

ASSESSMENT OF STORMWATER (OPERATIONAL) EFFECTS

NZ Transport Agency Waka Kotahi
Mill Road Stage 1

AUGUST 2026

NZ TRANSPORT AGENCY
WAKA KOTAHI

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QUALITY REVIEW AND APPROVAL RECORD

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EXECUTIVE SUMMARY

This report forms part of a suite of technical reports prepared to support the approvals sought for Stage 1 of the Mill Road Corridor Project **('Stage 1' or 'the Project')** for NZ Transport Agency Waka Kotahi **(NZTA)**, under the Fast Track Approvals Act 2024 **(FTAA)**. The purpose of this report is to inform the substantive application, with respect to operational related stormwater runoff, and to support the resource consent applications, and alteration to existing designations required for the Project.

Environmental effects with respect to stormwater runoff and discharges can relate to water quality (and subsequent sediment quality for streams) or on water quantity. In this case, potential quantity effects relate to erosion in streams from potential increase in discharge from day-to-day events and flooding due to infrequent but severe rain events. This report addresses general runoff from the operation of the Project roads.

Accordingly, this assessment focuses on demonstrating how the stormwater design for the Project (see **Appendix H1** of the substantive application) meet the relevant standards in Chapter E8, E9 and E10 of the Auckland Unitary Plan **(AUP)**; and in doing so how the Project will avoid, remedy, or mitigate any adverse stormwater effects. The assessment also addresses the effects of undertaking works in areas subject to flood hazard, as guided by the provisions in AUP Chapter E36 "Natural hazards and flooding", as there are some discrete areas where works may be carried out within a floodplain and / or where they would redirect an Overland Flow Path **(OFP)**.

The following outcomes have been concluded from the assessment:

a) Water quality effects will be positive for both the urban and rural sections as currently there is limited stormwater treatment provided. The Project will provide stormwater treatment of runoff from all new impervious, and some of existing areas in line with AUP;

b) Stream hydrology effects are positive for the urban section and are managed in line with AUP; and

c) The Project will result in a reduction to flood hazard to road users at Ranfurly Road.

The Project will be constructed in general accordance with the stormwater design in **Appendix H1** of the substantive application. The stormwater design will effectively manage stormwater effects associated with the Project, so that adverse effects are avoided, remedied or mitigated. In addition, we recommend conditions are included in relation to the stormwater consents to require:

a) Inclusion of flood attenuation volumes into proposed rain garden RG MM01, as shown on DR-0502, to mitigate against increase in runoff from the Project exacerbating existing flooding along the SH1 and Redoubt Road off-ramp;

b) Geometric design of Hollyford Drive to be refined such that the reduction to the freeboard of the adjacent nominated at-risk residential buildings is minimised; and

c) Measures to increase attenuation at or upstream of the existing Alfriston Road culvert to avoid any peak flow increase in the stream adjacent to the existing commercial buildings immediately downstream.

1. INTRODUCTION

Beca Limited **(Beca)** has been engaged by NZ Transport Agency Waka Kotahi **(NZTA)** to complete an Assessment of Stormwater Effects to support the approvals sought for Stage 1 of the Mill Road Corridor Project **('Stage 1' or 'the Project')** under the Fast Track Approvals Act 2024 **(FTAA)**.

The Project will provide a four-lane, divided carriageway from Manukau through to the Phillips Road intersection with Mill Road. The full description of the Project, the construction methodology and associated drawings can be found in the substantive application and is not repeated here.

The purpose of this report is to:

a) Undertake an operational stormwater effects assessment to support the regional resource consent applications and an alteration to existing designation required for the Project; and

b) Recommend measures to appropriately avoid, remedy or mitigate any adverse operational stormwater effects.

Environmental effects with respect to stormwater runoff and discharges can relate to effects on water quality (and subsequent sediment quality for streams) or water quantity. In this case, potential quantity effects relate to erosion in streams from potential increase in discharge from day-to-day events and flooding due to infrequent but severe rain events. This report addresses general runoff from the operation of the Project.

The assessment covers a range of actual and potential effects from pollutants released in day-to-day rainfall events from the carriageway through to flood risk changes from new culverts. This assessment is structured to consider a range of potential effects under the following categories:

a) Water quality – contaminant removal;

b) Water quantity – volume and flow control;

c) Primary drainage capacity; and

d) Secondary flow and flood hazard.

In addition to the operational stormwater effects outlined above, stormwater runoff during the construction phase can cause erosion and sediment generation effects. These construction effects are addressed in Part C of the substantive application.

2. STATUTORY APPROVALS

NZTA is seeking all necessary approvals to authorise the construction and operation of the Project through the substantive application (refer to Part C of the substantive application). This includes the following approvals, required in relation to the proposed stormwater infrastructure:

a) Resource consents required under the regional rules of the Auckland Unitary Plan **(AUP)** including:
    i) Chapter E8 – Diversion and discharge of stormwater runoff;
    ii) Chapter E9 – Stormwater quality – redevelopment of a high use road; and
    iii) Chapter E10 – New or redevelopment of impervious area within Stormwater Management Area Flow 1 **(SMAF 1)** control.

b) Alterations to Designation 6786 for the Redoubt Road-Mill Road include changes to the footprint of the designation to provide space for stormwater management assets; and

c) Changes to the existing designation conditions relating to stormwater design requirements to reflect the works being implemented as part of Stage 1 and the resource consents being sought by NZTA through the substantive application.

2.1 Network Discharge Consent

NZTA is seeking consents under the AUP for stormwater discharges from the Project to watercourses and streams.

The Project will also discharge to the existing Auckland Council stormwater network (including urban streams) in three locations: the pipe network by Hollyford Drive, and urban streams within Everglade Park and Kingsclere Place Reserve. Approval is required from Auckland Council for discharges into the existing public stormwater network at these locations through the Regional Stormwater Network Discharge Consent **(RWNDC)** and will be sought by NZTA separately.

3. ASSESSMENT SCOPE AND METHODOLOGY

3.1 Assessment scope

The assessment is structured as follows:

a) Stormwater quality;

b) Stormwater quantity - SMAF (retention and detention);

c) Primary drainage; and

d) Secondary drainage, overland flow, and flooding.

Refer to **Appendix C** for further details on assessment methodology.

3.1.1 Water quality – containment removal

Water quality effects arise as particles from car exhausts, tyres and brakes, silt, oils and litter collected on road surfaces. Many of these small particles adhere to sediments which are washed off impervious surfaces and transported through stormwater runoff to then discharge to the receiving environment. The accumulation of sediment, contaminants and changes to the chemical make-up of stormwater affect water and sediment quality and can then have a significant effect on aquatic flora and fauna.

The design rainfall storm event that is adopted for design of stormwater treatment devices and assessment of stormwater quality outcomes is the “first flush”, or the water quality event **(WQE)**. The first flush is generally characterised by a peak in some pollutant loads prior to the peak in-flow volumes. Good practice for water quality improvement therefore promotes the capture and treatment of the first flush as this is often more practical and cost effective than treating flow volumes from the entire storm event.

To mitigate adverse water quality effects, the first flush runoff from new and modified road surfaces will need to be captured and passed through stormwater treatment devices that remove the majority of contaminants. These devices could be constructed freshwater wetlands or vegetated systems such as swales and raingardens and otherwise, proprietary in-ground treatment systems such as cartridge filtration, tentacle filtration or vortex/centrifugal treatment systems.

Depending on the device selection and the type of treatment device (flow based or volume based), the device design could either be assessed against the water quality flow **(WQF)** or water quality volume **(WQV)**. For Auckland, the WQE is equivalent of a rainfall intensity of 10mm/hr or the 90th percentile of 24-hour storm event, which is between 23mm to 34mm.

3.1.2 Water quantity – volume and flow control

Within catchments with sensitive stream environments, flow from frequent events that discharge directly to stream receiving environments could cause adverse effects on stream health. An increase of impervious surfaces area in a catchment further increases the flow rate and volume of stormwater runoff. When left unmitigated, these changes can lead to an increase in river and stream erosion and bank instability and can create conditions that do not support healthy aquatic ecosystems.

The AUP identifies these susceptible areas and requires control measures when development activities occur in these areas. These are known as the Stormwater Management Area - Flow 1 or 2 **(SMAF 1 or 2)**. SMAF control requires developments to provide both retention and detention of flows as follows:

a) Provide retention (volume reduction) of at least 5 mm runoff depth;

b) Provide detention and a drain-down period of 24 hours for the difference between the pre- and post-development runoff volumes from the 90th percentile (SMAF 2) or 95th percentile (SMAF 1) 24-hour rainfall event, minus the 5mm retention volume provided. The detention volume needs to account for between 23mm and 48mm rainfall over a 24-hour design period.

Potential mitigation measures that can be implemented include stormwater devices with the ability to provide ponding at the surface or storage volumes for detention of flow. Retention can also be achieved via storing water and infiltrating to ground, if ground conditions are suitable. If retention volume cannot be practically achieved, then retention volume can be provided as additional detention volume. Types of potential green infrastructure that could provide ponding or storage volumes for road runoff include swales with check dams, wetlands and raingardens.

