STORMWATER MANAGEMENT PLAN

(REVISION E)

41-43 Brigham Creek Road
Whenuapai

JUNE 2022

REPORT PREPARED BY	REPORT REVIEWED BY	REPORT AUTHORISED BY
		
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EXECUTIVE SUMMARY

The purpose of this Stormwater Management Plan ('SMP') is to outline the high-level stormwater management strategy for the greenfield development at 41-43 Brigham Creek Road, Whenuapai and to support the associated Plan Change application. The SMP addresses the proposed urbanisation of the site, which will primarily consist of 230 residential lots, associated Jointly Owned Acess Lots (JOALs) and future public roads to be vested to Auckland Transport.

The site is currently contained within the Future Urban Zone of the Auckland Unitary Plan – Operative in Part ('AUP – OP'). The Plan Change application proposes to change the current site zoning to a Residential - Mixed Housing Urban Zone.

The plan sets up a clear process to mitigate the effects on the receiving environment - Sinton Stream, located south of the development. The stormwater management principles and methodologies proposed in this SMP are governed by the Unitary Plan NDC document (Schedule 4 – Greenfield Developments) and relevant Auckland Council publications. The primary focus of the SMP is to ensure the outcomes sought align with the NDC Schedule 4 requirements.

A high-level stormwater strategy is proposed for the development that focuses on a Water Sensitive Design (WSD), providing quality treatment before ultimate discharge of the development stormwater into the receiving environment. SMAF provisions will also be adhered to by providing appropriate retention and detention. Findings from the Whenuapai SMP (AECOM, 2016) that details stormwater management within the greater Whenuapai catchment have also been incorporated in the stormwater strategy for the development.

Existing flood plains in the site vicinity have been accounted for in the SMP. The proposed overland flow path strategy details the overland flow conveyance within the development roadways. The proposed design also minimizes adverse downstream effects of the proposed development in terms of flooding (up to 1% AEP including climate change) whilst ensuring a safe/hazard free living environment. The development can be considered a Low/Minor Hazard in terms of overland flows per Auckland Council guidelines.

A public stormwater reticulation network (in accordance with SWCoP and climate change) has been proposed to service the 10-yr flows from the development and will be subject to future engineering plan approval from Auckland Council. Final staging and detailed engineering design of the development shall be confirmed at Resource Consent and Engineering Approval stages. The design retains the existing natural catchment and ensures no permanent loss of downstream hydrology.

Subject to confirming compliance with Schedule 4 of the NDC, this SMP will be adopted into the NDC and the resulting discharge of stormwater will be authorised as detailed within Schedule 8 of the NDC.

1 EXISTING SITE APPRAISAL

1.1 SUMMARY OF DATA SOURCES AND DATES

Existing site appraisal item	Source and date of data used
Topography	• Maven Associates, 2022 • Auckland Council GeoMaps, Contours, 2022
Geotechnical / soil conditions	• Engeo Geotechnical Investigation Report, June 2021
Existing/Future stormwater network	• Auckland Council GeoMaps, 2022
Existing hydrological features	• Maven Associates, 2022 • Auckland Council GeoMaps, Catchments and Hydrology Layers, 2022
Stream, river, coastal erosion	• Auckland Council GeoMaps, 2022
Flooding and Flow paths	• Auckland Council GeoMaps, Overland Flow Paths Layer, 2022
Coastal Inundation	• N/A
Ecological / Environmental areas	• Auckland Council Unitary Plan Viewer, Significant Vegetation Layer, 2022
Cultural and heritage sites	• Auckland Council GeoMaps, Cultural Heritage Site, 2022
Contaminated Land	• N/A

1.2 LOCATION AND GENERAL INFORMATION

The development site is located on the southern side of Brigham Creek Road. The eastern boundary of the site is bounded by Mamari Road (Figure 1 below). Mamari Road, beyond the existing urban area, is an unformed paper road, which provides vehicle access to 5 Mamari Road (located to the south of the site).

Figure 1: Overall Development Site

As shown in Figure 1, there are existing residential buildings at the site. The buildings are accessed by a long driveway from Brigham Creek Road. The balance of the site supports pasture paddocks which have been grazed. Existing shelterbelts and scattered landscape planting also exist.

The legal description of the site is as follows:

Address	41-43 Brigham Creek Road, Whenuapai
Legal Description(s)	LOT 2 DP 538562
Property Area	5.1921 ha
Existing AUP OP – Zoning	Future Urban Zone

Table 1: Subject Site Legal Description

1.3 TOPOGRAPHY

The site is irregular in shape and comprises a total land area of 51,921m².

The site is best described as gently rolling. Highest elevations (RL 28.0m) are located centrally. Ground levels then drop unevenly with notable falls towards the western, southern, and south-eastern sections of the site. Lowest elevations (RL 21.0m) are recorded in the south-eastern corner.

Figure 2: Site Topography

1.4 GEOTECHNICAL

ENGEO will shortly conduct a second site investigation to confirm the adequacy of the site for the proposed development in terms of soakage and infiltration for the proposed stormwater strategy.

ENGEO attended site on 13 August 2020 to undertake an intrusive site investigation. This geotechnical investigation comprised ten hand auger boreholes, five Scala penetrometer tests, recovery of one soil sample for shrink swell testing, and installation of one groundwater measuring piezometer.

While on-site ENGEO did not observe any superficial features of instability around the western and south-eastern areas.

Ground conditions encountered on-site were generally in accordance with the mapped geology:

- Topsoil was encountered within all hand auger boreholes to between 0.2 m and 0.4 m below ground level (bgl).
- Alluvial soils of the Puketoka Formation were encountered underlying topsoil at all test locations. This material generally consists of interbedded brown, grey and orange silts and clay soils with variable sand, gravel and organic content. The alluvial soils were generally found to be stiff to hard. Peat was encountered within HA06 from 3.7 m to 5.0 m bgl.

1.5 EXISTING DRAINAGE FEATURES AND STORMWATER INFRASTRUCTURE

Due to the current land use in the greater catchment, piped stormwater infrastructure is limited to the existing residential developments and within the NZDF Airbase. Drainage of the remaining catchment is provided through a network of streams including natural and modified wetland remnants.

The recent downstream development to the north of the subject site is serviced by a public stormwater reticulation network.

As confirmed by RMA's ecological assessment of the site, the only wetland (as per NPS-FM) downstream of the site is located near the western boundary of 5 Mamari Road. In addition to the overland flows, there are no other hydrological features applicable to the development site. For full assessment of the hydrologocial features, refer to RMA Ecology's Ecological assesment in Appendix E.

Figure 3: Existing Site Hydrological Features ((via RMA Ecology)

1.6 FLOODING AND FLOWPATHS

Figure 4: Existing 100-yr Catchment

Auckland Council's GeoMaps identifies several overland flow paths (OLFP) traversing through the subject site. The contributing catchments are 45 Brigham Creek Road (north) and a section of the Brigham Creek Road road reserve.

An existing OLFP enters the site from the northern boundary and traverses south through the eastern side of site and discharges into 5 Mamari Road, Whenuapai. The catchment for this OLFP includes the central portion of 45 Brigham Creek Road (upstream) and the subject site. At the point of entrance into the subject site, the existing OLFP has been calculated using TP108 to be 0.69m³/s, and 1.18m³/s as it discharges into 5 Mamari Road and ultimately discharge into Sinton Stream.

A second OLFP (minor) enters the site from the northern boundary and traverses through the north western portion of the site. The catchment for this OLFP includes the western portion of 45 Brigham Creek Road (upstream) and the subject site. At the point of entrance into the subject site, the existing OLFP has been calculated be 0.28m³/s, and 0.80m³/s as it discharges onto Brigham Creek Road and overtops onto Joseph McDonald Drive.

There is an existing flood plain and flood prone area within the north-western corner of the site. This is the ponding that occurs before the 100-yr OLFP overtops the centre of Brigham Creek Road and discharges into Joseph McDonald Drive. Accordance to GeoMaps, this flood prone area has a max ponding depth of 880mm and 1381m³ volume stored in 100-yr ARI Future Scenario.

The remaining portion of the site sheet flows into several subject catchments and discharges to 5 Mamari Road and 39 Brigham Creek Road, before ultimately discharging into Sinton Stream. Refer to Maven Plan C460 for existing/pre-development flooding catchments and flow rates.

1.7 COASTAL INUNDATION

The site is not within the coastal inundation zone.

1.8 BIODIVERSITY

Auckland Council's Unitary Plan maps confirm that the site is not within the Significant Ecological Area ('SEA'). The ultimate receiving environment for the development – Sinton Stream, is identified as a Significant Ecological Area ('SEA'). None of the trees at the site are classified as 'notable' or have an additional level of protection under the AUP(OP).

RMA' ecology assessment confirms there are no streams at the site. There are also no wetlands, no indigenous vegetation, no SEAs and no plant or animal species of conservation significance. There is a wetland as defined under the RMA (but not an inland natural wetland under the NPS-FM) to the south-west of the site (off site). There is no remnant or secondary regenerating native forest on the site and the vegetation present does not meet any of the qualifying criteria for ecological significance.

The development design has taken RMA's findings into account.

1.9 CULTURAL AND HERITAGE SITES

*****Addressed within the planning report*****

1.10 TO CONTAMINATED LAND

*****Not Applicable*****

2 DEVELOPMENT SUMMARY AND PLANNING CONTEXT

2.1 REGULATORY AND DESIGN REQUIREMENTS

Requirement	Relevant regulatory / design to follow
Unitary Plan – SMAF hydrology mitigation	• AUP Chapter E10 – Stormwater management area
High Contaminant Generating Areas	• AUP Chapter E9 – Stormwater quality
Natural Hazards	• AUP Chapter E36 Natural hazards and flooding
Auckland Unitary Plan Precinct	• N/A
Existing Catchment Management Plan	• N/A
Auckland Council Regionwide Network Discharge Consent	• No existing Discharge Consent – proposed to adopt development SMP for stormwater management.

The primary focus of the SMP is to ensure the outcomes sought align with the NDC Schedule 4 requirements. The overarching design principle driving the stormwater strategy for this development is incorporation of Water Sensitive Urban Design wherever possible.

WSUD is a land planning and engineering design approach which integrates the urban water cycle, including stormwater, groundwater and wastewater management and water supply, to minimise environmental degradation and improve aesthetic and recreational outcomes. The stormwater Strategy incorporates WSUD engineering design principles to create a low impact, sustainable development.
Key legislative documents have also been acknowledged in developing the Stormwater Strategy, which include but are not limited to -

- Auckland Unitary Plan (AUP(OP))
- Regionwide Network Discharge Consent (NDC)
- NZS 4404: 2010 - Auckland Code of Practice for Land Development and Subdivision (Chapter 4 – Stormwater)
- Stormwater Management Devices in the Auckland Region – Guideline Document 2017/001 (GD01) December 2017
- Stormwater Management Devices – Design Guideline Manual (TP010) May 2003
- Auckland Transport Code of Practice (2013)
- Auckland Council Whenuapai Stormwater Management Plan (via. AECOM) August 2016

Please refer to section 6.0 of this report for the detailed development stormwater management strategy and its compliance with the NDC Schedule 4 and relevant Auckland Council publications.

Where stormwater management devices cannot be designed in accordance with GD01 & TP10 objectives, the applicant is able to take a BPO approach to designing the stormwater treatment / hydrology mitigation.

3 MANA WHENUA MATTERS

3.1 MANA WHENUA OUTCOMES

Private plan change documentation has been provided to Mana Whenua for their feedback. Based on HW's recommendation, the following Iwi's have been engaged for consultation:

- Ngā Maunga Whakahii o Kaipara
- Ngāti Manuhiri
- Ngāti Pāoa
- Ngāti Te Ata
- Ngāti Whātua
- Ngāti Whātua Ōrākei
- Te Aakitai
- Te Kawerau ā Maki
- Ngāti Maru

The proposed design is consistent with the values of Mana Whenua and the applicant is committed to working with Mana Whenua to ensure best possible outcome is achieved. Consultation will continue through the Resource Consent process.

Water sensitive design principals underpin the proposed stormwater management for the development site, the design will ensure:

- The holistic treatment of stormwater prior to discharge into the receiving environment (Sinton Stream) through utilising treatment trains.
- Treatment of sediments and trapping gross pollutants at localised areas via. stormwater devices.
- Alignment with Taiao: Avoiding the mixing of contaminated water into marine and freshwater receiving environment.

The proposed development shall also include stormwater management devices to align with Mana whenua according to GD01:

Rainwater Tanks

The proposed re-use and detention tanks for all units align with mana whenua as stated in the GD01:

Mana whenua alignment	Rainwater tanks that include reuse and/or recharge (in permeable soils) align with kaitiakitanga, Mauri Tu and Taiao and the protection of environmental health. Iwi management plans are a vital resource and should be referred to early in design.

Raingardens

These devices will be planted with native species and provide an ecological corridor for other species as stated in GD01:

Mana whenua alignment	Bioretention devices can be planted with native species and act as ecological corridors for birds, invertebrates and reptiles. Planting with harvestable plants can be considered as well as educational signage, with cultural context and history and can include Māori names. Hand weeding of these devices would align with the principles of Taiao and kaitiakitanga. Iwi management plans are a vital resource and should be referred to early in design.

Permeable Pavement

As discussed later in the report, permeable pavers will be used for all private driveways (within private lot). Use of permeable pavement aligns with mana whenua as stated in GD01:

Mana whenua alignment	Pervious paving can recharge groundwater but must be used in conjunction with water quality treatment to align with kaitiakitanga, Taiao and Mauri Tu. Also hand weeding and hand maintenance would align with the principles of Taiao. Iwi management plans are a vital resource and should be referred to early in design.

4 STAKEHOLDER ENGAGEMENT AND CONSULTATION

4.1 AUCKLAND TRANSPORT

Private plan change documentation has been provided to Auckland Transport for their feedback.
Resource consent has also been lodged and AT have reviewed the proposal and provided feedback.
Further consultation will be undertaken with Auckland Transport at EPA stage.

The public stormwater network, public stormwater management devices and flood management have been designed in accordance with Auckland Transport code of practice.

The applicant is committed to working with Auckland Transport to achieve the best possible outcome and one that it is consistent with AT's expectations.

Raingardens

The design of the proposed rain gardens within the public road reserve will be reviewed by AT during resource consent and EPA application. The proposed subdivision can accommodate the exact size and location of these devices.

Public Stormwater Network Within Mamari Road

The design, including sizing and position of the proposed public stormwater network within Mamari Road reserve will be reviewed by AT during resource consent and EPA application. The proposed subdivision can accommodate the exact size of the pipe and pipe alignment.

Flooding Within Public Road Reserve.

The proposed flood management within the public road reserve will be reviewed by AT during resource consent and EPA application. The proposed subdivision can safely accommodate the anticipated flood flows within the road reserve.

5 PROPOSED DEVELOPMENT

5.1 GENERAL DEVELOPMENT INFORMATION

The proposal is to rezone the site to enable the 230 Lot (free hold) residential development with associated Joint Owned Access Lots (JOALs) and five new public roads to be vested to Auckland Transport.

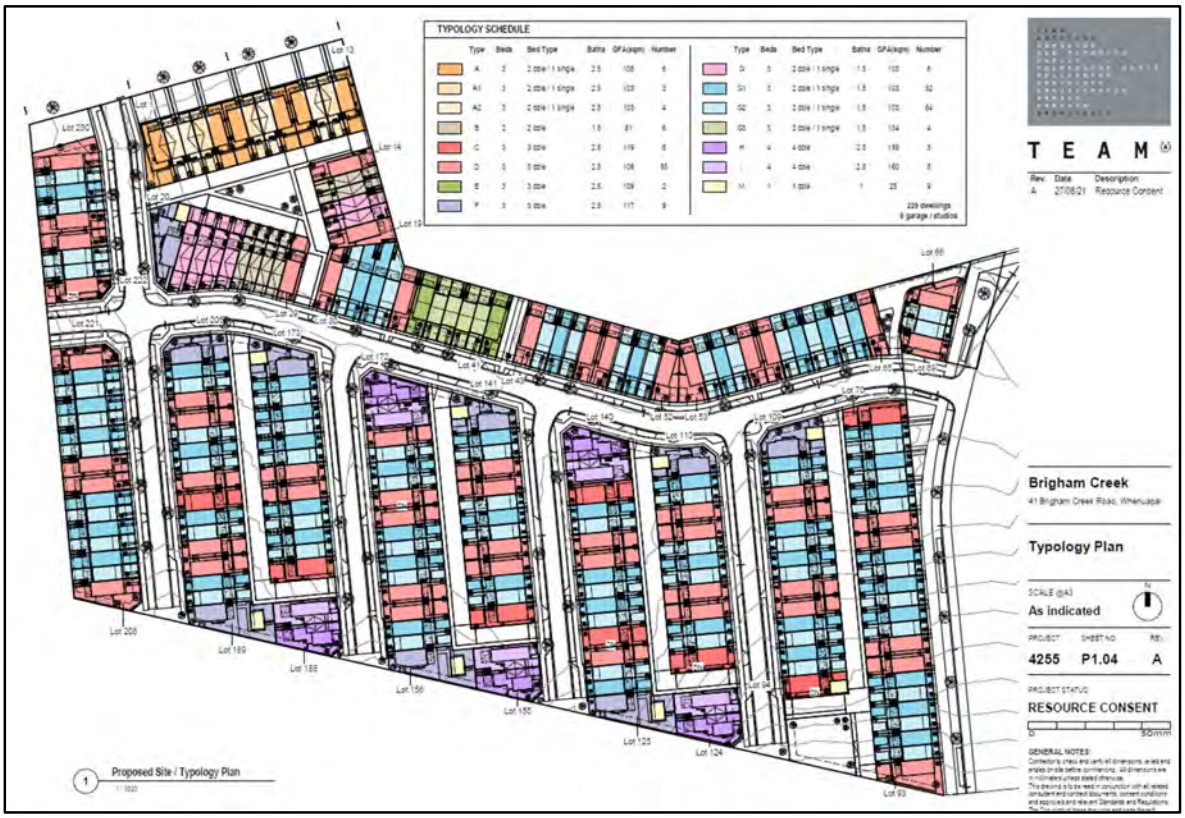


Figure 5: Development Site Plan (via. Team Architects)

5.2 LOCATION AND AREA

A shown in Figure 5 below, the site is situated within an evolving semi-rural environment. Surrounding properties are a mix of residential lots and un-developed/vacant land. Surrounding landholdings support a mixture of future urban, residential, and business activities.

The properties immediately east and north of the development site support residential tendencies.

Figure 6: Locality Plan

5.3 PURPOSE OF THE DEVELOPMENT

The Auckland Council led Whenuapai Structure Plan envisions a sustainable, quality built urban development in the wider Whenuapai region. The purpose of the proposed 230 Lot development is to primarily provide residential opportunities in the Whenuapai area, consistent with the structure plan.

5.4 SITE LAYOUT AND URBAN FORM

The development will be guided by the masterplan via. Team Architects. The detailed stormwater strategy and engineering designs to service the development have been proposed in line with masterplan.

5.5 EARTHWORKS

Site wide bulk earthworks will be carried out to achieve the proposed final ground levels for the development, followed by earthworks for the preparation of building platforms, pavement areas (including JOALs and public roads), underground services, construction of stormwater management devices and drainage.

Sediment and erosion control measures have been designed and implemented under the guidelines of Auckland Council's GD05 document. Sediment erosion controls shall be inspected and approved by the Engineer before any commencement of earthworks and shall be regularly maintained. Prolonged exposed areas shall be mulched, or grass seeded to minimise erosion.

As confirmed by RMA's ecological assessment(Appendix E) of the site, the only wetland (as per NPS-FM) downstream of the site is located near the western boundary of 5 Mamari Road.

Figure 7: Wetland Downstream of Development Site (via RMA Ecology)

To ensure there is no loss or degradation of this wetland (as required by the NPS-FM) during the construction phase, one of the proposed sediment retention ponds (SRP 1) will discharge to the natural low point in the south-western corner of the subject site.

Please refer to the **Appendix B** for the proposed earthworks plan series C200.

6 STORMWATER MANAGEMENT

6.1 PRINCIPLES OF STORMWATER MANAGEMENT

6.1.1 PRINCIPLES

The purpose of this SMP is to ensure that the receiving environment is protected and enhanced as it undergoes the proposed urbanisation. The primary focus of the SMP is to ensure the outcomes sought align with the NDC Schedule 4 requirements.

The priniciples applicable to the development which coincide with the NDC Schedule 4 are detailed below:

- Water Quality –
    - Treatment of all impervious areas by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants.

    Or
    - An alternative level of mitigation determined through a SMP that:
        - applies an Integrated Stormwater Management Approach (as per above);
        - meets the NDC Objectives and Outcomes in Schedule 2; and
        - is the BPO.
- Frequent Rain Event Management – Hydrology mitigation in accordance with the Stormwater Management for Flow Area 1 provisions as defined in Chapter E10 of the AUP(OP).
- Conveyance – Provide a stormwater network to convey runoff generated from the 10% AEP event from the development and convey this to the receiving environment. Where this network is proposed to be vested with the Auckland Council, the network should be designed in accordance with the requirements set out in the SWCoP.
- Overland Flow Management – Natural overland flowpaths are to be retained in the developed scenario. Flowpaths through development sites will be required to be incorporated into the final landform so as not to pose a risk to property or people. Flowpaths will also be protected and kept free from obstruction. Similar to flow attenuation, where alterations are made to the overland flowpath as a result of earthworks, it will be necessary for the developer to demonstrate no negative impacts are caused by the proposed changes.
- Floodplain Management – The management of the floodplain will be provided through the provisions contained within the AUP(OP). No vulnerable activities will be allowed within the floodplain (unless suitably mitigated) and general levels of development will be kept to a minimum in such areas.
- Receiving Environment – To provide protection to and promotion of the receiving environment.
- Residential Zones – Consideration of lot-based application of WSUD, which could include, but is not limited to the following solutions:
    - Reuse tanks for roof water.
    - Bioretention devices prior to discharge to the conveyance network.

  - Permeable paving for driveways (within private lot) and general site impervious areas minimising the size of public stormwater infrastructure and assist in obtaining green star ratings for the development.
- Roads – No additional requirements or considerations above the minimum set out (above).

The SMP ensures compliance with the NDC Schedule 4 requirements for Greenfield developments, these requirements are listed in Table 2 in section 6.2.1 and form the outcomes sought by the stormwater management strategy. The stormwater strategy developed for the site demonstrates the overarching principles of how stormwater is to be managed within the development, as required by the regional NDC. The stormwater management proposed for the site generally aligns with the concept of a Water Sensitive Design.
The strategy for the stormwater management is outcome focused. The stormwater management plan provides a solution-based approach for the receiving environment. The plan sets up a clear process to mitigate the effects on the receiving environment, which is the Sinton Stream - located south of the development.

The Whenuapai SMP has been utilized only as a general guideline for the stormwater management strategy design. The SMP outlines the stormwater provisions that are required to promote long-term sustainable stormwater management for the wider Whenuapai Area (which the site is located within). Please refer to **Appendix A f**or a copy of the 2016 AECOM SMP.

Maven Associates believes the proposed stormwater strategy ensures the proposed outcomes are consistent with Schedule 4 of the regional NDC and relevant mana whenua values.

6.2 PROPOSED STORMWATER MANAGEMENT

6.2.1 GENERAL

Table 2 below summarizes the stormwater management design approach for the development and outcomes sought in accordance with NDC schedule 4.

Table 2: NDC Requirements and Design Approach for 41-43 Brigham Creek Development

Stormwater Management Requirements and Outcomes	Design Approach
Water Quality	• JOALs - Underground stormwater filters and raingardens • Public Roads (High Contaminant Generating Areas (HCGAs)) - Raingardens • Buildings: Inert roofing materials and captured by private underground stormwater tanks which will provide an additional layer of quality treatment • Private Driveways - Permeable pavement for private Lot parking pads.
Flooding 10% AEP Pipe Network	• Design of new public stormwater reticulation network as per Auckland Council's Stormwater Code of Practice.
Stream Hydrology (SMAF or Stream Discharge)	• Inclusion of SMAF-1 controls • Retention of the first 5mm rainfall runoff depth volume generated from impervious areas • Detention (temporary storage) and a drain down period of 24 hours for the difference between the predevelopment and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the 5 mm retention volume
Flooding 1% AEP	• Consideration of upstream and on-site flood plains for development design. • Engineered design of internal OLFP flow rates and conveyance within the development. • Maintenance of internal OLFPs in consideration to the minimum freeboard requirements as per the SWCOP and NZBC.
Public Assets	• All new public assets to be vested to regional authorities to be designed and constructed as per the relevant design standards.

The outcomes sought in this strategy align with the NDC Schedule 4 requirements.

BEST PRACTICABLE OPTION (BPO ANALYSIS)

The Whenuapai SMP grades various stormwater management devices in terms of suitability. As shown in Figure 8 below, Bioretention (via. raingardens) and re-use tanks are deemed as the best practicable stormwater treatment options for the development.

	Business	Road	Commercial	Open Spaces	Single House	Mixed Use Suburban	Mixed Use Urban
Bioretention	●	●	●	●	●	●	●
Reuse Tanks	●	●	●	●	●	●	●
Swales	●	●	●	●	●	●	●
Living Roofs	●	●	●	●	●	●	●
Detention Basin	●	●	●	●	●	●	●

● - Very Suitable; ● - Somewhat Suitable; ● - Not Suitable

Figure 8: Extract from Whenuapai SMP (Table 10, Page 36)

A detention/retention pond is deemed not feasible for the development given its relatively small catchment area. This approach is consistent with the practice detailed in the Stormwater Management Devices Design (TP10) guideline as shown in Figure 9.

Additionally, the site is located upstream within its sub-catchment, there are properties downstream to the development in relation to the ultimate discharge into the Sinton Stream. It is not considered prudent to install a wetland in this scenario.

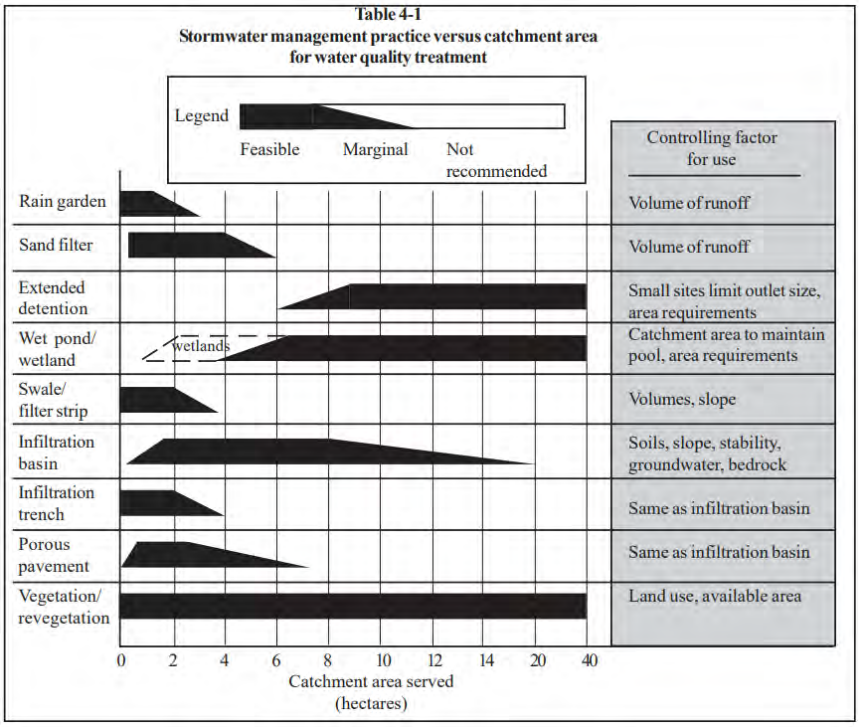


Figure 9: Extract from TP10 (Table 4.1, Page 4-5)

The wetland would result in a single discharge point for the development leading to concentrated flows. This would also result in alteration of the natural catchment flows and result in permanent loss of hydrology in relation to the existing downstream wetland/gullies on 5 Mamari Road.

Installation of raingardens allows retention of the existing catchment hydrology and parking bays. Especially given the size of the development, provisions for on-street parking can be considered a positive outcome in terms of overall amenity. Installation of bioretention swales will not allow for on-street parking and would also require maintenance provisions, similar to raingardens

In summary, raingardens can be considered the best form of bioretention for the proposed development. Installation of a singular treatment device, such as a wetland will have many disadvantages and is not appropriate for the development.

The detailed stormwater management strategy to service the proposed development at 41-43 Brigham Creek Road is detailed in sections below.

LIFE-CYCLE COST

Auckland Council's Technical Publication TR2013/043, compares the life cycle costs of a range of stormwater management devices that can be used to meet controlled activity requirements in the PAUP stormwater management flow and quality rules. This includes the reduction of runoff volumes through retention of small, frequent events in SMAF areas and the treatment of high-contaminant generating areas at source.

TR2013/043 concluded the following:

- To manage the stormwater runoff from housing developments to meet the SMAF requirements the least expensive construction cost option is the porous paving with increased gravel thickness with a cost approximately the same as the Base Case – Wetland Treatment.

- The construction costs to meet the requirements for parking areas and roads with the smaller sized HCGA rain garden is approximately the same as the Base Case – Wetland Treatment. Maintenance costs for the rain gardens and porous paving are similar to the Base Case – Wetland Treatment.

  Summary of Results (adapted from TR2013/043)

Scenario and PAUP Requirement	Least Construction Cost Option	Least Average Annualised Maintenance Option	Least Total Present Cost Option
Single House SMAF1	Porous Paving with Gravel	Rain Garden	Rain Garden
Parking Area SMAF1 and 2	Porous Paving and Rain Garden similar	Porous Paving	Porous Paving
Parking Area HCGA	Rain Garden	Porous Paving, Rain Garden and Sand Filter similar	Rain Garden and Porous Paving similar

- Wetlands provide detention but not the retention requirements needed to reduce stream erosion to maintain/enhance stream health (including biodiversity and ecological functioning).

6.2.2 WATER QUALITY

The treatment of discharges to the CMA will be required due to the receiving environment (Sinton Stream) being identified as a Significant Ecological Area ('SEA').

The proposed strategy will incorporate a WSUD approach focusing on reducing or eliminating stormwater contaminates through source control (inert materials), using stormwater treatment devices consistent with Auckland Council guidelines:

- Auckland Council's GD04 Water Sensitive Design for Stormwater and E.10 (Stormwater Management Area) of the AUP – OP.
- Trafficable surfaces require treatment as per Auckland Council requirements – GD01 Stormwater Management Devices in the Auckland Region: Design guideline document with treatment devices designed and sized to the guidelines set out in GD01.
- AUP – OP document E1: Water Quality and Integrated Management – to avoid as far as practicable or otherwise minimise or mitigate adverse effects of stormwater runoff from greenfield development on water quality (such as freshwater systems, freshwater and coastal water).

JOINT OWNED ACCESS LOTS (JOALS)

JOALs are considered high contaminant yielding and hence require treatment. Stormwater360's proprietary StormFilter™ devices will be installed under the JOALs to provide adequate stormwater quality treatment for TSS 75%.

PUBLIC ROADS

Public roads are considered high contaminant yielding and hence require treatment. Future public roads require treatment as per AUP – E10 and the guidelines set out in GD01. The primary water quality objective of the treatment is to remove 75% of total suspended sediment on a long-term average basis prior to discharging into the receiving environment. Stormwater quality treatment for public roads will be provided via. raingardens which will be installed within the public road berm. The raingardens will also provide retention and detention storages for the public roads.

The above-mentioned water quailty provisions will minmize the generation and discharge of contaminants, particularly from high contaminant generated on high use roads, as required by E1.3 (8) (b).

RESIDENTIAL LOTS

All buildings will be roofed with inert roofing materials (e.g., Coloursteel roofing). This removes the production of contaminants. This stormwater will be captured by private underground stormwater tanks which will provide an additional layer of quality treatment before discharging into the public retilculation network. As such, no additonal stormwater treatment will be required for residential lots.

Permeable pavers will be used for the private parking pads (within private lot). As they are a pervious surface no stormwater mitgiation is required. Please refer to **Appendix D** for more information.

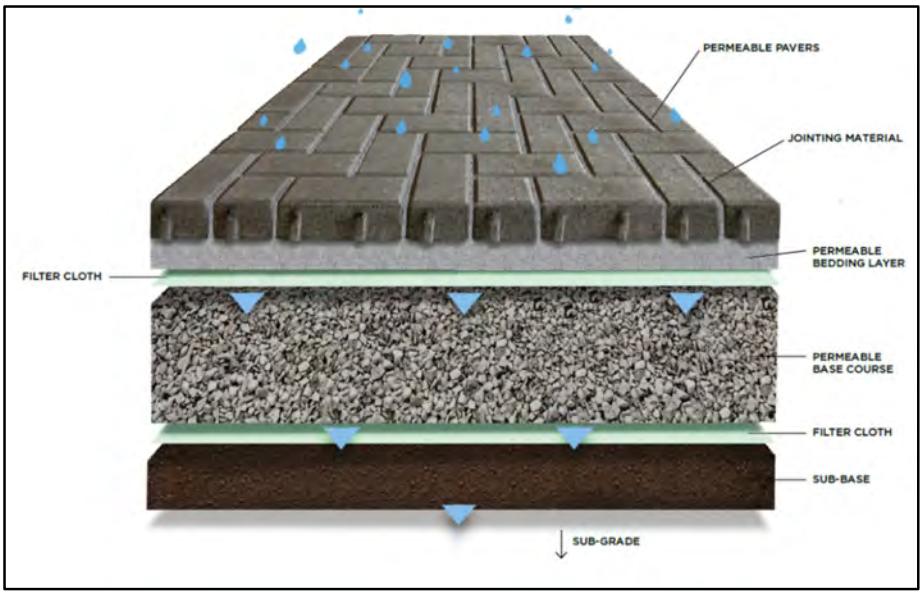


Figure 10: Firth Permeable Paver Detail

6.2.3 HYDROLOGY AND ATTENUATION

SMAF (Flow 1) controls, as detailed in Chapter E10 of the AUP-OP, will be introduced as part of the development. This approach is consistent with the NDC Schedule 4, as the development ultimately discharges to the natural Sinton Stream via. public stormwater reticulation.

By inclusion of SMAF provisions, the proposed urban development will protect the downstream receiving environment (Sinton Stream) and aquatic biodiversity. Hydrology mitigation is considered to promote stream health through maintaining natural baseflow regimes within the waterways through the area and minimising erosion risk through the slow release of runoff from future urban areas.

The SMAF-1 controls protocols will be implemented by providing:

- retention of the first 5mm rainfall runoff depth volume generated from impervious areas; and
- detention (temporary storage) and a drain downperiod of 24 hours for the difference between the predevelopment and post-development runoff volumes from the 95th percentile, 24 hour rainfall event minus the 5 mm retention volume

SMAF MANAGEMENT FOR RESIDENTIAL LOTS

The development will include 229 lots supporting residential tenancies, ranging from 97m² to 330m² (approx.) in total area.

Retention and detention for these lots will be provided via. undeground tanks sized to SMAF 1 provisions based on a Max Probable Development (MPD) scenario of 60% impervious coverage.

The adjusted 95th percentile detention volume from each Lot will be detained by the tanks and released over a 24-hour period through a control orifice and discharged into its respective public lot connection. The control orifice will be situated at the height above the retention volume equivalent to the first 5mm of runoff. A pump will installed on the tank to provide re-use capabilties within the indvidual lots. Final design of the tanks (inlcuding orifice sizing) will be confimed at the building consent stage.

As shown in Figure 11 below, six SMAF tank typologies (A – F) have been designed for the development. Tank volumes will range from 1.4m³ to 4.5m³. The design ensures the minimum retention and detention volumes. The total area of Lots 1 - 230 will be 3.23ha (approx.). Impervious coverage for design calculations assume 60% MPD (MHUZ), which is 1.94ha (approx.). The proposed design ensures the minimum retention and detention volumes to allow urbansiation of these Lots are met as required in Unitary plan.

Lot Typology	Lot Area m²	Impervious Cover (60% MPD) m²	Retention Vol. m³	Detention Vol. m³	Tank Vol m³	No. of Tanks Qty.
A	100	60	0.3	1.1	1.4	7
B	125	75	0.4	1.3	1.7	126
C	150	90	0.5	1.6	2.1	56
D	200	120	0.6	2.2	2.8	22
E	250	150	0.8	2.7	3.4	14
F	300	180	0.9	3.2	4.1	4
					TOTAL NO. OF TANKS =	229

MINIMUM RETENTION VOLUME REQUIRED =	96.96	m³	
DESIGN RETENTION VOLUME PROVIDED =	101.85	m³	OK
MINIMUM DETENTION VOLUME REQUIRED =	347.84	m³	
DESIGN DETENTION VOLUME PROVIDED =	365.385	m³	OK

Figure 11: SMAF Design Summary

The SMAF Typology Plan (C455) and SMAF calculations have been in attached in **Appendix B** and **Appendix C.**

SMAF MANAGEMENT FOR PUBLIC ROADS

Raingardens will provide the retention and detention volumes for the corresponding catchment's impervious surfaces and will serve the purpose of stormwater mitigation for SMAF. Detention volumes will be provided within the surface storage (ponding area), sub surface storage (planting media and drainage layer). Retention volumes will be in the storage gravel layer beneath the underdrain area. Where retention through infiltration cannot be achived only detention will be provided.

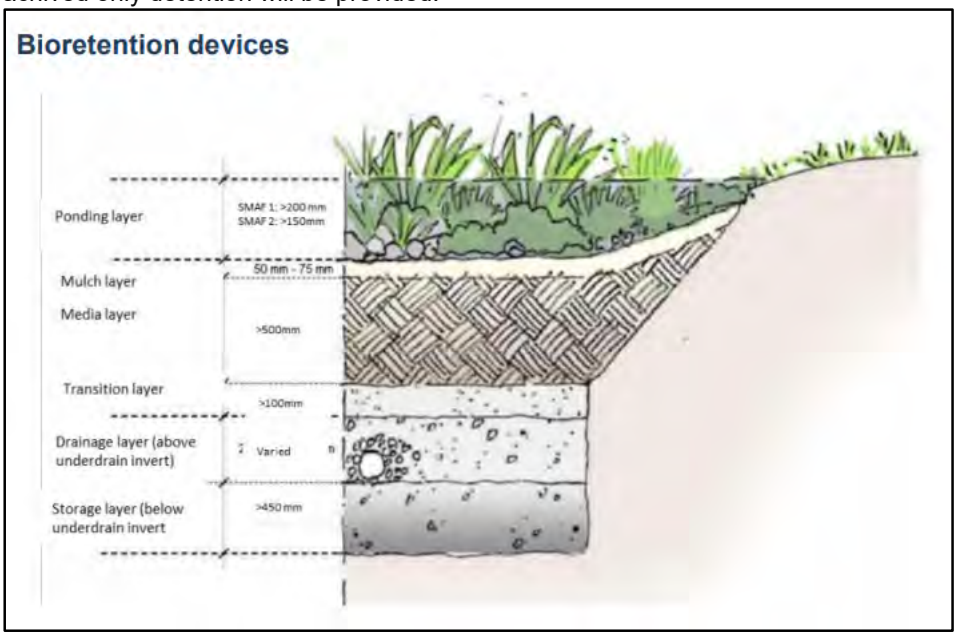


Figure 12: Typical Raingarden Section (Council GD01)

It is proposed to provide SMAF retention and detention for 6,089m² (approx.) area of the proposed public roads as part of the development. Raingardens will be located in the public road reserves and also provide stormwater quality treatment.

Raingarden No.	Proposed Footprint Area (m²)
1-1A	23.00
2-0	55.00
3-0	37.50
4-0	51.50
5-0	52.90
6-2A	21.50
6-2B	10.50
9-1A	32.50
20-0A	21.60

Table 3: Raingarden SMAF Summary (Public Roads)

The Stormwater Treatment Catchment Plan (C406), Stormwater Treatment Devices Plan (C407) and Raingarden SMAF calculations have been in attached in **Appendix B** and **Appendix C**.

As shown on Maven Plan C406, majority of the site has been treated. A minor portion of the road catchment cannot be treated now due to practicality issues and is expected to be treated in the future when temporary turning heads are removed.

The proposed rain gardens have been positioned in the most practical locations with no installations in series, and can in all cases be accommodated within the proposed road reserve. The raingardens have been designed to Auckland Transport design requirements. A total of 9 public raingardens will be required for the development, with only one raingarden under the minimum required footprint of 20m² due to design restraints. Consultations with Auckland Transport for the design and vesting of these raingardens as public are to be carried out at the Resource Consent approval stage.

SMAF MANAGEMENT FOR JOALs

JOAL 2

Similar to the strategy implemented for public roads, SMAF retention and detention for JOAL 2 will be provided via a privately owned raingarden. Where retention cannot be achieved by infiltration only detention will be provided.

JOALs 3-6

StormFilter™ tanks (or equivalent) will be installed for SMAF retention. In addition to retention, these tanks also provide stormwater quality treatment as discussed in section 6.2.2.

SMAF detention storage will be provided via. underground Chambermaxx™ tanks (or equivalent), which allows infiltration into the ground.

JOAL (No.)	SMAF Retention Storage required (m^3)	SMAF Detention Storage required (m^3)	Total Raingarden*/Tank Capacity (m^3)
2	5.90	21.10	27.00 (RG*)
3	4.25	15.25	19.50
4	4.15	14.89	19.04
5	4.02	14.42	18.44
6	5.48	19.66	25.14
7	1.48	5.29	6.77

Table 4: SMAF Summary (JOALS)

The Stormwater Treatment Catchment Plan (C406) and SMAF calculations have been in attached in **Appendix B** and **Appendix C.**

6.2.4 PUBLIC STORMWATER NETWORKS

New public stormwater infrastructure is proposed to service the development. A new public retilculation network (10% AEP) will be built within the site and the Mamari Road reserve.

Please refer to **Appendix B** for the proposed stormwater reticulation design to service the development. The design of the public assets will be in accorndance with the Auckland Council SWCoP (climate change inclusive).

The development 10-yr catchment has been subdivided to retain the original discharge to the gullies at 5 Mamari Road. The proposed stormwater network will include bubble-up chambers (Scruffy domes) at end of public roads 2, 3, 4 and 5 near the southern boundary with 5 Mamari Road. The future development at 5 Mamari Road can extend this public network further downstream via the scruffy dome manholes to maintain natural flows. This design approach will retain the existing natural catchment and hydrology in relation to the existing downstream and 6.2.4 for /gullies on 5 Mamari Road.

A section of the development will discharge to the proposed network under Mamari Road. This network will run south with an outfall structure discharging into Sinton Stream. The outfall will be specifically designed for erosion control. This discharge will be compliant with E8.6.1 general standards as there will be no increase in adverse effects to the receiving environment.

Please refer to C450 and C451 for the 10-yr stormwater catchment plans. The overall 10-yr post-development flows onto 5 Mamari will 0.80m³/s which is a decrease from the pre-development scenario of 1.2m³/s – this can be considered a positive outcome.

The integrated strategy aligns with E39.2 (8) by minimizing adverse effects on the environment by retaining the original hydrology. Minimizing changes to hydrology is also compliant with E1.3 (8)(c). This strategy also ensure there is no permanent loss of hydrological flows downstream of the development, this is consistent with the requirements of B7.3.2.

The overall proposed road catchment that will discharge to Sinton Stream is 4,900m². This compliant with E8.4.1 Activity Table (A4) and classified as a Permitted Activity.

The final design and approval of the public stormwater infrastructure will be confimed at the EPA stage.

Please refer to **Appendix C** for the 10%AEP stormwater calculations.

6.2.5 FLOODING 1% AEP

The existing 100-yr scenario has been summarized in section 1.6.

The post-development 100-yr runoff from the subject site will discharge via multiple sub-catchments which generally maintain the existing entry and exit point for the OLFPs.

OLFP generated from the upstream catchment – central portion of 45 Brigham Creek Road will be conveyed via open channel between buildings of proposed Lot 52 & Lot 53 before discharging onto the proposed road network. An easement will be provided within these lots to ensure the flow is not obstructed. Allowance has been made for development of 45 Brigham Creek Road with an imperviousness of up to 75%.

In accordance with the existing catchment western portion of 45 Brigham Creek Road will sheet flow into the north-western corner of the site and will be conveyed through the site.

Post development, the secondary flow paths generated from the subject site will be safely conveyed within the road reserves.

An assessment of peak flow rates along each of these roads and subject properties has been undertaken, for a 100-yr ARI rainfall event with the effect of climate change (16.8% increase) based on the following assumptions:

The imperviousness of the contributing catchments is a based on:

- 70% impervious for developed lots;
- 85% impervious for roads; and
- 100% impervious for JOALs

Building platforms are elevated above adjacent road reserve to ensure drainage away from future buildings as well as maximising freeboard (vertical offset) OLFPs.

A Depth-Velocity analysis has been conducted in section 6.2.6 below.

6.2.6 OVERLAND FLOWPATH AND PLAIN

6.2.7 MANAGEMENT

A Rapid Flood Hazard Modelling ('RFHM') was conducted for the greater catchment as part of the Whenuapai SMP. The results of the RFHM indicate that the risk to existing properties in the catchment is minimal when considering the resultant flows from a 1% AEP rain event in the MPD scenario.

It is proposed to pass forward post-development flows without attenuation. Post-development flows from the subject site will be conveyed via roads and will be discharged to 5 Mamari Road and Sinton Stream as quickly as possible in order to pass them through to the Harbour before the peak flows from the upper reaches of the catchment reach the area. This is to avoid coincidence of flood peaks that would worsen the downstream flooding and increase flood risk upstream. This approach has also been applied to post-development the sheet flow runoff onto 39 Brigham Creek Road.

There is an increase in pre to post 100-yr SW discharge from the site onto 5 Mamari Road (south). 5 Mamari Road is a majority pastureland and has an existing habitable building on the eastern side of a site. A cross-section at the critical location (adjacent to the existing building on 5 Mamari Road) has been produced to demonstrate the flooding effects post development of 41-43 Brigham Creek Road & 45 Brigham Creek Road. As shown on Maven Plan C462, the 100-yr discharge for this OLFP increases from 1.18m³/s to 1.31m³/s (Allows post-development flows from 45 Brigham Creek Road) and the flood level at this location increases by 5mm from pre to post development. Future development of 5 Mamari will convey the proposed OLFPs via extension of roads and discharge into Sinton Stream.

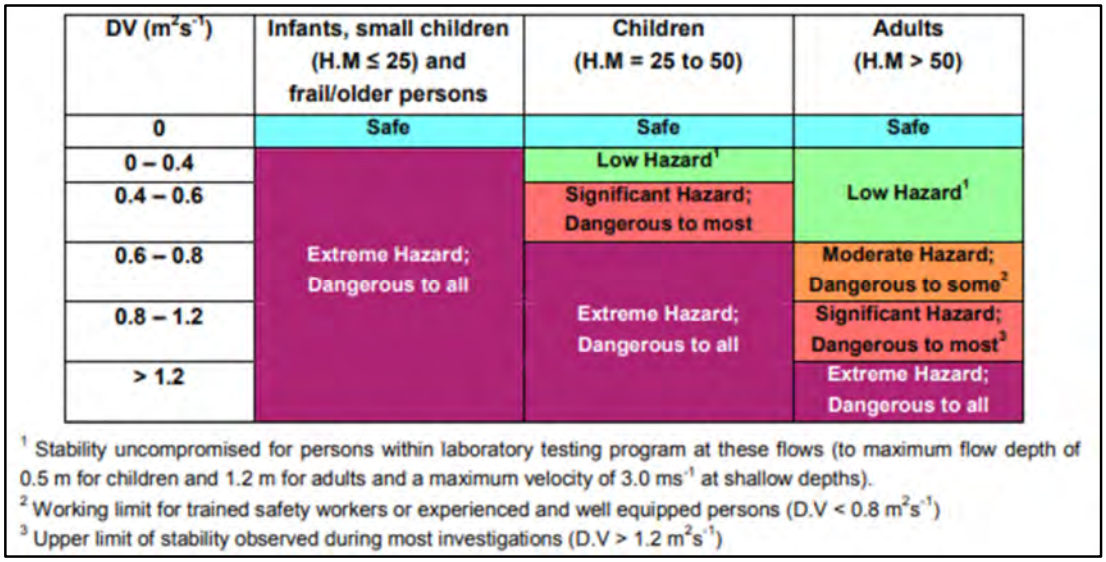
The post-development 100-yr runoff from the northern portion of the site will discharge to Brigham Creek Road (where it will overtop the road centreline crest and discharge onto Joseph Mcdonald Drive) decreases from 0.80m³/s predevelopment to 0.75m³/s post-development.

The post-development 100-yr runoff from the western portion of the site will be via sheet flow. As shown on Maven plans C461 & C462, the 100-yr runoff from this subject catchment decreases from pre to post development.
There are no known downstream capacity issues, Auckland Council Health are to provide confirmation of this as part of as part of the resource consent application.

Please refer to **Appendix C** for the 1% AEP stormwater calculations and **Appendix B** for the 1% AEP stormwater plans.

FLOOD HAZARD – DEPTH-VELOCITY ANALYSIS

The Australian Rainfall & Runoff Revision Project Stage 1 Report (April 2010) Table 5 (Figure 13 below) indicates flow hazard regimes for infants, children, and adults.



DV (m^2s^{-1})	Infants, small children (H.M ≤ 25) and frail/older persons	Children (H.M = 25 to 50)	Adults (H.M > 50)
0	Safe	Safe	Safe
0 – 0.4	Extreme Hazard; Dangerous to all	Low Hazard[1]	Low Hazard[1]
0.4 – 0.6		Significant Hazard; Dangerous to most	
0.6 – 0.8		Extreme Hazard; Dangerous to all	Moderate Hazard; Dangerous to some[2]
0.8 – 1.2			Significant Hazard; Dangerous to most[3]
> 1.2			Extreme Hazard; Dangerous to all

[1] Stability uncompromised for persons within laboratory testing program at these flows (to maximum flow depth of 0.5 m for children and 1.2 m for adults and a maximum velocity of 3.0 ms^{-1} at shallow depths).
[2] Working limit for trained safety workers or experienced and well equipped persons (D.V < 0.8 m^2s^{-1})
[3] Upper limit of stability observed during most investigations (D.V > 1.2 m^2s^{-1})

Figure 13: Australian Rainfall & Runoff Revision Project Stage 1 Report (April 2010) Table 5

As per the calculations **(Appendix C)** and plan series C462 **(Appendix B)** and Stormwater Treatment Catchment Plan (C406), a DV (Depth x Velocity) analysis has been conduced for the public roads during a 100-yr event.

The highest DV factor of 0.35 is observed at public road 5. All public roads will be under the DV value of 0.4 and can be classfied as no more than a Low Hazard under this criterion.

Public Road	Depth (m^3)	Veolcity (m^2/s)	D.V (Max.)
1	0.24	0.77	0.19
2	0.12	1.23	0.15
3	0.18	0.63	0.11
4	0.14	0.59	0.08
5	0.21	1.64	0.35
Mamari Rd	0.13	1.50	0.20

Table 5: Public Roads D.V Analysis Summary

For a conservative approach the highest OLFP channel depths are used for DV calculations. DV values for public roads 2, 3, 4 and 5 are modelled for sections at the ultimate downstream ends of the proposed road network which account for the biggest upstream catchments.

Essentially, the DV values for the majority extent of the public roads will be lower than the DV values in Table 5.

As shown in the overland flow sections in plans C463 and C464, the 100-yr flooding design depths will be under 300mm, with velocities under 2m/s. This classifies the public roads as a Minor Hazard under the Auckland Council Stormwater Flood Modelling Specifications (Figure 14 below).

Table7.5 Flood Hazard Classification Category

Hazard Classification	Description	Depth – Velocity Criteria
1	Potential Hazard	0.05 m < Depth < 0.1 m
2	Minor Hazard	0.1 m ≤ Depth < 0.3 m and Velocity < 2.0 m/s
3	Significant Hazard	Depth ≥ 0.3 m and Depth ≥ 0.1 m & Velocity ≥ 2.0 m/s

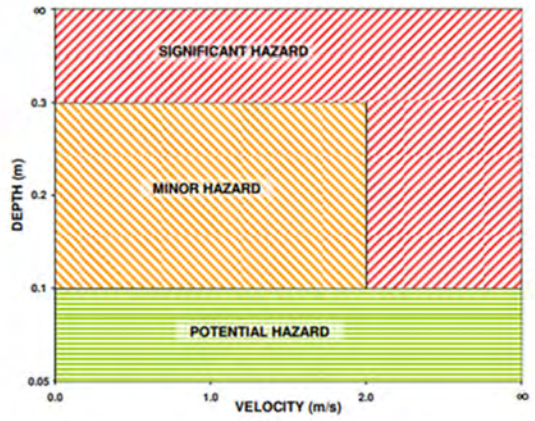


Figure 14: Auckland Council SW Flood Modelling Specifications Table 7.5

FLOOD HAZARD ASSESSMENT OF ADJACENT PROPERTIES/PERSONS

In accordance with AUP E36.9 a flood hazard risk assessment for adjacent properties has been undertaken.

(a) the type, frequency and scale of the flooding hazard and whether adverse effects on the development will be temporary or permanent
The adjacent properties which will be effected by the alteration of flood hazards as a result of the proposed development are 39 Brigham Creek Road & 5 Mamari Road. The effects of 1 in 100 year flood hazard have been assessed. The pre to post development 100 year storm event discharge into 39 Brigham Creek Road is reduced and therefore there are no adverse effects on this adjacent site. The pre to pre to post development 100 year stormwater discharge into 5 Mamari Road increases and therefore the flood hazard is to be assessed. The adverse effects of the subject development are permanent.
(b) the type of activity being undertaken and its vulnerability to flood hazard events;
5 Mamari Road is currently zoned for Future Urban Zone under the unitary plan. The property is currently being used for agricultural activities and is predominantly pastured land and has a single house on the eastern side of the property. The existing house is not vulnerable to flood hazards as it's topographical positioning within the site keeps it clear of proposed flood hazards. There are defined localised low laying areas within the site that convey overland flow paths, these are clear of the existing building.
(c) the consequences of a flood hazard event in relation to the proposed activity and the people likely to be involved in that activity;
Agricultural activities on 5 Mamari Road will not be undertaken during a 100 year flood event and therefore there are no consequences of a flood hazard event in relation to this activity. The flood hazards are away from and have freeboard to activities within the habitable area and therefore risk of consequences is very minimal.
(d) the potential effects on public safety and other property;
As the flood hazards are away and have freeboard to the habitable area and does not impede access, the flood hazard is expected to have close to no potential effects on the public safety and property.
(e) any exacerbation of an existing flooding hazard risks or creation of a new flooding hazard risks;
The exacerbation of the existing flooding hazard is considered to be negligible. The subject development will increase the depth of flooding within 5 Mamari Road by a maximum of 5mm, this is considered to be negligible when the flooding is within the pastured area and freeboard to the habitable area is maintained.
(h) the design and construction of buildings and structures to mitigate the effects of flooding hazard;
Freeboard from the flood hazard to the existing habitable area will be maintained. Any future development of 5 Mamari will require habitable areas to have freeboard to flood hazards in accordance with SWCOP.
(j) site layout and management to avoid or mitigate the adverse effects of flooding hazard including access and exit during a flood hazard event;
The entrance points of overland flow paths within 5 Mamari Road have been maintained and not altered. The subject development has not created any adverse effects from flooding hazards on access and exit to Mamari Road.
(l) any measures and/ or plans proposed to mitigate the flooding hazard or the effects of the flooding hazard.
The subject development proposes to convey overland flow paths along the proposed public roads. In the future this will allow adjacent properties to extend the public road network and continue to convey overland flow paths within the road reserve within their development.

OVERLAND MITIGATION AND MINIMUM FLOOR LEVELS

In accordance with the AUP - OP and AC SWCoP, the risk of damage to people, property and the environment as a result of flooding is to be mitigated through the adherence to minimum free board heights.

Auckland Council Code of Practice (2022) Table 4.5 indicates the minimum freeboard requirements for habitable zones.

Scenario	Freeboard
More Vulnerable Activities* in floodplains	• 500 mm
Less Vulnerable Activities* in floodplains	• 300 mm
Overland flow paths where flow is less than 2m³/s	• 500 mm where surface water has a depth of 100 mm or more and extends from the building directly to a road or car park, other than a car park for a single dwelling • 150 mm for all other cases
Overland flow paths, where flow is equal to or in excess of 2m³/s	• 500 mm for More Vulnerable Activities* • 300 mm for Less Vulnerable Activities*

Figure 15: AUP – OP Freeboard Requirements

In summary:

OLFPs passing through the site are less than 2m³/s, the OLFPs do not extend directly from the building to a road or car park. As such a minimum freeboard of 150mm above the maximum top water level of the OLFP is required. All proposed buildings have a 225mm step down from the building finished floor level resulting in no OLFP encroachment. The development design ensures compliance with Council freeboard requirements.

6.2.8 DEVELOPMENT STAGING

The entire development will be completed in one stage.

6.3 HYDRAULIC CONNECTIVITY

As detailed in Section 6.2.6, 1% AEP flows from the upstream floodplain at 45 Brigham Creek Road will be conveyed within the future public road whilst maintaining the original exit point.

The future public stormwater infrastructure (10% AEP) will be designed to accommodate flows from the upstream catchment for the Maximum Probable Development (MPD) scenario.

The proposed design retains the existing natural catchment flows onto downstream 5 Mamari Road. This also ensures there is no permanent loss of hydrological flows in relation to the downstream wetlands. Refer to RMA Ecology's Ecological assessment in Appendix E for full assessment of the existing ecological features.

The proposed 10-yr reticulation network terminating at the southern end of the development can be extended further downstream by the future development at 5 Mamari Road.

6.4 ASSET OWNERSHIP

All proposed public stormwater network extension within the development will owned by Auckland Council or the relevant CCO (Healthy Waters).

All stormwater management devices in the public road reserve shall be vested to Auckland Transport.

Stormwater devices treating JOALs are to be owned by Body Corporates/Resident Associations or Lot owners.

All public roadways and related assets will be owned by Auckland Transport.

6.5 ONGOING MAINTENANCE REQUIREMENTS

All public stormwater extensions at the site, pipes and manholes forming the extent there of, are to be maintained by Auckland Council. All private devices are to be maintained by related Body Corporates/Resident Associations or lot owners.

It is proposed that all stormwater devices proposed are proprietary systems that have documented operation and maintenance schedules and plans for such activities.

Operation and maintenance plans will be provided for all stormwater management devices that will be vested with Council. This will be required as a condition of any approved consent.

6.6 IMPLEMENTATION OF STORMWATER NETWORK

Provisions on protecting the downstream network shall be through implementing temporary sediment and erosion controls to ensure stormwater discharge is properly treated and discharged during construction.

The methodology is as follows:

- Existing site structures, pavement, and minor drainage to be stripped and removed prior to earthworks.
- Installation of erosion and sediment controls and treatment/retention devices.
- Conduct Earthworks, whilst discharging captured clean waters and treated ‘dirty water’ in accordance with the proposed erosion and sediment controls.
- Construction of public stormwater infrastructure.
- Construction/installation of attenuation/treatment devices and drainage under roadways
- Stabilisation of the site and construction of JOALs.
- Vesting of newly constructed public drainage assets.
- Construction of residential dwellings and associated private stormwater attenuation devices.

6.7 DEPENDENCIES

Section 6.6 details the sequencing for construction of drainage and civil infrastructure.

Construction of public stormwater assets (such as raingardens, stormwater reticulation pipes and manholes) shall be in accordance with Council/AT standards and EPA approvals. These assets will then undergo public vesting process to the appropriate authority as part Council rules and regulations.

Construction of public wastewater and water supply assets (such as pipes and manholes) shall be in accordance with Watercare standards and EPA approvals. These assets will then undergo public vesting process to Watercare.

Vesting of these public assets will be a pre-condition to conduct the legal subdivision of the site and to gain the final Lot titles for the development and build future buildings. This is identified as a dependency for the development.

The proposed development is dependent on the construction of the future Brigham Creek Road pumpstation. Watercare have confirmed the planned installation of the pump station subject to funding. The pump station will be commissioned in 2024. The proposed development will ultimately discharge into this pumpstation with no interim solutions required as per Watercare feedback.

Please refer to the development Infrastructure Report (via. Maven Associates) for more information.

6.8 RISKS

Risks in relation to stormwater management pertain to the proposed discharge to the ultimate receiving environment – Sinton Stream, which is identified as a Significant Ecological Area ('SEA'). Sediment run-off and damage to existing ecology is identified as a potential risk.

The public stormwater outfall will be installed with appropriate erosion control measures.

DEPARTURES FROM REGULATORY OR DESIGN CODES

At this stage, there are no known departures from Auckland regulatory and design standards.

7 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

7.1 CONCLUSIONS

The proposed SMP for the development sets out a high-level stormwater management framework which will enable the urbanisation of the site whilst mitigating any effects on the receiving environment. The outcomes sought in the SMP align with the NDC Schedule 4 (Greenfield) requirements.

The SMP includes provisions for a Water Sensitive Design (WSD). Before ultimate discharge into the receiving environment (Sinton Stream), stormwater run-off from the site (including public trafficable areas) will be treated for quality via. raingardens (bioretention) and proprietary treatment devices. The proposed treatment of stormwater is considered to align with the mana whenua values.

A public stormwater network (10% AEP including climate change) has been designed to Auckland Council standards to service the development. The design retains the existing natural catchment and ensures no permanent loss of downstream hydrology. Detailed engineering design of the development shall be confirmed at Resource Consent and Engineering Approval stages.

SMAF 1 provisions have been implemented for the development. Retention and detention storages will be provided via. a combination of raingardens and underground tanks.

The proposed strategy minimizes adverse downstream effects of the proposed development in terms of flooding (up to 1% AEP including climate change) whilst ensuring a safe/hazard free living environment. Existing flood plains in the site vicinity have been accounted for in the SMP. The proposed overland flow path strategy details the overland flow conveyance within the development roadways. The development can be considered a Low/Minor Hazard in terms of overland flows per Auckland Council guidelines.

The overall stormwater strategy and technical design complies with Auckland Council and Auckland Transport bylaws and is considered acceptable.

Subject to compliance with this SMP, there will be no stormwater effects and the discharge will be enabled under the regional wide NDC. Subject to the adoption of the SMP, the proposed stormwater management of the site will accord with Schedule 4 of the Regional NDC.

7.2 RECOMMENDATIONS

Maven Associates considers the Stormwater Management Plan acceptable to enable the intended development of the site, with the proposed outcomes consistent with Schedule 4 of the regional NDC and mana whenua values.

APPENDIX A: AECOM SMP EXCERPTS

5.0 Proposed Stormwater Management

5.1 General

This section of this SMP provides commentary on the assessments undertaken to identify the preferred method of stormwater management for the catchment, including the structure plan area.

Existing NDCs granted prior to the notification of the PAUP are present for the Plan Change 14 (Waiarohia), Plan Change 13 (Hobsonville Peninsula) and Plan Change 15 (Totara) development areas. The approved stormwater management for these plan change areas were consented under the Auckland Plan: Air land and Water and are not in alignment with the provisions of the PAUP. Once the PAUP becomes operative the Auckland Council will apply to amend the NDCs to reflect the provisions of the PAUP and the recommendations made in this SMP.

In the absence of comprehensive development or staging plans for the catchment it is not possible to provide defined extents and costs associated with public stormwater infrastructure; however, this section of the SMP provides some high level commentary on what Auckland Council may need to consider to facilitate on-going development.

The SMP provides overarching guidance for the development of the stormwater management at a catchment level. The preferred method of management is provided in the sections below. To ensure compliance with the preferred option, developers will need to consider specific site constraints / opportunities to define the best practicable method of stormwater management as detailed in Section 3.2 of this SMP.

5.2 Minimum Stormwater Provisions

5.2.1 Water Quality

Treatment of runoff is required for HCGAs (as defined in the PAUP) including:

- High use roads (with greater than 5,000 vehicle movements per day).
- Car park areas with greater than 50 vehicles per day.
- High contaminant yielding building and roofing materials.
- Industrial/Trade sites listed as high risk in Schedule 3 will require assessment under the ITA rules which may result in treatment being provided
- Treatment of discharges to the CMA will be required due to the receiving environment being identified as a SEA.

5.2.2 Frequent Rain Event Management

Frequent rain event management will be achieved through hydrology mitigation in accordance with the Stormwater Management for Flow Area 1 provisions as per the findings from the Proposed Auckland Unitary Plan mediation, '*Recommended amendments to H 4.14 Stormwater Management Rules*' 7 September 2015. This includes the following aspects:

- Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious areas.
- Provide detention (temporary storage) with a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from the 95th percentile, 24 hour rainfall event minus the retention volume for all impervious areas.

Hydrology mitigation is considered to promote stream health through maintaining natural baseflow regimes within the waterways through the area and minimising erosion risk through slow release of runoff from development areas.

5.2.3 Conveyance

Developers are required to provide a stormwater network to convey runoff generated from the 10% AEP event from their development and convey this to the receiving environment. Where this network is proposed to be vested with the Auckland Council, the network should be designed in accordance with the requirements set out in the SWCoP.

It is preferred to have a number of discreet outlets to the receiving environment to better mimic natural drainage paths and reduce the risk of erosion that can result from large point discharges. Additional controls to disperse flows should be considered through setting back of stormwater outlets within the riparian margin or at the coastal edge and allowing sheet flow to enter the waterway. The encouragement of sheet flow through the riparian margins will also provide additional treatment promoting waterway health.

5.2.4 Extreme Event Management

5.2.4.1 Flow Attenuation

The current results of the RFHM indicate that the risk to existing properties in the catchment is minimal when considering the resultant flows from a 1% AEP rain event in the MPD scenario. As a result attenuation of extreme events is not considered necessary

Where developments result in alterations to the natural landform it will be necessary for them to demonstrate no negative impact on the properties, upstream and downstream, otherwise mitigation will be required.

5.2.4.2 Overland Flow Management

Natural overland flowpaths are to be retained in the developed scenario. Flowpaths through development sites will be required to be incorporated into the final landform so as not to pose a risk to property or people.

Flowpaths will also be protected and kept free from obstruction.

Similar to flow attenuation, where alterations are made to the overland flowpath as a result of earthworks, it will be necessary for the developer to demonstrate no negative impacts are caused by the proposed changes.

5.2.4.3 Floodplain Management

It is considered that management of the floodplain will be provided through the provisions contained within the PAUP. No vulnerable activities will be allowed within the floodplain and general levels of development will be kept to a minimum.

5.2.5 Receiving Environment

To provide protection to and promotion of the receiving environment the following items are considered to be required.

- Protection of permanent and intermittent streams. Indicative stream locations are provided on **Plan 8** in **Appendix C** and will require developers to confirm stream classification and extents through site specific investigations.
- Permanent and intermittent streams should be enhanced through riparian planting and active management to promote biodiversity.
- Construction of erosion protection measures where possible, considering WSD (for example setbacks) initially before engineered protection works.
- The addition of fish passage where necessary and removal of existing barriers to promote ecological and biodiversity factors.
- Provision of setback stormwater discharges within the coastal esplanade area to promote diffuse flows to the CMA.
- Natural wetlands do not provide part of the stormwater management to service specific developments, but require protection and enhancement as part of development.

5.3 Land Use Specific Management

The text in 5.2.5 above outlines the general minimum stormwater provisions that are required to promote long-term sustainable stormwater management in the catchment. There are also land use activity specific requirements that developers will be required to address. These additional requirements are presented in Table 8 below.

Table 8: Additional Stormwater Management Requirements with regard to Land Use

Land Use Activity / Development Zoning	Additional Stormwater Management Requirements and Considerations
BusinessZone	- Consideration of disconnection of impervious surfaces prior to discharge to the public stormwater infrastructure to minimise the impact and risk of contamination reaching the receiving environment. - Consideration of proprietary device to provide target treatment of high risk contaminants associated with site specific activities. - Consideration of living roof and other WSD applications.
Residential Zones	- Consideration of lot based application of WSD (such as reuse tanks for roof water, bioretention devices prior to discharge to the conveyance network and permeable paving for driveway and general site impervious areas minimising the size of public stormwater infrastructure and assist in obtaining green star ratings for the development.
Commercial Zone	- Consideration of disconnection of impervious surfaces prior to discharge to the public stormwater infrastructure to minimise the impact and risk of contamination reaching the receiving environment. - Consideration of development applications of WSD incorporated into the development area, for example incorporation into landscaping components that add amenity aspects as well as stormwater management.
Roads	- No additional requirements or considerations above the minimum set out in sections 5.2.1 and 5.2.2.
Open Spaces / Reserves	- Consideration of incorporation of WSD approach to stormwater management - development specific. - Consideration of multi-purpose devices for stormwater management and amenity / community benefits.
Coastal Zone	- Provision of frequent rainfall event detention to minimise erosion risk for coastal discharges. - Preference for discharges to existing watercourses to minimise number of outfalls to the CMA and minimise the risk of potential coastal erosion; where unavoidable provision of outfall setbacks from the CMA to allow dispersal of flows prior to discharge and free drainage during high tide events.

- Four Well Beings (Social, Economic, Environmental and Cultural).
- Provisions of stormwater management as outlined in the PAUP (treatment, retention, detention and flood management).
- Costs (land acquisition costs, capital and operational expenditure).
- Health and Safety / risk (construction, maintenance and operation).

This initial grading was used to identify the preferred methods of stormwater management throughout the Whenuapai Structure Plan area.

The top five scoring devices considered applicable to Whenuapai are:

- Bioretention (raingardens, bio-swales and tree pits)
- Reuse tanks
- Swales
- Living Roofs (generally best suited for industrial and commercial applications where space requirements may not facilitate the construction of mitigation devices to address the total impervious area)
- Detention Basins / Dry Basins

Each of the above devices has also been graded in consideration to its suitability to specific land uses. The result of the analysis is included in Table 10 below.

Table 10: Stormwater management device suitability with land use

	Business	Road	Commercial	Open Spaces	Single House	Mixed Use Suburban	Mixed Use Urban
Bioretention	●	●	●	●	●	●	●
Reuse Tanks	●	●	●	●	●	●	●
Swales	●	●	●	●	●	●	●
Living Roofs	●	●	●	●	●	●	●
Detention Basin	●	●	●	●	●	●	●

● - Very Suitable; ● - Somewhat Suitable; ● - Not Suitable

2.4.2 Existing Drainage Networks

Due to the current land use in the catchment, piped stormwater infrastructure is limited to the existing residential area to the north east area and within the air base. Drainage of the remaining catchment is provided through a network of streams including natural and modified wetland remnants. Figure 7 shows the indicative location of the main streams and some of the wetland remnants. Refer to **Appendix C**, **Plan 8** for an indicative stream layout plan and the names of key watercourses. The identification of transition points between permanent/intermittent streams and ephemeral streams was undertaken by Morphum Environmental Consultants Ltd (Morphum). The definition of their scope and methodology for completing the study are included in Appendix D of this report.

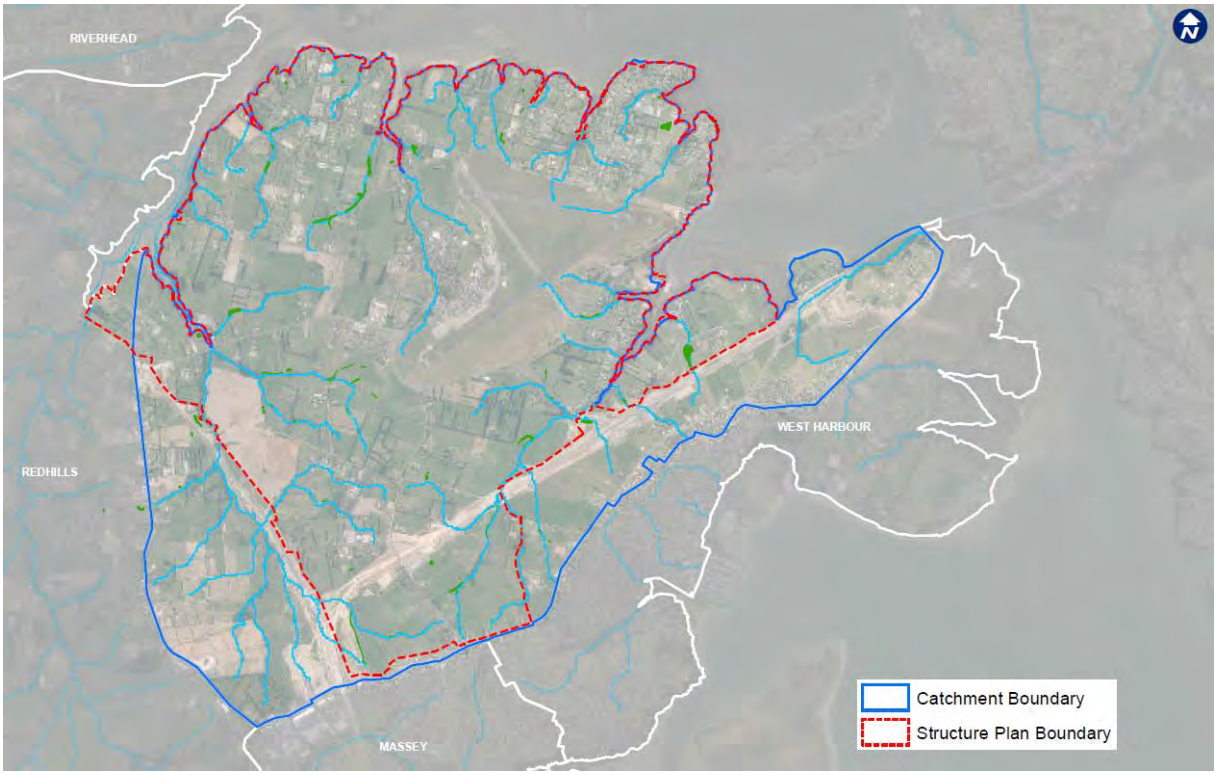


Figure 7 **Aerial with the main streams and additional water features (suspected wetlands and ponds – green) within the Whenuapai catchment area.**

Appendix C, Plan 1 depicts the sub-catchments associated with the natural drainage system. Most of the land surface drains via a number of first and second order streams, such as Riverlea Stream, Ratara Stream and Orchard Stream, in the north; with the remaining catchment area draining via two third order streams in the south: the Waiarohia Stream and Totara Creek. These streams feed into the Upper Waitemata Harbour via Brigham Creek and other tidal inlets into environments which have limited capacity for tidal flushing. The existing ecological values of the area are primarily centred around the coastal environment, and include areas of remnant indigenous riparian vegetation, mangroves, and salt marshes of regional and national significance.

The majority of streams associated with pastoral land use are unfenced and therefore providing access to stock, resulting in direct contamination of watercourses, stream bank erosion and associated sedimentation of the harbour. Fish barriers have been created through the damming or piping of streams.

There is evidence of natural wetland and pond features occurring in association with the catchment's stream network. A survey was undertaken in the northern portion of the plan area by Golder Associates in 2014, identified a series of wetlands (four), and ponds (12), while a further 16 ponds were identified within the reaches of the Totara and Waiarohia catchments by URS in 2010 (see Figure 7). Most are described as being highly modified by grazing, drainage or the creation of stock ponds. The largest natural wetland was located on Kotukutuku Inlet in Whenuapai, and other semi-modified wetlands were located to the west and south of the NZDF property. The majority of the ponds observed during URS investigations have been created by modification to permanent streams to support agricultural activities. Such modifications have been observed to reduce the base flows of streams during summer months and adversely affecting stream ecological values through increased stream temperatures and reduced oxygen levels. Removal of modifications and restoration of wetland systems will offer additional opportunities for enhancement.

5.0 Proposed Stormwater Management

5.1 General

This section of this SMP provides commentary on the assessments undertaken to identify the preferred method of stormwater management for the catchment, including the structure plan area.

Existing NDCs granted prior to the notification of the PAUP are present for the Plan Change 14 (Waiarohia), Plan Change 13 (Hobsonville Peninsula) and Plan Change 15 (Totara) development areas. The approved stormwater management for these plan change areas were consented under the Auckland Plan: Air land and Water and are not in alignment with the provisions of the PAUP. Once the PAUP becomes operative the Auckland Council will apply to amend the NDCs to reflect the provisions of the PAUP and the recommendations made in this SMP.

In the absence of comprehensive development or staging plans for the catchment it is not possible to provide defined extents and costs associated with public stormwater infrastructure; however, this section of the SMP provides some high level commentary on what Auckland Council may need to consider to facilitate on-going development.

The SMP provides overarching guidance for the development of the stormwater management at a catchment level. The preferred method of management is provided in the sections below. To ensure compliance with the preferred option, developers will need to consider specific site constraints / opportunities to define the best practicable method of stormwater management as detailed in Section 3.2 of this SMP.

5.2 Minimum Stormwater Provisions

5.2.1 Water Quality

Treatment of runoff is required for HCGAs (as defined in the PAUP) including:

- High use roads (with greater than 5,000 vehicle movements per day).
- Car park areas with greater than 50 vehicles per day.
- High contaminant yielding building and roofing materials.
- Industrial/Trade sites listed as high risk in Schedule 3 will require assessment under the ITA rules which may result in treatment being provided
- Treatment of discharges to the CMA will be required due to the receiving environment being identified as a SEA.

