6	0.00327				
AREA D -drainage reserves	0.5831	0.00	0	0	5831	0.005831	0.0	0.0		
AREA D - lot areas not piped	0.2038	0.00	0	0	2038	0.002038	0.0	0.0		
Area D - Totals:	0.7869	0.0000	0	0	7869	0.007869				
AREA E (Totara Rd NE)	0.0727	85.00	617.95	0.00062	109	0.00011	3.1	11.1		Retn & Detn in raingardens

Flows direct to western stream

Sub-Catchment		Impervious	Impervious		Pervious					
	(Ha)	(%)	(m2)	(km2)	(m2)	(km2)				
AREA F (Totara Rd West)	0.3070	85.00	2609.5	0.00261	461	0.00046	13.0	47.0		Retn & Detn in raingardens

Whenuapai Green

REV N UPDATED 30/11/22

Catchment to SW Basin A Sides 4:1 TP108 rainfall with CC

REV N Updates to impervious on lots

Lots to 60% ; School 40%; COALs 80%, Roads 85%

No permanent water allowed
Retn for all lots on-site
EDV from lots in SW basin A & B
EDV & Retn from COALs and Roads in SW basin A & B
EAST sub-catchmt - EDV & Retn on Lots & Road reserve
Totara Road only -WQ, part Retn & EDV in raingardens.

Control 1 ***Retention & EDV (5.0 + 18 = 23.0mm) in SW basin - 24 hr release***

Retn & EDV required in SW basin = ***1143*** m3
Average release rate over 24 hrs = 13.23 l/sec
Maximum release rate = ***26.46*** l/sec (2 x Qav over 24 hrs)

Control 2 Provide attentuation to reduce 10 %AEP runoff peak flows in dry basin.
Control 3 Provide attentuation to reduce 1 %AEP runoff peak flows in dry basin.

Geometry:

Reduced volumes from tab "Basin A vol revK"

Control 1: Orifice 1 outlet for Retenton & EDV flows
(from road impervious only)
Retn & EDV maxm release rate = 26.46 l/sec

Outflow1 Q1 (m3/s) = $3.47 \times Cd \times d^2 \times H1^{0.5}$

Control 1 : Retn & EDV control - orifice

Cd = 0.60 square edged orifice
d (m) = 0.120 orifice diameter
Base RL = 0.00
Permenet dead storge 0.00 m3
ORL1 = 0.000 CL of orifice
H1 (m) = WL-ORL1 orifice head

Control 2 - 10 yr ARI slot weir in side of MH
Pre-developed 10% AEP peak flow = 1.379 m3/sec

Outflow2 Q2(m3/s) = $1.8 \times w \times H2^{3/2}$

Control 2: Vertical slot weir in side of manhole

Slot width w = 1.50
Weir level WRL2= 0.80
H2 (m) = WL-WRL2

Control 3 - 100 yr ARI -slot weir in side on manhole:
Pre-developed 1% AEP peak flow = 2.543 m3/sec

Outflow3 Q2(m3/s) = $1.8 \times w \times H2^{3/2}$

Control 3: Vertical slot weir in side of manhole (additional to Control 2)

Slot width w = 7.92 (m)
(balance of top of 3.0m MH)
WRL3= 1.60
H3 (m) = WL-WRL3 weir head

Stage / Discharge:

Water depth (above base) z (m)	RL(m)	Water Level WL (m)	Total Volume Vtot (m3)	Permanent Dead storage PDV(m3)	**Live Storage volume V (m3)**	Live Storage volume V(1000m3)	Total head H1 (m)	**Outflow 1 - retn&EDV Q1 (m3/s)**	Total head H2 (m)	**Outflow 2 Q2 (m3/s)**	Total head H3 (m)	**Outflow 3 Q3 (m3/s)**	Water depth (above base)	**Live Storage volume V(1000m3)**	**Total Outflow Q (m3/sec)**	**Total Outflow Q (l/sec)**
0.000	13.90	**0.00**	**0.00**	0.0	**0.0**	0.0000	0.000	0.0000					0.000	**0.0000**	**0.0000**	0.00
0.100	14.00	**0.10**	**132.53**	0.0	**132.5**	0.1325	0.100	0.0095					0.100	**0.1325**	**0.0095**	9.48
0.200	14.10	**0.20**	**272.12**	0.0	**272.1**	0.2721	0.200	0.0134					0.200	**0.2721**	**0.0134**	13.41
0.300	14.20	**0.30**	**418.67**	0.0	**418.7**	0.4187	0.300	0.0164					0.300	**0.4187**	**0.0164**	16.42
0.400	14.30	**0.40**	**572.24**	0.0	**572.2**	0.5722	0.400	0.0190					0.400	**0.5722**	**0.0190**	18.96
0.500	14.40	**0.50**	**732.91**	0.0	**732.9**	0.7329	0.500	0.0212					0.500	**0.7329**	**0.0212**	21.20
0.600	14.50	**0.60**	**900.75**	0.0	**900.8**	0.9008	0.600	0.0232					0.600	**0.9008**	**0.0232**	23.22
0.700	14.60	**0.70**	**1075.89**	0.0	**1075.9**	1.0759	0.700	0.0251					0.700	**1.0759**	**0.0251**	25.08
0.800	14.70	**0.80**	**1258.44**	0.0	**1258.4**	1.2584	0.800	0.0268	0.0000	0.0000			0.800	**1.2584**	**0.0268**	26.82
0.900	14.80	**0.90**	**1448.54**	0.0	**1448.5**	1.4485	0.900	0.0284	0.1000	0.0854			0.900	**1.4485**	**0.1138**	113.82
1.000	14.90	**1.00**	**1646.30**	0.0	**1646.3**	1.6463	1.000	0.0300	0.2000	0.2415			1.000	**1.6463**	**0.2715**	271.48
1.100	15.00	**1.10**	**1851.92**	0.0	**1851.9**	1.8519	1.100	0.0314	0.3000	0.4437			1.100	**1.8519**	**0.4751**	475.10
1.200	15.10	**1.20**	**2085.13**	0.0	**2085.1**	2.0851	1.200	0.0328	0.4000	0.6831			1.200	**2.0851**	**0.7159**	715.89
1.300	15.20	**1.30**	**2333.09**	0.0	**2333.1**	2.3331	1.300	0.0342	0.5000	0.9546			1.300	**2.3331**	**0.9888**	988.78
1.400	15.30	**1.40**	**2594.21**	0.0	**2594.2**	2.5942	1.400	0.0355	0.6000	1.2548			1.400	**2.5942**	**1.2903**	1290.32
1.500	15.40	**1.50**	**2869.84**	0.0	**2869.8**	2.8698	1.500	0.0367	0.7000	1.5813			1.500	**2.8698**	**1.6180**	1618.01
1.600	15.50	**1.60**	**3160.50**	0.0	**3160.5**	3.1605	1.600	0.0379	0.8000	1.9320	0.00	0.0000	1.600	**3.1605**	**1.9699**	1969.89
1.700	15.60	**1.70**	**3463.72**	0.0	**3463.7**	3.4637	1.700	0.0391	0.9000	2.3053	0.10	0.4508	1.700	**3.4637**	**2.7952**	2795.20
1.800	15.70	**1.80**	**3779.32**	0.0	**3779.3**	3.7793	1.800	0.0402	1.0000	2.7000	0.20	1.2751	1.800	**3.7793**	**4.0153**	4015.32
1.900	15.80	**1.90**	**3941.53**	0.0	**3941.5**	3.9415	1.900	0.0413	1.1000	3.1150	0.30	2.3425	1.900	**3.9415**	**5.4988**	5498.79

120mm diam EDV orifice at 0.00

Required Retn & EDV volume = 1143 m3

10% AEP Peak Discharge = 1.503 m3/s (from HEC)
10% AEP Peak Storage = 2773 m3 (from HEC)

1% AEP peak Discharge = 2.952 m3/s (from HEC)
1% Peak Storage = 3504 m3 (from HEC)

RL 15.75 = base of spillway

Outlet to WEST Stream:

10% AEP DEV peak discharge = 1.551 m3/s (from HEC)
Pre-developed 10% AEP peak flow = 1.379 m3/s

1% AEP DEV peak discharge = 3.243 m3/s (from HEC)
Pre-developed 1% AEP peak flow = 2.543 m3/s

Whenuapai Green

Rev L UPDATED 22/08/22 Revised Basin B volumes

Catchment B to SW Basin B Sides 4:1 TP108 + CC

No EDV in Basin B
Retn & EDV piped to Coastal discharge

No permanent water allowed
On-site retention of first 5.00 mm of rainfall.
On-site extended detention volume (EDV) for 18 mm of runoff from all impervious areas, released over 24 hours.
provided onsite for lots and in raingardens for lots.

Control 1	***Retention (5.00mm) for COALs &Roads & EDV (18.0mm) for roads in SW basin - piped direct to coastal discharge***
	Provide a LOW Flow orifice
Control 2	Provide detention for 10 year ARI runoff to pre-development peak flows in dry basin
Control 3	Provide detention for 100 year ARI runoff to pre-devlopment peak flows in dry basin

Geometry:

Volumes from 12d

Control 1: Orifice 1 - low flows

(from road impervious only)
Retn & EDV maxm release rate = #REF! l/sec

Outflow1 Q1 (m3/s) = $3.47 \times Cd \times d^2 \times H1^{0.5}$

Control 1 : Low flow - orifice
Retn & EDV = #REF! m3

Cd = 0.60 square edged orifice
d (m) = 0.250 orifice diameter
Base RL = 0.00

Permenet dead storge 0.00 m3
ORL1 = 0.000 CL of orifice
H1 (m) = WL-ORL1 orifice head

Control 2 - 10 yr control - limited

Greenfields 10yr peak flow = NA m3/sec
(Catchments B & C)

Outflow2 Q2(m3/s) = $1.8 \times w \times H2^{3/2}$

Control 2: Vertical slot weir in side of manhole

Slot width w = 0.30

Weir level WRL2= 0.40
H2 (m) = WL-WRL2

Control 3 - 100 yr ARI -slot weir in side on manhole:

Greenfields 100yr peak flow = NA m3/sec

Outflow3 Q2(m3/s) = $1.8 \times w \times H2^{3/2}$

Control 3: Vertical slot weir in side of manhole (additional to Control 2)

1.1 diam MH, Circ = 4.71

Slot width w = 1.50 (m)