3.1.3 Primary drainage capacity

The purpose of a primary drainage system is conveyance of stormwater runoff from the day-to-day events up to the 10% Annual Exceedance Probability **(AEP)** storm event. It is focused on maintaining operation to a required level of service of the road and avoiding nuisance flooding to any downstream properties (from any additional runoff from the Project due to an increase in impervious surface area) or upstream properties (where the primary system is undersized).

The design requirements adopted are as set out in the NZTA P46 Design Specification. The specification prescribes parameters that are to be met for the performance of the primary system, such as allowable water flow depths and widths for surface flow, and velocity and freeboard requirements for piped and open channel systems.

This assessment focuses on effects at downstream properties of connection points or new discharge points. The assessment was also used to inform the design of the Project (e.g. changes to the stormwater network and provision of attenuation volume in devices for peak flow reduction were considered in the design) to manage those effects. While the scope of this assessment does not cover detailed design of the primary network to NZTA P46 design standards, it was considered at a high level to provide adequate space in the Project footprint for it to be completed as part of the detailed design phase.

3.1.4 Secondary flow and flood hazard

Effects of flooding arising from large storm events are assessed in terms of the risk to vulnerable activities and buildings. Rainfall events above the 10% AEP and up to the 1% AEP event were used to consider the increase in flood risk resulting from increased impervious area, loss of upstream flood storage volume due to infill works and obstruction/constriction of overland flow paths at crossing structures (namely, culverts and bridges).

The change in extent and depth of flood water on downstream and upstream properties has been assessed to determine the change in flood risk to these properties. Stream crossing structures have been assessed to confirm that the level of flood resilience required by the asset owner can be achieved without overly constricting flood flow (which could potentially increase the flood risk to upstream properties) or reducing attenuation (which could potentially increase the floor risk to downstream properties).

Flood risk mitigation measures could include stormwater devices designed to attenuate the 1% AEP flow (located along the corridor or downstream within the catchment) or changes to culverts.

3.2 Area of works to be assessed

The assessment of stormwater effects is separated into urban and rural sections of the alignment. These sections are based on existing stormwater infrastructure, adjacent land use and current urbanisation limits along the proposed alignment, as shown in **Figure 1** and detailed in **Table 1**.

NZTA's works will also involve works at the interface with local roads. This assessment covers effects of proposed work on Hollyford Drive, Everglade Drive, Hilltop Road, Murphys Road and the new connection proposed for Polo Prince Drive. All other minor road tie-ins do not result in stormwater changes and are therefore not specifically considered in this assessment.



Figure 1: Sections for stormwater assessment - operational effects

Table 1: Sections for stormwater assessment - operational effects

Section	Chainage	Road Extent
Urban	Ch 10000 to 11300	**Main alignment:** SH1 Interchange to Tōtara Park Entrance/Alexia Place **Local roads**: Hollyford Drive, Everglade Drive
Rural	Ch 11300 to 17100	**Main alignment:** Tōtara Park Entrance/Alexia Place to Puhinui Creek Tributary **Local roads**: Hilltop Road, Murphys Road, Polo Prince Drive/Mill Road connection

In summary, the Project will result in:

a) A change in the proportion of impervious areas within the road corridor;

b) Widening of the road corridor within the designation; converting land currently used for residential purposes to road corridor;

c) Establishment of new impervious area within the designation, where previously it was greenfield land;

d) Installation of new stormwater quality treatment devices to capture and remove contaminants from road runoff;

e) Installation of new drainage infrastructure (catchpits, pipes, manholes, gutters) and discharge of runoff to new stream outfalls;

f) Changes to overland flow paths to suit new road, footpath and cycleway arrangements;

g) Raising and/or lowering of road embankment over areas where it forms part of an existing overland flow path or is currently within a flood plain; and

h) Culverting streams or overland flow paths under the proposed new or widened road embankment.

Sections 6.1 and 6.2 below provide an assessment of the stormwater effects.

4. EXISTING ENVIRONMENT

The proposed Mill Road alignment is located within three stormwater catchments discharging into three main watercourses.

From the SH1 Redoubt Road Interchange to approximately 38 Mill Road (the Watercare Redoubt Road reservoir site), the alignment follows the existing Redoubt Road along the catchment boundary between Otara Creek (including Flatbush) to the north and Puhinui Creek to the southwest. The alignment then crosses over into the Papakura Stream catchment and continues south until it ties into the existing Mill Road at Alfriston. Refer to **Figure 2**.

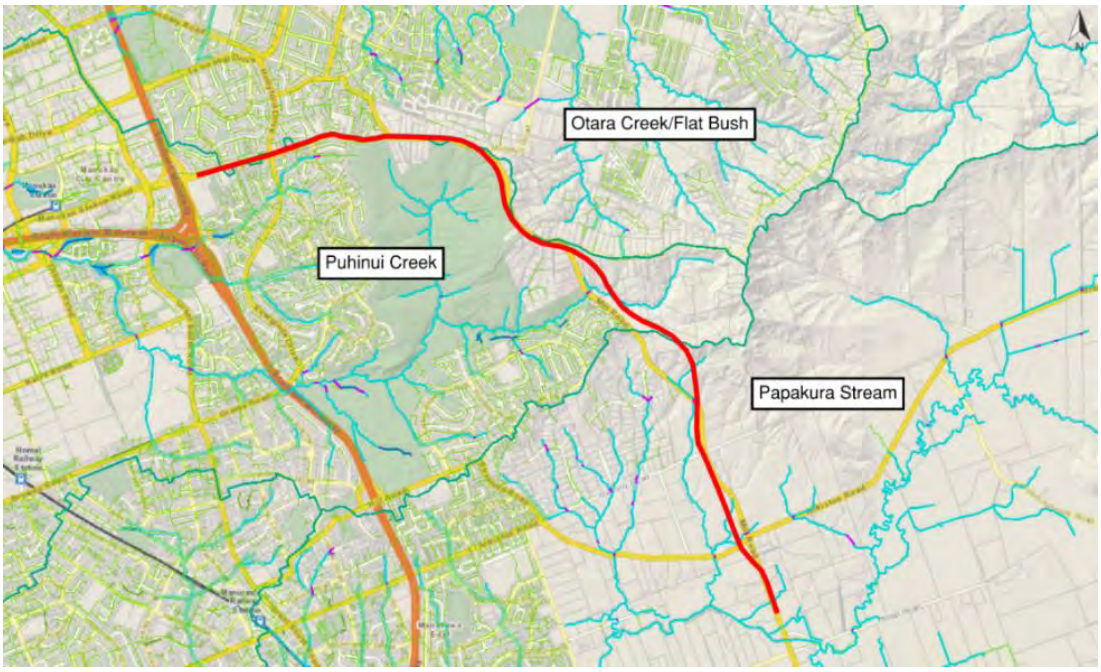


Figure 2: Existing stormwater catchment boundaries and streams, with proposed road alignment in red. Background image: Auckland Council GeoMaps, accessed July 2025.

4.1 Stormwater infrastructure

4.1.1 Stormwater management devices

Existing stormwater infrastructure is generally limited to the western section of the corridor within the urbanised environment to the west of Tōtara Park (i.e. the section from SH1 to Tōtara Park/Alexia Place). The existing stormwater infrastructure services both the existing Redoubt Road and properties in the area.

According to Auckland Council's GeoMaps viewer, the existing Redoubt Road carriageway is serviced by catchpits which are connected to a public stormwater network, both to the north of the corridor, located within the Otara Creek/Flat Bush catchment; and to the south within the Puhinui Creek catchment. There are no formal stormwater treatment devices identified within the existing road reserve or within the immediate downstream environment. There is an existing wet pond identified further downstream, located at the De Havilland Reserve, which services some approximately 8,300 m^2 of the existing Redoubt Road and a large area of residential catchment via a series of pipe networks and open channels through reserves. According to records provided by Auckland Council Healthy Waters, the total catchment designed to be drained to this pond is 85ha and is designed to remove 75% Total Suspended Solids **(TSS)**. Refer to **Figure 3** for location of this pond and catchment area. Since the pond was constructed in the early 2000's, it is assumed that it was designed as a wet pond to the legacy TP108 standard. However, this design standard has been replaced by GD01 and the legacy standard is no longer considered an appropriate device for water quality treatment purposes.