5.2.2 Frequent Rain Event Management

Frequent rain event management will be achieved through hydrology mitigation in accordance with the Stormwater Management for Flow Area 1 provisions as per the findings from the Proposed Auckland Unitary Plan mediation, '*Recommended amendments to H 4.14 Stormwater Management Rules*' 7 September 2015. This includes the following aspects:

- Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious areas.
- Provide detention (temporary storage) with a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from the 95th percentile, 24 hour rainfall event minus the retention volume for all impervious areas.

Hydrology mitigation is considered to promote stream health through maintaining natural baseflow regimes within the waterways through the area and minimising erosion risk through slow release of runoff from development areas.

5.2.3 Conveyance

Developers are required to provide a stormwater network to convey runoff generated from the 10% AEP event from their development and convey this to the receiving environment. Where this network is proposed to be vested with the Auckland Council, the network should be designed in accordance with the requirements set out in the SWCoP.

It is preferred to have a number of discreet outlets to the receiving environment to better mimic natural drainage paths and reduce the risk of erosion that can result from large point discharges. Additional controls to disperse flows should be considered through setting back of stormwater outlets within the riparian margin or at the coastal edge and allowing sheet flow to enter the waterway. The encouragement of sheet flow through the riparian margins will also provide additional treatment promoting waterway health.

5.2.4 Extreme Event Management

5.2.4.1 Flow Attenuation

The current results of the RFHM indicate that the risk to existing properties in the catchment is minimal when considering the resultant flows from a 1% AEP rain event in the MPD scenario. As a result attenuation of extreme events is not considered necessary

Where developments result in alterations to the natural landform it will be necessary for them to demonstrate no negative impact on the properties, upstream and downstream, otherwise mitigation will be required.

5.2.4.2 Overland Flow Management

Natural overland flowpaths are to be retained in the developed scenario. Flowpaths through development sites will be required to be incorporated into the final landform so as not to pose a risk to property or people.

Flowpaths will also be protected and kept free from obstruction.

Similar to flow attenuation, where alterations are made to the overland flowpath as a result of earthworks, it will be necessary for the developer to demonstrate no negative impacts are caused by the proposed changes.

5.2.4.3 Floodplain Management

It is considered that management of the floodplain will be provided through the provisions contained within the PAUP. No vulnerable activities will be allowed within the floodplain and general levels of development will be kept to a minimum.

5.2.5 Receiving Environment

To provide protection to and promotion of the receiving environment the following items are considered to be required.

- Protection of permanent and intermittent streams. Indicative stream locations are provided on **Plan 8** in **Appendix C** and will require developers to confirm stream classification and extents through site specific investigations.
- Permanent and intermittent streams should be enhanced through riparian planting and active management to promote biodiversity.
- Construction of erosion protection measures where possible, considering WSD (for example setbacks) initially before engineered protection works.
- The addition of fish passage where necessary and removal of existing barriers to promote ecological and biodiversity factors.
- Provision of setback stormwater discharges within the coastal esplanade area to promote diffuse flows to the CMA.
- Natural wetlands do not provide part of the stormwater management to service specific developments, but require protection and enhancement as part of development.

5.3 Land Use Specific Management

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Swales	●	●	●	●	●	●	●
Living Roofs	●	●	●	●	●	●	●
Detention Basin	●	●	●	●	●	●	●

● - Very Suitable; ● - Somewhat Suitable; ● - Not Suitable

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RIVERHEAD

REDHILLS

WEST HARBOUR

MASSEY

Westgate

Indicative Intermittent or Permanent Streams

- Ephemeral/Intermittent Transition Zone
- Intermittent or Permanent
- Subcatchments

Proposed Structure Plan

- Local Centre
- Business
- Low Density
- Medium Density
- High Density
- Mixed Use
- School

- Catchment Boundary
- Structure Plan Boundary
- NZDF Land/Airbase

Please be aware that the stream data contained in this map is provisional only as it was produced at a catchment modelled scale and not at an individual development scale

Rev.	By	App.	Description	Date
B				23 Aug 2016

Notes:

Printed	23/08/2016		
Approved	JB	Date	
Designed		Checked	AC
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File Name			

Map features depicted in terms of NZTM projection.

Data Sources:
NZ Topographical Features – LINZ NZ National Topo Dataset 2014
Cadastral Boundaries – LINZ NZ Cadastral Dataset 2014

AECOM

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Whenuapai Stormwater Management Plan

Title: **PLAN 1: SUBCATCHMENTS WITHIN WHENUAPAI STRUCTURE PLAN AREA**

Scale: 1:25,000 (A3 size) 0.25 0.125 0 0.25 0.5 0.75 1 km

Status: Final | Map No. 60491313_01 | Sheet No. 1 of 12 | Rev. B

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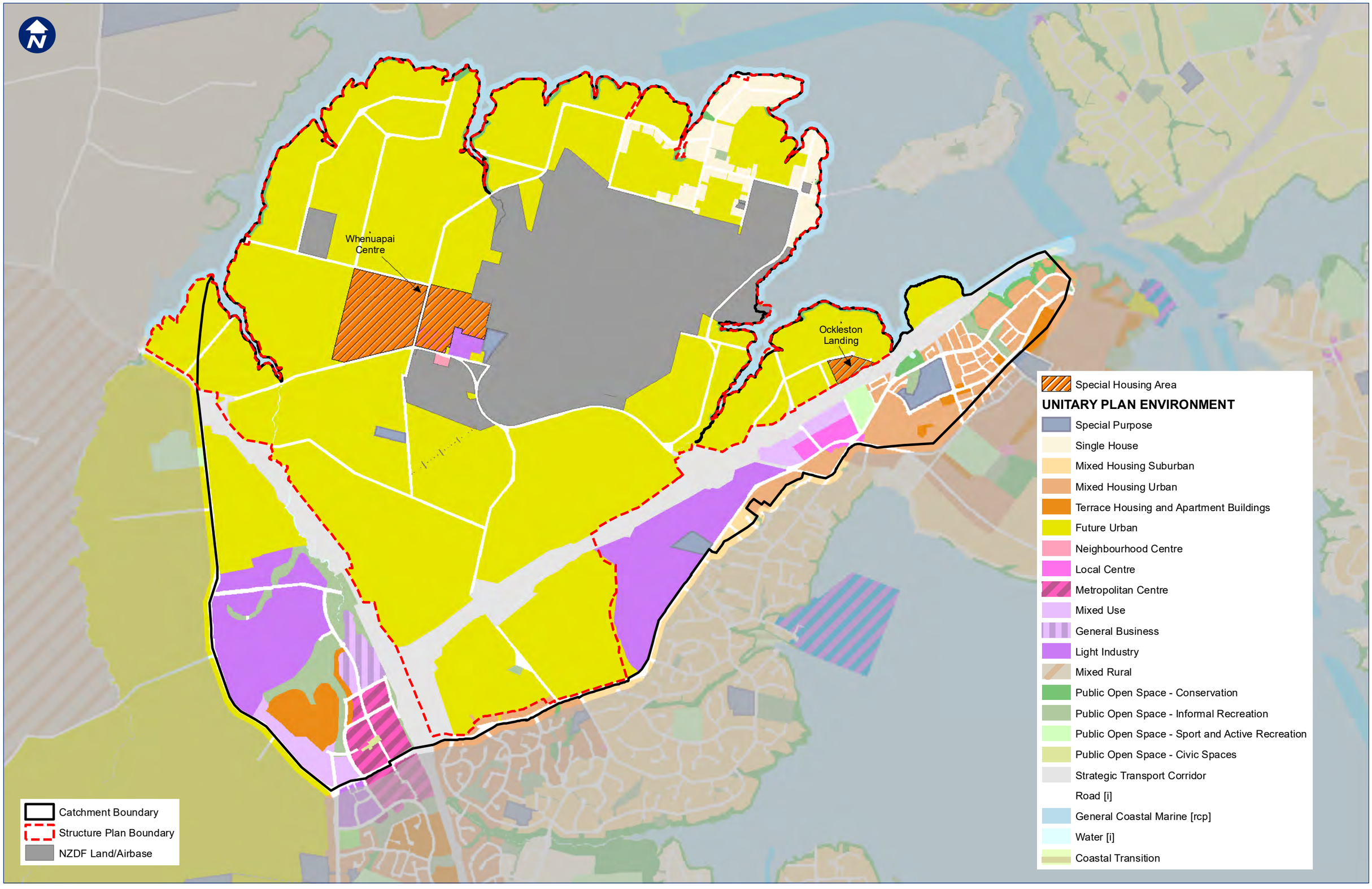

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B				23 Aug 2016

Notes:

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Approved	JB	Date	
Designed		Checked	AC
Drawn	FP	Checked	
File Name			

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Whenuapai Stormwater Management Plan

Title: **PLAN 2: PAUP LAND USES**

Scale: 1:25,000 (A3 size) 0.25 0.125 0 0.25 0.5 0.75 1 km

Status: Final | Map No. 60491313_02 | Sheet No. 2 of 12 | Rev. B

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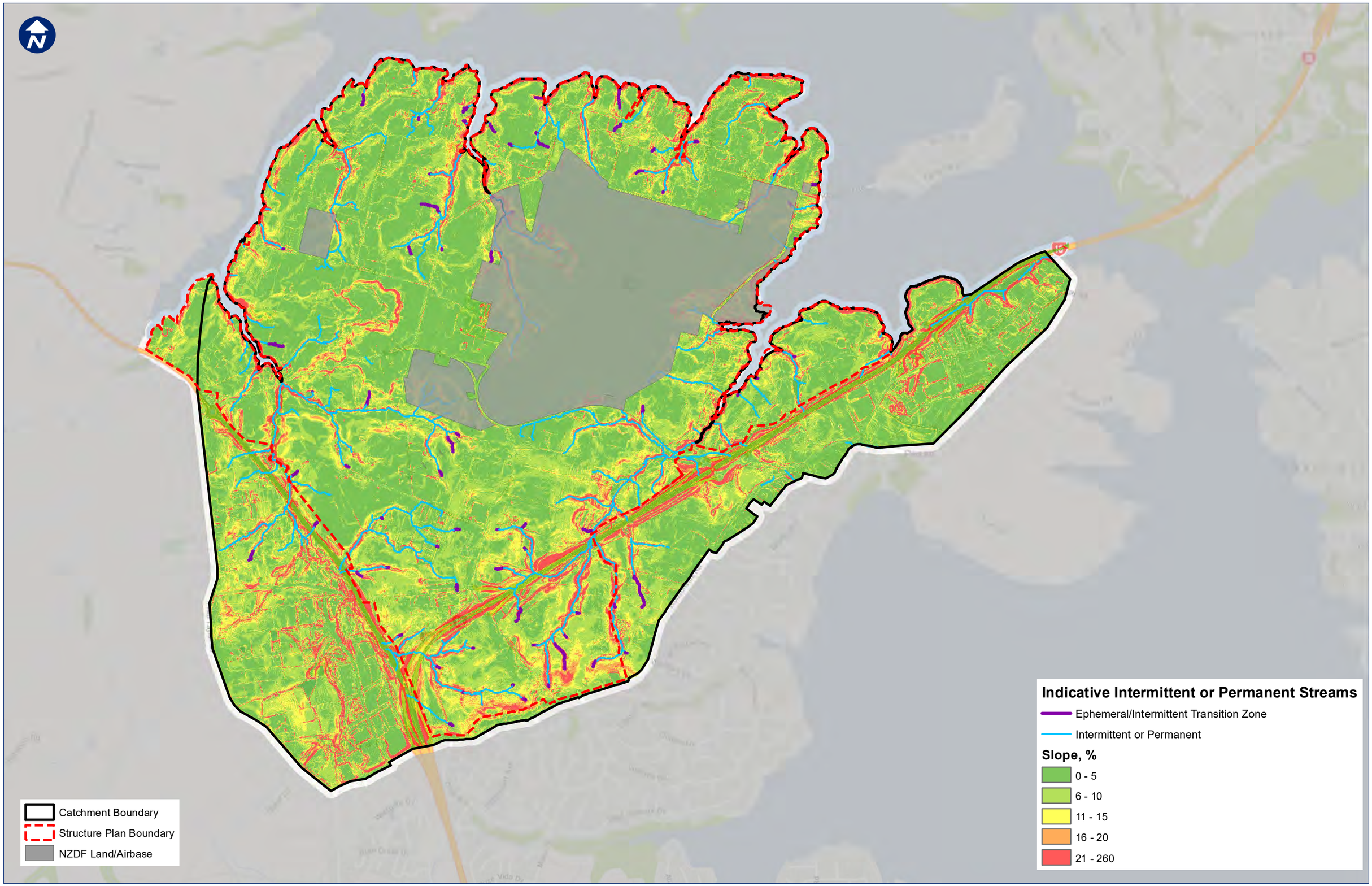

Rev.	By	App.	Description	Date
B				23 Aug 2016

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Approved	JB	Date	
Designed		Checked	AC
Drawn	FP	Checked	
File Name			

Map features depicted in terms of NZTM projection.

Data Sources:
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Whenuapai Stormwater Management Plan

Title: **PLAN 5: SLOPE ANALYSIS**

Scale: 1:25,000 (A3 size) 0.25 0.125 0 0.25 0.5 0.75 1 km

Status: Final | Map No. 60491313_05 | Sheet No. 5 of 12 | Rev. B

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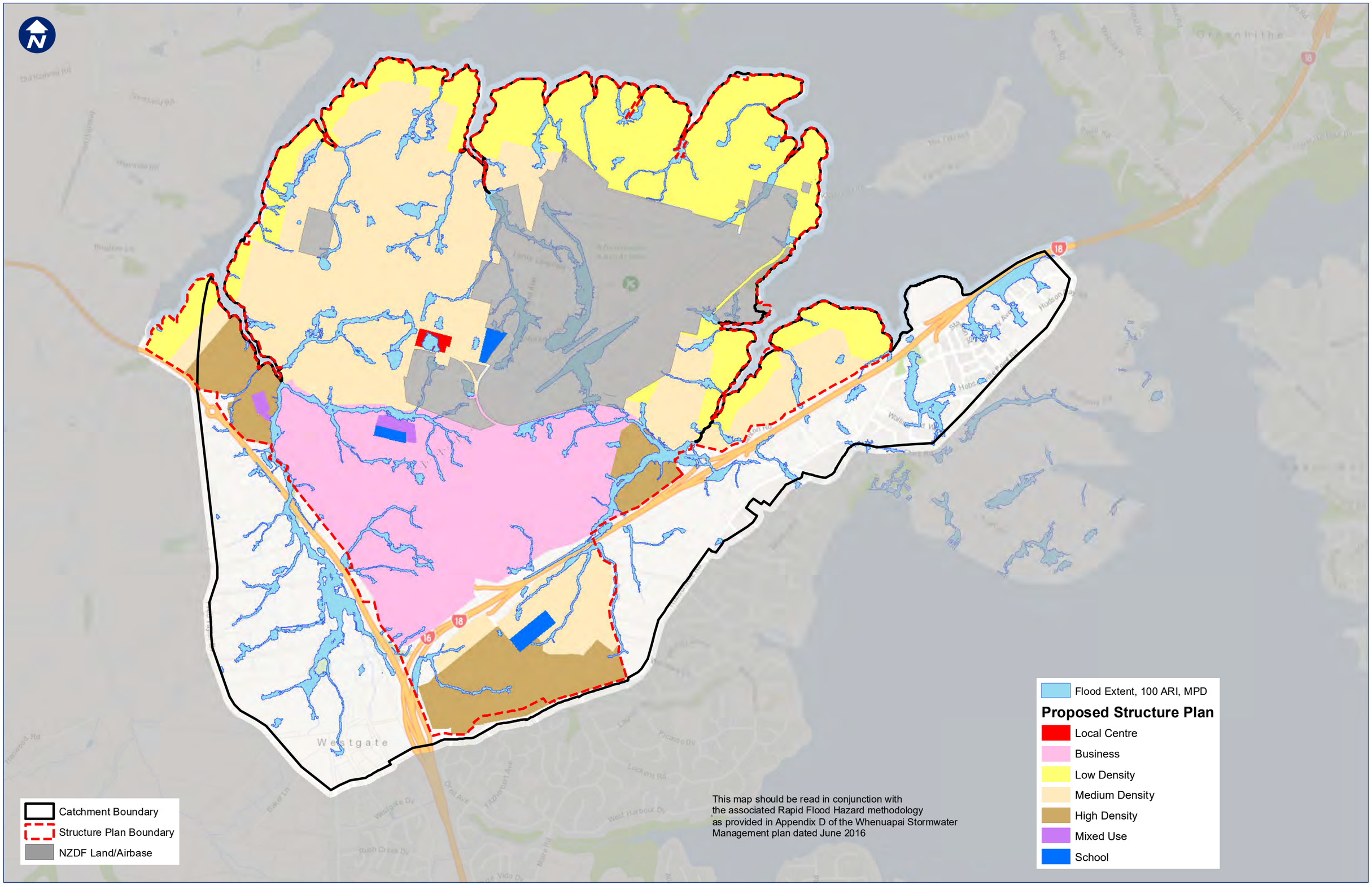

Rev.	By	App.	Description	Date
B				23 Aug 2016

Notes:

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Whenuapai Stormwater Management Plan

Title: **PLAN 6: FLOODPLAIN BASED ON A 100 YEAR EVENT AND PROPOSED LAND USE**

Scale:	Status:	Map No.	Sheet No.	Rev.
1:25,000 (A3 size)	Final	60491313_06	6 of 12	B

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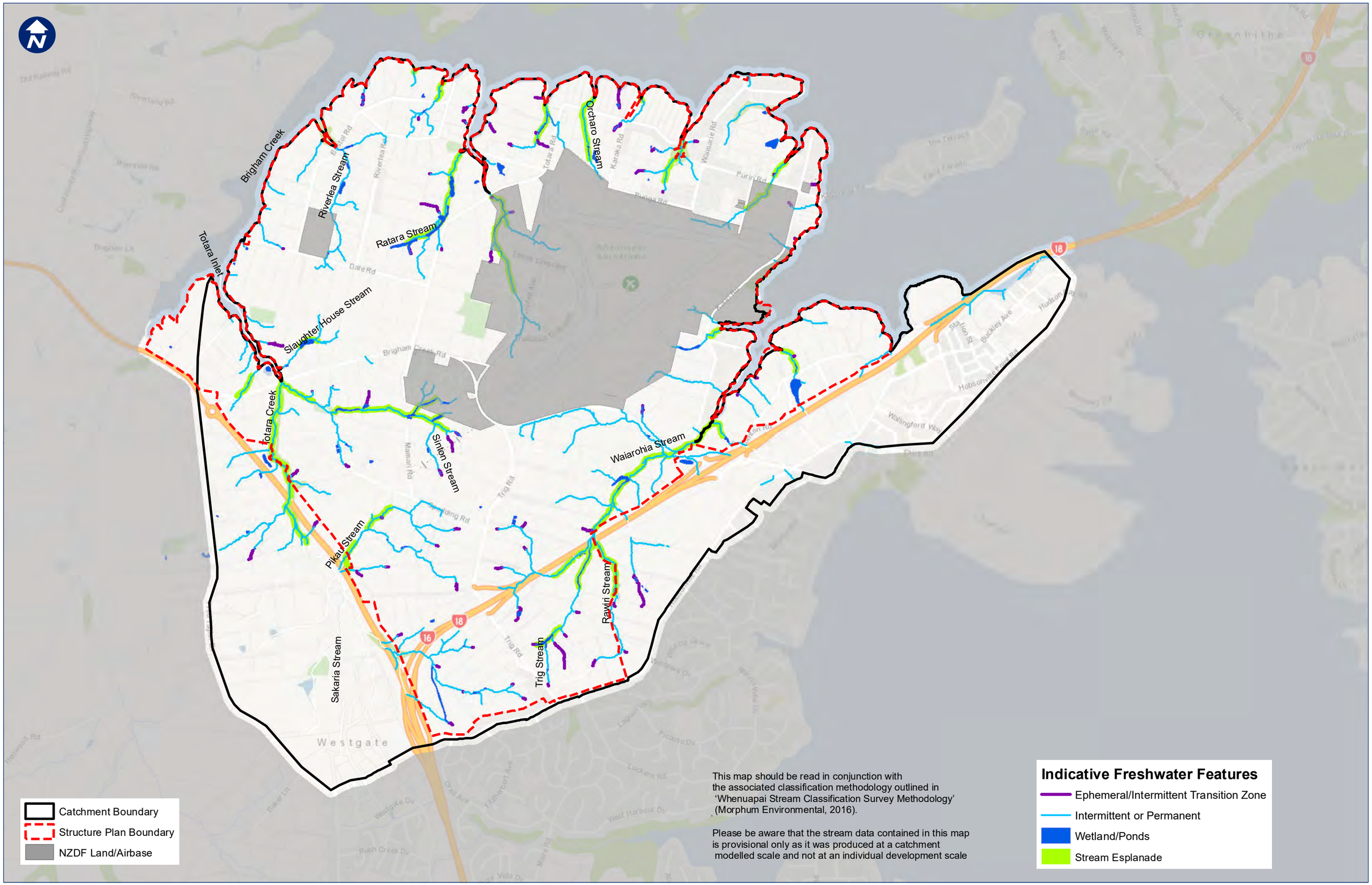

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B				23 Aug 2016

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Approved	JB	Date	
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Data Sources:
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Whenuapai Stormwater Management Plan

Title: **PLAN 8: STREAM AND WETLAND CLASSIFICATION**

Scale: 1:25,000 (A3 size) 0.25 0.125 0 0.25 0.5 0.75 1 km

Status: Final | Map No. 60491313_08 | Sheet No. 8 of 12 | Rev. B

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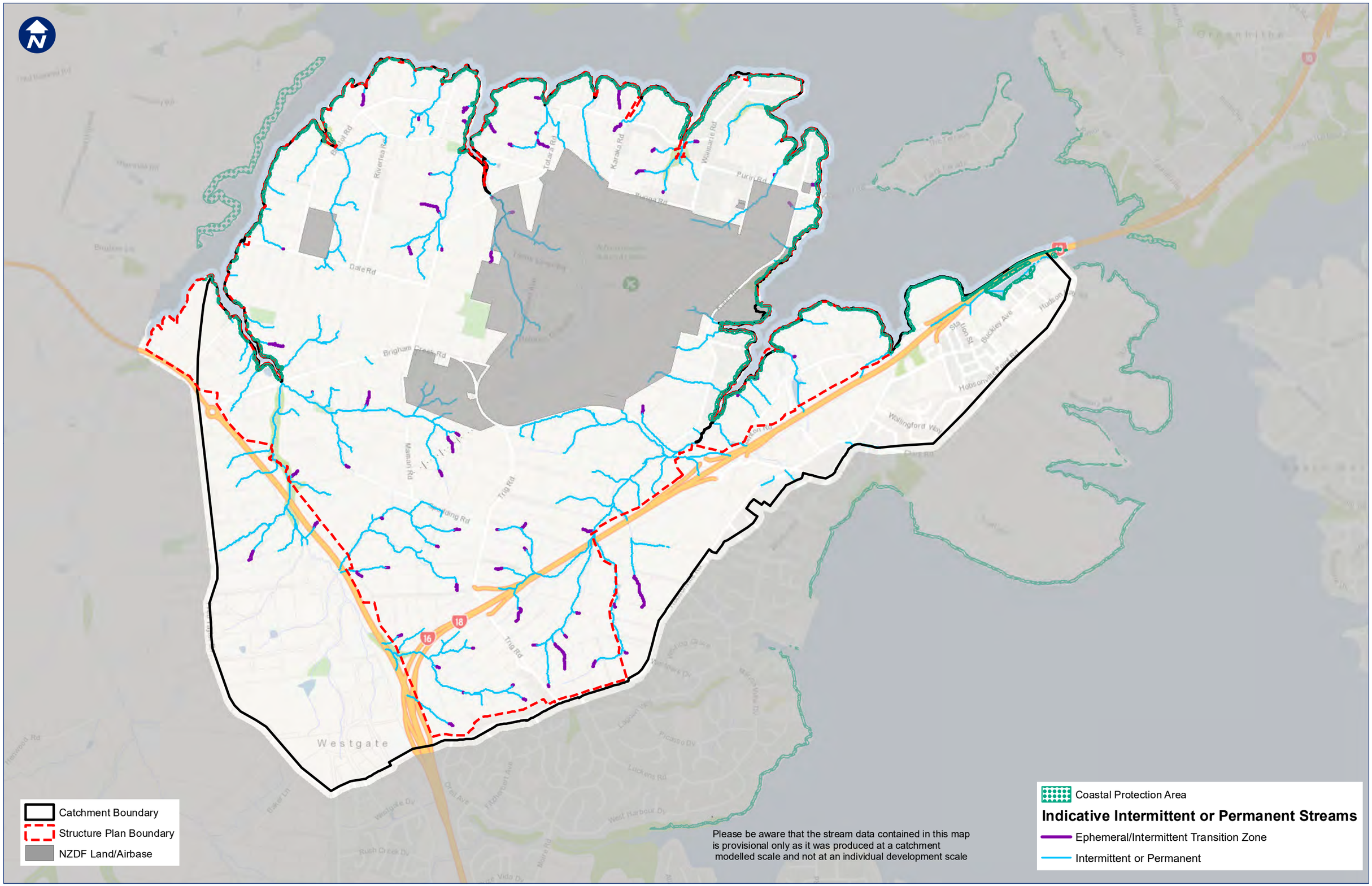

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Whenuapai Stormwater Management Plan

Title: **PLAN 10: COASTAL PROTECTION AREAS**

Scale: 1:25,000 (A3 size) 0.25 0.125 0 0.25 0.5 0.75 1 km

Status:	Map No.	Sheet No.	Rev.
Final	60491313_10	10 of 12	B

APPENDIX B: ENGINEERING PLANS

BRIGHAM CREEK ROAD

PROP STABILISED VEHICLE ENTRANCE.

PROP CLEAN WATER DIVERSION BUND
REFER TO PLAN C205 FOR DETAIL.
TOP OF BUND TO BE MINIMUM RL OF 27.0m TO DIVERT CLEAN WATER TO BRIGHAM CREEK ROAD AND PROVIDE 300mm FREEBOARD

PROP DECANT 1
VOLUME = 60m³
DEAD STORAGE = 18m³ (0.463m DEPTH)
LIVE STORAGE = 42m³
BASE = 2.90m x 8.79m x 1.0 m DEEP
REFER TO PLAN C207 FOR DETAILS

DECANT TO DISCHARGE TO EXISTING PUBLIC STORMWATER NETWORK WITHIN BRIGHAM CREEK ROAD

EARTHWORKS CATCHMENT 1 = 5900m2

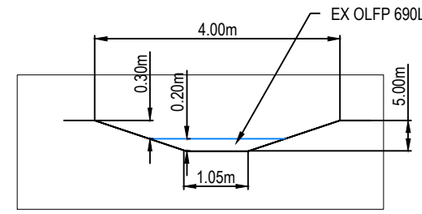
MAXIMUM AREA TO BE OPEN WITHIN THIS CATCHMENT = 3000m2.

CONTRACTOR TO CONDUCT WORKS OVER MULTIPLE STAGES WHILE PROGRESSIVELY STABILISING THE SITE WITH MAX OPEN AREA OF 3,000m²

NOTE:

ALL DEBs AND SRPs TO INCLUDE RAINFALL ACTIVATED CHEMICAL TREATMENT DOSING SYSTEMS.

CONTRACTOR TO PROVIDE CHEMICAL TREATMENT MANAGEMENT PLAN (IN ACCORDANCE WITH GD05) PRIOR TO EARTHWORKS COMMENCING.



EARTHWORKS CATCHMENT 2
AREA = 5,420m²

EARTHWORKS IN THIS AREA TO BE LIMITED TO OPEN AREA OF 1000m² AT A TIME

PROP CLEAN WATER DIVERSION BUND
REFER TO PLAN C205 FOR DETAIL

PROP STABILISED VEHICLE ENTRANCE

EARTHWORKS CATCHMENT 3
AREA = 25,200m²

PROP CLEAN-WATER DIVERSION OF EXISTING OVERLAND FLOW PATH.
TO BE MAINTAINED UNTIL FINAL OVERLAND FLOW PATH IS INSTALLED.
REFER TO DETAIL ABOVE

MAMARI ROAD

PROP SUPER SILT FENCE
REFER TO PLAN C
FOR DETAILS

EARTHWORKS CATCHMENT 4
AREA = 15,400m²

PROP SRP TO DISCHARGE TO EXISTING LOW POINT.
CLEAN WATER DISCHARGE TO THE BE MAINTAINED FOR THE DURATION OF CONSTRUCTION

PROP SRP 1
REFER TO PLAN C201
FOR FURTHER DETAIL

PROP SUPER SILT FENCE
REFER TO PLAN C
FOR DETAILS

PROP SRP TO DISCHARGE TO EXISTING LOW POINT

PROP SRP 2
REFER TO PLAN C202
FOR FURTHER DETAIL

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
4. Origin of Levels = SM XXXX SO XXXX(XXXX) Published RL=XX.XX, sourced from The LINZ Digital Geodetic Database.
5. It is the contractors responsibility to locate all services that may be affected by his operations.
6. The contractor shall comply with all relevant Health and Safety requirements.
7. The contractor shall obtain all necessary approval from utility operators before commencing work under or near their services.
8. Sediment control shall be installed and operational before earthworks start onsite in accordance with council standards.
9. Contractor shall provide asbuilt of working sediment control devices and confirmation of pond/decent volumes to engineer.

Legend

- EX BDY
- PROP BDY
- EX MAJOR CONTOUR
- EX MINOR CONTOUR
- PR MAJOR CONTOUR
- PR MINOR CONTOUR
- PROP EXTENT WORK
- PROP CLEANWATER
- PROP DIRTYWATER
- PROP SILT FENCE
- PROP STOCKPILE
- PROP DECANT
- PROP DECANT BAR

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Auckland 1023

Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title
PROPOSED EROSION & SEDIMENT CONTROL OVIERVIEW PLAN

Project no.	210001
Scale	1:1000 @ A3
Cad file	C200 - EW.DWG
Drawing no.	C200 Rev B

DATE: 4/14/22

NOTE:

ALL DEBs AND SRPs TO INCLUDE RAINFALL ACTIVATED CHEMICAL TREATMENT DOSING SYSTEMS.

CONTRACTOR TO PROVIDE CHEMICAL TREATMENT MANAGEMENT PLAN (IN ACCORDANCE WITH GD05) PRIOR TO EARTHWORKS COMMENCING.

TOP OF POND RL = 24.50m

504m³ SEDIMENT POND 1
TOP OF POND RL = 24.50m
BASE: 25.0m x 8.5m, RL = 22.40m
DEAD STORAGE: 151.2m^3 , RL = 23.00m
LIVE STORAGE: 352.8m^3, RL = 23.90
REFER TO PLAN C204 / C205 FOR FURTHER DETAILS

FOREBAY BASE RL = 23.20m

SPILL WAY BASE RL = 24.20m
LEVEL SPREADER RL = 24.30m

3:1 SLOPE

2:1 SLOPE

POND BASE RL = 22.40m

2:1 SLOPE

2:1 SLOPE

26.00

25.50

25.00

24.50

24.00

23.50

23.00

22.50

POND OUTER BASE EDGE TO BE TEMPORARY PROTECTED WITH SILT FENCE WHILE CONSTRUCTION OF PONDING IS BEING UNDERTAKEN

PROP SRP TO DISCHARGE TO EXISTING LOW POINT.
CLEAN WATER DISCHARGE TO THE BE MAINTAINED FOR THE DURATION OF CONSTRUCTION

EMERGENCY SPILLWAY BASE LEVEL = 24.20m
BASE WIDTH = 8.5m
TOP OF SRP EMBANKMENT = 24.50m

Notes

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9. Contractor shall provide asbuilt of working sediment control devices and confirmation of pond/decent volumes to engineer.

Legend

- EX BDY
- PROP BDY
- EX MAJOR CONTOUR
- EX MINOR CONTOUR
- PR MAJOR CONTOUR
- PR MINOR CONTOUR
- PROP EXTENT WORK
- PROP CLEANWATER
- PROP DIRTYWATER
- PROP SILT FENCE
- PROP STOCKPILE
- PROP DECANT
- PROP DECANT BAR

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
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Drawn	JP	08/21
Checked	WM	08/21

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Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title
PROPOSED SW RETENTION POND 1 PLAN

Project no.	210001		
Scale	1:200 @ A3		
Cad file	C200 - EW.DWG		
Drawing no.	C201	Rev	B

DATE: 4/14/22

NOTE:

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CONTRACTOR TO PROVIDE CHEMICAL TREATMENT MANAGEMENT PLAN (IN ACCORDANCE WITH GD05) PRIOR TO EARTHWORKS COMMENCING.

TOP OF POND RL = 22.00m

462m³ SEDIMENT POND
TOP OF POND RL = 22.00m
BASE: 24.0m x 8.0m, RL = 19.90m
DEAD STORAGE: 138.6m^3 , RL = 20.50m
LIVE STORAGE: 323.4m^3, RL = 21.40m
REFER TO PLAN C204 / C205 FOR FURTHER DETAILS

POND BASE RL = 19.90m

2:1 SLOPE

2:1 SLOPE

2:1 SLOPE

3:1 SLOPE

22.00

21.50

21.00

FOREBAY BASE RL = 20.70m

SPILL WAY BASE RL = 21.70m
LEVEL SPREADER RL = 21.80m

PROP POND OUTLET
DISCHARGE INTO EX STREAM

EMERGENCY SPILLWAY BASE LEVEL = 21.70m
BASE WIDTH = 8.0m
TOP OF SRP EMBANKMENT = 22.00m

POND OUTER BASE EDGE TO BE TEMPORARY PROTECTED WITH SILT FENCE WHILE CONSTRUCTION OF PONDING IS BEING UNDERTAKEN

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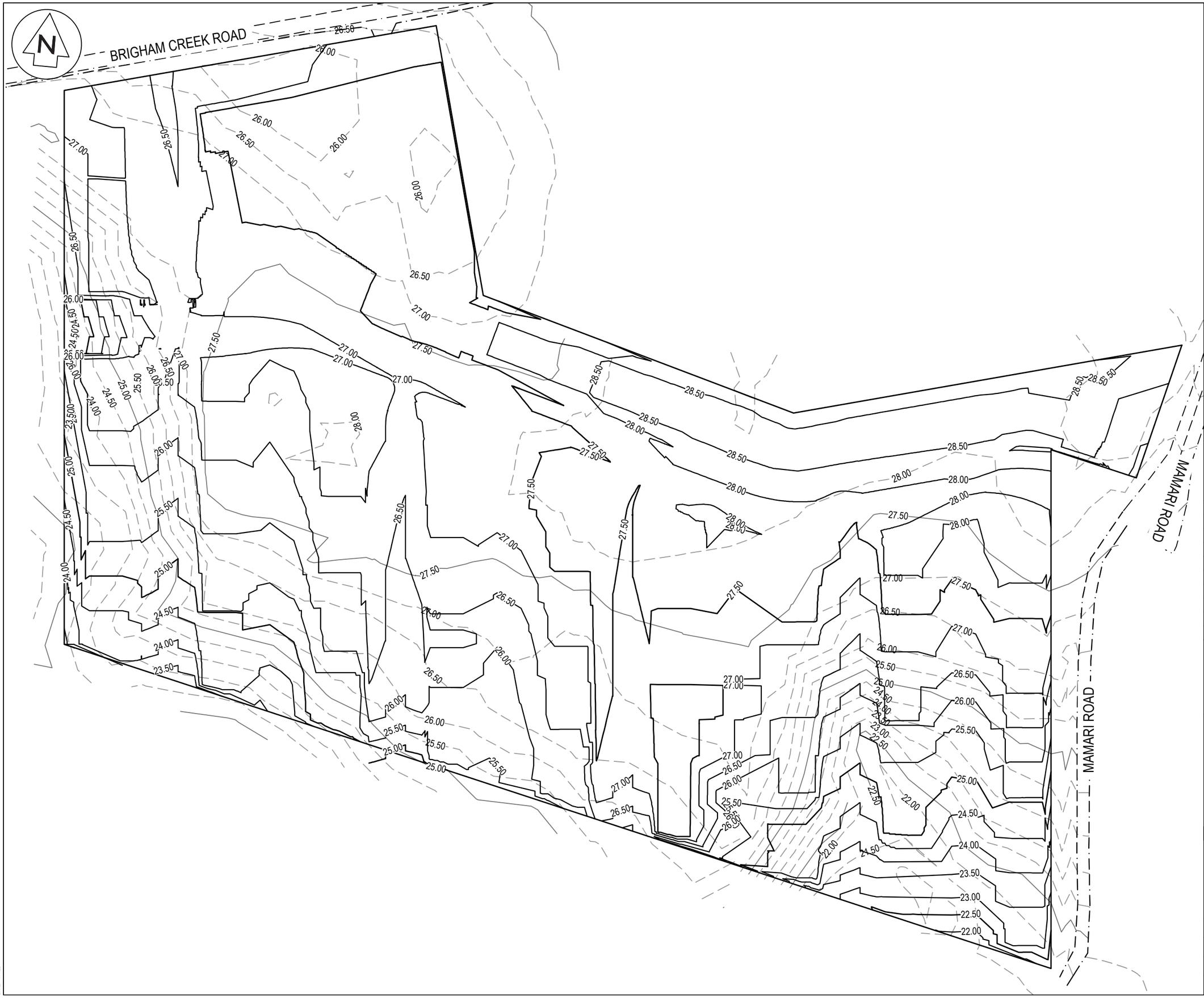
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title
PROPOSED SW RETENTION POND 2 PLAN

Project no.	210001		
Scale	1:200 @ A3		
Cad file	C200 - EW.DWG		
Drawing no.	C202	Rev	B

DATE: 4/14/22



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- PR MINOR CONTOUR
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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

EXISTING GROUND VS PROPOSED GROUND LEVELS PLAN

Project no.	210001		
Scale	1:1000 @ A3		
Cad file	C200 - EW.DWG		
Drawing no.	C203	Rev	B

DATE: 4/14/22

BULK EARTHWORKS

VOLUMES ARE CALCULATED FROM EX GROUND LEVEL (TOP SOIL STRIPPED) TO SUBGRADE LEVEL .

CUT TO FILL VOLUME	=	12,200 m³
FILL VOLUME REQUIRED	=	25,700 m³
NET FILL(IMPORT)	=	13,500 m³
TOPSOIL STRIPPED (150mm)	=	7,720 m³
EARTHWORKS AREA	=	51,460m² / 5.15 Ha

NOTE: NO ALLOWANCE FOR SERVICES TRENCHES, VOLUMES AREA UNFACTORED AND IN SITU

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10. Contractor shall provide asbuilt of working sediment control devices and confirmation of pond/decent volumes to engineer.
11. Sediment control to comply with GD05 Standards.

Legend

- EX BDY
- PROP BDY
- PROP EXTENT WORK

Cut/Fill Table			
Number #	Minimum Elevation	Maximum Elevation	Color
1	-2.000	-1.500	
2	-1.500	-1.000	
3	-1.000	-0.500	
4	-0.500	0.000	
5	0.000	0.500	
6	0.500	1.000	
7	1.000	1.500	
8	1.500	2.000	
9	2.000	4.000	

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41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
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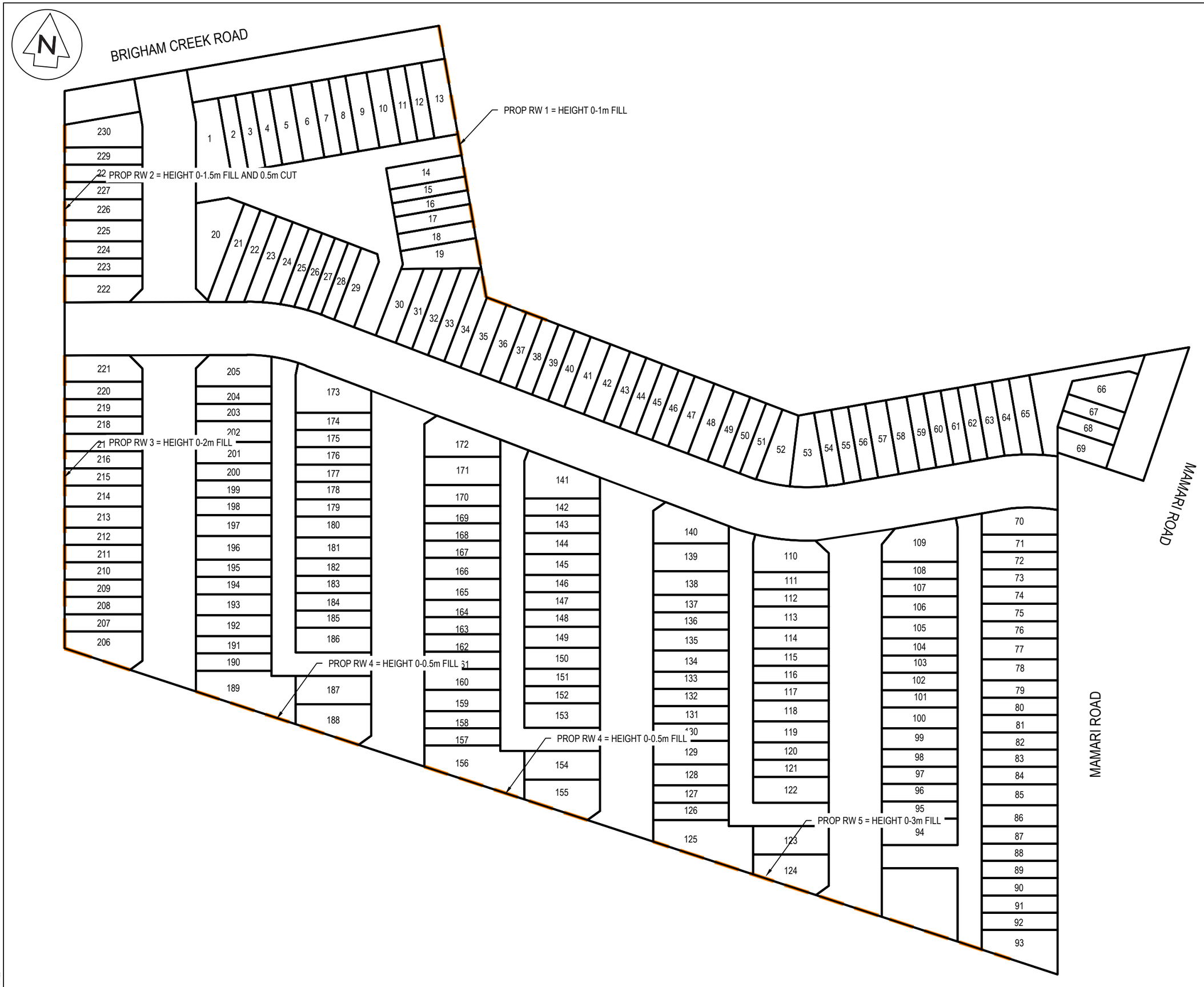
FOR AI LING

Title

PROPOSED
CUT AND FILL
PLAN

Project no.	210001		
Scale	1:1000 @ A3		
Cad file	C200 - EW.DWG		
Drawing no.	C204	Rev	B

DATE: 4/14/22



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- EX MINOR CONTOUR
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- PROP CLEANWATER
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- PROP DECANT
- PROP DECANT BAR

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED SITE PERIMETER RETAINING WALL PLAN

Project no.	210001		
Scale	1:1000 @ A3		
Cad file	C200 - EW.DWG		
Drawing no.	C205	Rev	B

DATE: 4/14/22

STABILISED CONSTRUCTION ENTRANCE SPECIFICATIONS:

APPLICATION

USE A STABILISED CONSTRUCTION ENTRANCE AT ALL POINTS OF CONSTRUCTION SITE INGRESS AND EGRESS WITH A CONSTRUCTION PLAN LIMITING TRAFFIC TO THESE ENTRANCES ONLY. THEY ARE PARTICULARLY USEFUL ON SMALL CONSTRUCTION SITES BUT CAN BE UTILISED FOR ALL PROJECTS.

DESIGN:

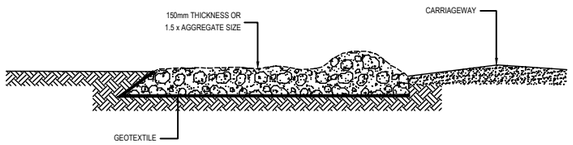
1. CLEAR THE ENTRANCE AND EXIT AREA OF ALL VEGETATION, ROOTS AND OTHER UNSUITABLE MATERIAL AND PROPERLY GRADE IT.
2. LAY WOVEN GEOTEXTILE; PIN DOWN EDGES AND OVERLAP JOINTS.
3. PROVIDE DRAINAGE TO CARRY RUNOFF FROM THE STABILISED CONSTRUCTION ENTRANCE TO A SEDIMENT CONTROL MEASURE.
4. PLACE AGGREGATE TO THE SPECIFICATIONS BELOW AND SMOOTH IT.

STABILISED CONSTRUCTION ENTRANCE AGGREGATE SPECIFICATIONS:

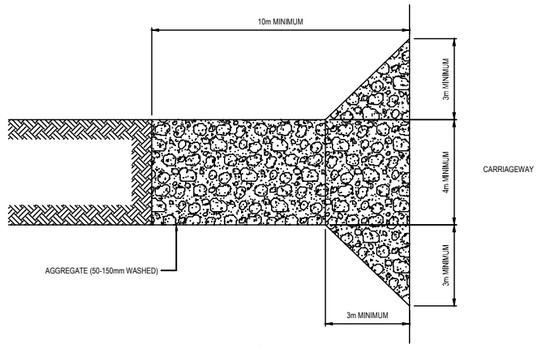
AGGREGATE SIZE	5-150mm WASHED AGGREGATE
THICKNESS	150mm MINIMUM OR 1.5 X AGGREGATE SIZE
LENGTH	10m MINIMUM LENGTH RECOMMENDED
WIDTH	4m MINIMUM

MAINTENANCE

1. MAINTAIN THE STABILISED CONSTRUCTION ENTRANCE IN A CONDITION TO PREVENT SEDIMENT FROM LEAVING THE CONSTRUCTION SITE. AFTER EACH RAINFALL INSPECT ANY STRUCTURE USED TO TRAP SEDIMENT FROM THE STABILISED CONSTRUCTION ENTRANCE AND CLEAN OUT AS NECESSARY.
2. WHEN WHEEL WASHING IS ALSO REQUIRED, ENSURE THIS IS DONE ON AN AREA STABILISED WITH AGGREGATE WHICH DRAINS TO AN APPROVED SEDIMENT RETENTION FACILITY.

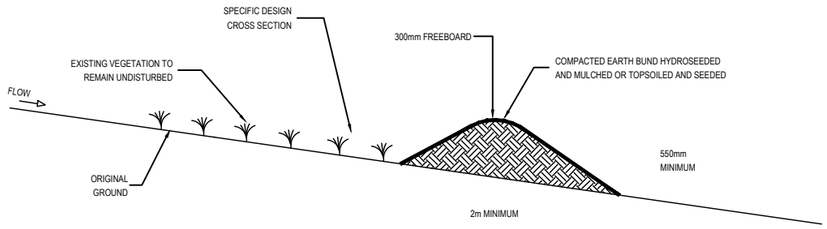


SIDE ELEVATION

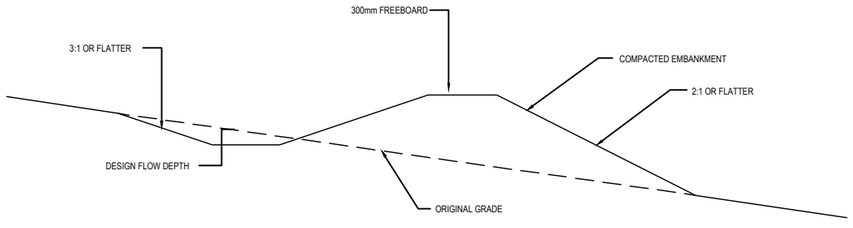


PLAN VIEW

STABILISED CONSTRUCTION ENTRANCE

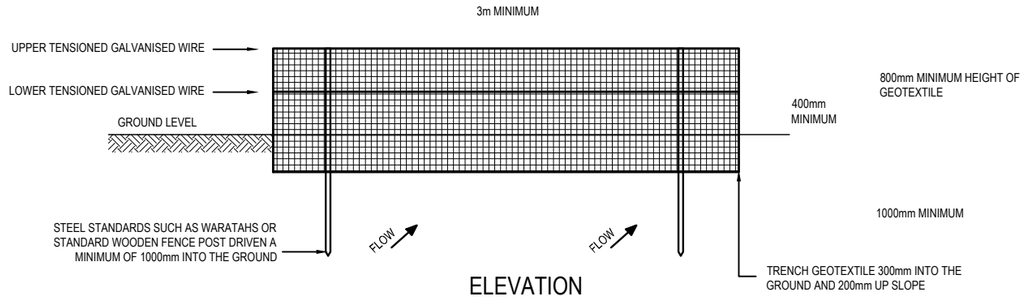


CLEANWATER RUNOFF DIVERSION BUND - CROSS SECTION

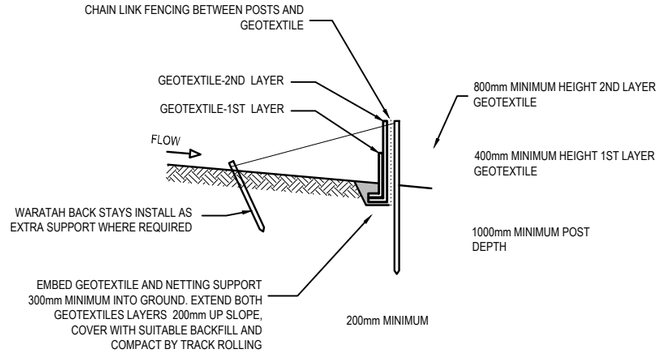


RUNOFF DIVERSION BUND - CROSS SECTION

SUPER SILT FENCE CONSTRUCTION



ELEVATION



CROSS SECTION

SUPER SILT FENCE DESIGN CRITERIA:

SLOPE STEEPNESS %	SLOPE LENGTH (m) (MAXIMUM)	SPACING OF RETURNS (m)
0-10%	UNLIMITED	60
10-20%	60	50
20-33%	30	40
33-50%	30	30
>50%	15	20

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- PROP CLEANWATER
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- PROP STOCKPILE
- PROP DECANT
- PROP DECANT BAR

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Project

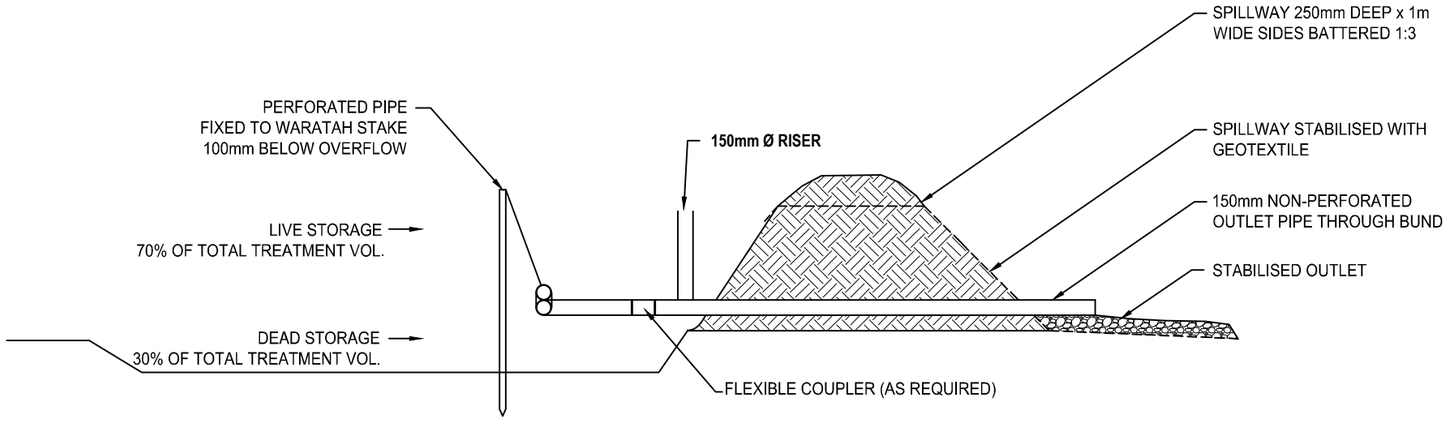
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED SEDIMENT CONTROL DETAILS PLAN

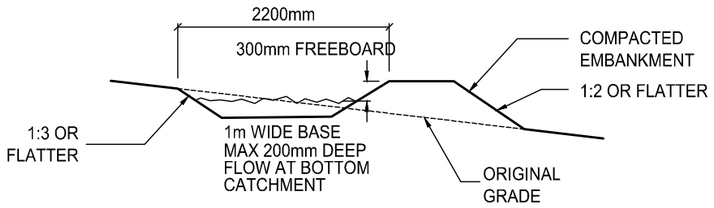
Project no.	210001		
Scale	-		
Cad file	C200 - EW.DWG		
Drawing no.	C206	Rev	B

DATE: 4/14/22



EARTH BUND DECANT DETAIL A

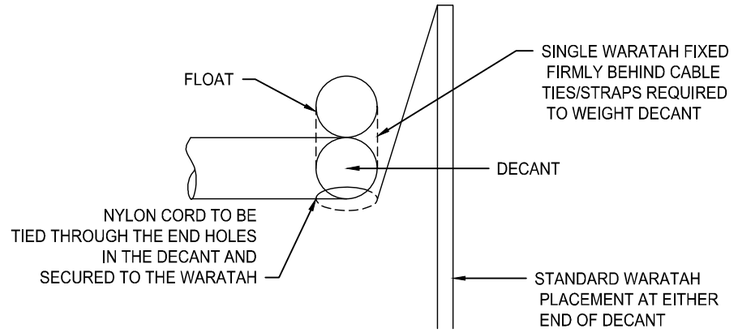
N.T.S

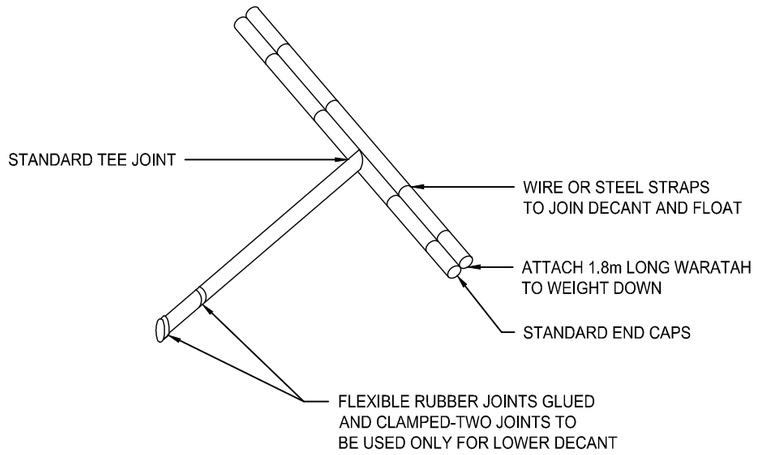


TYPICAL CROSS SECTION OF A RUNOFF DIVERSION

TYPICAL DIMENSIONS UNLESS OTHERWISE NOTED

LEVEL SPREADER DESIGN CRITERIA (20 YEAR STORM EVENT)				
DESIGN FLOW (m^3/sec)	INLET WIDTH (m)	DEPTH (m)	END WIDTH (m)	LENGTH (mm)
0-0.3	3	150	1	3
0.3-0.6	5	180	1	7
0.6-0.9	7	220	1	10





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WHENUAPAI
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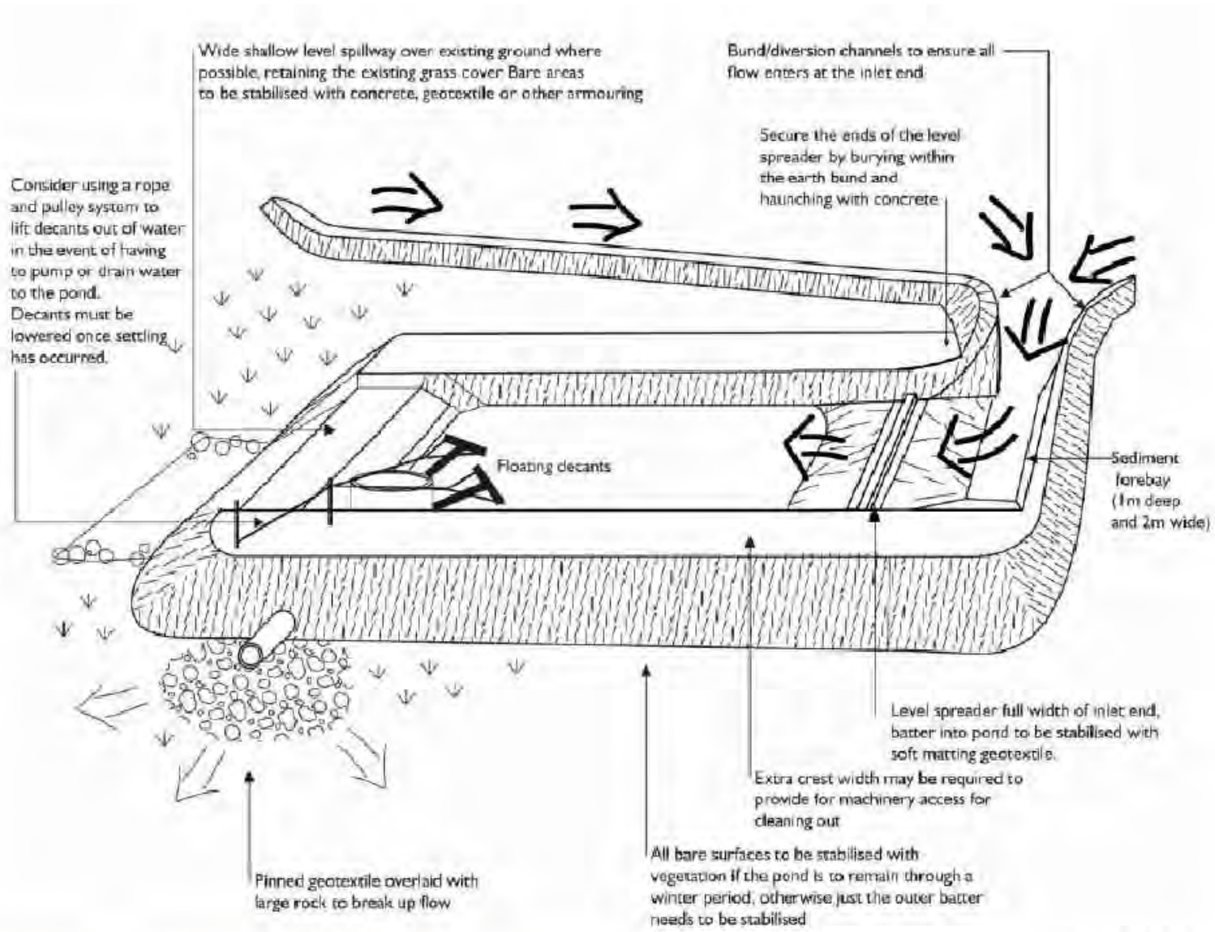
Title

PROPOSED
SEDIMENT CONTROL
DETAILS PLAN

Project no.	210001		
Scale	-		
Cad file	C200 - EW.DWG		
Drawing no.	C207	Rev	B

DATE: 4/14/22



64: Schematic of a sediment retention pond

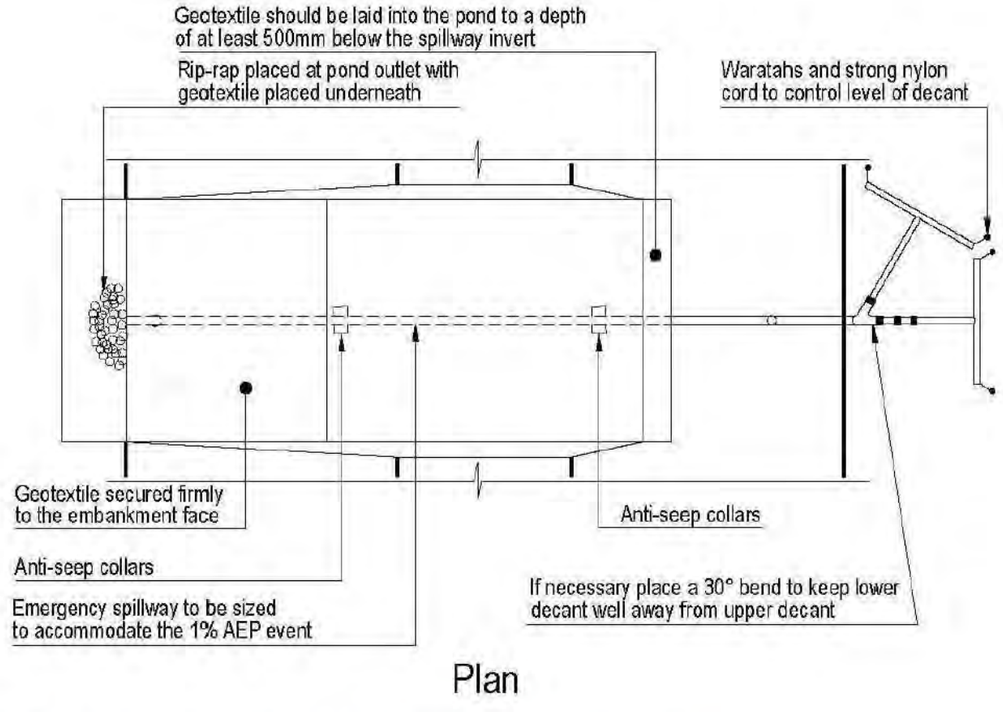


Figure 72: Sediment retention pond for 1.5 to 3 ha catchment

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PROPOSED SEDIMENT CONTROL DETAILS PLAN

Project no.	210001
Scale	-
Cad file	C200 - EW.DWG
Drawing no.	C208 Rev B

DATE: 4/14/22

BRIGHAM CREEK ROAD

WESTERN
RETAINING WALL 1

WESTERN
RETAINING WALL 2

SOUTHERN
RETAINING WALL 1

SOUTHERN
RETAINING WALL 2

SOUTHERN
RETAINING WALL 3

SOUTHERN
RETAINING WALL 4

SOUTHERN
RETAINING WALL 5

CH 0
CH 20
CH 21
CH 0
CH 20
CH 40
CH 52
CH 0
CH 20
CH 40
CH 52
CH 0
CH 20
CH 40
CH 52
CH 0
CH 32
CH 40
CH 56

5 MAMARI ROAD

MAMARI ROAD

MAMARI ROAD

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
4. It is the contractors responsibility to locate all services that may be affected by his operations.
5. The contractor shall comply with all relevant Health and Safety requirements.
6. The contractor shall obtain all necessary approval from utility operators before commencing work under or near their services.

Legend

- EX BDY
- PROP BDY
- PROP RETAINING WALL

Rev	Description	By	Date
B	RC RFI	AP	04/22
-	-	-	-

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Auckland 1023

Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

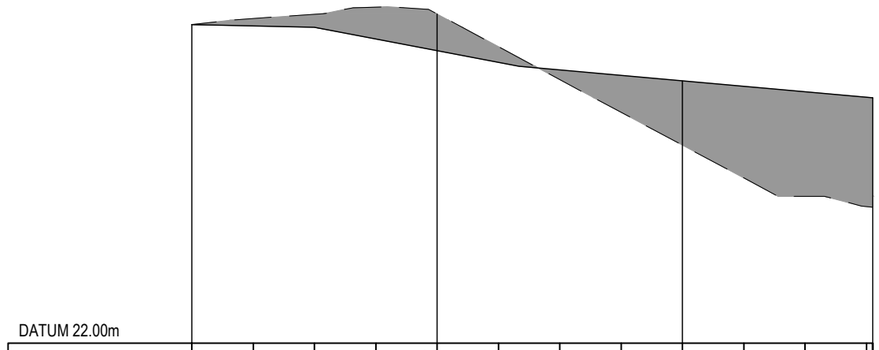
PROPOSED
RETAINING WALL
PLAN

Project no.	210001		
Scale	1:1000 @ A3		
Cad file	C250 - RW.DWG		
Drawing no.	C250	Rev	B

DATE: 4/14/22

NOTE:

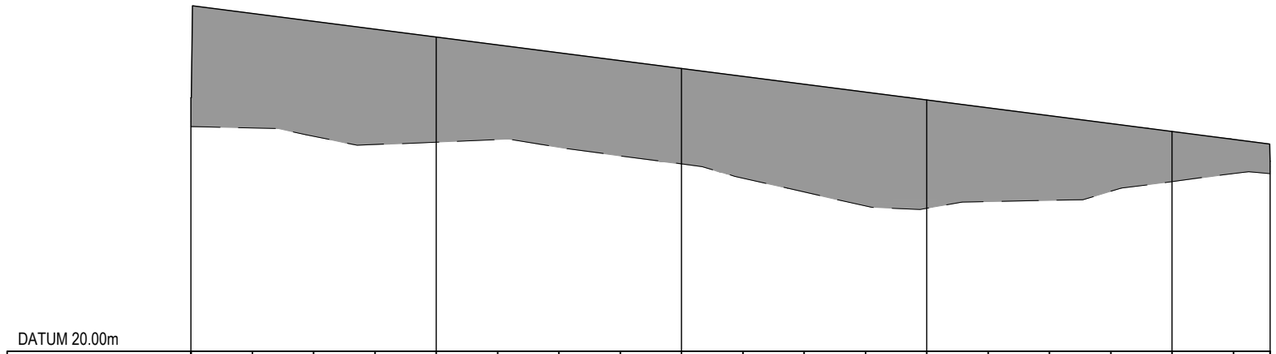
FINAL RETAINING WALL DESIGN TO BE CONFIRMED BY STRUCTURAL ENGINEER



DATUM 22.00m												
HEIGHT OF WALL	0.00	0.12	0.22	0.52	0.60	0.26	0.16	0.60	1.05	1.49	1.70	1.79
BOTTOM OF WALL	27.20	27.17	27.15	26.95	26.76	26.57	26.45	26.36	26.27	26.18	26.10	26.00
TOP OF WALL	27.20	27.17	27.15	26.95	26.76	26.57	26.45	26.36	26.27	26.18	26.10	26.00
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.52

PROPOSED WESTERN RETAINING WALL 1 CHAINAGE CH0 - CH56

SCALE: 1:500 @ A3



DATUM 20.00m																				
HEIGHT OF WALL	0.47	1.87	1.88	1.88	1.71	1.54	1.54	1.55	1.56	1.66	1.76	1.86	1.77	1.53	1.38	1.10	0.82	0.56	0.21
BOTTOM OF WALL	24.13	25.51	25.38	25.25	25.12	24.99	24.87	24.74	24.61	24.48	24.35	24.22	24.10	23.97	23.84	23.71	23.58	23.45	23.10
TOP OF WALL	24.13	25.51	25.38	25.25	25.12	24.99	24.87	24.74	24.61	24.48	24.35	24.22	24.10	23.97	23.84	23.71	23.58	23.45	23.10
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	87.98

PROPOSED WESTERN RETAINING WALL 2 CHAINAGE CH0 - CH88

SCALE: 1:500 @ A3

Notes

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Rev	Description	By	Date
B	RC RFI	AP	04/22
-	-	-	-

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED RETAINING WALL LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C250 - RW.DWG		
Drawing no.	C251	Rev	B

DATE: 4/14/22

NOTE:

FINAL RETAINING WALL DESIGN TO BE CONFIRMED BY STRUCTURAL ENGINEER

Notes

1. All works to be in accordance with Auckland council standards.
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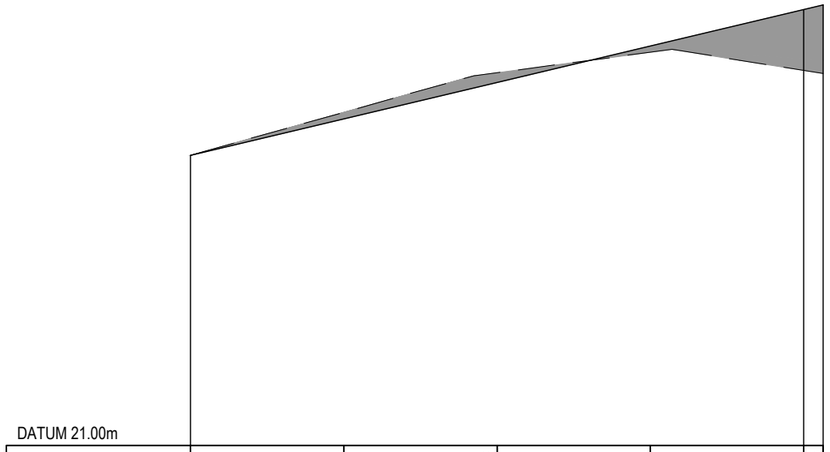
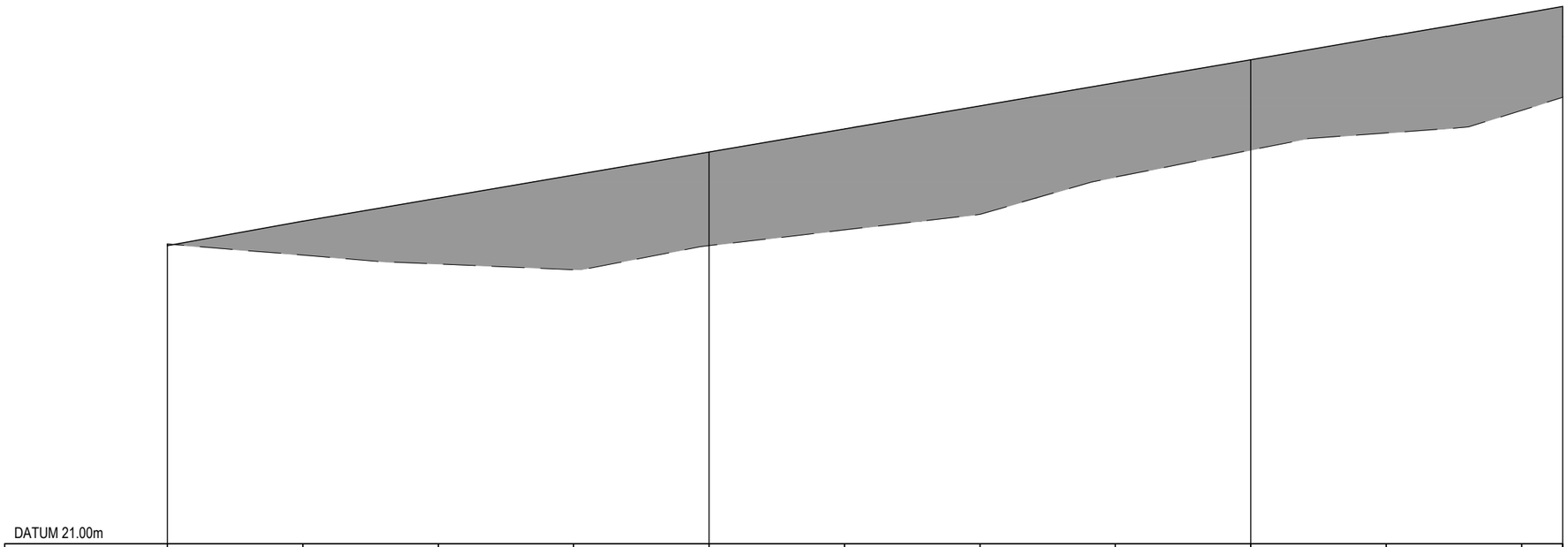


DATUM 21.00m

HEIGHT OF WALL		0.04	0.06	0.04		0.45
BOTTOM OF WALL		23.13	23.37	23.60		23.87
TOP OF WALL	22.89	23.17	23.43	23.56		23.43
CHAINAGE	0.00	5.00	10.00	15.00		20.64

PROPOSED SOUTHERN RETAINING WALL 1 CHAINAGE CH0 - CH21

SCALE: 1:500 @ A3



DATUM 21.00m

HEIGHT OF WALL	0.01	0.25	0.49	0.70	0.69	0.75	0.80	0.70	0.67	0.71		0.67
BOTTOM OF WALL	23.20	23.38	23.55	23.72	23.89	24.06	24.23	24.40	24.57	24.74		24.96
TOP OF WALL	23.21	23.13	23.06	23.02	23.20	23.31	23.43	23.70	23.90	24.03		24.29
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00		51.52

PROPOSED SOUTHERN RETAINING WALL 2 CHAINAGE CH0 - CH52

SCALE: 1:500 @ A3

Rev	Description	By	Date
B	RC RFI	AP	04/22
-	-	-	-

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

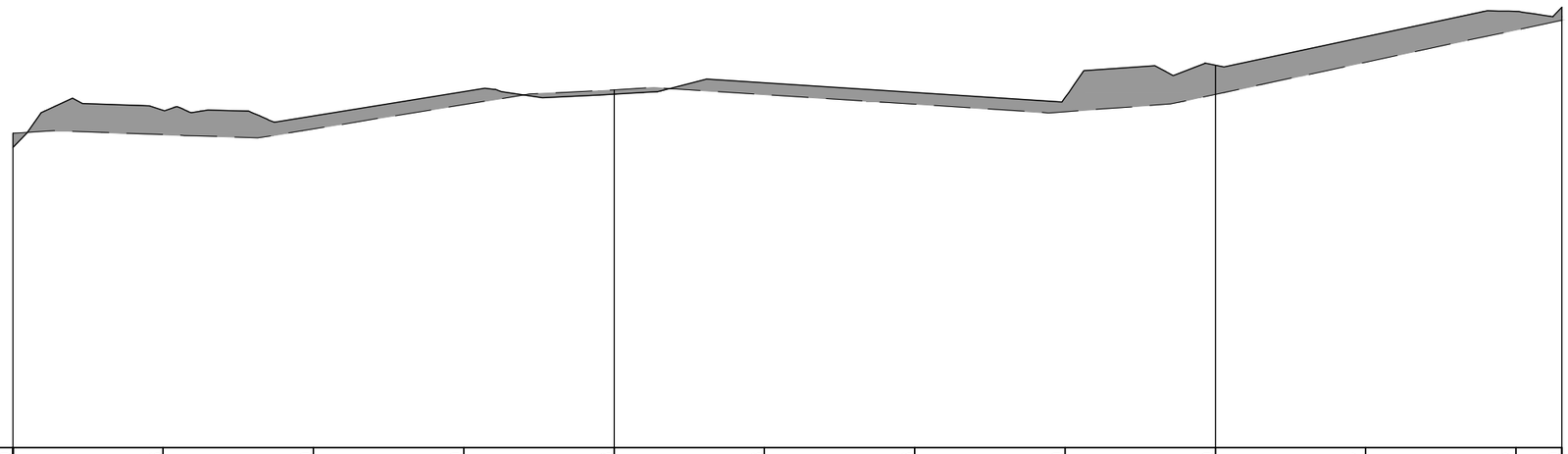
PROPOSED RETAINING WALL LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C250 - RW.DWG		
Drawing no.	C252	Rev	B

DATE: 4/14/22

NOTE:

FINAL RETAINING WALL DESIGN TO BE CONFIRMED BY STRUCTURAL ENGINEER



DATUM 23.00m

HEIGHT OF WALL	0.09	0.16	0.09	0.09	0.03	0.08	0.08	0.09	0.19	0.17	0.12	0.09
BOTTOM OF WALL	25.00	25.24	25.20	25.37	25.35	25.42	25.36	25.33	25.54	25.73	25.90	25.93
TOP OF WALL	25.09	25.08	25.12	25.28	25.38	25.35	25.28	25.23	25.35	25.56	25.78	25.84
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	51.52

PROPOSED SOUTHERN RETAINING WALL 3 CHAINAGE CH0 - CH52

SCALE: 1:200 @ A3

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
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Rev	Description	By	Date
B	RC RFI	AP	04/22
-	-	-	-

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

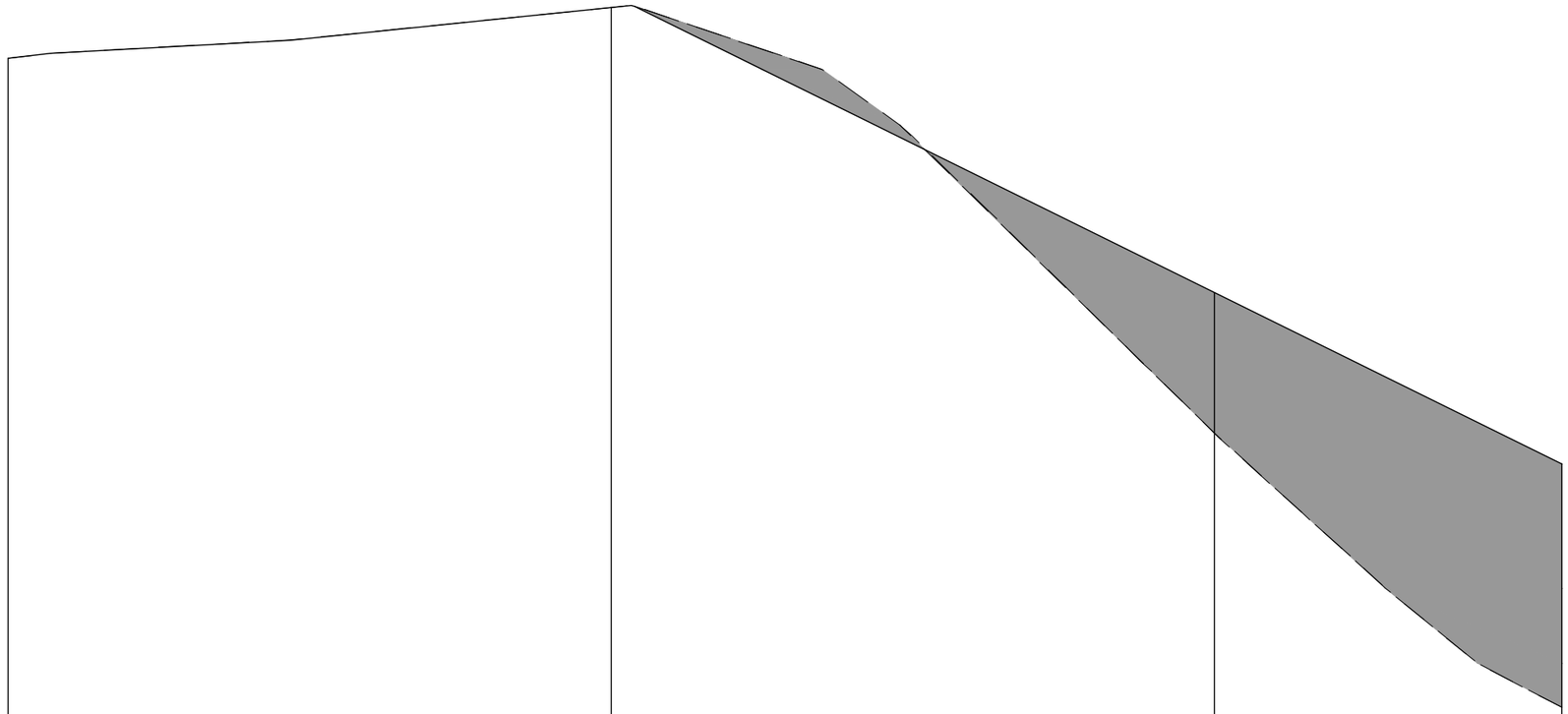
PROPOSED
RETAINING WALL
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C250 - RW.DWG		
Drawing no.	C253	Rev	B

DATE: 4/14/22

NOTE:

FINAL RETAINING WALL DESIGN TO BE CONFIRMED BY STRUCTURAL ENGINEER



DATUM 21.00m

HEIGHT OF WALL	0.00	0.00	0.00	0.00	0.00	0.13	0.05	0.44	0.93	1.34		1.61
BOTTOM OF WALL	26.02	26.09	26.15	26.25	26.35	25.94	25.45	24.96	24.46	23.97		23.33
TOP OF WALL	26.02	26.09	26.15	26.25	26.35	25.94	25.45	24.96	24.46	23.97		23.33
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00		51.52

PROPOSED SOUTHERN RETAINING WALL 4 CHAINAGE CH0 - CH52

SCALE: 1:200 @ A3

Notes

1. All works to be in accordance with Auckland council standards.
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3. Levels in terms of the Auckland Vertical Datum 1946.
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Rev	Description	By	Date
B	RC RFI	AP	04/22
-	-	-	-

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

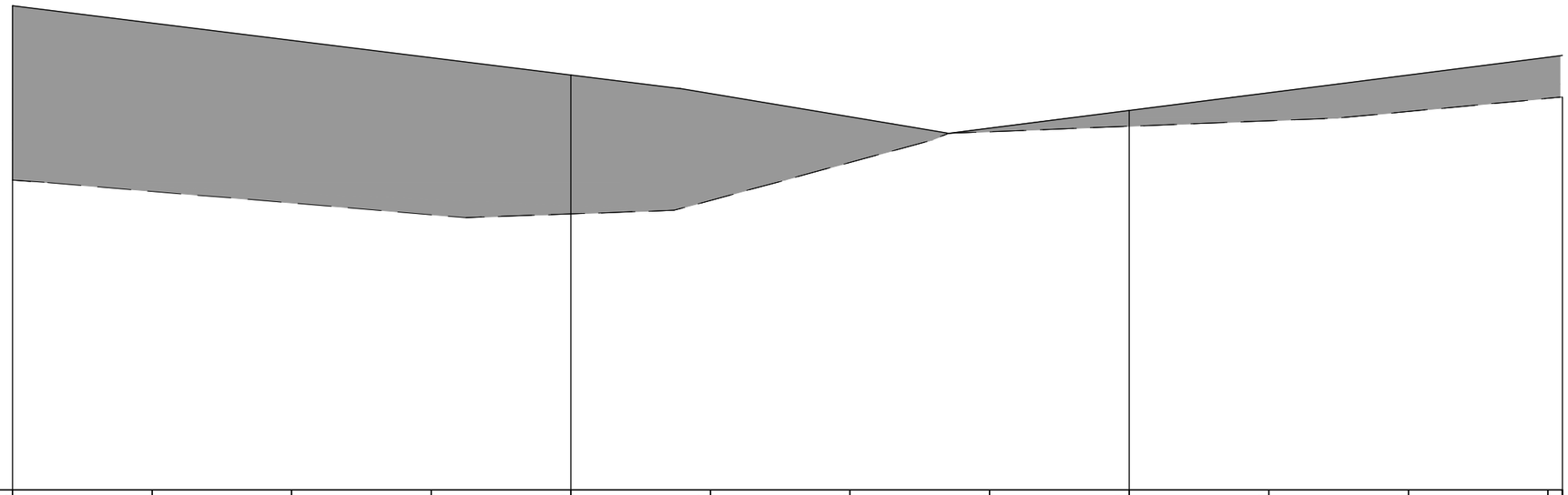
PROPOSED
RETAINING WALL
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C250 - RW.DWG		
Drawing no.	C255	Rev	B

DATE: 4/14/22

NOTE:

FINAL RETAINING WALL DESIGN TO BE CONFIRMED BY STRUCTURAL ENGINEER



DATUM 19.00m

HEIGHT OF WALL	1.25				1.00	0.77	0.33	0.03	0.11	0.20	0.26	
BOTTOM OF WALL	22.47	22.34	22.22	22.10	21.97	21.84	21.67	21.59	21.72	21.85	21.97	
TOP OF WALL	22.47	22.34	22.22	22.10	21.97	21.84	21.67	21.59	21.72	21.85	21.97	
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.52

PROPOSED SOUTHERN RETAINING WALL 5 CHAINAGE CH0 - CH56

SCALE: 1:200 @ A3

Notes

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3. Levels in terms of the Auckland Vertical Datum 1946.
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6. The contractor shall obtain all necessary approval from utility operators before commencing work under or near their services.