WRL3= 1.50
H3 (m) = WL-WRL3 weir head

Stage / Discharge: 12d data

Water depth (above base) z (m)	RL (m)	Water Level WL (m)	Total Storage Volume Vtot (m3)	Permanent Dead storage PDV(m3)	**Live Storage volume V (m3)**	Live Storage volume V(1000m3)	Total head H1 (m)	**Outflow 1 - retn&EDV Q1 (m3/s)**	Total head H2 (m)	**Outflow 2 Q2 (m3/s)**	Total head H3 (m)	**Outflow 3 Q3 (m3/s)**
0.000	13.70	**0.00**	**0.00**	0.0	**0.0**	0.0000	0.000	0.0000				
0.100	13.80	**0.10**	**15.17**	0.0	**15.2**	0.0152	0.100	0.0411				
0.200	13.90	**0.20**	**33.35**	0.0	**33.3**	0.0333	0.200	0.0582				
0.300	14.00	**0.30**	**54.80**	0.0	**54.8**	0.0548	0.300	0.0713				
0.400	14.10	**0.40**	**79.65**	0.0	**79.7**	0.0797	0.400	0.0823	0.00	0.0000		
0.500	14.20	**0.50**	**107.95**	0.0	**108.0**	0.1080	0.500	0.0920	0.10	0.0171		
0.600	14.30	**0.60**	**140.00**	0.0	**140.0**	0.1400	0.600	0.1008	0.20	0.0483		
0.700	14.40	**0.70**	**180.22**	0.0	**180.2**	0.1802	0.700	0.1089	0.30	0.0887		
0.800	14.50	**0.80**	**228.07**	0.0	**228.1**	0.2281	0.800	0.1164	0.40	0.1366		
0.900	14.60	**0.90**	**283.25**	0.0	**283.3**	0.2833	0.900	0.1234	0.50	0.1909		
1.000	14.70	**1.00**	**346.41**	0.0	**346.4**	0.3464	1.000	0.1301	0.60	0.2510		
1.100	14.80	**1.10**	**468.62**	0.0	**468.6**	0.4686	1.100	0.1365	0.70	0.3163		
1.200	14.90	**1.20**	**600.56**	0.0	**600.6**	0.6006	1.200	0.1425	0.80	0.3864		
1.300	15.00	**1.30**	**742.55**	0.0	**742.5**	0.7425	1.300	0.1484	0.90	0.4611		
1.400	15.10	**1.40**	**894.97**	0.0	**895.0**	0.8950	1.400	0.1540	1.00	0.5400		
1.500	15.20	**1.50**	**1058.24**	0.0	**1058.2**	1.0582	1.500	0.1594	1.10	0.6230	0.00	0.0000
1.600	15.30	**1.60**	**1232.82**	0.0	**1232.8**	1.2328	1.600	0.1646	1.20	0.7098	0.10	0.0854
1.700	15.40	**1.70**	**1419.22**	0.0	**1419.2**	1.4192	1.700	0.1697	1.30	0.8004	0.20	0.2415
1.800	15.50	**1.80**	**1620.43**	0.0	**1620.4**	1.6204	1.800	0.1746	1.40	0.8945	0.30	0.4437
1.900	15.60	**1.90**	**1833.95**	0.0	**1834.0**	1.8340	1.900	0.1794	1.50	0.9920	0.40	0.6831
2.000	15.70	**2.00**	**2060.36**	0.0	**2060.4**	2.0604	2.000	0.1840	1.60	1.0929	0.50	0.9546
2.100	15.80	**2.10**	**2300.45**	0.0	**2300.5**	2.3005	2.100	0.1886	1.70	1.1969	0.60	1.2548

Water depth (above base)	**Live Storage volume V(1000m3)**	**Total Outflow Q (m3/sec)**	**Total Outflow Q (l/sec)**	
0.000	**0.0000**	**0.0000**	0.00	250mm diam low flow orifice at 0.00
0.100	**0.0152**	**0.0411**	41.15	
0.200	**0.0333**	**0.0582**	58.19	
0.300	**0.0548**	**0.0713**	71.27	
0.400	**0.0797**	**0.0823**	82.30	
0.500	**0.1080**	**0.1091**	109.09	
0.600	**0.1400**	**0.1491**	149.09	
0.700	**0.1802**	**0.1976**	197.60	
0.800	**0.2281**	**0.2530**	253.00	
0.900	**0.2833**	**0.3144**	314.37	
1.000	**0.3464**	**0.3811**	381.09	
1.100	**0.4686**	**0.4527**	452.73	
1.200	**0.6006**	**0.5289**	528.94	10% AEP peak Discharge = 0.609 m3/s (from HEC)
1.300	**0.7425**	**0.6094**	609.43	10% AEP Peak Storage = 741 m3 (from HEC)
1.400	**0.8950**	**0.6940**	693.97	
1.500	**1.0582**	**0.7824**	782.36	1% AEP peak Discharge = 0.801 m3/s (from HEC)
1.600	**1.2328**	**0.9598**	959.83	1% AEP Peak Storage = 1077 m3 (from HEC)
1.700	**1.4192**	**1.2116**	1211.56	Top of MH RL 15.30
1.800	**1.6204**	**1.5127**	1512.75	**Emergency spillway base RL15.40**
1.900	**1.8340**	**1.8545**	1854.46	
2.000	**2.0604**	**2.2315**	2231.50	
2.100	**2.3005**	**2.6403**	2640.34	

Flow to East Stream in "panhandle"

Pre-Dev 10% AEP (Junct 4) = 0.7050 m3/s
Dev 10% AEP (Junct 4) = 0.3880 m3/s

Pre-Dev 1% AEP (Junct 4) = 1.1840 m3/s
Dev 1% AEP (Junct 4) = 0.6590 m3/s

Outlet to East Stream:

Pre-Dev = 0.977 m3/s
DEV 10% AEP peak discharge = 0.931 m3/s (from HEC)

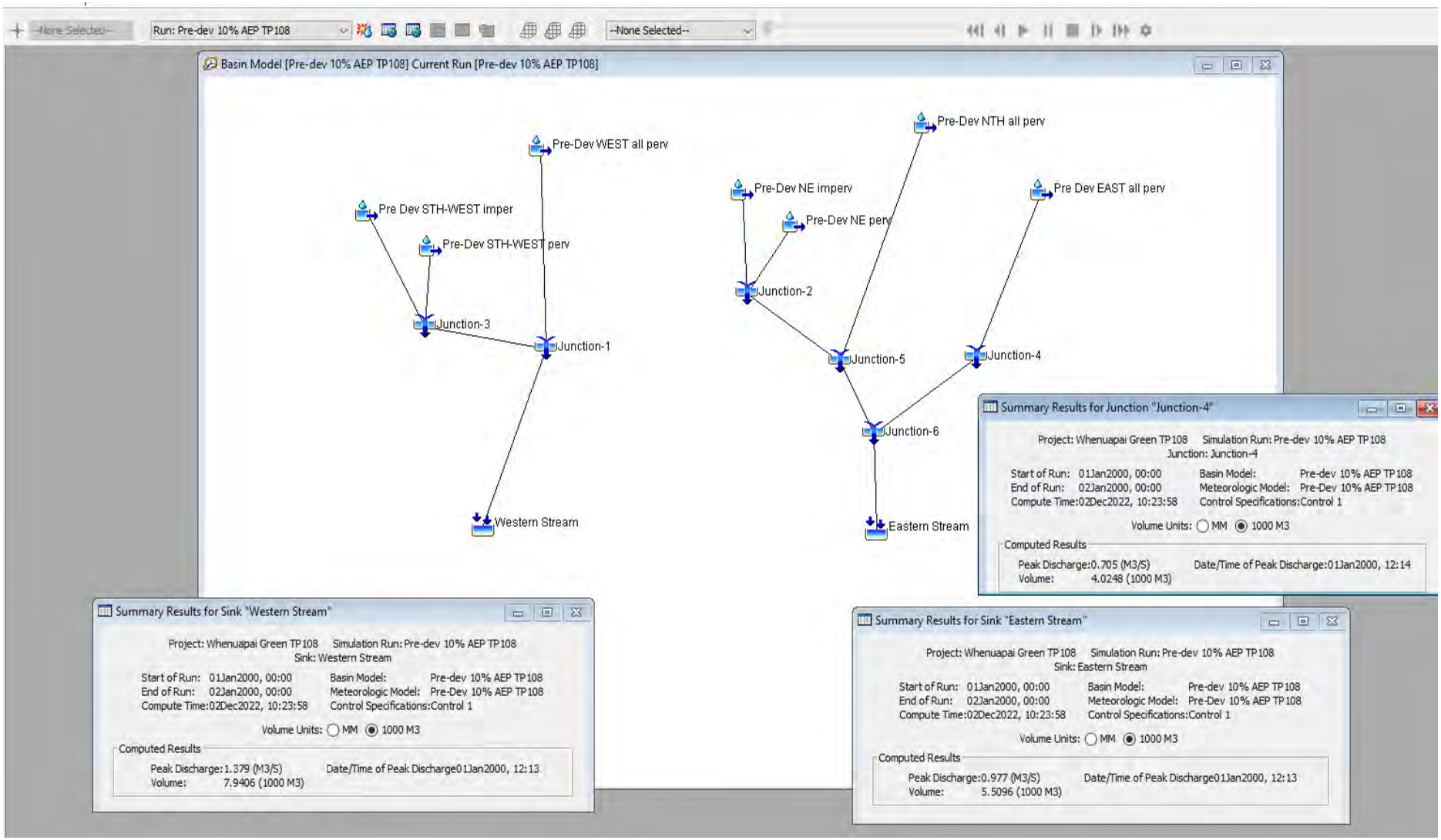
Pre-Dev = 1.627 m3/s
1% AEP peak discharge = 1.351 m3/s (from HEC)