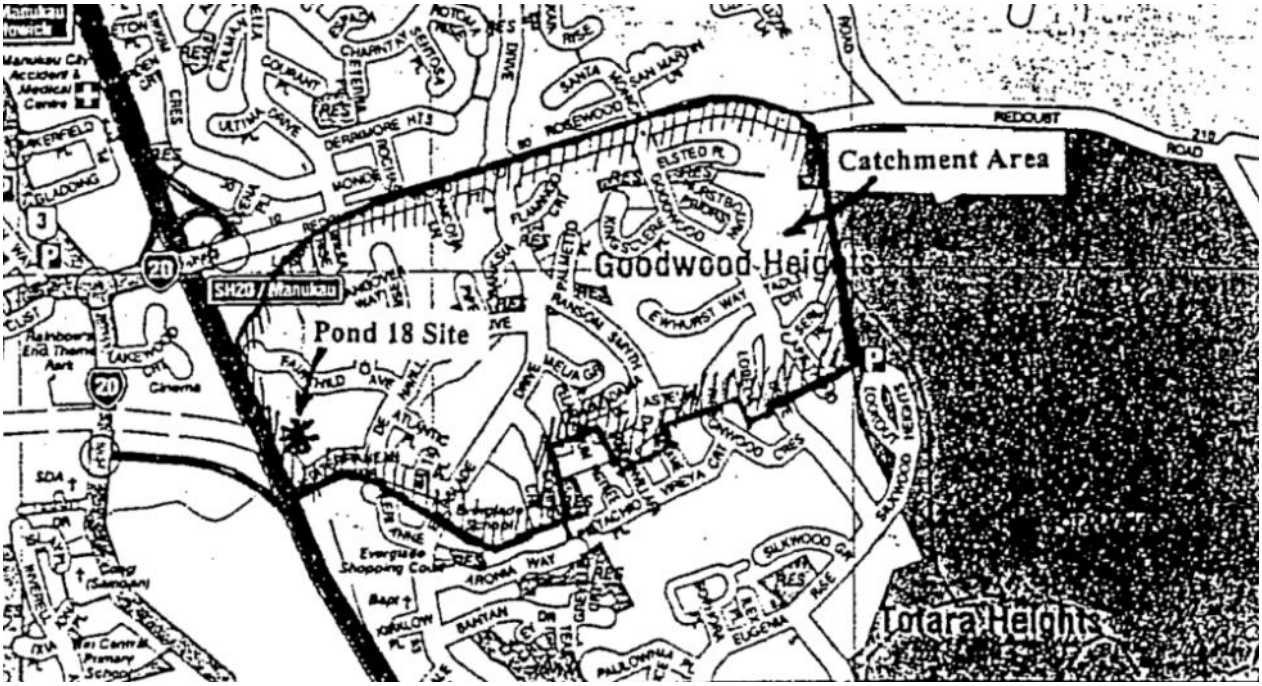


Figure 3: Location of the De Havilland wet pond (De Havilland 55R) and catchment area recorded, shown as Pond 18 in the figure.

For the rural section of the corridor to the east of Alexia Place, the existing Redoubt Road corridor does not currently have any formal stormwater treatment devices other than grassed verge or roadside drains that may offer some limited level of treatment.

4.1.2 Stormwater pipe network

The existing stormwater pipe network and the main trunk pipes are shown in **Figure 4**. The majority of the network is owned by Auckland Council, with some stormwater assets owned by NZTA where the network

traverses under the existing SH1 corridor, notably the 750mm diameter and 375mm diameter pipes shown in **Figure 4**. The existing network generally drains to the north and south on either side of the existing Redoubt Road corridor and ridge, to Otara Creek (including Flatbush) to the north and Puhinui Creek to the southwest.

The capacity of the existing Auckland Council public network was assessed using Auckland Council GeoMaps data, supplemented by manhole inspections from previous design phase, as-built drawings obtained from ASM and RAMM data. An assessment of the existing network found that the network has capacity to convey flows up to an approximately 20% AEP (5-year ARI) historical design event. This is a typical level of service for the age of this infrastructure, given this network was generally constructed in the 1960's and until 2010, this area of Auckland had a 20% AEP peak flow design criteria. The current standard for level of service is a 10% AEP peak flow with allowances for future climate change rainfall increases.

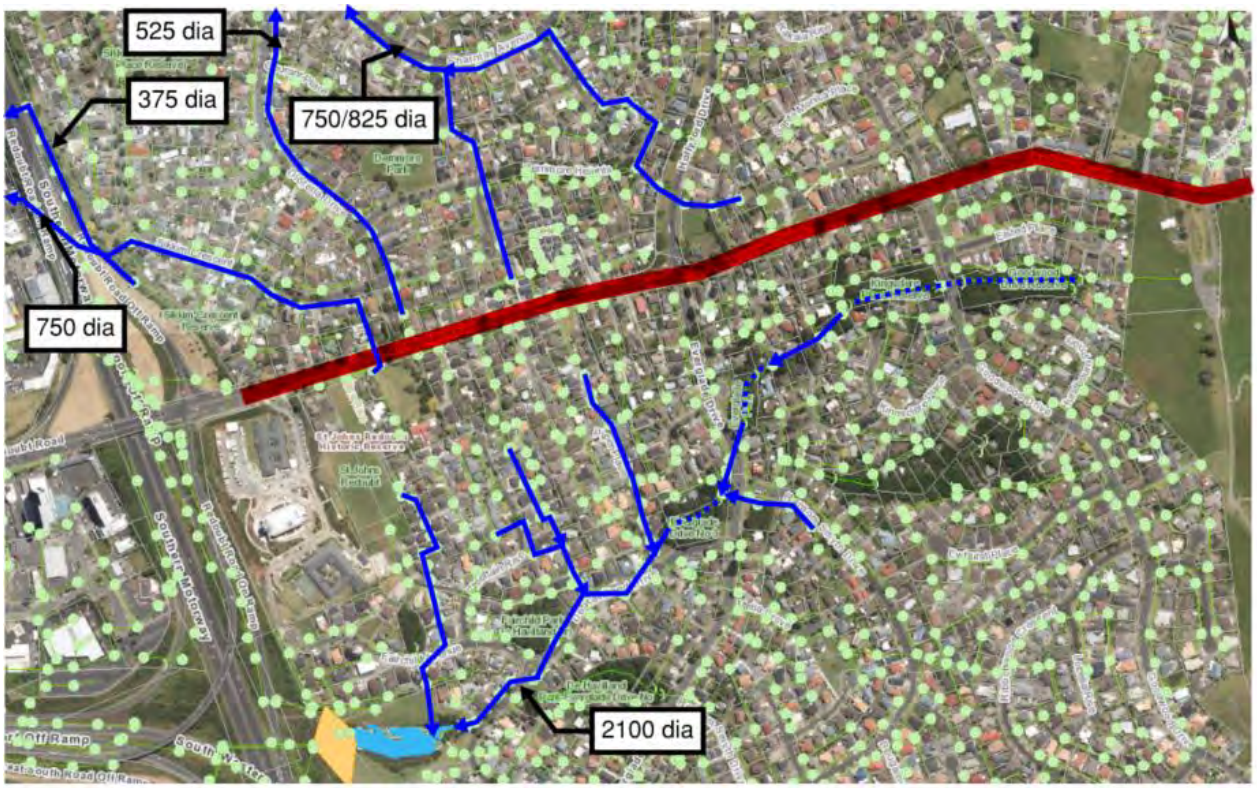


Figure 4: Existing stormwater network in the urban section, with main trunk pipes shown in blue and proposed road alignment in red. Background image: Auckland Council GeoMaps, accessed July 2025.

4.1.3 Cross culverts

There are no existing cross culverts within the urban section along Redoubt Road, which is located on a ridgeline with no stream crossings. There are a limited number of existing cross culverts along the proposed alignment through the rural section; these range between 225mm diameter and 600mm diameter based on site observations and available GeoMaps GIS data.

4.2 Stormwater receiving environment

The downstream receiving environments for stormwater discharges from the proposed alignment are mostly freshwater watercourses or streams within Tōtara Park or rural land. These streams drain to the Pahurehure Inlet and Papakura Channel, and ultimately the Manukau Harbour.

At the western end of the urban section, there are existing public stormwater networks draining to both the north (through existing properties and under SH1 via a 300mm diameter or a 750mm diameter pipe) and south (through reserves and private properties and into de Haviland pond). These networks ultimately drain to the Puhinui Creek to the west of SH1.

The majority of Redoubt Road and the urban residential area within the Puhinui Creek catchment is subject to a SMAF 1 control (**Figure 5**). The SMAF control seeks to protect and enhance Auckland's rivers, streams and aquatic biodiversity, in urban areas that discharge to sensitive or high value streams (including, for example, Puhinui Creek) that have relatively low levels of existing impervious area. Development and redevelopment (such as the Project) are still enabled under this control but are subject to controls that seek to reduce stormwater runoff volume to protect aquatic biodiversity and other values from further decline and to enhance them where practicable.