Rev	Description	By	Date
B	RC RFI	AP	04/22
-	-	-	-

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED
RETAINING WALL
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C250 - RW.DWG		
Drawing no.	C256	Rev	B

DATE: 4/14/22

10. Pram crossings are to be flush to the channel with no lip.
11. All kerb and channel to have sawcuts at max. 4m centres.
12. All kerbing, channels and edge beams shall have 4kg black oxide.
13. All signage and pavement markings to be in accordance with NZTA MOTSAM standards and the ATCOP TCDM.
14. All street name signs shall follow ATCOP guidelines in terms of layout, clearances, and construction details.
15. All line markings to be reflectorised in accordance with MOTSAM standards.
16. The minimum vertical and lateral clearances for signage shall be in accordance with MOTSAM standards.
17. Street lighting shall be designed in accordance with all applicable New Zealand Standards including but not restricted to the current version of AS/NZS 1158 Lighting for Roads and Public Spaces series of standards.
18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

Notes

1. All works to be in accordance with Auckland Council standards.
2. Contractor is to avoid using GPS for set out of the kerb levels where gradients less than 1%.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. The contractor shall comply with all relevant Health and Safety requirements.
5. The contractor shall obtain all necessary approval from utility operators before commencing work under or near their services.
6. Final pavement design subject to CBR/Beam tests on subgrade material.
7. Setout schedule with co-ordinates of chainage points along road centreline to be supplied to the contractor prior to construction.
8. Refer to long section for finished centreline levels. Refer to typical cross sections to obtain levels for other locations
9. All ducts shall have locations marked on kerb lines in accordance with specification.

Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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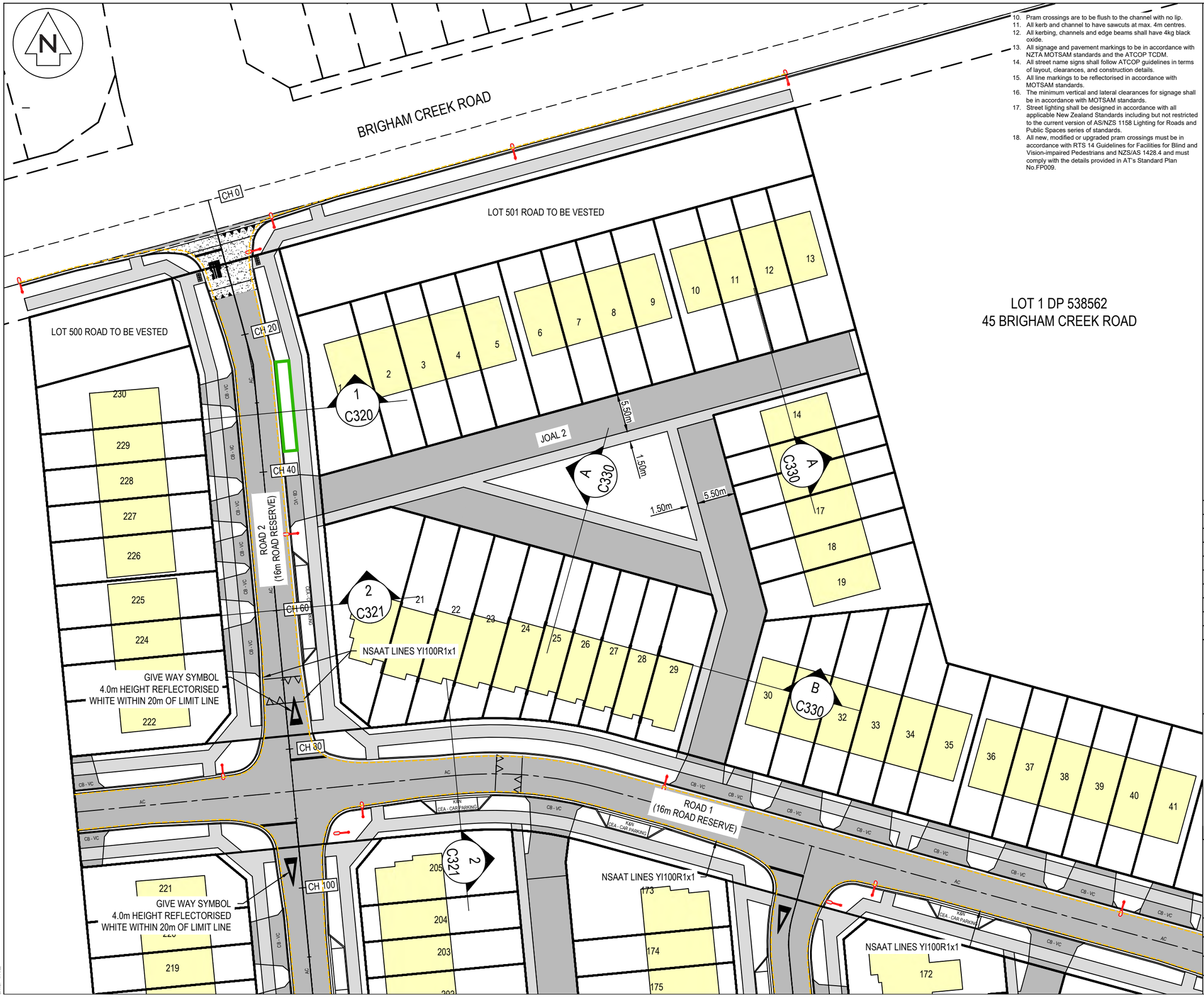
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

Title
PROPOSED ROADING OVERVIEW PLAN

Project no.	210001		
Scale	1:1500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C300	Rev	B

DATE: 4/14/22



LOT 1 DP 538562
45 BRIGHAM CREEK ROAD

10. Pram crossings are to be flush to the channel with no lip.
11. All kerb and channel to have sawcuts at max. 4m centres.
12. All kerbing, channels and edge beams shall have 4kg black oxide.
13. All signage and pavement markings to be in accordance with NZTA MOTSAM standards and the ATCOP TCDM.
14. All street name signs shall follow ATCOP guidelines in terms of layout, clearances, and construction details.
15. All line markings to be reflectorised in accordance with MOTSAM standards.
16. The minimum vertical and lateral clearances for signage shall be in accordance with MOTSAM standards.
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18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

Notes

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8. Refer to long section for finished centreline levels. Refer to typical cross sections to obtain levels for other locations
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Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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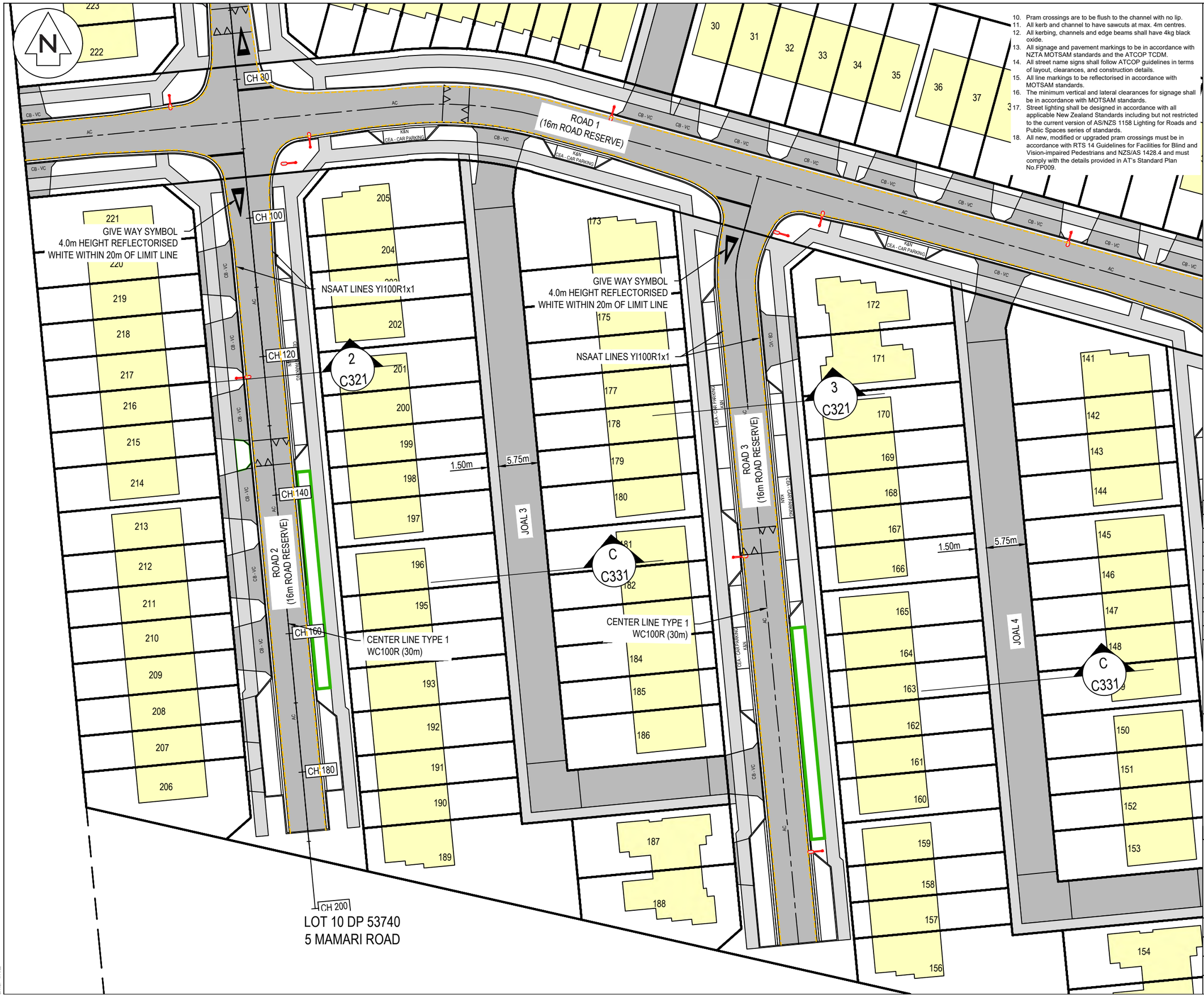
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED ROADING DETAIL PLAN
ROADS 1 (WEST) AND 2

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C301	Rev	B

DATE: 4/14/22



Notes

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Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

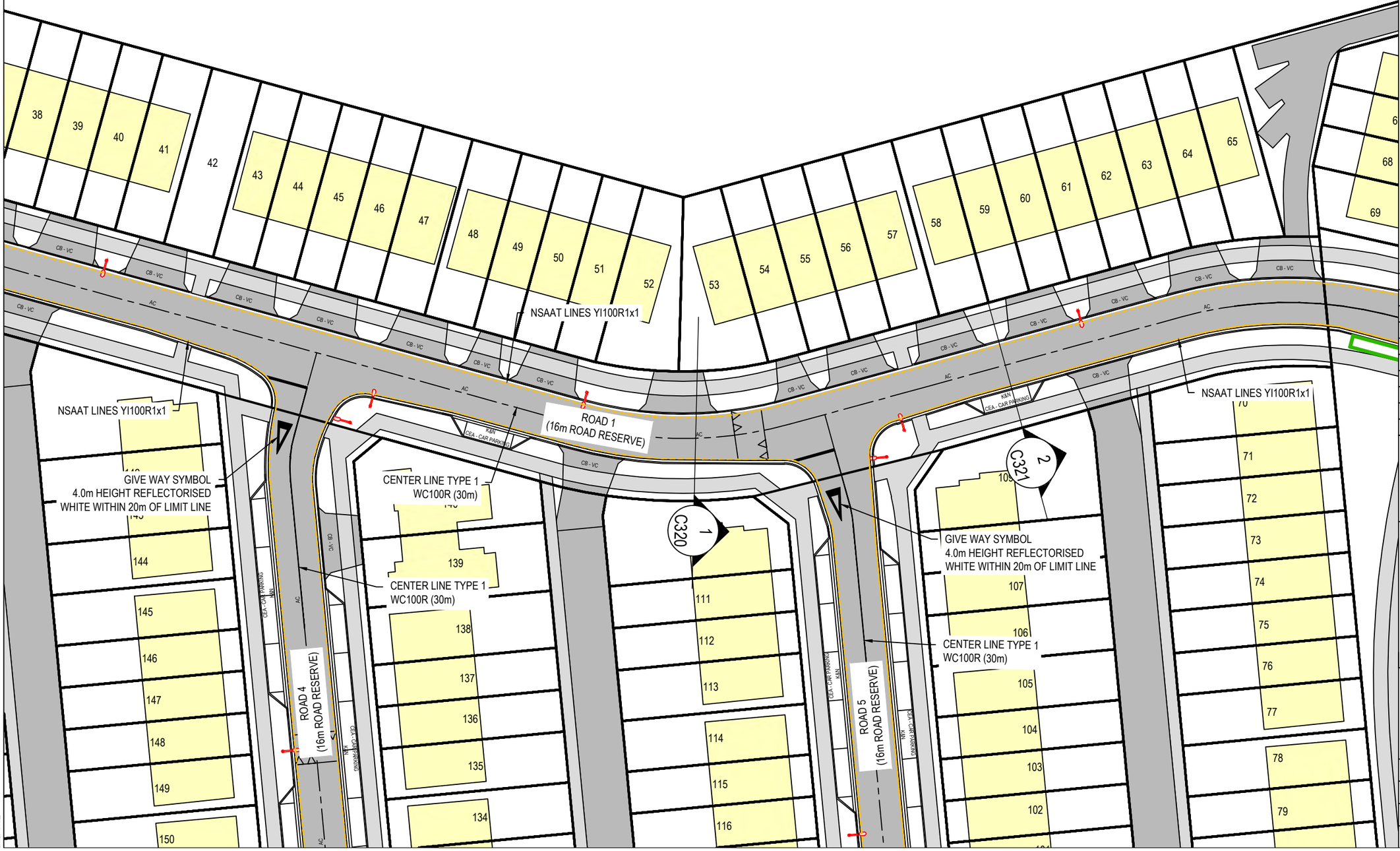
Title

PROPOSED ROADING DETAIL PLAN ROADS 2 AND 3

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C302	Rev	B

DATE: 4/14/22

LOT 1 DP 538562
45 BRIGHAM CREEK ROAD



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11. All kerb and channel to have sawcuts at max. 4m centres.
12. All kerbing, channels and edge beams shall have 4kg black oxide.
13. All signage and pavement markings to be in accordance with NZTA MOTSAM standards and the ATCOP TCDM.
14. All street name signs shall follow ATCOP guidelines in terms of layout, clearances, and construction details.
15. All line markings to be reflectorised in accordance with MOTSAM standards.
16. The minimum vertical and lateral clearances for signage shall be in accordance with MOTSAM standards.
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18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

Notes

1. All works to be in accordance with Auckland Council standards.
2. Contractor is to avoid using GPS for set out of the kerb levels where gradients less than 1%.
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4. The contractor shall comply with all relevant Health and Safety requirements.
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7. Setout schedule with co-ordinates of chainage points along road centreline to be supplied to the contractor prior to construction.
8. Refer to long section for finished centreline levels. Refer to typical cross sections to obtain levels for other locations
9. All ducts shall have locations marked on kerb lines in accordance with specification.

Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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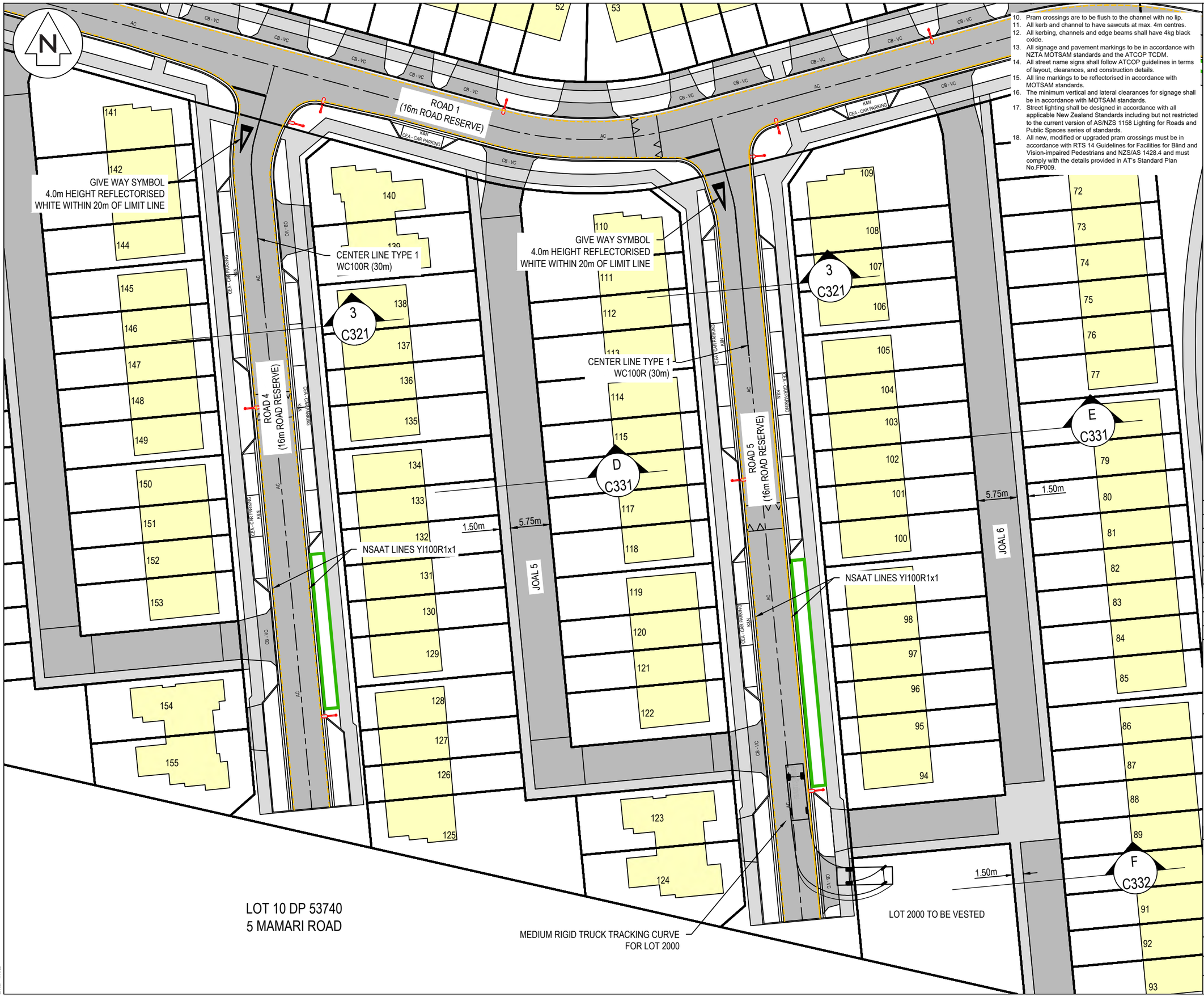
5 Owens Road, Epsom
Auckland 1023

Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED ROADING DETAIL PLAN
ROADS 1, 4 AND 5

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C303	Rev	B

DATE: 4/14/22



Notes

10. Pram crossings are to be flush to the channel with no lip.
11. All kerb and channel to have sawcuts at max. 4m centres.
12. All kerbing, channels and edge beams shall have 4kg black oxide.
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18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

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9. All ducts shall have locations marked on kerb lines in accordance with specification.

Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project

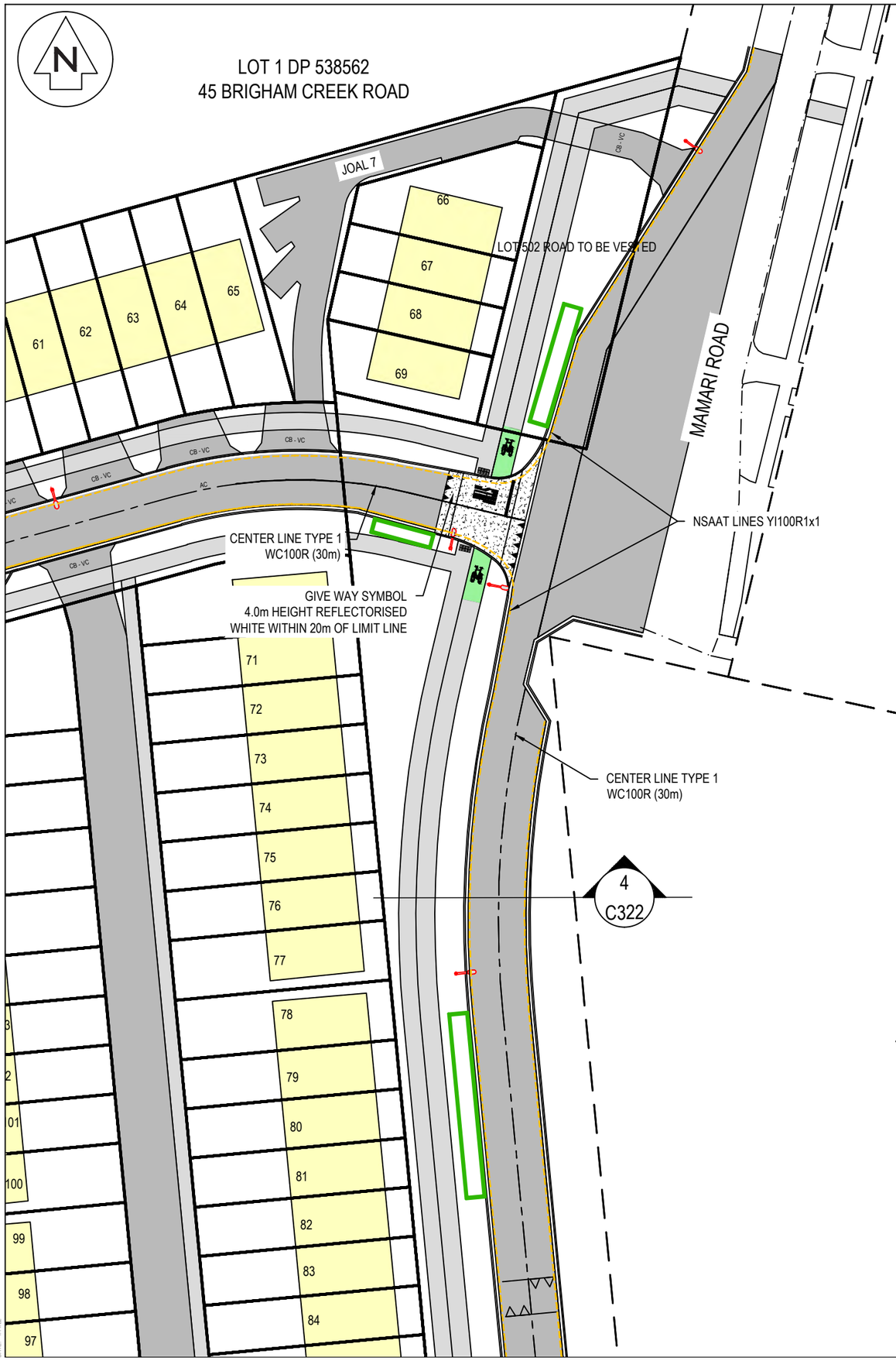
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

Title

PROPOSED ROADING DETAIL PLAN ROADS 4 AND 5

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C304	Rev	B

DATE: 4/14/22



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11. All kerb and channel to have sawcuts at max. 4m centres.
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18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

Notes

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7. Setout schedule with co-ordinates of chainage points along road centreline to be supplied to the contractor prior to construction.
8. Refer to long section for finished centreline levels. Refer to typical cross sections to obtain levels for other locations
9. All ducts shall have locations marked on kerb lines in accordance with specification.

Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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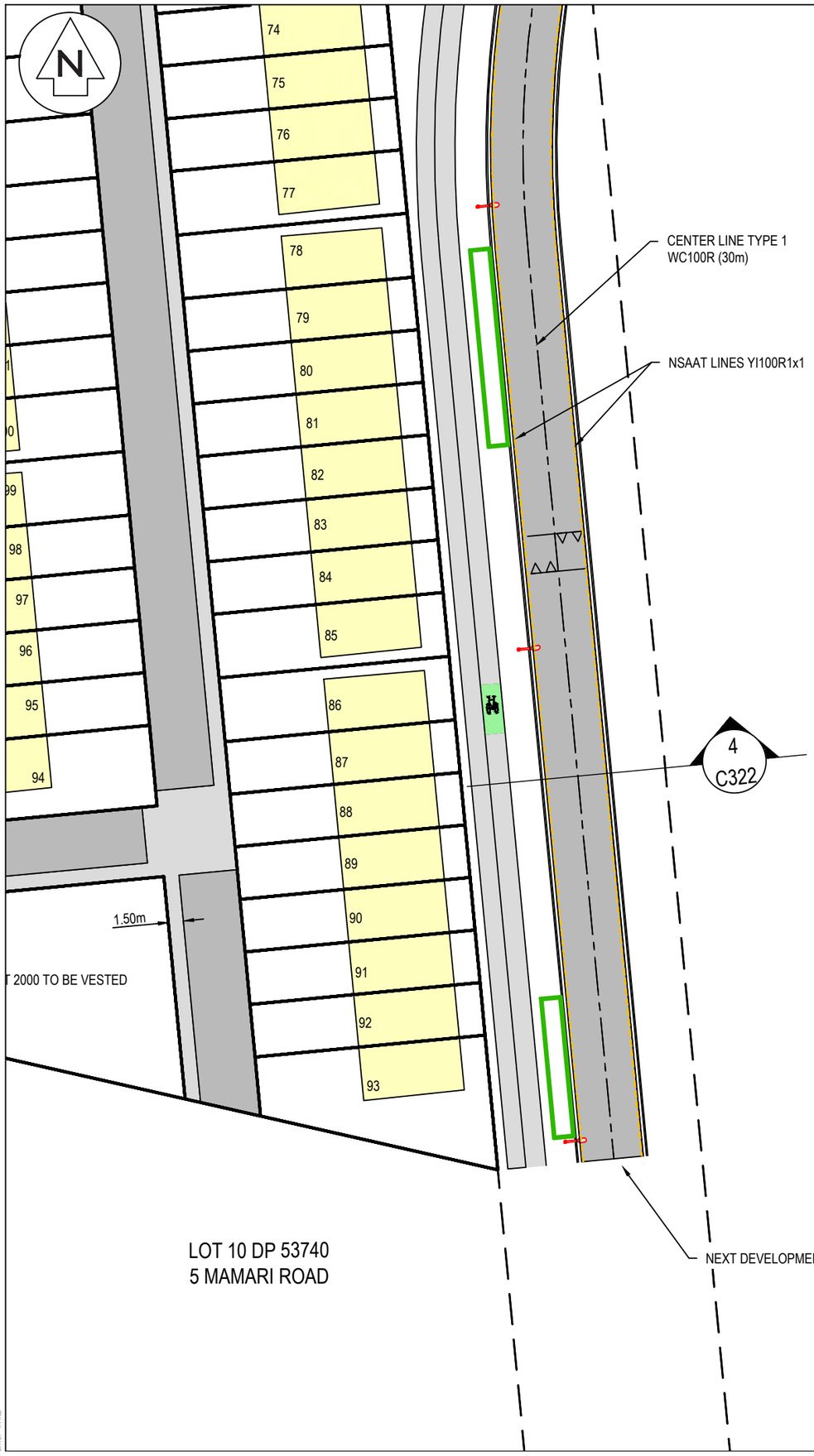
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED MAMARI RD UPGRADE DETAIL PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C305	Rev	B

DATE: 4/14/22



131-137 BRIGHAM CREEK ROAD

10. Pram crossings are to be flush to the channel with no lip.
11. All kerb and channel to have sawcuts at max. 4m centres.
12. All kerbing, channels and edge beams shall have 4kg black oxide.
13. All signage and pavement markings to be in accordance with NZTA MOTSAM standards and the ATCOP TCDM.
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Notes

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9. All ducts shall have locations marked on kerb lines in accordance with specification.

Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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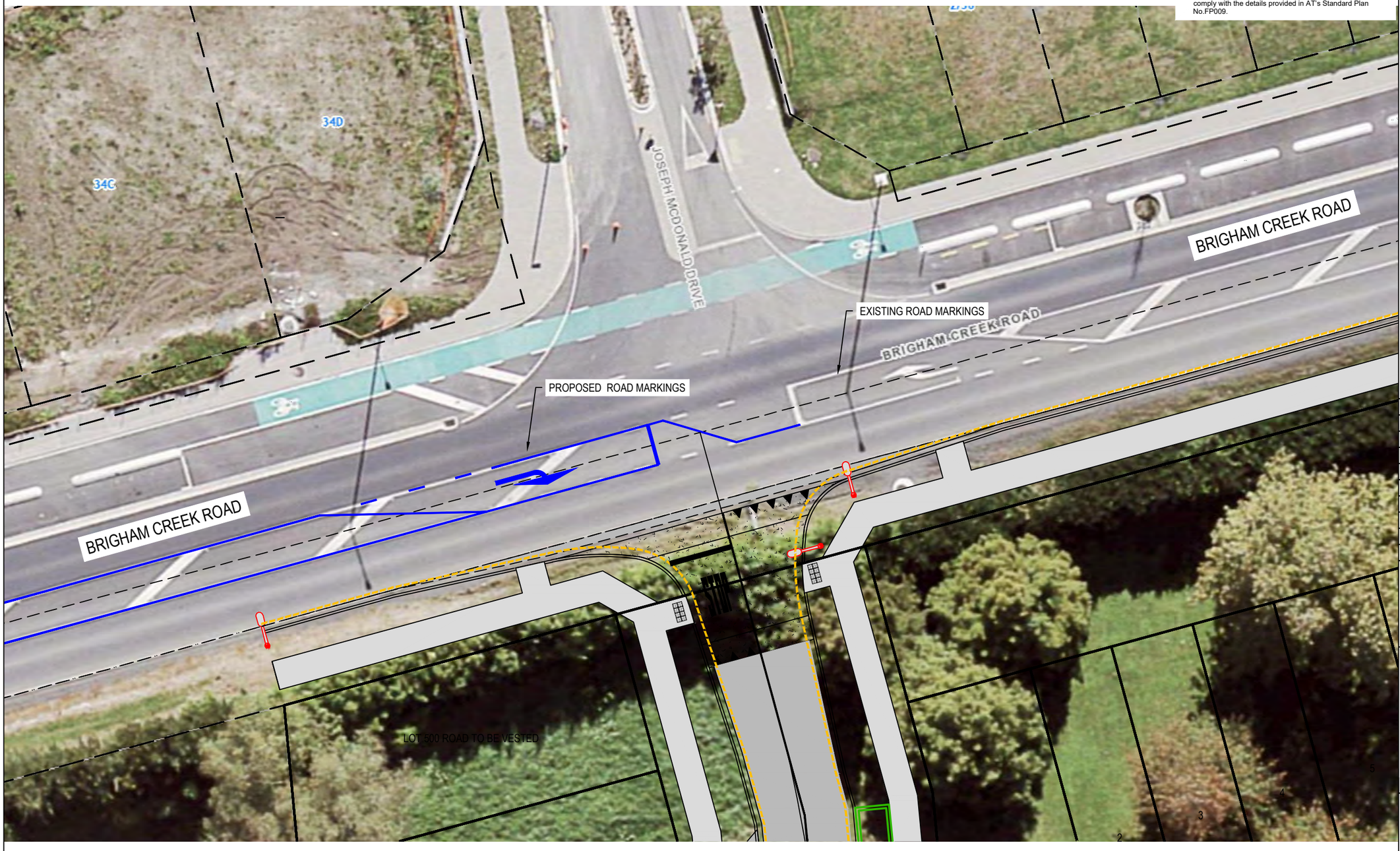
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED MAMARI RD UPGRADE DETAIL PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C306	Rev	B

DATE: 4/14/22



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Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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5 Owens Road, Epsom
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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

Title

PROPOSED ROAD MARKINGS AT BRIGHAM CREEK RD INTERSECTION

Project no.	210001		
Scale	1:250 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C307	Rev	A

DATE: 4/14/22

10. Pram crossings are to be flush to the channel with no lip.
11. All kerb and channel to have sawcuts at max. 4m centres.
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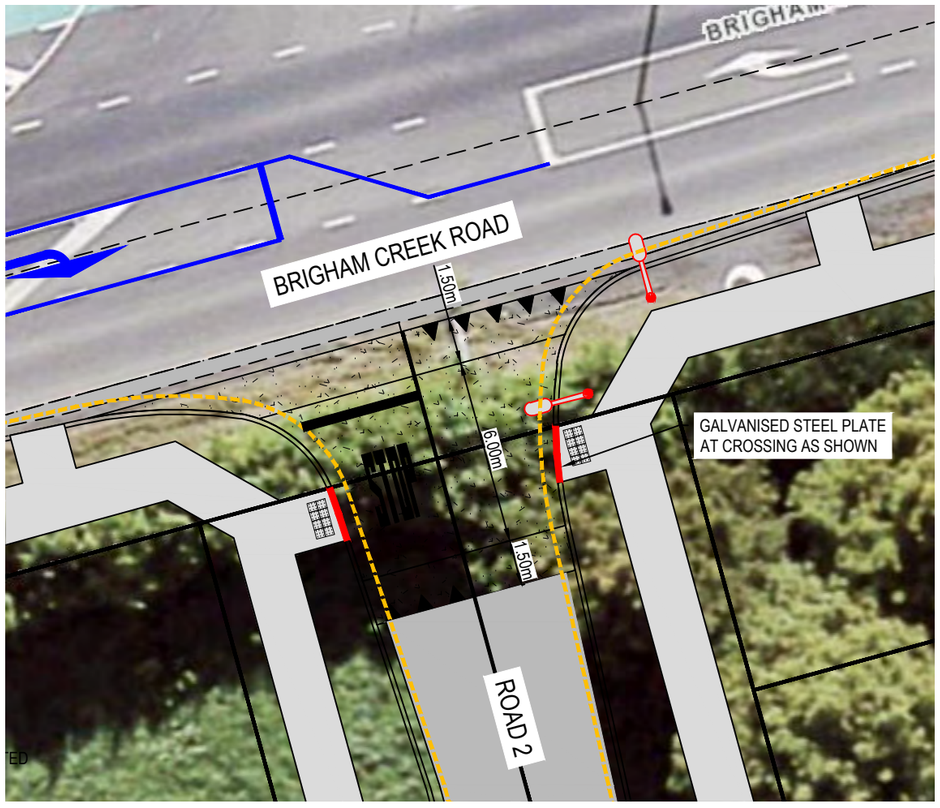
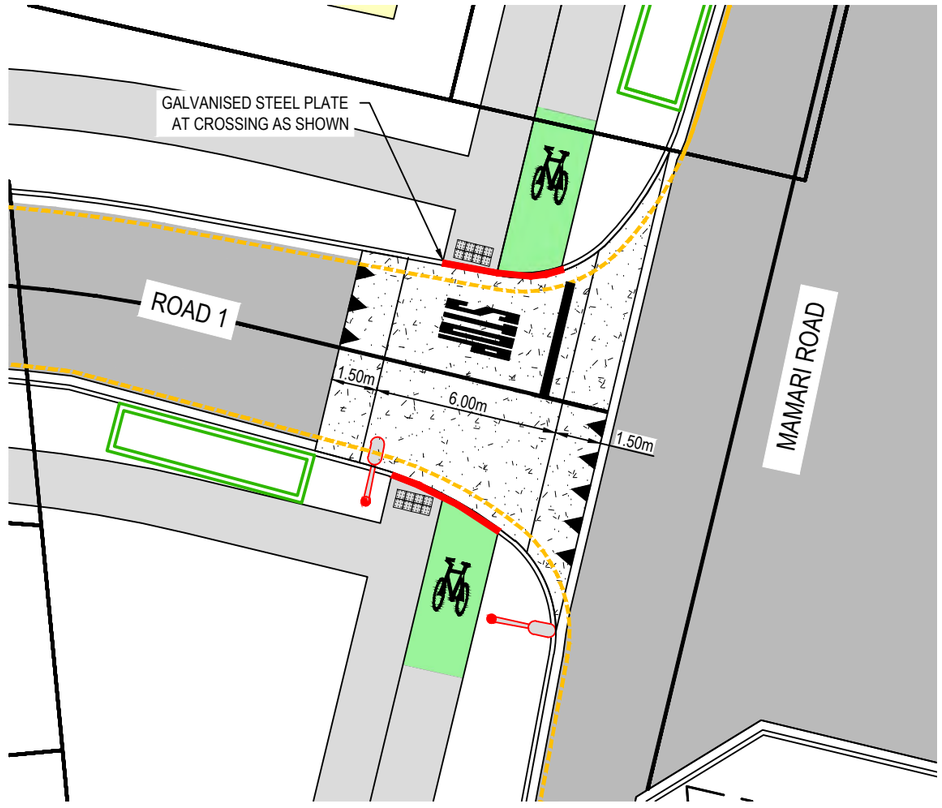
NOTE:

PROP RAISED TABLE BUILT TO AUCKLAND TRANSPORT SPEED TABLE STANDARD TC005.



PEDESTRIAN CROSSING RAISED TABLE 1 - BRIGHAM CREEK ROAD
SCALE 1:200 @ A3



PEDESTRIAN CROSSING RAISED TABLE 2 - MAMARI ROAD
SCALE 1:200 @ A3

Notes
1. All works to be in accordance with Auckland Council standards.
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Line Marking

CENTER LINE 1-	WC100R (30m)
CENTER LINE 2-	WC100R
NO STOPPING LINE-	YI100R1x1
CONTINUITY LINE-	WI100R1x3
LIMIT LINE-	WC300R

Legend

	EX BDY
	PROP BDY
AC	AC PAVING
CB	BRUSHED CONCRETE
CEA	EXPOSED CONCRETE
DC	DISH CHANNEL
K&C	KERB AND CHANNEL
K&N	KERB AND NIB
WS	WHEEL STOP
	PROP SWCP SINGLE
	PROP STREET LIGHT
	PROP STREET SIGN
	ROAD NAME SIGN
	TACTILE PAVERS

Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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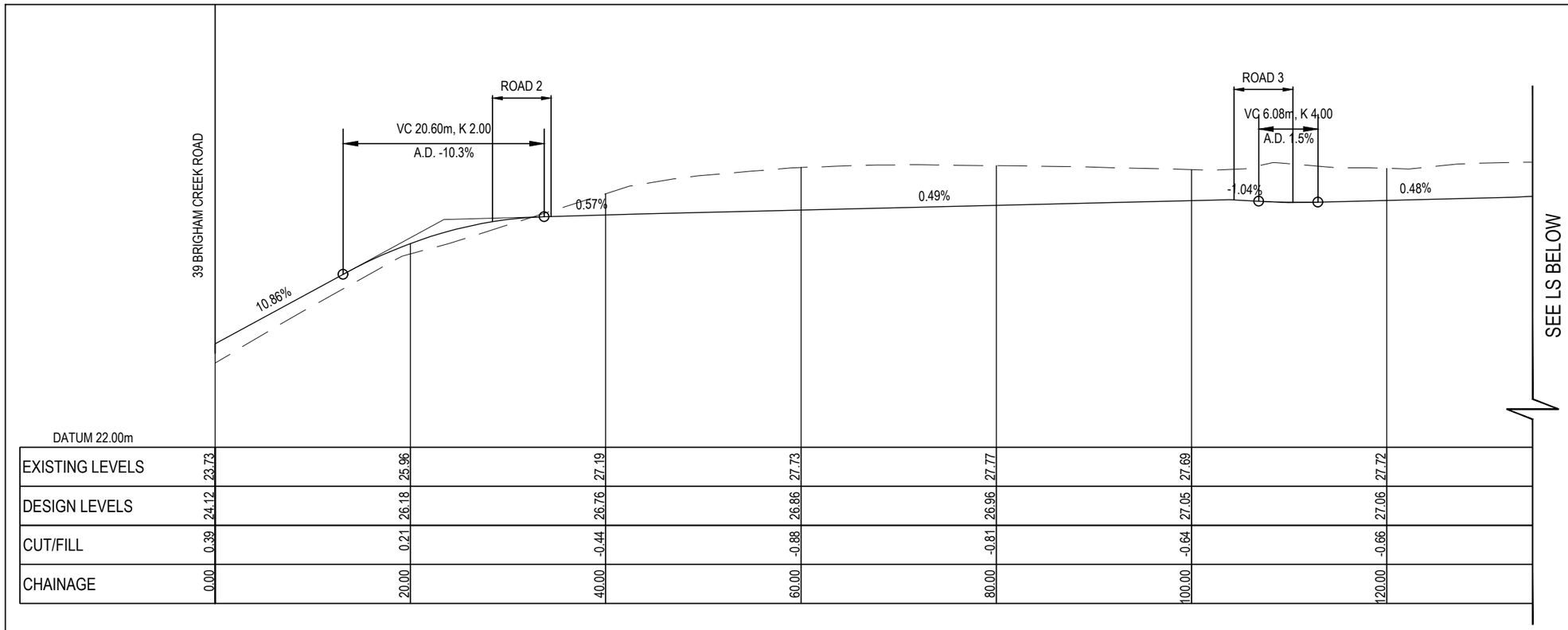
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

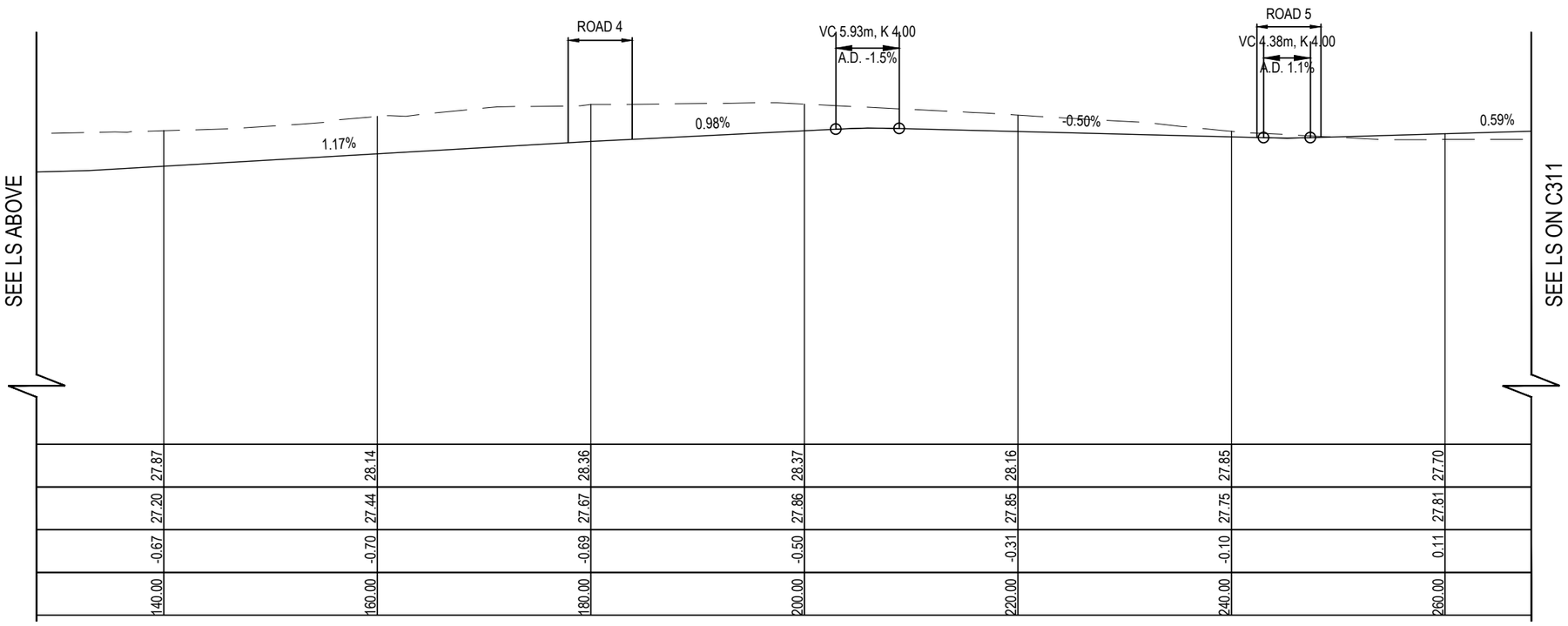
Title
PROPOSED PEDESTRIAN CROSSING RAISED TABLE PLAN

Project no.	210001		
Scale	1:200 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C308	Rev	B

DATE: 4/14/22



ROAD 1 LONG-SECTION
SCALE HORI1:500 VERT 1:100 @ A3



ROAD 1 LONG-SECTION (CONTINUED)
SCALE HORI1:500 VERT 1:100 @ A3

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Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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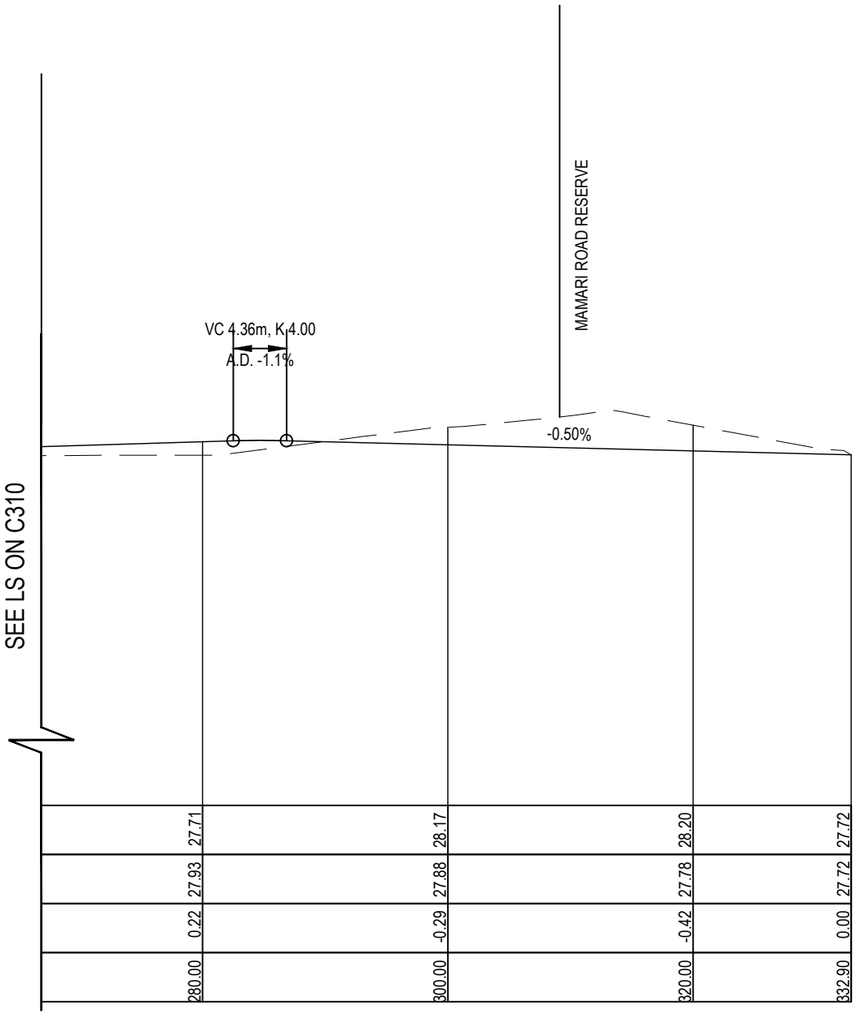
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

Title
PROPOSED ROAD 1 LONG-SECTION

Project no.	210001
Scale	1:500 @ A3
Cad file	C300 - ROADING.DWG
Drawing no.	C310 Rev B

DATE: 4/14/22



27.71	28.17	28.20	27.72
27.93	27.88	27.78	27.72
0.22	-0.29	-0.42	0.00
280.00	300.00	320.00	332.90

ROAD 1 LONG-SECTION (CONTINUED)
SCALE HORI1:500 VERT 1:100 @ A3

Notes
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Rev	Description	By	Date
B	RC S92	AP	02/22
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	By	Date
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Drawn	AP	08/21
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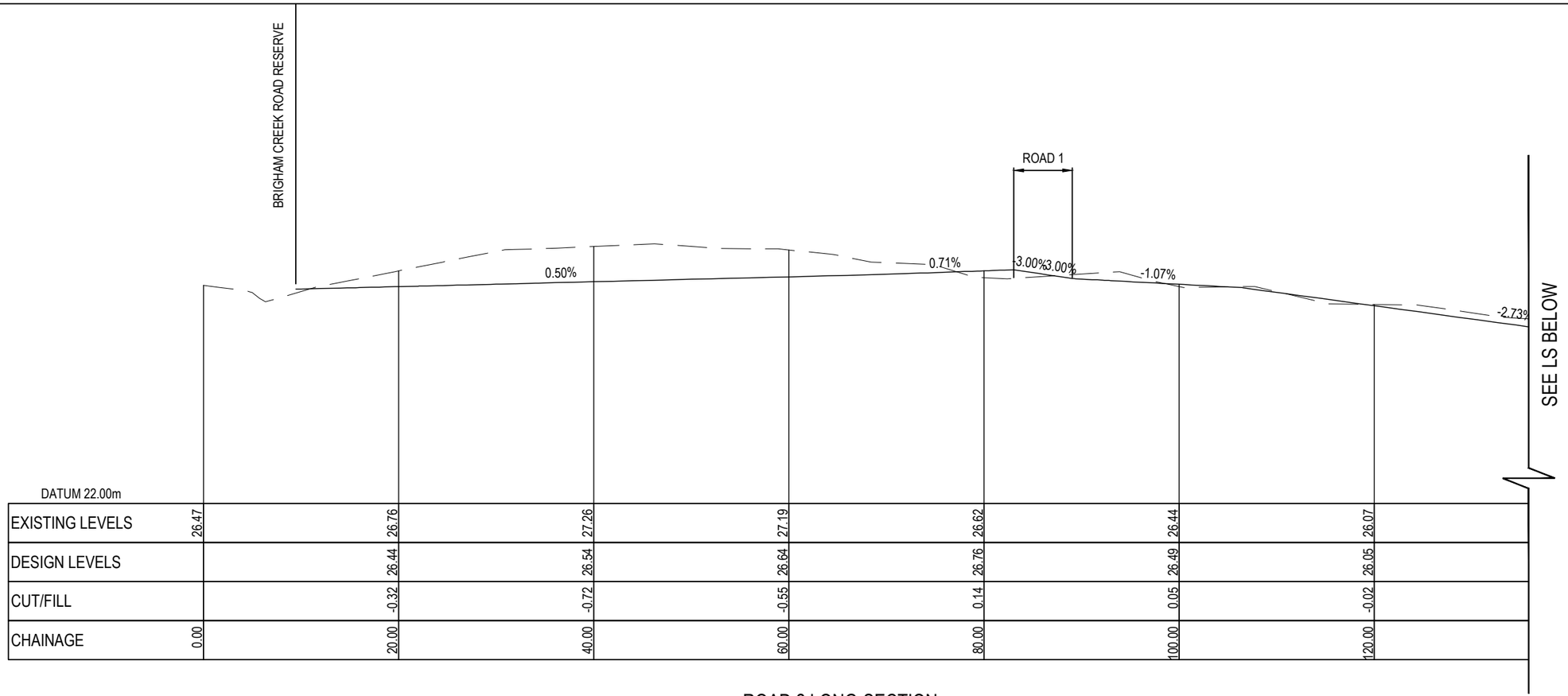
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED
ROAD 1
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C311	Rev	B

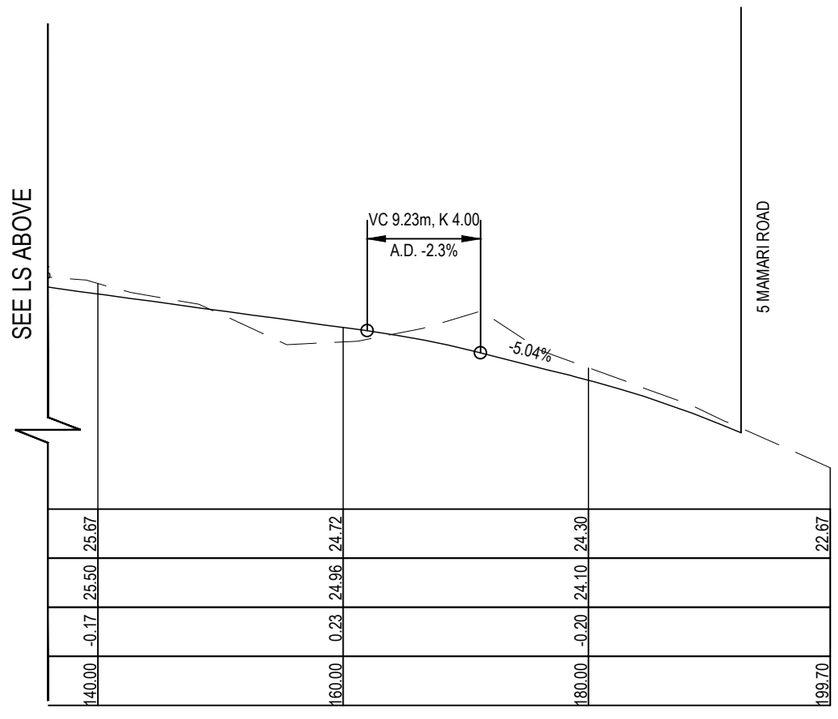
DATE: 4/14/22



DATUM 22.00m

EXISTING LEVELS	26.47	26.76	27.26	27.19	26.62	26.44	26.07
DESIGN LEVELS		26.44	26.54	26.64	26.76	26.49	26.05
CUT/FILL		-0.32	-0.72	-0.55	0.14	0.05	-0.02
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00

ROAD 2 LONG-SECTION
SCALE HORI1:500 VERT 1:100 @ A3



	25.67	24.72	24.30	22.67
	25.50	24.96	24.10	
	-0.17	0.23	-0.20	
	140.00	160.00	180.00	199.70

ROAD 2 LONG-SECTION (CONTINUED)
SCALE HORI1:500 VERT 1:100 @ A3

Notes
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18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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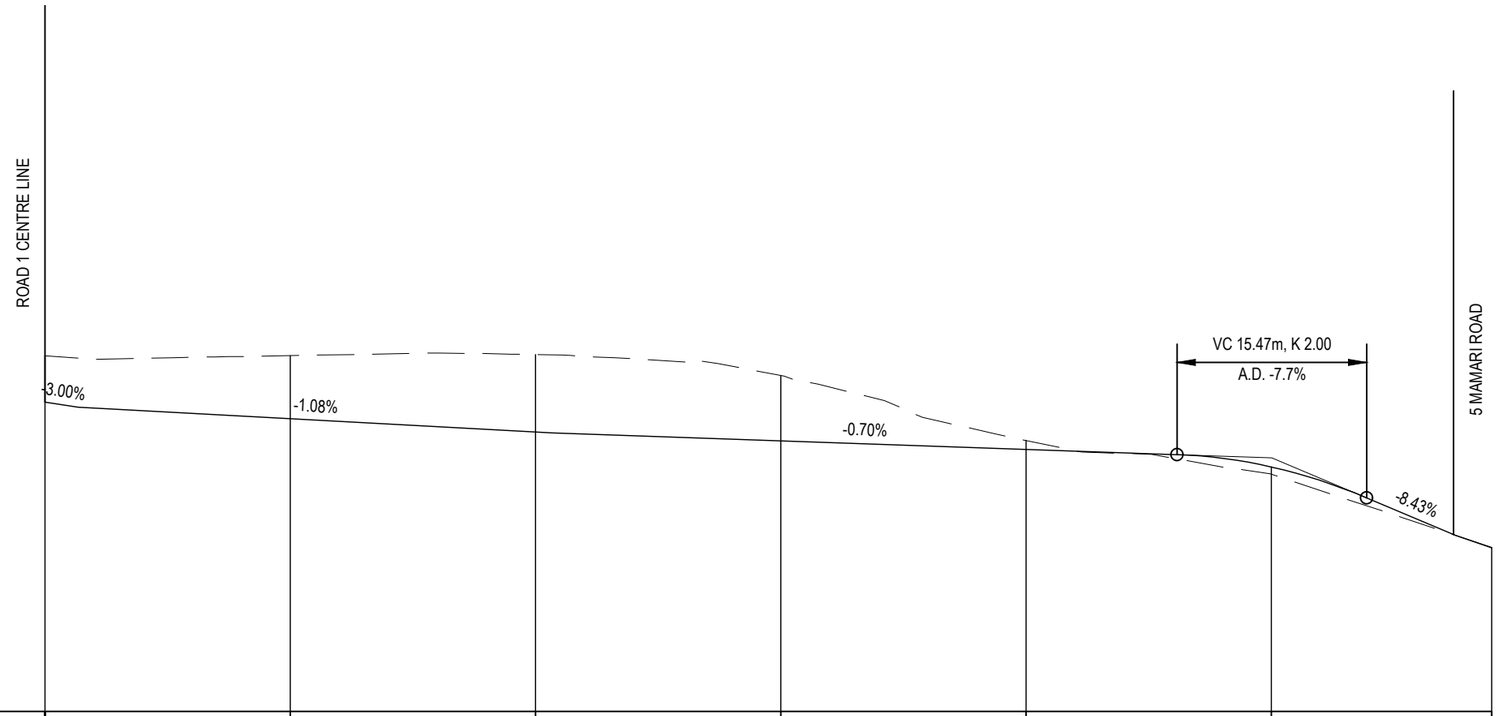
Auckland 1023

Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED
ROAD 2
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C312	Rev	B

DATE: 4/14/22



DATUM 22.00m							
EXISTING LEVELS	27.79	27.80	27.81	27.47	26.41	25.86	24.67
DESIGN LEVELS		26.77	26.55	26.41	26.27	25.98	24.66
CUT/FILL		-1.03	-1.26	-1.06	-0.14	0.12	-0.01
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	117.95

ROAD 3 LONG-SECTION
SCALE HORI1:500 VERT 1:100 @ A3

Notes
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Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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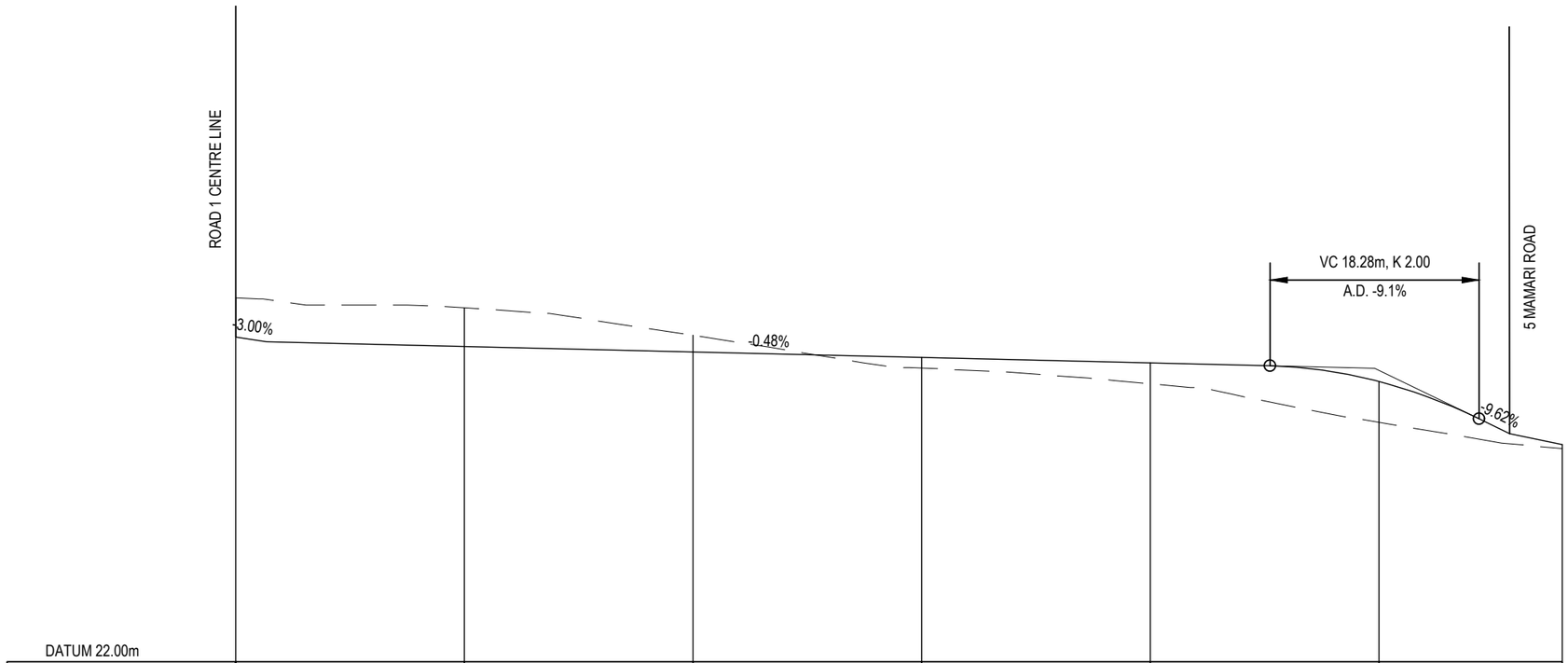
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED
ROAD 3
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C313	Rev	B

DATE: 4/14/22



DATUM 22.00m							
EXISTING LEVELS	28.36	28.19	27.71	27.13	26.86	26.18	25.73
DESIGN LEVELS		27.51	27.42	27.32	27.22	26.90	25.80
CUT/FILL		-0.67	-0.29	0.19	0.36	0.71	0.07
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	116.03

ROAD 4 LONG-SECTION

SCALE HORI1:500 VERT 1:100 @ A3

Notes

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Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project

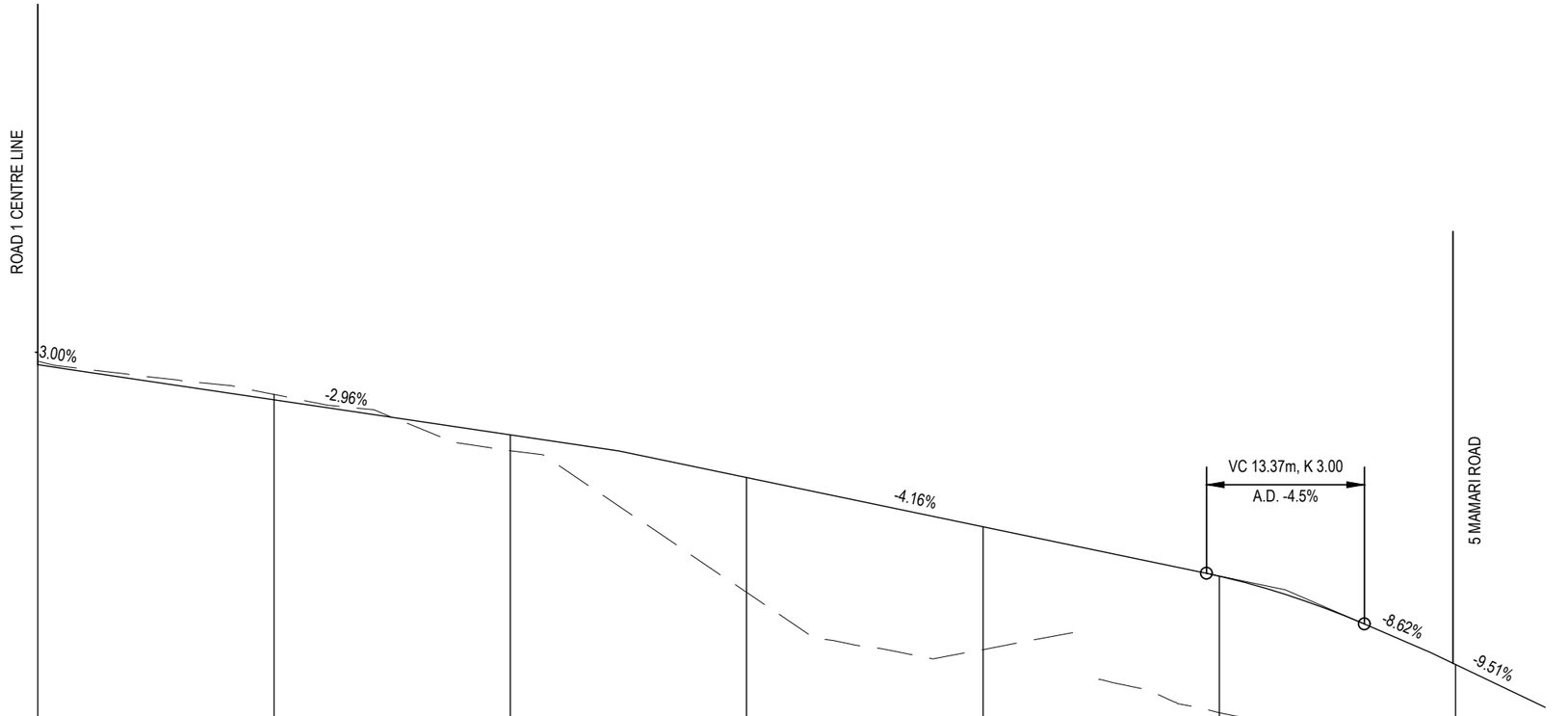
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title

PROPOSED
ROAD 4
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C314	Rev	B

DATE: 4/14/22



DATUM 20.00m

EXISTING LEVELS	27.79	27.23	26.28	23.88	22.91	21.85	21.34	
DESIGN LEVELS	27.73	27.14	26.54	25.82	24.99	24.15	22.66	
CUT/FILL	-0.06	-0.09	0.27	1.94	2.07	2.31	1.33	
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	129.28

ROAD 5 LONG-SECTION
SCALE HORI1:500 VERT 1:100 @ A3

Notes
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Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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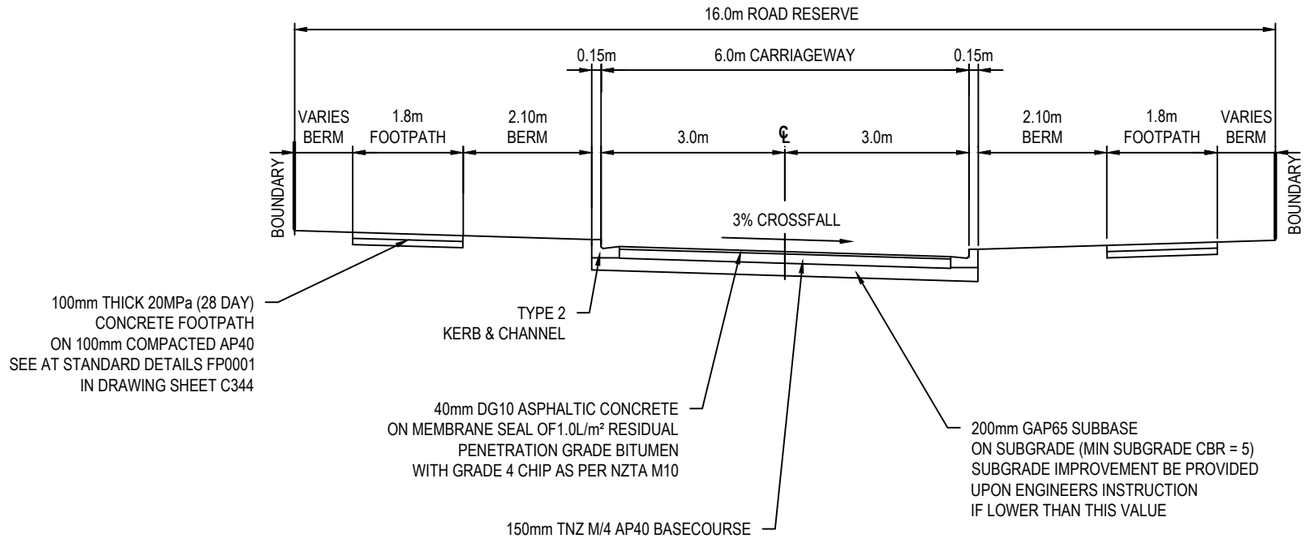
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED
ROAD 5
LONG-SECTION

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C315	Rev	B

DATE: 4/14/22



TYPICAL LOCAL ROAD SECTION - 1

SCALE 1:100 @ A3

Notes

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B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
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Project

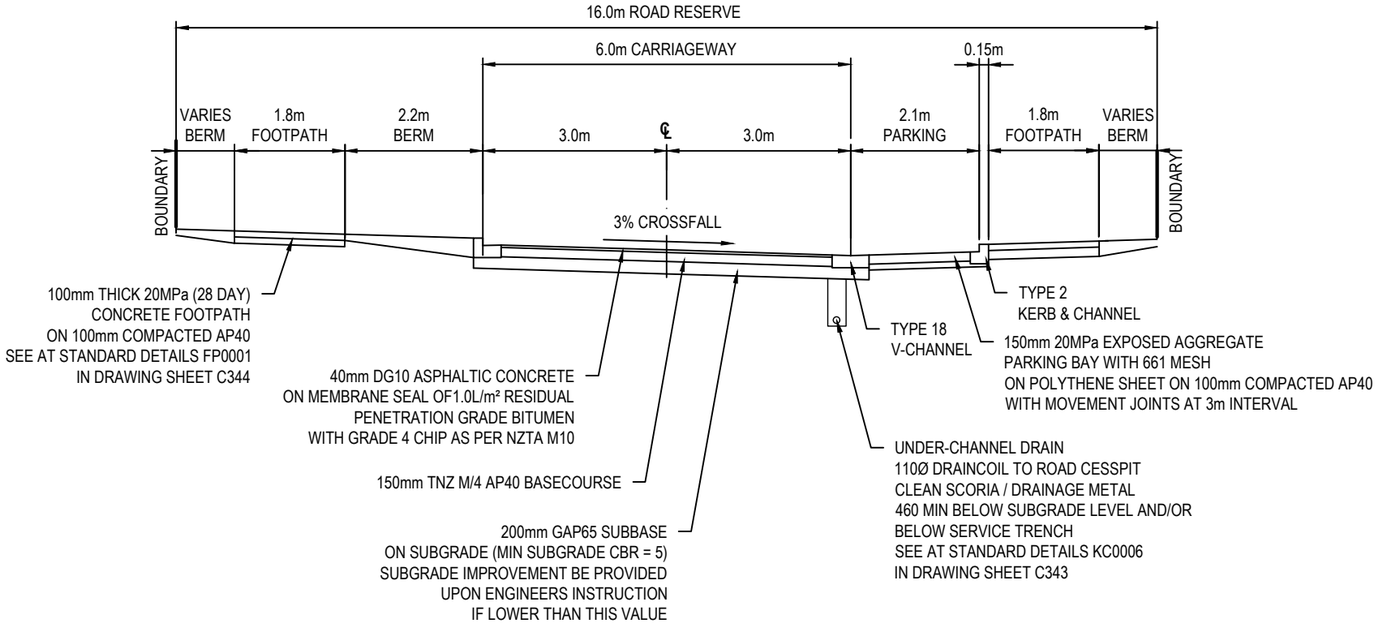
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title