WHENUAPAI GREEN

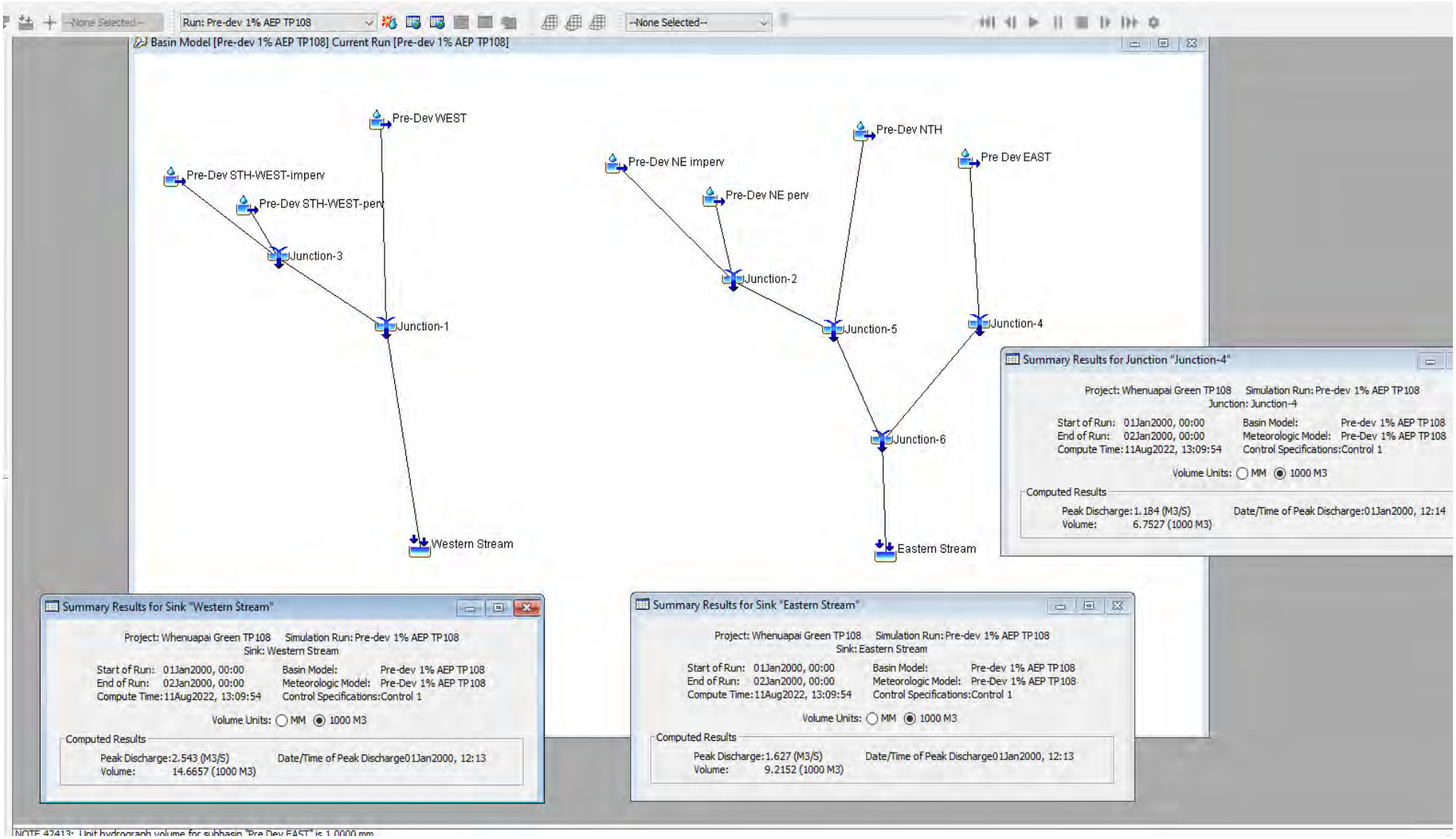
HEC-HMS OUTPUT using TP108 rainfall

Pre-Development & Post-Development

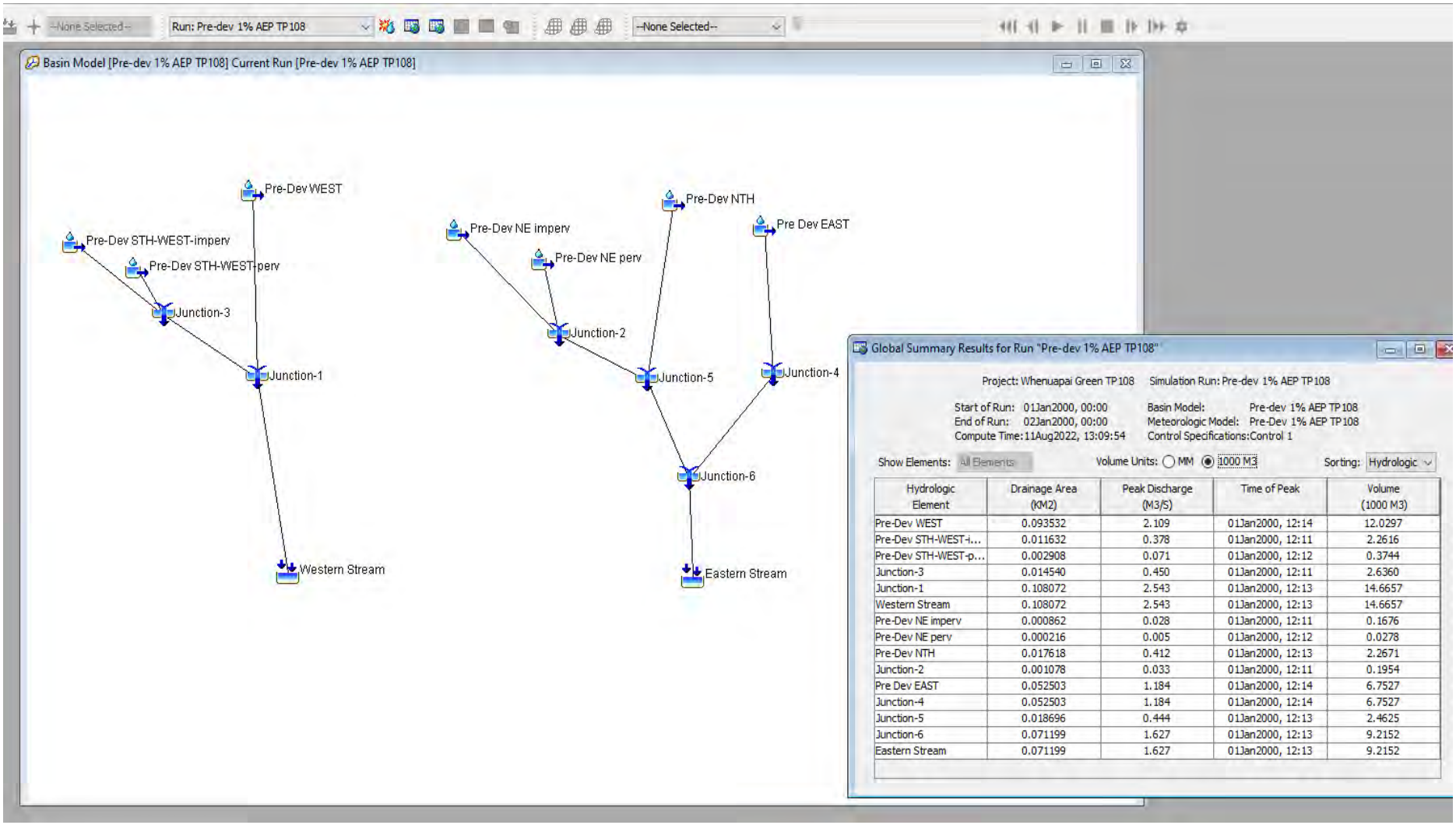
Updated 02/12/22 Rev N



Pre-Development 10% AEP TP108

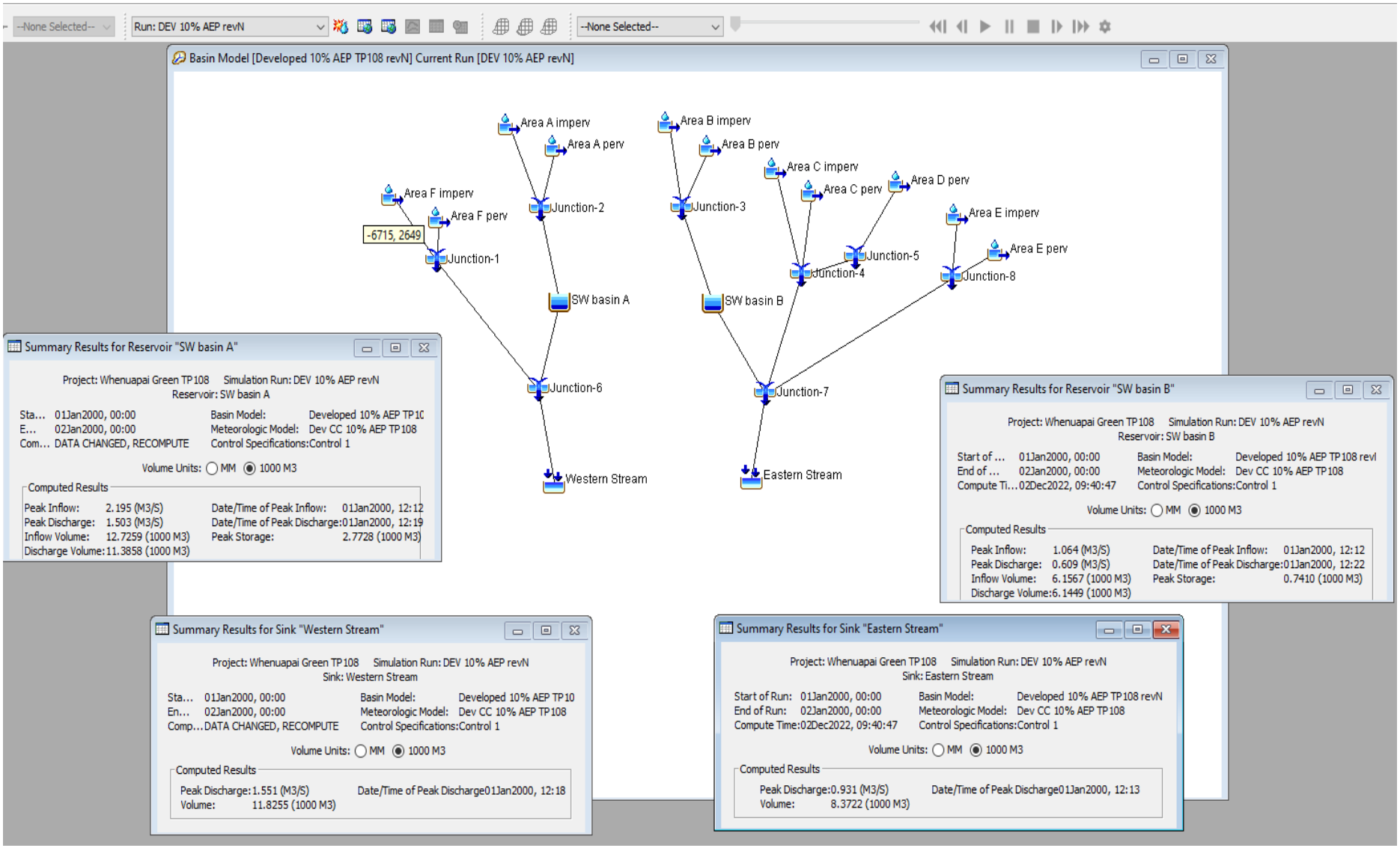


Pre-Development 1% AEP TP108

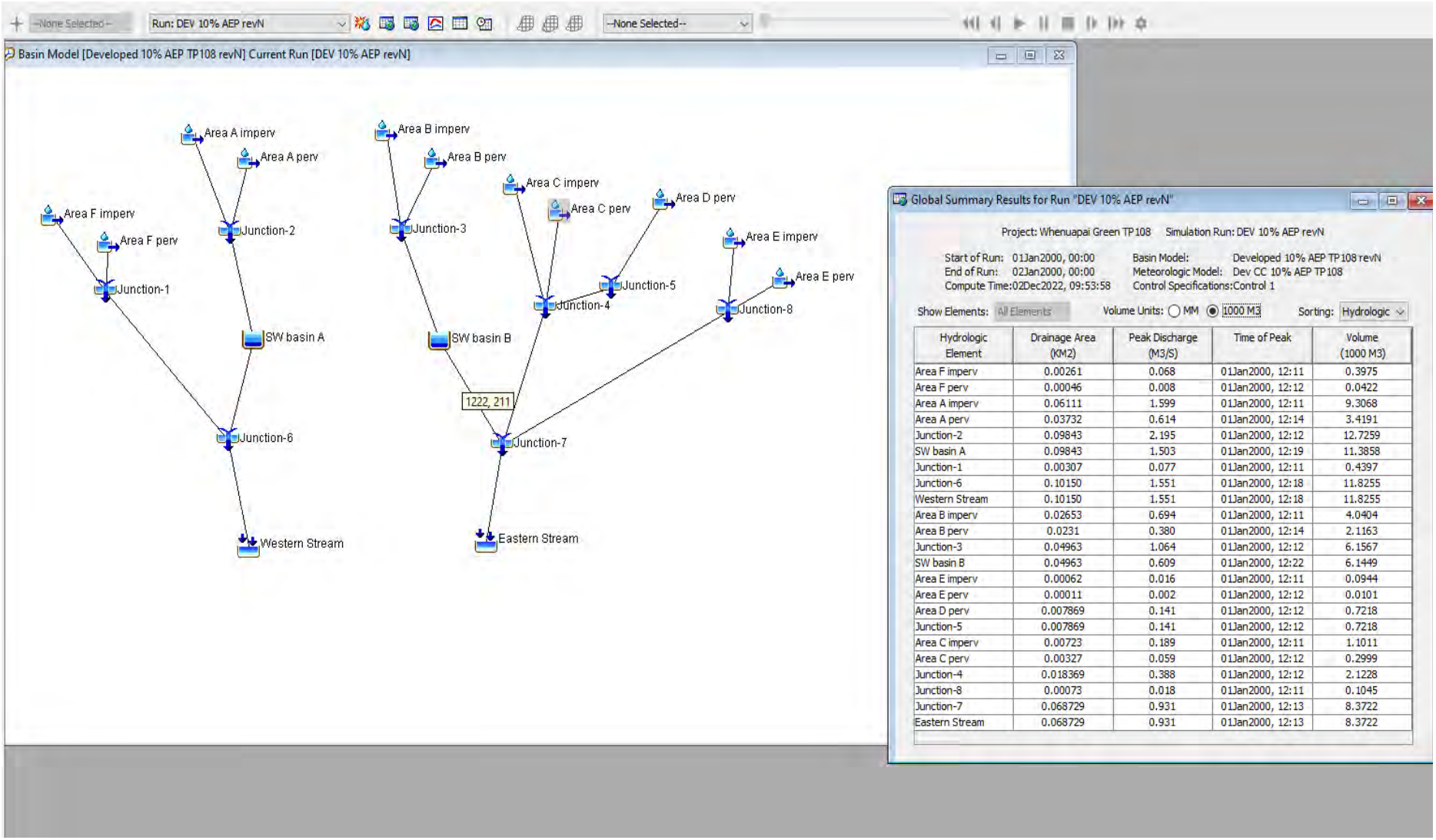


Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Pre-Dev WEST	0.093532	2.109	01Jan2000, 12:14	12.0297
Pre-Dev STH-WEST-i...	0.011632	0.378	01Jan2000, 12:11	2.2616
Pre-Dev STH-WEST-p...	0.002908	0.071	01Jan2000, 12:12	0.3744
Junction-3	0.014540	0.450	01Jan2000, 12:11	2.6360
Junction-1	0.108072	2.543	01Jan2000, 12:13	14.6657
Western Stream	0.108072	2.543	01Jan2000, 12:13	14.6657
Pre-Dev NE imperv	0.000862	0.028	01Jan2000, 12:11	0.1676
Pre-Dev NE perv	0.000216	0.005	01Jan2000, 12:12	0.0278