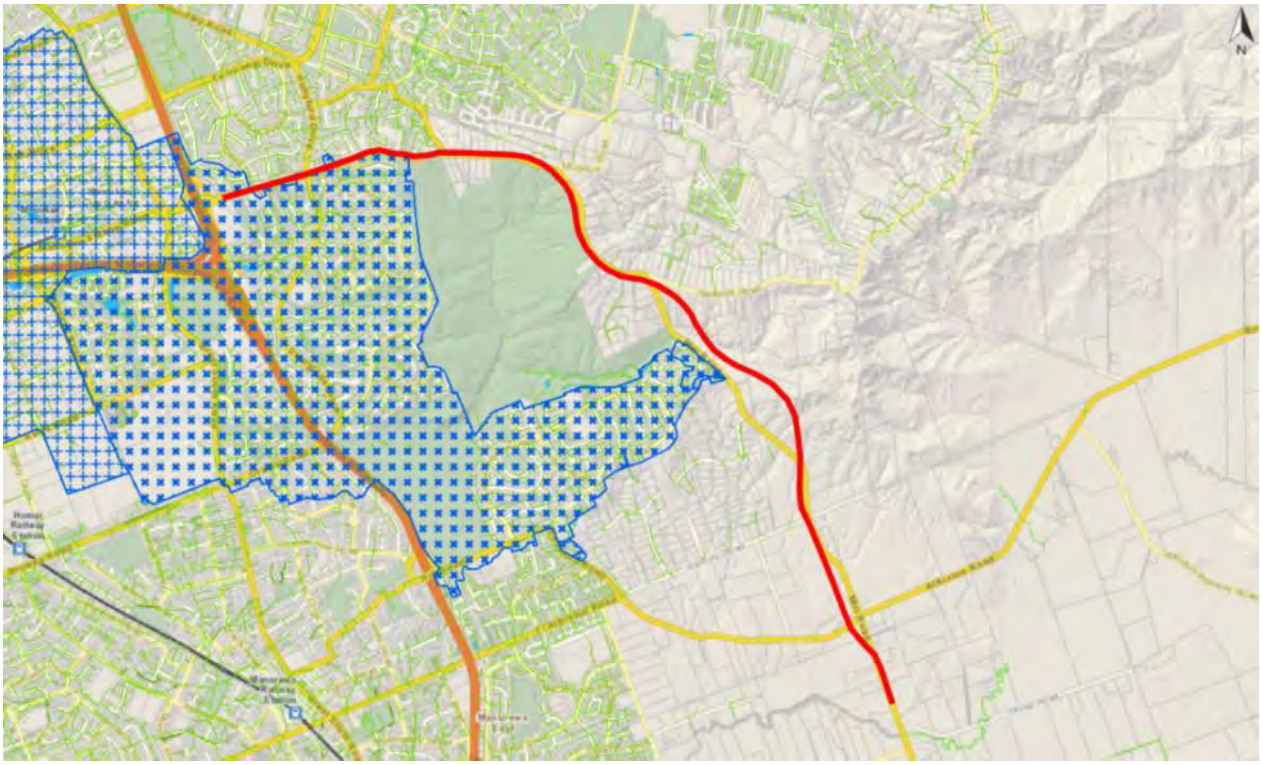


Figure 5: SMAF 1 overlay with proposed road alignment in red. Background image: Auckland Council GeoMaps, accessed July 2025.

4.3 Natural hazards - flooding

4.3.1 General

Existing flood risk along the proposed alignment is minimal, noting that much of the corridor is along a ridgeline. Refer to **Figure 6** for 1% AEP catchment modelled flood extents. There are some minor overland flow paths and localised low / sag points throughout the corridor on Redoubt Road which can be managed with standard road geometry and drainage practices developed through detailed design.

While the existing pipe networks in the urban section have a lower capacity than current standards require (refer Section 4.1.2), the flood risk to properties is low due to most private properties having relatively steep gradients with well elevated buildings and provision made for overland flow paths.

Specific areas of higher flood risk either within the Project area or the receiving environment which have the potential to be exacerbated by the works are discussed below.

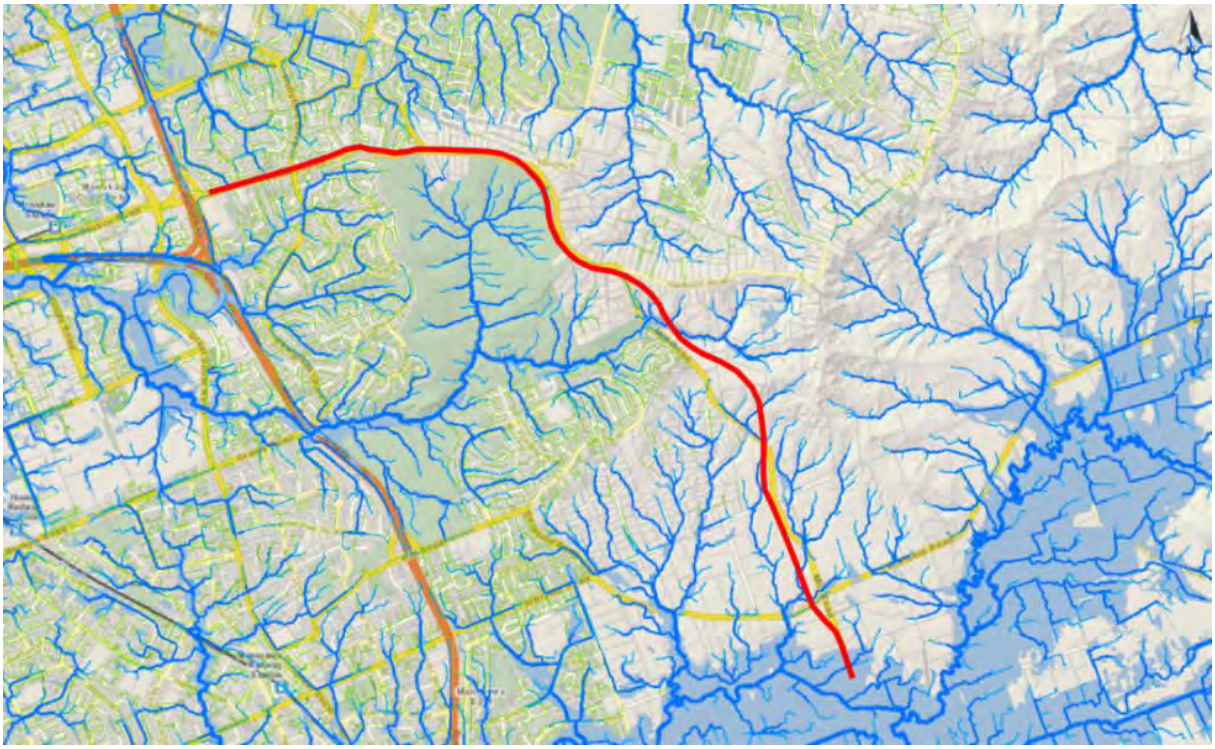


Figure 6: Flood plain and overland flow path with proposed road alignment in red. Background image: Auckland Council GeoMaps, accessed July 2025

4.3.2 Flood risk area – Mill Road southern tie-in

The last approximately 350 metres of the southern end of the alignment (where the Project ties into the existing Mill Road) crosses the Papakura Stream 1% AEP floodplain, as presented in Auckland Council flood extent mapping shown in **Figure 7**.

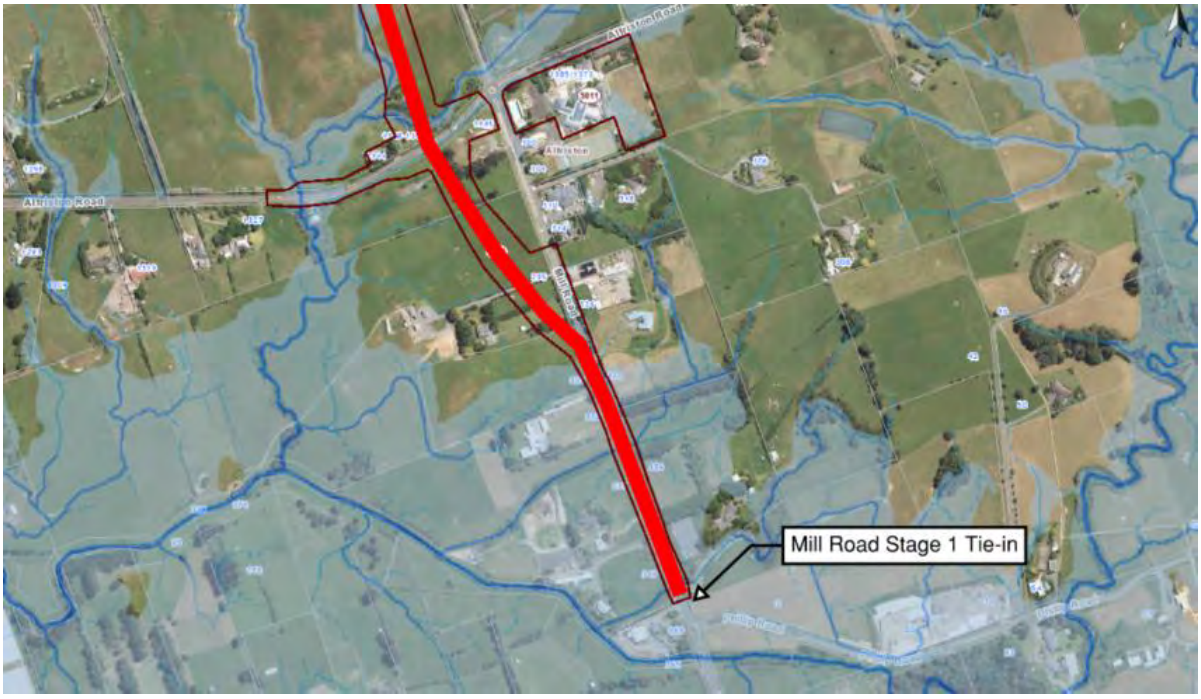


Figure 7: Flood plain and overland flow path with proposed road alignment in red at the southern tie-in. Background image: Auckland Council GeoMaps, accessed August 2025

4.3.3 Flood risk area – Ranfurly Road culvert

There is an existing watercourse and culvert which is predicted to overtop at Ranfurly Road in the 10% AEP event or lower. The proposed works include re-grading of Ranfurly Road above the existing culvert, changing both the minimum road level and the shape of the area where the culvert overtops. These works will change the existing situation by changing the flood overtopping frequency and / or increasing afflux upstream of the culvert and / or increasing peak flow downstream.