PROPOSED
ROADING
CROSS-SECTIONS

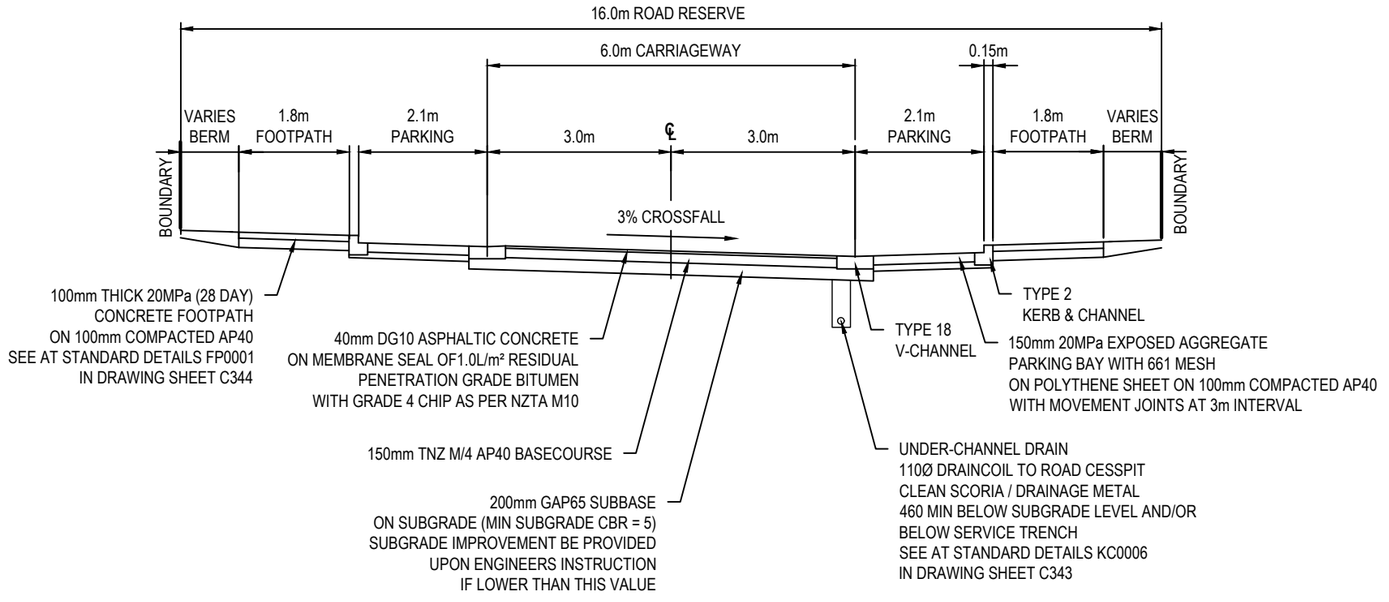
Project no.	210001		
Scale	1:100 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C320	Rev	B

DATE: 4/14/22



TYPICAL LOCAL ROAD SECTION - 2

SCALE 1:100 @ A3



TYPICAL LOCAL ROAD SECTION - 3

SCALE 1:100 @ A3

Notes

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Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project

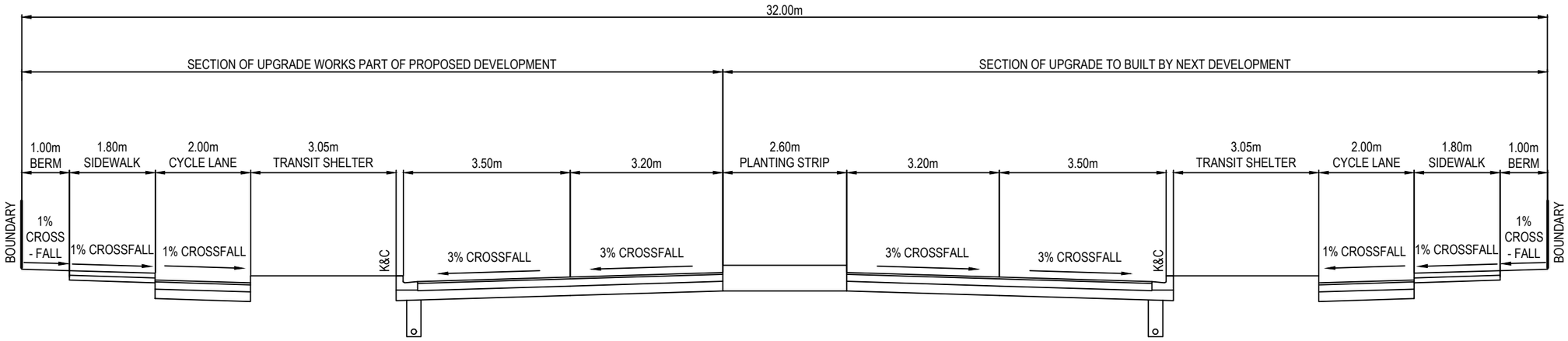
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

Title

PROPOSED ROADING CROSS-SECTIONS

Project no.	210001
Scale	1:100 @ A3
Cad file	C300 - ROADING.DWG
Drawing no.	C321 Rev B

DATE: 4/14/22



PROPOSED MAMARI RD UPGRADE SECTION

SCALE 1:100 @ A3

Notes

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Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project

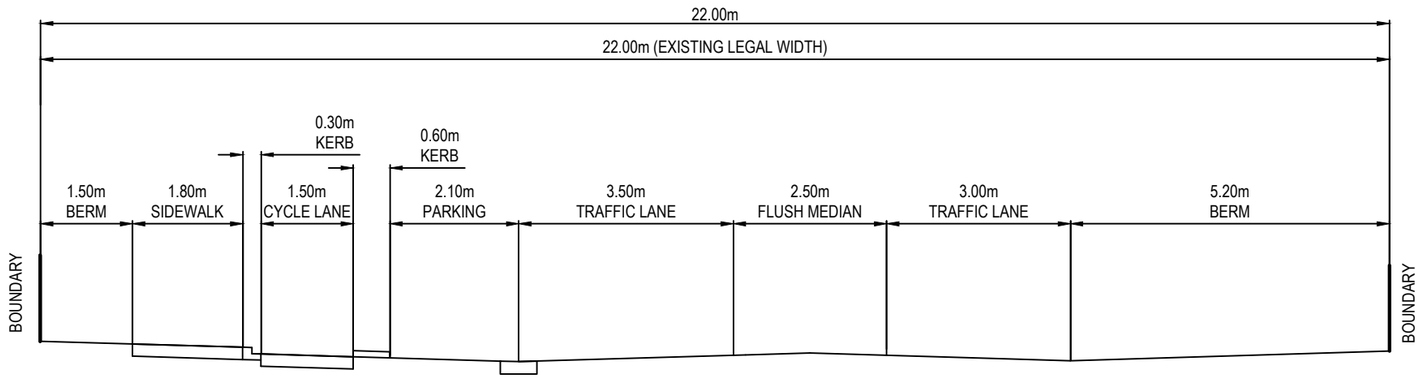
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR AI LING

Title

PROPOSED MAMARI RD UPGRADE ROADING CROSS-SECTION

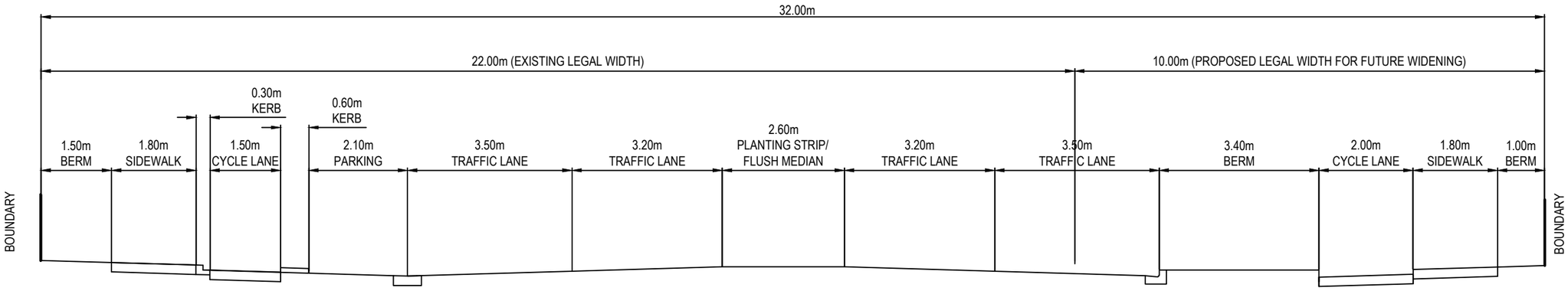
Project no.	210001		
Scale	1:100 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C322	Rev	A

DATE: 4/14/22



EXISTING BRIGHAM CREEK ROAD SECTION

SCALE 1:100 @ A3



FUTURE BRIGHAM CREEK ROAD SECTION

SCALE 1:100 @ A3

Notes

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Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	A	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project

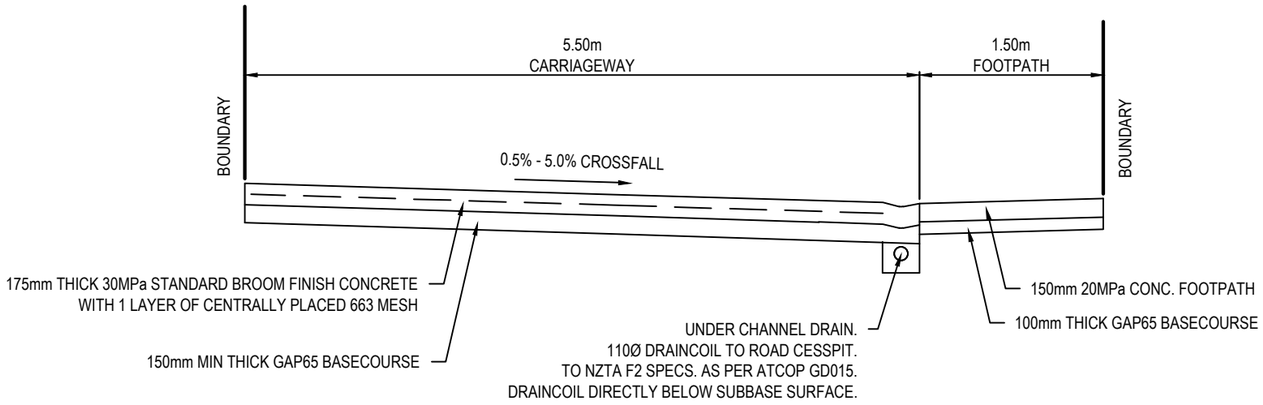
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title

BRIGHAM CREEK ROAD CROSS-SECTION

Project no.	210001		
Scale	1:100 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C323	Rev	A

DATE: 4/14/22

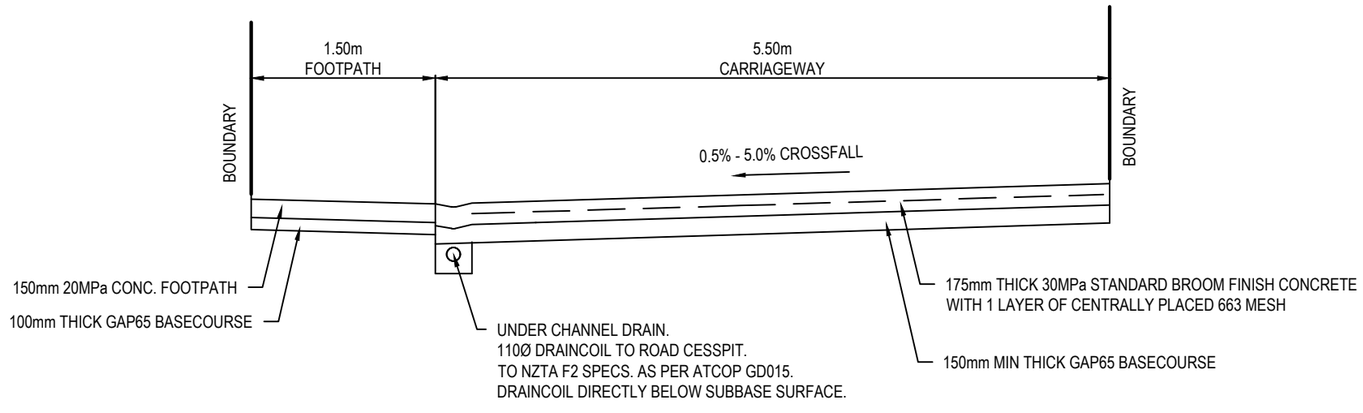


A
-

TYPICAL JOAL CROSS SECTION - A

SCALE 1:50 @ A3

DESIGN BASED ON MINIMUM CBR OF 5.0



B
-

TYPICAL JOAL CROSS SECTION - B

SCALE 1:50 @ A3

DESIGN BASED ON MINIMUM CBR OF 5.0

Notes

1. All works to be in accordance with Auckland Council standards.
2. Contractor is to avoid using GPS for set out of the kerb levels where gradients less than 1%.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. The contractor shall comply with all relevant Health and Safety requirements.
5. The contractor shall obtain all necessary approval from utility operators before commencing work under or near their services.
6. Final pavement design subject to CBR/Beam tests on subgrade material.
7. Setout schedule with co-ordinates of chainage points along road centreline to be supplied to the contractor prior to construction.
8. Refer to long section for finished centreline levels. Refer to typical cross sections to obtain levels for other locations
9. All ducts shall have locations marked on kerb lines in accordance with specification.
10. Pram crossings are to be flush to the channel with no lip.
11. All kerb and channel to have sawcuts at max. 4m centres.
12. All kerbing, channels and edge beams shall have 4kg black oxide.
13. All signage and pavement markings to be in accordance with NZTA MOTSAM standards and the ATCOP TCDM.
14. All street name signs shall follow ATCOP guidelines in terms of layout, clearances, and construction details.
15. All line markings to be reflectorised in accordance with MOTSAM standards.
16. The minimum vertical and lateral clearances for signage shall be in accordance with MOTSAM standards.
17. Street lighting shall be designed in accordance with all applicable New Zealand Standards including but not restricted to the current version of AS/NZS 1158 Lighting for Roads and Public Spaces series of standards.
18. All new, modified or upgraded pram crossings must be in accordance with RTS 14 Guidelines for Facilities for Blind and Vision-impaired Pedestrians and NZS/AS 1428.4 and must comply with the details provided in AT's Standard Plan No.FP009.

Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Auckland 1023

Project

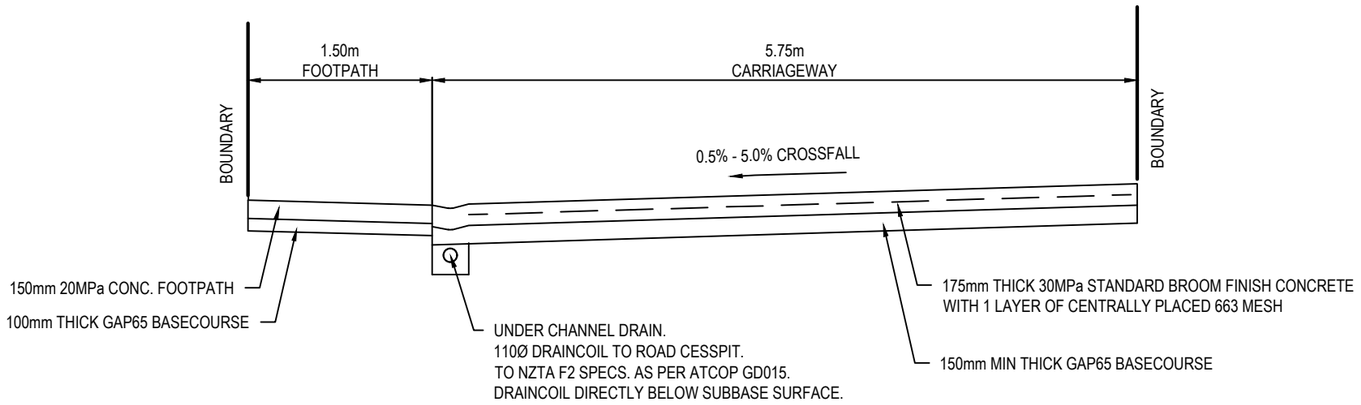
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title

PROPOSED
ROADING
CROSS-SECTIONS

Project no.	210001		
Scale	1:50 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C330	Rev	A

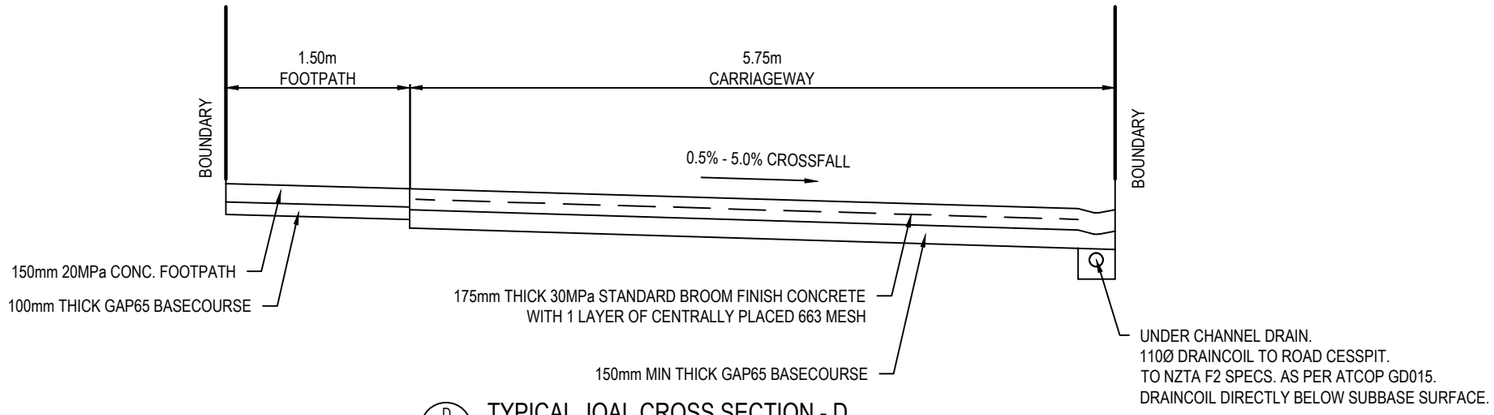
DATE: 4/14/22



C - TYPICAL JOAL CROSS SECTION - C

SCALE 1:50 @ A3

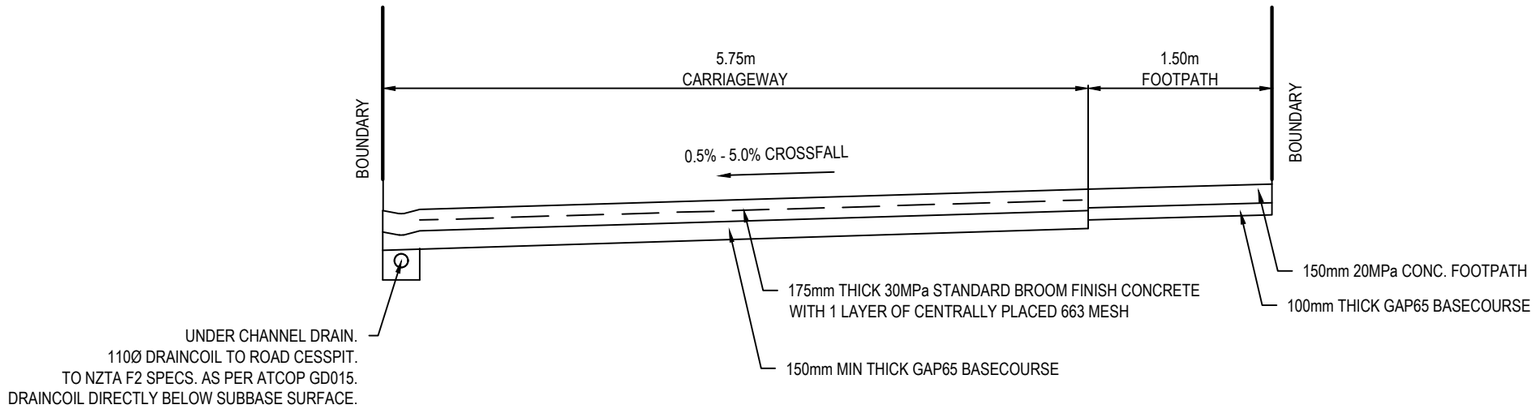
DESIGN BASED ON MINIMUM CBR OF 5.0



D - TYPICAL JOAL CROSS SECTION - D

SCALE 1:50 @ A3

DESIGN BASED ON MINIMUM CBR OF 5.0



E - TYPICAL JOAL CROSS SECTION - E

SCALE 1:50 @ A3

DESIGN BASED ON MINIMUM CBR OF 5.0

Notes

1. All works to be in accordance with Auckland Council standards.
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Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
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Drawn	AP	08/21
Checked	JP	08/21

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41-43 BRIGHAM CREEK RD
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FOR
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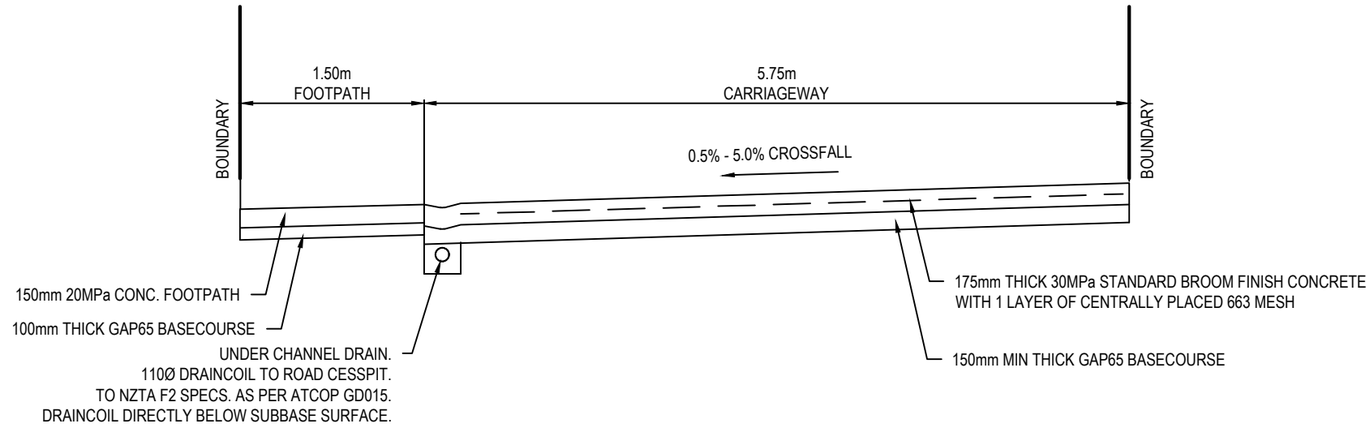
Title

PROPOSED
ROADING
CROSS-SECTIONS

Project no.	210001
Scale	1:50 @ A3
Cad file	C300 - ROADING.DWG
Drawing no.	C331 Rev A

DATE: 4/14/22



F
-

TYPICAL JOAL CROSS SECTION - F

SCALE 1:50 @ A3

DESIGN BASED ON MINIMUM CBR OF 5.0

Notes

1. All works to be in accordance with Auckland Council standards.
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Rev	Description	By	Date
A	RC	AP	08/21

	By	Date
Survey	MH	03/21
Design	AP	08/21
Drawn	AP	08/21
Checked	JP	08/21

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Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
AI LING

Title
PROPOSED
ROADING
CROSS-SECTIONS

Project no.	210001		
Scale	1:50 @ A3		
Cad file	C300 - ROADING.DWG		
Drawing no.	C332	Rev	A

DATE: 4/14/22

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

- EX BDY
- PROP BDY
- EX WW
- PROP WW
- PROP WW RISING MAIN
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE
- PROP RAIN GARDEN

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

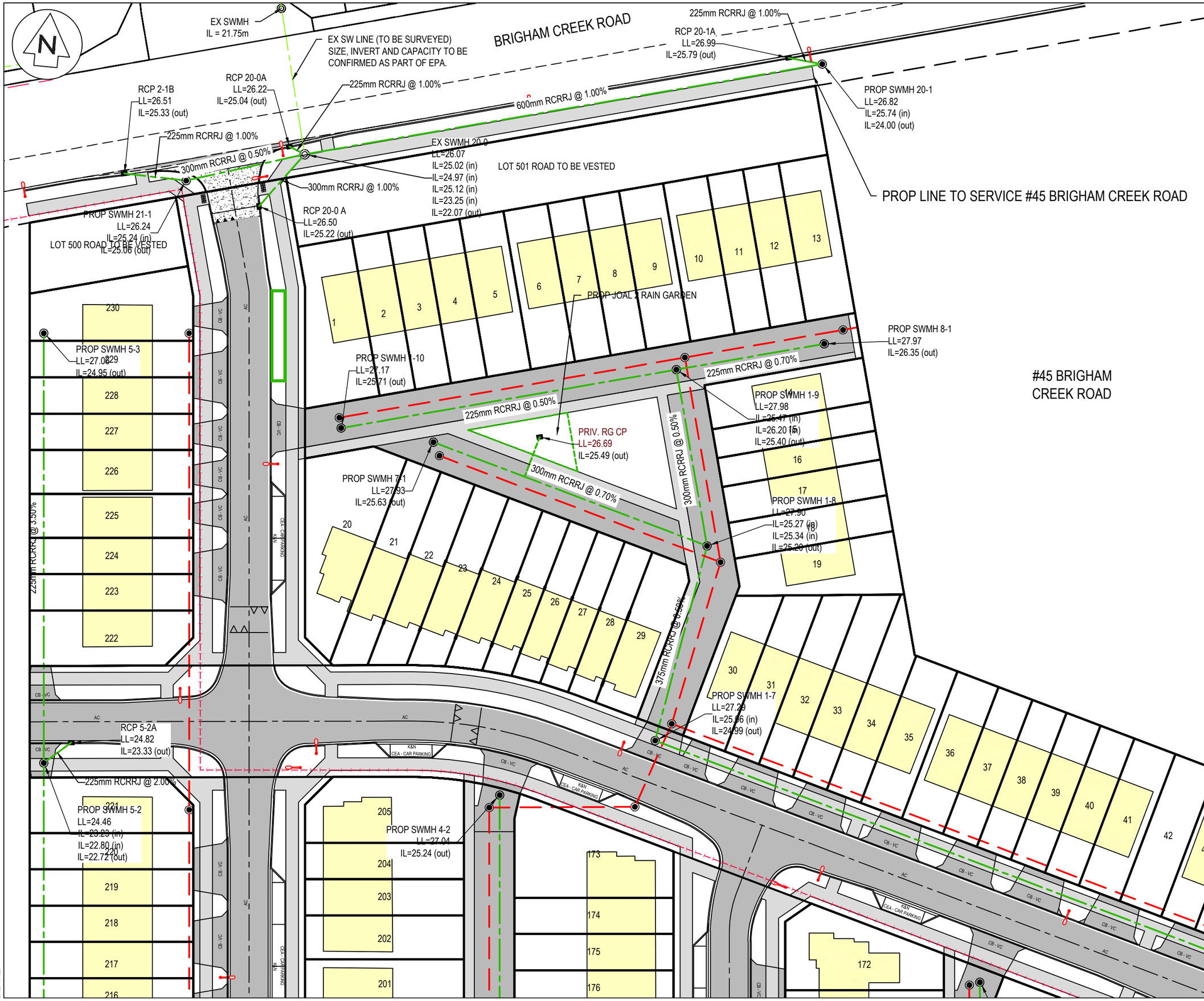
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED STORMWATER DRAINAGE OVIERVIEW PLAN

Project no.	210001
Scale	1:1500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C400 Rev B

DATE: 4/14/22



Notes

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Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED STORMWATER DRAINAGE PLAN

Project no.	210001
Scale	1:500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C401 Rev B

DATE: 4/14/22

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
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Legend

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- PROP RAIN GARDEN

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

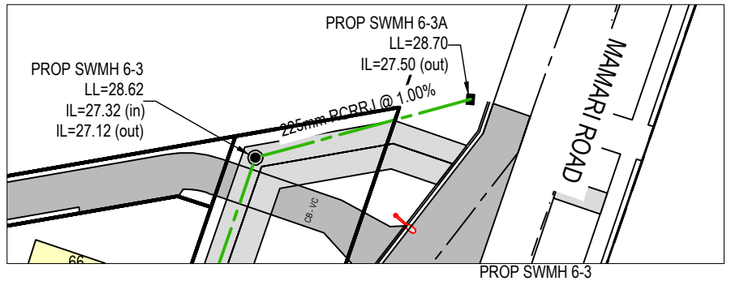
Title

PROPOSED STORMWATER DRAINAGE PLAN

Project no.	210001
Scale	1:500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C402 Rev B

DATE: 4/14/22

INSET



#45 BRIGHAM CREEK ROAD

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
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Rev	Description	By	Date
B	RC S92	AP	04/22
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Design	JP	08/21
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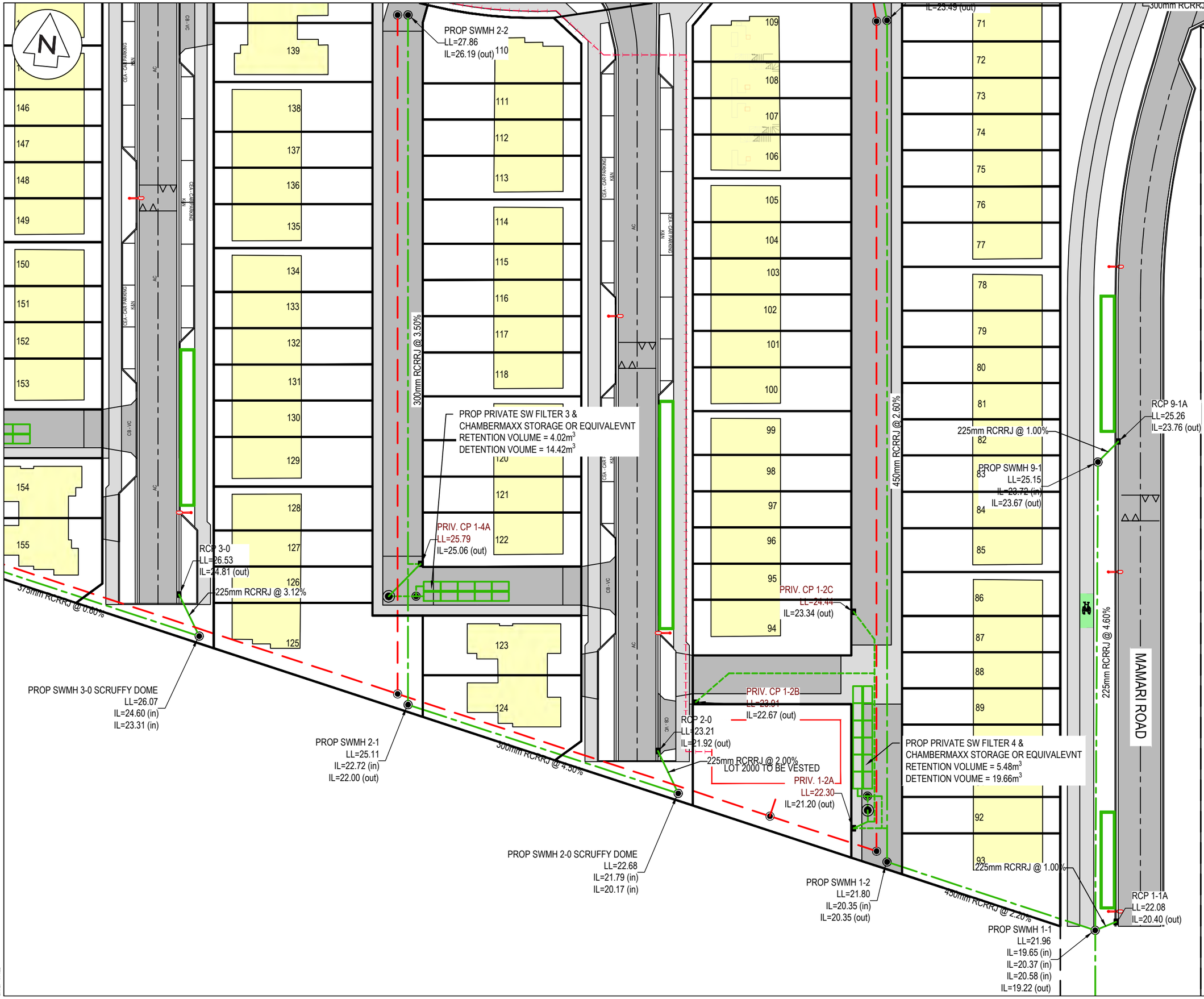
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title
PROPOSED
DRAINAGE
OVIERVIEW PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C403	Rev	B

DATE: 4/14/22



Notes

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED STORMWATER DRAINAGE PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C404	Rev	B

DATE: 4/14/22

#5 MAMARI ROAD

525mm RCRRJ @ 2.27%

MAMARI ROAD

PROP OUTLET 1-0
LL=17.84
IL=16.29 (in)

PROP ROCK RIPRAP OUTLET
MINIMUM 5.5m LONG x 1.6m WIDE x 0.4m DEEP (MINIMUM ROCK SIZE 200mmØ)
LAID ON COCONUT FIBRE1200 MAT - BIOCOIR BC1200 OR EQUIVALENT

SINTON STREAM

Notes

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B	RC S92	AP	04/22
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Title

PROPOSED STORMWATER DRAINAGE PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C405	Rev	B

DATE: 4/14/22

RG No.	Proposed Raingarden Footprint area (m2)
Road Reserve - Rain Gardens	
1-1A	23.00
2-0	55.00
3-0	37.50
4-0	51.50
5-0	52.90
6-2A	21.50
6-2B	10.50
9-1A	32.50
20-0A	21.60
Private - Rain Gardens	
JOAL 2	59.00
Filter No.	**Size**
1	1500mm (5 cartridges)
2	1500mm (5 cartridges)
3	1500mm (5 cartridges)
4	1500mm (5 cartridges)

Notes

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Rev	Description	By	Date
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	By	Date
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Design	JP	08/21
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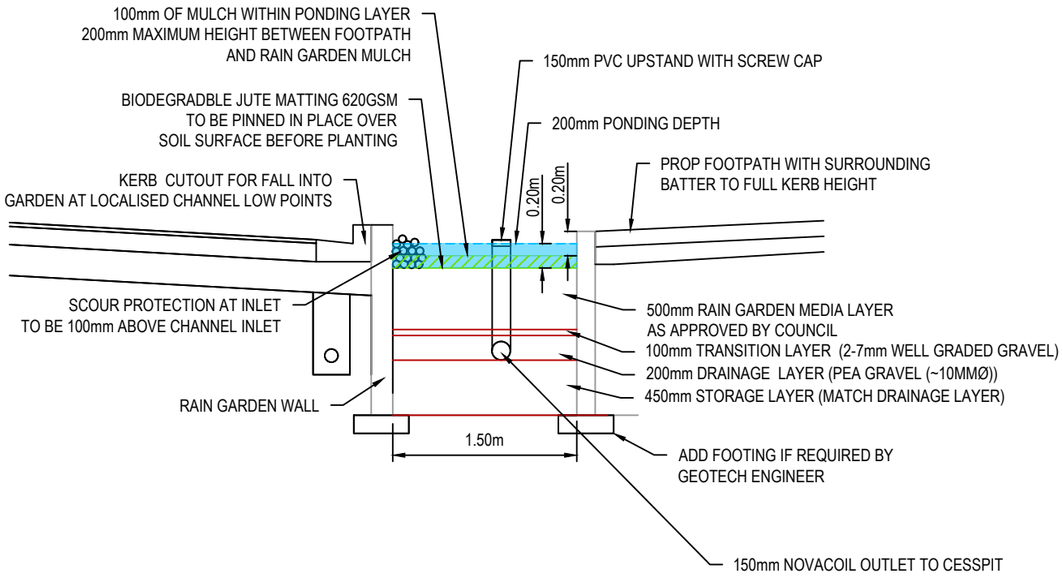
Title

PROPOSED SW TREATMENT DEVICES PLAN

Project no.	210001
Scale	1:1500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C407 Rev B

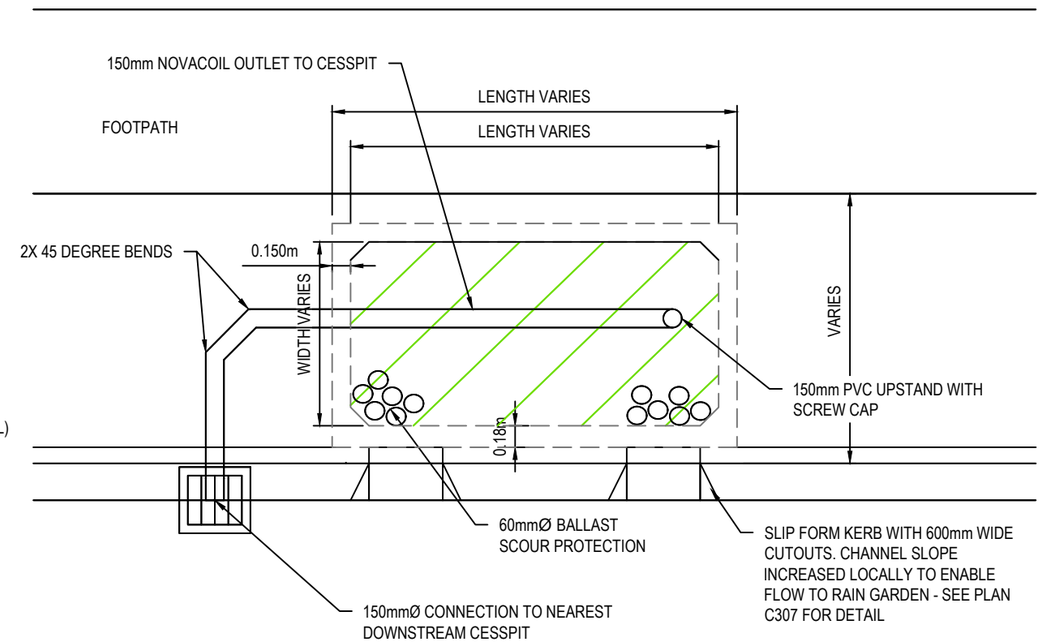
DATE: 4/14/22



RG
-

TYPICAL RAIN GARDEN SECTION DETAIL

SCALE 1:50 @ A3



RG
-

TYPICAL RAIN GARDEN PLAN DETAIL

SCALE 1:50 @ A3

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
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5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
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8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

- EX BDY
- PROP BDY
- EX WW
- PROP WW
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE

Rev	Description	By	Date
C	RC S92	JP	07/22
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Auckland 1023

Project

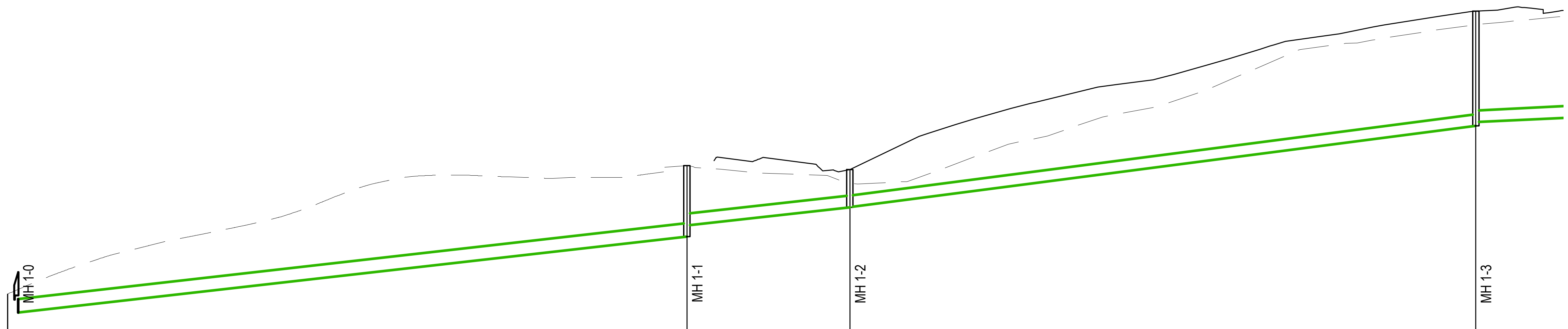
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED
RAINGARDEN DETAIL
PLAN

Project no.	210001		
Scale	-		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C408	Rev	C

DATE: 7/19/22

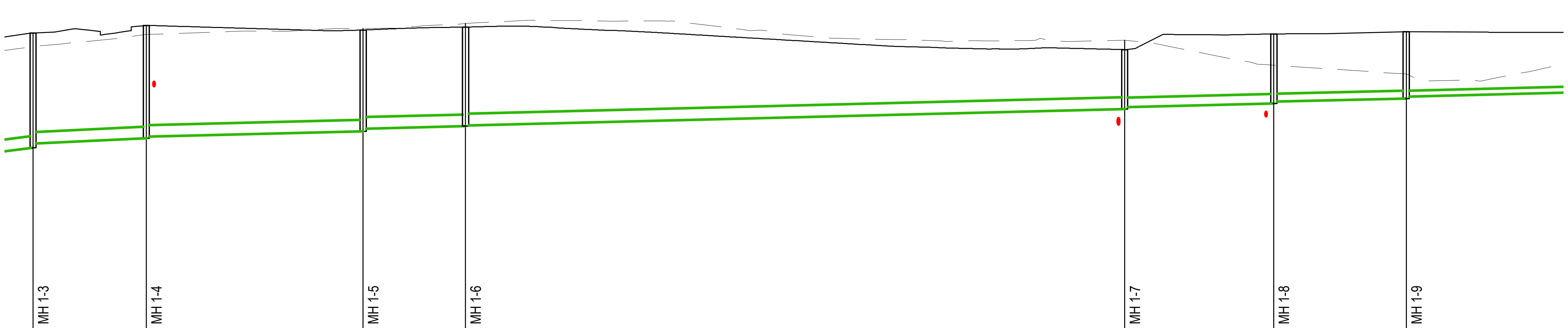


DATUM 15.00m

	MH 1-0		MH 1-1		MH 1-2		MH 1-3	
EXISTING LEVELS	17.00		21.96		21.29		27.41	
DESIGN LEVELS					21.80		27.93	
PIPE INVERT	16.29		19.22 19.65		20.35 20.35		23.49 23.64	
DEPTH INVERT (m)	1.63		2.74		1.46		4.44	
PIPE GRADE		525mm RCRRJ Ø @ 2.27%		450mm RCRRJ Ø @ 2.20%		450mm RCRRJ Ø @ 2.60%		450mm RCRR. @ 1.00%
CHAINAGE	0.00		131.07		162.51		283.25	

PROPOSED STORMWATER LONGSECTION 1

SCALE 1:1000 HORI 1:200 VERT



DATUM 15.00m

	MH 1-3		MH 1-4		MH 1-5		MH 1-6		MH 1-7		MH 1-8		MH 1-9	
EXISTING LEVELS	27.41		27.88		28.10		28.29		27.65		26.68		26.34	
DESIGN LEVELS	27.93		28.23		28.05		28.16		27.29		27.90		27.98	
PIPE INVERT	23.49 23.64		23.86 23.91		24.12 24.22		24.32 24.35		24.99 25.06		25.20 25.27		25.40 25.47	
DEPTH INVERT (m)	4.44		4.37		3.92		3.84		2.30		2.70		2.58	
PIPE GRADE		450mm RCRRJ Ø @ 1.00%		450mm RCRRJ Ø @ 0.50%		450mm RCRRJ Ø @ 0.50%		450mm RCRRJ Ø @ 0.50%		375mm RCRRJ Ø @ 0.50%		300mm RCRRJ Ø @ 0.50%		225mm RCRR. @ 0.50%
CHAINAGE	283.25		305.15		347.08		366.88		494.35		523.20		548.82	

PROPOSED STORMWATER LONGSECTION 1

SCALE 1:1000 HORI 1:200 VERT

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Legend

- EX GROUND LEVEL
- PROP FINISHED LEVEL
- HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

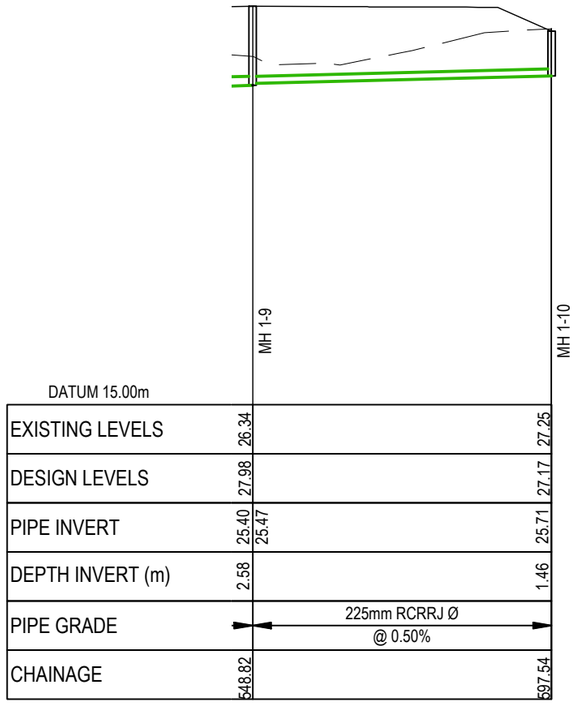
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

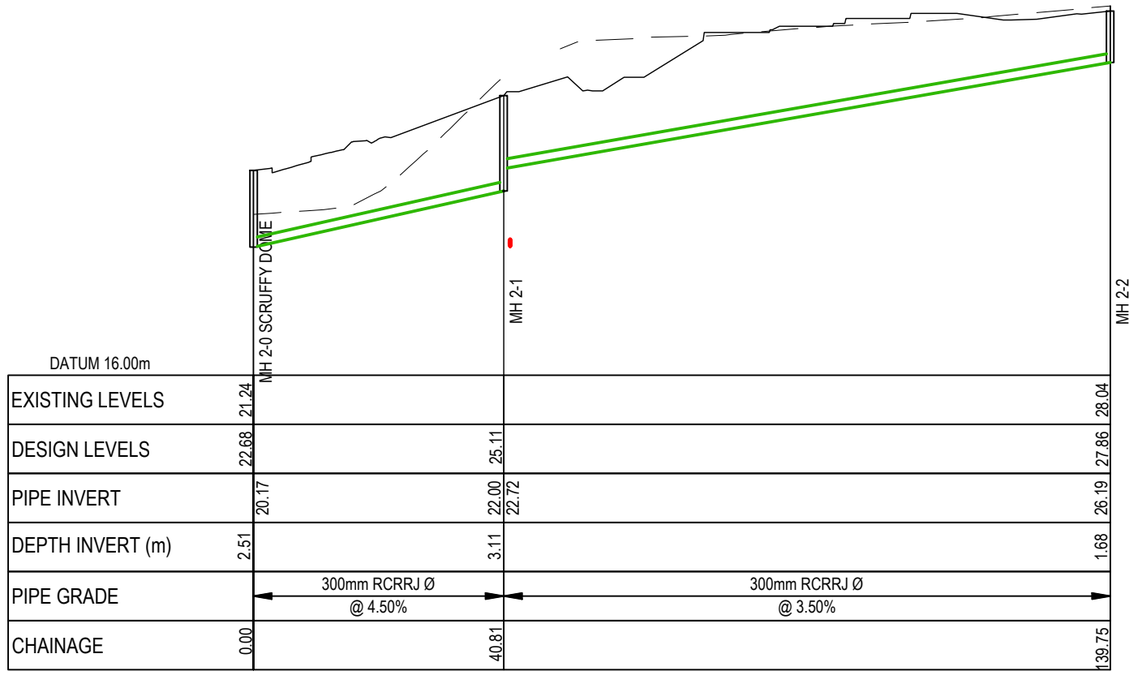
PROPOSED STORMWATER LONGSECTIONS

Project no.	210001
Scale	-
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C410
Rev	B

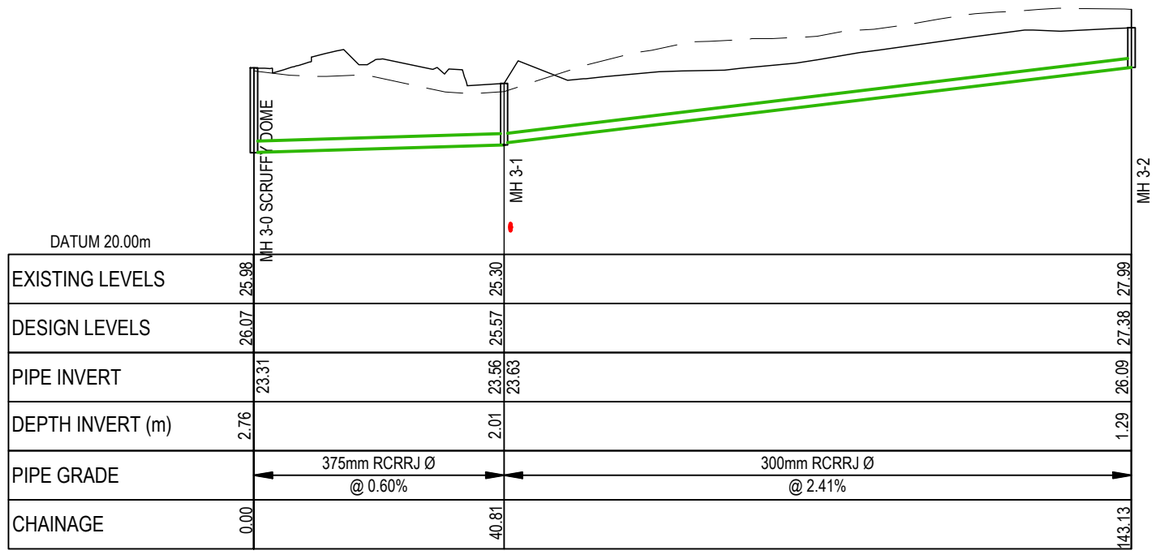
DATE: 4/14/22



PROPOSED STORMWATER LONGSECTION 1
SCALE 1:1000 HORI 1:200 VERT



PROPOSED STORMWATER LONGSECTION 2
SCALE 1:1000 HORI 1:200 VERT



PROPOSED STORMWATER LONGSECTION 3
SCALE 1:1000 HORI 1:200 VERT

Notes

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Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
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Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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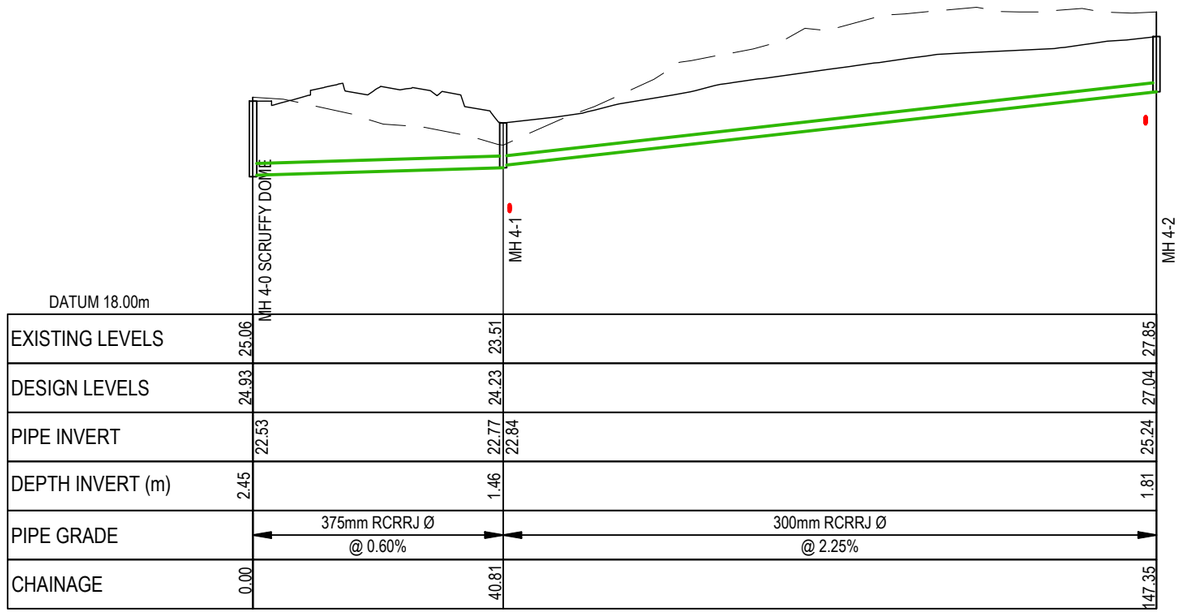
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title
PROPOSED STORMWATER LONGSECTIONS

Project no.	210001		
Scale	-		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C411	Rev	B

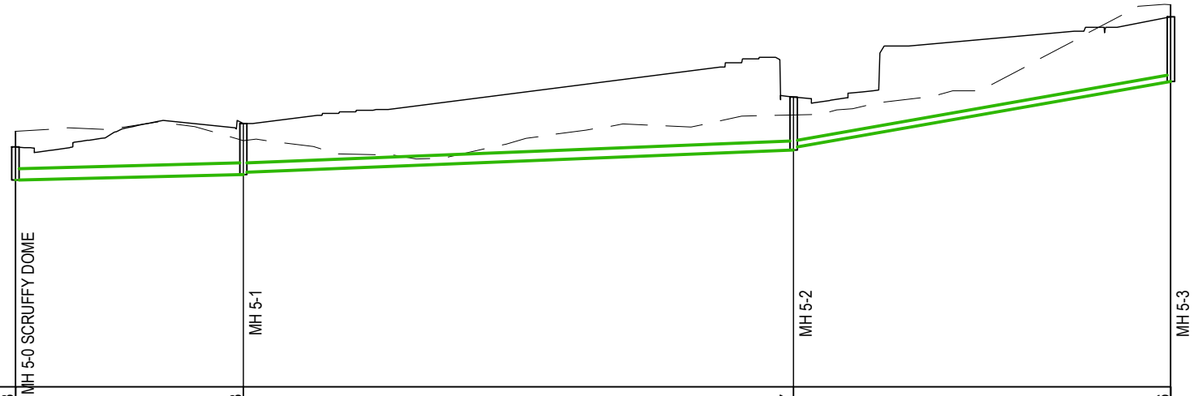
DATE: 4/14/22



DATUM 18.00m				
EXISTING LEVELS	25.06	23.51		27.85
DESIGN LEVELS	24.93	24.23		27.04
PIPE INVERT	22.53	22.77	22.84	25.24
DEPTH INVERT (m)	2.45	1.46		1.81
PIPE GRADE		375mm RCRRJ Ø @ 0.60%		300mm RCRRJ Ø @ 2.25%
CHAINAGE	0.00	40.81		147.35

PROPOSED STORMWATER LONGSECTION 4

SCALE 1:1000 HORI 1:200 VERT



DATUM 15.00m				
EXISTING LEVELS	23.33	23.03	23.87	27.46
DESIGN LEVELS	22.82	23.59	24.46	27.06
PIPE INVERT	21.74	21.93 22.00	22.72 22.80	24.95
DEPTH INVERT (m)	1.08	1.66	1.74	2.11
PIPE GRADE		375mm RCRRJ Ø @ 0.50%	300mm RCRRJ Ø @ 0.80%	225mm RCRRJ Ø @ 3.50%
CHAINAGE	0.00	37.16	126.88	188.40

PROPOSED STORMWATER LONGSECTION 5

SCALE 1:1000 HORI 1:200 VERT

Notes

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Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
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Project

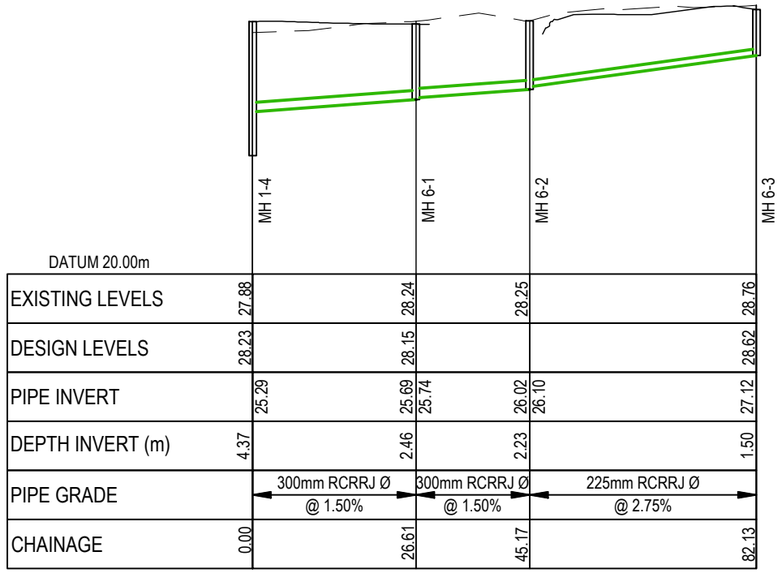
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

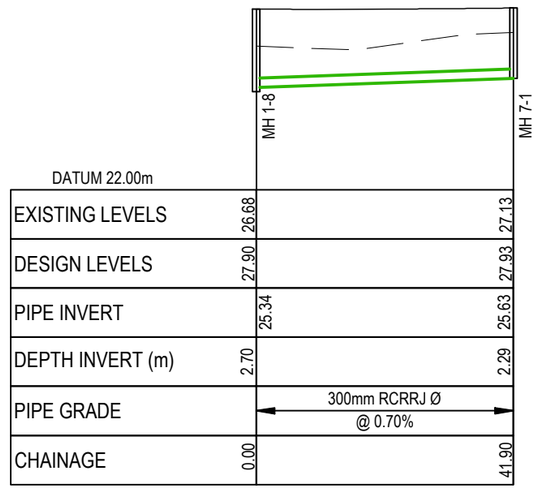
PROPOSED STORMWATER LONGSECTIONS

Project no.	210001
Scale	-
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C412 Rev B

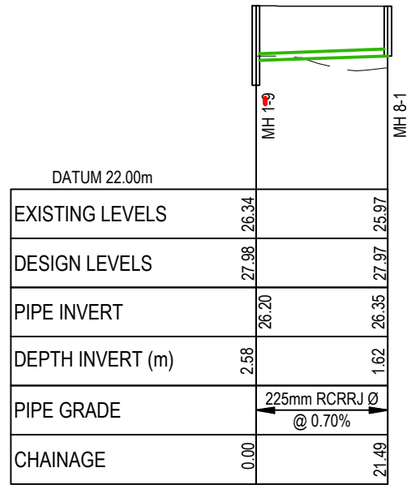
DATE: 4/14/22



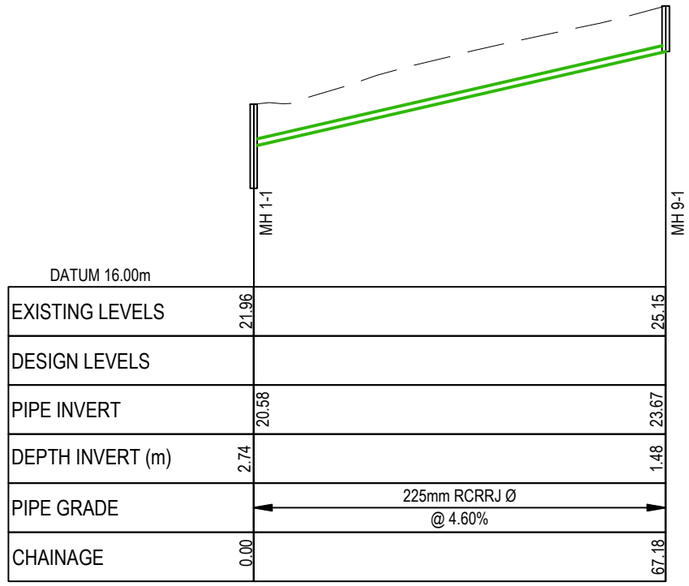
PROPOSED STORMWATER LONGSECTION 6
SCALE 1:1000 HORI 1:200 VERT



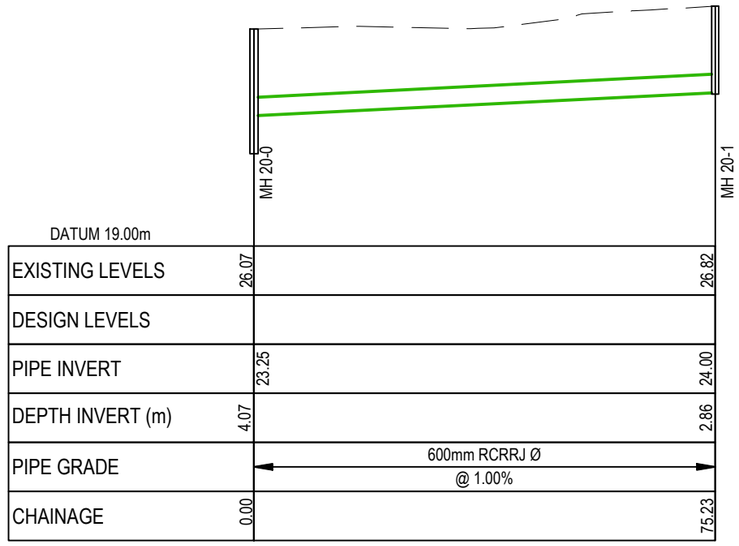
PROPOSED STORMWATER LONGSECTION 7
SCALE 1:1000 HORI 1:200 VERT



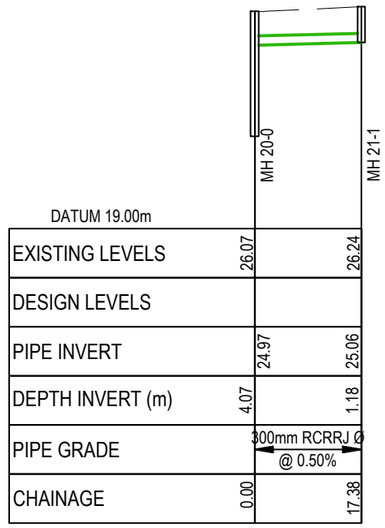
PROPOSED STORMWATER LONGSECTION 8
SCALE 1:1000 HORI 1:200 VERT



PROPOSED STORMWATER LONGSECTION 9
SCALE 1:1000 HORI 1:200 VERT



PROPOSED STORMWATER LONGSECTION 20
SCALE 1:1000 HORI 1:200 VERT



PROPOSED STORMWATER LONGSECTION 21
SCALE 1:1000 HORI 1:200 VERT

Notes

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Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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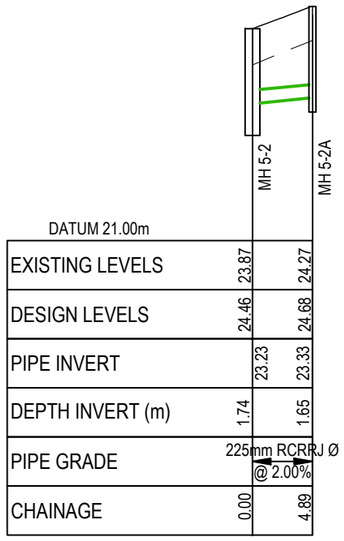
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

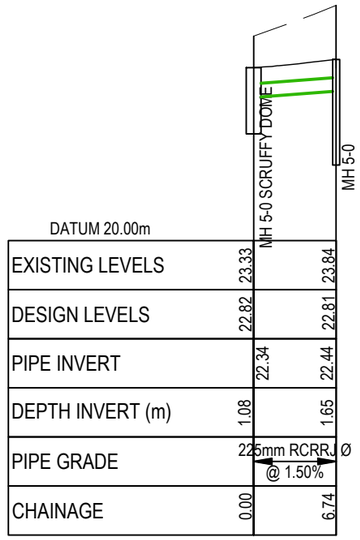
Title
PROPOSED STORMWATER LONGSECTIONS

Project no.	210001		
Scale	-		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C413	Rev	B

DATE: 4/14/22



CP LEAD 5-2
SCALE: HORI 1:500 VERT 1:100



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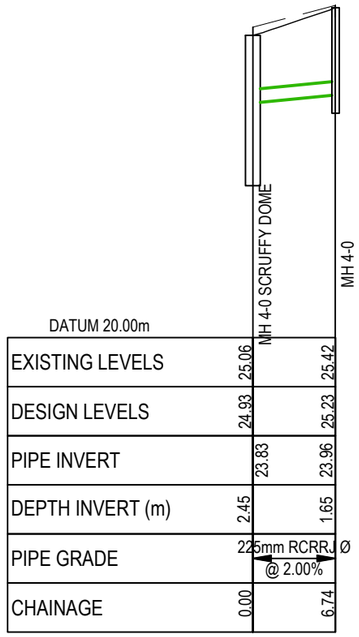
SCALE: HORI 1:500 VERT 1:100



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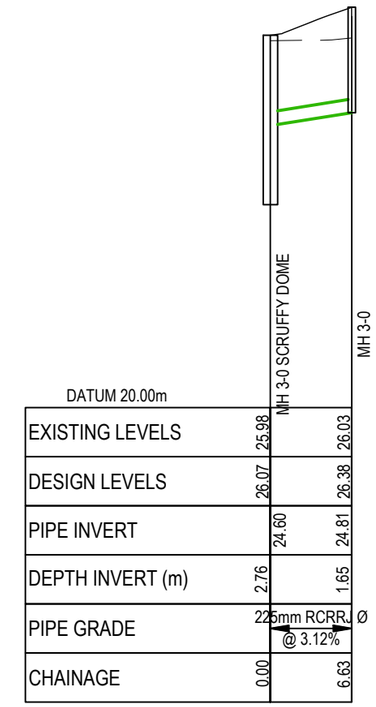
SCALE: HORI 1:500 VERT 1:100



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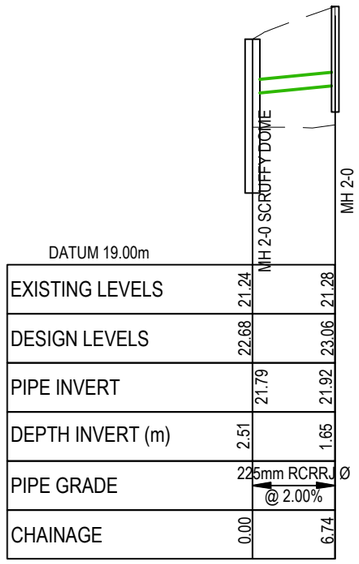
SCALE: HORI 1:500 VERT 1:100



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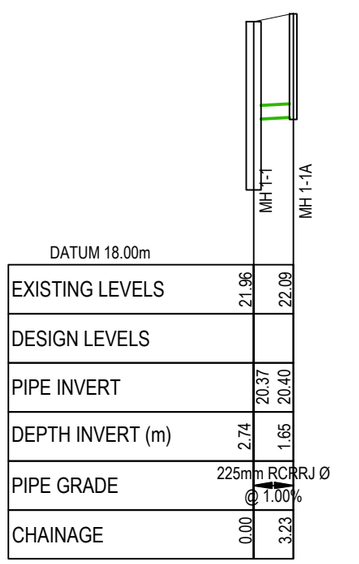
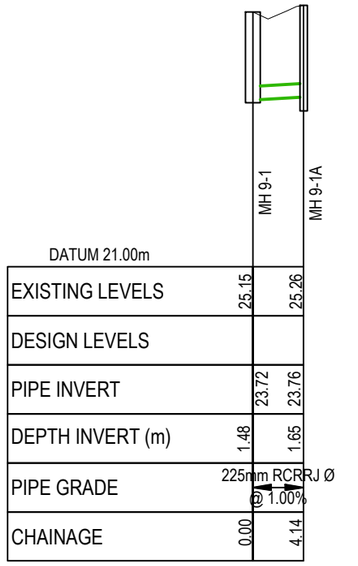


CP LEAD 1-1A
SCALE: HORI 1:500 VERT 1:100



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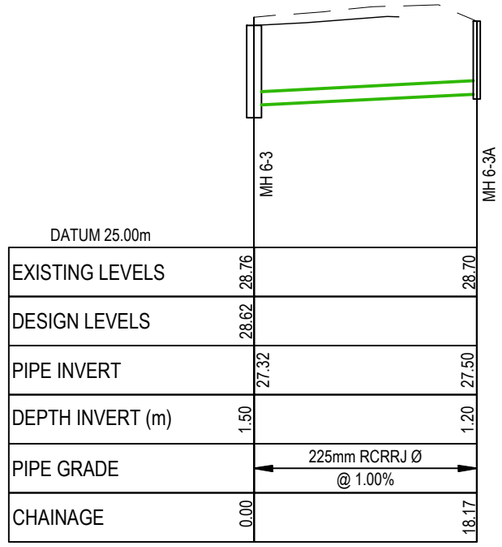
SCALE: HORI 1:500 VERT 1:100



CP LEAD 6-3A
SCALE: HORI 1:500 VERT 1:100

Notes

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Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
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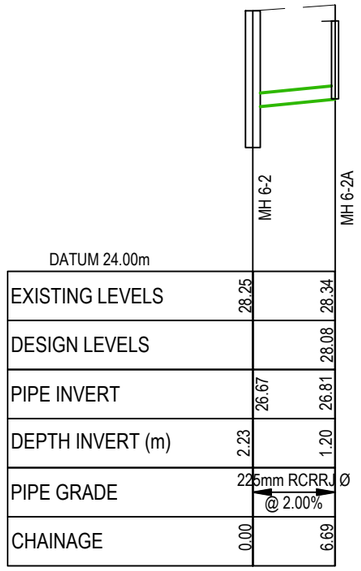
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

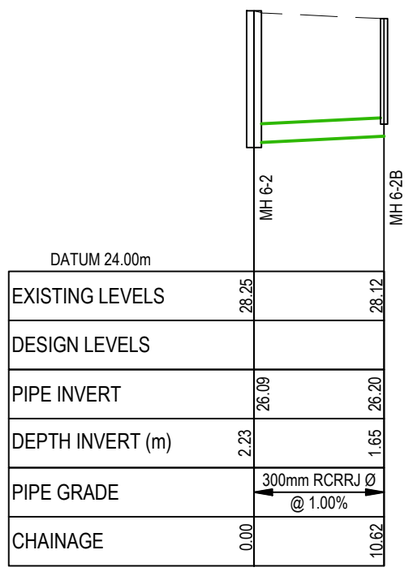
Title
PROPOSED STORMWATER LONGSECTIONS

Project no.	210001
Scale	-
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C414 Rev B

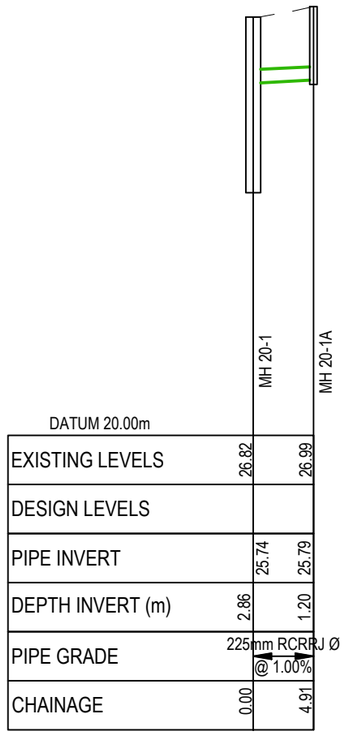
DATE: 4/14/22



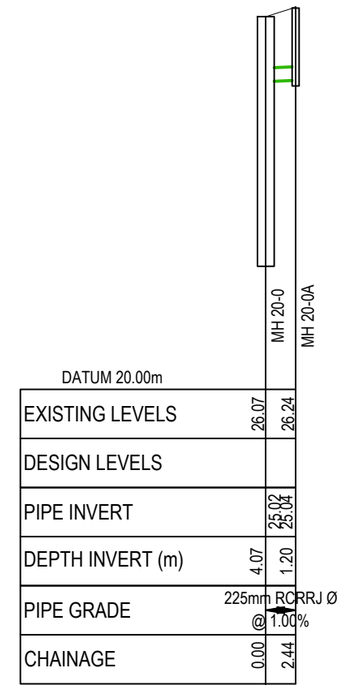
CP LEAD 6-2A
SCALE: HORI 1:500 VERT 1:100



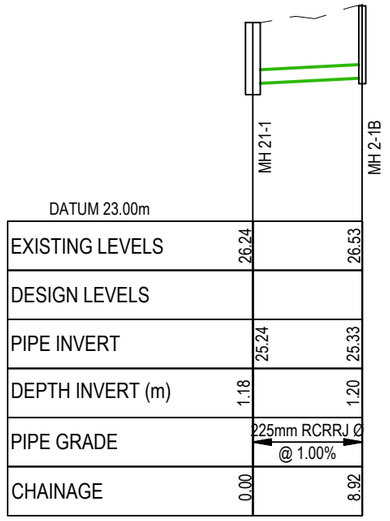
CP LEAD 6-2B
SCALE: HORI 1:500 VERT 1:100



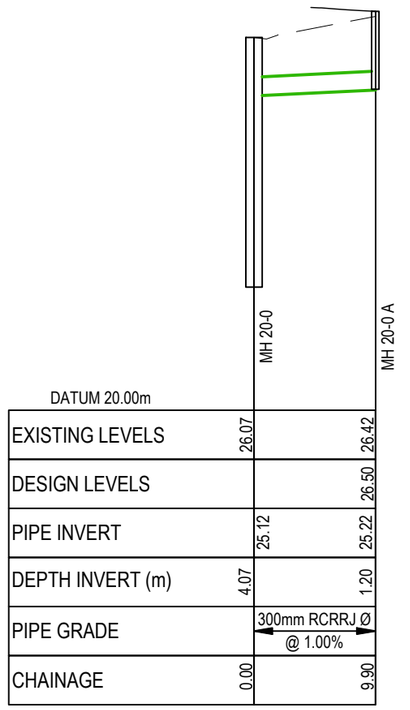
CP LEAD 20-1A
SCALE: HORI 1:500 VERT 1:100



CP LEAD 20-0A
SCALE: HORI 1:500 VERT 1:100



CP LEAD 21-1B
SCALE: HORI 1:500 VERT 1:100



CP LEAD 20-0B
SCALE: HORI 1:500 VERT 1:100

Notes

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9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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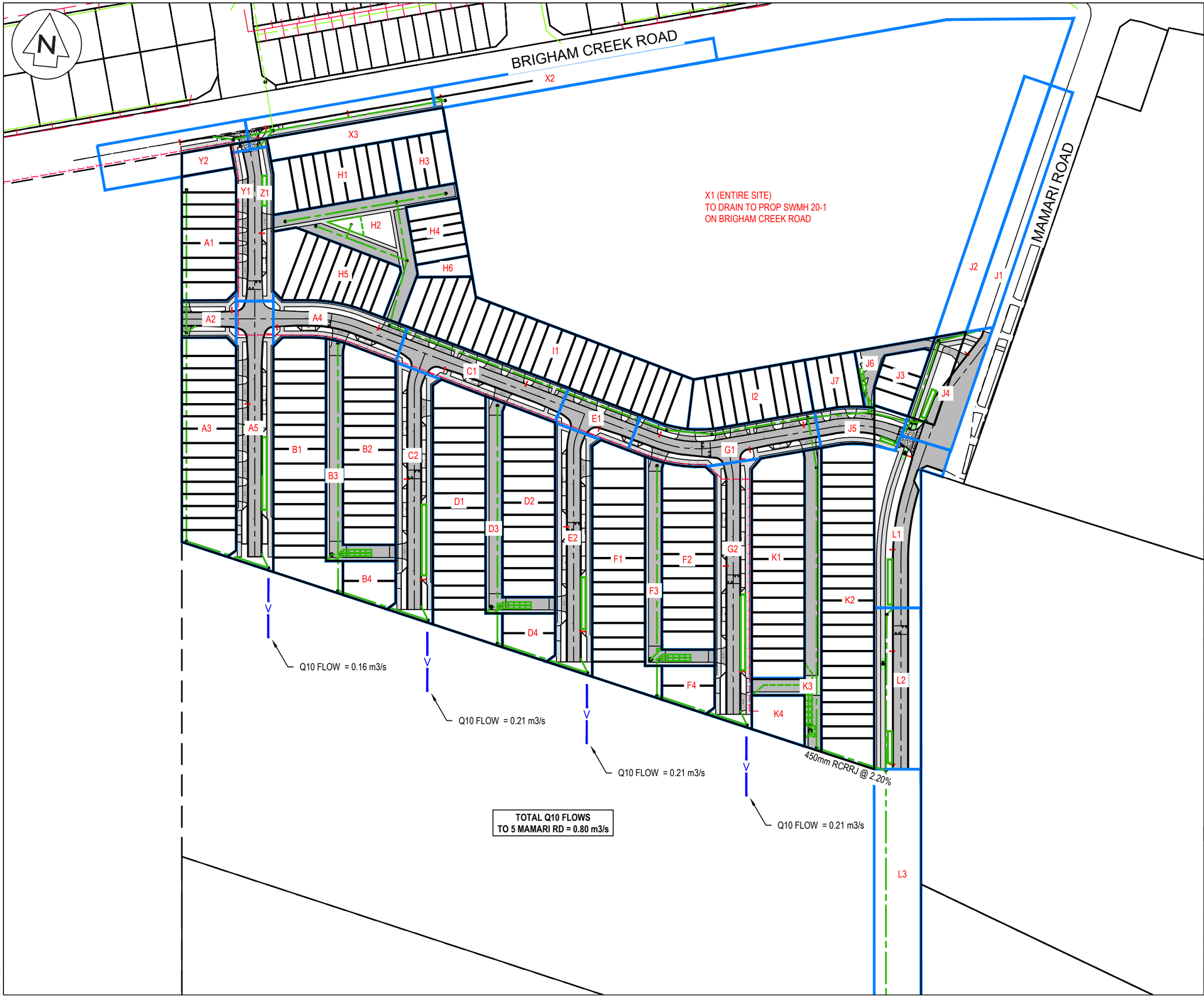
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title
PROPOSED STORMWATER LONGSECTIONS