Pre-Dev NTH	0.017618	0.412	01Jan2000, 12:13	2.2671
Junction-2	0.001078	0.033	01Jan2000, 12:11	0.1954
Pre Dev EAST	0.052503	1.184	01Jan2000, 12:14	6.7527
Junction-4	0.052503	1.184	01Jan2000, 12:14	6.7527
Junction-5	0.018696	0.444	01Jan2000, 12:13	2.4625
Junction-6	0.071199	1.627	01Jan2000, 12:13	9.2152
Eastern Stream	0.071199	1.627	01Jan2000, 12:13	9.2152

Pre-Development 1% AEP TP108



Post-Development 10% AEP TP108



Global Summary Results for Run "DEV 10% AEP revN"

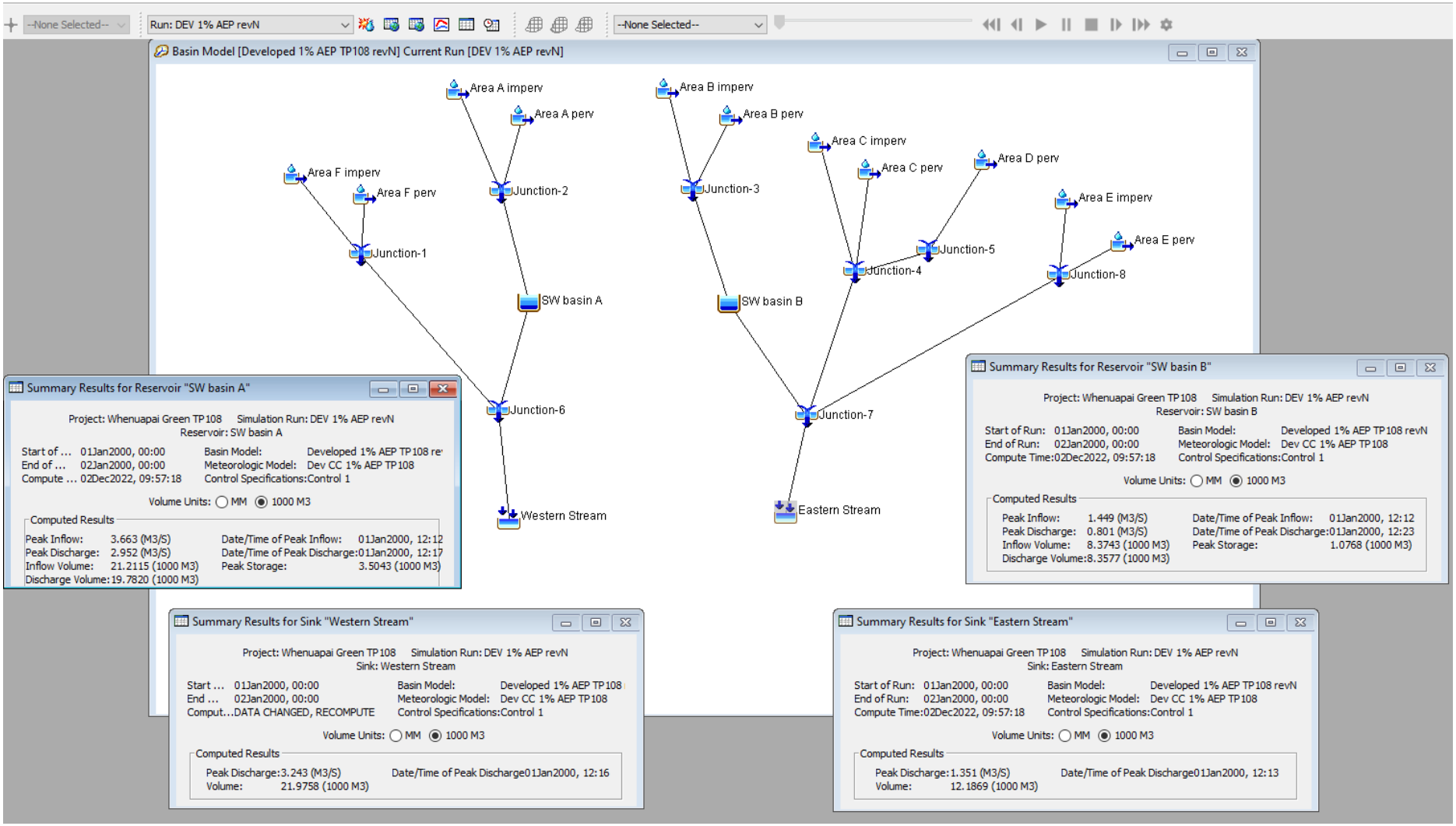
Project: Whenuapai Green TP108 Simulation Run: DEV 10% AEP revN

Start of Run: 01Jan2000, 00:00 Basin Model: Developed 10% AEP TP108 revN
End of Run: 02Jan2000, 00:00 Meteorologic Model: Dev CC 10% AEP TP108
Compute Time: 02Dec2022, 09:53:58 Control Specifications: Control 1