4.3.4 Flood risk area – SH1 and Redoubt Road off-ramp

A portion of SH1 and the off-ramp, north of the interchange where the Project extent ties in, is shown on Auckland Council flood maps with an overland flow path along the carriageway and within a 1% AEP flood plain. The area of SH1 subject to flood risk extends approximately 1.4km to the north, between Redoubt Road and Boundary Road / Reagan Road.

A desktop assessment (at the location shown in the red circle in **Figure 8** and **Figure 9**) indicates that more than half of the lane on the off-ramp could be inundated in a 10% AEP event), with conditions worsening in the 1% AEP event.



Figure 8: 1% AEP Puhinui flood plains publish on Auckland Council GeoMaps, accessed August 2025



Figure 9: Draft 1% AEP Puhinui flood plains based on Regionwide Urban Flood Model Unit C, data supplied by Auckland Council Healthy Waters Team, May 2025.

As such, the existing situation along SH1 and Redoubt Road off-ramp does not meet the level of service stated in the current NZTA P46 requirement, in terms of allowable flow spread and depth (refer to **Figure 10** below). Further, the existing drainage network has little resilience in this location, relying on only one catchpit located within a vegetated gully (particularly susceptible to blockage) and a small (300mm diameter) pipeline.

Shoulder and median flow width/depth serviceability standards			
Road type	Maximum Width		Maximum Depth
	10-year ARI (10-minute duration)	100-year ARI (10-minute duration)	100-year ARI (10-minute duration)
Multi-lane roads, on-ramps and off-ramps	No encroachment onto traffic lanes (including priority lanes).	May cover up to one lane (including priority lanes).	100 millimetres within the covered lane.
Two-lane roads, ramps and special lanes	No encroachment onto the traffic lane.	Three metres of the carriageway free of stormwater.	100 millimetres within the covered lane.

Figure 10: Extract from P46 regarding allowable flow widths and depths for both 10-year and 100-year ARI events.

5. PROPOSED STORMWATER INFRASTRUCTURE

The stormwater environment can be categorised into urban and rural environments, with the Tōtara Park entrance/Alexia Place delineating the two areas.

Stormwater runoff from the proposed corridor is to be conveyed by a series of new piped networks. These drain to a combination of management devices to provide treatment for stormwater runoff, detention volume for hydrological mitigation and attenuation for some areas with downstream properties presently subject to flood risk. A combination of green infrastructure (wetland, raingardens and swales) and proprietary devices (underground tank, gross pollutant trap and filter) are proposed where practicable. Most of these management devices will discharge to channel drains or streams via new outlets with erosion protection measures or will connect to an existing Auckland Council or NZTA networks in the urban area.

For the section between Alfriston Road and the Phillip Road tie-in, an open channel system is proposed for stormwater collection rather than a series of piped networks. While not always achievable due to space constraints and / or clashes with property access requirements, this approach is preferred over a piped system for this section due to:

a) Lower capital and carbon costs;

b) Improved water quality outcomes (where open channels are grassed or vegetated);

c) Lower limitation on grades (drive heads); and

d) Greater flexibility for future modifications when the design and construction of the next stage of the Project continues.

Refer to **Figure 11** below for a high-level overview of the proposed stormwater infrastructure for the Project and to **Appendix H1** of the substantive application for stormwater layout plans.

5.1 Mana Whenua Partnership

The stormwater design and philosophy prepared for this application was informed through working in partnership with Mana Whenua. In summary, Mana Whenua has expressed a desire to achieve stormwater water quality outcomes across the Project that are higher than the minimum requirement from a regulatory perspective.

Specifically, Mana Whenua have sought more than “75% total suspended solid (TSS) removal on a long term annual average basis”. To achieve this outcome, pre-treatment (or a “treatment train” approach) has been adopted to increase removal efficiency and resilience where practicable. In addition, vegetated based treatment systems have also been adopted to increase the range of contaminants removed where practicable (i.e. where there is sufficient space).

The stormwater philosophy identifies preferred treatment approaches along the Project corridor and includes the treatment train approach where practicable for the management of stormwater quality effects (as shown in the stormwater layout plans in **Appendix H1** of the substantive application and the catchment plans in **Appendix B**). These outcomes are also provided for through the proposed conditions as further discussed in Section 7.

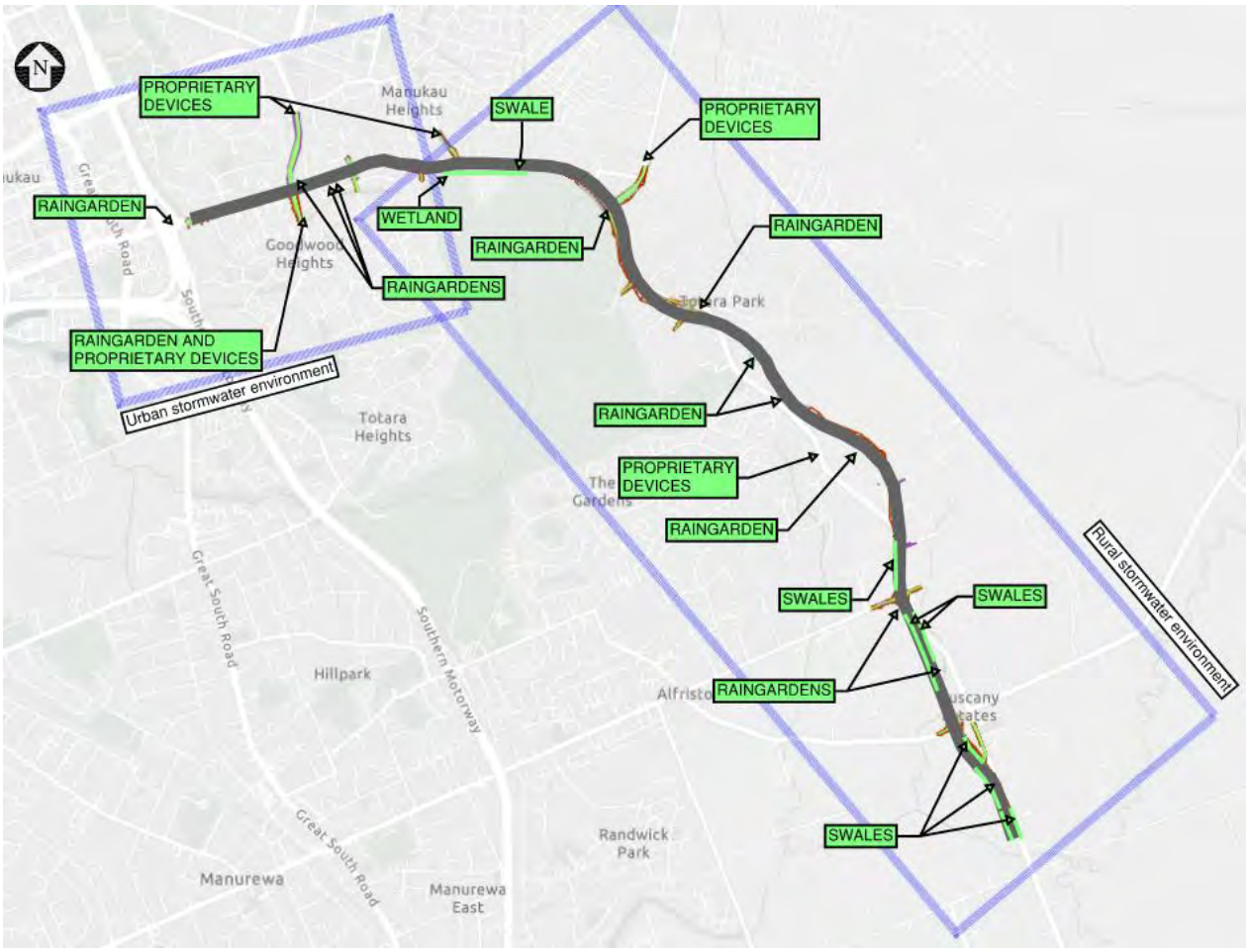


Figure 11: High level summary of proposed stormwater infrastructure and management devices

6. EFFECTS ASSESSMENT AND MANAGEMENT

6.1 Assessment of the design – Urban

In the urban section of the Project (from SH1 to Hilltop Road), the road stormwater drainage system is proposed to discharge via a new stormwater pipe network system with several management devices.

6.1.1 Stormwater quality

All stormwater runoff generated from existing and new road surfaces along the main alignment will be treated before discharge via the new stormwater pipe network proposed under Redoubt Road. The runoff will be treated in cesspits, Gross Pollutant Traps **(GPTs)** and then new raingardens along the corridor before discharging to streams or existing pipe networks.

There are four proposed raingardens along the main corridor, between SH1 and Santa Monica Place, that have been sized in accordance with GD01 design standards to provide water quality treatment. These raingardens have been modelled to demonstrate that there is adequate space available within the designation. Some devices are sized larger than the minimum required by GD01 guidance to achieve the treatments outcomes sought (refer to Section 5.1). There are opportunities to refine the shape and positioning of raingardens at future design phases, provided that the overall ponding area and volume is maintained.