Project no.	210001
Scale	-
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C415 Rev B

DATE: 4/14/22



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Legend

- EX BDY
- PROP BDY
- EX WW
- PROP WW
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

10YR STORMWATER POST-DEVELOPMENT CATCHMENT PLAN

Project no.	210001
Scale	1:1500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C450 Rev B

DATE: 4/14/22

Rev	Description	By	Date
B	RC S92	AP	01/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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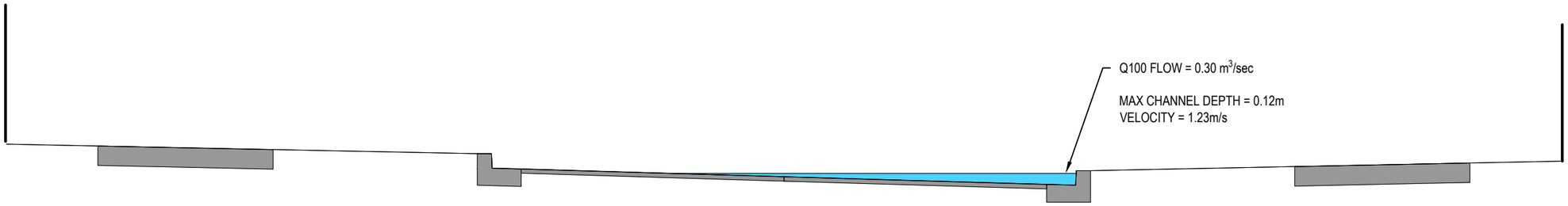
Auckland 1023

Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

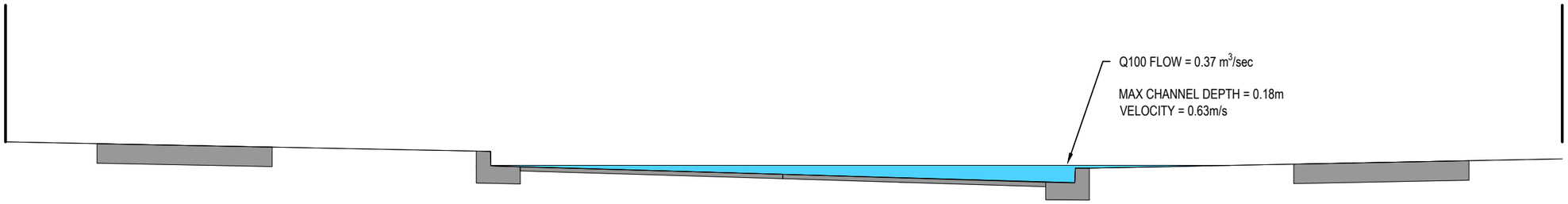
Title
POST DEVELOPMENT
100YR OVERLAND
FLOW PATH PLAN

Project no.	210001
Scale	1:250 @ A3
Cad file	C460 - FLOODING.DWG
Drawing no.	C462 Rev B

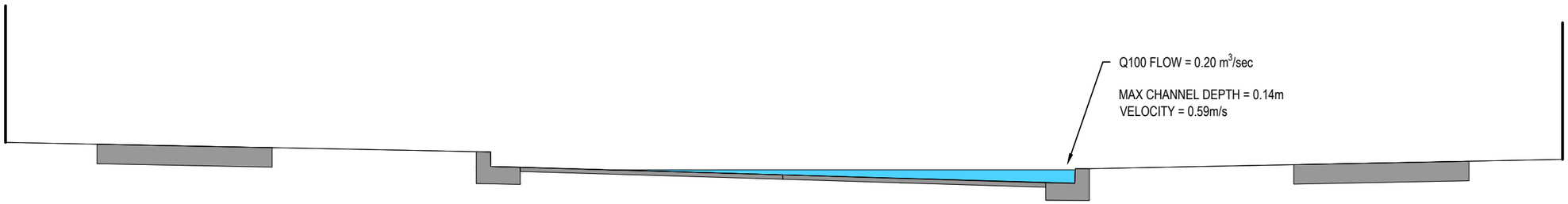
DATE: 4/14/22



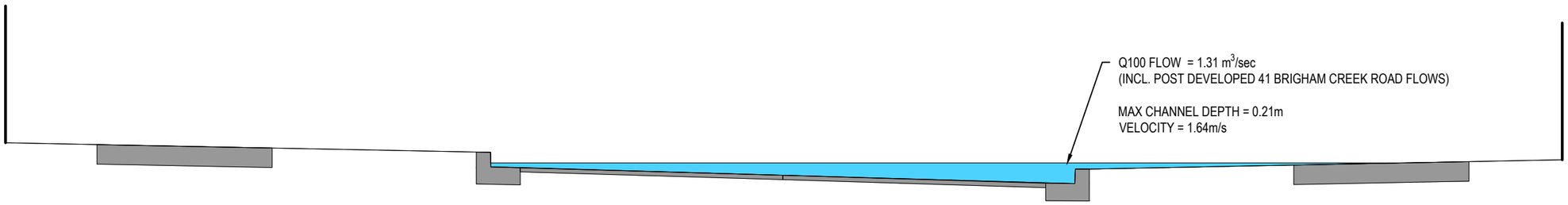
SECTION A : ROAD 2
SCALE 1:50 @ A3



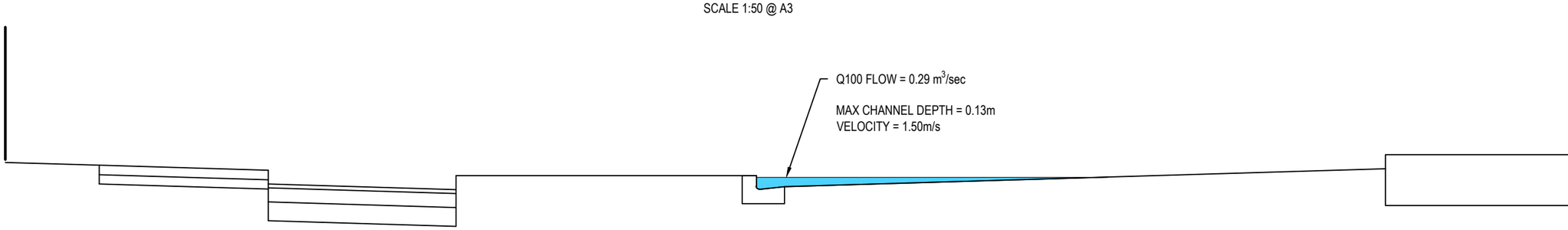
SECTION B : ROAD 3
SCALE 1:50 @ A3



SECTION C : ROAD 4
SCALE 1:50 @ A3



SECTION D : ROAD 5
SCALE 1:50 @ A3



SECTION E : MAMARI ROAD
SCALE 1:50 @ A3

Rev	Description	By	Date
B	RC S92	AP	01/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
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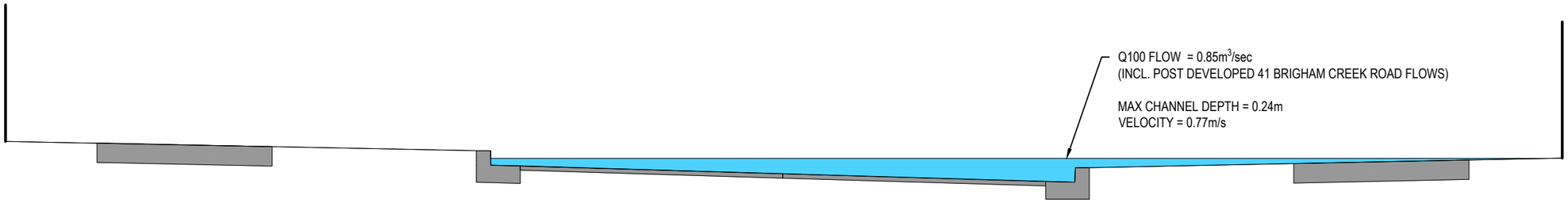
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

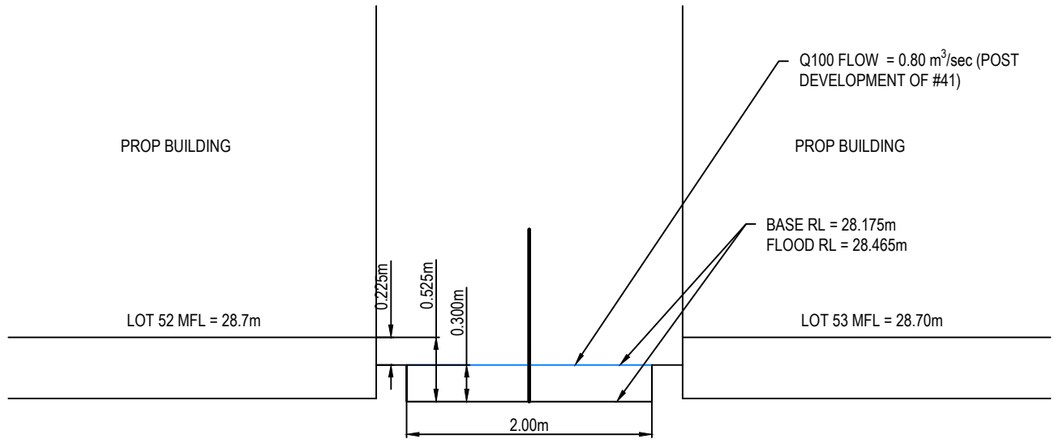
Title
PROPOSED
OLFP
SECTIONS

Project no.	210001		
Scale	-		
Cad file	C460 - FLOODING.DWG		
Drawing no.	C463	Rev	B

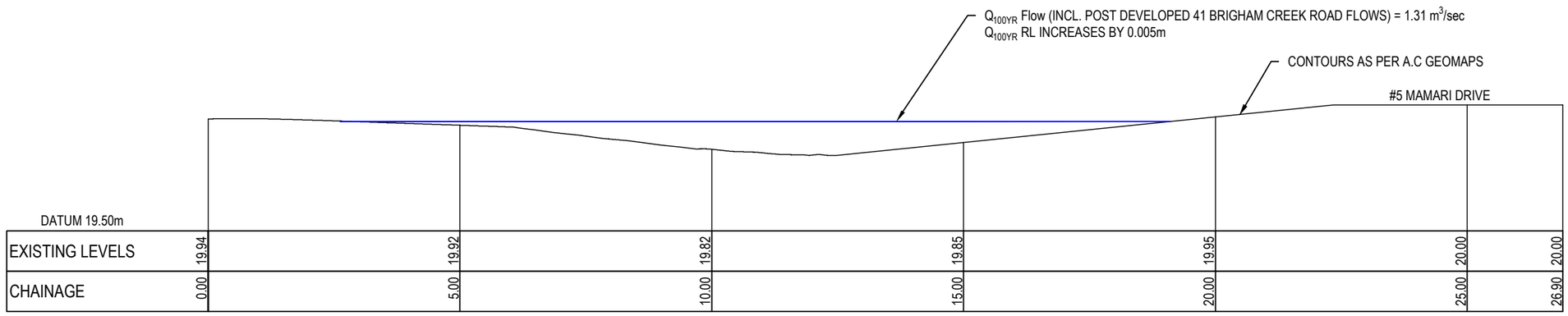
DATE: 4/14/22



SECTION F : ROAD 1
SCALE 1:50 @ A3



SECTION G : BETWEEN LOT 52 & 53
SCALE 1:50 @ A3



EXISTING LEVELS	19.94	19.92	19.82	19.85	19.95	20.00	20.00
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	26.90

SECTION H : CRITICAL SECTION AT #5 MAMARI ROAD
SCALE 1:50 @ A3

Rev	Description	By	Date
B	RC S92	AP	01/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title
PROPOSED
OLFP
SECTIONS

Project no.	210001		
Scale	-		
Cad file	C460 - FLOODING.DWG		
Drawing no.	C464	Rev	B

DATE: 4/14/22

Notes

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Legend

- EX BDY
- PROP BDY
- EX WW
- PROP WW
- PROP WW RISING MAIN
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE
- PROP RAIN GARDEN

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED
WASTEWATER DRAINAGE
OVIERVIEW PLAN

Project no.	210001		
Scale	1:1500 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C500	Rev	B

DATE: 4/14/22

BRIGHAM CREEK ROAD

LOT 501 ROAD TO BE VESTED

LOT 500 ROAD TO BE VESTED

#45 BRIGHAM CREEK ROAD

PROP SSMH A-7
LL=26.86
IL=25.43 (out)

PROP SSMH E-5
LL=27.98
IL=24.85 (in)
IL=25.06 (in)
IL=24.71 (out)

PROP SSMH H-1
LL=27.17
IL=25.67 (out)

PROP SSMH G-1
LL=27.92
IL=25.09 (out)

PROP SSMH E-4
LL=27.90
IL=24.81 (in)
IL=24.66 (in)
IL=24.58 (out)

PROP SSMH E-3
LL=27.93
IL=24.45 (in)
IL=25.32 (in)
IL=24.42 (out)

PROP SSMH A-6
LL=26.44
IL=24.75 (in)
IL=24.72 (out)

PROP SSMH E-1
LL=26.99
IL=24.20 (in)
IL=24.12 (out)

PROP SSMH E-2
LL=27.08
IL=24.34 (in)
IL=24.31 (out)

PROP SSMH D-1
LL=27.36
IL=25.86 (out)

PROP CONNECTION POINT FOR
#45 BRIGHAM CREEK ROAD
IL = 25.00m

PROP SSMH E-6
LL=27.94
IL=24.98 (in)
IL=24.98 (out)

225mm uPVC SN16 @ 1.00%

225mm uPVC SN16 @ 0.55%

150mm uPVC SN16 @ 1.00%

150mm uPVC SN16 @ 2.39%

150mm uPVC SN16 @ 1.00%

225mm uPVC SN16 @ 0.55%

225mm uPVC SN16 @ 0.55%

225mm uPVC SN16 @ 0.55%

150mm uPVC SN16 @ 1.00%

Notes

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- PROP BDY
- EX WW
- PROP WW
- PROP WW RISING MAIN
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE
- PROP RAIN GARDEN

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
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Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title
PROPOSED WASTEWATER DRAINAGE PLAN

Project no.	210001
Scale	1:500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C501 Rev B

DATE: 4/14/22

Notes

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Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED WASTEWATER DRAINAGE PLAN

Project no.	210001
Scale	1:500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C502
Rev	B

DATE: 4/14/22

#45 BRIGHAM
CREEK ROAD

PROP SSMH F-2
LL=28.39
IL=26.75 (out)

PROP SSMH I-1
LL=28.27
IL=26.57 (out)

PROP SSMH B-4
LL=28.14
IL=26.42 (out)

PROP SSMH B-3
LL=28.32
IL=25.99 (in)
IL=26.00 (in)
IL=25.92 (out)

PROP SSMH F-1
LL=28.15
IL=26.57 (in)
IL=26.49 (out)

PROP SSMH C-1
LL=27.88
IL=26.34 (out)

PROP SSMH B-2
LL=27.92
IL=25.87 (in)
IL=25.64 (out)

150mm uPVC SN16 @ 1.00%

LOT 502 ROAD TO BE V

MAMARI ROAD

CB - VC
AC
K&N
CEA - CAR PARKING

Notes

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- EX SW
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Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

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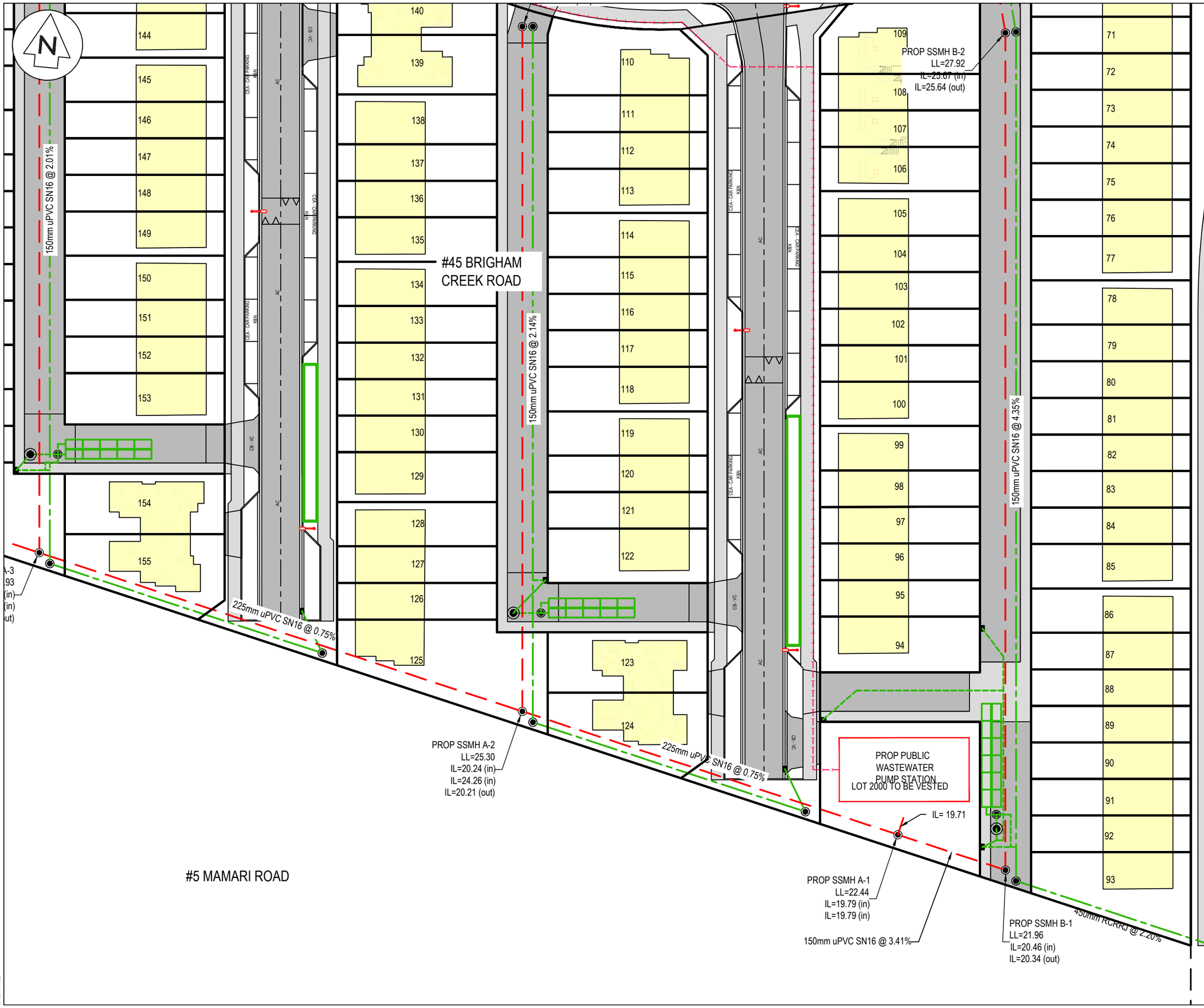
Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title
PROPOSED WASTEWATER DRAINAGE PLAN

Project no.	210001
Scale	1:500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C503 Rev B

DATE: 4/14/22



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Rev	Description	By	Date
B	RC S92	AP	04/22
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Project

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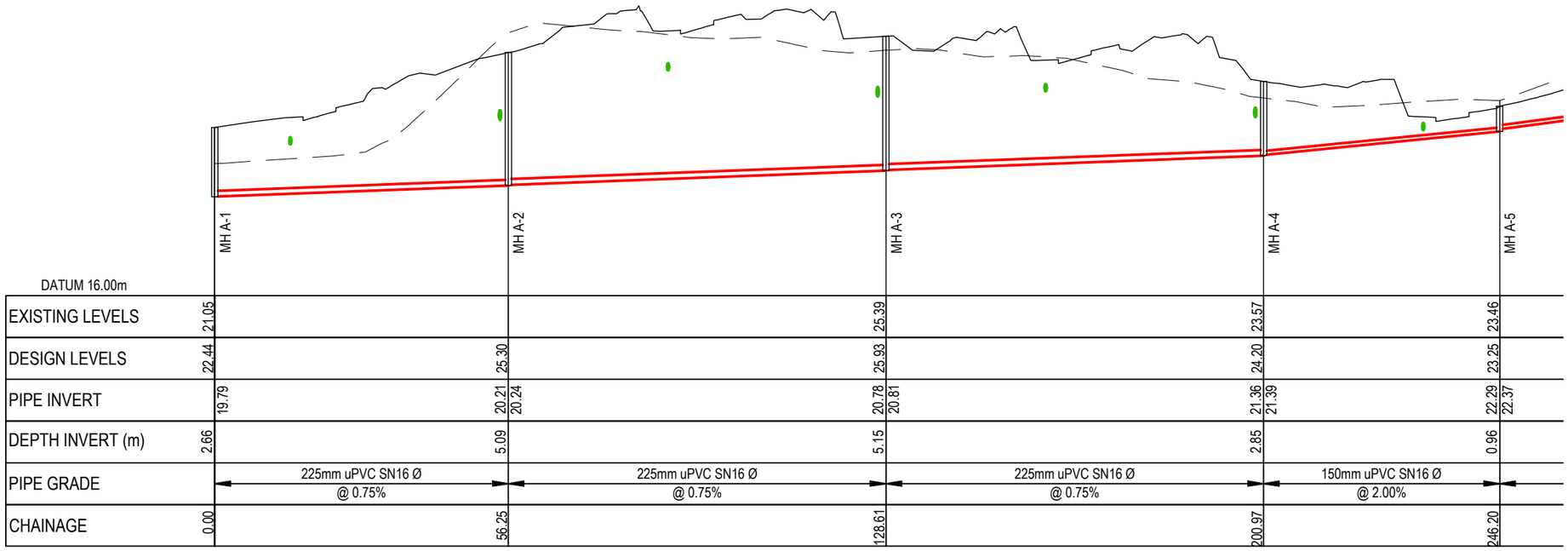
Title

PROPOSED WASTEWATER DRAINAGE PLAN

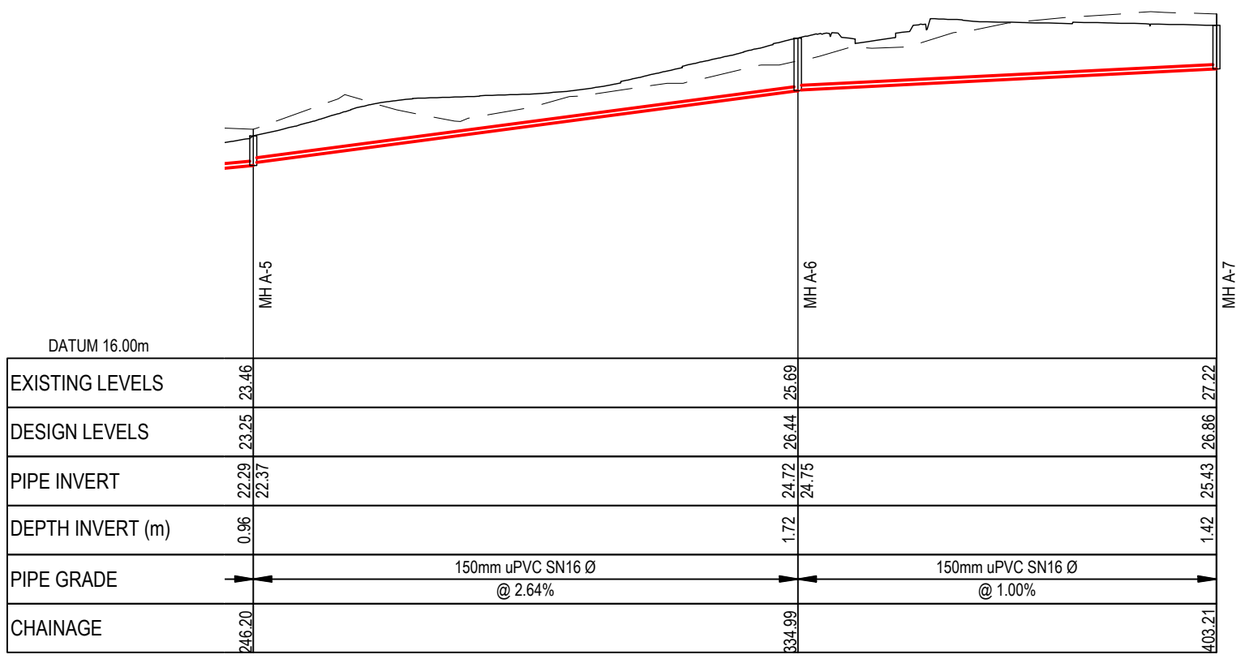
Project no.	210001
Scale	1:500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C504 Rev B

DATE: 4/14/22



PROPOSED WASTEWATER LONGSECTION A

SCALE 1:1000 HORI 1:200 VERT



PROPOSED WASTEWATER LONGSECTION A

SCALE 1:1000 HORI 1:200 VERT

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

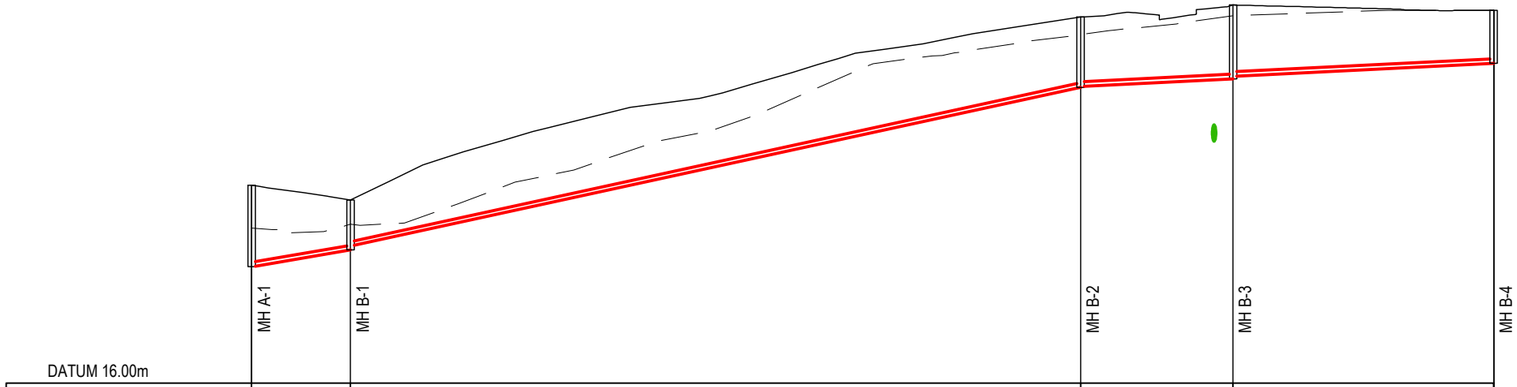
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED WASTEWATER LONGSECTIONS

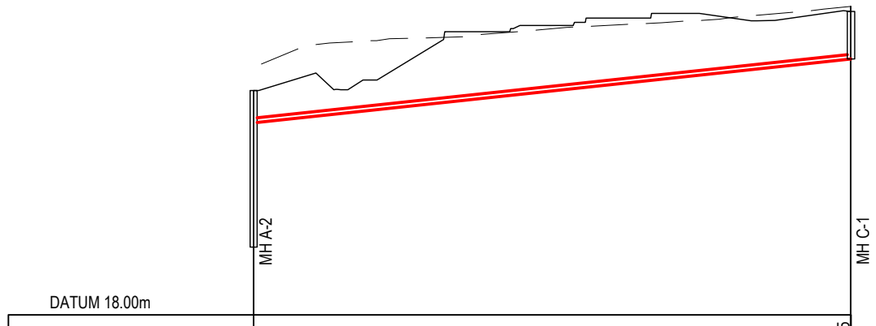
Project no.	210001		
Scale	-		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C510	Rev	B

DATE: 4/14/22



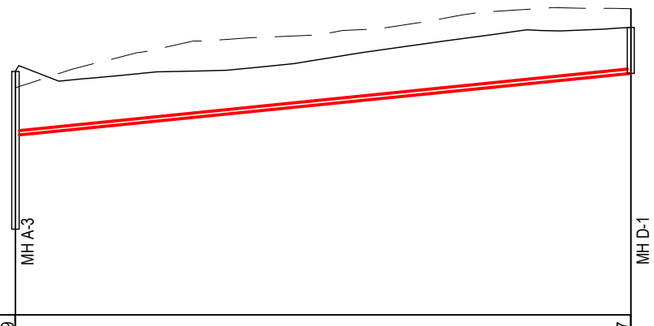
DATUM 16.00m	MH A-1	MH B-1	MH B-2	MH B-3	MH B-4
EXISTING LEVELS	21.05	21.18	27.35	27.97	28.14
DESIGN LEVELS	22.44	21.96	27.92	28.32	28.14
PIPE INVERT	19.79	20.34 / 20.46	25.64 / 25.67	25.92 / 25.99	26.42
DEPTH INVERT (m)	2.66	1.62	2.29	2.40	1.72
PIPE GRADE	150mm uPVC SN16 Ø @ 3.41%		150mm uPVC SN16 Ø @ 4.35%	150mm uPVC SN16 Ø @ 1.00%	150mm uPVC SN16 Ø @ 1.00%
CHAINAGE	0.00	16.11	135.18	160.05	202.55

PROPOSED WASTEWATER LONGSECTION B
SCALE 1:1000 HORI 1:200 VERT



DATUM 18.00m	MH A-2	MH C-1
EXISTING LEVELS		28.05
DESIGN LEVELS	25.30	27.88
PIPE INVERT	24.26	26.34
DEPTH INVERT (m)	5.09	1.54
PIPE GRADE	150mm uPVC SN16 Ø @ 2.14%	
CHAINAGE	0.00	97.40

PROPOSED WASTEWATER LONGSECTION C
SCALE 1:1000 HORI 1:200 VERT



DATUM 18.00m	MH A-3	MH D-1
EXISTING LEVELS	25.39	27.97
DESIGN LEVELS	25.93	27.36
PIPE INVERT	23.84	25.86
DEPTH INVERT (m)	5.15	1.50
PIPE GRADE	150mm uPVC SN16 Ø @ 2.01%	
CHAINAGE	0.00	100.36

PROPOSED WASTEWATER LONGSECTION D
SCALE 1:1000 HORI 1:200 VERT

Notes
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3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend
EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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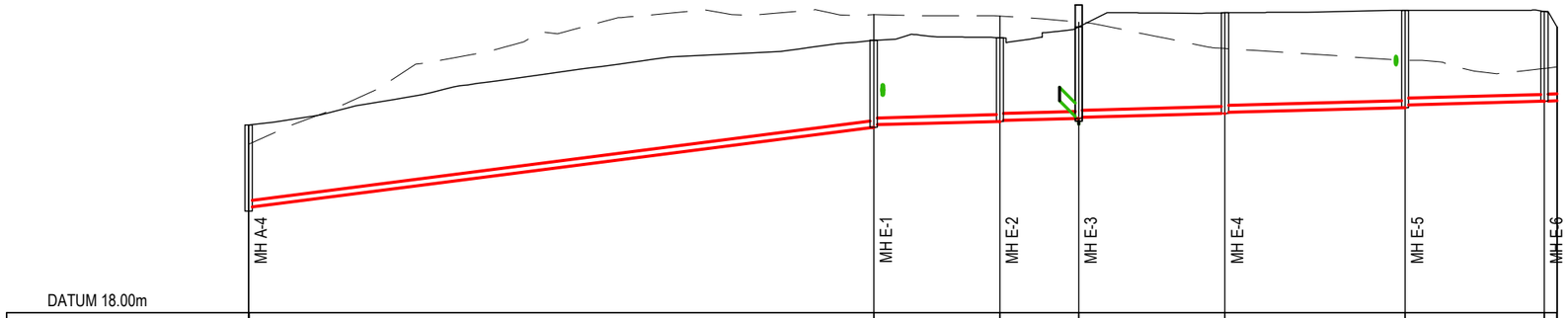
Project
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title
PROPOSED WASTEWATER LONGSECTIONS

Project no.	210001		
Scale	-		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C511	Rev	B

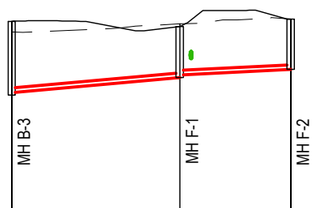
DATE: 4/14/22



DATUM 18.00m								
EXISTING LEVELS	23.57	27.84	27.79	27.59	26.72	26.33	26.06	26.11
DESIGN LEVELS	24.20	26.99	27.08	27.43	27.90	27.98	27.94	27.43
PIPE INVERT	21.47	24.12	24.20	24.31	24.34	24.42	24.45	24.58	24.61	24.77	24.85	24.98	25.08	25.08	25.08
DEPTH INVERT (m)	2.85	2.87	2.77	3.02	3.32	3.21	2.96	2.86	2.86	2.86
PIPE GRADE		225mm uPVC SN16 Ø @ 2.56%	225mm uPVC SN16 Ø @ 0.55%	225mm uPVC SN16 Ø @ 0.55%	225mm uPVC SN16 Ø @ 0.55%	225mm uPVC SN16 Ø @ 0.55%	225mm uPVC SN16 Ø @ 0.55%	225mm uPVC SN16 Ø @ 1.00%	225mm uPVC SN16 Ø @ 1.00%
CHAINAGE	0.00	103.22	124.08	137.09	161.25	190.99	213.99	216.09

PROPOSED WASTEWATER LONGSECTION E

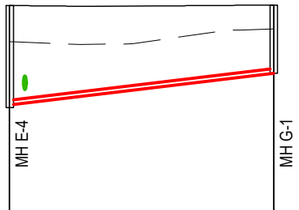
SCALE 1:1000 HORI 1:200 VERT



DATUM 22.00m				
EXISTING LEVELS	27.97	28.23	28.40
DESIGN LEVELS	28.32	28.15	28.39
PIPE INVERT	26.00	26.49	26.57	26.75
DEPTH INVERT (m)	2.40	1.66	1.64
PIPE GRADE		150mm uPVC SN16 Ø @ 1.80%	150mm uPVC SN16 Ø @ 1.00%
CHAINAGE	0.00	27.41	45.48

PROPOSED WASTEWATER LONGSECTION F

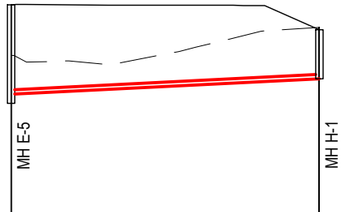
SCALE 1:1000 HORI 1:200 VERT



DATUM 21.00m			
EXISTING LEVELS	26.72	27.13
DESIGN LEVELS	27.90	27.92
PIPE INVERT	24.66	25.69
DEPTH INVERT (m)	3.32	2.23
PIPE GRADE		150mm uPVC SN16 Ø @ 2.39%
CHAINAGE	0.00	43.03

PROPOSED WASTEWATER LONGSECTION G

SCALE 1:1000 HORI 1:200 VERT



DATUM 21.00m			
EXISTING LEVELS	26.33	27.24
DESIGN LEVELS	27.98	27.17
PIPE INVERT	25.06	25.57
DEPTH INVERT (m)	3.21	1.60
PIPE GRADE		150mm uPVC SN16 Ø @ 1.00%
CHAINAGE	0.00	50.22

PROPOSED WASTEWATER LONGSECTION H

SCALE 1:1000 HORI 1:200 VERT

Notes

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3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

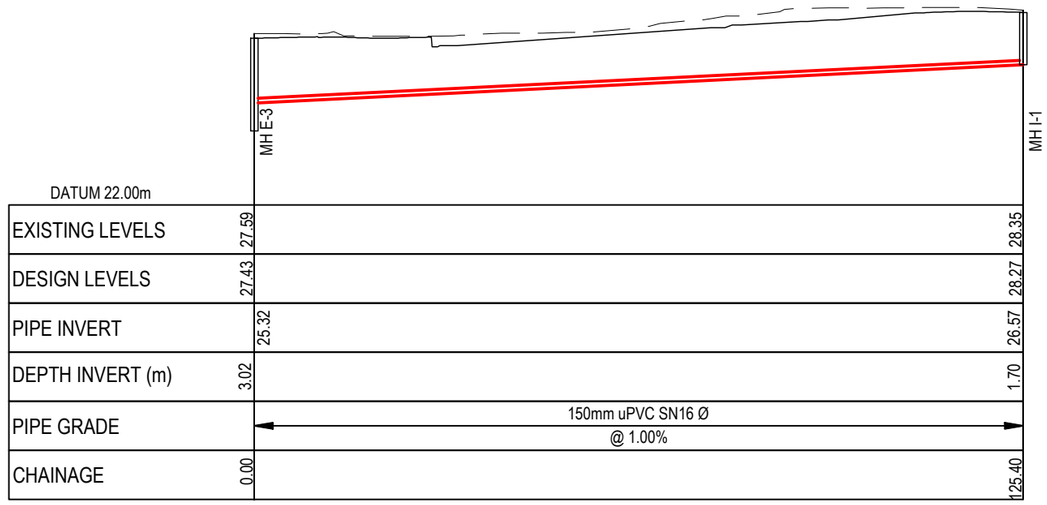
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED WASTEWATER LONGSECTIONS

Project no.	210001
Scale	-
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C513 Rev B

DATE: 4/14/22



PROPOSED WASTEWATER LONGSECTION I

SCALE 1:1000 HORI 1:200 VERT

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

EX GROUND LEVEL
PROP FINISHED LEVEL
HARDFILL BACKFILL

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

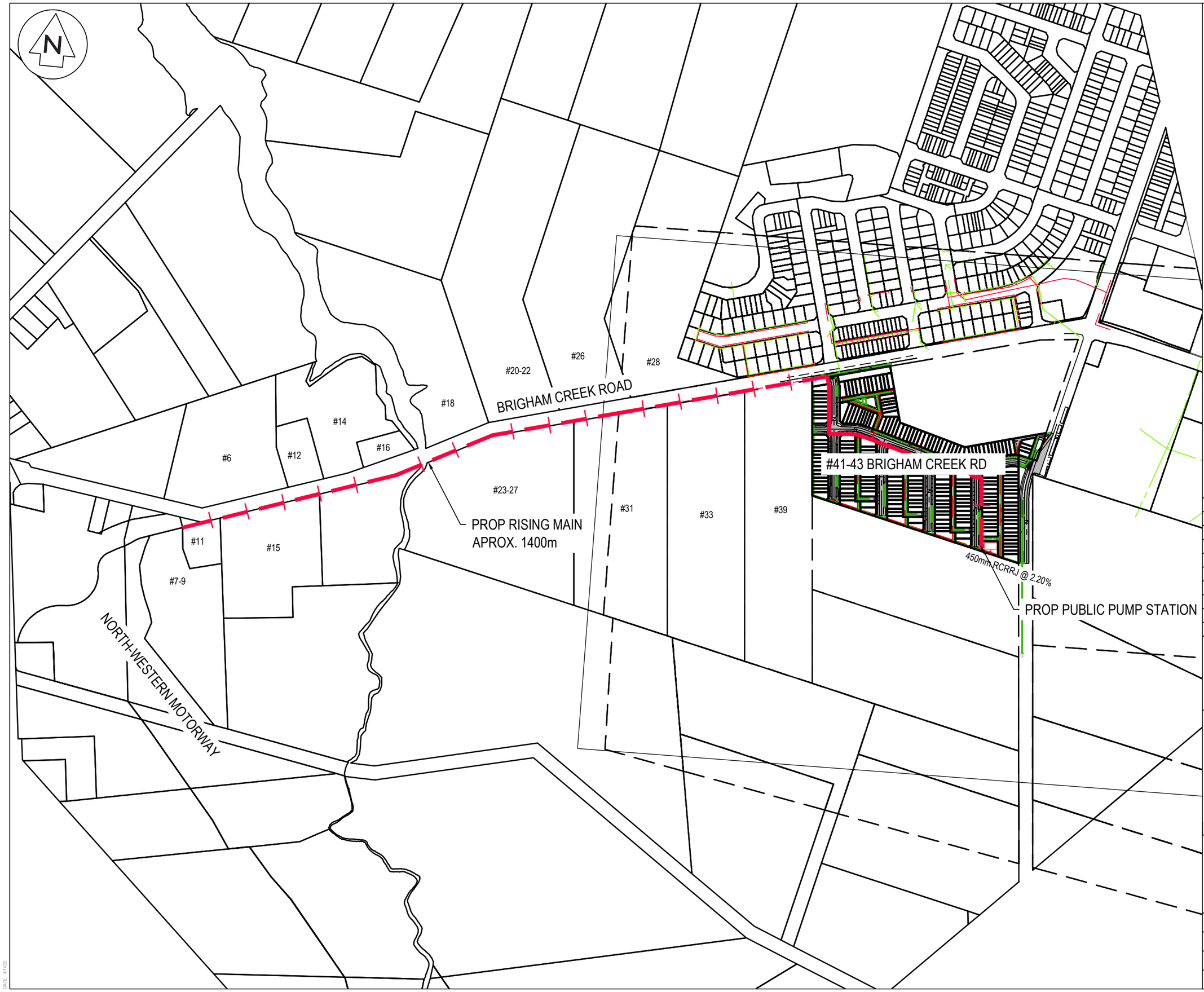
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED WASTEWATER LONGSECTIONS

Project no.	210001		
Scale	-		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C514	Rev	B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas, all manholes shall have stainless grates installed.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All lines are to be 150mmØ PVC Class SN16 unless shown otherwise.
10. 150mmØ pipes that do not terminate in a manhole must be terminated with a 100mmØ on a 150mmØ london junction and blank cap.
11. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

- EX BDY
- PROP BDY
- EX WW
- PROP WW
- PROP WW RISING MAIN
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE
- PROP RAIN GARDEN

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

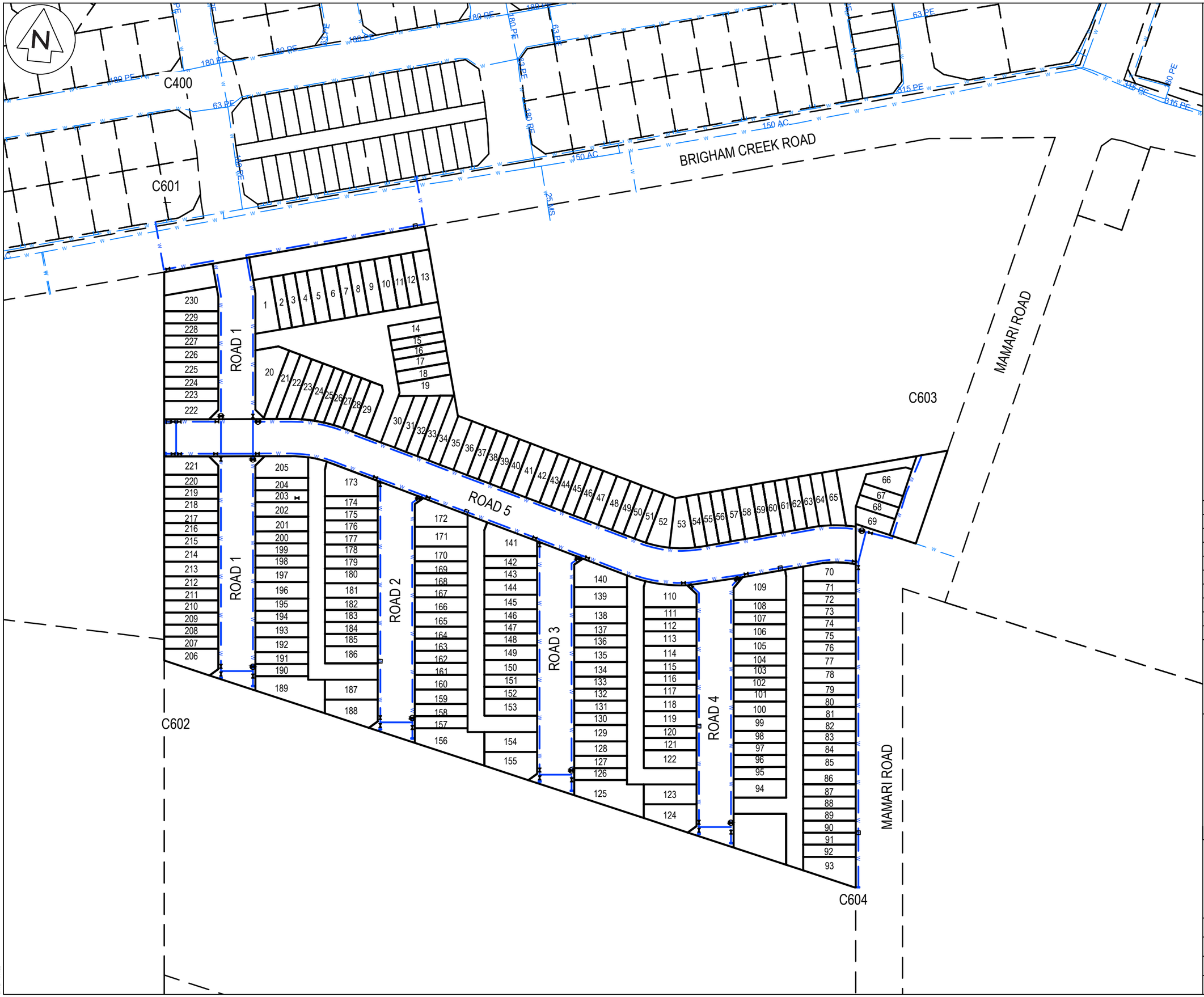
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED WASTEWATER RISING MAIN OVIERVIEW PLAN

Project no.	210001		
Scale	1:5000 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C520	Rev	B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. It is the contractors responsibility to locate any underground services prior to the commencement of works.
3. Minimum cover shall be:
   - Roads, footpaths,crossings: 1000mm
   - Berms 600mm
   - Service connections: 550-650mm
4. Watermains laid across roads shall be backfilled with hardfill compacted in 200mm layers above the embedment material.
5. All uPVC pipe shall be PN12 minimum pressure rated with spignot and socket rubber ring joints.
6. All PE pipe shall be PN12.5 minimum pressure rated with butt-welded. Weld beads shall be removed to provide a smooth bore.
7. All non-metalic pipes are to have tracer wire fitted to council standards.
8. Pipes shall be bedded and surrounded to 150mm above the pipe soffit with sand or ap20.
9. Metal detector tape printed with 'water pipe below' shall be laid 150mm above all watermains.
10. A yellow isosceles triangle with cats eye pointing to FH shall be painted in the centre of all sealed roads.
11. All valves to be marked with sawcut kerb and blue paint.
12. All flange joints to be protected with denso tape or similar approved by the engineer.

Legend

- EX BDY
- PROP BDY
- EX WATERMAIN
- FH EX/PROP HYDRANT
- WM EX/PROP METER/ METER BANK
- EX SLUICE VALVE
- EX PEAT VALVE
- PROP WATERMAIN
- PROP SLUICE VALVE
- PROP PEAT VALVE

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

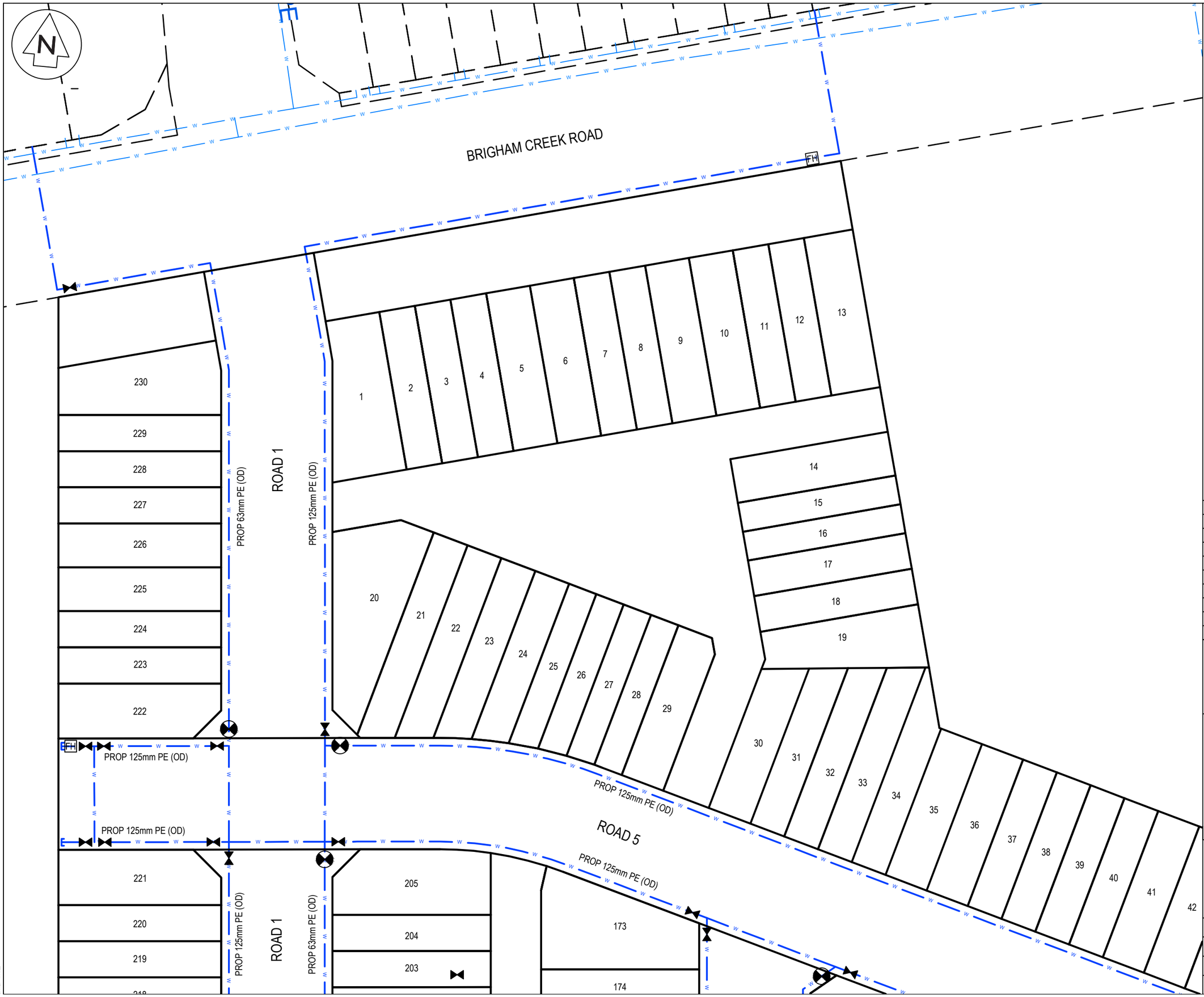
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED WATERMAIN OVIERVIEW PLAN

Project no.	210001
Scale	1:1500 @ A3
Cad file	C600 WATER SUPPLY.DWG
Drawing no.	C600 Rev B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. It is the contractors responsibility to locate any underground services prior to the commencement of works.
3. Minimum cover shall be:
   - Roads, footpaths,crossings: 1000mm
   - Berms 600mm
   - Service connections: 550-650mm
4. Watermains laid across roads shall be backfilled with hardfill compacted in 200mm layers above the embedment material.
5. All uPVC pipe shall be PN12 minimum pressure rated with spignot and socket rubber ring joints.
6. All PE pipe shall be PN12.5 minimum pressure rated with butt-welded. Weld beads shall be removed to provide a smooth bore.
7. All non-metalic pipes are to have tracer wire fitted to council standards.
8. Pipes shall be bedded and surrounded to 150mm above the pipe soffit with sand or ap20.
9. Metal detector tape printed with 'water pipe below' shall be laid 150mm above all watermains.
10. A yellow isosceles triangle with cats eye pointing to FH shall be painted in the centre of all sealed roads.
11. All valves to be marked with sawcut kerb and blue paint.
12. All flange joints to be protected with denso tape or similar approved by the engineer.

Legend

- EX BDY
- PROP BDY
- EX WATERMAIN
- FH EX/PROP HYDRANT
- WM EX/PROP METER/ METER BANK
- EX SLUICE VALVE
- EX PEAT VALVE
- PROP WATERMAIN
- PROP SLUICE VALVE
- PROP PEAT VALVE

Rev	Description	By	Date
B	RC S92	AP	02/22
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	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
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Project

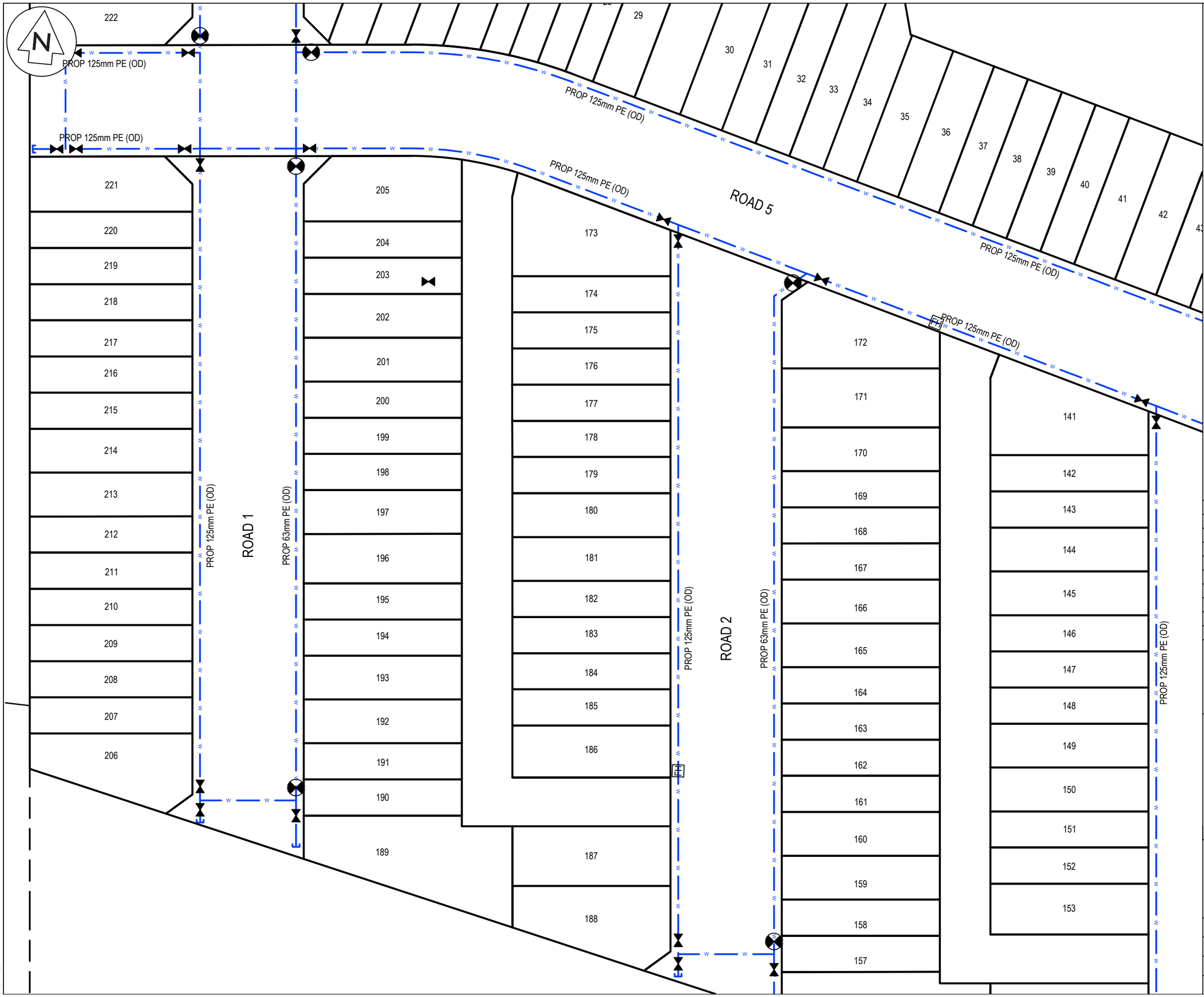
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED WATERMAIN DETAIL PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C600 WATER SUPPLY.DWG		
Drawing no.	C601	Rev	B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. It is the contractors responsibility to locate any underground services prior to the commencement of works.
3. Minimum cover shall be:
   - Roads, footpaths,crossings: 1000mm
   - Berms 600mm
   - Service connections: 550-650mm
4. Watermains laid across roads shall be backfilled with hardfill compacted in 200mm layers above the embedment material.
5. All uPVC pipe shall be PN12 minimum pressure rated with spignot and socket rubber ring joints.
6. All PE pipe shall be PN12.5 minimum pressure rated with butt-welded. Weld beads shall be removed to provide a smooth bore.
7. All non-metalic pipes are to have tracer wire fitted to council standards.
8. Pipes shall be bedded and surrounded to 150mm above the pipe soffit with sand or ap20.
9. Metal detector tape printed with 'water pipe below' shall be laid 150mm above all watermains.
10. A yellow isosceles triangle with cats eye pointing to FH shall be painted in the centre of all sealed roads.
11. All valves to be marked with sawcut kerb and blue paint.
12. All flange joints to be protected with denso tape or similar approved by the engineer.

Legend

- EX BDY
- PROP BDY
- EX WATERMAIN
- FH EX/PROP HYDRANT
- WM EX/PROP METER/ METER BANK
- EX SLUICE VALVE
- EX PEAT VALVE
- PROP WATERMAIN
- PROP SLUICE VALVE
- PROP PEAT VALVE

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

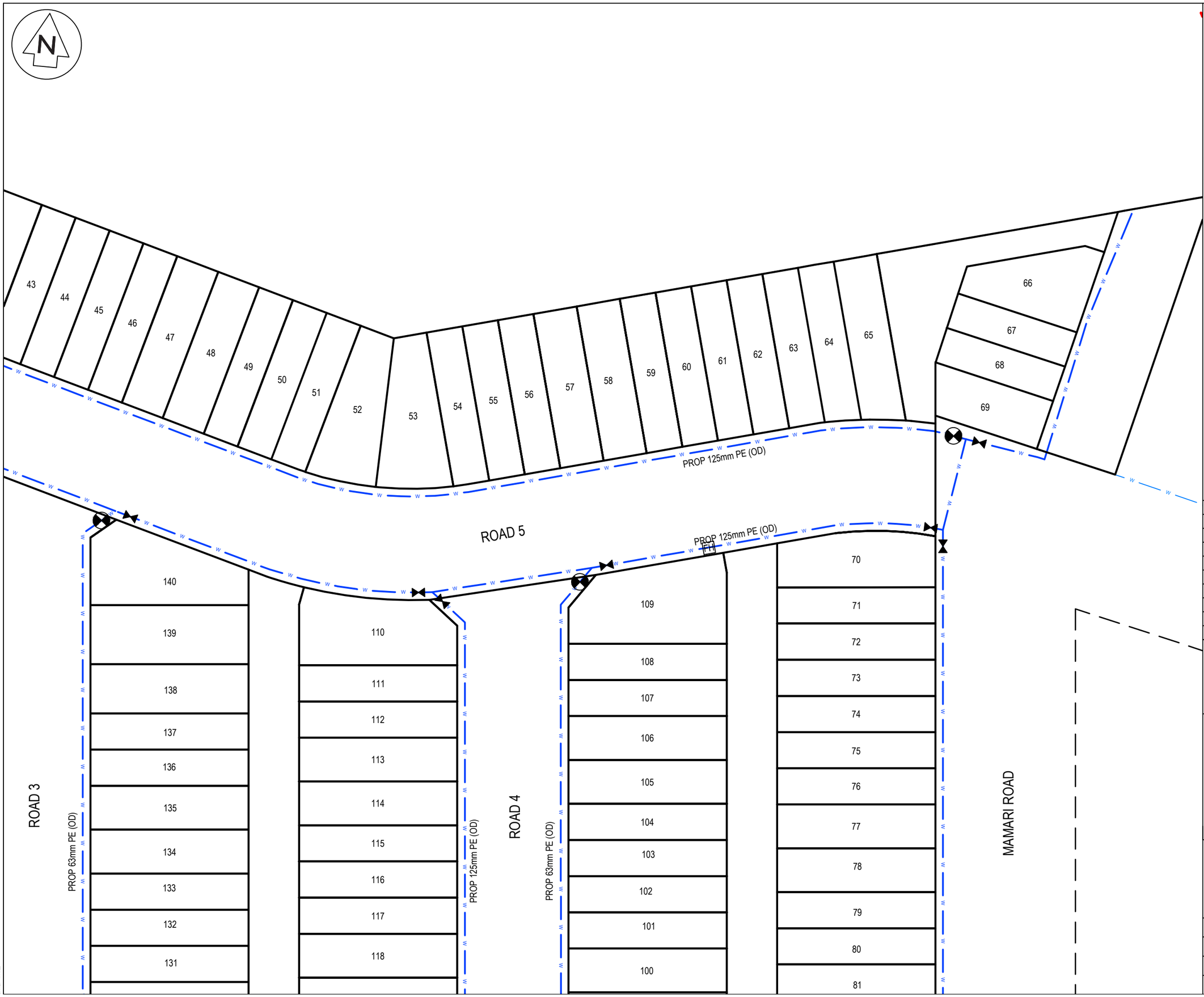
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED WATERMAIN DETAIL PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C600 WATER SUPPLY.DWG		
Drawing no.	C602	Rev	B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. It is the contractors responsibility to locate any underground services prior to the commencement of works.
3. Minimum cover shall be:
   - Roads, footpaths,crossings: 1000mm
   - Berms 600mm
   - Service connections: 550-650mm
4. Watermains laid across roads shall be backfilled with hardfill compacted in 200mm layers above the embedment material.
5. All uPVC pipe shall be PN12 minimum pressure rated with spignot and socket rubber ring joints.
6. All PE pipe shall be PN12.5 minimum pressure rated with butt-welded. Weld beads shall be removed to provide a smooth bore.
7. All non-metalic pipes are to have tracer wire fitted to council standards.
8. Pipes shall be bedded and surrounded to 150mm above the pipe soffit with sand or ap20.
9. Metal detector tape printed with 'water pipe below' shall be laid 150mm above all watermains.
10. A yellow isosceles triangle with cats eye pointing to FH shall be painted in the centre of all sealed roads.
11. All valves to be marked with sawcut kerb and blue paint.
12. All flange joints to be protected with denso tape or similar approved by the engineer.

Legend

- EX BDY
- PROP BDY
- EX WATERMAIN
- FH EX/PROP HYDRANT
- WM EX/PROP METER/ METER BANK
- EX SLUICE VALVE
- EX PEAT VALVE
- PROP WATERMAIN
- PROP SLUICE VALVE
- PROP PEAT VALVE

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

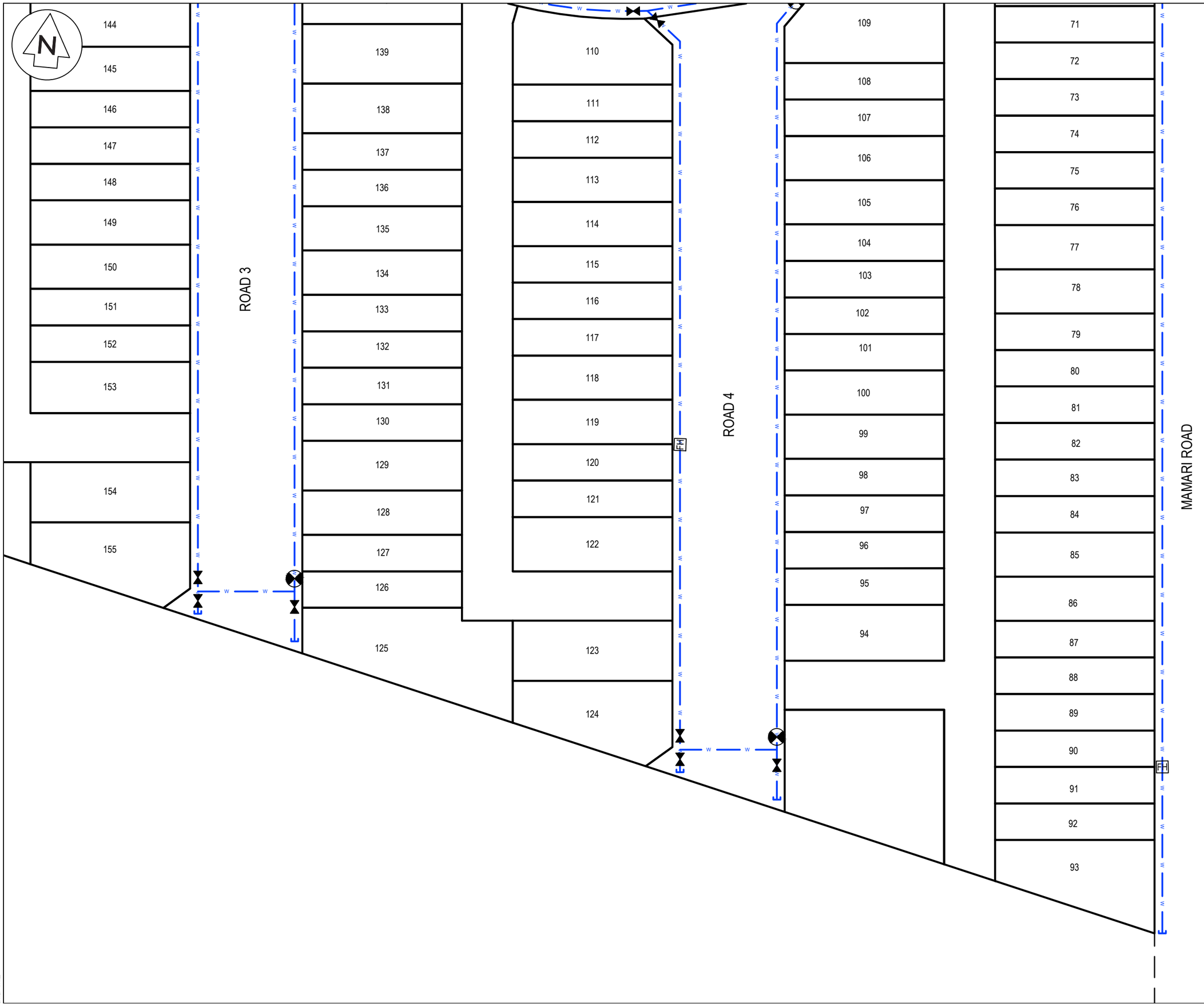
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED WATERMAIN DETAIL PLAN

Project no.	210001
Scale	1:500 @ A3
Cad file	C600 WATER SUPPLY.DWG
Drawing no.	C603 Rev B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. It is the contractors responsibility to locate any underground services prior to the commencement of works.
3. Minimum cover shall be:
   - Roads, footpaths,crossings: 1000mm
   - Berms 600mm
   - Service connections: 550-650mm
4. Watermains laid across roads shall be backfilled with hardfill compacted in 200mm layers above the embedment material.
5. All uPVC pipe shall be PN12 minimum pressure rated with spignot and socket rubber ring joints.
6. All PE pipe shall be PN12.5 minimum pressure rated with butt-welded. Weld beads shall be removed to provide a smooth bore.
7. All non-metalic pipes are to have tracer wire fitted to council standards.
8. Pipes shall be bedded and surrounded to 150mm above the pipe soffit with sand or ap20.
9. Metal detector tape printed with 'water pipe below' shall be laid 150mm above all watermains.
10. A yellow isosceles triangle with cats eye pointing to FH shall be painted in the centre of all sealed roads.
11. All valves to be marked with sawcut kerb and blue paint.
12. All flange joints to be protected with denso tape or similar approved by the engineer.

Legend

- EX BDY
- PROP BDY
- EX WATERMAIN
- EX/PROP HYDRANT
- EX/PROP METER/ METER BANK
- EX SLUICE VALVE
- EX PEAT VALVE
- PROP WATERMAIN
- PROP SLUICE VALVE
- PROP PEAT VALVE

Rev	Description	By	Date
B	RC S92	AP	02/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED WATERMAIN DETAIL PLAN

Project no.	210001		
Scale	1:500 @ A3		
Cad file	C600 WATER SUPPLY.DWG		
Drawing no.	C604	Rev	B

DATE: 4/14/22

Catchment Area Key	Location	Area (m2)	Treatment Device
	Roads	6089	Rain Garden
	JOAL 2	1179	Rain Garden
	JOAL 3	850	Filter
	JOAL 4	830	Filter
	JOAL 5	804	Filter
	JOAL 6	1096	Filter

AREA TO BE TREATED IN THE FUTURE WHEN TEMPORARY TURNING HEADS ARE REMOVED AND ROAD IS EXTENDED.