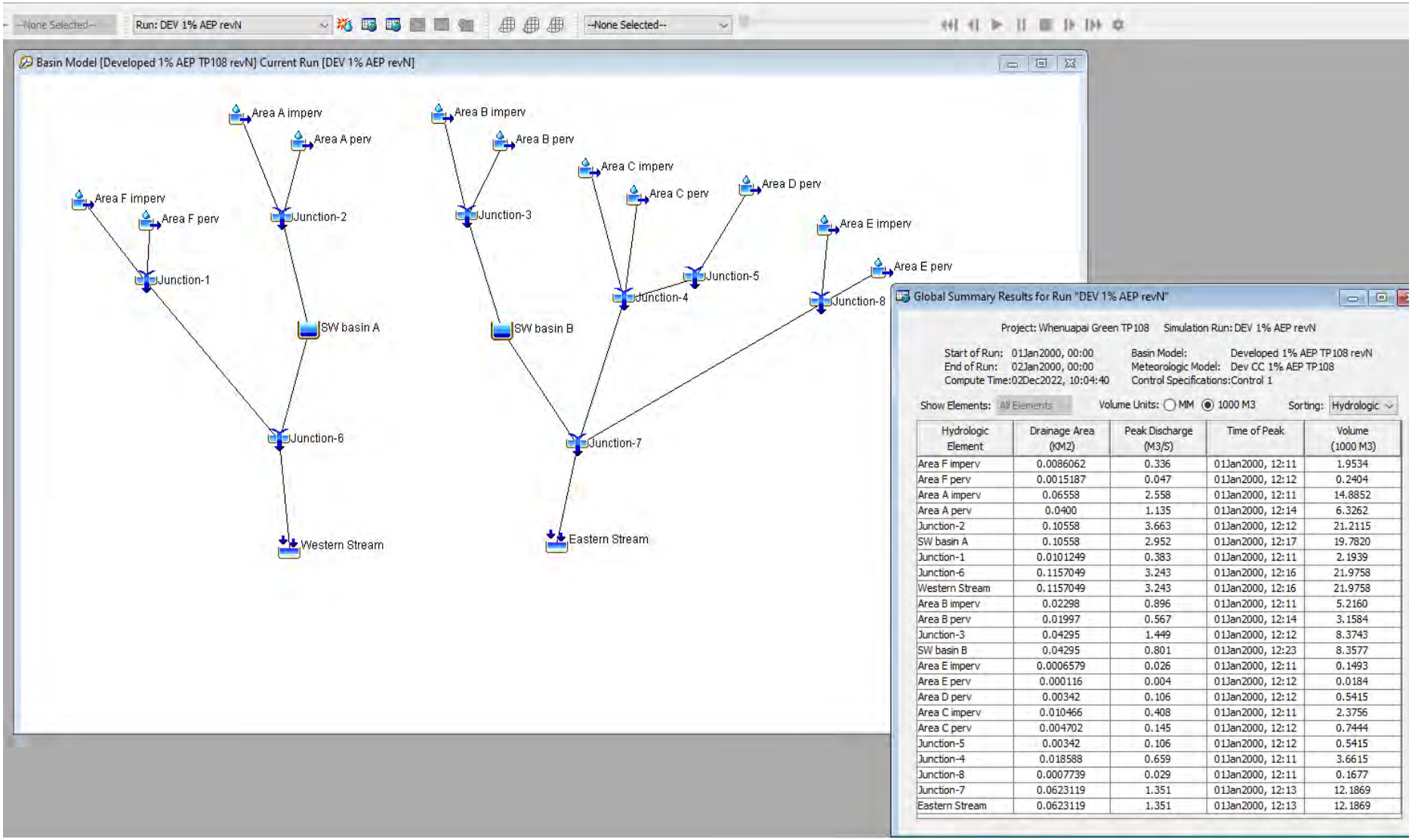
Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Hydrologic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Area F imperv	0.00261	0.068	01Jan2000, 12:11	0.3975
Area F perv	0.00046	0.008	01Jan2000, 12:12	0.0422
Area A imperv	0.06111	1.599	01Jan2000, 12:11	9.3068
Area A perv	0.03732	0.614	01Jan2000, 12:14	3.4191
Junction-2	0.09843	2.195	01Jan2000, 12:12	12.7259
SW basin A	0.09843	1.503	01Jan2000, 12:19	11.3858
Junction-1	0.00307	0.077	01Jan2000, 12:11	0.4397
Junction-6	0.10150	1.551	01Jan2000, 12:18	11.8255
Western Stream	0.10150	1.551	01Jan2000, 12:18	11.8255
Area B imperv	0.02653	0.694	01Jan2000, 12:11	4.0404
Area B perv	0.0231	0.380	01Jan2000, 12:14	2.1163
Junction-3	0.04963	1.064	01Jan2000, 12:12	6.1567
SW basin B	0.04963	0.609	01Jan2000, 12:22	6.1449
Area E imperv	0.00062	0.016	01Jan2000, 12:11	0.0944
Area E perv	0.00011	0.002	01Jan2000, 12:12	0.0101
Area D perv	0.007869	0.141	01Jan2000, 12:12	0.7218
Junction-5	0.007869	0.141	01Jan2000, 12:12	0.7218
Area C imperv	0.00723	0.189	01Jan2000, 12:11	1.1011
Area C perv	0.00327	0.059	01Jan2000, 12:12	0.2999
Junction-4	0.018369	0.388	01Jan2000, 12:12	2.1228
Junction-8	0.00073	0.018	01Jan2000, 12:11	0.1045
Junction-7	0.068729	0.931	01Jan2000, 12:13	8.3722
Eastern Stream	0.068729	0.931	01Jan2000, 12:13	8.3722

Post-Development 10% AEP TP108



Post-Development 1% AEP TP108



Global Summary Results for Run "DEV 1% AEP revN"

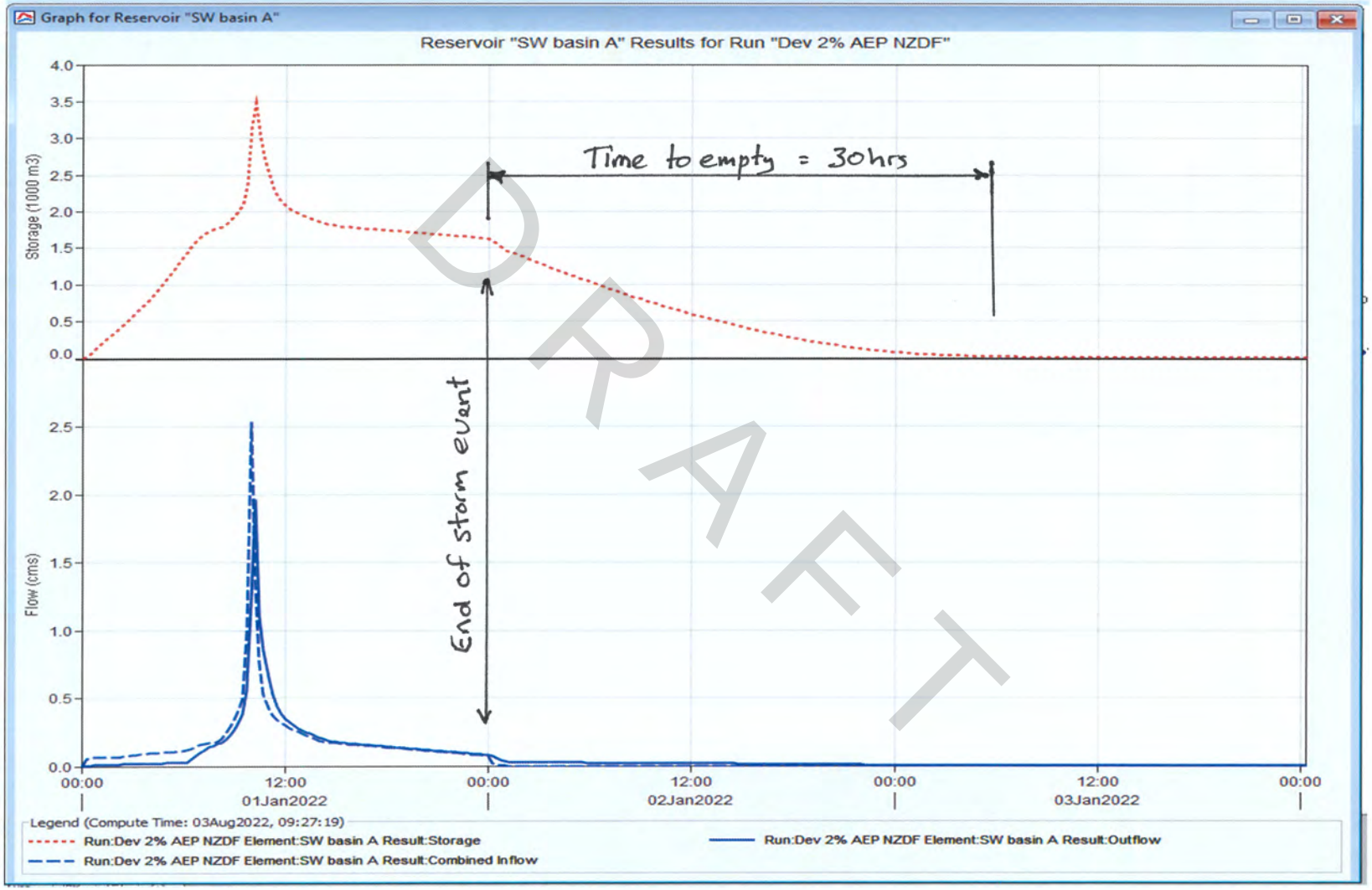
Project: Whenuapai Green TP108 Simulation Run: DEV 1% AEP revN

Start of Run: 01Jan2000, 00:00 Basin Model: Developed 1% AEP TP108 revN
End of Run: 02Jan2000, 00:00 Meteorologic Model: Dev CC 1% AEP TP108
Compute Time: 02Dec2022, 10:04:40 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Hydrologic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Area F imperv	0.0086062	0.336	01Jan2000, 12:11	1.9534
Area F perv	0.0015187	0.047	01Jan2000, 12:12	0.2404
Area A imperv	0.06558	2.558	01Jan2000, 12:11	14.8852
Area A perv	0.0400	1.135	01Jan2000, 12:14	6.3262
Junction-2	0.10558	3.663	01Jan2000, 12:12	21.2115
SW basin A	0.10558	2.952	01Jan2000, 12:17	19.7820
Junction-1	0.0101249	0.383	01Jan2000, 12:11	2.1939
Junction-6	0.1157049	3.243	01Jan2000, 12:16	21.9758
Western Stream	0.1157049	3.243	01Jan2000, 12:16	21.9758
Area B imperv	0.02298	0.896	01Jan2000, 12:11	5.2160
Area B perv	0.01997	0.567	01Jan2000, 12:14	3.1584
Junction-3	0.04295	1.449	01Jan2000, 12:12	8.3743
SW basin B	0.04295	0.801	01Jan2000, 12:23	8.3577
Area E imperv	0.0006579	0.026	01Jan2000, 12:11	0.1493
Area E perv	0.000116	0.004	01Jan2000, 12:12	0.0184
Area D perv	0.00342	0.106	01Jan2000, 12:12	0.5415
Area C imperv	0.010466	0.408	01Jan2000, 12:11	2.3756
Area C perv	0.004702	0.145	01Jan2000, 12:12	0.7444
Junction-5	0.00342	0.106	01Jan2000, 12:12	0.5415
Junction-4	0.018588	0.659	01Jan2000, 12:11	3.6615
Junction-8	0.0007739	0.029	01Jan2000, 12:11	0.1677
Junction-7	0.0623119	1.351	01Jan2000, 12:13	12.1869
Eastern Stream	0.0623119	1.351	01Jan2000, 12:13	12.1869