The Hollyford Drive and Everglade Drive carriageways are proposed to be widened for a significant length along their alignment. While green infrastructure is generally preferred for water quality, due to spatial constraints, in-ground proprietary treatment devices are proposed along these local road corridors. A new stormwater pipe network is proposed to collect and convey the runoff to treatment devices before discharging back into the existing piped system. Other local roads are subject to minor modifications at their intersections with the Project corridor, these changes do not warrant new infrastructure as the surface runoff from those areas will continue to drain to the existing stormwater system.

All stormwater devices are sized in accordance with GD01 design guidance where available and in-ground proprietary devices sized in accordance with supplier advice. A higher standard of treatment outcome is achieved in some locations, where larger devices can be accommodated within the designation boundaries.

All proprietary devices will be designed to achieve an equivalent level of contaminant or sediment removal performance to that of GD01 and there are various suppliers who can provide suitable products to achieve these outcomes. Device selection will be finalised through detailed design.

6.1.2 Stormwater quantity - SMAF (retention and detention)

The total retention and detention volumes are catered for by the proposed raingardens along the main corridor and for the local roads (Everglade Drive), by modular underground tank systems. It is noted that SMAF controls do not technically apply over Hollyford Drive, but a modular underground tank system (TD MM01) has been allowed for as part of the design to make provisions for either detention or peak flow attenuation volumes should it be required through a future RWNDC approvals process.

The design includes no retention via infiltration to ground due to geotechnical conditions (the estimated infiltration rate of the surface soils is only 1 – 2mm/hr) and the importance of draining the adjacent new road pavement subsoil layers adequately. Retention via reuse of rainwater from road runoff is not practical for the Project. Therefore, the total SMAF volume is provided as detention only.

In terms of detention device sizing within the urban section, all devices have been sized in accordance with GD01. Raingarden RG MM01 and MM02 are larger than required for SMAF as the sizing of these are driven by attenuation requirements for the primary drainage design. Provision of retention volume can be later included in the design of these devices should geotechnical condition changes with additional investigation results, and these devices are intended to be unlined to encourage infiltration, where practicable.

6.1.3 Primary drainage system

A new stormwater system consisting of pipes, catchpits, manholes and GPTs is proposed along Redoubt Road for the urban section. Catchpits are spaced nominally at 60m centre to centre and the pipe size at the downstream discharge point is expected to be in the order of 675mm diameter or less. The pipe network hydraulics, catchpit spacing and compliance with NZTA P46 requirements will be confirmed as part of detailed design.

Road runoff discharges to stormwater management devices before discharging to the receiving environment. Flows larger than the designed capacity of these devices may be bypassed to avoid damage to the device. Treated runoff will ultimately discharge to the outlets proposed for each device, with outlet erosion protection measures, before flowing into the receiving environment.

An assessment of change in catchment areas and imperviousness has been undertaken along the Project corridor, within the designation boundary, for both the pre- and post-development scenario. The changes

were assessed in order to understand the potential increase in stormwater peak runoff rates and where necessary, size devices to mitigate that increase through attenuation.

The proposed road widening works will not result in an overall increase in imperviousness, due to disestablishment of existing impervious areas from the demolition of existing residential dwellings and returning some parcels to landscaped areas. The results of this analysis are summarised in **Table 2**.

Table 2: Change in catchment area and imperviousness for the pre- and post-development scenario for the urban section

Upstream land use scenario	Project scenario	Total area (ha)	Pervious area (ha)	Impervious area (ha)	Pervious area (%)	Impervious area (%)
Existing	Pre-development (no Mill Road)	11.54	4.56	6.98 (2.80 for carriageway)	39	61
	Post-development (with Mill Road)	11.54	4.51	7.03 (4.05 for carriageway)	39	61
Maximum Probable Development (MPD)	Pre-development (no Mill Road)	11.54	2.36	9.18 (2.80 for carriageway)	20	80
	Post-development (with Mill Road)	11.54	1.93	9.61 (4.05 for carriageway)	17	83

Notes:

1. This is assessed within the designation boundary between SH1 and up to the highpoint near Alexia Place.
2. Imperviousness adopted for:
   a. Existing land use, pre-development condition
      Carriageway (kerb to kerb) = 100%; Kerb to road reserve/lot boundary = 45%; Residential lots = 50%
   b. Existing land use, post-development condition
      As per (2a), and 35% for any residual property areas within designation with the Project in place.
   c. MPD land use, pre-development condition
      Carriageway (kerb to kerb) = 100%; Kerb to road reserve/lot boundary = 90%; Residential lots = 60%
   d. MPD land use, post-development condition
      As per (2d), and 60% for any residual property areas within designation with the Project in place.

The Project is estimated to increase impervious area by approximately 3%, resulting in a negligible increase of peak runoff. On this basis, it is reasonable to conclude that there is no increase to nuisance flooding (considered in the surface water provisions of the Building Act to be flooding to occur in up to the 10% AEP event affecting land rather than buildings) for properties downstream of the Project.

A sensitivity test was carried out to assess the change in peak flow / flow depth in a worst-case scenario. That is, the comparison of change in imperviousness between the current land use scenario without the Project, to the Maximum Probable Development **(MPD)** land use scenario once the Project is in place. Under the MPD post-development case, it was assumed that all areas beyond the kerb and up to the existing lot boundary were developed to 90% imperviousness, and any residual land between the existing lot boundary within designation that is not used for new carriageway or footpath is assumed to be developed to 60% imperviousness. These assumptions result in upwards of a 22% increase in impervious area.

Figure 12 shows selected locations for assessment of flood levels for the pre- and post-development scenario within the urban area, considering the potential impact of a 22% increase in impervious coverage. **Table 4** shows the results of this assessment.



Figure 12: Locations of assessment point for change in flood levels for the 10% and 1% AEP flood event within the urban area

Pre-development 10% AEP event peak flows were estimated using overland flow path peak flow rates published on the Auckland Council's GeoMaps.

Post-development 10% AEP peak flows at the same locations were estimated by approximating the increase in flow using the unit flow rates as shown in the **Table 3** assuming a 22% increase in the total imperviousness of the contributing catchment from the road designation.

Table 3: Unit flow rates for per hectare of increase in impervious area from Project within the designation boundary in the urban area

AEP %	24hr Design Rainfall Depth (mm)	Climate change scenario	Runoff Peak Flow (m3/s), for 1ha of catchment		
			0% impervious	100% impervious	Difference
10	145	Existing	0.180	0.267	0.087
10	170	2.1°C	0.225	0.313	0.088
1	223	Existing	0.298	0.378	0.080
1	296	3.8°C	0.488	0.575	0.087

Table 4: Estimated change in flood levels for the 10% AEP flood event within the urban area

Location	10% AEP peak flow (m^3/s)		10% AEP water surface level (RL m)		
	Pre	Post	Pre	Post	Change (m)
A	1.24	1.49 (1.33)	34.86	34.87 (34.87)	0.008 (0.003)
B	0.51	0.86 (0.59)	39.10	39.12 (39.11)	0.021 (0.006)
C	1.54	1.56	38.47	38.47	0.001
D	1.53x	1.55	43.84	43.84	0.000
E	0.83	0.85	61.72	61.72	0.001
F	1.27	1.36	51.04	51.05	0.002
G	1.75	1.79	61.85	61.95 (61.87)	0.097 (0.020)
H	2.63	2.67	81.88	81.88	0.002
I	4.79	4.87	57.08	57.08	0.005
J	4.79	4.87	56.38	56.38	0.001

Notes:

1. Peak flow and water surface elevations are computed with 61% imperviousness for the pre-development condition, and 83% impervious for the post-development condition under the MPD scenario
2. The water surface elevation presented above is based vertical datum in NZVD2016, except for location G is reported in AVD1946
3. 10% AEP peak flow
    a. Pre-development: estimated using a combination of both the existing and 3.8°C 10% AEP event, were adopted for estimation of the 2.1°C 10% AEP peak flow
    b. Post-development: estimated by approximating the increased in flow due to additional imperious area, using the unit flow rates as shown in the **Table 3** and assuming a 22% increase in the total imperviousness of the contributing catchment from the road designation
    c. Peak flow shown for location A, B and G are calculated based on catchment delineation
4. Numbers in (bracket) represent results with mitigation measures in place, if applicable

The results shown in **Table 4** further demonstrate that for the majority of offsite properties downstream of the Project, no increase to nuisance flooding up to the 10% AEP event is predicted as the change in flood water elevation is typically under 10mm with no buildings affected. The highest calculated flood level increase is at location G (refer **Figure 12**) and is approximately 100mm with no buildings affected. This represents the worst-case scenario using the conservative land use case of 22% impervious area increase.

Mitigation measures have been allowed for in the Project design at Location A, B and G to minimise the predicted increase in flood elevation. These are detailed in Section 6.1.3.1 and 6.1.3.2 below. Otherwise, no mitigation is required for events to the 10% AEP event along the Project corridor.

6.1.3.1 Locations A and B - SH1 and Redoubt Road off-ramp

The predicted increase in water level due to the Project can be mitigated through the implementation of device rain garden RG MM01, as shown on DR-0502 and DR-0503. This will maintain the existing flood risk along the SH1 and Redoubt Road off-ramp to be no worse than existing. The Project works will retain the existing level of service, which does not meet the NZTA P46 requirements at this location.