DATE: 4/14/22

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

- EX BDY
- PROP BDY
- EX WW
- PROP WW
- PROP WW RISING MAIN
- EX SW
- PROP PUBLIC SW
- PROP PRIVATE SW
- EX/PROP MANHOLE
- PROP PRSWCP SINGLE
- PROP RAIN GARDEN

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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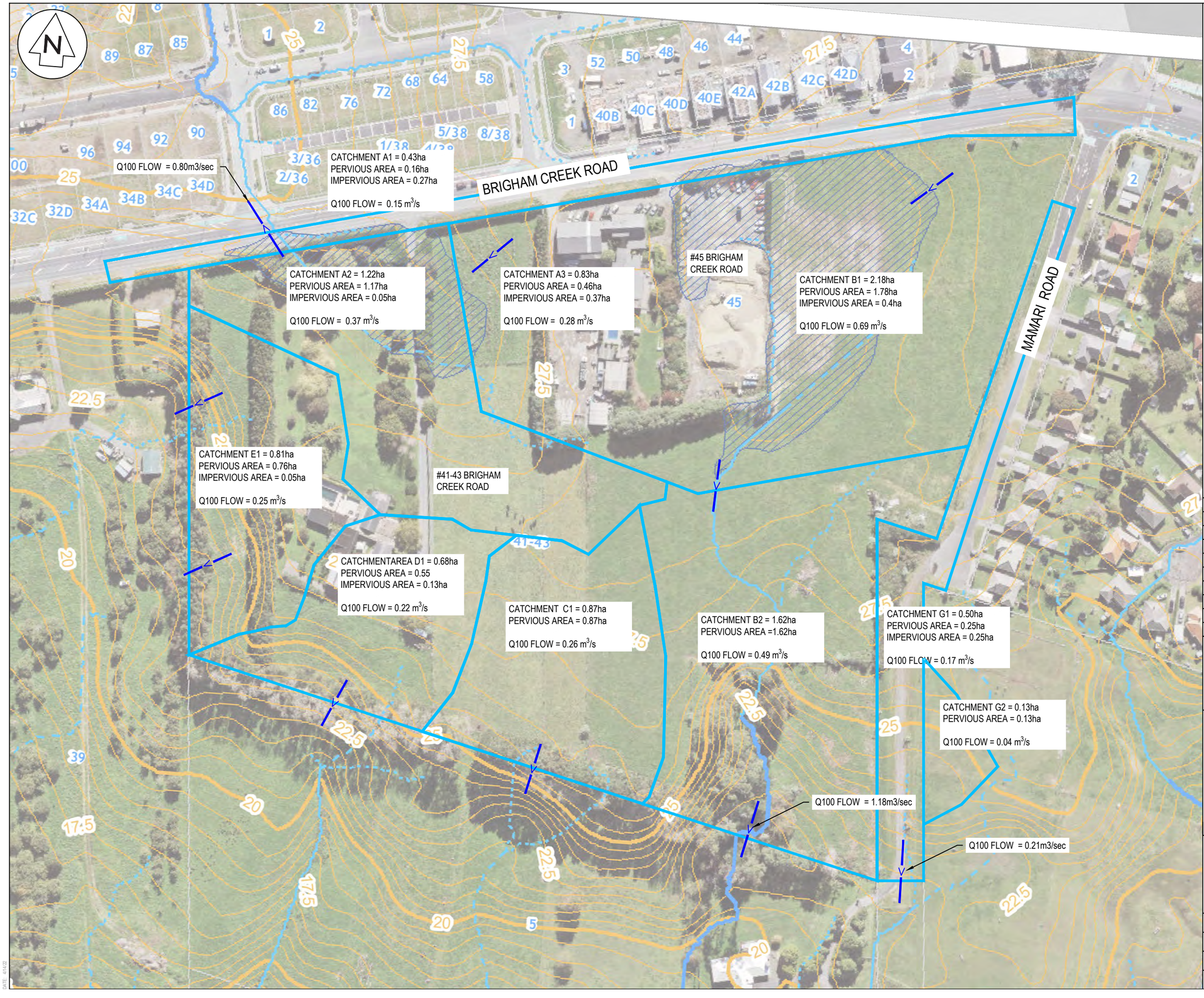
Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

PROPOSED SW TREATMENT CATCHMENT PLAN

Project no.	210001		
Scale	1:1500 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C406	Rev	B



Legend

- EX BDY
- PROP BDY
- CATCHMENT EXTENT

Rev	Description	By	Date
B	RC S92	AP	01/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

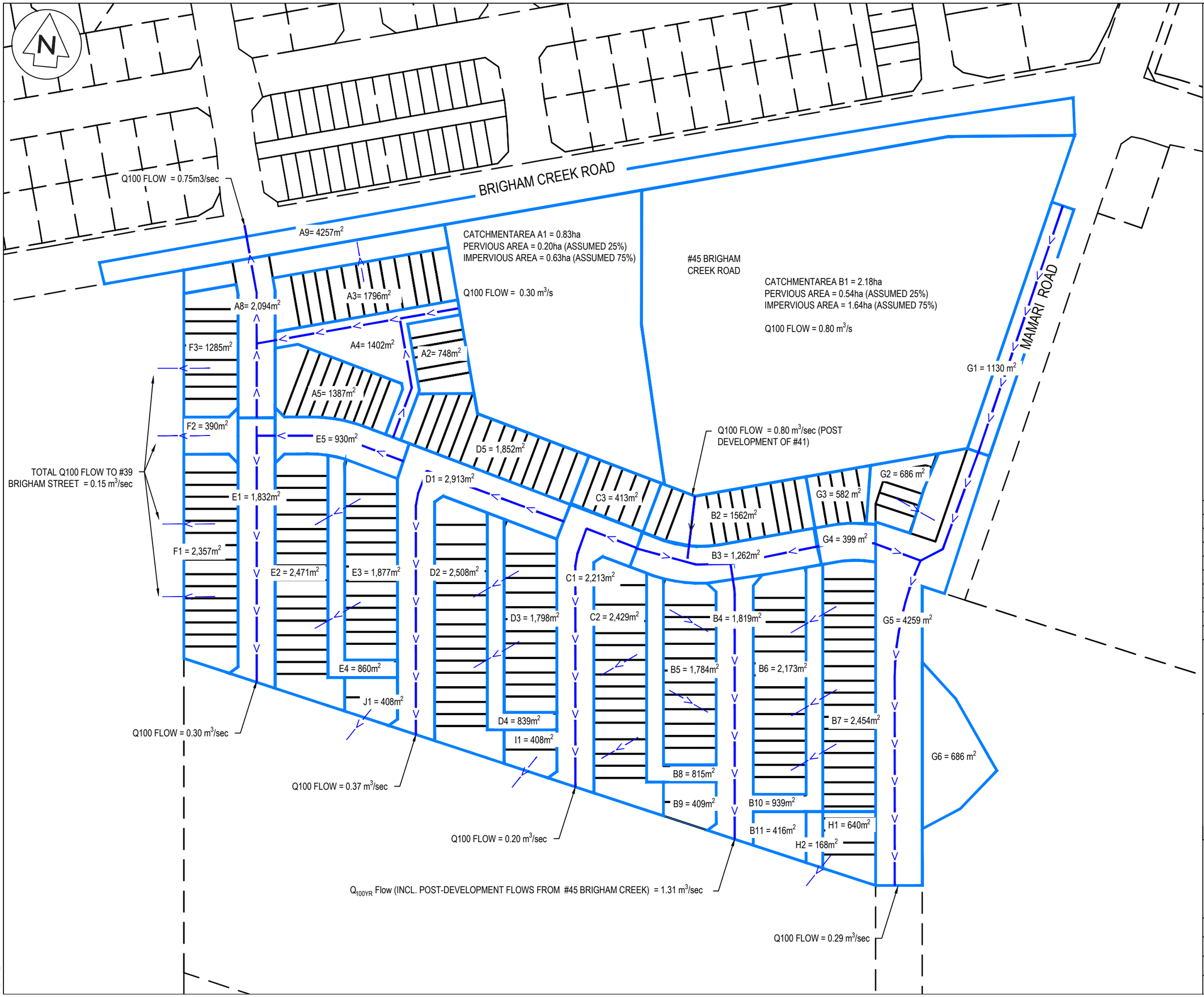
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PRE-DEVELOPMENT
100YR STORMWATER
CATCHMENT

Project no.	210001		
Scale	1:250 @ A3		
Cad file	C460 - FLOODING.DWG		
Drawing no.	C460	Rev	B

DATE: 4/14/22



Rev	Description	By	Date
B	RC S92	AP	01/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title
POST DEVELOPMENT 100YR STORMWATER CATCHMENT

Project no.	210001		
Scale	1:250 @ A3		
Cad file	C460 - FLOODING.DWG		
Drawing no.	C461	Rev	B

DATE: 4/14/22

CATCHMENT A1 = 0.43ha
PERVIOUS AREA = 0.16ha
IMPERVIOUS AREA = 0.27ha

Q10 FLOW = 0.10 m^3/s

CATCHMENT A2 = 1.22ha
PERVIOUS AREA = 1.17ha
IMPERVIOUS AREA = 0.05ha

Q10 FLOW = 0.22 m^3/s

#45 BRIGHAM CREEK ROAD

CATCHMENT B1 = 3.01ha
PERVIOUS AREA = 2.24ha
IMPERVIOUS AREA = 0.77ha

Q10 FLOW = 0.61 m^3/s

CATCHMENT E1 = 0.81ha
PERVIOUS AREA = 0.76ha
IMPERVIOUS AREA = 0.05ha

Q10 FLOW = 0.15 m^3/s

CATCHMENTAREA D1 = 0.68ha
PERVIOUS AREA = 0.55
IMPERVIOUS AREA = 0.13ha

Q10 FLOW = 0.13 m^3/s

CATCHMENT C1 = 0.87ha
PERVIOUS AREA = 0.87ha

Q10 FLOW = 0.16 m^3/s

CATCHMENT B2 = 1.62ha
PERVIOUS AREA =1.62ha

Q10 FLOW = 0.29 m^3/s

CATCHMENT G1 = 0.50ha
PERVIOUS AREA = 0.25ha
IMPERVIOUS AREA = 0.25ha

Q10 FLOW = 0.11 m^3/s

CATCHMENT G2 = 0.13ha
PERVIOUS AREA = 0.13ha

Q10 FLOW = 0.02 m^3/s

Q10 FLOW = 0.9 m3/s

Q10 FLOW = 0.13 m3/s

TOTAL Q10 FLOWS TO 5 MAMARI RD = 1.19 m3/s

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

- EX BDY
- PROP BDY
- CATCHMENT EXTENT

Rev	Description	By	Date
A	RC S92	AP	04/22

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

10YR STORMWATER PRE-DEVELOPMENT CATCHMENT PLAN

Project no.	210001
Scale	1:1500 @ A3
Cad file	C400 & C500 - DRAINAGE.DWG
Drawing no.	C451 Rev A

DATE: 4/14/22

BRIGHAM CREEK ROAD

#45 BRIGHAM CREEK ROAD

#39 BRIGHAM CREEK ROAD

#5 MAMARI ROAD

MAMARI ROAD

NO DWELLING UNIT

Legend

- TYPOLOGY A
- TYPOLOGY B
- TYPOLOGY C
- TYPOLOGY D
- TYPOLOGY E
- TYPOLOGY F

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JS	04/22
Drawn	JS	04/22
Checked	AP	04/22

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Project

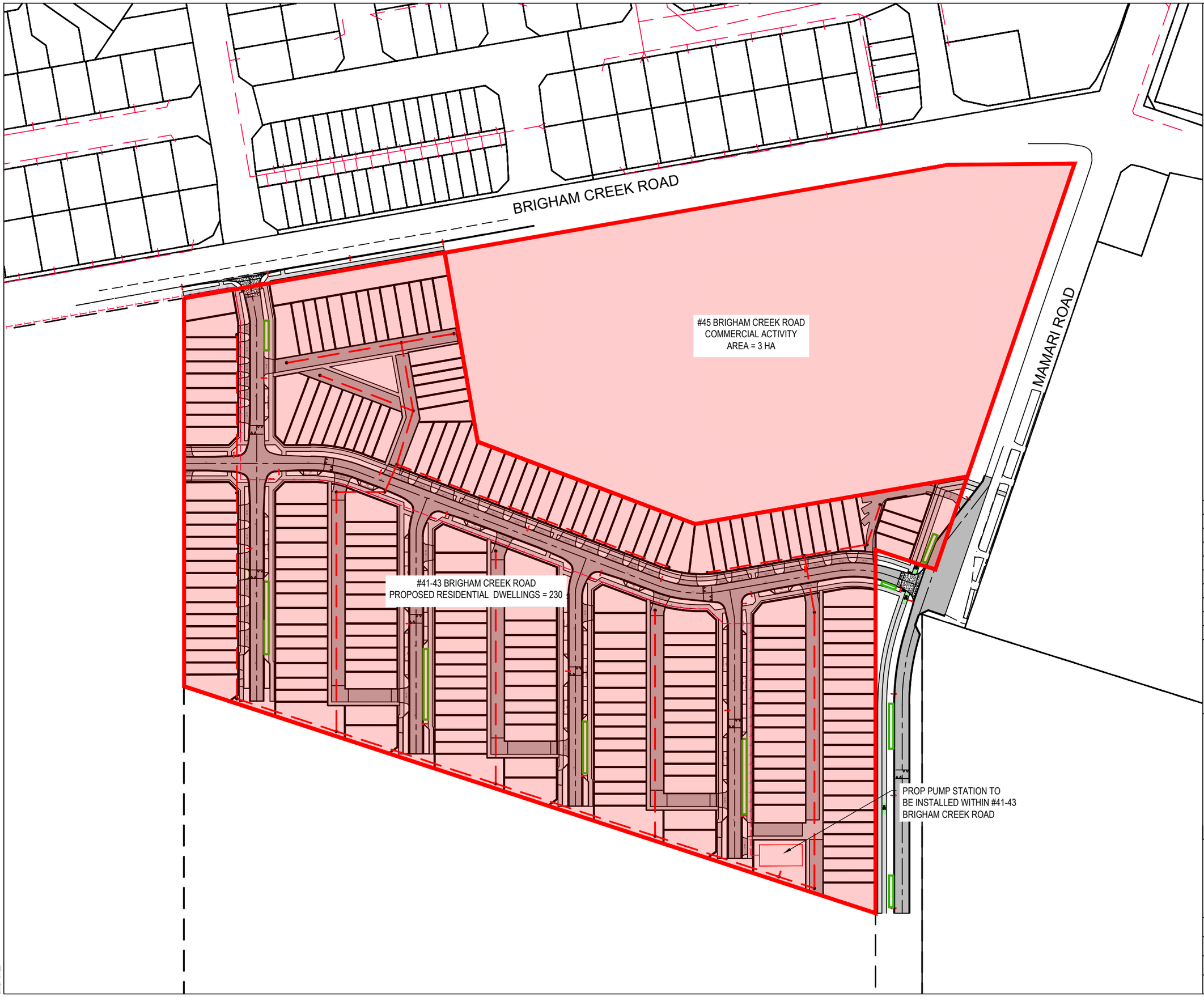
41-43 BRIGHAM CREEK RD WHENUAPAI DEVELOPMENT FOR FOR AI LING

Title

SMAF RESIDENTIAL UNITS TYPOLOGY PLAN

Project no.	210001		
Scale	1:1000 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C455	Rev	B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding.greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas, all manholes shall have stainless grates installed.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All lines are to be 150mmØ PVC Class SN16 unless shown otherwise.
10. 150mmØ pipes that do not terminate in a manhole must be terminated with a 100mmØ on a 150mmØ london junction and blank cap.
11. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

- EX BDY
- PROP BDY
- EX WASTEWATER
- PROP WASTEWATER
- EX/PROP WWMH

Rev	Description	By	Date
B	RC S92	AP	04/22
A	RC	JP	08/21

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Project

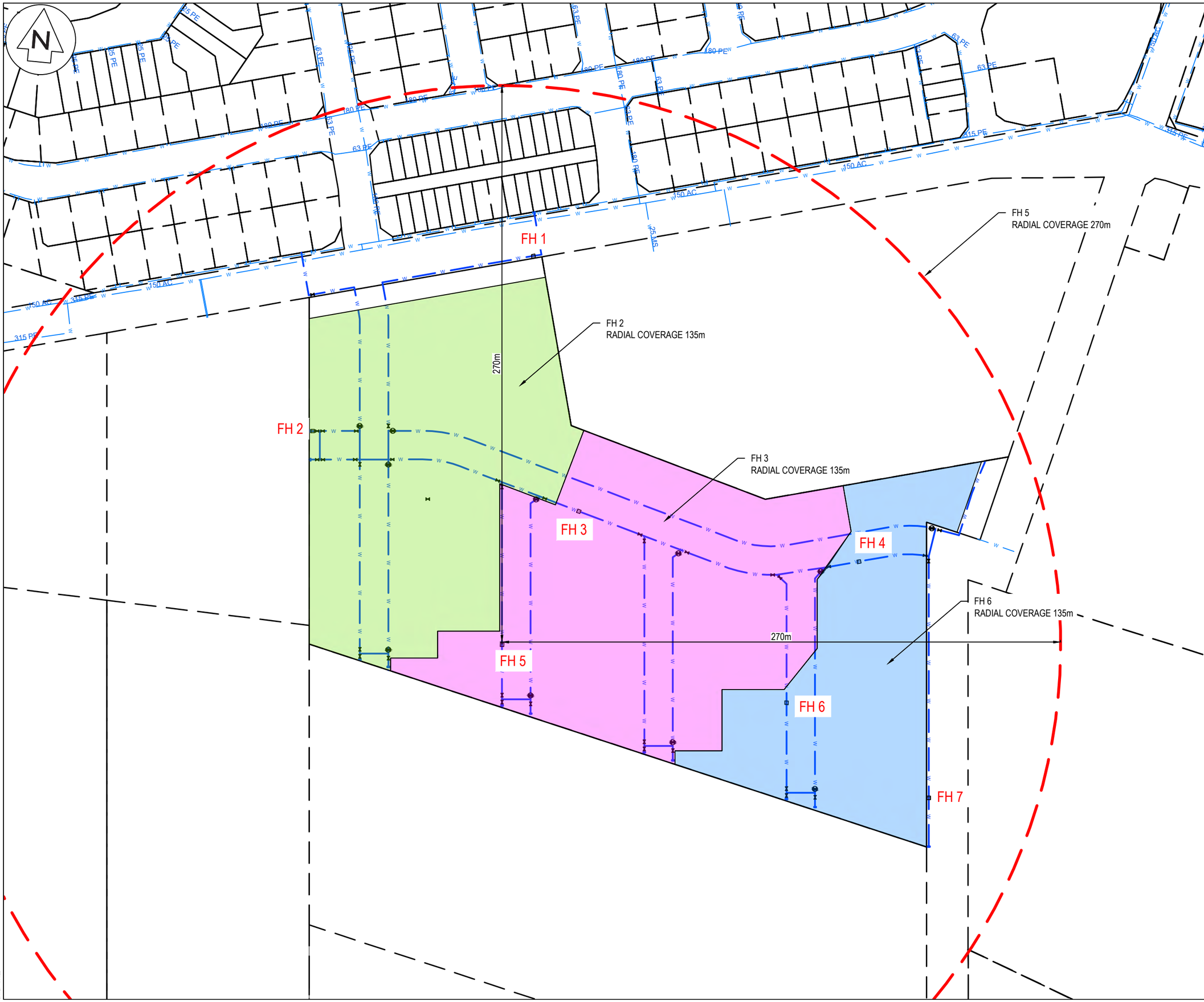
41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED WASTEWATER CATCHMENT PLAN

Project no.	210001		
Scale	1:1500 @ A3		
Cad file	C400 & C500 - DRAINAGE.DWG		
Drawing no.	C550	Rev	B

DATE: 4/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. It is the contractors responsibility to locate any underground services prior to the commencement of works.
3. Minimum cover shall be:
   - Roads, footpaths,crossings: 1000mm
   - Berms 600mm
   - Service connections: 550-650mm
4. Watermains laid across roads shall be backfilled with hardfill compacted in 200mm layers above the embedment material.
5. All uPVC pipe shall be PN12 minimum pressure rated with spignot and socket rubber ring joints.
6. All PE pipe shall be PN12.5 minimum pressure rated with butt-welded. Weld beads shall be removed to provide a smooth bore.
7. All non-metalic pipes are to have tracer wire fitted to council standards.
8. Pipes shall be bedded and surrounded to 150mm above the pipe soffit with sand or ap20.
9. Metal detector tape printed with 'water pipe below' shall be laid 150mm above all watermains.
10. A yellow isosceles triangle with cats eye pointing to FH shall be painted in the centre of all sealed roads.
11. All valves to be marked with sawcut kerb and blue paint.
12. All flange joints to be protected with denso tape or similar approved by the engineer.

Legend

- EX BDY
- DEVELOPMENT BDY
- EX WATERMAIN
- EX/PROP HYDRANT
- EX/PROP METER/ METER BANK
- EX SLUICE VALVE
- EX PEAT VALVE
- PROP WATERMAIN
- PROP SLUICE VALVE
- PROP PEAT VALVE

Rev	Description	By	Date
B	RC S92	AP	02/22

	By	Date
Survey	-	-
Design	AP	02/22
Drawn	AP	02/22
Checked	-	-

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Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

PROPOSED FIREFIGHTING COVERAGE PLAN

Project no.	210001		
Scale	1:1500 @ A3		
Cad file	C600 WATER SUPPLY.DWG		
Drawing no.	C650	Rev	A

DATE: 41422

APPENDIX C: ENGINEERING CALCULATIONS

Maven Associates	Job Number	Sheets	Rev
	210001	1	A

Job Title	41-43 Brigham Creek Road	Author	Date	Checked
Calc Title	USLE - CATCHMENT 1	JP	26-Aug	WM

Design Spreadsheet for USLE

Calc 1: Estimate of Sediment Generation (A), tonnes/ha/yr

A= R x K x LS x C x P

Where
- A = Sediment Generation (tonnes/ha/ya)
- R = Rainfall Erosion Index (J/hectare)
- K = Soil Erodibility Factor (tonnes/unit of R)
- LS = Slope Lenth and steepness Factor
- C= Ground Cover Factor
- P= Roughness Factor

Rainfall Erosion Index

R = 0.008828*P^2.2*1.7

1 = 50.24

P is the 2yr 24 hour rainfall from ARC TP108 Figure A.1 for a 6 hour duration period

TP108 2yr = 80 mm/24hr

Therefore **R** = **82.91** **J/ha**

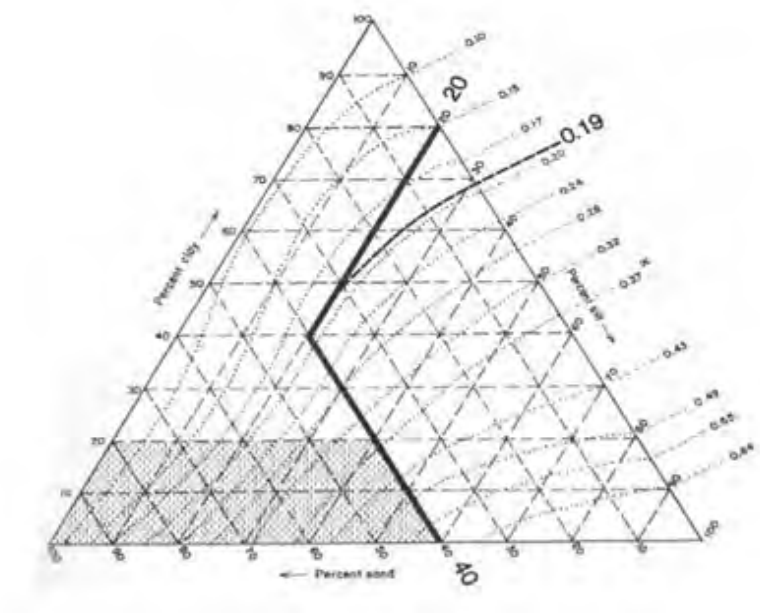

Figure 1: USLE Nomograph for Estimating k value

Soil Erodibility Factor

K = k x Organic % Factor x M-I Factor

The K factor can be determined by using the nomograph method, which requires that a particle size analysis be done to determine the percentages of sand, very fine sand, silt and clay. Use the figure above to determine appropriate K value.

Site Geology			
sand	%	0	assumed based on geotech report
silt	%	80	to be confirmed
clay	%	20	

Therefore from Figure 1 of USLE, k value unfactored =

k = 0.49

Organic % = 2 assumed

Therefore from Table 1 of USLE, Organic % Factor =

O%F = 0

Metric To Imperial Factor

M-I Factor = 1.32

Therefore **K** = **0.6468** **tonnes/unit of R**

Correct for organic content using Table 1 (the nomograph assumes 2% organic matter).

Table 1

K Value	Correction factor when percent organic matter is				
	0% (clay)	1%	2%	3%	4% (topsoil)
Greater than 0.40	+ 0.14	+ 0.07	0	- 0.07	- 0.14
0.20 – 0.40	+ 0.10	+ 0.05	0	- 0.05	- 0.10
Less than 0.20	+ 0.06	+ 0.03	0	- 0.03	- 0.06

In this table, exposed clay is considered 0% organic; topsoil 4% organic. In our example, if the surface is clay, the value would be corrected by adding 0.06 to the K value of 0.19 i.e. K = 0.25

Multiply the corrected K value by 1.32 to convert from imperial to metric
i.e. K = 0.33 (tonnes/unit of R)

Table 1: USLE Organic % Correction Factor

Slope Length and Steepness Factor

LS = From Appendix 1 equation

Slope Length =	45
Maximum Elevation =	27.5
Minimum Elevation =	26
Slope As a %	3.33
Therefore m =	0.4

Therefore **LS** = **0.24**

Ground Cover Factor

C = **1** Assumed site as **Bare Soil** and taking value from Table 2

Roughness Factor

P = **1.32** Assumed site as **Bare Soil** and taking value from Table 2

Ground Cover Factor

This is the ratio of soil loss from an actual site (or parts of a site) with specific ground cover (e.g. clay, topsoil, grass) compared to a bare site (i.e. no vegetation or topsoil). The bare site is given a value of 1.0.

Roughness Factor

The P factor provides adjustment for the degree to which surface roughness affects the erosion of sediment from a site (or part of a site).

As a standard practice, it is appropriate to use the range of C and P values given in Table 2 below.

Table 2

Treatment	C factor	P factor
Bare Soil		
- compacted and smooth	1.0	1.32
- track walked on contour	1.0	1.2
- rough irregular surface	1.0	0.9
- disked to 250 mm depth	1.0	0.8
Native vegetation (undisturbed)	0.01	1.0
Pasture (undisturbed)	0.02	1.0
Establishing grass[1]	0.1	1.0
Mulch – on subsoil[2]	0.15 (3 month period only)	1.0
Mulch – on topsoil[3]	0.05 (3 month period only)	1.0

Table 2: USLE Organic % Correction Factor

Therefore **A** = **16.93** **tonnes/ha/yr**

Estimate of Sediment yield

S (Yeild) = **A x Area x SD x SCE x Duration**

where	A	=	16.93	tonnes/ha/yr
	Area	=	0.59	ha
	SDR	=	0.7	
	SCM	=	0.5	%
	Duration	=	0.333333333	yrs

SDR Sediment Deilvery Ratio, 0.5 for slopes < 10%, 0.7 for slopes > 10%

SCM Sediment Contro Measures (%) 50% is considered conservative

Therefore **S** (Yeild) = **1.166** **tonnes / per** **4 months**

Maven Associates	Job Number	Sheets	Rev
	210001	1	A
Job Title: 41-43 Brigham Creek Road	Author	Date	Checked
Calc Title: USLE - CATCHMENT 2	JP	26-Aug	WM

Design Spreadsheet for USLE

Calc 1: Estimate of Sediment Generation (A), tonnes/ha/yr

A= R x K x LS x C x P

Where
- A = Sediment Generation (tonnes/ha/ya)
- R = Rainfall Erosion Index (J/hectare)
- K = Soil Erodibility Factor (tonnes/unit of R)
- LS = Slope Lenth and steepness Factor
- C= Ground Cover Factor
- P= Roughness Factor

Rainfall Erosion Index

R = 0.008828*P^2.2*1.7

1 = 50.24

P is the 2yr 24 hour rainfall from ARC TP108 Figure A.1 for a 6 hour duration period

TP108 2yr = 80 mm/24hr

Therefore **R** = **82.91** **J/ha**

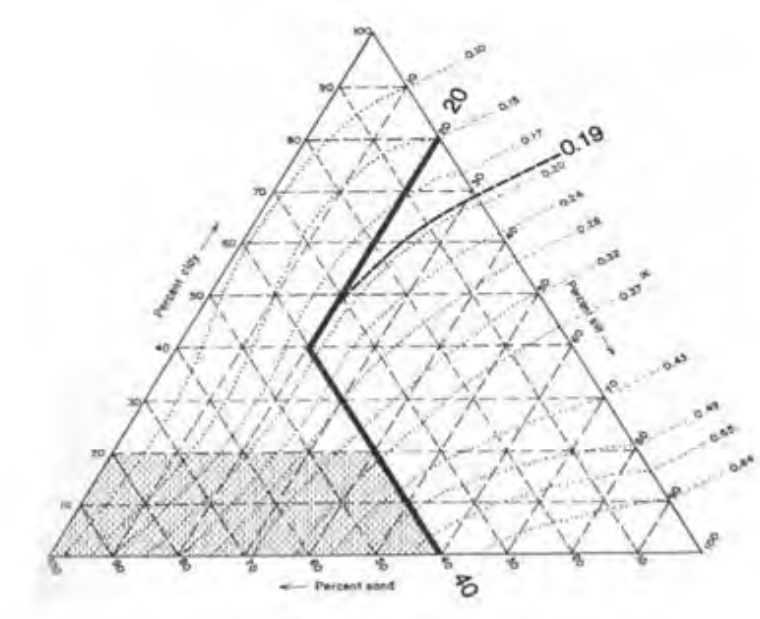

Figure 1: USLE Nomograph for Estimating k value

Soil Erodibility Factor

K = k x Organic % Factor x M-I Factor

The K factor can be determined by using the nomograph method, which requires that a particle size analysis be done to determine the percentages of sand, very fine sand, silt and clay. Use the figure above to determine appropriate K value.

Site Geology			
sand	%	0	assumed based on geotech report
silt	%	80	to be confirmed
clay	%	20	

Therefore from Figure 1 of USLE, k value unfactored =

k = 0.49

Organic % = 2 assumed

Therefore from Table 1 of USLE, Organic % Factor =

O%F = 0

Metric To Imperial Factor

M-I Factor = 1.32

Therefore **K** = **0.6468** **tonnes/unit of R**

Correct for organic content using Table 1 (the nomograph assumes 2% organic matter).

Table 1

K Value	Correction factor when percent organic matter is				
	0% (clay)	1%	2%	3%	4% (topsoil)
Greater than 0.40	+ 0.14	+ 0.07	0	- 0.07	- 0.14
0.20 – 0.40	+ 0.10	+ 0.05	0	- 0.05	- 0.10
Less than 0.20	+ 0.06	+ 0.03	0	- 0.03	- 0.06

In this table, exposed clay is considered 0% organic; topsoil 4% organic. In our example, if the surface is clay, the value would be corrected by adding 0.06 to the K value of 0.19 i.e. K = 0.25

Multiply the corrected K value by 1.32 to convert from imperial to metric
i.e. K = 0.33 (tonnes/unit of R)

Table 1: USLE Organic % Correction Factor

Slope Length and Steepness Factor

LS = From Appendix 1 equation

Slope Length =	42
Maximum Elevation =	27.5
Minimum Elevation =	22.5
Slope As a %	11.90
Therefore m =	0.5

Therefore **LS** = **1.16**

Ground Cover Factor

C = **1** Assumed site as **Bare Soil** and taking value from Table 2

Roughness Factor

P = **1.32** Assumed site as **Bare Soil** and taking value from Table 2

Ground Cover Factor

This is the ratio of soil loss from an actual site (or parts of a site) with specific ground cover (e.g. clay, topsoil, grass) compared to a bare site (i.e. no vegetation or topsoil). The bare site is given a value of 1.0.

Roughness Factor

The P factor provides adjustment for the degree to which surface roughness affects the erosion of sediment from a site (or part of a site).

As a standard practice, it is appropriate to use the range of C and P values given in Table 2 below.

Table 2

Treatment	C factor	P factor
Bare Soil		
- compacted and smooth	1.0	1.32
- track walked on contour	1.0	1.2
- rough irregular surface	1.0	0.9
- disked to 250 mm depth	1.0	0.8
Native vegetation (undisturbed)	0.01	1.0
Pasture (undisturbed)	0.02	1.0
Establishing grass[1]	0.1	1.0
Mulch – on subsoil[2]	0.15 (3 month period only)	1.0
Mulch – on topsoil[3]	0.05 (3 month period only)	1.0

Table 2: USLE Organic % Correction Factor

Therefore **A** = **81.79** **tonnes/ha/yr**

Estimate of Sediment yield

S (Yeild) = **A x Area x SD x SCE x Duration**

where	A	=	81.79	tonnes/ha/yr
	Area	=	0.542	ha
	SDR	=	0.7	
	SCM	=	0.5	%
	Duration	=	0.333333333	yrs

SDR Sediment Deilvery Ratio, 0.5 for slopes < 10%, 0.7 for slopes > 10%

SCM Sediment Contro Measures (%) 50% is considered conservative

Therefore **S** (Yeild) = **5.172** **tonnes / per** **4 months**

Maven Associates	Job Number	Sheets	Rev
	210001	1	A
Job Title: 41-43 Brigham Creek Road	Author	Date	Checked
Calc Title: USLE - CATCHMENT 3	JP	26-Aug	WM

Design Spreadsheet for USLE

Calc 1: Estimate of Sediment Generation (A), tonnes/ha/yr

A= R x K x LS x C x P

Where
- A = Sediment Generation (tonnes/ha/ya)
- R = Rainfall Erosion Index (J/hectare)
- K = Soil Erodibility Factor (tonnes/unit of R)
- LS = Slope Lenth and steepness Factor
- C= Ground Cover Factor
- P= Roughness Factor

Rainfall Erosion Index

R = 0.008828*P^2.2*1.7

1 = 50.24

P is the 2yr 24 hour rainfall from ARC TP108 Figure A.1 for a 6 hour duration period

TP108 2yr = 80 mm/24hr

Therefore **R** = **82.91** **J/ha**

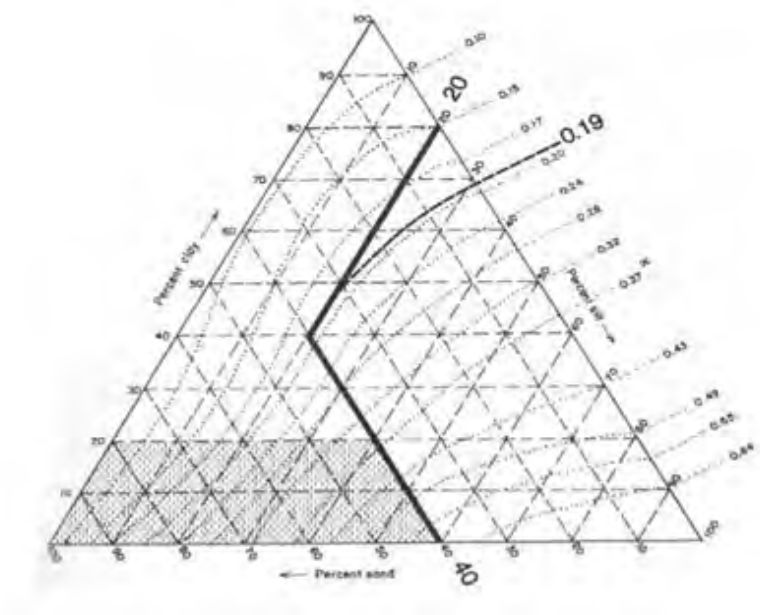

Figure 1: USLE Nomograph for Estimating k value

Soil Erodibility Factor

K = k x Organic % Factor x M-I Factor

The K factor can be determined by using the nomograph method, which requires that a particle size analysis be done to determine the percentages of sand, very fine sand, silt and clay. Use the figure above to determine appropriate K value.

Site Geology			
sand	%	0	assumed based on geotech report
silt	%	80	to be confirmed
clay	%	20	

Therefore from Figure 1 of USLE, k value unfactored =

k = 0.49

Organic % = 2 assumed

Therefore from Table 1 of USLE, Organic % Factor =

O%F = 0

Metric To Imperial Factor

M-I Factor = 1.32

Therefore **K** = **0.6468** **tonnes/unit of R**

Correct for organic content using Table 1 (the nomograph assumes 2% organic matter).

Table 1

K Value	Correction factor when percent organic matter is				
	0% (clay)	1%	2%	3%	4% (topsoil)
Greater than 0.40	+ 0.14	+ 0.07	0	- 0.07	- 0.14
0.20 – 0.40	+ 0.10	+ 0.05	0	- 0.05	- 0.10
Less than 0.20	+ 0.06	+ 0.03	0	- 0.03	- 0.06

In this table, exposed clay is considered 0% organic; topsoil 4% organic. In our example, if the surface is clay, the value would be corrected by adding 0.06 to the K value of 0.19 i.e. K = 0.25

Multiply the corrected K value by 1.32 to convert from imperial to metric
i.e. K = 0.33 (tonnes/unit of R)

Table 1: USLE Organic % Correction Factor

Slope Length and Steepness Factor

LS = From Appendix 1 equation

Slope Length =	175
Maximum Elevation =	28.5
Minimum Elevation =	23
Slope As a %	3.14
Therefore m =	0.4

Therefore **LS** = **0.39**

Ground Cover Factor

C = **1** Assumed site as **Bare Soil** and taking value from Table 2

Roughness Factor

P = **1.32** Assumed site as **Bare Soil** and taking value from Table 2

Ground Cover Factor

This is the ratio of soil loss from an actual site (or parts of a site) with specific ground cover (e.g. clay, topsoil, grass) compared to a bare site (i.e. no vegetation or topsoil). The bare site is given a value of 1.0.

Roughness Factor

The P factor provides adjustment for the degree to which surface roughness affects the erosion of sediment from a site (or part of a site).

As a standard practice, it is appropriate to use the range of C and P values given in Table 2 below.

Table 2

Treatment	C factor	P factor
Bare Soil		
- compacted and smooth	1.0	1.32
- track walked on contour	1.0	1.2
- rough irregular surface	1.0	0.9
- disked to 250 mm depth	1.0	0.8
Native vegetation (undisturbed)	0.01	1.0
Pasture (undisturbed)	0.02	1.0
Establishing grass[1]	0.1	1.0
Mulch – on subsoil[2]	0.15 (3 month period only)	1.0
Mulch – on topsoil[3]	0.05 (3 month period only)	1.0

Table 2: USLE Organic % Correction Factor

Therefore **A** = **27.47** **tonnes/ha/yr**

Estimate of Sediment yield

S (Yeild) = **A x Area x SD x SCE x Duration**

where	A	=	27.47	tonnes/ha/yr
	Area	=	2.52	ha
	SDR	=	0.7	
	SCM	=	0.5	%
	Duration	=	0.333333333	yrs

SDR Sediment Deilvery Ratio, 0.5 for slopes < 10%, 0.7 for slopes > 10%

SCM Sediment Contro Measures (%) 50% is considered conservative

Therefore **S** (Yeild) = **8.076** **tonnes / per** **4 months**

Maven Associates	Job Number	Sheets	Rev
	210001	1	A
Job Title: 41-43 Brigham Creek Road	Author	Date	Checked
Calc Title: USLE - CATCHMENT 4	JP	26-Aug	WM

Design Spreadsheet for USLE

Calc 1: Estimate of Sediment Generation (A), tonnes/ha/yr

A= R x K x LS x C x P

Where
- A = Sediment Generation (tonnes/ha/ya)
- R = Rainfall Erosion Index (J/hectare)
- K = Soil Erodibility Factor (tonnes/unit of R)
- LS = Slope Lenth and steepness Factor
- C= Ground Cover Factor
- P= Roughness Factor

Rainfall Erosion Index

R = 0.008828*P^2.2*1.7

1 = 50.24

P is the 2yr 24 hour rainfall from ARC TP108 Figure A.1 for a 6 hour duration period

TP108 2yr = 80 mm/24hr

Therefore **R** = **82.91** **J/ha**

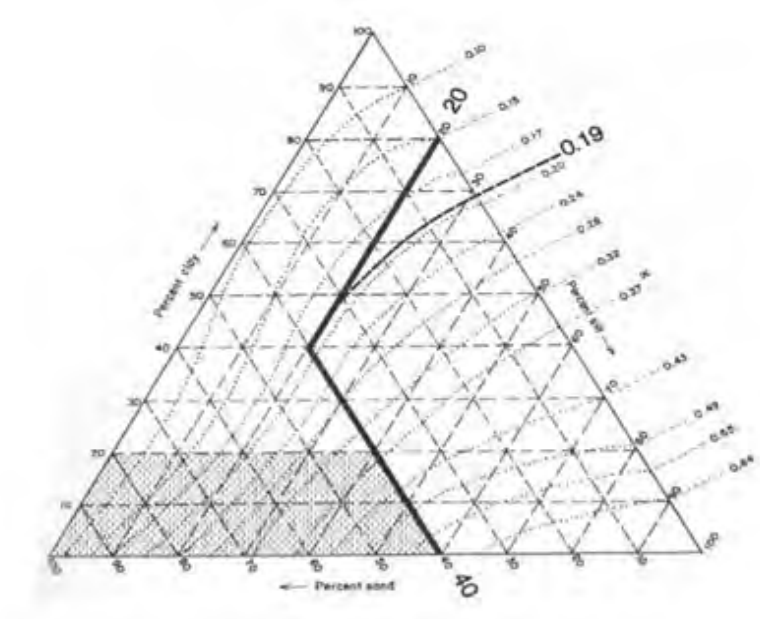

Figure 1: USLE Nomograph for Estimating k value

Soil Erodibility Factor

K = k x Organic % Factor x M-I Factor

The K factor can be determined by using the nomograph method, which requires that a particle size analysis be done to determine the percentages of sand, very fine sand, silt and clay. Use the figure above to determine appropriate K value.

Site Geology			
sand	%	0	assumed based on geotech report
silt	%	80	to be confirmed
clay	%	20	

Therefore from Figure 1 of USLE, k value unfactored =

k = 0.49

Organic % = 2 assumed

Therefore from Table 1 of USLE, Organic % Factor =

O%F = 0

Metric To Imperial Factor

M-I Factor = 1.32

Therefore **K** = **0.6468** **tonnes/unit of R**

Correct for organic content using Table 1 (the nomograph assumes 2% organic matter).

Table 1

K Value	Correction factor when percent organic matter is				
	0% (clay)	1%	2%	3%	4% (topsoil)
Greater than 0.40	+ 0.14	+ 0.07	0	- 0.07	- 0.14
0.20 – 0.40	+ 0.10	+ 0.05	0	- 0.05	- 0.10
Less than 0.20	+ 0.06	+ 0.03	0	- 0.03	- 0.06

In this table, exposed clay is considered 0% organic; topsoil 4% organic. In our example, if the surface is clay, the value would be corrected by adding 0.06 to the K value of 0.19 i.e. K = 0.25

Multiply the corrected K value by 1.32 to convert from imperial to metric
i.e. K = 0.33 (tonnes/unit of R)

Table 1: USLE Organic % Correction Factor

Slope Length and Steepness Factor

LS = From Appendix 1 equation

Slope Length =	150
Maximum Elevation =	28.5
Minimum Elevation =	21
Slope As a %	5.00
Therefore m =	0.5

Therefore **LS** = **0.66**

Ground Cover Factor

C = **1** Assumed site as **Bare Soil** and taking value from Table 2

Roughness Factor

P = **1.32** Assumed site as **Bare Soil** and taking value from Table 2

Ground Cover Factor

This is the ratio of soil loss from an actual site (or parts of a site) with specific ground cover (e.g. clay, topsoil, grass) compared to a bare site (i.e. no vegetation or topsoil). The bare site is given a value of 1.0.

Roughness Factor

The P factor provides adjustment for the degree to which surface roughness affects the erosion of sediment from a site (or part of a site).

As a standard practice, it is appropriate to use the range of C and P values given in Table 2 below.

Table 2

Treatment	C factor	P factor
Bare Soil		
- compacted and smooth	1.0	1.32
- track walked on contour	1.0	1.2
- rough irregular surface	1.0	0.9
- disked to 250 mm depth	1.0	0.8
Native vegetation (undisturbed)	0.01	1.0
Pasture (undisturbed)	0.02	1.0
Establishing grass[1]	0.1	1.0
Mulch – on subsoil[2]	0.15 (3 month period only)	1.0
Mulch – on topsoil[3]	0.05 (3 month period only)	1.0

Table 2: USLE Organic % Correction Factor

Therefore **A** = **46.41** **tonnes/ha/yr**

Estimate of Sediment yield

S (Yeild) = **A x Area x SD x SCE x Duration**

where	A	=	46.41	tonnes/ha/yr
	Area	=	2.52	ha
	SDR	=	0.7	
	SCM	=	0.5	%
	Duration	=	0.333333333	yrs

SDR Sediment Deilvery Ratio, 0.5 for slopes < 10%, 0.7 for slopes > 10%

SCM Sediment Contro Measures (%) 50% is considered conservative

Therefore **S** (Yeild) = **13.646** **tonnes / per** **4 months**

MAVEN ASSOCIATES	Job Number 210001	Sheets 1 of 1	Rev A
Job Title: 41-43 Brigham Creek Road Calc Title: Decanting Earth Bund	Author: AP	Date: 16/08/2021	Checked: WM

Catchment Area	3000	m^2
Pond Volume **2%** of Area	60	m^3
Dead Storage 30% of volume	18	m^3
Live Storage 70% of volume	42	m^3
Decant Dewatering (3l/s/ha)	0.9	l/s

Size Decant

Standard decant	4.5	l/s	=	200	holes
Therefore	0.90	l/s	=	40	holes

Use 1 decants

Pond Dimensions

v = 60 m^3

d = 1 m

x = width of pond base

Pond calculations allow for the sides and outlet of the pond to be at a 2:1 batter slope and for the inlet of the pond to be at a 3:1 batter slope.

Calc 2: Calculate width and length of base, Quadratic Equation

3:1 ratio

$v = (((3x^2)+((x+4d)(3x+5d)))/2)d$

=> $v = 3x^2d+8.5xd^2+10d^3$ quadratic equation to find "x"

		a		b		c
0	=	3	x^2+	8.5	x+	-50
x	=	2.90	width of pond base			
or	=	-5.74				

Check = 60 m^3

5:1 ratio

$v = (((5x^2)+((x+4d)(5x+5d)))/2)d$

=> $v = 5x^2d+12.5xd^2+10d^3$ quadratic equation to find "x"

		a		b		c
0	=	5	x^2+	12.5	x+	-50
x	=	2.15	width of pond base			
or	=	-4.65				

Check = 60 m^3

Width = 2.90 m

Length = 8.71 m

Dead Storage Depth

Pond calculations allow for the sides

Pond Dimensions

x = 2.90 m

v = 18.0 m^3

d = Dead storage depth

and outlet of the pond to be at a 2:1 batter slope and for the inlet of the pond to be at a 3:1 batter slope.

3:1 ratio

$v = (((3x^2)+((x+4d)(3x+5d)))/2)d$

=> $v = 10d^3+8.5xd^2+3x^2d$ cubic equation to find "d"

			a		b		c
0	=	d^3+	2.468936	d^2+	2.531064	+d	-1.8

e = 0.17

f = 1.38

g = 1.40

h = -0.12

d = 0.463 depth of dead storage

Check v = 18.00 m^3

Spillway Dimensions

Side Slope horizontal 3 vertical 1

Gradient 1 %

Base Width 8.00 m

Calc 3: Calculate spillway flow (Q) Rational Formula

Q=CIA 1% AEP

where C = 0.3

I = 0.00005 m/s (200mm/hr)

A = 3000 m2

Therefore **Q = 0.045 m3/sec**

Calc 4: Calculate spillway depth (H) Mannings Formula

$V=(1/n)R^{2/3}S^{1/2}$ R=A/P Q=AV

n = 0.018 Flow path is firm earth

Where: H = depth of channel P = wetted parameter

A = Sectional Area S = slope of channel

H	P	A	S	R	V	Q
0.3	9.897367	2.67	0.01	0.269769	2.319469	6.1929818

Therefore **H = 0.3 m**

MAVEN ASSOCIATES	Job Number 210001	Sheets 1 of 1	Rev A
Job Title 41-43 Brigham Creek Road **Calc Title** Sediment Retention Pond 1	**Author** AP	**Date** 16/08/2021	**Checked** WM

Catchment Area	**25200**	m^2
Pond Volume **2%** of Area	504	m^3
Dead Storage 30% of volume	151.2	m^3
Live Storage 70% of volume	352.8	m^3
Decant Dewatering (3l/s/ha)	7.56	l/s

Size Decant

Standard decant	4.5 l/s	=	200	holes
Therefore	7.56 l/s	=	336	holes

Use 2 decants

Pond Dimensions

v = 504 m^3

d = 1.5 m

x = width of pond base

Pond calculations allow for the sides and outlet of the pond to be at a 2:1 batter slope and for the inlet of the pond to be at a 3:1 batter slope.

Calc 2: Calculate width and length of base, Quadratic Equation

3:1 ratio

$v = (((3x^2)+((x+4d)(3x+5d)))/2)d$

=> $v = 3x^2d+8.5xd^2+10d^3$ quadratic equation to find "x"

		a		b		c
0	=	4.5	x^2+	19.125	x+	-470.25
x	=	8.32	width of pond base			
or	=	-12.57				

Check = 504 m^3

5:1 ratio

$v = (((5x^2)+((x+4d)(5x+5d)))/2)d$

=> $v = 5x^2d+12.5xd^2+10d^3$ quadratic equation to find "x"

		a		b		c
0	=	7.5	x^2+	28.125	x+	-470.25
x	=	6.26	width of pond base			
or	=	-10.01				

Check = 504 m^3

Width = 8.32 m

Length = 24.95 m

Dead Storage Depth

Pond Dimensions

x = 8.32 m

v = 151.2 m^3

d = Dead storage depth

Pond calculations allow for the sides and outlet of the pond to be at a 2:1 batter slope and for the inlet of the pond to be at a 3:1 batter slope.

3:1 ratio

$v = (((3x^2)+((x+4d)(3x+5d)))/2)d$

=> $v = 10d^3+8.5xd^2+3x^2d$ cubic equation to find "d"

			a		b		c
0	=	d^3+	7.068647	d^2+	20.74703	+d	-15.12

e = 1.36

f = 18.92

g = 3.36

h = -0.41

d = 0.597 depth of dead storage

Check v = 151.20 m^3

Spillway Dimensions

Side Slope horizontal 3 vertical 1

Gradient 1 %

Base Width 8.00 m

Calc 3: Calculate spillway flow (Q) Rational Formula

Q=CIA 1% AEP

where C = 0.3

I = 0.00005 m/s (200mm/hr)

A = 25200 m2

Therefore **Q = 0.378 m3/sec**

Calc 4: Calculate spillway depth (H) Mannings Formula

$V=(1/n)R^{2/3}S^{1/2}$ R=A/P Q=AV

n = 0.018 Flow path is firm earth

Where: H = depth of channel P = wetted parameter

A = Sectional Area S = slope of channel

H	P	A	S	R	V	Q
0.3	9.897367	2.67	0.01	0.269769	2.319469	6.1929818

Therefore **H = 0.3 m**

MAVEN ASSOCIATES	Job Number 210001	Sheets 1 of 1	Rev A
Job Title: 41-43 Brigham Creek Road Calc Title: Sediment Retention Pond 2	Author AP	Date 16/08/2021	Checked WM

Catchment Area	**15400**	m^2
Pond Volume **3%** of Area	462	m^3
Dead Storage 30% of volume	138.6	m^3
Live Storage 70% of volume	323.4	m^3
Decant Dewatering (3l/s/ha)	4.62	l/s

Size Decant

Standard decant	4.5	l/s	=	200	holes
Therefore	4.62	l/s	=	205	holes

Use 2 decants

Pond Dimensions

v = 462 m^3

d = 1.5 m

x = width of pond base

Pond calculations allow for the sides and outlet of the pond to be at a 2:1 batter slope and for the inlet of the pond to be at a 3:1 batter slope.

Calc 2: Calculate width and length of base, Quadratic Equation

3:1 ratio

$v = (((3x^2)+((x+4d)(3x+5d)))/2)d$

=> $v = 3x^2d+8.5xd^2+10d^3$ quadratic equation to find "x"

		a		b		c
0	=	4.5	x^2+	19.125	x+	-428.25
x	=	7.86	width of pond base			
or	=	-12.11				

Check = 462 m^3

5:1 ratio

$v = (((5x^2)+((x+4d)(5x+5d)))/2)d$

=> $v = 5x^2d+12.5xd^2+10d^3$ quadratic equation to find "x"

		a		b		c
0	=	7.5	x^2+	28.125	x+	-428.25
x	=	5.91	width of pond base			
or	=	-9.66				

Check = 462 m^3

Width = 7.86 m

Length = 23.58 m

Dead Storage Depth

Pond calculations allow for the sides

Pond Dimensions

x = 7.86 m

v = 138.6 m^3

d = Dead storage depth

and outlet of the pond to be at a 2:1 batter slope and for the inlet of the pond to be at a 3:1 batter slope.

3:1 ratio

$v = (((3x^2)+((x+4d)(3x+5d)))/2)d$

=> $v = 10d^3+8.5xd^2+3x^2d$ cubic equation to find "d"

			a		b		c
0	=	d^3+	6.680237	d^2+	18.52965	+d	-13.86

e = 1.22

f = 16.52

g = 3.21

h = -0.38

d = 0.604 depth of dead storage

Check v = 138.60 m^3

Spillway Dimensions

Side Slope horizontal 3 vertical 1

Gradient 1 %

Base Width 8.00 m

Calc 3: Calculate spillway flow (Q) Rational Formula

$Q=CIA$ 1% AEP

where C = 0.3

I = 0.00005 m/s (200mm/hr)

A = 15400 m2

Therefore **Q = 0.231 m3/sec**

Calc 4: Calculate spillway depth (H) Mannings Formula

$V=(1/n)R^{2/3}S^{1/2}$ R=A/P Q=AV

n = 0.018 Flow path is firm earth

Where: H = depth of channel P = wetted parameter

A = Sectional Area S = slope of channel

H	P	A	S	R	V	Q
0.3	9.897367	2.67	0.01	0.269769	2.319469	6.1929818

Therefore **H = 0.3 m**

Maven Associates	Job Number 210001	Sheet 1	Rev B
Job Title 41-43 Brigham Creek Road, Whenuapai Title Raingarden Retention and Detention at Source Summary	Author AP	Date 20/01/2022	Checked WM

GD01 Bioretention Device Sizing Criteria for SMAF 1 :	
Infiltration footprint	≥ 3.5%
Ponding footprint*	≥ 5%
Ponding depth	≥ 200 mm
Media depth	≥ 500 mm
Transition layer	100 mm
Drainage layer	≥ 200-300 mm
Storage layer depth	≥ 450 mm
Infiltration rate of subsoils for retention	2 mm/hr
Infiltration rate of media	50-300 mm/hr

Design parameters

5 mm retention will be provided through infiltration into the subsoils over a period of 72 hours as per GD01

The volume of water stored in the ponding area (200mm 100% @ Void space)
The volume of water stored in the void space of the bioretention media (500mm Media Depth + 50mm Transition Layer @ 30% Void space)
The volume of water stored in the void space of the drainage layer, above the underdrain invert. (200mm @ 35% Void Space)
The volume of water stored in the void space of the storage layer (450mm @ 35% Void Space)

Asummed Infiltration rate of subsoils for retention is 2.1mm/hr (on site testing to be carried out to confirm flow rate)

Required detention volume = Post-development runoff volume – Pre-development runoff volume – retention volume
(Post/Pre-development volumes found using TP108
Rainfall (As per Technical Report 2013/024)
SMAF 1 Average 95th Percentile Rainfall Depth, P24= 35 mm
Pervious CN = 74
Impervious CN = 98

TP108
Runoff volume, $V_{24} = 1000xQ_{24}A$
Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

RG No.	Catchment no.	Trafficable Impervious Catchment Area	Minimum Ponding Footprint Area Required (m2) (5%)	Proposed Raingarden Footprint area m^2	Ok?	Retention Footprint (m2)	Retention Required m^3	Retention Storage Available m^3	Ok?	Infiltration in 72 hours m^3	Evapotranspiration in 72 hours m^3	Infil + Evapo within 72 hours m3	Infil + Evapo ≥ Retention Required Ok?	Infil + Evapo within 24 hours m3	Pre-development Runoff Volume (m3)	Post-development Runoff Volume (m3)	Detention Required in RG (m^3)	Detention Available in RG (m^3)	Ok?
Road Reserve - Rain Gardens																			
1-1A	-	456	22.80	23.00	OK	23.0	2.28	3.62	OK	3.48	0.07	3.55	OK	2.32	3.44	13.90	8.14	10.01	OK
2-0	-	1100	55.00	55.00	NO	55.0	5.50	8.66	OK	8.32	0.17	8.48	OK	5.54	8.30	33.53	19.69	23.93	OK
3-0	-	744	37.20	37.50	OK	37.5	3.72	5.91	OK	5.67	0.11	5.78	OK	3.78	5.62	22.68	13.29	16.31	OK
4-0	-	1027	51.35	51.50	OK	51.5	5.14	8.11	OK	7.79	0.15	7.94	OK	5.19	7.75	31.31	18.37	22.40	OK
5-0	-	1056	52.80	52.90	OK	52.9	5.28	8.33	OK	8.00	0.16	8.16	OK	5.33	7.97	32.19	18.89	23.01	OK
6-2A	-	421	21.05	21.50	OK	21.5	2.11	3.39	OK	3.25	0.06	3.32	OK	2.17	3.18	12.83	7.49	9.35	OK
6-2B	-	210	10.50	10.50	NO	10.5	1.05	1.65	OK	1.59	0.03	1.62	OK	1.06	1.58	6.40	3.76	4.57	OK
9-1A	-	648	32.40	32.50	OK	32.5	3.24	5.12	OK	4.91	0.10	5.01	OK	3.28	4.89	19.75	11.59	14.14	OK
20-0A	-	431	21.55	21.60	OK	21.6	2.16	3.40	OK	3.27	0.06	3.33	OK	2.18	3.25	13.14	7.71	9.40	OK
Private - Rain Gardens																			
JOAL 2	-	1179	58.95	59.00	OK	59.0	5.90	9.29	OK	8.92	0.18	9.10	OK	5.95	8.90	35.94	21.10	25.67	OK
Total		**7272**	**363.60**	**365.00**		**365.00**	**36.36**	**57.49**		**55.19**	**1.10**						**130.01**	**158.78**	

Summary Road Rain Gardens:
The stored retention can be infiltrated to the ground in 72 hours with the assumed infiltration rate of 2.1mm/hr.

Maven Associates

Job Number	Sheet	Rev	41-43 Brigham Creek Road, Hobsonville	Author	Date	Checked
210001	1	B	Calc Title: Pipe Capacity Check (10-yr)	AP	12/04/2022	WM

Rainfall Depth	ARI 10YR (mm)	
TP108 rainfall data	140	
Climate change Increase	158.48	(13.2% Increase)

Pipe ks factor = 0.15 mm

	CN Number		CN Number	
Impervious area	98	Proposed Residential Lots	90.8	Equivalent CN - (70% impervious coverage, 30% pervious coverage)
Pervious	74	Proposed Roads	94.4	Equivalent CN - (85% impervious coverage, 15% pervious coverage)
		Proposed JOALS	98	Equivalent CN - (100% impervious coverage)

Pipe Line	Catchment	Catchment Area	CN	Peak Flow rate - 10YR ARI	Cum. Flow	Pipe dia	Gradient	Capacity	Velocity	Check
number	*letter*	*m2*		*l/s*	*l/s*	*m*	*%*	*l/s*	*m/s*	OK
5-3 to 5-2	A1	1285	90.8	31.56	**31.56**					
	A2	390	94.4	9.99	**41.54**	0.225	3.50	116.80	2.94	OK
5-2 to 5-1	A3	2135	90.8	52.44	**93.98**	0.300	0.80	118.30	1.67	OK
5-1 to 5-0	No Additional Flows				**93.98**	0.375	0.50	167.42	1.52	OK
	A4	929	94.4	23.79						
RCP 5-0 to 5-0	A5	1832	94.4	46.92	**70.71**	0.225	1.50	76.39	1.92	OK
	B1	2471	90.8	60.69						
	B2	1888	90.8	46.38						
	B3	850	98	22.31						
4-2 to 4-1	B4	408	90.8	10.02	**139.41**	0.300	2.25	198.65	2.81	OK
4-1 to 4-0	No Additional Flows				**139.41**	0.375	0.60	183.45	1.66	OK
	C1	1182	94.4	30.27						
RCP 4-0 to 4-0	C2	1731	94.4	44.33	**74.61**	0.225	2.00	88.24	2.22	OK
	D1	2508	90.8	61.60						
	D2	2411	90.8	59.22						
	D3	830	98	21.79						
3-2 to 3-1	D4	408	90.8	10.02	**152.64**	0.300	2.41	205.60	2.91	OK
3-1 to 3-0	No Additional Flows				**152.64**	0.375	0.60	183.45	1.66	OK
	E1	537	94.4	13.75						
RCP 3-0 to 3-0	E2	1676	94.4	42.93	**56.68**	0.225	1.00	62.34	1.57	OK
	F1	2429	90.8	59.65						
	F2	1794	90.8	44.08						
	F3	803	98	21.09						
2-2 to 2-1	F4	408	90.8	10.02	**134.83**	0.300	3.50	247.85	3.51	OK

2-1 to 2-0	No Additional Flows				**134.83**	0.300	4.50	281.09	3.98	OK
	G1	1284	94.4	32.89						
RCP 2-0 to 2-0	G2	1819	94.4	46.59	**79.47**	0.225	2.00	88.24	2.22	OK
1-10 to 1-9	H1	1246	90.8	30.60	**30.60**	0.225	0.50	44.02	1.11	OK
8-1 to 1-9	H3	550	90.8	13.50	**13.50**	0.225	1.00	62.34	1.57	OK
1-9 to 1-8	H4	580	90.8	14.24	**58.34**	0.300	0.50	93.45	1.32	OK
7-1 to 1-8	H5	1387	90.8	34.08						
	H2	1402	98	36.80	**70.88**	0.300	0.50	93.45	1.32	OK
1-8 to 1-7	H6	169	98	4.43	**133.64**	0.375	0.50	167.42	1.52	OK
1-7 to 1-6	I1	3010	90.8	73.92	**207.56**	0.450	0.50	269.46	1.69	OK
1-6 to 1-5	No additional Flows				**207.56**	0.450	0.50	269.46	1.69	OK
1-5 to 1-4	I2	1160	90.8	28.50	**236.07**	0.450	0.50	269.46	1.69	OK
	J1	1118	90.8	27.47		0.225	1.00	62.34	1.57	OK
	J2	1374	94.4	35.20						
6-3 to 6-2	J3	466	90.8	11.44	**74.11**	0.225	1.50	76.39	1.92	OK
RCP 6-2A to 6-2	J4	1122	94.4	28.74		0.225	2.00	88.24	2.22	OK
RCP 6-2B to 6-2	J5	592	94.4	15.16		0.225	1.00	62.34	1.57	OK
6-2 to 6-1					**118.01**	0.300	1.50	162.13	2.29	OK
6-1 to 1-4	J7	501	94.4	12.84	**130.85**	0.300	1.50	162.13	2.29	OK
	Flows from 1-5 to1-4			236.07						
1-4 to 1-3	Flows from 6-1 to 1-4			130.85	**366.92**	0.450	1.00	381.42	2.40	OK
	K1	2173	94.4	55.64						
	K2	3094	94.4	79.24						
	K3	1107	98	29.06						
1-3 to 1-2	K4	416	94.4	10.65	**541.51**	0.450	2.60	615.55	3.87	OK
1-2 to 1-1	No additional Flows				**541.51**	0.450	2.20	566.15	3.56	OK
9-1 to 1-1	L1	1562	94.4	40.01	**40.01**	0.225	1.00	62.34	1.57	OK
1-1 to 1-0	Flows from 1-2 to 1-1			541.51						
	Flows from 9-1 to 1-1			40.01						
	L2	1402	94.4	35.90						
	L3	2647	94.4	67.81	**685.22**	0.525	2.27	859.60	3.97	OK
20-1 to EX 20-0	X1	30000	98	787.53						
	X2	1159	94.4	29.69						
	X3	1568	94.4	40.15	**857.36**	0.600	1.50	989.27	3.50	OK

21-1 to EX 20-0	Y1	483	98	12.68		0.225	1.00	62.34	1.57	OK
	Y2	1206	94.4	30.88		0.225	1.00	62.34	1.57	OK
					43.56	0.225	1.00	62.34	1.57	OK
CP to EX 20-0	Z1	843	98	22.13	**22.13**	0.225	1.00	62.34	1.57	OK
EX 20-0 to 3000057230					**923.06**	0.675	1.00	1097.36	3.07	OK

Combined Flows Onto 5 Mamari Rd =	**802.34**

Maven Associates		Job Number 210001	Sheet 1 OF 4	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Pre-Development SMAF 1	AP	11/04/2021	WM

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	60% (MPD) of total area for Lots 1-230	74	1.939	143.50
	*pre development pervious			
* from Appendix B		Totals =	1.939	143.50

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{143.50}{1.939} =$ 74.0

Ia (average) = $\frac{\text{5 x pervious area}}{\text{total area}} = \frac{5 \times 1.9392}{1.939}$ 5.0 mm

2. Time of Concentration

Channelisation factor C = 0.8 (From Table 4.2)

Catchment length L = 0.1 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.0}{200-74.0} =$ 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.8 0.22 1.34 3.98 = 0.13 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.09 hrs

NO GOOD
use
0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 210001	Sheet 2 OF 4	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Pre-Development SMAF 1	AP	11/04/2021	WM

1. Data

Catchment Area	A=	0.019392	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	10	(yr)
4. 24 hour rainfall depth, P24	35	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.12	
6. Specific peak flow rate q*	0.038	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.026**	
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	7.5	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	146.36	(m3)

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 210001	Sheet 3 OF 4	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post Development SMAF 1	AP	11/04/2021	WM

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	60% (MPD) of total area for Lots 1-230	98	1.939	190.04
	*post development impervious			
* from Appendix B		Totals =	1.939	190.04

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{190.04}{1.939} =$ 98.0

Ia (average) = $\frac{\text{5 x pervious area}}{\text{total area}} = \frac{5 \times 0.0000}{1.939}$ 0.0 mm

2. Time of Concentration

Channelisation factor C = 0.8 (From Table 4.2)

Catchment length L = 0.1 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{98.0}{200- 98.0} =$ 0.96

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.8 0.22 1.02 3.98 = 0.10 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.07 hrs

NO GOOD
use
0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 210001	Sheet 4 OF 4	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post Development SMAF 1	AP	11/04/2021	WM

1. Data

Catchment Area	A=	0.019392	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5.2 mm

3. Average recurrence interval, ARI	10	(yr)
4. 24 hour rainfall depth, P24	35	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.77	
6. Specific peak flow rate q*	0.157	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.107**	
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	30.5	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	591.17	(m3)

Pre development volume =	146.36	(m3)	
Post development volume =	591.17	(m3)	
Pre to Post Detention Volume =	444.80	(m3)	
5mm Retention Volume Reduction =	96.96	(m3)	i.e 1.93ha * .005
Minimum Detention Volume Required =	**347.84**	**(m3)**	

Worksheet 2: Graphical Peak Flow Rate

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Design Summary	Author AP	Date 11-Apr-22	Checked WM

Lot Typology	Lot Area m²	Impervious Cover (60% MPD) m²	Retention Vol. m³	Detention Vol. m³	Tank Vol m³	No. of Tanks Qty.
A	100	60	0.3	1.1	1.4	7
B	125	75	0.4	1.3	1.7	126
C	150	90	0.5	1.6	2.1	56
D	200	120	0.6	2.2	2.8	22
E	250	150	0.8	2.7	3.4	14
F	300	180	0.9	3.2	4.1	4
				TOTAL NO. OF TANKS =		229

MINIMUM RETENTION VOLUME REQUIRED =	**96.96**	**m³**	
DESIGN RETENTION VOLUME PROVIDED =	**101.85**	**m³**	**OK**
MINIMUM DETENTION VOLUME REQUIRED =	**347.84**	**m³**	
DESIGN DETENTION VOLUME PROVIDED =	**365.385**	**m³**	**OK**

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Controls - Typology A	Author AP	Date 11-Apr-22	Checked WM

Full Site = 50% or greater site area to be redeveloped

(1) Rainfall (As per Technical Report 2013/035)

FLOW 1	Average 95th Percentile Rainfall Depth	35	mm
FLOW 2	Average 90th Percentile Rainfall Depth	NA	mm

Catchment Summary

(2) Pre-Development Condition

Impervious - Roof	0	m^2
Impervious - Paved	0	m^2
Permeable Area	60	m^2
Site Area	60.0	m^2

(3) Post-Development Condition Proposed

Impervious - Roof	60	m^2	
Impervious - Paved	0	m^2	(a)
Permeable Area	0	m^2	
Site Area	60.0	m^2	

Flow Mitigation Summary

(4) Retention Volume Required

Impervious Area (a)	60	m^2	
5mm Runoff Volume	0.30	m^3	
Min. Retention Volume Required	**0.3**	**m^3**	(b)

(5) Detention Volume Required

Pre-Development Runoff Volume	0.45	m^3	(c)
Post-Development Runoff Volume	1.83	m^3	(d)
Pre-Post Volume Difference (d-c)	1.4	m^3	(e)
Retention Volume Reduction (b)	0.3	m^3	
Min. Detention Volume Required (e-b)	**1.1**	**m^3**	

(Post/Pre-development volumes found using TP108)
Runoff volume, V24 = 1000xQ24A
Runoff depth, Q24 = (P24-Ia)2/(P24-Ia)+S
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

Pervious CN =	74
Impervious CN =	98

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Controls - Typology B	Author AP	Date 11-Apr-22	Checked WM

Full Site = 50% or greater site area to be redeveloped

(1) Rainfall (As per Technical Report 2013/035)

FLOW 1	Average 95th Percentile Rainfall Depth	35	mm
FLOW 2	Average 90th Percentile Rainfall Depth	NA	mm

Catchment Summary

(2) Pre-Development Condition

Impervious - Roof	0	m^2
Impervious - Paved	0	m^2
Permeable Area	75	m^2
Site Area	75.0	m^2

(3) Post-Development Condition Proposed

Impervious - Roof	75	m^2	
Impervious - Paved	0	m^2	(a)
Permeable Area	0	m^2	
Site Area	75.0	m^2	

Flow Mitigation Summary

(4) Retention Volume Required

Impervious Area (a)	75	m^2	
5mm Runoff Volume	0.38	m^3	
Min. Retention Volume Required	**0.4**	**m^3**	(b)

(5) Detention Volume Required

Pre-Development Runoff Volume	0.57	m^3	(c)
Post-Development Runoff Volume	2.29	m^3	(d)
Pre-Post Volume Difference (d-c)	1.7	m^3	(e)
Retention Volume Reduction (b)	0.4	m^3	
Min. Detention Volume Required (e-b)	**1.3**	**m^3**	

(Post/Pre-development volumes found using TP108)
Runoff volume, V24 = 1000xQ24A
Runoff depth, Q24 = (P24-Ia)2/(P24-Ia)+S
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

Pervious CN =	74
Impervious CN =	98

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Controls - Typology C	Author AP	Date 11-Apr-22	Checked WM

Full Site = 50% or greater site area to be redeveloped

(1) Rainfall (As per Technical Report 2013/035)

FLOW 1	Average 95th Percentile Rainfall Depth	35	mm
FLOW 2	Average 90th Percentile Rainfall Depth	NA	mm

Catchment Summary

(2) Pre-Development Condition

Impervious - Roof	0	m^2
Impervious - Paved	0	m^2
Permeable Area	90	m^2
Site Area	90.0	m^2

(3) Post-Development Condition Proposed

Impervious - Roof	90	m^2	
Impervious - Paved	0	m^2	(a)
Permeable Area	0	m^2	
Site Area	90.0	m^2	

Flow Mitigation Summary

(4) Retention Volume Required

Impervious Area (a)	90	m^2	
5mm Runoff Volume	0.45	m^3	
Min. Retention Volume Required	**0.5**	**m^3**	(b)

(5) Detention Volume Required

Pre-Development Runoff Volume	0.68	m^3	(c)
Post-Development Runoff Volume	2.74	m^3	(d)
Pre-Post Volume Difference (d-c)	2.1	m^3	(e)
Retention Volume Reduction (b)	0.5	m^3	
Min. Detention Volume Required (e-b)	**1.6**	**m^3**	

(Post/Pre-development volumes found using TP108)
Runoff volume, V24 = 1000xQ24A
Runoff depth, Q24 = (P24-Ia)2/(P24-Ia)+S
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

Pervious CN =	74
Impervious CN =	98

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Controls - Typology D	Author AP	Date 11-Apr-22	Checked WM

Full Site = 50% or greater site area to be redeveloped

(1) Rainfall (As per Technical Report 2013/035)

FLOW 1	Average 95th Percentile Rainfall Depth	35	mm
FLOW 2	Average 90th Percentile Rainfall Depth	NA	mm

Catchment Summary

(2) Pre-Development Condition

Impervious - Roof	0	m^2
Impervious - Paved	0	m^2
Permeable Area	120	m^2
Site Area	120.0	m^2

(3) Post-Development Condition Proposed

Impervious - Roof	120	m^2	
Impervious - Paved	0	m^2	(a)
Permeable Area	0	m^2	
Site Area	120.0	m^2	

Flow Mitigation Summary

(4) Retention Volume Required

Impervious Area (a)	120	m^2	
5mm Runoff Volume	0.60	m^3	
Min. Retention Volume Required	**0.6**	**m^3**	(b)

(5) Detention Volume Required

Pre-Development Runoff Volume	0.91	m^3	(c)
Post-Development Runoff Volume	3.66	m^3	(d)
Pre-Post Volume Difference (d-c)	2.8	m^3	(e)
Retention Volume Reduction (b)	0.6	m^3	
Min. Detention Volume Required (e-b)	**2.2**	**m^3**	

(Post/Pre-development volumes found using TP108)
Runoff volume, V24 = 1000xQ24A
Runoff depth, Q24 = (P24-Ia)2/(P24-Ia)+S
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

Pervious CN =	74
Impervious CN =	98

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Controls - Typology E	Author AP	Date 11-Apr-22	Checked WM

Full Site = 50% or greater site area to be redeveloped

(1) Rainfall (As per Technical Report 2013/035)

FLOW 1	Average 95th Percentile Rainfall Depth	35	mm
FLOW 2	Average 90th Percentile Rainfall Depth	NA	mm

Catchment Summary

(2) Pre-Development Condition

Impervious - Roof	0	m^2
Impervious - Paved	0	m^2
Permeable Area	150	m^2
Site Area	150.0	m^2

(3) Post-Development Condition Proposed

Impervious - Roof	150	m^2	
Impervious - Paved	0	m^2	(a)
Permeable Area	0	m^2	
Site Area	150.0	m^2	

Flow Mitigation Summary

(4) Retention Volume Required

Impervious Area (a)	150	m^2	
5mm Runoff Volume	0.75	m^3	
Min. Retention Volume Required	**0.8**	**m^3**	(b)

(5) Detention Volume Required

Pre-Development Runoff Volume	1.13	m^3	(c)
Post-Development Runoff Volume	4.57	m^3	(d)
Pre-Post Volume Difference (d-c)	3.4	m^3	(e)
Retention Volume Reduction (b)	0.8	m^3	
Min. Detention Volume Required (e-b)	**2.7**	**m^3**	

(Post/Pre-development volumes found using TP108)
Runoff volume, V24 = 1000xQ24A
Runoff depth, Q24 = (P24-Ia)2/(P24-Ia)+S
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

Pervious CN =	74
Impervious CN =	98

MAVEN ASSOCIATES	Job Number 210001	Sheet 1	Rev A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: SMAF Controls - Typology F	Author: AP	Date: 11-Apr-22	Checked: WM

Full Site = 50% or greater site area to be redeveloped

(1) Rainfall (As per Technical Report 2013/035)

FLOW 1	Average 95th Percentile Rainfall Depth	35	mm
FLOW 2	Average 90th Percentile Rainfall Depth	NA	mm

Catchment Summary

(2) Pre-Development Condition

Impervious - Roof	0	m^2
Impervious - Paved	0	m^2
Permeable Area	150	m^2
Site Area	150.0	m^2

(3) Post-Development Condition Proposed

Impervious - Roof	180	m^2	
Impervious - Paved	0	m^2	(a)
Permeable Area	0	m^2	
Site Area	180.0	m^2	

Flow Mitigation Summary

(4) Retention Volume Required

Impervious Area (a)	180	m^2	
5mm Runoff Volume	0.90	m^3	
Min. Retention Volume Required	**0.9**	**m^3**	(b)

(5) Detention Volume Required

Pre-Development Runoff Volume	1.36	m^3	(c)
Post-Development Runoff Volume	5.49	m^3	(d)
Pre-Post Volume Difference (d-c)	4.1	m^3	(e)
Retention Volume Reduction (b)	0.9	m^3	
Min. Detention Volume Required (e-b)	**3.2**	**m^3**	

(Post/Pre-development volumes found using TP108)
Runoff volume, V24 = 1000xQ24A
Runoff depth, Q24 = (P24-Ia)2/(P24-Ia)+S
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

Pervious CN =	74
Impervious CN =	98

MAVEN ASSOCIATES	Job Number	Sheet	Rev
	210001	1	A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: Lot SMAF Typology Table	Author: AP	Date: 11-Apr-22	Checked: WM

Lot No.	Lot Typology	Lot Area (m2)	Lot No.	Lot Typology	Lot Area (m2)
1	E	206.1	41	C	141.8
2	B	119.6	42	No Dwelling Unit	
3	B	119.6	43	B	117.0
4	B	119.6	44	B	117.0
5	C	147.2	45	B	117.0
6	C	147.2	46	B	117.0
7	B	119.6	47	C	141.8
8	B	119.6	48	C	141.8
9	C	147.2	49	B	117.0
10	C	147.2	50	B	117.0
11	B	119.6	51	B	117.0
12	B	119.6	52	D	170.5
13	D	163.4	53	D	175.0
14	C	147.2	54	B	117.0
15	A	96.6	55	B	117.0
16	A	96.6	56	B	117.0
17	B	119.6	57	C	141.8
18	B	119.6	58	C	141.8
19	D	168.6	59	B	117.0
20	F	271.0	60	B	117.0
21	D	158.9	61	B	117.0
22	C	148.8	62	B	117.0
23	C	138.8	63	B	117.0
24	C	130.6	64	B	118.5
25	B	101.2	65	C	148.9
26	A	98.5	66	D	158.3
27	A	97.1	67	A	93.2
28	A	96.7	68	A	93.2
29	C	146.0	69	B	120.8
30	C	144.7	70	D	173.2
31	C	129.3	71	B	118.3
32	C	139.8	72	B	118.3
33	D	150.3	73	B	118.3
34	C	137.5	74	B	118.3
35	C	141.8	75	B	118.3
36	C	141.8	76	B	118.3
37	B	117.0	77	C	143.3
38	B	117.0	78	C	143.3
39	B	117.0	79	B	118.3
40	B	117.0	80	B	118.3

MAVEN ASSOCIATES	Job Number	Sheet	Rev
	210001	1	A
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: Lot SMAF Typology Table	Author: AP	Date: 11-Apr-22	Checked: WM

Lot No.	Lot Typology	Lot Area (m2)	Lot No.	Lot Typology	Lot Area (m2)
81	B	118.3	**121**	B	118.3
82	B	118.3	**122**	D	176.3
83	B	118.3	**123**	D	195.0
84	B	118.3	**124**	E	213.1
85	C	143.3	**125**	F	329.8
86	C	143.3	**126**	B	118.3
87	B	118.3	**127**	B	118.3
88	B	118.3	**128**	C	143.3
89	B	118.3	**129**	D	161.5
90	B	118.3	**130**	B	118.3
91	B	118.3	**131**	B	118.3
92	B	118.3	**132**	B	118.3
93	E	218.0	**133**	B	118.3
94	D	180.8	**134**	C	143.3
95	B	118.3	**135**	C	143.3
96	B	118.3	**136**	B	118.3
97	B	118.3	**137**	B	118.3
98	B	118.3	**138**	D	161.5
99	C	143.3	**139**	D	192.7
100	C	143.3	**140**	E	206.6
101	B	118.3	**141**	E	239.2
102	B	118.3	**142**	B	118.3
103	B	118.3	**143**	B	118.3
104	B	118.3	**144**	C	143.3
105	C	143.3	**145**	C	143.3
106	C	143.3	**146**	B	118.3
107	B	118.3	**147**	B	118.3
108	B	118.3	**148**	B	118.3
109	E	246.1	**149**	C	143.3
110	E	215.8	**150**	C	143.3
111	B	118.3	**151**	B	118.3
112	B	118.3	**152**	B	118.3
113	C	143.3	**153**	D	166.1
114	C	143.3	**154**	D	195.0
115	B	118.3	**155**	E	213.1
116	B	118.3	**156**	F	325.3
117	B	118.3	**157**	B	118.3
118	C	143.3	**158**	B	118.3
119	C	143.3	**159**	C	143.3
120	B	118.3	**160**	C	143.3

MAVEN ASSOCIATES	Job Number	Sheet	Rev
	210001	1	A

Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Lot SMAF Typology Table	AP	11-Apr-22	WM

Lot No.	Lot Typology	Lot Area (m2)
161	B	118.3
162	B	118.3
163	B	118.3
164	B	118.3
165	C	143.3
166	C	143.3
167	B	118.3
168	B	118.3
169	B	118.3
170	C	143.3
171	D	192.7
172	E	208.6
173	E	247.1
174	B	118.3
175	B	118.3
176	B	118.3
177	B	118.3
178	B	118.3
179	B	118.3
180	C	143.3
181	C	143.3
182	B	118.3
183	B	118.3
184	B	118.3
185	B	118.3
186	D	170.0
187	D	195.0
188	E	213.1
189	F	323.0
190	B	118.3
191	B	118.3
192	C	143.3
193	C	143.3
194	B	118.3
195	B	118.3
196	D	161.5
197	C	143.3
198	B	118.3
199	B	118.3
200	B	118.3

Lot No.	Lot Typology	Lot Area (m2)
201	C	143.3
202	C	143.3
203	B	118.3
204	B	118.3
205	E	205.2
206	E	201.3
207	B	121.7
208	B	121.7
209	B	121.7
210	B	121.7
211	B	121.7
212	B	121.7
213	C	147.5
214	C	147.5
215	B	121.7
216	B	121.7
217	B	121.7
218	B	121.7
219	B	121.7
220	B	121.7
221	D	178.0
222	D	177.0
223	B	121.7
224	B	121.7
225	C	147.5
226	C	147.5
227	B	121.7
228	B	121.7
229	B	121.7
230	E	204.3

Maven Associates		Job Number 210001	Sheet 1	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Title	JOAL Retention & Detention Calculations	JP	21/08/2021	WM

Design parameters

Required detention volume = Post-development runoff volume – Pre-development runoff volume – retention volume
(Post/Pre-development volumes found using TP108
Rainfall (As per Technical Report 2013/024)
SMAF 1 Average 95th Percentile Rainfall Depth, P24= 35 mm
Pervious CN = 74
Impervious CN = 98

TP108
Runoff volume, $V_{24} = 1000xQ_{24}A$
Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$
Calculate storage, S =(1000/CN - 10)25.4
Initial abstraction,Ia = (5 x pervious area) / Total area

JOAL No.	Catchment no.	Trafficable Impervious Catchment Area	Retention Required m^3	Pre-development Runoff Volume (m3)	Post-development Runoff Volume (m3)	Detention Required in RG ($m^{3)}$	Total Tank Volume Required -	
3		850	4.25	6.42	25.91	15.25	19.50	
4		830	4.15	6.26	25.30	14.89	19.04	
5		804	4.02	6.07	24.51	14.42	18.44	
6		1096	5.48	8.27	33.41	19.66	25.14	
7		295	1.48	2.23	8.99	5.29	6.77	
Totals		**3875**	**19.38**			**69.51**	**88.88**	

CSF 0052; StormFilter Flow-Based Sizing - Auckland Council Method

Stormwater360

Project Name	41-43 Brigham Creek Road		**Location**	Auckland	
Job #	6652	**Device #** SF 3	**Option #**	A	**Revision #** RA
Author	Matthew Howes		**Date**	27 August 2021	

CALCULATIONS - Please Read Instructions First

1.0 Water Quality Design Storm Peak Runoff Flowrate (RATIONAL METHOD)

1.1 Runoff Co-efficients

Coefficient of Impervious Roof **(Croof)**	1.00
Coefficient of Impervious Road **(Croad)**	1.00
Coefficient of Pervious Area **(Cper)**	0.40

1.2 Catchment Areas

Area Impervious Roof **(Aroof)**	0 m^2
Area Impervious Road **(Aroad)**	815 m^2
Area Pervious Area **(Aper)**	0 m^2
Area Total Catchment **(Acatch)**	815 m^2
Product of Area & Coefficients **(CA)**	815 m^2

1.3 Rainfall Intensity

Water Quality Rainfall Intensity (**iWQ**)	10 mm/hr

1.4 Water Quality Design Storm Peak Runoff Flowrate

Design Water Quality Treatment Flowrate (**Qwq**)	2.264 L/s

2.0 StormFilter Peak Treatment Flowrate

2.1 Preliminary

Cartridge Media **(Media)**	Perlite
Cartridge Height **(Hcart)**	46 cm
Diameter Disc Orifice **(d)**	25.0 mm
Internal bypass weir height **(Hweir)**	0.56 m
Priming depth **(Hprime)**	0.43 m
Area of a Cartridge **(Acart)**	0.181 m^2

2.2 StormFilter Cartridge Peak Treatment Flowrate

StormFilter cartridge stage-discharge equation	$=0.111d^{2.06}\Delta h^{0.5}$ L/min
Design treatment flowrate per cartridge **(Qcart)**	0.950 L/s/cart
Number (actual) of StormFilter cartridges required	2.383 cart(s)
Number (rounded) of StormFilter cartridges required (**nCart**)	3 cart(s)
Design StormFilter Treatment Flowrate (**QSF**)	2.850 L/s

3.0 Estimate Sediment Mass Loading

3.1 StormFilter Manhole/Vault Dimensions

Length Cartridge Bay **(Lbay)**	1.000 m
Width Cartridge Bay **(Wbay)**	2.440 m
Area Cartridge Bay **(Abay)**	2.440 m^2
Total area of Cartridges **(Acarts)**	0.543 m^2
Area Lower Volume **(Alow)**	1.897 m^2
Volume Lower Volume **(Vlow)**	873 L
Area Upper Volume **(Aupp)**	2.440 m^2
Volume Upper Volume **(Vupp)**	244 L
Live storage volume at internal bypass **(Vstor)**	1117 L

3.2 Catchment Sediment Loading

Estimated TSS Concentration Impervious Roof **(TSSroof)**	100 kg/ha/year
Estimated TSS Concentration Impervious Road **(TSSroad)**	300 kg/ha/year
Estimated TSS Concentration Pervious Area **(TSSper)**	200 kg/ha/year
Estimated Total TSS Load **(TSSload)**	24 kg/year

3.3 Treatment Efficiencies

Pre-treatment Efficiency **(EFFpre)**	0 %
System Efficiency **(EFFsys)**	75 %

3.4 Maintenance Requirements

Estimated number of cleans per annum **(nCleans)**	0.58
Estimated Maintenance Frequency **(Mfreq)**	20.690 months

4.0 Design Summary

Design Water Quality Treatment Flowrate (**Qwq**)	2.264 L/s
StormFilter Design WQ Treatment flowrate (**QSF**)	2.850 L/s
StormFilter Design flowrate at internal bypass (**Qbypass**)	3.149 L/s
Number of StormFilter Cartridges required (**nTOTAL**)	3ea x 46cm Perlite cart(s)
Treatment Flux per cartridge (**FLUX**)	1.4 L/s/m^2
Restrictor Disc Size (**d**)	25.000 mm
Maximum Hydraulic Effect (**hmax**)	0.700 m
Estimated Maintenance Frequency (**Mfreq**)	21 months

INSTRUCTIONS

1.0. Use the rational method to compute the water quality design storm peak runoff flow rate. Values with blue text require user input. Values in red text are automatically calculated. Values with black text remain constant.