Post-Development 1% AEP TP108



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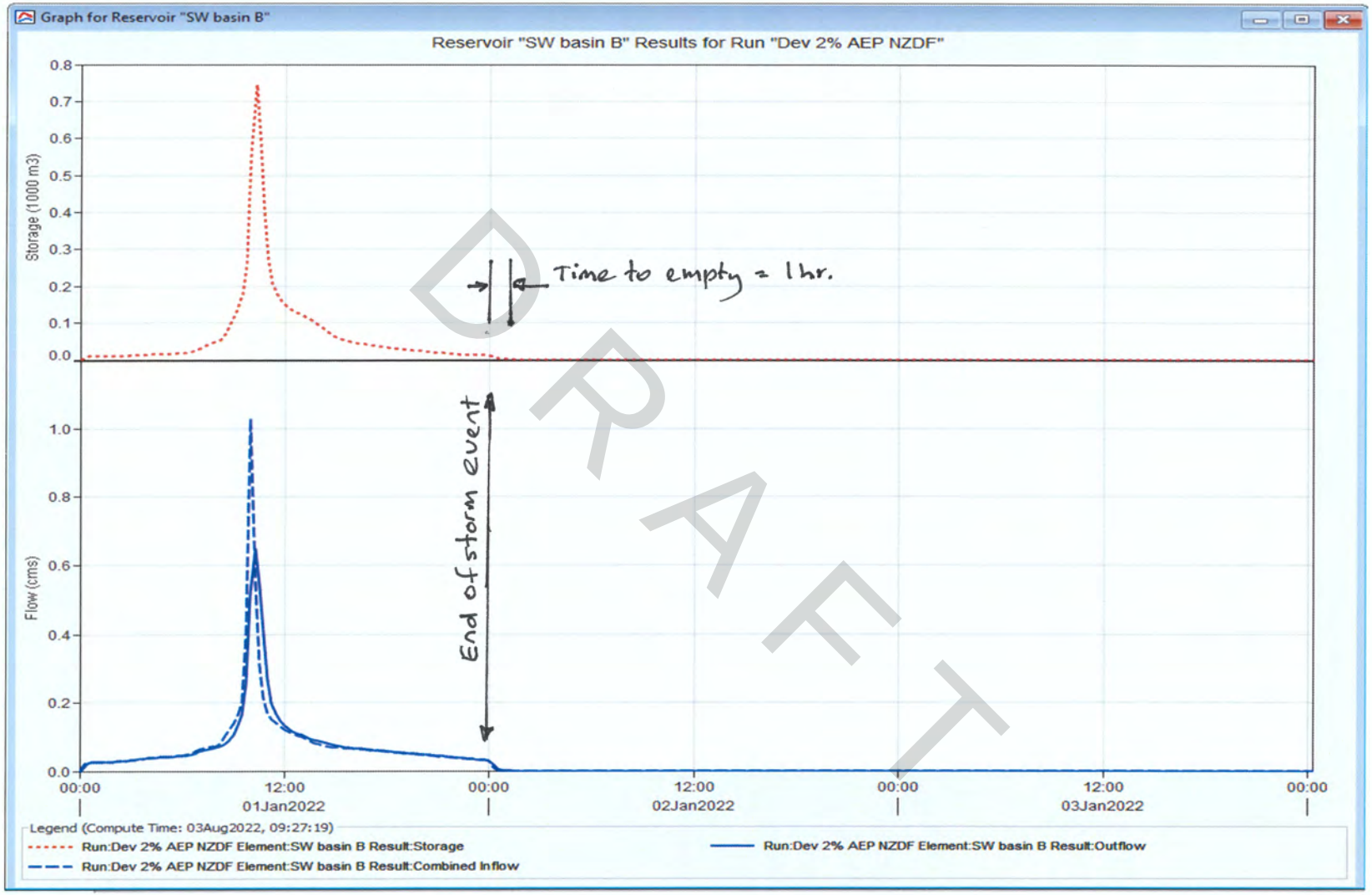
SW BASIN 'A'

2% AEP 24hr Rainfall event



DRAFT

SW BASIN 'B'

2% AEP 24hr Rainfall event

AECOM Consulting Services (NZ) Ltd +64 9 967 9200 tel
8 Mahuhu Crescent +64 9 967 9201 fax
Auckland 1010
PO Box 4241 Shortland St
Auckland 1140
New Zealand
www.aecom.com

Memorandum

To	Cheilo Manalo	Page	1
CC	Kevin Fan; Jahangir Islam		
Subject	Whenuapai Rapid Flood Hazard Assessment		
From	Christian Aranibar		
File/Ref No.		Date	03 June 2016

1.0 Scope

The objective is to carry out rapid flood hazard assessment (RFHA) modelling of the Whenuapai Stormwater Catchment based on 2013 LiDAR data and prepare the 100yr ARI floodplain extent to inform the Whenuapai Stormwater Management and Structure Planning Process.

2.0 Methodology

A hydraulic model was built in Infoworks ICM v 6.0.4. The following steps were taken:

2.1.1 2D Surface and Mesh zones:

- A flexible mesh that was created for the entire site using 2013 LiDAR.
- 2D Zone: Maximum triangle area of 100m^2 and minimum element area of 50m_2.
- Mesh zones were defined along major overland flow paths and where the model initially predicted flooding. Maximum triangle area of 6m^2 and minimum element area of 2 m^2.
- No inland banks used next to culverts but large element sizes are used at inlet and outlet locations.
- A Manning's roughness n value of 0.1 for the entire catchment. The resistance due to buildings was included and modelled as roughness zones with a Manning's n value of 0.5.
- A downstream water level boundary of 1.9m RL was used.
- No kerb lines were used when generating the mesh.

2.1.2 Culverts

- All culverts under SH1 are included in the model. They were imported from the existing Totara and Wairohia models.
- Culvert upstream / downstream energy losses are appropriately included in the model by using culvert inlet and outlets.
- Scruffy domes were modelled by using weirs.

2.1.3 Hydrology

- Rain on grid method was used, with 100% of net effective rainfall to runoff.
- A 24-hour 100-year ARI rainfall depth of 209mm (net effective rainfall) was used for the simulation. This was based on the TP108 rainfall-runoff model generated runoff depths using the 24-hour 100-year ARI future design rainfall with climate change (227.8mm) and 80% impervious land development scenario.

2.1.4 Initial conditions

- Depressions were filled in with water with the initial run for 6 hours from 9am to 3pm. A hyetograph equivalent to twice of the 100-year ARI synthetic rainfall was used for initial run to fill in all depressions.
- The end of the initialisation run was used as the initial condition for the 1 in 100yr 24-hour simulation.

3.0 Results

- The flood extent was exported to GIS and mapped in accordance with Auckland Council Stormwater Flood Modelling Specifications (Nov 2011).

Appendix C2 – Stormwater management selection process and assessment

The stormwater management selection process occurred concurrently with the design process. Options were considered and where possible the best practical option (BPO) was selected. In some cases, the BPO could not be implemented as there were conflicts with other requirements eg NZDF, AT.

Appendix C3 – Operation and Maintenance Plan - DRAFT

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WHENUAPAI GREEN SUBDIVISION

98-102 Totara Road
Whenuapai

Stormwater Operation & Maintenance Plan

- Stormwater Basin ‘A’
- Stormwater Basin ‘B’
- Raingardens
- Planting

Neil Construction Limited

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14 Dec 2022

The Neil Group Limited
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Whenuapai Green

Stormwater Operation & Maintenance Plan

Attachments

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1. SITE LOCATION

Whenuapai Green Subdivision
98-102 Totara Road, Whenuapai, Auckland

New Zealand Transverse Mercator (NZTM). Basin A 1744140mE 5927640 mN
Basin B 1744350mE 5927890 mN

Legal Description:

The Whenuapai Green subdivision is a comprehensive subdivision of 98-100 & 102 Totara Road, Whenuapai, being Lot 2 DP81411 and Lot 1 DP53062.
Two stormwater basins are proposed as part of the stormwater management and the new lots for the stormwater basins will become Local Purpose Reserves (Drainage) to vest in Auckland Council as Lot 601 and 605 DP XXXXX.
At the completion of works, access to the stormwater basins will be available from adjacent roads. Since the project is to be staged, easements will initially be provided to provide maintenance access and conveyance of runoff to the stormwater basins. At the completion of Stage 1, legal access to SW Basin A will be provided from Road 2 and to SW Basin B from Road 1.

Location Plan

2. OVERVIEW

2.1 Assessment

The proposed Whenuapai Green development is located on existing properties at 98-100 and 102 Totara Road, Whenuapai and occupies a total area of 16.36 hectares. The site is currently predominantly in pasture and has been used for cattle farming. McCaw Avenue is on the southern boundary of the site, Totara Road to the west and northwest and the NZDF Whenuapai Air Force Base is to the east. There are recent new housing developments to the south of the site.

The site is currently zoned "future urban". The proposed development will provide a total of 349 residential houses as part of a comprehensive consent for development of terrace units, duplex units, and standalone houses. An area of 2.79 ha (lot 800) will be developed into a proposed school which will service the surrounding area.
An application to the Ministry for the Environment has been accepted for the proposed development to be considered under the Covid-19 Recovery (Fast-track Consenting Act 2020. The following consents have been applied for to Auckland Council to allow the development, including the stormwater basins:

BUNXXXXXXX: LUCXXXXX, SUBXXXXXX
Engineering Approval: ENGXXXXXX

A site-specific stormwater management plan has been prepared for the site. This refers to the Whenuapai 2 SMP but has been updated to meet the current requirements of the AUP-OIP and Schedules 2 and 4 of the Regionwide Network Discharge Consent.

The stormwater management principles and objectives of this development will meet the SMAF 1 requirements of the AUP-OIP as follows:

- Retention / reuse of the first 5mm of runoff from new impervious areas.
- Detention of runoff from the 95th percentile rainfall event with controlled release over 24 hours to prevent stream erosion.
- Water quality treatment of runoff from high contaminate generating activities, namely high use roads and carparks.
- A piped stormwater network with capacity to convey up to the 10% AEP rainfall event.
- Attenuation of stormwater flood flows for 10% AEP and 1% AEP rainfall events to minimise flooding of downstream properties.

The Stormwater Basins are required as part of the stormwater management requirements (attenuation / detention /retention / quality treatment) of stormwater flows from the proposed subdivision.

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This Stormwater Operation and Maintenance Plan provides a methodology for the on-going operation and maintenance of the stormwater basins and other features of the stormwater management plan.

2.2 Catchments

The existing and proposed stormwater catchments for the site flow to the Ratara Stream to the west of Totara Road and to the Rarawaru Creek to the east.
The two streams discharge into the upper reaches of the Waitemata Harbour.

The contributing catchment from the completed development that discharges via SW Basin A to the Ratara Stream for the 10% AEP runoff will comprise medium density residential housing plus roading and reserves. Catchment areas are as follows:

10% AEP	Total catchment 9.84 Ha	Impervious 6.11 Ha (62%)
1% AEP	Total catchment 10.56Ha	Impervious 6.56 Ha (62%)

The contributing catchment from the completed development that discharges via SW Basin B to the Rarawaru Creek will comprise medium density residential housing plus roading and reserves. Catchment areas are as follows:

10% AEP	Total catchment 4.96Ha	Impervious 2.65 Ha (53%)
1% AEP	Total catchment 4.29Ha	Impervious 2.30 Ha (54%)

Due to the topography of the site part of the total catchment (area 'C') having an area of 1.93 ha (1.11 ha impervious) cannot be easily directed to either stormwater basin, so will discharge directly to a tributary of the Rarawaru Creek.
Lots and COALs in this area will have private on-site detention tanks, while the public road will have a public detention tank which will be vested in Auckland Council.

See Appendix A for drawings showing the developed catchments for the 10% and 1% AEP rainfall events and the proposed stormwater network.

3 STORMWATER DEVICE DETAILS

3.1 Rain Gardens

Totara Road is the only high use road connected with the proposed subdivision which will require the treatment of stormwater runoff. It is being upgraded on the development side and includes a new footpath and cycle lane. Rain gardens are proposed to be constructed in the road berm to provide detention and treatment of the runoff from the impervious areas.

The rain gardens have been designed to the requirements of Auckland Council Guidance document GD-01 Stormwater Management Devices, C3 Bioretention.

Details of the design and construction of the raingarden are provided on drawings SW-461 and 462, copies of which are included in Appendix A.