6.1.3.2 Location G – Hollyford Drive grading

The combination of the proposed grading along Hollyford Drive (shifting in crown) and widening (increase in impervious area) at the intersection upstream causes a two or threefold increase in catchment area draining towards the southbound side.

Based on the geometric design, the Project could cause an increase of approximately 100mm in flood water elevation that will extend up to the property boundary of 1/1B Aspiring Avenue but remain within the road reserve. The change in flood elevation is mainly due to the change in road vertical levels and the tie-in design being narrower than the existing carriageway.

The increase in road surface elevation shown in the design will cause a reduction in freeboard to the building at 1/1B Aspiring Avenue when assessed against the 1% AEP event as assessed in **Table 5** below. This impact on freeboard will be sensitive to any changes in road geometry and drainage design but can be adequately mitigated through detailed topographic survey and design. A condition requiring assessment of freeboard to buildings at this location is recommended.

6.1.4 Secondary drainage system, overland flow and flooding

During the 1% AEP flood event and under the assumption that the primary drainage system is blocked or at capacity, the change in flood risk to downstream properties has been assessed at the locations shown in **Figure 12** above. **Table 5** shows the results of this assessment and the estimated change in freeboard to adjacent buildings.

Table 5: Estimated change in flood levels for the 1% AEP flood event within the urban area

Location	1% AEP peak flow (m^3/s)		1% AEP water surface level (RL m)			Estimated floor level (RL m)	Freeboard (m)	
	Pre	Post	Pre	Post	Change (m)		Pre	Post
A	2.44	2.44	34.89	34.89	0.000	n/a	n/a	n/a
B	1.01	1.01	39.13	39.13	0.000	n/a	n/a	n/a
C	3.15	3.17	38.54	38.54	0.000	39.50	0.96	0.96
D	3.14	3.16	43.92	43.92	0.000	44.16	0.24	0.24
E	1.69	1.71	61.82	61.83	0.002	Refer to Section 6.1.4.1		
F	2.56	2.60	51.08	51.08	0.001	52.00	0.92	0.92
G	3.47	3.51	61.87	62.08	0.205 (0.037)	62.10	0.23	0.02 (0.19)
H	5.48	5.51	81.99	81.99	0.002	85.06	3.07	3.07
I	9.92	9.99	57.30	57.31	0.003	58.00	0.70	0.70
J	9.92	9.99	56.43	56.43	0.001	58.00	1.57	1.57

Notes:

1. Per notes in **Table 4**
2. Unless otherwise noted, change to freeboard to nearby habitable floor levels are assessed by deducting the estimated existing freeboard by the increased in flood water depth, for places where the nearby habitable floor level is higher than the road level.

The assessment results presented in **Table 5** assume that the Project will maintain conveyance of the existing OFPs at the locations potentially impacted by the Project works (refer **Table 6**), as they flow along the corridor or across at any sag points.

A review of proposed levels has confirmed that these OFP can generally be maintained or will be able to be maintained with refinement in the geometric design in the detailed design stage. Refer to **Table 6** below.

Table 6: Existing OFPs to be maintained by the Project

OFP Location	OFP assessment
SH1 / Redoubt Road southbound on-ramp 	OFP will be maintained as the Project ties into the kerb lines at this location. The OFP will continue to flow to the south.
16 Redoubt Road 	OFP will be maintained with design refinements to be made at the detailed design stage. This can be achieved through grading adjustments and introducing a break within the continuous raised median to maintain OFP, allowing flows to continue to the north. Refer to freeboard to habitable floor level commentary as noted in Section 6.1.4.1
38 Redoubt Road 	OFP will be maintained with design refinements to be made at the detailed design stage. This can be achieved through grading adjustments and introducing a break within the continuous raised median to maintain OFP, allowing flows to continue to the north.

OFP Location	OFP assessment
Redoubt Road / Hollyford Drive intersection 	OFP will be maintained with design refinements to be made at the detailed design stage. Grading adjustment is required at the intersection to maintain OFP through the intersection, allowing flows to continue to the north. Also, refinement of the geometric design is required as noted in Section 6.1.3.2 to avoid adverse impact on building freeboards.
Redoubt Road / Goodwood Drive intersection 	OFP will be maintained as the Project ties into the kerb lines at this location, allowing flows to continue to the south.

6.1.4.1 Location E - 16 Redoubt Road: freeboard to existing habitable floor

Due to the existing building at 16 Redoubt Road being lower than the road level, a site-specific approach (which differs from the method used in **Table 5** for other properties) has been adopted.

The change in water depth was assessed by approximating the overtopping flow for the pre- and post-development condition over the kerb line and the footpath and applied to sheet flow over the yard. This increase was estimated to be less than 5mm under the MPD case when it reaches the front entrance of the building.

As shown in **Figure 13**, the front threshold is elevated above the surrounding ground by a set of stairs and a porch area, by approximately 300mm. The existing freeboard provided to this building is less than the minimum requirement specified in the assessment criteria, being that a minimum 500mm freeboard is required for habitable floors. It is therefore recommended that this site specific mitigation is confirmed at a later stage and informed by detailed topographic survey of the area, refined geometric design and a detailed hydraulic assessment. A condition requiring assessment of flood risk to buildings at this location is recommended.



Figure 13: Image of 16 Redoubt Road. From Google Street View, accessed Sept 2025.

6.1.4.2 Flood hazard and public safety

The Project is not expected to create new flood hazard and/or increase existing level of existing flood hazards, to public road users or pedestrians as those matters will be adequately managed by application of current design standards (NZTA P46 and / or Council Codes of Practice) to the road upgrades.

6.1.4.3 Bridges, culverts and fish passage

There are no new bridges or culverts within this urban section.

6.2 Assessment of the design - Rural

This covers the 6km section of the Project from Alexia Place/Tōtara Park carpark to Phillip Road. Much of the rural section of the Project is adjacent to Tōtara Park, with the designation passing through mostly rural land and sections of established bush (Cheesman's Bush and Puhinui Gully).

The proposed stormwater system includes network of pipes and swales for primary flow, stormwater management devices for water quality and detention functions and cross culverts for overland flow.

6.2.1 Stormwater quality

All stormwater runoff generated from new road surfaces along the main alignment will be treated before discharging to the receiving environment. The water quality treatment regime consists of a series of vegetated swales, raingardens and one constructed wetland designed in accordance with GD01, as well as two proprietary devices where space does not allow for nature-based solutions.

There are eight proposed raingardens between Murphy's Road and Alfriston Road that have been sized in accordance with GD01 design standards to provide water quality treatment. These raingardens have been modelled to demonstrate that there is adequate space available within the designation. There are opportunities to refine the shape and positioning of raingardens at future design phases, provided that the overall ponding area is maintained.

The Project design proposes eight treatment swales with varying dimensions. Swales 1 to 4 will discharge runoff to raingardens, thus providing a two stage treatment train while Swales 5 to 8 will have check dams and discharge treated runoff from outfalls into the receiving environment.

The design proposes two proprietary devices on two local roads, Hilltop Road and Murphy Road, where there is insufficient space for bioretention or other types of GD01 devices. Proprietary devices are proposed as an alternative to GD01 devices and can achieve an equivalent level of contaminant removal performance (in terms of TSS) to that of GD01. There are various suppliers who can provide suitable products and final device selection can be finalised through detailed design.

All nature-based stormwater devices are sized in accordance with GD01 design standards. A higher standard of treatment outcome is achieved in locations where some devices are larger than the required minimum (where space allows) or are in a treatment train, with swales and / or GPTs providing pre-treatment before filtration through raingardens or the wetland.

6.2.2 Stormwater quantity - SMAF (retention and detention)

The rural section is not within a SMAF zone. However, new outfalls will discharge to stream receiving environments and have impervious areas greater than 5,000m^2, and therefore under Chapter E8.6.4 of AUP, detention of the 95th percentile event (equivalent to SMAF 1) has been applied.

All raingardens for the rural section have been sized in accordance with GD01, providing both water quality treatment and detention for stream protection. As noted in Section 6.1.2, the estimated infiltration rate of surface soils is between 1-2 mm/hr, which is insufficient for groundwater recharge and reuse of rainwater is not practical for the Project. Therefore, it is proposed that the retention volume be provided as detention – in other words the full hydrology mitigation volume will be provided as detention.

The constructed wetland (Wetland 1) size is based on GD01 standards to provide water quality treatment and hydrology mitigation for stream protection. Based on the design and catchment delineated, the proposed wetland will provide the required 972 m^3 of permanent water volume (for water quality) and 1,063 m^3 live storage for detention of the 95th percentile rainfall event (for stream protection).

To achieve 95th percentile detention at Hilltop Road and Murphy Road, modular underground tanking systems are proposed in the design. Modular solutions provide flexibility in terms of footprint and volume, but other detention options could be considered at later design stages.

Swales 5, 6, 7 and 8 will have check dams at least 150mm in height, a small longitudinal gradient and large cross-sectional area, thus providing a form of detention. Check dam details and swale geometry could be optimised in detailed design.

Provision of retention volume can be later included in the design of raingardens and swales should geotechnical condition changes with additional investigation results, and these devices are intended to be unlined to encourage infiltration, where practicable.