1.1 Input the appropriate runoff co-efficient for each sub-catchment.

Use C=1.0 for impervious roof surfaces runoff co-efficient[1]

Use C=1.0 for impervious paved surfaces runoff co-efficient[1]

Use C=0.4 for pervious surfaces with clay soils runoff co-efficient & C=0.3 for all other pervious surfaces[1]

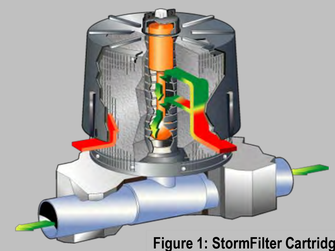

Figure 1: StormFilter Cartridge

1.2 Input the appropriate catchment area for each sub-catchment.

Enter impervious roof surface catchment area

Enter impervious paved surfaces catchment area

Enter pervious grassed/landscaped surfaces catchment area

Total catchment area *i.e. Acatch = Aroof + Aroad + Aper*

Product of catchment areas & runoff co-efficients *i.e. CA = (Croof x Aroof) + (Croad x Aroad) + (Cper x Aper)*

1.3 Input rainfall intensity

Rainfall intensity of 10mm/hr to be used for StormFilter water quality treatment within Auckland Council boundaries[1]

1.4 Compute the water quality design storm peak runoff flow rate via Rational Method

i.e. Q = f.C.i.A

$$Q = 0.111 d^{2.06} \Delta h^{0.5}$$

$[Q]$=L min^{-1}; $[d]$=mm; $[h]$=m

Figure 2: StormFilter Stage Discharge Equation [2]

2.0. Use the stormfilter stage-discharge equation to calculate the StormFilter peak treatment flowrate.

Enter cartridge filtration media *i.e. Perlite or ZPG*

Enter cartridge height *i.e. 69cm / 46cm / 30cm*

Enter restrictor disc size, refer table below for max disc diameter

Cart Height (cm)	Actual Height (m)	Priming Depth (m)	Max Disc Diam. (mm)	Max. Design Q (L/s)	Filter Bed Area (m^2)	Flow Rate (L/s/m^2)	Bed Depth (mm)	Media Volume (m^3)	Flow Rate (L/s/m^3)
30	0.305	0.27	22.70	0.63	0.460	1.37	175	0.052	12.0
46	0.457	0.43	25.00	0.95	0.689	1.38	175	0.078	12.1
69	0.686	0.66	27.60	1.42	1.034	1.37	175	0.118	12.1

Table 1. StormFilter Cartridge Specifics [3]

Compute the Stormfilter peak treatment flowrate at internal bypass per cartridge via the StormFilter stage-discharge equation

Compute the number of actual StormFilter cartridges required i.e. nCart = QWQ / QCART

Compute the number (rounded up to whole number) of StormFilter cartridges required

Compute the Stormfilter peak treatment flowrate at internal bypass via the StormFilter stage-discharge equation

3.0 Estimate sediment mass loading (Refer sheet '2. Mass Load Calcs' for more details)

3.1 Use tables 2 & 3 below to fill in StormFilter Dimensions based on number of cartridges as calculated in cl 2.2 above

3.2 Use table 3 below to fill in estimated TSS concentration. For roads with ≥25,000vpd, use minimum 600kg/ha/yr

3.3 Use 0% pretreatment for vaults/manholes with no forebay. Use 10-15% pretreatmnet for vaults/manholes with forebays. Use 50% pretreatment for upstream GPT ie EnviroPod. Use 75%-90% system efficiency

Std Manhole Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
1050	1.00	0.77	0.77	1	1.00	N/A	N/A	N/A
1200	1.00	1.03	1.03	3	1.00	0.76	0.76	2
1500	1.00	1.67	1.67	4	1.00	1.39	1.39	3
1800	1.00	2.44	2.44	7	1.00	1.83	1.83	5
2050	1.00	3.20	3.20	9	1.00	2.80	2.80	7

Table 2: Standard Stormwater360 Manhole Dimensions

Std Vault Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
3.4 L x 1.5 W x 1.8 D	2.85	1.50	4.28	11	2.30	1.80	4.14	8
4.5 L x 1.5 W x 1.8 D	3.95	1.50	5.93	17	3.40	1.50	5.10	14
4.2 L x 2.0 W x 1.8 D	3.95	1.95	7.70	23	3.40	2.10	7.14	18
5.6 L x 2.0 W x 1.8 D	5.05	1.95	9.85	31	4.50	2.10	9.45	26
5.6 L x 2.4 W x 1.8 D	5.05	2.40	12.12	39	4.50	2.10	9.45	27
6.2 L x 2.4 W x 1.8 D	5.60	2.40	13.44	44	4.50	2.40	10.80	33

Table 3: Standard Stormwater360 Vault Dimensions

Land Use	TSS (kg/ha/yr)
Road	281 - 723
Commercial	242 - 1369
Residential (low)	60 - 340
Residential (high)	97 - 547
Terraced	133 - 755
Bush	26 - 146
Grass	80 - 588
Roof	50-110 *(1)*
Pasture	103 - 583

Table 4: Suggested TSS loads[4]

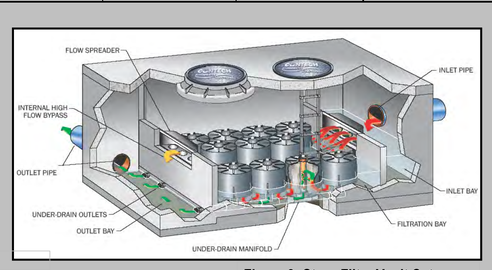

Figure 3: StormFilter Vault Cutaway

References

1. Stormwater360 StormFilter: Interim Proprietary Device Evaluation, Part 1 – Air, Land and Water Plan Evaluation, Auckland Council, 24th August 2015.
2. Derived from Stormwater Management Inc., Technical Publication PD-04-002.0
3. Contech Stormwater Solutions, StormFilter Product Design Manual.
4. Table 4-4, Technical Publication 10, 2nd Edition, May 2003, Auckland Regional Council

CSF 0052; StormFilter Flow-Based Sizing - Auckland Council Method

Stormwater360

Project Name	41-43 Brigham Creek Road		**Location**	Auckland	
Job #	6652	**Device #** SF 2	**Option #**	A	**Revision #** RA
Author	Matthew Howes		**Date**	27 August 2021	

CALCULATIONS - Please Read Instructions First

1.0 Water Quality Design Storm Peak Runoff Flowrate (RATIONAL METHOD)

1.1 Runoff Co-efficients

Coefficient of Impervious Roof **(Croof)**	1.00
Coefficient of Impervious Road **(Croad)**	1.00
Coefficient of Pervious Area **(Cper)**	0.40

1.2 Catchment Areas

Area Impervious Roof **(Aroof)**	0	m^2
Area Impervious Road **(Aroad)**	839	m^2
Area Pervious Area **(Aper)**	0	m^2
Area Total Catchment **(Acatch)**	839	m^2
Product of Area & Coefficients **(CA)**	839	m^2

1.3 Rainfall Intensity

Water Quality Rainfall Intensity (**iWQ**)	10	mm/hr

1.4 Water Quality Design Storm Peak Runoff Flowrate

Design Water Quality Treatment Flowrate (**Qwq**)	2.331	L/s

2.0 StormFilter Peak Treatment Flowrate

2.1 Preliminary

Cartridge Media **(Media)**	Perlite	
Cartridge Height **(Hcart)**	46	cm
Diameter Disc Orifice **(d)**	25.0	mm
Internal bypass weir height **(Hweir)**	0.56	m
Priming depth **(Hprime)**	0.43	m
Area of a Cartridge **(Acart)**	0.181	m^2

2.2 StormFilter Cartridge Peak Treatment Flowrate

StormFilter cartridge stage-discharge equation	$=0.111d^{2.06}\Delta h^{0.5}$	L/min
Design treatment flowrate per cartridge **(Qcart)**	0.950	L/s/cart
Number (actual) of StormFilter cartridges required	2.453	cart(s)
Number (rounded) of StormFilter cartridges required (**nCart**)	3	cart(s)
Design StormFilter Treatment Flowrate (**QSF**)	2.850	L/s

3.0 Estimate Sediment Mass Loading

3.1 StormFilter Manhole/Vault Dimensions

Length Cartridge Bay **(Lbay)**	1.000	m
Width Cartridge Bay **(Wbay)**	2.440	m
Area Cartridge Bay **(Abay)**	2.440	m^2
Total area of Cartridges **(Acarts)**	0.543	m^2
Area Lower Volume **(Alow)**	1.897	m^2
Volume Lower Volume **(Vlow)**	873	L
Area Upper Volume **(Aupp)**	2.440	m^2
Volume Upper Volume **(Vupp)**	244	L
Live storage volume at internal bypass **(Vstor)**	1117	L

3.2 Catchment Sediment Loading

Estimated TSS Concentration Impervious Roof **(TSSroof)**	100	kg/ha/year
Estimated TSS Concentration Impervious Road **(TSSroad)**	300	kg/ha/year
Estimated TSS Concentration Pervious Area **(TSSper)**	200	kg/ha/year
Estimated Total TSS Load **(TSSload)**	25	kg/year

3.3 Treatment Efficiencies

Pre-treatment Efficiency **(EFFpre)**	0	%
System Efficiency (**EFFsys**)	75	%

3.4 Maintenance Requirements

Estimated number of cleans per annum **(nCleans)**	0.59	
Estimated Maintenance Frequency **(Mfreq)**	20.339	months

4.0 Design Summary

Design Water Quality Treatment Flowrate (**Qwq**)	2.331	L/s
StormFilter Design WQ Treatment flowrate (**QSF**)	2.850	L/s
StormFilter Design flowrate at internal bypass (**Qbypass**)	3.149	L/s
Number of StormFilter Cartridges required (**nTOTAL**)	3ea x 46cm Perlite cart(s)	
Treatment Flux per cartridge (**FLUX**)	1.4	L/s/m²
Restrictor Disc Size (**d**)	25.000	mm
Maximum Hydraulic Effect (**hmax**)	0.700	m
Estimated Maintenance Frequency (**Mfreq**)	20	months

INSTRUCTIONS

1.0. Use the rational method to compute the water quality design storm peak runoff flow rate. Values with blue text require user input. Values in red text are automatically calculated. Values with black text remain constant.

1.1 Input the appropriate runoff co-efficient for each sub-catchment.

Use C=1.0 for impervious roof surfaces runoff co-efficient[1]

Use C=1.0 for impervious paved surfaces runoff co-efficient[1]

Use C=0.4 for pervious surfaces with clay soils runoff co-efficient & C=0.3 for all other pervious surfaces[1]

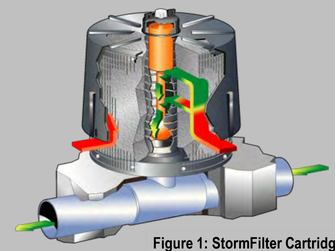

Figure 1: StormFilter Cartridge

1.2 Input the appropriate catchment area for each sub-catchment.

Enter impervious roof surface catchment area

Enter impervious paved surfaces catchment area

Enter pervious grassed/landscaped surfaces catchment area

Total catchment area *i.e. Acatch = Aroof + Aroad + Aper*

Product of catchment areas & runoff co-efficients *i.e. CA = (Croof x Aroof) + (Croad x Aroad) + (Cper x Aper)*

1.3 Input rainfall intensity

Rainfall intensity of 10mm/hr to be used for StormFilter water quality treatment within Auckland Council boundaries[1]

1.4 Compute the water quality design storm peak runoff flow rate via Rational Method

i.e. Q = f.C.i.A

$$Q = 0.111 d^{2.06} \Delta h^{0.5}$$

$[Q]$=L min^{-1}; $[d]$=mm; $[h]$=m

Figure 2: StormFilter Stage Discharge Equation [2]

2.0. Use the stormfilter stage-discharge equation to calculate the StormFilter peak treatment flowrate.

Enter cartridge filtration media *i.e. Perlite or ZPG*

Enter cartridge height *i.e. 69cm / 46cm / 30cm*

Enter restrictor disc size, refer table below for max disc diameter

Cart Height (cm)	Actual Height (m)	Priming Depth (m)	Max Disc Diam. (mm)	Max. Design Q (L/s)	Filter Bed Area (m^2)	Flow Rate (L/s/m^2)	Bed Depth (mm)	Media Volume (m^3)	Flow Rate (L/s/m^3)
30	0.305	0.27	22.70	0.63	0.460	1.37	175	0.052	12.0
46	0.457	0.43	25.00	0.95	0.689	1.38	175	0.078	12.1
69	0.686	0.66	27.60	1.42	1.034	1.37	175	0.118	12.1

Table 1. StormFilter Cartridge Specifics [3]

Compute the Stormfilter peak treatment flowrate at internal bypass per cartridge via the StormFilter stage-discharge equation

Compute the number of actual StormFilter cartridges required i.e. nCart = QWQ / QCART

Compute the number (rounded up to whole number) of StormFilter cartridges required

Compute the Stormfilter peak treatment flowrate at internal bypass via the StormFilter stage-discharge equation

3.0 Estimate sediment mass loading (Refer sheet '2. Mass Load Calcs' for more details)

3.1 Use tables 2 & 3 below to fill in StormFilter Dimensions based on number of cartridges as calculated in cl 2.2 above

3.2 Use table 3 below to fill in estimated TSS concentration. For roads with ≥25,000vpd, use minimum 600kg/ha/yr

3.3 Use 0% pretreatment for vaults/manholes with no forebay. Use 10-15% pretreatmnet for vaults/manholes with forebays. Use 50% pretreatment for upstream GPT ie EnviroPod. Use 75%-90% system efficiency

Std Manhole Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
1050	1.00	0.77	0.77	1	1.00	N/A	N/A	N/A
1200	1.00	1.03	1.03	3	1.00	0.76	0.76	2
1500	1.00	1.67	1.67	4	1.00	1.39	1.39	3
1800	1.00	2.44	2.44	7	1.00	1.83	1.83	5
2050	1.00	3.20	3.20	9	1.00	2.80	2.80	7

Table 2: Standard Stormwater360 Manhole Dimensions

Std Vault Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
3.4 L x 1.5 W x 1.8 D	2.85	1.50	4.28	11	2.30	1.80	4.14	8
4.5 L x 1.5 W x 1.8 D	3.95	1.50	5.93	17	3.40	1.50	5.10	14
4.2 L x 2.0 W x 1.8 D	3.95	1.95	7.70	23	3.40	2.10	7.14	18
5.6 L x 2.0 W x 1.8 D	5.05	1.95	9.85	31	4.50	2.10	9.45	26
5.6 L x 2.4 W x 1.8 D	5.05	2.40	12.12	39	4.50	2.10	9.45	27
6.2 L x 2.4 W x 1.8 D	5.60	2.40	13.44	44	4.50	2.40	10.80	33

Table 3: Standard Stormwater360 Vault Dimensions

Land Use	TSS (kg/ha/yr)
Road	281 - 723
Commercial	242 - 1369
Residential (low)	60 - 340
Residential (high)	97 - 547
Terraced	133 - 755
Bush	26 - 146
Grass	80 - 588
Roof	50-110 *(1)*
Pasture	103 - 583

Table 4: Suggested TSS loads[4]

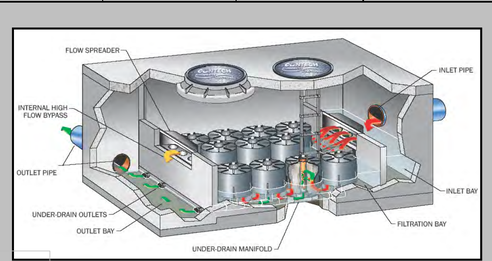

Figure 3: StormFilter Vault Cutaway

References

1. Stormwater360 StormFilter: Interim Proprietary Device Evaluation, Part 1 – Air, Land and Water Plan Evaluation, Auckland Council, 24th August 2015.
2. Derived from Stormwater Management Inc., Technical Publication PD-04-002.0
3. Contech Stormwater Solutions, StormFilter Product Design Manual.
4. Table 4-4, Technical Publication 10, 2nd Edition, May 2003, Auckland Regional Council

CSF 0052; StormFilter Flow-Based Sizing - Auckland Council Method

Stormwater360

Project Name	41-43 Brigham Creek Road		**Location**	Auckland	
Job #	6652	**Device #** SF 1	**Option #**	A	**Revision #** RA
Author	Matthew Howes		**Date**	27 August 2021	

CALCULATIONS - Please Read Instructions First

1.0 Water Quality Design Storm Peak Runoff Flowrate (RATIONAL METHOD)

1.1 Runoff Co-efficients

Coefficient of Impervious Roof **(Croof)**	1.00
Coefficient of Impervious Road **(Croad)**	1.00
Coefficient of Pervious Area **(Cper)**	0.40

1.2 Catchment Areas

Area Impervious Roof **(Aroof)**	0	m^2
Area Impervious Road **(Aroad)**	860	m^2
Area Pervious Area **(Aper)**	0	m^2
Area Total Catchment **(Acatch)**	860	m^2
Product of Area & Coefficients **(CA)**	860	m^2

1.3 Rainfall Intensity

Water Quality Rainfall Intensity (**iWQ**)	10	mm/hr

1.4 Water Quality Design Storm Peak Runoff Flowrate

Design Water Quality Treatment Flowrate (**Qwq**)	2.389	L/s

2.0 StormFilter Peak Treatment Flowrate

2.1 Preliminary

Cartridge Media **(Media)**	Perlite	
Cartridge Height **(Hcart)**	46	cm
Diameter Disc Orifice **(d)**	25.0	mm
Internal bypass weir height **(Hweir)**	0.56	m
Priming depth **(Hprime)**	0.43	m
Area of a Cartridge **(Acart)**	0.181	m^2

2.2 StormFilter Cartridge Peak Treatment Flowrate

StormFilter cartridge stage-discharge equation	$=0.111d^{2.06}\Delta h^{0.5}$	L/min
Design treatment flowrate per cartridge **(Qcart)**	0.950	L/s/cart
Number (actual) of StormFilter cartridges required	2.515	cart(s)
Number (rounded) of StormFilter cartridges required (**nCart**)	3	cart(s)
Design StormFilter Treatment Flowrate (**QSF**)	2.850	L/s

3.0 Estimate Sediment Mass Loading

3.1 StormFilter Manhole/Vault Dimensions

Length Cartridge Bay **(Lbay)**	1.000	m
Width Cartridge Bay **(Wbay)**	2.440	m
Area Cartridge Bay **(Abay)**	2.440	m^2
Total area of Cartridges **(Acarts)**	0.543	m^2
Area Lower Volume **(Alow)**	1.897	m^2
Volume Lower Volume **(Vlow)**	873	L
Area Upper Volume **(Aupp)**	2.440	m^2
Volume Upper Volume **(Vupp)**	244	L
Live storage volume at internal bypass **(Vstor)**	1117	L

3.2 Catchment Sediment Loading

Estimated TSS Concentration Impervious Roof **(TSSroof)**	100	kg/ha/year
Estimated TSS Concentration Impervious Road **(TSSroad)**	300	kg/ha/year
Estimated TSS Concentration Pervious Area **(TSSper)**	200	kg/ha/year
Estimated Total TSS Load **(TSSload)**	26	kg/year

3.3 Treatment Efficiencies

Pre-treatment Efficiency **(EFFpre)**	0	%
System Efficiency (**EFFsys**)	75	%

3.4 Maintenance Requirements

Estimated number of cleans per annum **(nCleans)**	0.61	
Estimated Maintenance Frequency **(Mfreq)**	19.672	months

4.0 Design Summary

Design Water Quality Treatment Flowrate (**Qwq**)	2.389	L/s
StormFilter Design WQ Treatment flowrate (**QSF**)	2.850	L/s
StormFilter Design flowrate at internal bypass (**Qbypass**)	3.149	L/s
Number of StormFilter Cartridges required (**nTOTAL**)	3ea x 46cm Perlite cart(s)	
Treatment Flux per cartridge (**FLUX**)	1.4	L/s/m²
Restrictor Disc Size (**d**)	25.000	mm
Maximum Hydraulic Effect (**hmax**)	0.700	m
Estimated Maintenance Frequency (**Mfreq**)	20	months

INSTRUCTIONS

1.0. Use the rational method to compute the water quality design storm peak runoff flow rate. Values with blue text require user input. Values in red text are automatically calculated. Values with black text remain constant.

1.1 Input the appropriate runoff co-efficient for each sub-catchment.

Use C=1.0 for impervious roof surfaces runoff co-efficient[1]

Use C=1.0 for impervious paved surfaces runoff co-efficient[1]

Use C=0.4 for pervious surfaces with clay soils runoff co-efficient & C=0.3 for all other pervious surfaces[1]

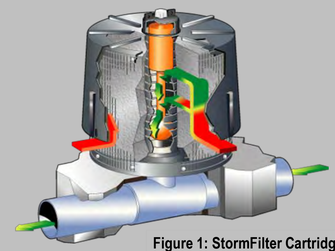

Figure 1: StormFilter Cartridge

1.2 Input the appropriate catchment area for each sub-catchment.

Enter impervious roof surface catchment area

Enter impervious paved surfaces catchment area

Enter pervious grassed/landscaped surfaces catchment area

Total catchment area *i.e. Acatch = Aroof + Aroad + Aper*

Product of catchment areas & runoff co-efficients *i.e. CA = (Croof x Aroof) + (Croad x Aroad) + (Cper x Aper)*

1.3 Input rainfall intensity

Rainfall intensity of 10mm/hr to be used for StormFilter water quality treatment within Auckland Council boundaries[1]

1.4 Compute the water quality design storm peak runoff flow rate via Rational Method

i.e. Q = f.C.i.A

$$Q = 0.111 d^{2.06} \Delta h^{0.5}$$

$[Q]$=L min^{-1}; $[d]$=mm; $[h]$=m

Figure 2: StormFilter Stage Discharge Equation [2]

2.0. Use the stormfilter stage-discharge equation to calculate the StormFilter peak treatment flowrate.

Enter cartridge filtration media *i.e. Perlite or ZPG*

Enter cartridge height *i.e. 69cm / 46cm / 30cm*

Enter restrictor disc size, refer table below for max disc diameter

Cart Height (cm)	Actual Height (m)	Priming Depth (m)	Max Disc Diam. (mm)	Max. Design Q (L/s)	Filter Bed Area (m^2)	Flow Rate (L/s/m^2)	Bed Depth (mm)	Media Volume (m^3)	Flow Rate (L/s/m^3)
30	0.305	0.27	22.70	0.63	0.460	1.37	175	0.052	12.0
46	0.457	0.43	25.00	0.95	0.689	1.38	175	0.078	12.1
69	0.686	0.66	27.60	1.42	1.034	1.37	175	0.118	12.1

Table 1. StormFilter Cartridge Specifics [3]

Compute the Stormfilter peak treatment flowrate at internal bypass per cartridge via the StormFilter stage-discharge equation

Compute the number of actual StormFilter cartridges required i.e. nCart = QWQ / QCART

Compute the number (rounded up to whole number) of StormFilter cartridges required

Compute the Stormfilter peak treatment flowrate at internal bypass via the StormFilter stage-discharge equation

3.0 Estimate sediment mass loading (Refer sheet '2. Mass Load Calcs' for more details)

3.1 Use tables 2 & 3 below to fill in StormFilter Dimensions based on number of cartridges as calculated in cl 2.2 above

3.2 Use table 3 below to fill in estimated TSS concentration. For roads with ≥25,000vpd, use minimum 600kg/ha/yr

3.3 Use 0% pretreatment for vaults/manholes with no forebay. Use 10-15% pretreatmnet for vaults/manholes with forebays. Use 50% pretreatment for upstream GPT ie EnviroPod. Use 75%-90% system efficiency

Std Manhole Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
1050	1.00	0.77	0.77	1	1.00	N/A	N/A	N/A
1200	1.00	1.03	1.03	3	1.00	0.76	0.76	2
1500	1.00	1.67	1.67	4	1.00	1.39	1.39	3
1800	1.00	2.44	2.44	7	1.00	1.83	1.83	5
2050	1.00	3.20	3.20	9	1.00	2.80	2.80	7

Table 2: Standard Stormwater360 Manhole Dimensions

Std Vault Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
3.4 L x 1.5 W x 1.8 D	2.85	1.50	4.28	11	2.30	1.80	4.14	8
4.5 L x 1.5 W x 1.8 D	3.95	1.50	5.93	17	3.40	1.50	5.10	14
4.2 L x 2.0 W x 1.8 D	3.95	1.95	7.70	23	3.40	2.10	7.14	18
5.6 L x 2.0 W x 1.8 D	5.05	1.95	9.85	31	4.50	2.10	9.45	26
5.6 L x 2.4 W x 1.8 D	5.05	2.40	12.12	39	4.50	2.10	9.45	27
6.2 L x 2.4 W x 1.8 D	5.60	2.40	13.44	44	4.50	2.40	10.80	33

Table 3: Standard Stormwater360 Vault Dimensions

Land Use	TSS (kg/ha/yr)
Road	281 - 723
Commercial	242 - 1369
Residential (low)	60 - 340
Residential (high)	97 - 547
Terraced	133 - 755
Bush	26 - 146
Grass	80 - 588
Roof	50-110 *(1)*
Pasture	103 - 583

Table 4: Suggested TSS loads[4]

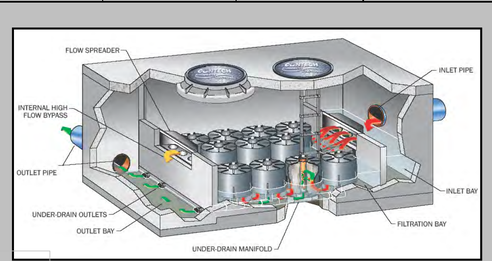

Figure 3: StormFilter Vault Cutaway

References

1. Stormwater360 StormFilter: Interim Proprietary Device Evaluation, Part 1 – Air, Land and Water Plan Evaluation, Auckland Council, 24th August 2015.
2. Derived from Stormwater Management Inc., Technical Publication PD-04-002.0
3. Contech Stormwater Solutions, StormFilter Product Design Manual.
4. Table 4-4, Technical Publication 10, 2nd Edition, May 2003, Auckland Regional Council

CSF 0052; StormFilter Flow-Based Sizing - Auckland Council Method

Stormwater360

Project Name	41-43 Brigham Creek Road		**Location**	Auckland	
Job #	6652	**Device #** SF 4	**Option #**	A	**Revision #** RA
Author	Matthew Howes		**Date**	27 August 2021	

CALCULATIONS - Please Read Instructions First

1.0 Water Quality Design Storm Peak Runoff Flowrate (RATIONAL METHOD)

1.1 Runoff Co-efficients

Coefficient of Impervious Roof **(Croof)**	1.00
Coefficient of Impervious Road **(Croad)**	1.00
Coefficient of Pervious Area **(Cper)**	0.40

1.2 Catchment Areas

Area Impervious Roof **(Aroof)**	0 m^2
Area Impervious Road **(Aroad)**	939 m^2
Area Pervious Area **(Aper)**	0 m^2
Area Total Catchment **(Acatch)**	939 m^2
Product of Area & Coefficients **(CA)**	939 m^2

1.3 Rainfall Intensity

Water Quality Rainfall Intensity (**iWQ**)	10 mm/hr

1.4 Water Quality Design Storm Peak Runoff Flowrate

Design Water Quality Treatment Flowrate (**Qwq**)	2.608 L/s

2.0 StormFilter Peak Treatment Flowrate

2.1 Preliminary

Cartridge Media **(Media)**	Perlite
Cartridge Height **(Hcart)**	46 cm
Diameter Disc Orifice **(d)**	25.0 mm
Internal bypass weir height **(Hweir)**	0.56 m
Priming depth **(Hprime)**	0.43 m
Area of a Cartridge **(Acart)**	0.181 m^2

2.2 StormFilter Cartridge Peak Treatment Flowrate

StormFilter cartridge stage-discharge equation	$=0.111d^{2.06}\Delta h^{0.5}$ L/min
Design treatment flowrate per cartridge **(Qcart)**	0.950 L/s/cart
Number (actual) of StormFilter cartridges required	2.746 cart(s)
Number (rounded) of StormFilter cartridges required (**nCart**)	3 cart(s)
Design StormFilter Treatment Flowrate (**QSF**)	2.850 L/s

3.0 Estimate Sediment Mass Loading

3.1 StormFilter Manhole/Vault Dimensions

Length Cartridge Bay **(Lbay)**	1.000 m
Width Cartridge Bay **(Wbay)**	2.440 m
Area Cartridge Bay **(Abay)**	2.440 m^2
Total area of Cartridges **(Acarts)**	0.543 m^2
Area Lower Volume **(Alow)**	1.897 m^2
Volume Lower Volume **(Vlow)**	873 L
Area Upper Volume **(Aupp)**	2.440 m^2
Volume Upper Volume **(Vupp)**	244 L
Live storage volume at internal bypass **(Vstor)**	1117 L

3.2 Catchment Sediment Loading

Estimated TSS Concentration Impervious Road **(TSSroof)**	100 kg/ha/year
Estimated TSS Concentration Impervious Road **(TSSroad)**	300 kg/ha/year
Estimated TSS Concentration Pervious Area **(TSSper)**	200 kg/ha/year
Estimated Total TSS Load **(TSSload)**	28 kg/year

3.3 Treatment Efficiencies

Pre-treatment Efficiency **(EFFpre)**	0 %
System Efficiency **(EFFsys)**	75 %

3.4 Maintenance Requirements

Estimated number of cleans per annum **(nCleans)**	0.66
Estimated Maintenance Frequency **(Mfreq)**	18.182 months

4.0 Design Summary

Design Water Quality Treatment Flowrate (**Qwq**)	2.608 L/s
StormFilter Design WQ Treatment flowrate (**QSF**)	2.850 L/s
StormFilter Design flowrate at internal bypass (**Qbypass**)	3.149 L/s
Number of StormFilter Cartridges required (**nTOTAL**)	3ea x 46cm Perlite cart(s)
Treatment Flux per cartridge (**FLUX**)	1.4 L/s/m^2
Restrictor Disc Size (**d**)	25.000 mm
Maximum Hydraulic Effect (**hmax**)	0.700 m
Estimated Maintenance Frequency (**Mfreq**)	18 months

INSTRUCTIONS

1.0. Use the rational method to compute the water quality design storm peak runoff flow rate. Values with blue text require user input. Values in red text are automatically calculated. Values with black text remain constant.

1.1 Input the appropriate runoff co-efficient for each sub-catchment.

Use C=1.0 for impervious roof surfaces runoff co-efficient[1]

Use C=1.0 for impervious paved surfaces runoff co-efficient[1]

Use C=0.4 for pervious surfaces with clay soils runoff co-efficient & C=0.3 for all other pervious surfaces[1]

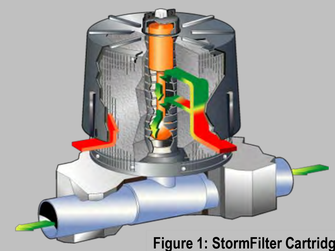

Figure 1: StormFilter Cartridge

1.2 Input the appropriate catchment area for each sub-catchment.

Enter impervious roof surface catchment area

Enter impervious paved surfaces catchment area

Enter pervious grassed/landscaped surfaces catchment area

Total catchment area *i.e. Acatch = Aroof + Aroad + Aper*

Product of catchment areas & runoff co-efficients *i.e. CA = (Croof x Aroof) + (Croad x Aroad) + (Cper x Aper)*

1.3 Input rainfall intensity

Rainfall intensity of 10mm/hr to be used for StormFilter water quality treatment within Auckland Council boundaries[1]

1.4 Compute the water quality design storm peak runoff flow rate via Rational Method

i.e. Q = f.C.i.A

$$Q = 0.111 d^{2.06} \Delta h^{0.5}$$

$[Q]$=L min^{-1}; $[d]$=mm; $[h]$=m

Figure 2: StormFilter Stage Discharge Equation [2]

2.0. Use the stormfilter stage-discharge equation to calculate the StormFilter peak treatment flowrate.

Enter cartridge filtration media *i.e. Perlite or ZPG*

Enter cartridge height *i.e. 69cm / 46cm / 30cm*

Enter restrictor disc size, refer table below for max disc diameter

Cart Height (cm)	Actual Height (m)	Priming Depth (m)	Max Disc Diam. (mm)	Max. Design Q (L/s)	Filter Bed Area (m^2)	Flow Rate (L/s/m^2)	Bed Depth (mm)	Media Volume (m^3)	Flow Rate (L/s/m^3)
30	0.305	0.27	22.70	0.63	0.460	1.37	175	0.052	12.0
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Table 1. StormFilter Cartridge Specifics [3]

Compute the Stormfilter peak treatment flowrate at internal bypass per cartridge via the StormFilter stage-discharge equation

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3.1 Use tables 2 & 3 below to fill in StormFilter Dimensions based on number of cartridges as calculated in cl 2.2 above

3.2 Use table 3 below to fill in estimated TSS concentration. For roads with ≥25,000vpd, use minimum 600kg/ha/yr

3.3 Use 0% pretreatment for vaults/manholes with no forebay. Use 10-15% pretreatmnet for vaults/manholes with forebays. Use 50% pretreatment for upstream GPT ie EnviroPod. Use 75%-90% system efficiency

Std Manhole Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
1050	1.00	0.77	0.77	1	1.00	N/A	N/A	N/A
1200	1.00	1.03	1.03	3	1.00	0.76	0.76	2
1500	1.00	1.67	1.67	4	1.00	1.39	1.39	3
1800	1.00	2.44	2.44	7	1.00	1.83	1.83	5
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Table 2: Standard Stormwater360 Manhole Dimensions

Std Vault Dimensions	Without forebay				With forebay			
	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts	Cart Bay Length (m)	Cart Bay Width (m)	Cart Bay Area (m^2)	Max Number Carts
3.4 L x 1.5 W x 1.8 D	2.85	1.50	4.28	11	2.30	1.80	4.14	8
4.5 L x 1.5 W x 1.8 D	3.95	1.50	5.93	17	3.40	1.50	5.10	14
4.2 L x 2.0 W x 1.8 D	3.95	1.95	7.70	23	3.40	2.10	7.14	18
5.6 L x 2.0 W x 1.8 D	5.05	1.95	9.85	31	4.50	2.10	9.45	26
5.6 L x 2.4 W x 1.8 D	5.05	2.40	12.12	39	4.50	2.10	9.45	27
6.2 L x 2.4 W x 1.8 D	5.60	2.40	13.44	44	4.50	2.40	10.80	33

Table 3: Standard Stormwater360 Vault Dimensions

Land Use	TSS (kg/ha/yr)
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Grass	80 - 588
Roof	50-110 *(1)*
Pasture	103 - 583

Table 4: Suggested TSS loads[4]

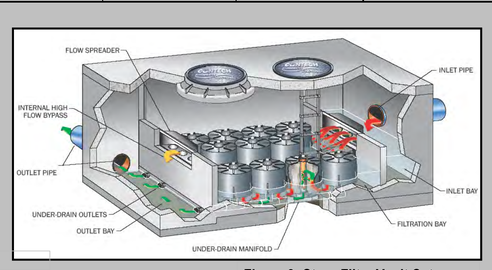

Figure 3: StormFilter Vault Cutaway

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2. Derived from Stormwater Management Inc., Technical Publication PD-04-002.0
3. Contech Stormwater Solutions, StormFilter Product Design Manual.
4. Table 4-4, Technical Publication 10, 2nd Edition, May 2003, Auckland Regional Council

Maven Associates	Job Number	Sheet	Rev
	210001	1	B
Job Title: 41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title: Outlet Structure 1-0 - Rock Riprap Calcs	AP	9/02/2022	WM

OUTLET 1-0 STRUCTURE - ROCK RIPRAP

Pipe diameter =	0.525	m	ks=	1.5	
Pipe gradient =	2.27	%			
Velocity =	3.01	m/s			
Froude Number Fo =	1.33				
Rock diameter =	174	mm	=> Use	**200**	mm (min 2 layers of aggregate)
Outfall width =	1.575	m	=> Use	**1.60**	m
Outfall length =	5.29	m	=> Use	**5.50**	m

5.5m LONG x 1.6m WIDE ROCK RIPRAP OUTLET
0.700m DEEP LAID ON COCONUT FIBRE1200 MAT - BIOCOIR
BC1200 OR EQUIVALENT WITH MINIMUM ROCK SIZE 350mmØ

Maven Associates

Job Number	Sheet	Rev	41-43 Brigham Creek Road, Hobsonville	Author	Date	Checked
210001	1	A	Calc Title: 100YR Demand - Predevelopment	JP	30/07/2021	WM

Rainfall Depth	ARI 100YR (mm)	
TP108 rainfall data	200	
Climate change Increase	233.6	(16.8% Increase)

	CN Number		**CN Number**	
Impervious area	98	Proposed Residential Lots	90.8	Equivalent CN - (70% impervious coverage, 30% pervious coverage)
Pervious	74	Proposed Roads	94.4	Equivalent CN - (85% impervious coverage, 15% pervious coverage)
		Proposed JOALS	98	Equivalent CN - (100% impervious coverage)

Catchment *letter*	**Catchment Area** *m2*	**CN**	**Peak Flow rate - 100YR ARI** *l/s*	**Cum. Flow** *l/s*
A1	1600	74	48.04	
	2700	98	104.71	152.74
A2	11700	74	351.27	
	500	98	19.39	370.66
A3	4600	74	138.11	
	3700	98	143.49	281.59
				804.99
B1	17800	74	534.41	
	4000	98	155.12	689.53
B2	16200	74	486.37	486.37
				1175.90
C1	8700	74	261.20	261.20
				261.20
D1	5500	74	165.13	
	1300	98	50.41	215.54
				215.54
E1	7600	74	228.17	
	500	98	19.39	247.56
				247.56
G1	2500	74	75.06	
	2500	98	96.95	172.01
G2	1300	74	39.03	39.03
				211.04

Maven Associates

Job Number	Sheet	Rev	41-43 Brigham Creek Road, Hobsonville	Author	Date	Checked
210001	1	B	Calc Title: 100YR Demand - Post-development	AP	20/01/2021	WM

Rainfall Depth	ARI 100YR (mm)	
TP108 rainfall data	200	
Climate change Increase	233.6	(16.8% Increase)

Pipe ks factor = 0.15 mm

	CN Number		**CN Number**	
Impervious area	98	Proposed Residential Lots	90.8	Equivalent CN - (70% impervious coverage, 30% pervious coverage)
Pervious	74	Proposed Roads	94.4	Equivalent CN - (85% impervious coverage, 15% pervious coverage)
		Proposed JOALS	98	Equivalent CN - (100% impervious coverage)

Catchment *letter*	**Catchment Area** *m2*	**CN**	**Peak Flow rate - 100YR ARI** *l/s*	**Cum. Flow** *l/s*	
A1	2000	74	60.05		
	6300	98	244.31		
A2	748	90.8	28.01		
A3	1796	90.8	67.24		
A4	1402	98	54.37		
A5	1387	90.8	51.93		
A8	2094	94.4	80.19		
A9	4257	98	165.09	**751.2**	FLOWS TO BRIGHAM CREEK RD CARRIAGEWAY
B1	5400	74	162.12		
	16400	98	635.99	**798.1**	REFER TO C464 SECTION G
B2	1562	90.8	58.48		
B3	1262	98	48.94		
B4	1819	98	70.54		
B5	1784	90.8	66.79		
B6	2173	90.8	81.36		
B7	2454	90.8	91.88		
B8	815	98	31.61		
B9	409	90.8	15.31		
B10	939	98	36.41		
B11	416	90.8	15.58	**1315.0**	REFER TO C463 SECTION D
B1	5400	74	162.12		
	16400	98	635.99		
B2 *0.5	781	90.8	29.24		
B3 *.05	631	98	24.47	**851.8**	REFER TO C464 SECTION F
C1	2213	94.4	84.74		
C2	2429	90.8	90.94		
C3	740	90.8	27.71	**203.4**	REFER TO C463 SECTION C
D1	2913	94.4	111.55		

D2	2508	90.8	93.90		
D3	1798	90.8	67.32		
D4	839	98	32.54		
D5	1852	90.8	69.34	**374.6**	REFER TO C463 SECTION B
E1	1832	94.4	70.15		
E2	2471	90.8	92.52		
E3	1877	90.8	70.28		
E4	860	98	33.35		
E5	930	94.4	35.61	**301.9**	REFER TO C463 SECTION A
F1	2357	90.8	88.25		
F2	390	94.4	14.93		
F3	1285	90.8	48.11	**151.3**	FLOWS TO 39 BRIGHAM CREEK RD
G1	1130	94.4	43.27		
G2	686	90.8	25.68		
G3	582	90.8	21.79		
G4	399	94.4	15.28		
G5	4259	94.4	163.09		
G6	686	74	20.60	**289.7**	REFER TO C463 SECTION E
H1	640	90.8	23.96		
H2	168	98	6.52	**30.5**	
I1	408	90.8	15.28	**15.3**	
J1	408	90.8	15.28	**30.6**	

Maven Associates

Job Number	Sheet	Rev	41-43 Brigham Creek Road, Hobsonville	Author	Date	Checked
210001	1	A	Calc Title: 10YR Flows - Predevelopment	AP	27/01/2022	WM

Rainfall Depth	ARI 10YR (mm)	
TP108 rainfall data	140	
Climate change Increase	163.52	(16.8% Increase)

	CN Number		**CN Number**	
Impervious area	98	Proposed Residential Lots	90.8	Equivalent CN - (70% impervious coverage, 30% pervious coverage)
Pervious	74	Proposed Roads	94.4	Equivalent CN - (85% impervious coverage, 15% pervious coverage)
		Proposed JOALS	98	Equivalent CN - (100% impervious coverage)

Catchment *letter*	**Catchment Area** *m2*	**CN**	**Peak Flow rate - 100YR ARI** *l/s*	**Cum. Flow** *l/s*
A1	1600	74	28.64	
	2700	98	73.15	101.79
A2	11700	74	209.40	
	500	98	13.55	222.95
				324.74
B1	22400	74	400.91	
	7700	98	208.61	609.52
B2	16200	74	289.94	289.94
				899.46
C1	8700	74	155.71	155.71
				155.71
D1	5500	74	98.44	
	1300	98	35.22	133.66
				133.66
E1	7600	74	136.02	
	500	98	13.55	149.57
				149.57
G1	2500	74	44.74	
	2500	98	67.73	112.48
G2	1300	74	23.27	23.27
				135.74

Combined Flows Onto 5 Mamari Rd = 1188.83 L/s

Maven Consulting		Job Number 210001	Sheet 5 OF 11	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	20/01/2022	WM

SECTION LOCATION: MAMARI ROAD

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

	Q=	$(AR^{2/3}S^{1/2})/n$	R=A/P
Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal Slope, S = **0.043** m/m

Section Location **MAMARI ROAD**

Depth=	0.13	m	
Width=		m	
S=	0.043	m/m	
A=	0.2131	m^2	
P=	3.86	m	
R=	0.055		
n=	0.020		
Velosity (V) R(2/3) S(1/2)/ n	1.50	m/sec	**DV= 0.20**
Channel Flow (Q) VxA	**320**	l/sec	
100 year peak discharge =	290	l/sec	OK

* Refer TP108 Modelling for Flow rates

Maven Consulting	Job Number 210001	Sheet 1 OF 11	Rev B
Job Title: 41-43 Brigham Creek Road, Whenuapai Calc Title: Post-development - 100YR Overland Flowpath	Author AP	Date 20/01/2022	Checked WM

SECTION LOCATION: ROAD 2

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

$Q = (AR^{2/3}S^{1/2})/n$ where $R = A/P$

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Conservative Longitudinal Slope, S = **0.027** m/m

Section Location **ROAD 2**

Depth=	0.12	m	
Width=		m	
S=	0.027	m/m	
A=	0.2486	m^2	
P=	4.26	m	
R=	0.058		
n=	0.020		
Velosity (V) R(2/3) S(1/2)/ n	1.23	m/sec	**DV= 0.15**
Channel Flow (Q) VxA	**307**	l/sec	
100 year peak discharge =	300	l/sec	OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 2 OF 11	Rev B
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	20/01/2022	WM

SECTION LOCATION: ROAD 3

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

$Q = (AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Conservative Longitudinal Slope, S =	**0.005**	m/m

Section Location	**ROAD 3**		
Depth=	0.18	m	
Width=		m	
S=	0.005	m/m	
A=	0.589	m^2	
P=	7.83	m	
R=	0.075		
n=	0.020		
Velosity (V) R(2/3) S(1/2)/ n	0.63	m/sec	**DV= 0.11**
Channel Flow (Q) VxA	**371**	l/sec	
100 year peak discharge =	370	l/sec	OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 3 OF 11	Rev B
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	20/01/2022	WM

SECTION LOCATION: ROAD 4

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

$Q = (AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Conservative Longitudinal Slope, S =	**0.005**	m/m

Section Location	**ROAD 4**		
Depth=	0.14	m	
Width=		m	
S=	0.005	m/m	
A=	0.34	m^2	
P=	4.96	m	
R=	0.069		
n=	0.020		
Velosity (V) R(2/3) S(1/2)/ n	0.59	m/sec	**DV= 0.08**
Channel Flow (Q) VxA	**201**	l/sec	
100 year peak discharge =	200	l/sec	OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 4 OF 11	Rev B
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	20/01/2022	WM

SECTION LOCATION: ROAD 5

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Conservative Longitudinal Slope, S =	**0.026**	m/m

Section Location **ROAD 5**

Depth=	0.21	m	
Width=		m	
S=	0.026	m/m	
A=	0.886	m^2	
P=	9.61	m	
R=	0.092		
n=	0.020		
Velosity (V) R(2/3) S(1/2)/ n	1.64	m/sec	**DV= 0.35**
Channel Flow (Q) VxA	**1457**	l/sec	
100 year peak discharge =	1310	l/sec	OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 6 OF 11	Rev B
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	20/01/2022	WM

SECTION LOCATION: ROAD 1 CREST SPILL

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal Slope, S = **0.005** m/m

Section Location **ROAD 1 CREST OVER TOP**

Depth=	0.24	m	
Width=		m	
S=	0.005	m/m	
A=	1.099	m^2	
P=	10.70	m	
R=	0.103		
n=	0.020		
Velosity (V) R(2/3) S(1/2)/ n	0.77	m/sec	DV= 0.19
Channel Flow (Q) VxA	**852**	l/sec	
100 year peak discharge =	852	l/sec	OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 7 OF 11	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	6/08/2021	WM

SECTION LOCATION: ROAD 1 CREST OVERTOP

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

	Q=	$(AR^{2/3}S^{1/2})/n$	R=A/P
Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

	S =	RL(start)-RL(end) / L	
		m	
	RL(end)	m	
	L	m	
Therefore	S=	**0.0125**	m/m

Section Location **ROAD 1 CREST OVER TOP**

Depth=	0.1	m
Width=		m
S=	0.013	m/m
A=	0.6	m^2
P=	2.60	m
R=	0.231	
n=	0.030	
Velosity (V) R(2/3) S(1/2)/ n	1.401	m/sec
Channel Flow (Q) VxA	**841**	l/sec
100 year peak discharge =	800	l/sec OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 8 OF 11	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Pre-development - 100YR Overland Flowpath	AP	6/08/2021	WM

SECTION LOCATION: 5 Mamari Road (pre-development)

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

	S =	RL(start)-RL(end) / L	
		m	
	RL(end)	m	
	L	m	
Therefore	S=	**0.035**	m/m

Section Location **5 Mamari (pre-development)**

Depth=	0.135	m
Width=		m
S=	0.035	m/m
A=	1.1932	m^2
P=	17.63	m
R=	0.068	
n=	0.030	
Velosity (V) R(2/3) S(1/2)/ n	1.035	m/sec
Channel Flow (Q) VxA	**1235**	l/sec
100 year peak discharge =	1180	l/sec OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 9 OF 11	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	6/08/2021	WM

SECTION LOCATION: 5 Mamari Road (post-development)

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

	S =	RL(start)-RL(end) / L	
		m	
	RL(end)	m	
	L	m	
Therefore	S=	**0.035**	m/m

Section Location **5 Mamari (post-development)**

Depth=	0.14	m
Width=		m
S=	0.035	m/m
A=	1.283	m^2
P=	18.28	m
R=	0.070	
n=	0.030	
Velosity (V) R(2/3) S(1/2)/ n	1.060	m/sec
Channel Flow (Q) VxA	**1360**	l/sec
100 year peak discharge =	1310	l/sec OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 10 OF 11	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	6/08/2021	WM

SECTION LOCATION: SECTION 1

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

$Q = (AR^{2/3}S^{1/2})/n$ $\quad R=A/P$

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

	S =	RL(start)-RL(end) / L	
		m	
	RL(end)	m	
	L	m	
Therefore	S=	**0.020**	m/m

Section Location **GRASS CHANNEL**

Depth=		m
Width=		m
S=	0.020	m/m
A=	0.32	m^2
P=	2.26	m
R=	0.141	
n=	0.020	
Velosity (V) R(2/3) S(1/2)/ n	1.917	m/sec
Channel Flow (Q) VxA	**613**	l/sec
100 year peak discharge =	690	l/sec OK

* Refer TP108 Modelling for Flow rates

Maven Consulting		Job Number 210001	Sheet 11 OF 11	Rev A
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Post-development - 100YR Overland Flowpath	AP	6/08/2021	WM

SECTION LOCATION: BRIGHAM CREEK ROAD CREST SPILL

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

	S =	RL(start)-RL(end) / L	
		m	
	RL(end)	m	
	L	m	
Therefore	S=	**0.005**	m/m

Section Location **BRIGHAM BRIGHAM CREEK ROAD CREST SPILL**

Depth=	0.1	m
Width=		m
S=	0.005	m/m
A=	1.6767	m^2
P=	27.95	m
R=	0.060	
n=	0.020	
Velosity (V) R(2/3) S(1/2)/ n	0.541	m/sec
Channel Flow (Q) VxA	**908**	l/sec
100 year peak discharge =	900	l/sec OK

* Refer TP108 Modelling for Flow rates

	Maven Associates	Job Number 210001	Sheet 1	Rev B
Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Wastewater Demand	AP	27/01/2022	WM

As per Watercare standards: 3 people per dwelling
PWWF = 1206 l/person/day
ks for uPVC = 0.6

Residential Discharge Rates

Design Wastewater flow allowance =	180	litres/person/day
Peaking Factor: Self-Cleansing Design Flow (PDWF) =	540	litres/person/day
Peaking Factor: Peak Design Flow (PWWF) =	1206	litres/person/day

Commercial Discharge Rates

Unknown and site area >10ha,<100ha =	1	L/s/ha (complete land area)
Peaking Factor: Self-Cleansing Design Flow (PDWF) =	2	L/s/ha (complete land area)
Peaking Factor: Peak Design Flow (PWWF) =	6.7	L/s/ha (complete land area)

CATCHMENT - 41-43 Brigham Creek Road (RESIDENTIAL)

Population	Dwellings	People	Occupancy
Proposed Residential Dwellings	230	3	690

Discharges	Persons	Rate l/p/day	Flow l/s
ADWF	690	180	1.44
PDWF	690	540	4.31
PWWF	690	1206	**9.63**

CATCHMENT - 45 Brigham Creek Road (COMMERICIAL - Supermarket)

Discharges	Area (ha)	Rate L/s/ha	Flow l/s
ADWF	3.00	1	3.00
PDWF	3.00	2	6.00
PWWF	3.00	6.7	**20.10**

CATCHMENT - 5 Mamari Rd Northern Half Catchment (RESIDENTIAL)

Population	Dwellings	People	Occupancy
Proposed Residential Dwellings	95	3	285

Discharges	Persons	Rate l/p/day	Flow l/s
ADWF	285	180	0.59
PDWF	285	540	1.78
PWWF	285	1206	**3.98**

TOTAL DISCHARGE (PWWF) (L/S) **33.71**

* Estimation based on a site area of 2.1ha and in comparision with proposed Lot density at 41-43 Brigham Creek Rd.
(Not allowed for wetland on-site)

Maven Associates	Job Number	Sheet	Rev	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
	210001	1	A	Calc Title: Pipe Capacity Check	JP	25.08.21	WM

Pipe ks factor = 1.5 mm

Pipe Line *number*	Catchment *letter*	Peak Cum. Flow rate *l/s*	Pipe dia *m*	Gradient *%*	Capacity *l/s*	Velocity *m/s*	Check OK
All lines	#41-43	9.63	0.150	0.75	13.47	0.76	OK
All lines	#41-43 + #45	29.73	0.225	0.55	33.98	0.85	OK

Maven Associates	Job Number	Sheet	Rev
	210001	1	A

Job Title	41-43 Brigham Creek Road, Whenuapai	Author	Date	Checked
Calc Title	Site Water Demand	AP	14/08/2021	JP

As per Watercare standards: 3 people per dwelling

Demand 220 l/person/day

Demand Rates

Average Demand = 220 litres/person/day

Peak Demand (5x) = 1100 litres/person/day

41-43 BRIGHAM CREEK ROAD

Population	Dwellings	People	Occupancy
Proposed Residential Dwellings	230	3	690

Demand	Persons	Rate l/p/day	Flow l/s
AD Water	690	220	1.76
PD Water	690	1100	8.78

Peak Demand	Persons	Rate l/p/day	Flow l/s
PD Water	690	1100	**8.78**

APPENDIX D: PERMEABLE PAVEMENT

JUNE 2021

+Firth EcoPave®

Permeable Paving Range

The Firth EcoPave® range will assist in the management of rain and stormwater runoff.

Firth FlowPave

Firth FlowPave Set

Firth PorousPave®

Firth Patio Paver

Firth Gobi® Block

Firth Grass Paver

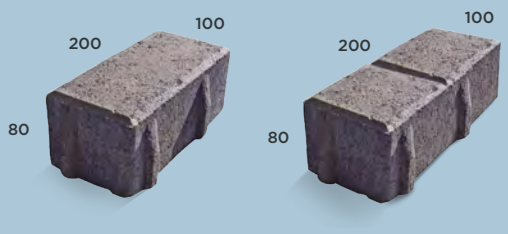
FIRTH ECOPAVE® RANGE

- Firth's EcoPave® range provides permeable paving solutions to assist storm water management, reduce run off, and filter pollutants from the water.
- The EcoPave system is made up of Permeable Pavers overlaying a storage medium consisting of Firth EnviroMix concrete or a specifically designed drainage aggregate. Geotextiles are used to separate the storage area from the bedding layer and the sub-grade.

> Together these elements create a highly functional system of permeability, without compromising on aesthetics.

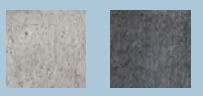
FOR TRAFFICABLE APPLICATIONS, DRIVEWAYS, JOAL'S, CARPARKS ETC

FIRTH FLOWPAVE & FIRTH FLOWPAVE SET



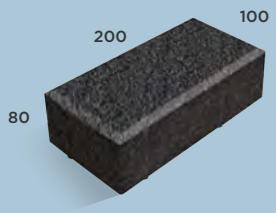
Firth FlowPave has enlarged nibs on all four sides which creates wider than usual gaps around each paver. This space allows water to filter through to the underlying drainage medium. The FlowPave Set adds a cobblestone effect to your design.

Dimensions:	200 x 100 x 80mm
Number per m²:	50
Permeability Rate:	5500mm/hr



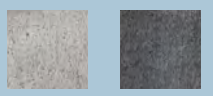
Natural Black Sands

FIRTH POROUSPAVE®



Firth PorousPave® has a very open texture which allows water to filter through it to the underlying drainage medium.

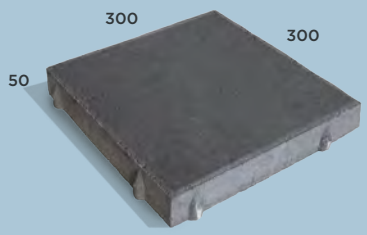
Dimensions:	200 x 100 x 80mm
Number per m²:	50
Permeability Rate:	1200mm/hr



Natural Black Sands

FOR RESIDENTIAL PEDESTRIAN USE ONLY

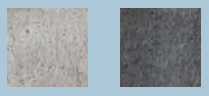
FIRTH PATIO PAVER (NORTH ISLAND ONLY)



Firth Patio Paver in a stylish square format has enlarged nibs on all four sides which allows water to filter through. This paver is only available in the North Island.

Dimensions:	300 x 300 x 50mm
Number per m²:	11.11
Permeability Rate:	1800mm/hr

Classic Collection



Natural Black Sands

Designer Collection

Natural Honed Black Sands Honed

FOR LIGHT RESIDENTIAL PARKING ONLY

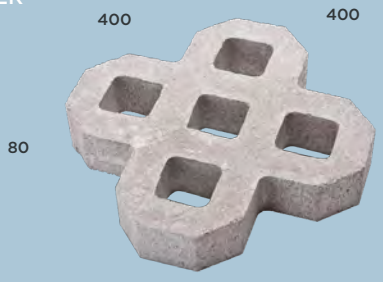
FIRTH GOBI® BLOCK

Firth Gobi® Block is a paved surface that's up to the task for high-traction requirements. Ideal for a semi-grassed look; as the design allows grass to grow through.

Dimensions:	200 x 100 x 80mm
Number per m²:	25
Permeability Rate:	subject to top soil and type of grass

Natural

FIRTH GRASS PAVER

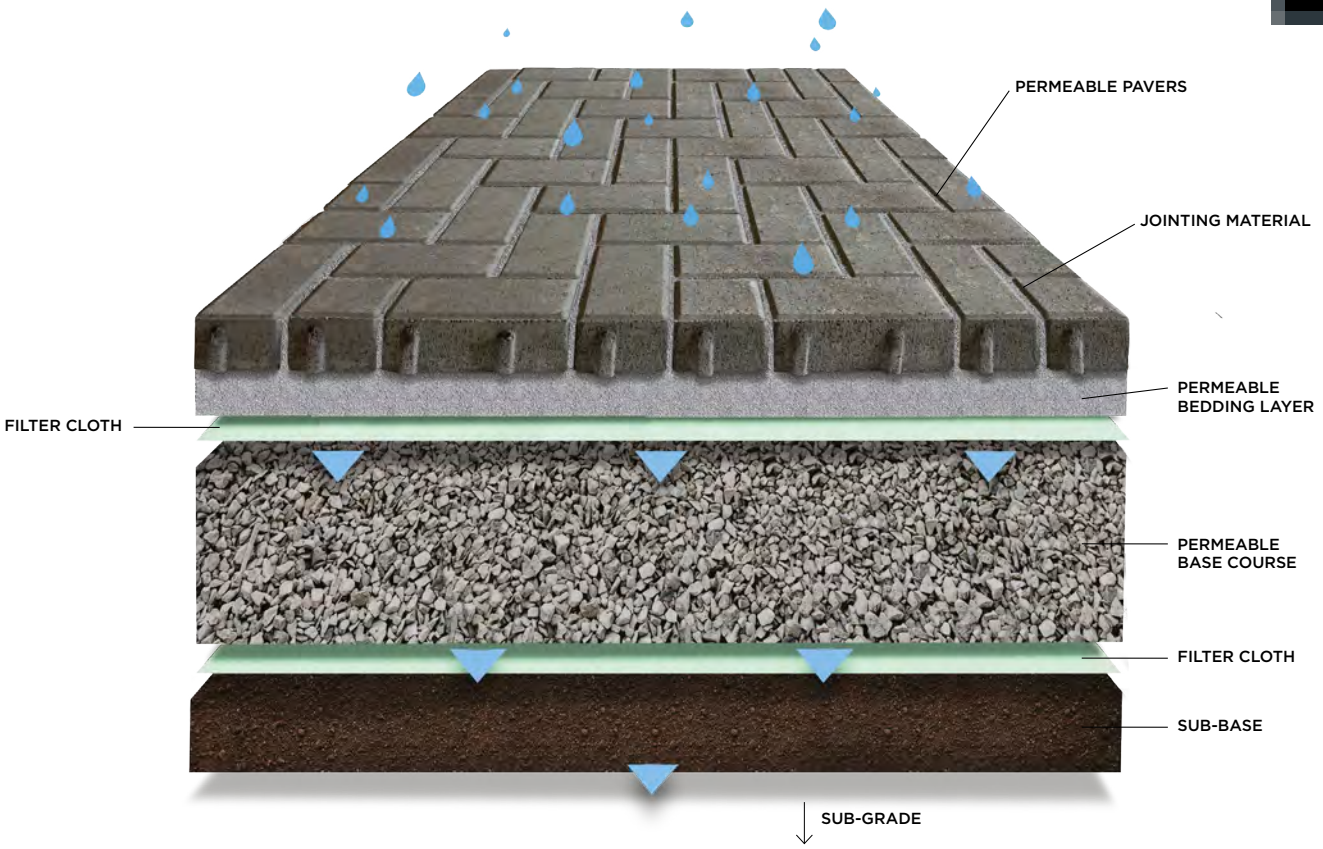


Firth Grass Pavers combine the natural and welcoming look of a grass lawn with the strength and durability of a paved surface. Permeability subject to top soil and type of grass.

Dimensions:	400 x 400 x 80mm
Number per m²:	6.25
Permeability Rate:	subject to top soil and type of grass

Natural

HOW THE PERMEABLE SYSTEM WORKS



COUNCIL RECOGNISED

Proven permeability of FlowPave 5500mm/hr as installed

Councils now require steps to be taken to reduce the effects that property development has on natural water runoff, stormwater and drainage. Firth's EcoPave is a council recognised paving system that will help to maintain the natural water balance of a property and reduces the need for retention structures.

WHY PERMEABLE PAVING?

- The Firth EcoPave® system reduces rainfall runoff from hard surfaces, decreasing the demand on drainage systems.
- Helps manage stormwater peak flows, by holding and releasing rainwater in a controlled manner
- The ideal solution for light to medium residential traffic applications, including carparks and driveways.
- Improves water quality through filtration and sedimentation, helping to filter out pollutants that contribute to water pollution.
- Firth EcoPave provides a variety of colours, shapes and textures and can often be useful to distinguish bus stops and pedestrian areas.
- Reduces the need for retention structures (eg. Ground sumps, ponds or dams) and maximizes land use by retaining water within the EcoPave system.

INSTALLATION

When using Firth's EcoPave Systems, Firth recommends the use of an accredited paving contractor to ensure the system is correctly installed to function effectively and meet council requirements.

MAINTENANCE

A properly designed, located, and constructed concrete block pavement will perform well for many years. A combination of regular inspection and light maintenance will ensure long term durability and performance.

FAQs

What's the difference between the Firth FlowPave 80mm paver and the Firth Porous paver 80mm?

The Firth FlowPave paver is a solid unit with enlarged spacer nibs (7mm) which widen the joints between the pavers to allow the runoff water to permeate through the joints. The Firth Porous Paver is like a no-fines concrete made with an aggregate chip which allows runoff water to permeate through the actual paver itself.

What's the difference between the installation of the Firth FlowPave 80mm and the Firth Porous paver 80mm?

The Firth FlowPave paver uses a chip for both the bedding and jointing material. The Firth Porous Paver uses sand for both the bedding and jointing material. Both pavers have either a suitable drainage aggregate or Firth Enviromix no-fines concrete sub-base.

Refer to **firth.co.nz** for your copy of the **Firth EcoPave® Permeable Paving Installation Guide.**

For more information on the **Firth EcoPave® range**, including the name and location of product suppliers and permeable paving installation contractors, or to obtain free training please contact the Firth Team on

0800 800 576.

CONCRETE & MASONRY PRODUCTS: A SUSTAINABLE BUILDING OPTION & SOLUTION

- ✓ Environmentally compliant manufacturing plants
- ✓ Surplus water and some aggregates recycled
- ✓ Low transport impacts
- ✓ Leftover concrete returned from construction sites
- ✓ Passive solar heated thermal mass makes completed buildings more energy-efficient
- ✓ Most wash water returned from construction sites
- ✓ Highly durable, low maintenance buildings and no rot
- ✓ High degree of noise control
- ✓ Inherent fire resistance
- ✓ Overall longer effective building life
- ✓ Demolished concrete can be recycled as hard fill or aggregate

APPENDIX E: RMA ECOLOGY's ELCOLOGICAL ASSESSMENT

41-43 Brigham Creek Road, Auckland

Ecological Effects Assessment for resource consent

Report prepared for

41-43 Brigham Creek Road JV Ltd

Prepared by

RMA Ecology Ltd

Report number and date

Job 2112

January 2022

BETTER ECOLOGICAL OUTCOMES

PREPARED FOR:

41-43 Brigham Creek Road JV Ltd

C/- The Property Group

Level 4

55 Shortland Street

Auckland 1010

Prepared by:	Graham Ussher Principal Ecologist
Reviewed and Authorised by:	Graham Ussher Principal Ecologist

Project No. 2112

Version date: January 2022

Version status: Rev 2

Citation:

RMA Ecology Ltd. January 2022. 41-43 Brigham Creek Road JV, Auckland: ecological effects assessment for resource consent (Rev 2). Report prepared for 41-43 Brigham Creek Road JV Ltd, Auckland. 25 pages.

RMA ECOLOGY LTD

BETTER ECOLOGICAL OUTCOMES

Executive Summary

41-43 Brigham Creek Road JV Ltd has engaged RMA Ecology Ltd to undertake an assessment of the ecological values and potential ecological effects of earthworks proposed for 41-43 Brigham Creek Road, Auckland, for the purpose of applying for resource consents.

Desktop analyses and field/site visits were used to determine the ecological values of terrestrial and freshwater areas within and surrounding the development footprint, as well as the significance of those values.

The site is located within a typical Auckland rural environment. The landform slopes gently to the south, with catchment watercourses in the general area discharging to the upper part of the Waitemata Harbour. The site supports one dwelling with substantial amenity gardens, and surrounding paddocks and fields that are used for stock grazing. Several appear to have been retired for several years with rank grasses and weedland establishing.

The site has been heavily modified by past farming activities, which have influenced the state and quality of indigenous communities and habitat for indigenous species on the site.

There are no streams on the site. There are also no wetlands, no indigenous vegetation, no SEAs and no plant or animal species of conservation significance. There is a wetland as defined under the RMA (but not an inland natural wetland under the NPS-FM) to the south-west of the site (off site), and the development design has taken this into account.

One native animal that could be present is the native copper skink, within the rough pasture and weedland areas of the eastern gully. This species is listed as Not Threatened, and this location (if it is present) would not constitute important or core habitat. All native lizards are protected under the Wildlife Act 1953. Where consent is granted under the RMA for the development of native lizard habitat, the salvage and relocation of lizards is required.

There are nine (9) old, large trees located on the eastern part of the property that could provide suitable roosting habitat for native boats. We have assessed this risk as low; the possibly means that protocols should be adopted around clearance of these trees to ensure that potential harm to bats (if present) are avoided.

There is no remnant or secondary regenerating native forest on the site and the vegetation present does not meet any of the qualifying criteria for ecological significance. Mature exotic trees and dense exotic scrub provide limited and low-quality nesting and food resources for birds, and at most benefit a few native birds that are neither threatened nor rare.

The engineering design proposes to retain generally the same catchment sizes pre versus post-development and the same flow rates. Surface water flows from the site into the south-western gully off the site where a wetland under the RMA is located will remain generally the same. There is no risk of complete or partial drainage to this wetland.

Potential adverse effects on copper skinks within the eastern gully system are assessed as very low, and will be minimised by the salvage and relocation of lizards prior to the commencement of vegetation clearance.

Recommendations:

1. An ecologist should undertake a physical mark out on site to ensure that potential habitat for copper skinks is clearly delineated on the ground, that proposed works avoid these features, and that a salvage for native lizards within this potential habitat is undertaken prior to (as part of) vegetation clearance.

2. Undertake a survey for bats in the nine old, large trees near the eastern part of the site immediately prior to felling of those trees in accordance with accepted practice for managing potential adverse effects on bats.

CONTENTS

1.0 Introduction

1.1 Background

This report provides an assessment of the ecological values and potential ecological effects of earthworks proposed for 41-43 Brigham Creek Road, Auckland (hereafter, 'the site').

The site is proposed to be developed as housing, with bulk earthworks proposed over the entire site (Figure 1). This report is for the purpose of applying for resource consents.

1.2 Purpose and scope

41-43 Brigham Creek Road JV Ltd has engaged RMA Ecology Ltd to undertake an assessment of the values of the site in terms of aquatic and terrestrial ecology[1] and an assessment of potential adverse effects arising from the proposed earthworks.

The approach included survey of terrestrial and freshwater areas and provides the following:

- Identification of sites of particular ecological significance (Significant Ecological Areas; SEA);
- Review of databases to identify the likelihood of species of conservation significance being present, with an emphasis on freshwater fish, native lizards, and plants and birds;
- Walkover survey to identify or validate the presence of native vegetation, especially areas that meet criteria for assessing ecological significance under the Auckland Unitary Plan (AUP);
- Walkover and stream-specific sampling (where access is feasible and flow exists) to:
  - Determine stream values, using qualitative scoring methods along multiple reaches of all accessible, flowing streams;
  - Map the boundaries of stream types (permanent, intermittent and ephemeral);
  - Map wetlands, ponds, and potential barriers to stream functioning (e.g. culverts);

This report contains the following:

- An overview of the methods used to assess the ecological values and the ecological significance of areas potentially affected by the development;
- A description of ecological values within the development footprint and immediate surrounds;
- An assessment of ecological significance of the development footprint and immediate surrounds, based on assessing the ecological values of the development area against:
  - significance criteria in the AUP; and
  - based on the presence of listed Significant Ecological Areas and/or Natural Stream Management Areas (NSMAs) in the AUP;
  - An assessment of the type and magnitude of potential effects associated with the development, construction and operational activities, including potential habitat loss and degradation, and direct mortality or injury of indigenous fauna where the rules of the AUP, for example E3, E15, E16 or E38 are triggered by development; and
  - Recommendations to address adverse effects.

[1] This report has been prepared in accordance with our letter of engagement dated 11 February 2021.

Figure 1. The investigations area (turquoise boundary), with location of wetland investigation soil cores and vegetation plots. Potential wetland areas in the eastern part of the site and in the southern and western parts of adjoining land (not on the site) were investigated for the presence of wetlands (yellow circles).

2.0 Methods

Desktop analyses and field/site visits were used to determine the ecological values of terrestrial, and freshwater areas within and surrounding the development footprint, as well as the significance of those values. This section of the report describes the methods used for desktop and field investigation locations.

2.1 Desktop assessment

A desktop assessment of the development footprint and surrounding area was undertaken to identify sites assessed as potentially having ecological values, as well as sites already listed as being ecologically significant based on a review of the AUP. Legacy District and Regional Plans were reviewed for completeness and to cross-verify against the descriptions and extents of features identified in the AUP.

These resources were also used, where available, to provide insight as to the reasons why areas were significant, and the ecological values they comprise. Areas with ecological values that were not identified or which were not listed as ecologically significant in the various reviewed documents were assessed against the significance criteria of the AUP (Schedule 3 – Significant Ecological Areas: Terrestrial Schedule).

The Auckland Council GIS was reviewed to identify existing vegetation, streams and overland flow paths present on the site and to establish an understanding of the ecological status of the waterways present. Maps of these existing features (streams and overland flow paths (categories 4000 m^2 to 3 ha and > 3 ha)) were then ground-truthed.

The following documents and databases were reviewed for the ecological assessment:

- New Zealand Freshwater Fish Database;
- NIWA Freshwater Biodiversity Database;
- National Amphibian and Reptile Database System (Herpetofauna) to gather information on lizard species that have been recorded in proximity to the project site; and
- Auckland Unitary Plan.

Any threatened species found were recorded and their threat status checked against the relevant national threatened species classification lists (Hitchmough et al. 2021, Robertson et al. 2016 and Dunn et al. 2018).

2.2 Field assessment

A site visit was undertaken on 11 March 2021 to assess the variety of ecosystems and the ecological values present within the development footprint.

A further site visit was undertaken on 21 December 2021 to obtain information within potential wetland areas within the site and on the property adjoining the southern boundary of the site. This included soils and vegetation plots. An assessment of bat habitat was also undertaken.

2.3 Aquatic ecology

The site walkover was carried out to assess and map all streams and wetlands within the site.

All waterways and flow paths were mapped as being permanent, intermittent or ephemeral based on the definitions in the AUP (see below). Photographs were taken and a general description of the waterway was undertaken to note characteristics including riparian species and cover, and connectivity to other waterways.

A general characterisation assessment of the mapped stream reaches and wetlands was also undertaken with key ecological features recorded.

The definitions of stream types within the AUP are listed below in italics.

Permanent river or stream

The continually flowing reaches of any river or stream.

Intermittent stream

Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:

a) it has natural pools;
b) it has a well-defined channel, such that the bed and banks can be distinguished;
c) it contains surface water more than 48 hours after a rain event which results in stream flow;
d) rooted terrestrial vegetation is not established across the entire cross-sectional width of the
e) channel;
f) organic debris resulting from flood can be seen on the floodplain; or
g) there is evidence of substrate sorting process, including scour and deposition.

Ephemeral stream

Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.

2.4 Terrestrial ecology

Vegetation was assessed across the site with a focus on the presence of indigenous species. Birds identified visually and audibly were recorded across the site, including native and introduced species. Potential food sources and nesting habitat were noted for the purpose of estimating the potential loss of resources associated with the planned development. The field survey included identification of habitats potentially occupied by native lizards, and an assessment of potential bat habitat[2]. The ecological investigation used the AUP SEA criteria (Sawyer & Stanley, 2012) to assess the significance of ecology values recorded from the site.

[2] Smith, D., Borkin, K., Jones, C., Lindberg, S., Davies, F., & Eccles, G. (2017). Effects of land transport activities on New Zealand's endemic bat populations: review of ecological and regulatory literature. NZ Transport Agency research report 623.

2.5 Wetlands

Wetlands were assessed using the definition within the Resource Management Act 1991:

- Wetland: permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions, including within the coastal marine area.

Wetlands on site were also assessed using the definition within the National Policy Statement on Freshwater Management 2020 (NPS-FM):

- Natural inland wetland: means a wetland (as defined in the Act) that is not:

  (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or

  (b) a geothermal wetland; or

  (c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.

The NPS-FM requires that any effects on natural inland wetlands are avoided, including a restriction on activities within a 10 m buffer around those wetlands, and controls on the level of potential adverse effects (from, for example, discharge of water or diversion of water) within a 100 m buffer around the wetland.