Each rain garden cell is made up of six (6) zones, listed from upper to lower levels:

- Planted vegetation – Ficini Nodosa (4/m2), Apodasmia Similis (4/m2) and Cyperus Ustulatis (4/m2).
- Ponding area – for these rain gardens a 200mm ponding depth is specified above the soil media layer.
- Soil media – for these rain gardens 400mm depth of bio-retention media used. The soil media used proposed is "Living Earth Rain Garden Mix".
- Sand layer – for these rain gardens there is 100mm transition layer of sand below the soil media.
- Drainage layer – 200mm with perforated subsoil pipe connected to adjacent catchpit.
- Storage layer - for these rain gardens 450mm depth of granular storage is provided below the subsoil drainage for stormwater retention. The granular material is 40/20 drainage metal which has a voids ratio of 0.4.

3.2 Riparian Planting

There are two existing streams on the eastern side of the site there are existing streams which are tributaries of the Rarawaru Creek. Riparian margins will be provided and planted.

The planting has been specified by Greenwood Associates and is shown on their drawings.

3.2 Stormwater Basins A & B

3.2.1 Introduction

The type of stormwater basin is a "Dry Basin" (also referred to as detention basin or winter-wet pond) which temporarily stores stormwater runoff to control the peak rate of discharges without having a permanent standing pool of water. Dry basins may empty between rainfall events, depending on the time interval between the events.

While no stormwater treatment is required in the SW basin pond for this development, treatment occurs in SW Basin A as the detention volume is retained in the planted base of the basin as it is released over 24 hours. This gives an average "residence time" of approximately 12 hours for the 90th percentile water quality rainfall event.
The only high use road associated with the development is Totara Road. Rain gardens have been provided to treat SW runoff from the road reserve.

3.2.2 Stormwater Attenuation

Attenuation for the 10% AEP and 1% AEP year storm events has also been provided within the stormwater basins to restrict flow increases in the receiving streams. Allowance has been made to compensate for those areas where runoff flows are unable to be directed to the SW basin.

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Stormwater Calculations have been completed in accordance with Auckland Councils Publications: GD01 'Stormwater management Devices in the Auckland Region'. The computer modelling program HEC-HMS was used to model the runoff and storage / discharge within the SW basin. Details of the calculations are included in the Stormwater Management Plan.

3.2.3 Detention for Channelised Erosion

Detention is provided to limit stream channel erosion from high frequency storm events. As bank full flows increase in frequency with development, the channel erodes to become stable for the increased flow and velocity, this often results in a wider 'U' shaped channel, during which habitat is lost.

To limit this, the runoff from the 95th percentile rainfall event is detained and released over a 24-hour period.
In SW Basin B detention is not required as the outflow is piped to discharge into the upper tidal reach of the Rarawaru Stream.

3.2.4 Flooding Issues

As part of the Stormwater Management Plan, consideration was given to the potential for downstream flooding due to the increased impervious area resulting from the development. Attenuation within SW basin B was provided so that the net runoff from the 10% AEP rainfall event for post-development flows did not exceed those from pre-development flows. Partial attenuation within SW basin A was provided so that the net runoff from the 10% AEP rainfall event for post-development flows such that downstream flooding was not an issue.

For SW basin B it was also possible to provide sufficient attenuation so that the 1% AEP runoff did not exceed pre-development flows. Hence there will be no increase in peak flood flows within the downstream Rarawaru Creek.

For SW basin A it was not possible for all overland flow to be taken to the SW basin due to the topography. This involved an area of 1.01 Ha (Area F dwg SW-431) which included Totara Road. Downstream flooding in the Ratara Stream and tributaries was investigated and found to comply with the AC SW CoP and AUP, providing a freeboard of at least 500mm to existing habitable dwellings.

3.2.5 Planting of the SW Basins and Riparian Margins

The base and embankments of the stormwater basins will be planted to provide erosion protection and to contribute to stormwater treatment.

There are also two existing streams on the eastern side of the site which are tributaries of the Rarawaru Creek. Riparian margins will be provided and planted.

The planting has been designed by Greenwood Associates and details are shown on drawings 1395/1-12.

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3.2.6 Summary – Stormwater Basin A

			Notes:
Pond type	Dry pond		NZDF Whenuapai air base restriction on ponded water.
Pond purpose	Detention of 95th percentile rainfall event with 24-hour release. Attenuation of 10% AEP rainfall event to prevent downstream flooding. Attenuation of 1% AEP rainfall event to prevent downstream flooding.		Excludes 5.0mm retention (re-use) provided within dwellings. Excludes detention and retention for school site.
1% AEP Catchment area Maximum pond volume Peak discharge:	10.56 Ha 3504m3 (RL15.61)	62% impervious 2.952 m3/s	
10% AEP Catchment area Pond volume; Peak discharge:	9.843 Ha 2773m3 (RL15.46)	62% impervious 1.503 m3/s	
Detention volume; Max. discharge:	1143m3 (RL14.64)	26.5 l/s	
Emergency spillway:	RL15.75, 13m wide		
Top of embankment:	RL16.25		
Freeboard:	0.3m		
2% AEP (50yr) drain down time:	30 hours from end of rainfall event		NZDF requires less than 48 hours.
Control structure details:	2 x 1500mm diameter MHs 120mm diam orifice for detention control (RL13.90) – one MH only. 500mm slot weir for 10% attenuation (RL14.70) – both MHs. Top of MH weir for 1% attenuation (RL15.50) – both MHs.		Outlet pipes 2 x 750diam. Top of MHs also act as primary spillway.
Internal bank slope:	Max 1 in 4 (V:H)		
External bank slope:	Max 1 in 4		

Note: To be updated when design approved.

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3.2.7 Summary – Stormwater Basin B

			Notes:
Pond type	Dry pond		NZDF Whenuapai air base restriction on ponded water.
Pond purpose	95th percentile rainfall event released to coastal discharge. Attenuation of 10% AEP rainfall event to pre-development flows. Attenuation of 1% AEP rainfall event to pre-development flows.		Excludes 5.0mm retention (re-use) provided within dwellings. Excludes detention and retention for school site.
1% AEP Catchment area Maximum pond volume; Peak discharge:	 4.296 Ha 1077 m3 (RL 15.21)	 54% impervious 0.801 m3/s	
10% AEP Catchment area Pond volume; Peak discharge:	 4.965 Ha 741m3 (RL 15.0)	 53% impervious 0.609 m3/s	
Detention volume:	Not applicable.		Discharges to tidal area.
Emergency spillway:	RL 15.40, 10 m wide		
Top of embankment:	RL 15.80		
Freeboard:	0.3m		
2% AEP (50yr) drain down time:	1 hour from end of rainfall event		NZDF requirement is less than 48 hours.
Control structure details:	1500 mm diameter MH 250 mm diam low flow outlet (RL13.70) 300 mm slot weir for 10% attenuation (RL14.10) 1500 mm slot weir for 1% attenuation (RL15.20) Top of MH (RL 15.30)		600mm diam outlet pipe. Top of MH also acts as primary spillway.
Internal bank slope:	Max 1 in 4 (V:H)		
External bank slope:	Max 1 in 4		

Note: To be updated when design approved.

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4 DEVICE MAINTENANCE

4.1 Rain Gardens

Rain gardens require regular maintenance to ensure they continue to perform as stormwater management devices and as attractive landscape features. The following is based on TP10 and TR2010/53 maintenance guidelines.

Debris Cleanout:

Following storms and at regular intervals, an inspection of the rain garden and surrounding area should be undertaken with general rubbish and debris removed and disposed.

Interval – After storm events or monthly.

Vegetation:

The health of plants within the rain garden is vital for removal of contaminants. Plant health should be inspected annually and if any plants are suffering or dead they should be replaced.

Planted vegetation will require thinning and pruning to ensure satisfactory shape, size and structure. This should be undertaken by experienced personal.

Unwanted plants (weeds) can invade the rain garden and should be removed. Non-chemical methods of weed removal (hand pulling) should be used.

Interval – 6 monthly, preferably spring and autumn.

Sedimentation:

During establishment of dwellings in the development, sediment laden runoff needs to be controlled so as not to overload the raingardens. Appropriate sediment and erosion controls need to be in place on allotments with additional sediment and erosion protection in place around the rain gardens, (i.e filter socks and cess pit covers).
Sediment control from building sites is governed by Council Building Consent controls.

Any sedimentation on the top of the drainage media, or in the adjacent cess pit, should be removed to an approved landfill in accordance with current Council Policies, and the drainage media topped up as required.

Interval – Every 3 Months.

Structural and function:

A visual structural and function inspection should be undertaken by experienced stormwater / rain garden maintenance personal, looking for:

- standing water more than a few days after a rain event,
- evidence of surface clogging,
- evidence of water bypassing / piping though the rain garden, in particular around the internal surrounds,

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- evidence of media draining – visual check of water exiting the Novacoil drainage in the adjacent pit or manhole after a rain event,
- ensure soil media is filled up to the design level,
- ensure the soil media is horizontally level across the whole rain garden cell,
- ensure no concrete kerb or inlet damage,
- ensure no adjacent cess pit damage.

If the above are encountered, remedial works should be undertaken by experienced personal or expert advice sought.

Interval – Every 6 Months.

Refer Appendix A-1 for inspection forms.

4.2 Stormwater Basins

The stormwater basins form an integral part of the stormwater detention and attenuation before discharge into the adjacent streams. As such inspections and maintenance will be in accordance with this approved Stormwater Operation and Management Plan and will include but will not be limited to the following Corrective Maintenance.

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of the pond. Corrective maintenance is done on an as required basis, not only on a scheduled basis. Failure to promptly address a corrective maintenance problem may jeopardize the performance and integrity of the pond. It may also present a potential safety problem to those living by or below it. Corrective maintenance activities include:

Removal of Debris and Sediment

Sediment, debris and trash which threaten the ability of the pond to store or convey water should be removed immediately and be properly disposed of in order to restore proper pond function. A blocked inlet or outlet means that stormwater will travel in an area that was not normally designed as a flow path. In the case of an inlet, the stormwater could travel over a kerb onto a grassed area and scour it. If the outlet is blocked, water will back up in the pond and may travel over the emergency spillway. These areas are not designed for frequent flow and may become eroded. If sediments are clogging a pond component, the lack of an available disposal site should not delay removal of the sediments. Temporary arrangements should be made for handling the sediments until a more permanent arrangement is made.

Note: It should be expected that a vacuum loading tanker or truck may be required for the removal of sediment as there is limited suitable space available for the drying of sediment prior to removal from site.

Structural Repairs

Repairs to any structural component of the pond such as the outlet manhole, should be made promptly. Equipment, materials, and personnel must be readily available to perform repairs on short notice. The immediate nature of the repairs depends on the type of damage and its effects on the safety and operation of the pond. Where structural damage has occurred, the design and conduct of repairs should be undertaken only by qualified personnel.