The methodology applied for the assessment of wetlands at this site was as follows:

1. Apply the Clarkson (et al. 2013)[3] method cited in the NPS-FM 2020 Wetland Assessment Protocol;
2. Assess soils by applying the criteria outlined in Fraser et al. (2018)[4] for identifying hydric (wetland) soils. This involved excavating a hole ca. 400 mm deep to assess and photograph soil moisture, topsoil structure, subsoil structure and presence of gleyed soils and mottling; and
3. When analysing data from the field plots, plots with a vegetation community that met the definition of improved pasture and were >50 % exotic pasture species dominant were excluded from being NPS-FM-level wetlands; the Clarkson method for the Rapid Test and/or Dominance Test/ Prevalence Test was then followed to assess whether an RMA-level wetland was present or not.

Assessment of plant indicator status was undertaken in accordance with Clarkson et al. 2021[5].

[3] Clarkson BR, Champion PD, Johnson PN, Bodmin KA, Forester I, Gerbeaux P, Reeves PN 2013. Wetland indicator status ratings for New Zealand species. Landcare Research, Hamilton.

[4] Fraser S, Singleton P, Clarkson B 2018. Hydric soils – field identification guide. Envirolink Tools Contract C09X1702. Manaaki Whenua – Landcare Research Contract Report LC3233 for Tasman District Council.

[5] Clarkson BR, Fitzgerald NB, Champion PD, Forester L, Rance BD 2021. New Zealand wetland plant indicator status ratings 2021: Data associated with Manaaki Whenua - Landcare Research contract report LC3975 for Hawke's Bay Regional Council.

3.0 Results

3.1 Ecological context

The site is located within a typical Auckland rural environment. The original natural ecology has been heavily modified or removed through past farming activities, and the general area around the development site, for the large part, supports exotic-dominated ecosystems, production farmland or recently converted farmland to residential developments.

The landform slopes gently to the south, with catchment watercourses in the general area discharging to the upper part of the Waitemata Harbour.

The site supports one dwelling with substantial amenity gardens, and surrounding paddocks and fields that are used for stock grazing. Several appear to have been retired for several years with rank grasses and weedland establishing.

Table 1 summarises the extent of stream and wetland within the site.

Table 1. Summary of stream lengths and wetland areas within the site.

Watercourse type	Length (m) or Area (m^2) within the site	Notes
Stream	nil	There is no feature on the site that meets the definition of a stream
Wetland	nil	There is no feature on the site that meets the definition of a wetland

3.2 Aquatic ecology

There are no streams on the site.

The land form is gently sloping, and the land use is currently in stock grazing, amenity gardens and retired agriculture/ horticulture.

The AUP predicted overland flow path model shows flow paths arising in the northern part of the site and discharging to the north, as well as several flow paths originating from the central and southern areas of the site and discharging to the south.

The northern part of the site has been extensively landscaped and no flow path is discernible. There is no stream in this location.

The southern part of the site supports two small, headwater slopes in the central and western portions that discharge overland flow into shallow gullies off the site to the south. There is no stream in these locations on the site (Plates 1-3).

The far eastern part of the site discharges overland flow to the south as well. At that location, there is a broad shallow flow path that discharges to the southern boundary, where it is impounded by a shallow excavated pond and bund created by plantings on the next-door property (see Plates 4-6). The flow path does not support a stream – there is no indication of a channel, sediment sorting, pools or floodplain, and the entire extent of the basin floor is well colonised by terrestrial plants.

The pond at the boundary has been created (if not through deliberate excavation), by a combination of cattle or animal trampling, and a row of planting across the boundary creating a bund that impounds surface flows behind it (see next section).

Plate 1. Western part of the site looking to the north (slightly upslope). The vegetation comprises exotic blackberry, inkweed, cocksfoot, ryegrass and kikuyu grass – all dryland terrestrial species.

Plate 2. Central part of the site looking to the north (upslope).

Plate 3. Central part of the site, looking south (downslope). Pasture is mainly Paspalum, cocksfoot and kikuyu.

Plate 4. Gully head of the eastern gully showing broad shallow bowl and weedy pasture grassland with privet, gorse, pampas, woolly nightshade and macrocarpa pine over kikuyu, cocksfoot, sweet vernal and ryegrass.

Plate 5. Mid-section of eastern gully.

Plate 6. Lower part of eastern gully just above the ponded section formed by the boundary bund. Within this area there are also nine (9) large old eucalyptus and macrocarpa pine trees, which may offer roosting areas for long-tailed bats.

3.3 Wetlands

As part of the entire site walkover, the Clarkson Rapid Test was applied to identify areas of possible wetland vegetation. Locations of particular interest were low-lying paddock areas and around flow paths.

Potential locations within the site were assessed, as were potential locations adjoining the site which may have been within 10 m of the site boundary, or where a catchment within the site was within 100 m of a potential wetland outside of the site where hydrological connections were possible.

Three potential wetland areas were identified (Figure 1), all of which were associated with headwater gullies. Further assessment of these was undertaken by applying the full Wetland Delineation Protocols in the NPS-FW (a derivation of the Clarkson et al. 2013 method).

The first potential wetland is at the base of the eastern gully (Eastern potential wetland area). Water pools there and the soils are pugged from stock damage. The 'pond' or seasonally wet area has been formed by a bund of arum lily that has been planted or has otherwise established along the boundary of the adjoining property, which has impounded surface flows down the gully (Plate 7).

Plate 7. Discharge point for the eastern gully, showing constructed pond and vegetation forming a bund which impounds water along the southern boundary.

Soil samples taken within the ponded area – as well as further up the gully (Plate 8) show no evidence of hydric soil characteristics (fine silts with no mottling and no high or low chroma colour change).

A vegetation plot undertaken at soil core 1 returned a Prevalence Index score which indicates a dryland plant community (Table 1).

By contrast, vegetation within the ponded area comprises mostly creeping buttercup (Ranunculus repens), water pepper (Persicaria hydropiper) and Yorkshire fog grass (Holcus lanatus), all of which are wetland facultative or wetland plants, contributing to a Prevalence Index score of less than 3 – which means the plant community is a wetland community.

When paired with the soils test, and the NPS-FM wetland classification flow chart, this area does not support the necessary characteristics (in particular hydric soils) to qualify as a wetland under the NPS-FM or the RMA. This site does not support a wetland.

There are no potential wetlands within 100 m of this gully.

Table 1. Results of the site assessment for vegetation plot 1.

Location	41-43 Brigham Creek Road			
Date	11 March 2021			
Common Name	Species Name	Wetland Status	Group score	Score (prevalence %)
White clover	Trifolium repens	FACU	4	50
Paspalum	Paspalum distichum	FACW	2	10
Ryegrass	Lolium perenne	UPL	5	25
Browntop	Agrostis capillaris	FACU	4	5
Wild carrot	Daucus carota	FACU	4	5
Creeping buttercup	Ranunculus repens	FAC	3	5
		Total		100
Rapid Test – Pass?	No			
Dominance Test – Pass?	No			
Hydric Soils and Wetland hydrology present?	Hydric – no Hydrology - no			
Prevalence Index	4.0			
Is it a wetland?	No Fails on soils and hydrology.			
Improved Pasture?	No – rough grazed			
Is it a NPS-FM wetland?	No			

The second site at which a potential wetland is present is off-site and is located approximately 60 m beyond the southern boundary of this subject site (Southern potential wetland area). The area was accessed in December 2021 to assess vegetation and soil status.

Southern wet area:

- Vegetation is dominated by Yorkshire fog (40 %), lotus (10 %) and sweet vernal (5 %), also with creeping buttercup (35 %), soft rush (10 %) and sorrel (2 %).
- Most of the stippling on the aerial photo (indicative of soft rush areas) above has either been removed by pasture maintenance since this aerial photo was taken, or is along the margins of the adjoining overland flow path; the potential wetland area is at the head of the gully and in this aerial is beneath the shading caused by the adjacent shelterbelt line.
- Soils are fine silts with no mottling and no dark or light low chroma colours in the top 400 mm (Plate 9).

- Overall, while the area is wetter than the surrounding basin sides and spurs, the soils are not hydric, and the vegetation is dominated by pasture grass species (Yorkshire fog, lotus and sweet vernal; which are part of paddock maintenance (pasture improvement) including weed control, fertiliser application and re-seeding) – meaning that the site does not qualify as a natural inland wetland under the NPS-FM nor as a wetland under the RMA.

Western wet area:

- Vegetation dominated by Yorkshire fog (55 %), lotus (5 %) and sweet vernal (5 %), with also creeping buttercup (10 %), soft rush (5 %), paspalum (10 %), sorrel (3 %) and bare ground (7 %).
- Soils are fine, moist, silts with light red mottling in the top 300 mm and a light low chroma colour change at 350 mm (see below). This qualifies this soil as a hydric (wetland) soil.
- Overall, while the area is wetter than the surrounding basin sides and spurs and the soils are hydric, the vegetation is dominated by pasture grass species (Yorkshire fog, lotus and sweet vernal; which are part of paddock maintenance (pasture improvement) including weed control, fertiliser application and re-seeding) – meaning that the site does not qualify as a natural inland wetland under the NPS-FM.
- The site does qualify as a wetland under the RMA.
- The closest point of the wetland to the proposed development at 41-43 Brigham Creek Road is 65 m.

See Plates 10-12 for a photo of the western wetland area, a photograph of a representative 2 m x 2 m portion of the wetland and a soil core taken within the wettest part of this western wetland area.

Plate 8. Soil cores within the eastern gully. See Figure 1 for locations. All soil cores show deep topsoils with no mottling or light or dark low chroma colours in the soils that might indicate wetland.

Plate 8 continued. Soil cores taken within the ponded area (cores 3-6) and a core taken outside of the basin on the nearby slope/ spur (Core 2). Core 3 is taken after summer and shows dry soils. Cores 4 – 6 are taken just after the wet season and show moist profiles. None of the cores show redox mottling in the upper 300 mm or dark or light low chroma colours within the top 400 mm that are at variance with the reference core. The cores indicate that the basin comprises accumulated fine sediments over underlying basement clays.

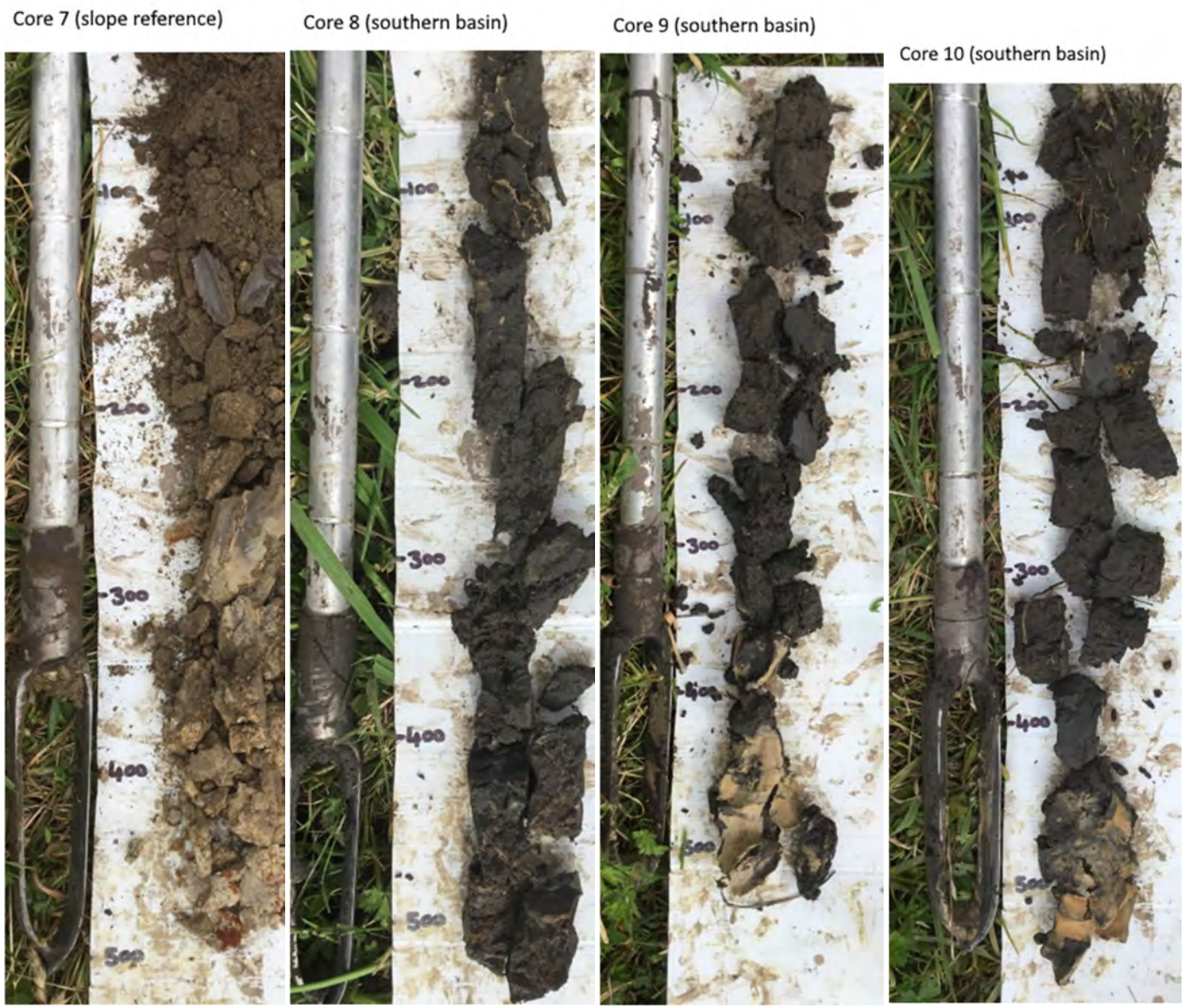


Plate 9. Soil cores taken within the Southern potential wetland area (cores 8-10 on Figure 1) and a core taken outside of the area on the nearby slope/ spur (Core 7). None show hydric soil indicators.

Plate 10- 12. Western wetland area (top left), a photograph of a representative 2 m x 2 m portion of the wetland (top right) and a soil core taken within the wettest part of this western wetland area (bottom left).

3.4 Terrestrial ecology

3.4.1 Vegetation

An assessment of historical and current aerial photos of the site indicates that the area has been actively farmed for an extensive period of time. The current ecological state of the site is extensively modified from its original, pre-human natural state.

Indigenous vegetation is absent.

There are no SEAs recognised by the AUP within the boundaries of the proposed development site.

No threatened plants were recorded from the site.

Vegetation is predominantly pasture, with shelter belts of radiata pine and she-oak (Casuarina sp.), small patches of exotic scrub, and exotic conifers and deciduous amenity trees.

Shelterbelts and pasture grassland were the only combination over much of the site. Where pasture had been left ungrazed for several years, inkweed (Phytolacca octandra), blackberry (Rubus fruticosus agg.) and kikuyu (Cenchrus clandesinus) were becoming dominant.

The eastern gully had the greatest amount of woody vegetation and diversity of plant species; however, all of this is exotic species, many of them invasive weeds. Dominant vegetation through this gully (apart from rough pasture) is radiata pine (Pinus radiata), macrocarpa pine (Cupressus macrocarpa), eucalyptus sp., pampas (Cortaderia sp.), gorse (Ulex europeaus), inkweed, woolly nightshade (Solanum mauritianum) and arum lily (Zantedeschia aethiopica).

The overall ecology values of the vegetation on the site is very low for habitat for native wildlife, and nil for native plant species.

3.4.2 Birdlife

Birdlife observed on site reflects the modified state of this rural environment. Of the 9 species recorded on site, two were native and are considered to be commonly recorded in rural areas of Auckland. Neither of the native species are classified as Not Threatened (Robertson, et al. 2016).

Native birds recorded on site include:

- Pukeko (Porphyrio porphyrio subsp. melanotus)
- Spur wing plover (Vanellus miles)

Exotic birds recorded from the site:

- Australian magpie (Gymnorhina tibicen)
- Blackbird (Turdus merula)
- Gold finch (Carduelis carduelis)
- Song thrush (Turdus philomelos)
- House sparrow (Passer domesticus)

- Indian myna (Acridotheres tristis)
- Welcome swallow (Hirundo neoxena neoxena)

Nesting habitat for birds on site comprises predominantly large, mature shelter belt and amenity trees which are considered to be of low ecological value (for birds) and do not qualify as being ecologically significant under the AUP ecological criteria[6]. Food resources for birds currently present on site come largely from mature weeds and exotic amenity trees which do not meet any of the Auckland Council ecological significance criteria.

3.4.3 Lizards

The Department of Conservation's National Herpetofauna Database has no records of native lizards within ca. 4 km of the site – and even then, those are species found in far less modified environments (forest gecko Mokopirirakau granulatus and ornate skink Oligosoma ornatum). The nearest record of a copper skink (Oligosoma aeneum; not threatened) – which is the species most likely to be present within rural, farmed areas – is 4.2 km to the west and dates to 1968.

Copper skinks can be found in a range of urban and rural environments, including those that have been extensively and recently modified. The majority of the subject site is managed as grazed pasture, however there are some areas of rank grass, scrubby weedland and fallen logs within the eastern gully area which are potential copper skink habitat. The habitat quality in this part of the site is moderate (a good range of refuges and similar to habitat in local rural areas where they have been previously recorded).

Based on the presence (albeit over a small area) of habitat and local records, we regard the likelihood of skinks being present on the site to be moderate. The site is unlikely to constitute core or important habitat for the maintenance of any local lizard populations (should they still exist in the surrounding landscape).

Prior to the removal of vegetation within the area of the site, a lizard salvage should be undertaken by a suitably qualified and experienced herpetologist.

3.4.4 Bats

The national bat database has three records of long-tailed bats 300 m to the west of the site (recorded in 2020), within an area of large plantation trees and older exotic shelterbelt trees, and in close proximity to a key watercourse that has large, mature trees lining it.

We have assessed the potential for bat habitat within the site, using the criteria in the DOC/NZTA national guidance[7] to assess quality.

For this site, there are no streams on the site and the nearest substantial watercourse with open water is near to where the Bat Database records are shown.

[6] Auckland Unitary Plan; Schedule 3 Significant Ecological Areas – Terrestrial Schedule

[7] Smith, D., Borkin, K., Jones, C., Lindberg, S., Davies, F., & Eccles, G. (2017). Effects of land transport activities on New Zealand's endemic bat populations: review of ecological and regulatory literature. NZ Transport Agency research report 623

For this site, the shelterbelts in the central and western part of the site are young and until recently have been managed (trimmed sides). The species of tree (Casuarina) has an open foliage and lacks flaky bark, knot holes or cavities that bats might find favourable. Therefore, these trees score as Low Risk Trees and, in our opinion, no further consideration of these is required in term of potential bat habitat.

The trees at the eastern end of the site are a cluster of older and large macrocarpa and eucalyptus trees (total 9 trees). These support features (flaky bark) that bats may find favourable for roosting – and therefore score as High-Risk trees. No sign of roosts was found from our ground inspection and we could not see occlusions, holes, splits or cavities from the ground in those trees; however, that cannot be relied upon solely as an assessment of bat presence or potential for the trees overall to provide favourable roost habitat.

We note that all of the trees on this property can be felled without requiring resource consent from Auckland Council, and that the survey for bats is matter for the Wildlife Act (DOC), rather than the Resource Management Act.

The landowner's intention is to follow the NZTA/ DOC protocols for managing potential adverse effects on bats (Protocol B: Pre-felling procedure 1.4.1 and Protocol C (if bats are confirmed to be present)). These include undertaking a survey for bats immediately prior to felling of the older trees in the eastern macrocarpa/ eucalyptus group to ensure that bats are not using these trees at the time of felling.

Overall, given the history of the site and its distance from a substantial watercourse, we regard the potential for bats to be using the site to be low.

3.5 Summary of ecological values

The site has been heavily modified by past farming activities, which have influenced the state and quality of indigenous communities and habitat for indigenous species on the site.

There are no streams on the site. There are also no wetlands, no indigenous vegetation, no SEAs and no plant or animal species of conservation significance. There is a wetland as defined under the RMA (but not an inland natural wetland under the NPS-FM) to the south-west of the site (off site), which comprises entirely exotic species of pasture grasses and associated pasture weeds that are part of a paddock grazed by cattle and sheep.

One native animal that could be present is the native copper skink, within the rough pasture and weedland areas of the eastern gully. This species is listed as Not Threatened, and this location (if it is present) would not constitute important or core habitat. All native lizards are protected under the Wildlife Act 1953. Where consent is granted under the RMA for the development of such land, the salvage and relocation of native lizards is required.

There are nine (9) old, large trees located on the eastern part of the property that could provide suitable roosting habitat for native boats. We have assessed this risk as low; the possibly means that protocols should be adopted around clearance of these trees to ensure that potential harm to bats (if present) are avoided.

There is no remnant or secondary regenerating native forest on the site and the vegetation present does not meet any of the qualifying criteria for ecological significance. Mature exotic trees and dense exotic scrub provide limited and low-quality nesting and food resources for birds, and at most benefit a few native birds that are neither threatened nor rare.

4.0 Proposed earthworks and management of potential adverse effects

4.1 Earthworks & development programme

The intended works across the site in terms of stormwater management, treatment and discharge, and management of catchment areas pre and post development are shown in the Figures 2 – 5, and the Drawing sets that accompany the resource consent application.

The following potential adverse ecological effects were identified at the commencement of the engineering design process in relation to the potential wetland to the south of the site:

- Increase in level of sediment discharged to the western off-site wetland during construction.
- Increase or decrease in the quantity of stormwater discharged to the western off-site wetland following development.
- Potential harm to bats, if present within the large trees at the eastern basin when they are felled.

4.2 Management of potential adverse effects

As can be seen from Figures 2-5:

- There will not be a significant change to the pre-catchment areas following development; and
- There will be little change to flow rates into the southern, western or eastern catchments – the rates post-development will be slightly increased.

There is no risk of complete or partial drainage to the western off-site RMA wetland.

The level of potential adverse effect on copper skinks (assuming conservatively that a population is present within the eastern gully area) can be assessed by considering the rarity value of the species being affected, and the magnitude of its loss at the local (catchment or District) level.

For bats, the clearance of potential bat roost trees will be undertaken in accordance with the DOC/NZTA bat guidelines, which prevent the risk of direct harm to bats. Long-tailed bats occupy large home ranges and use several roots that may be scattered around the local landscape. Loss of potential roost area (s) at this site (should they be shown to be used by bats) would constitute a low level of habitat loss compared to a bat's likely home range and roost availability.

The best practice tool widely used to assess significance of effects is the matrix approach as described by the Environment Institute of Australia and New Zealand (EIANZ). The EIANZ matrix approach, and the guidelines within which it is included, has been developed as a guide for ecologists undertaking effects assessments under the RMA (EIANZ, 2018). The EIANZ guidelines and

the impact assessment matrix in particular, provides a robust, concise and consistent approach to effects assessment, whilst ensuring that individual expert evaluation and opinion is preserved.

The guidelines have been updated since they were originally released in 2015. We have applied the 2nd Edition version (released in May 2018) which provides updates to parts of the values, magnitude and level of effect analysis.

The three key inputs into an assessment of the level of ecological effect is provided by:

- An assessment of the values (Tables 5 and 6 of the guidance);
- An assessment of the magnitude of the effects on these values (based on criteria listed in Table 8 of the guidance; measured in the context of the catchment (streams) or District (terrestrial values)); and
- The application of a matrix (Table 10 of the guidance) which determines the level of effect based on the ecological value of the site or species assessed and the magnitude of effect.

The level of effect resulting from the matrix analysis can range from 'net-gain' through to 'very high' depending on the various inputs.

Level of effect can then be used as a guide to the extent and nature of the ecological management response required, as outlined in the EIANZ Guidance as follows:

- Project effects in the 'Very High adverse' category are unlikely to be acceptable on ecological grounds alone (even with offset or compensation proposals). Activities having very high adverse effects should be avoided. Where very high adverse effects cannot be avoided (and where policy allows), ecological offsetting or compensation with a net biodiversity gain would be appropriate.
- Project effects in the 'High and Moderate adverse' category represent a level of effect that should be managed through avoidance, design, or offset or compensation actions. Wherever adverse effects cannot be avoided, no net loss of biodiversity values would be appropriate.
- Project effects in the 'Low and Very Low' categories should not normally be of ecological concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure Low or Very Low-level effects.
- Project effects in the 'Very Low' category can generally be considered to be classed as 'not more than minor' effects.

The EIANZ effects matrix approach is applied in Table 2.

Figure 2. Scheme plan for the development of the site.

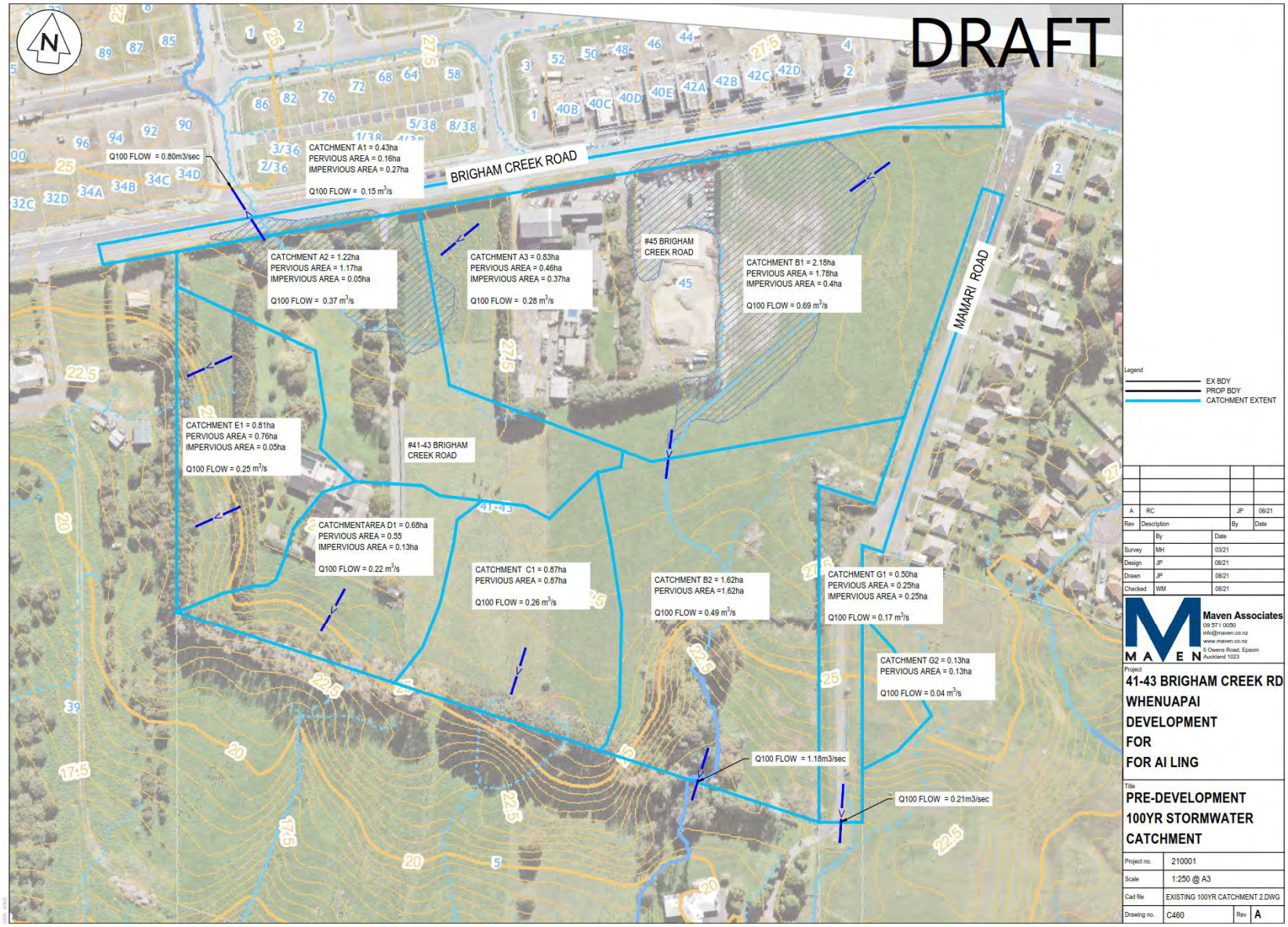


Figure 3. Pre-development sub-catchments and 100 year event flow rates.

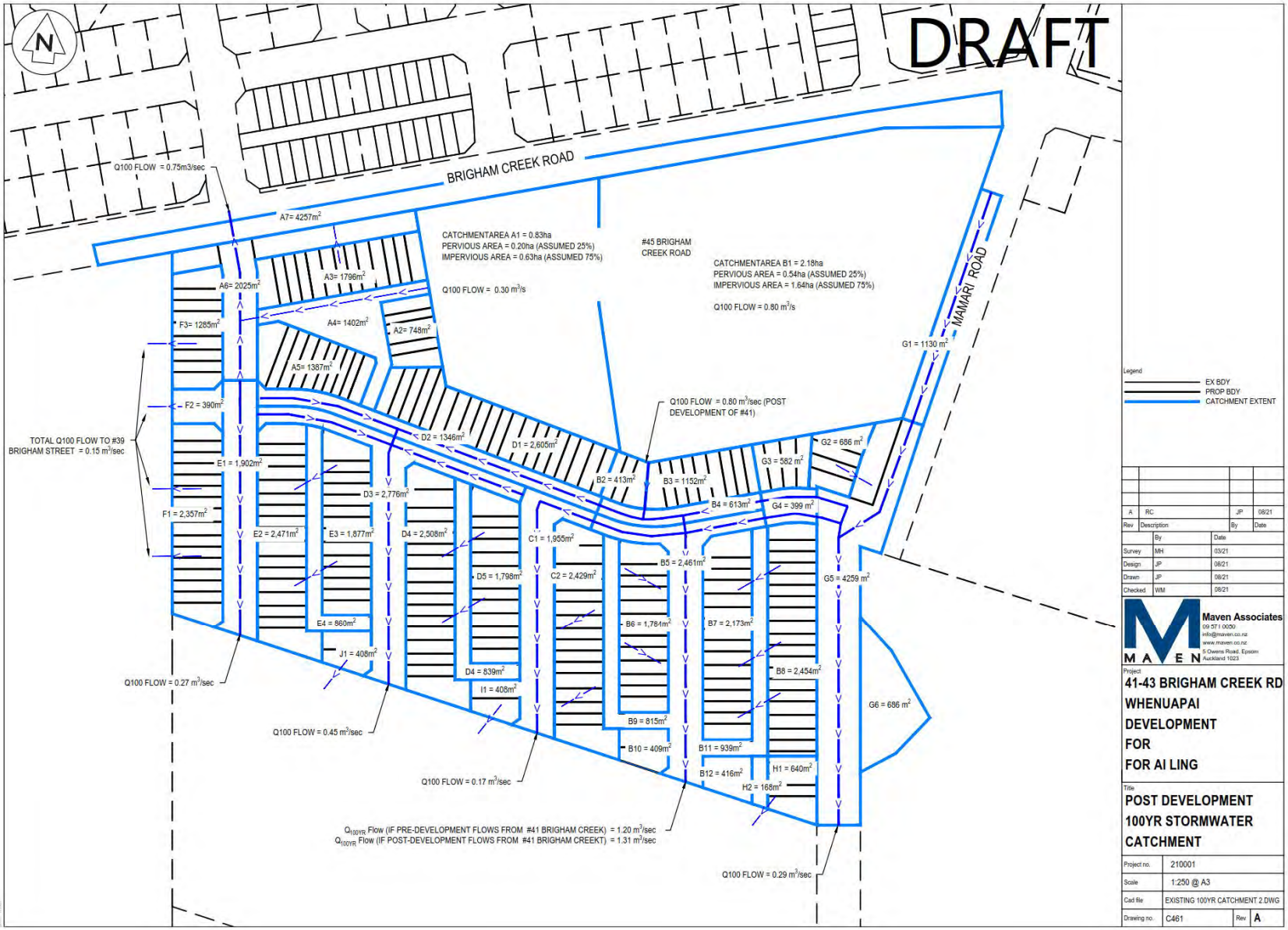


Figure 4. Post-development sub-catchments and modelled 100 year event stormwater flow rates.

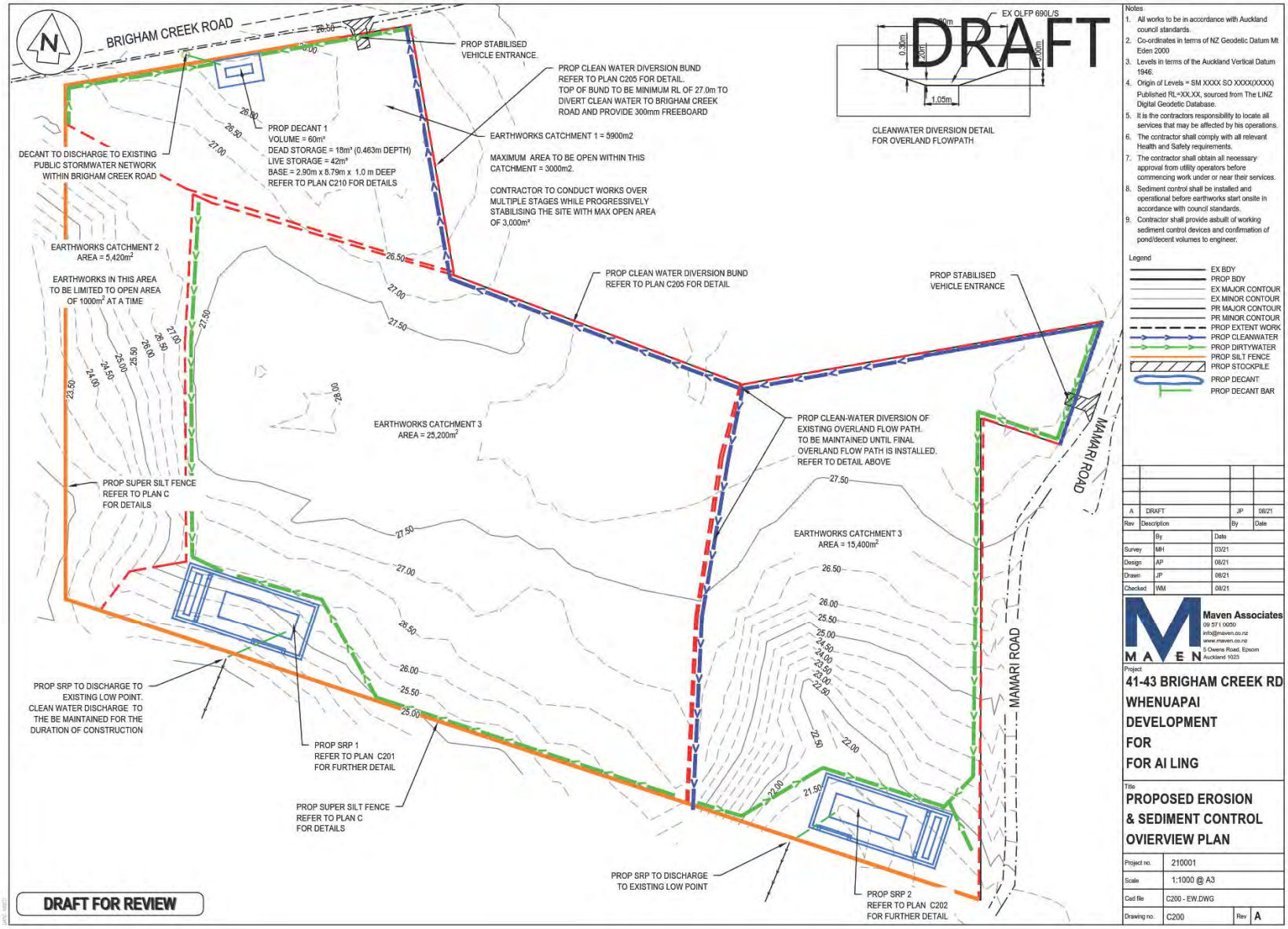


Figure 5. Erosion and sediment controls proposed for the site works.

Table 2. Assessment of significance of ecological effects using the EIANZ matrix method.

Factor	Value of resource[a]	Magnitude of effect[b]	Level of effect[c]
Loss of copper skink habitat	High	Negligible	Very low
Loss of tailed bat roost trees	Moderate	Low	Low

[a] EIANZ matrix tables 5 and 6.

[b] EIANZ matrix table 8; measured in the context of the catchment (wetlands/ streams) or District (terrestrial values).

[c] EIANZ matrix table10.

The level of potential effects in terms of loss of ecology values is assessed as 'Very low' for copper skink and 'Low' for bat roost availability.

This 'Very low'/ 'Low' level of ecological effect is equivalent to 'less than minor' when considered in the context of potential effects on the environment under the RMA.

Where the level of effects is anticipated to be 'Very low' or 'Low', the EIANZ guidelines recommend that normal design, construction and operational care should be exercised to minimise adverse effects.

For native lizards, this equates to good practice salvage and relocation as part of vegetation clearance.

For a site where moderate quality habitat exists for copper skinks, but where there are few local records, the development of a Lizard Management Plan would be disproportionate to the level of potential effect. Instead, a condition of the resource consent (if granted) should be sufficient to require that a qualified and experienced herpetologist is present on site to undertake a salvage operation in accordance with best practice, prior to the removal of vegetation within the eastern gully area.

For bats, this equates to good practice survey prior to felling of potential roost trees (up to 9 trees on site) in accordance with the DOC/NZTA protocols.

5.0 Recommendations

1. An ecologist should undertake a physical mark out on site to ensure that potential habitat for copper skinks is clearly delineated on the ground, that proposed works avoid these features, and that a salvage for native lizards within this potential habitat is undertaken prior to (as part of) vegetation clearance.

2. Undertake a survey for bats in the nine old, large trees near the eastern part of the site immediately prior to felling of those trees in accordance with accepted practice for managing potential adverse effects on bats.

6.0 References

Goodman JM, Dunn NR, Ravenscroft PJ, Allibone R, Boubee JAT, David BO, Griffiths M, Ling N, Hitchmough RA, and Rolfe JR. 2014. New Zealand Threat Classification Series 7: Conservation status of New Zealand freshwater fish, 2013. Department of Conservation, Wellington.

Hitchmough R, Barr B, Knox C, Lettink M, Monks J, Patterson GB, Reardon J, van Winkel D, and Rolfe J, and Michel P. 2021. Conservation status of New Zealand reptiles, 2021. New Zealand Threat Classification Series 35. Department of Conservation, Wellington.

Robertson HA, Dowding JE, Elliott GP, Hitchmough RA, Miskelly CM, O'Donnell CFJ, Powlesland RG, Sagar PM, Scofield RP and Taylor GA. 2013. Conservation status of New Zealand birds, 2012. Department of Conservation: New Zealand Threat Classification Series 4.

Sawyer J. and Stanley R. 2012. Criteria for the identification of significant ecological areas in Auckland. Auckland Council.

Report prepared by:

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Graham Ussher

Principal Ecologist

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RMA ECOLOGY LTD

Project No: 2112

15 March 2022

41-43 Brigham Creek Road JV Ltd

c/- Property Group Ltd

Attention: Natasha Rivai

Dear Natasha,

41-43 Brigham Creek Road: Plan Change

We have been engaged by 41-43 Brigham Creek Road JV Ltd[1] to provide an assessment of the ecological values of the 41-43 Brigham Creek Road site for the purpose of informing a proposed Private Plan Change.

The site is proposed to be rezoned, for the purposes of developing future housing (Figure 1).

Methods

A site visit was undertaken on 11 March 2021 to assess the variety of ecosystems and the ecological values present within the Plan Change footprint. A further site visit was undertaken on 21 December 2021 to obtain information within potential wetland areas within the site and on the property adjoining the southern boundary of the site. This included soils and vegetation plots. An assessment of bat habitat was also undertaken.

The site walkover was carried out to assess and map all streams and wetlands within the site.

All waterways and flow paths were mapped as being permanent, intermittent or ephemeral based on the definitions in the AUP (see below). Photographs were taken and a general description of the waterway was undertaken to note characteristics including riparian species and cover, and connectivity to other waterways.

A general characterisation assessment of the mapped stream reaches and wetlands was also undertaken with key ecological features recorded. Vegetation was assessed across the site with a focus on the presence of indigenous species. Birds identified visually and audibly were recorded across the site, including native and introduced species. The field survey included identification of habitats potentially occupied by native lizards, and an assessment of potential bat habitat.

The ecological investigation used the AUP SEA criteria to assess the significance of ecology values recorded from the site. Wetlands were assessed using the definition within the Resource Management Act 1991 using the definition within the National Policy Statement on Freshwater Management 2020 (NPS-FM).

Results

The site is located within a typical Auckland rural environment. The landform slopes gently to the south, with catchment watercourses in the general area discharging to the upper part of the Waitemata Harbour. The site supports one dwelling with substantial amenity gardens, and surrounding paddocks and fields that are

[1] This report has been prepared in accordance with our letter of engagement dated 11 February 2021.

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used for stock grazing. Several appear to have been retired for several years with rank grasses and weedland establishing.

The site has been heavily modified by past farming activities, which have influenced the state and quality of indigenous communities and habitat for indigenous species on the site.

The northern part of the site has been extensively landscaped and no flow path is discernible. There is no stream in this location.

The southern part of the site supports two small, headwater slopes in the central and western portions that discharge overland flow into shallow gullies off the site to the south. There is no stream in these locations on the site.

The far eastern part of the site discharges overland flow to the south as well. At that location, there is a broad shallow flow path that discharges to the southern boundary, where it is impounded by a shallow excavated pond and bund created by plantings on the next-door property. The flow path does not support a stream – there is no indication of a channel, sediment sorting, pools or floodplain, and the entire extent of the basin floor is well colonised by terrestrial plants.

The pond at the boundary has been created (if not through deliberate excavation), by a combination of cattle or animal trampling, and a row of planting across the boundary creating a bund that impounds surface flows behind it. The 'pond' or seasonally wet area has been formed by a bund of arum lily that has been planted or has otherwise established along the boundary of the adjoining property, which has impounded surface flows down the gully.

Soil samples taken within the ponded area – as well as further up the gully show no evidence of hydric soil characteristics (fine silts with no mottling and no high or low chroma colour change). A vegetation plot returned a Prevalence Index score which indicates a dryland plant community.

By contrast, vegetation within the ponded area comprises mostly creeping buttercup (Ranunculus repens), water pepper (Persicaria hydropiper) and Yorkshire fog grass (Holcus lanatus), all of which are wetland facultative or wetland plants, contributing to a Prevalence Index score of less than 3 – which means the plant community is a wetland community.

When paired with the soils test, and the NPS-FM wetland classification flow chart, this area does not support the necessary characteristics (in particular hydric soils) to qualify as a wetland under the NPS-FM or the RMA. This site does not support a wetland.

There are no potential wetlands within 100 m of this gully.

Two potential wetland sites to the south of the subject site were investigated. The areas were accessed in December 2021 to assess vegetation and soil status.

Southern wet area:

- Vegetation is dominated by Yorkshire fog (40 %), lotus (10 %) and sweet vernal (5 %), also with creeping buttercup (35 %), soft rush (10 %) and sorrel (2 %).
- Most of the stippling on the aerial photo (indicative of soft rush areas) above has either been removed by pasture maintenance since this aerial photo was taken, or is along the margins of the adjoining overland flow path; the potential wetland area is at the head of the gully and in this aerial is beneath the shading caused by the adjacent shelterbelt line.
- Soils are fine silts with no mottling and no dark or light low chroma colours in the top 400 mm (Plate 9).

- Overall, while the area is wetter than the surrounding basin sides and spurs, the soils are not hydric, and the vegetation is dominated by pasture grass species (Yorkshire fog, lotus and sweet vernal; which are part of paddock maintenance (pasture improvement) including weed control, fertiliser application and re-seeding) – meaning that the site does not qualify as a natural inland wetland under the NPS-FM nor as a wetland under the RMA.

Western wet area:

- Vegetation dominated by Yorkshire fog (55 %), lotus (5 %) and sweet vernal (5 %), with also creeping buttercup (10 %), soft rush (5 %), paspalum (10 %), sorrel (3 %) and bare ground (7 %).
- Soils are fine, moist, silts with light red mottling in the top 300 mm and a light low chroma colour change at 350 mm (see below). This qualifies this soil as a hydric (wetland) soil.
- Overall, while the area is wetter than the surrounding basin sides and spurs and the soils are hydric, the vegetation is dominated by pasture grass species (Yorkshire fog, lotus and sweet vernal; which are part of paddock maintenance (pasture improvement) including weed control, fertiliser application and re-seeding) – meaning that the site does not qualify as a natural inland wetland under the NPS-FM.
- The site does qualify as a wetland under the RMA.
- The closest point of the wetland to the proposed development at 41-43 Brigham Creek Road is 65 m.

One native animal that could be present is the native copper skink, within the rough pasture and weedland areas of the eastern gully. This species is listed as Not Threatened, and this location (if it is present) would not constitute important or core habitat.

The national bat database has three records of long-tailed bats 300 m to the west of the site (recorded in 2020), within an area of large plantation trees and older exotic shelterbelt trees, and in close proximity to a key watercourse that has large, mature trees lining it. We have assessed the potential for bat habitat within the site, using the criteria in the DOC/NZTA national guidance to assess quality.

For this site, there are no streams on the site and the nearest substantial watercourse with open water is near to where the Bat Database records are shown.

For this site, the shelterbelts in the central and western part of the site are young and until recently have been managed (trimmed sides). The species of tree (Casuarina) has an open foliage and lacks flaky bark, knot holes or cavities that bats might find favourable. Therefore, these trees score as Low Risk Trees and, in our opinion, no further consideration of these is required in term of potential bat habitat.

The trees at the eastern end of the site are a cluster of older and large macrocarpa and eucalyptus trees (total 9 trees). These support features (flaky bark) that bats may find favourable for roosting – and therefore score as High-Risk trees. No sign of roosts was found from our ground inspection and we could not see occlusions, holes, splits or cavities from the ground in those trees; however, that cannot be relied upon solely as an assessment of bat presence or potential for the trees overall to provide favourable roost habitat.

We note that all of the trees on this property can be felled without requiring resource consent from Auckland Council, and that the survey for bats is matter for the Wildlife Act (DOC), rather than the Resource Management Act.

The landowner's intention is to follow the NZTA/ DOC protocols for managing potential adverse effects on bats (Protocol B: Pre-felling procedure 1.4.1 and Protocol C (if bats are confirmed to be present)). These

include undertaking a survey for bats immediately prior to felling of the older trees in the eastern macrocarpa/ eucalyptus group to ensure that bats are not using these trees at the time of felling.

Overall, given the history of the site and its distance from a substantial watercourse, we regard the potential for bats to be using the site to be low.

There is no remnant or secondary regenerating native forest on the site, the vegetation present meet does not meet any of the qualifying criteria for ecological significance. Mature exotic trees and dense exotic scrub provide limited and low-quality nesting and food resources for birds, and at most benefit a few native birds that are neither threatened nor rare; most birds present are exotic species.

In terms of stormwater flows, the post-development flows have been designed to closely match the pre-development flows. This is relevant for the south-western part of the site (catchment D1 on the plans by Maven in Attachment B) where the western wet area qualifies as an RMA wetland.

Conclusions with regard to Plan Change provisions

The Private Plan Change proposes to re-zone this area for housing, with the possibility that all vegetation could be removed from across the site.

There are no ecology values recorded from the site or nearby that warrant the inclusion of specific Provisions associated with this Plan Change. The existing suite of objectives and policies within the Auckland Unitary Plan, and national-level legislation such as the NPS-FM provide adequate protections for biodiversity and ecology values, and would be applied to this site.

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Graham Ussher

Principal Ecologist[2]

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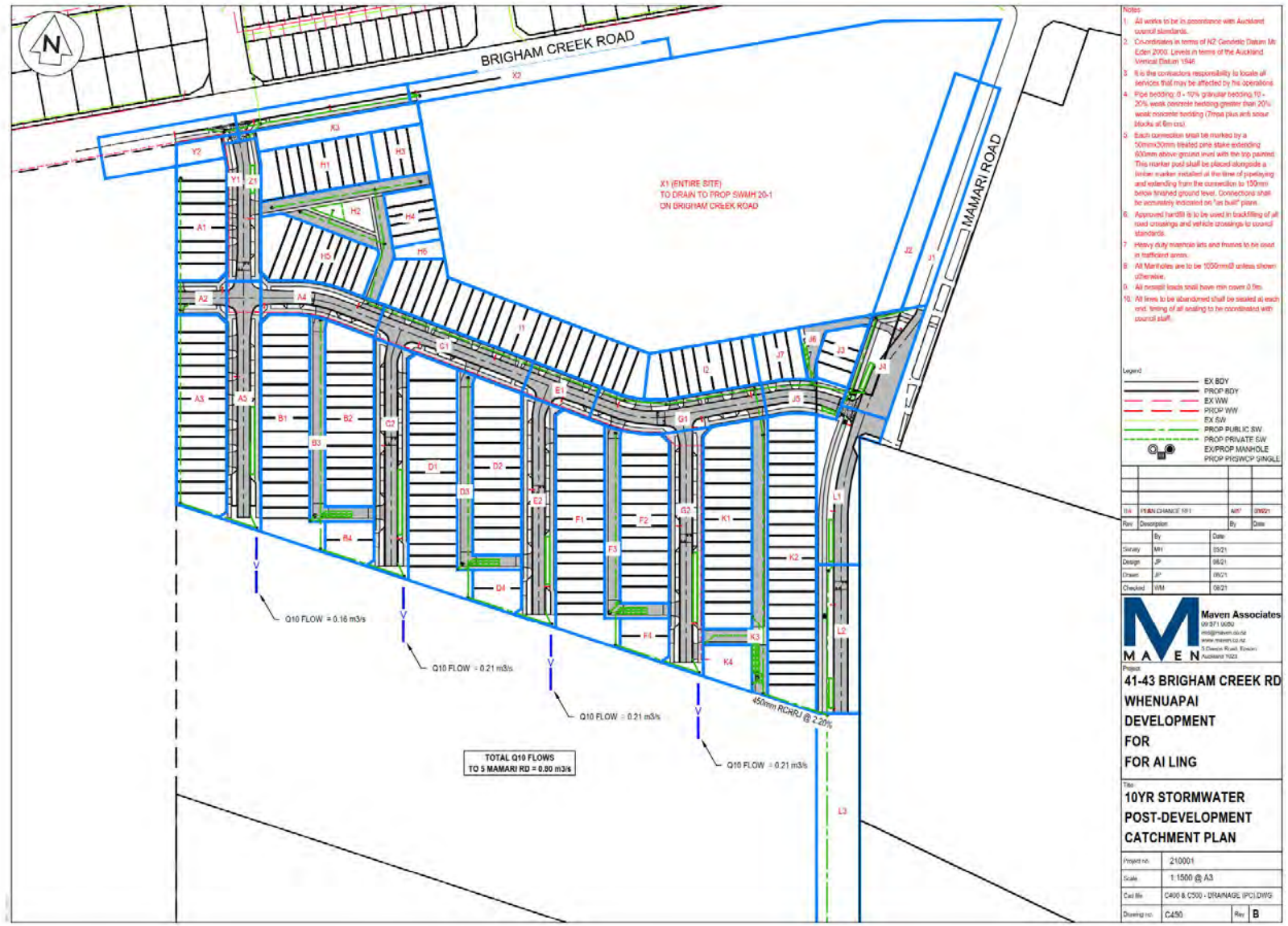
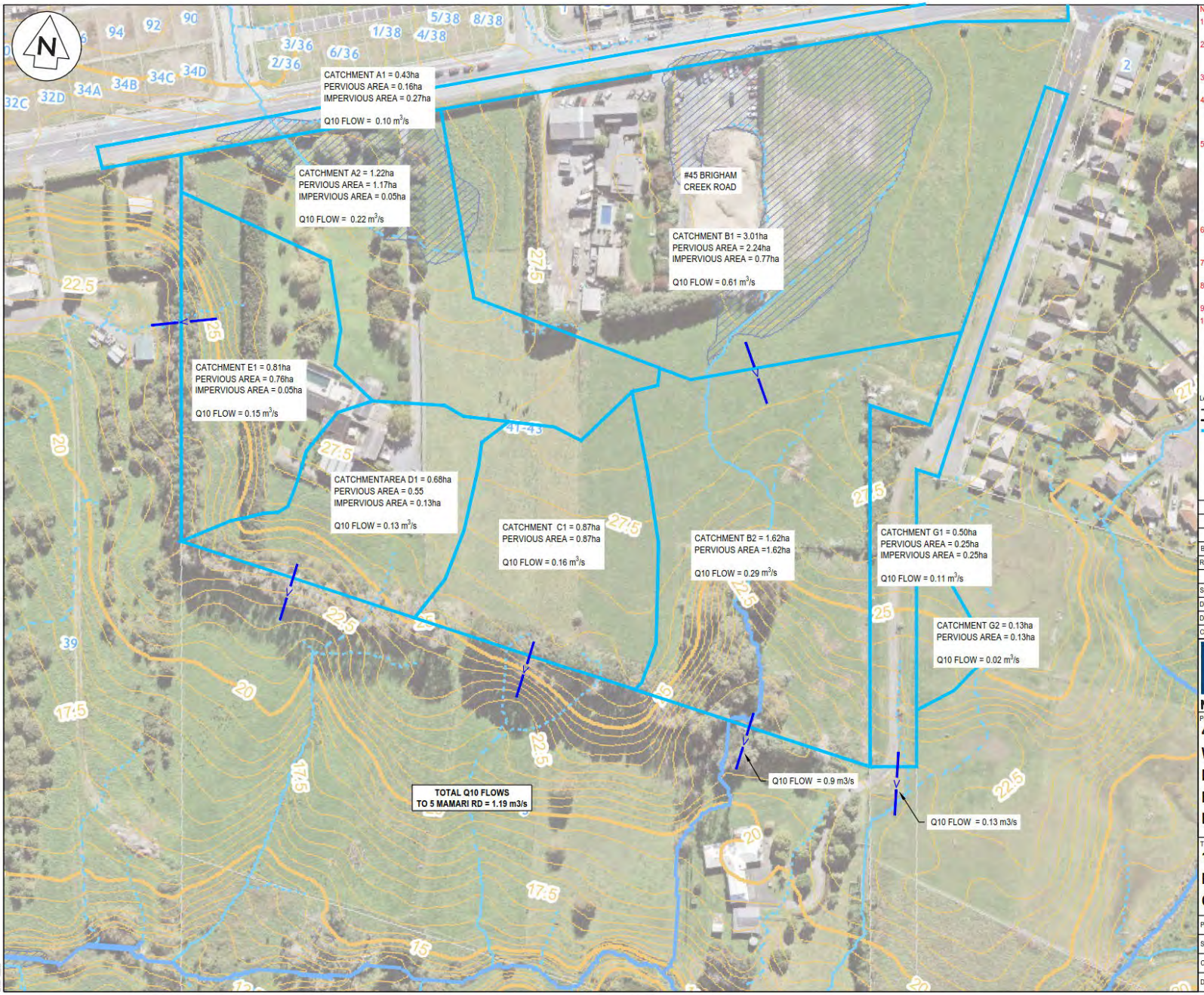
[2] This report has been prepared for the benefit of our Client with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate, without independent verification, unless otherwise indicated. No liability or responsibility is accepted by RMA Ecology Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Attachment A

Figure 1. The investigations area (turquoise boundary), with location of wetland investigation soil cores and vegetation plots. Potential wetland areas in the eastern ('pond') part of the site and in the southern and western parts of adjoining land (not on the site) were investigated for the presence of wetlands (yellow circles).

Attachment B





Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.
4. Pipe bedding: 0 - 10% granular bedding,10 - 20% weak concrete bedding,greater than 20% weak concrete bedding (7mpa plus anti scour blocks at 6m crs).
5. Each connection shall be marked by a 50mmx50mm treated pine stake extending 600mm above ground level with the top painted. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. Connections shall be accurately indicated on "as built" plans.
6. Approved hardfill is to be used in backfilling of all road crossings and vehicle crossings to council standards.
7. Heavy duty manhole lids and frames to be used in trafficked areas.
8. All Manholes are to be 1050mmØ unless shown otherwise.
9. All cesspit leads shall have min cover 0.9m.
10. All lines to be abandoned shall be sealed at each end. timing of all sealing to be coordinated with council staff.

Legend

EX BDY
PROP BDY
CATCHMENT EXTENT

Rev	Description	By	Date
B	PLAN CHANGE RFI	AP	03/22

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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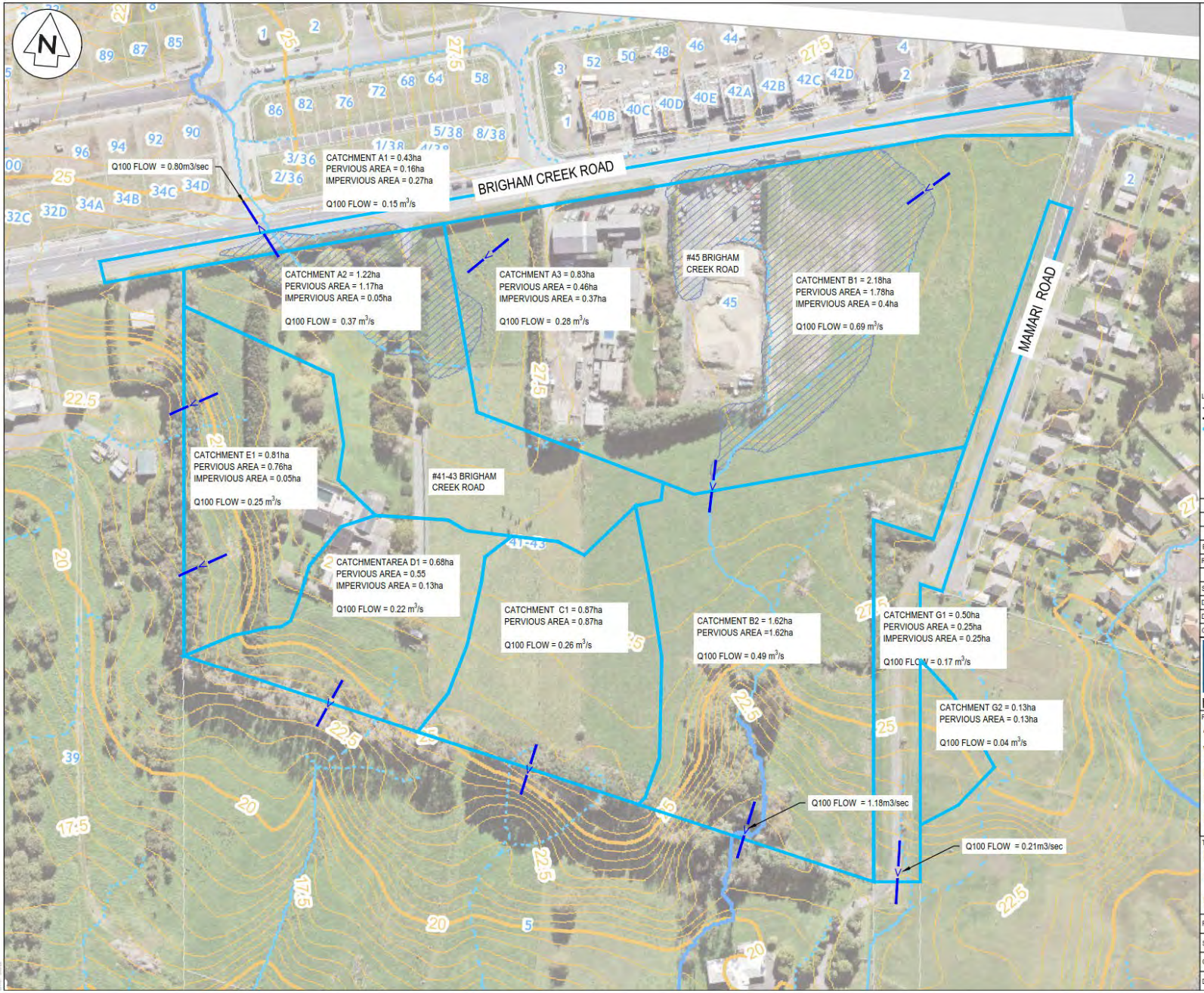
Project

41-43 BRIGHAM CREEK RD
WHENUAPAI
DEVELOPMENT
FOR
FOR AI LING

Title

10YR STORMWATER PRE-DEVELOPMENT CATCHMENT PLAN

Project no.	210001		
Scale	1:1500 @ A3		
Cad file	C400 & C500 - DRAINAGE (PC).DWG		
Drawing no.	C451	Rev	B



Rev	Description	By	Date
B	PLAN CHANGE	AP	03/22

	By	Date
Survey	MH	03/21
Design	JP	08/21
Drawn	JP	08/21
Checked	WM	08/21

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Title
PRE-DEVELOPMENT
100YR STORMWATER
CATCHMENT

Project no.	210001
Scale	1:250 @ A3
Cad file	C460 - FLOODING (PC).DWG
Drawing no.	C460 Rev B

RMA ECOLOGY LTD

Project No: 2112

28 May 2022

41-43 Brigham Creek Road JV

C/ - The Property Group

Level 14

55 Shortland Street

Auckland 1010

Attention Natasha Rivai

Dear Natasha

41-43 Brigham Creek Road: Plan Change: further Clause 23 request regarding wetlands

We refer to the further information request dated 13 May 2022 from Todd Elder, Policy Planner at Auckland Council regarding Council's further information request for proposed private plan change at 41-43 Brigham Creek Road, Whenuapai.

We have provided an assessment of the ecological values and potential adverse effects on those values in our report dated 15 March 2022[1], and further information in our Clause 23 reply letter dated 15 March 2022[2]. Auckland Council has reviewed this information and requested further information regarding one of the locations assessed as a potential wetland.

Auckland Council's query regarding ecological matters is presented below in italics, followed by our reply.

Request

> Southern' and 'western' potential wetland areas on the neighbouring property
>
> Based in the information provided I am satisfied that the 'southern' and 'western' potential wetland areas on the neighbouring property to the south are not Natural Wetlands under the NPS:FM due to the fact they meet the pasture exclusion clause in the NPS:FM definition of a Natural Wetland.
>
> However, I note that dominance and prevalence test results have not been provided. I also note that while images of soil assessments have been provided these are not accompanied with the Mansell colour chart value, chroma and hue values.
>
> 'Pond'/'OLFP' on the subject site
>
> 1. Can the applicant please provide the Dominance and Prevalence Test results (including species and percentages for each plot) for the 'Pond'/'OLFP' on the site.

[1] RMA Ecology Ltd. 15 March 2022. 41-43 Brigham Creek Road: Plan Change. Report prepared for 41-43 Brigham Road JV Ltd. 9 pp.
[2] RMA Ecology Ltd. 15 March 2022. 41-43 Brigham Creek Road: Plan Change: information request regarding ecological effects. Letter prepared for 41-43 Brigham Road JV Ltd.

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2. Can the applicant please provide the value, chroma and Hue values for soil cores 4, 5, and 6. From the photos provided these would appear to be low value and chroma (contrary to what is described in the c23 response). However, it is noted that dark topsoil colour values of 3 or less are not good indicators of hydric soils.
3. The cl23 response provided considers:

   'The flow chart within the guidance attached to the NPS-FM provides a step-wise sequence of assessment using vegetation, soil and hydrology indicators. The process requires that soils are hydric for a potential wetland site to qualify. It is not enough to have vegetation (or hydrology) as the only wetland indicators. Without qualifying soils, the site is not a wetland'.

   Assuming the response is referring to the Wetland Delineation Protocols (WDP) referenced within the NPS:FM; can the applicant please explain the above rational when following the flow chart in the WDP passing the dominance test with obligate and facultative wetland species only leads to a wetland vegetation conclusion with no need to assess soils or hydrology.

4. The c23 response provided also considers:

   'When paired with the soils test, and the NPS-FM wetland classification flow chart, this area does not support the necessary characteristics (in particular hydric soils) to qualify as a wetland under the NPS-FM or the RMA. This site does not support a wetland.'

   Again, assuming the response is referring to the WDP referenced within the NPS:FM; can the applicant please explain how the flow chart has been considered/applied given the Dominance and Prevalence Test results, as well as the soil assessment.

Our reply

The request for further information relates to the Basin/'Pond'/ OLFP area.

The two flow charts applied to the analysis are the flow chart in the NPS-FM Wetland Delineation Protocols and the flow chart in Fraser et al. 2018 for assessing hydric soils. These charts are shown in Appendix A.

The following steps were undertaken:

1. Rapid Test
2. Dominance Test
3. Hydric soils and hydrology
4. Prevalence Index.

The information used for this assessment was:

1. Soil cores obtained from coring work in March 20221 and December 2021. Soil cores were taken from within the central part of the 'pond' and around the periphery within vegetation that was 'wetland-like'.

2. Vegetation plots taken in May 2022. These were taken as four 2 m x 2 m plots within the pond. The wettest part of the pond (lowest-lying) is approximately 2 m x 2.3 m; therefore, most plots were taken in the peripheral areas where vegetation comprised 'wetland-type' species that were obviously different from the surrounding slope 'dryland vegetation'.

   Vegetation plot information was also taken in December 2021. The May 2022 plot information was undertaken in a more systematic manner and is presented here. We note that the NPS-FM does not stipulate when vegetation plots should be undertaken at a site. The hydrological tool developed to support the NPS-FM delineation protocols notes that an assessment can be undertaken at any time during the growing season, which for the Auckland Region is from 12 July through to 23 June. If vegetation plot sample collection should adhere to the hydrology tool guidance, our samples were collected at an appropriate time of the year.

Table 1. Wetland protocol assessment for the wet basin area – plots, soils, overall wetland classification.

Plant species	Common name	Hydrotype	Score	Plot 1 (%)	Plot 2 (%)	Plot 3 (%)	Plot 4 (%)
Holcus lanatus	Yorkshire fog	FAC	3		5	5	
Juncus effusus	Soft rush	FACW	2	15	5	20	
Ranunculus repens	Creeping buttercup	FAC	3	15		40	
Paspalum dilatatum	Paspalum	FACU	4	25	35		25
Rumex obtusifolius	Broadleaved dock	FAC	3	5			5
Anthoxanthum odoratum	Sweet vernal	FACU	4				
Lolium perenne	Perennial ryegrass	FACU	4		10	25	10
Persicaria maculosa	Willow weed	FACW	2	10	25		25
Agrostis capillaris	Brown top	FACU	4	30	20	5	25
Plantago lanceolata	Narrowleaved plantain	FACU	4			5	10
Total cover				100%	100%	100%	100%
Dominant species[3]				Shaded cells	Shaded cells	Shaded cells	Shaded cells
Rapid Test (all dominants OLB or FACW)				Fail	Fail	Fail	Fail
Dominance Test (>50% dominants OBL, FACW or FAC)				Fail (go to soils)	Fail (go to soils)	Pass	Fail (go to soils)
Are all/ most dominants FAC (i.e. not FACU or UPL)				-	-	Yes (go to soils)	-

[3] 50/20 rule. Highest cover species when added achieve or exceed 50 % cover, plus any species with 20 % or more cover. As per Clarkson et al. 2013/14 & NSP-FM 2020 Wetland Delineation Protocols.

Hydric soils?[4]				Fine, silty topsoil 0-300 mm 10YR 4/3 300-400 10YR 4/3 No mottles Not hydric	Fine, silty topsoil 0-300 mm 10YR 2/2 300-400 10YR 2/2 No mottles Possibly hydric	Fine, silty topsoil 0-300 mm 10YR 2/2 300-400 10YR 2/2 No mottles Possibly hydric	Fine, silty topsoil 0-300 mm 10YR 4/3 300-400 10YR 4/3 No mottles Not hydric
Hydrology?				Not undertaken	Not undertaken	Not undertaken	Not undertaken
Prevalence Index Score				3.3	3.4	3.2	3.5
Overall conclusion				Not wetland	Not wetland	Not wetland	Not wetland

[4] Soil cores were taken at different times of the year to vegetation plots. Soil core locations are within 0.5 m of the respective vegetation plot. Dark low chroma topsoils are not good indicators of hydric soils.

Table 1 shows the assessment of plots and soils within the basin area.

The vegetation indicates a mix of dryland species and 'wet' pasture species with pasture weeds prevalent throughout. None are native - all plants are exotic. The presence of ryegrass and sweet vernal most likely relate to when the site was used as a grazing paddock and indicate that pasture grasses were actively sown in here in the past.

Across multiple plots, the vegetation does not meet the minimum Index score for a hydric (wetland) plant community. The soils are all fine topsoils for at least 500 mm and show signs of organic deposition – or are simply indicative of past farming and fertiliser use and rich loamy soils of this location – and hence show as dark chroma colours.

Overall, the combination of vegetation and soils indicates that the basin is not a natural inland wetland under the NPS-FM (and neither is it a wetland under the RMA/AUP).

(above). Soil cores taken within the wet basin on the site, and a core taken outside of the basin on the nearby slope/ spur (Core 2). Core 3 is taken after summer and shows dry soils. Cores 4 – 6 are taken just after the wet season and show moist profiles. None of the cores show redox mottling in the upper 300 mm. The cores indicate that the basin comprises accumulated fine sediments associated with topsoil deposition.

Note that the following soil-vegetation plot associations have been liked for this analysis (as the soil cores are within the respective plot or are close it it).

- Vegetation plot 1 + soil core 5
- Vegetation plot 2 + soil core 4
- Vegetation plot 3 + soil core 6
- Vegetation plot 4 + soil core 3

We trust that this provides the information that Council has requested.

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Graham Ussher

Principal Ecologist

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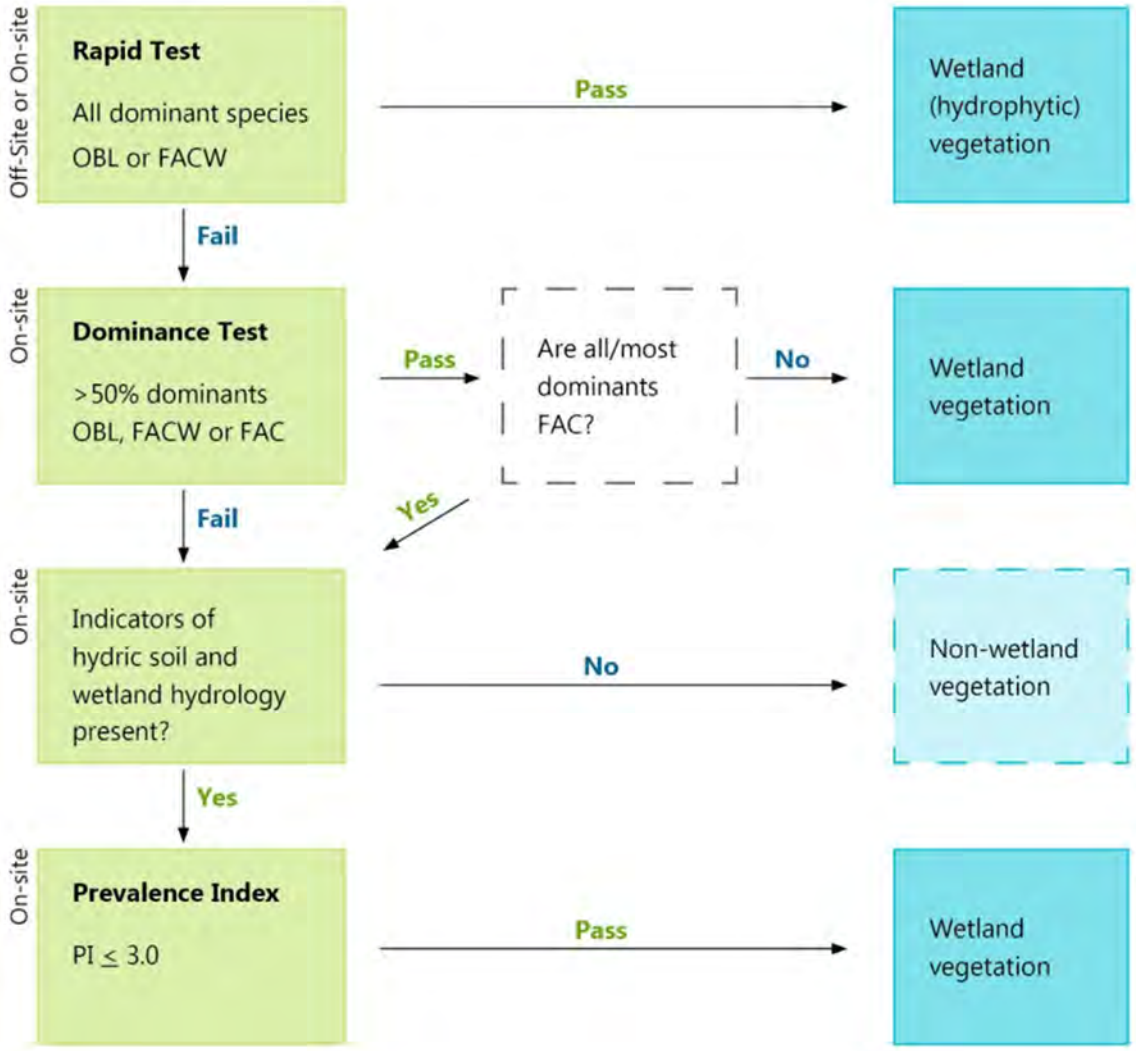
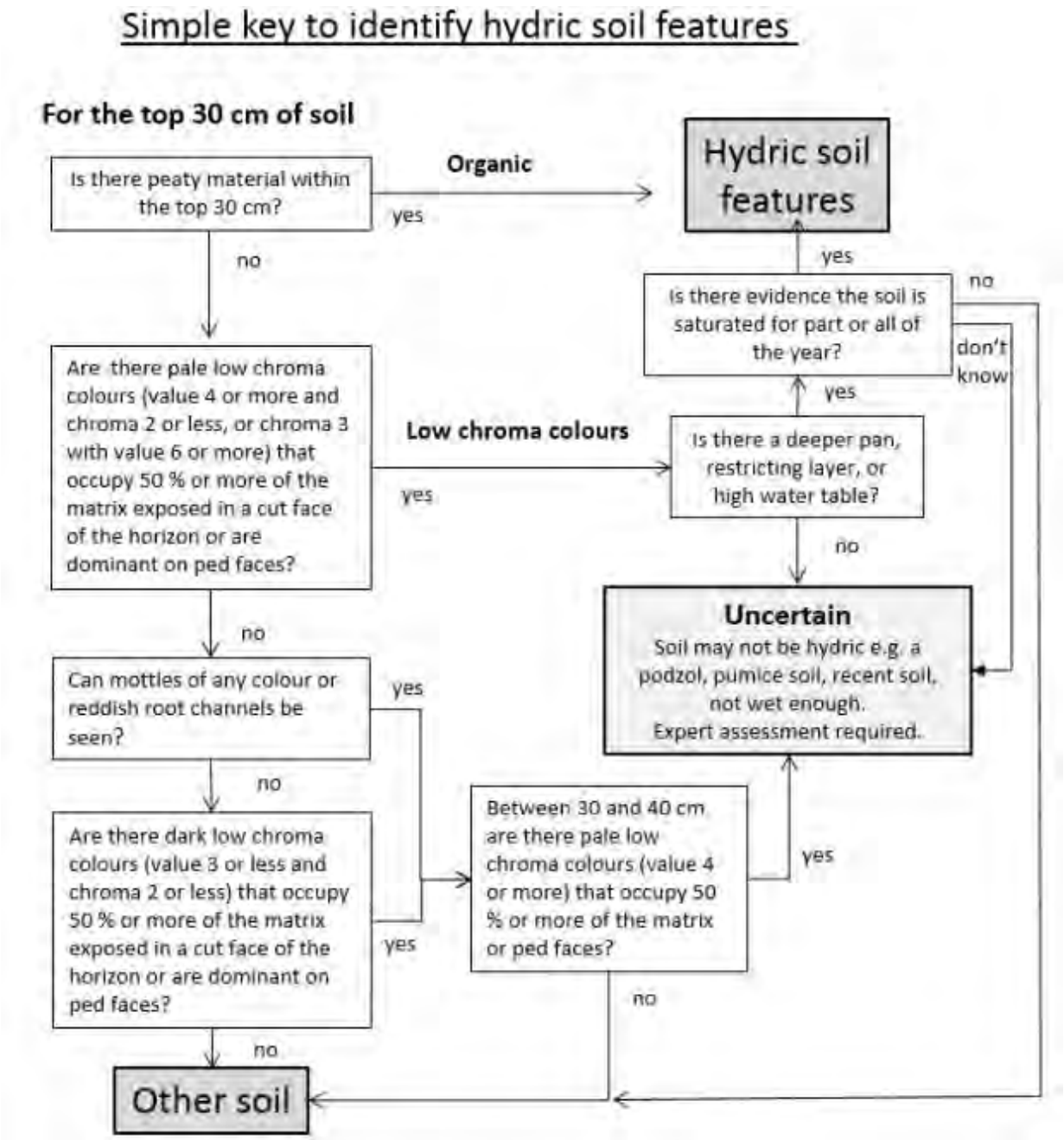
Appendix A



Flow chart 1. Steps for hydrophytic (wetland) vegetation determination. Wetland indicator status abbreviations: FAC= facultative; FACW = facultative wetland; OBL = obligate wetland (NPS-FM Wetland Delineation Protocols).



Flow chart 2. Simple key to identifying hydric soil features (Fraser et al. 2018).