Embankment and Slope Repairs

Damage to embankments and slopes must be repaired quickly. Typical problems include settlement, scouring, cracking, sloughing, seepage and filling. A common concern in embankments with outflow pipes through them is seepage around the outside of the pipe barrel. This can also cause movement of embankment soils, which can weaken the embankment. Repairs need to be made promptly. Other temporary activities may be needed, such as drawing down the water level in the pond in order to relieve pressure on an embankment or to facilitate repairs. Crack repair in a concrete structure may necessitate draining the pond and cleaning before repair. If the pond is to be dewatered, pumps will be necessary if there is no drain valve.

Specific details to look for when inspecting embankments and spillways include:

- Unusually damp or soft areas on the downstream face of the dam or ground to either side.
- Signs of where water is or has been exiting on the sides of the embankments or downstream of the dam face, including at times of low flow in the main outlet.
- Any cracking, slumping or movement of fill areas.
- Erosion of the dam fill on the upstream face, particularly at the water line.
- Any blockage, erosion or bank slumping in the emergency flood spillway.

All changes or damage noted should be photographed and recorded. Significant damage should be referred to an experienced engineer and repaired immediately if significant. Minor damage should be noted for follow up inspections.

Erosion Repair

Vegetative cover is necessary to prevent soil loss and maintain the structural integrity of the pond. Where a reseeding program has been ineffective, or where other factors have created erosive conditions (such as pedestrian traffic, concentrated flow or the like), corrective steps should be taken to prevent further loss of soil and any subsequent danger to the performance of the pond. Corrective action can include erosion control blankets, riprap, sodding or reduced flow through the area.

Outlet Control Manhole

Inspection should include the manhole structure, orifice control, weirs, and all debris screens. Also check functionality and security of scruffy dome and personnel access hatches.
Check ground around manhole and outlet pipe for signs of erosion or settlement.
Any repairs or maintenance should be carried out promptly.

Pipe Outfalls

Outfalls to the stormwater inlet pipes and the pond outlet pipe are to be checked for structural defects and stability of the headwalls. Check for erosion or scouring around the headwall, within the outlet channel and around concrete aprons or any rock rip rap. Check round the outfall pipe for signs of seepage. Check the gabion mattresses for integrity and security of the mesh and rocks. Any repairs or maintenance should be carried out promptly. For pipe outfalls direct to a stream, also check that there has been no undermining by stream flows. Check all aspects for signs of unusual movement.

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Spillway

The emergency spillway shall be checked for signs of instability or erosion. The vegetative cover should also be checked to ensure that there is no exposed ground which could erode. Check top of spillway for signs of settlement. Check condition of rock riprap at the base of the spillway to ensure it is still stable and, if applicable, has not been undermined by stream flows.
Undertake remedials works as required, promptly.
As well as yearly inspections, the spillway shall be thoroughly checked after significant rainfall events to see water if has been flowing over the spillway which could result from either flow above the design level or due to blockage of the service outlet.

Planting

All grassed and planted areas should be regularly checked for the health of the plants and any weeds removed. Embankments need to be checked for signs of slumping or erosion. Remedial actions to be taken as required.

Coir Matting

During the 2-year maintenance period, the plastic reinforcing mesh in the coir matting shall be progressively removed as it degrades, and the planting becomes established. All the mesh shall be removed prior to final inspection at the end of the maintenance period.

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4.1.3 Inspection Check List - Summary

FREQUENCY	OPERATION
Monthly and after significant storm events.	Brief visual inspection of SW Ponds. Note any possible issues for follow up inspections or remedial works. Remove debris particularly from screens to pipe inlets and outlets.
Six Monthly	Structure inspection and repair (including inlet and outlet structures and debris or safety screens). Weed removal.
Yearly	Detailed inspection. SW Ponds:- Erosion Sediment build-up Grassed and planted areas. Outlet control manhole, inlets and outfalls. Access safety screens. Spillway.
5 Yearly	Clean out main ponds.

Refer to Appendix A-2 for Inspection Check List Forms.

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5. RESPONSIBILITY

On completion of the subdivision, Stormwater Basin A will occupy Lot 601 and SW Basin B Lot 605 DP XXXXX (when deposited), which will be vested in Auckland Council as Local Purpose Reserve (Drainage). The riparian planting will be located in Lots 600, 601, 602 and 603 and will similarly be vested as Drainage Reserve.

'Neil Construction Limited' will take responsibility for the maintenance of Stormwater Basins A & B, the rain gardens, and the riparian planting for two years from the issue date of the 224C certificate.
After two years and a final inspection by Council, the responsibility for maintenance will then transfer to Auckland Council.

Any discharge consents will also be transferred to Auckland Council after satisfactory completion of the maintenance period.

6. FUTURE UPDATES

This Stormwater Maintenance and Operation Plan is to be updated as required.
A final update should be completed once construction is complete using as-built information.

Prepared by:
Brian Jones BE CMEngNZ CPEng
Neil Construction Ltd.

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APPENDIX A-1

Inspection Forms – Rain Gardens

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APPENDIX A-1

Rain Garden Operation and Maintenance
(from TR2010/53 – Stormwater Treatment Devices Operation and maintenance)

Component	Maintenance Activity	Frequency				
		After storm events (min monthly)	3 monthly	6 monthly	12 monthly	2 or more years
Grass filter strip (if included)	Mow grass to a minimum height of 50 mm. Do not mow the grass shorter than this or the effectiveness of the filter strip will decrease. The frequency will vary depending on growth rates and seasons. Re-sow grass as necessary.					
	Remove rubbish, leaves and other debris.	✓	✓			
	Check grass strip for gouging and eroding flow channels. Repair as necessary.	✓		✓		
Ponding area	Check that level of media and mulch stays below the surrounding hard surface areas and overflow (between 200 mm and 300 mm lower). Remove excess mulch/media as required.			✓		
	Remove rubbish, leaves and other debris.	✓		✓		
	Test drainage of ponding area by checking the garden 24 hours after rain to ensure there is no water still ponding (after storm event). This can also be done by digging a hole 20 cm wide by 20 cm deep, and pouring 10 L of water into the hole. The water should go down at a minimum rate of approximately 2.5 cm per hour.	✓			✓	
	Clear inflow points of build up of sediment, rubbish and leaves. Check that there is no erosion or gouging.	✓		✓		
	Check the surface of the rain garden media mix for a crust of fine sediment which can inhibit drainage. Remove if present and rework top layer of rain garden media mix. Top up media and mulch as necessary (ensuring level is below surrounding hard surface and overflow).	✓	✓			

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Component	Maintenance Activity	Frequency				
		After storm events (min monthly)	3 monthly	6 monthly	12 monthly	2 or more years
Rain garden media mix	Media needs to be free draining – avoid compaction from planting and filling bed with too much media. Level must be below surrounding hard surface level and overflow grate. Use drainage test as described above. Rain garden media mix should be a mix of 50 – 60% sand, 20 – 30% topsoil (no clay) and 20 – 30% organic material.				✓	
Mulch layer (bark, pebbles, etc)	Remove rubbish, leaves and other debris. After storm events mulch may need to be redistributed or added around inflow points.	✓		✓		
	Check the surface of mulch for build up of sediment, remove and replace as required.				✓	
	Check mulch depth to ensure adequate cover, redistribute and replace as required.			✓		
	Mulch may need to be completely replaced periodically to prevent surface clogging.					✓
Plants	Remove weeds (particularly those identified in the Council's Regional Pest Management Strategy) – do not use herbicides or pesticides as these chemicals will pollute the stormwater.			✓		
	During extended dry periods the plants may require extra watering. This is particularly important while plants are getting established in the garden when weekly or bi-weekly watering may be required.			✓		
	Check plant health and replace dead plants as necessary. Use native species suitable for the conditions of your garden (e.g. full sun or shaded**). See TP10 for partial list of suitable species.**			✓		

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Component	**Maintenance Activity**	**Frequency**				
		After storm events (min monthly)	3 monthly	6 monthly	12 monthly	2 or more years
	Periodic pruning of vegetation may be required to ensure lines of sight for traffic are maintained.			✓		
Underdrain system	Check that garden is draining freely using the drainage test as described above.			✓		
	If underdrain is blocked the rain garden will need to be refurbished by removing plants and rain garden media mix. An inspection well (installed during construction) can be used to verify that the underdrain is working properly or CCTV can show any blockages or collapse. Low pressure backwash may be used to clear any blockages or clogging from fine sediments.					✓

NOTE: A storm event is any heavy rain event or prolonged rainfall period whereby flooding can occur or debris can be blown into the device (e.g. falling trees, or branches). Typically, a storm event is greater than a 2-year event.

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98-102 Totara Road, Whenuapai

Stormwater Operation and Maintenance Plan

APPENDIX A-2

Inspection Forms – SW Dry Basins A&B

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APPENDIX A-2

OPERATION AND MAINTENANCE INSPECTION REPORT FOR SW DRY BASIN

Pond Name:

Inspection Date:

Inspected By:

Item	Frequency					Checked		Remarks
	Monthly	Sept, Dec, Mar, June	Dec, June	July	Following Storm	Yes	No	
A. Clear Access								
1 For inspection & Maint.	Y				Y			
B. Litter/Debris/Pollution								
1 In Basin	Y				Y			
2 Outlet trash rack	Y				Y			
3 Outlet weir or pipe	Y				Y			
4 Emergency spillway	Y				Y			
5 Basin inlets	Y				Y			
C. Sediment Accumulation								
1 In forebay				Y	Y			
2 In main Basin	Y			Y				
3 Affecting outlet	Y		Y		Y			
4 Affecting inlets	Y		Y		Y			
D. Wetland Vegetation								
1 Wetland plants healthy		Y						
2 Invasive weeds		Y						
3 Excessive growth outlet		Y						
4 Excessive growth inlet		Y						
E. Vegetation on Banks								
1 Ground cover OK				Y				
2 Noxious weeds				Y				
3 Excess veg. growth				Y				
F. Embankment and Emergency Spillway								
1 Ground cover adequate				Y	Y			
2 Unauthorised works		Y						
3 Erosion, cracking, etc.		Y						
4 Seepage or leaks		Y			Y			
5 Other (Specify)								
G. Service Outlet – Detailed Overall Inspection Including Structural and Erosion								
1 Trash rack				Y	Y			
2 Low flow orifice				Y	Y			
3 Manhole riser				Y	Y			
4 Outlet weir				Y	Y			
5 Flood flow pipe				Y	Y			
6 Flood flow pipe outlet				Y	Y			
H. Inlets Into Basin								
1 Headwalls		Y		Y	Y			
2 Riprap Apron failures		Y		Y	Y			
3 Slope erosion		Y		Y	Y			
4 Culvert Access Safety Screens	Y		Y		Y			
I. General								
1 Fencing				Y				
2 Viewing platforms Walkways/ Bridges				Y				

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Stormwater Operation and Maintenance Plan

APPENDIX B

DESIGN DRAWINGS

(To be included once they are approved)

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APPENDIX 4

As-Built Drawings

(To be included after completion of works)

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