6.2.3 Primary drainage system

A new stormwater system consisting of pipes, manholes, catchpits and GPTs is proposed along the new road alignment. Catchpits are spaced nominally at 60m intervals and pipe sizes at discharge points are expected to be 675mm diameter or less. Pipe network hydraulics, catchpit spacing and compliance with NZTA P46 requirements (and other relevant standards) can be confirmed as part of detailed design.

Road runoff for smaller events will drain to various stormwater management devices before discharging to the receiving environment. Flows larger than the designed capacity of treatment devices may bypass the

treatment devices, generally through an external bypass arrangement. Stormwater will ultimately discharge to the outlets proposed for each device with adequately sized erosion protection measures, before flowing into the receiving environment.

Existing network capacity is not a constraint for the rural section. The proposed primary drainage system will discharge to a series of new outfalls to be established at suitable locations such as streams or open channel systems. These existing channels or streams are well defined and incised and are able to contain the 10% AEP event within riparian margins as inferred from Auckland Council's GeoMaps floodplain mapping. While some increase in peak 10% AEP flows may occur, no downstream flooding effects are anticipated. Therefore, no mitigation is proposed for the primary system (that is, up to the 10% AEP event) along the Project corridor in the rural section.

6.2.4 Secondary drainage system, overland flow and flooding

The Project is estimated to have a total of 12 hectares of road impervious area (new and redeveloped impervious area). Runoff will be treated and detained by swales, GPTs and the proposed raingardens and wetland noted above, before discharging to the receiving environment.

The receiving environments generally consist of tributaries of the Puhinui Creek within Tōtara Park or streams within the Papakura Stream catchment through rural land. These streams are within large open space where we expect flow to be contained within the existing channel and riparian margins. The increase in imperviousness will result in minimal change of flood water elevation. The assessed locations are shown in **Figure 14** where the change in peak flow and flow depth due to the proposed changes in imperviousness from the Project was evaluated. **Table 7** shows the results of this assessment.

New or additional flood risk is not anticipated (upstream or downstream) between Hilltop Road and Kinnard Lane where the proposed carriageway follows an existing ridgeline. Minor overland flow paths, where crossed by the new road embankment are preserved by new culverts. Refer to Section 6.2.4.2 for detailed assessment of cross culverts.

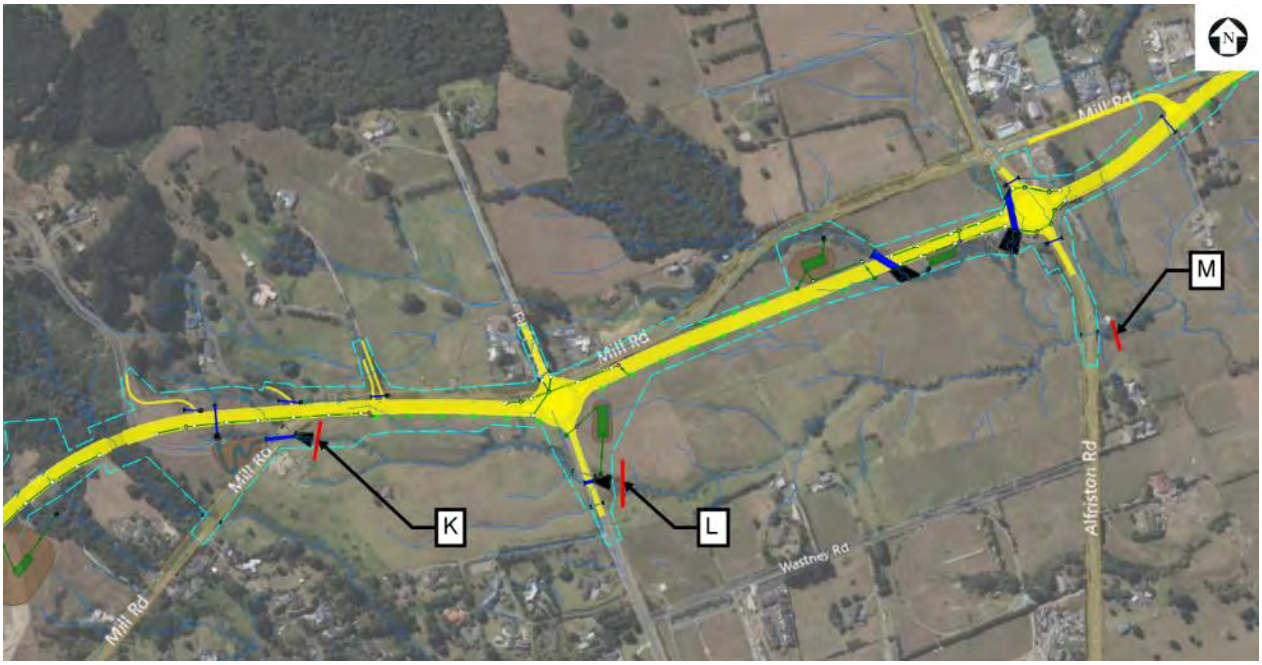


Figure 14: Locations of assessment point for change in flood levels for the 1% AEP flood event within the rural area

Table 7: Estimated change in flood levels for the 1% AEP flood event within the rural area

Location	1% AEP peak flow (m^3/s)		1% AEP water surface level (RL m)			Estimated floor level (RL m)	Freeboard (m)	
	Pre	Post	Pre	Post	Change (m)		Pre	Post
K	5.49	5.57	54.548	54.552	0.004	n/a	n/a	n/a
L	9.85	10.00	34.003	34.009	0.006	n/a	n/a	n/a
M	52.09	52.56	20.699	20.705	0.006	20.16	-0.539	-0.545

Notes:

1. The water surface elevation presented above is based vertical datum in AVD1946
2. Peak flow and water surface elevations are computed the based on the following imperviousness, based on the existing land-use scenario
3. Imperviousness adopted for:
    a. Carriageway = 100%; Farmland / rural lots = 10%
4. Unless otherwise noted, change to freeboard to nearby habitable floor levels are assessed by deducting the estimated existing freeboard by the increased in flood water depth, for places where the nearby habitable floor level is higher than the road level.

For assessment location K and L, the results presented in **Table 7** shows an increase in water surface elevation for the 1% AEP event, however the flood plain is contained within existing streams and channels, there is no increase in flood risk and there are no existing buildings located adjacent to the assessed location. The flood effect at location M is further discussed in detail in the section below.

6.2.4.1 Locations M - 3/1327 Alfriston Road

At location M, it has been determined that the existing building at 3/1327 Alfriston Road is inundated during a 1% AEP flood event. This finding aligns with the flood mapping shown on Auckland Council's GeoMaps viewer. The building is likely used for industrial or commercial activities as indicated in the legal descriptions of the land parcel and the large number of cars parked at the front of the property (as shown in **Figure 15**). We have determined that the building currently does not have any freeboard to the 1% AEP flood event and the Project could potentially worsen the flood level at this location by an estimated 6mm based on peak flows generated from the additional impervious areas from the road.



Figure 15: Image of 3/1327 Alfriston Road. From Google Street View, accessed Sept 2025.

The estimated change in the 1% AEP flood level is small but considering that that building is already subject to flooding, mitigation should be provided so that flood risk to buildings is not exacerbated by the Project. There are a range of options that could be considered during detailed design, such as:

a) Upsizing Swale 2, 3, 4 and RG MM11 for attenuation of part of the road catchment;

b) Opportunity within 116 Ranfurly Road (subject to final land negotiation) to provide additional flood storage. We understand the designation at this location is proposed to be extended to the stream and the flood storage design can be incorporated with the ecological offset measures proposed here;

c) Opportunity for attenuation upstream of the proposed culvert CUL MM06 as part of creating a new wetland area for ecological mitigation; and

d) Reduce the inletting capacity of the existing culvert under Alfriston Road (e.g. choke the culvert by installing an orifice plate or sleeve a smaller pipe).

This impact of flood risks at this location can be adequately mitigated through the approaches listed above. Because of the scale of the potential effect (estimated as a 6mm flood level increase) it is recommended that this mitigation is confirmed as a later stage and informed by detailed topographic survey of the area and detailed design. A condition requiring assessment of flood risk to buildings at this location is recommended.

6.2.4.2 Bridges, culverts and fish passage

The design has adopted the following approach for flood resilience of road infrastructure:

a) Set the corridor vertical alignment above the 1% AEP flood plain;

b) Providing 0.5m freeboard for culverts between the headwater level and edge of the corridor in the 1% AEP rainfall event; and

c) Provide freeboard to new bridges in accordance with the NZTA Bridge Manual requirements.

These are further assessed in detail in the sections below.

Figure 16 and **Figure 17** demonstrate how flood criteria can be achieved for the two proposed bridges – Puhinui Gully Bridge and Cheesman's Bush Bridge.

Puhinui Gully Bridge:

a) Floodplain data was obtained from the Draft Puhinui Flood Model (Auckland Council, received May 2025);

b) The estimated flood level is approximately RL 70.5m (NZVD2016) / RL 70.76 m (AVD46);

c) Includes allowance for 3.8°C climate change;

d) New stream diversion governed by ecological reason, as detailed in Section 6.2.5.2; and

e) Relocated watermain is assumed to be attached to the new Puhinui Gully Bridge columns with minimum freeboard provided and does not obstruct the flows in a flood event.

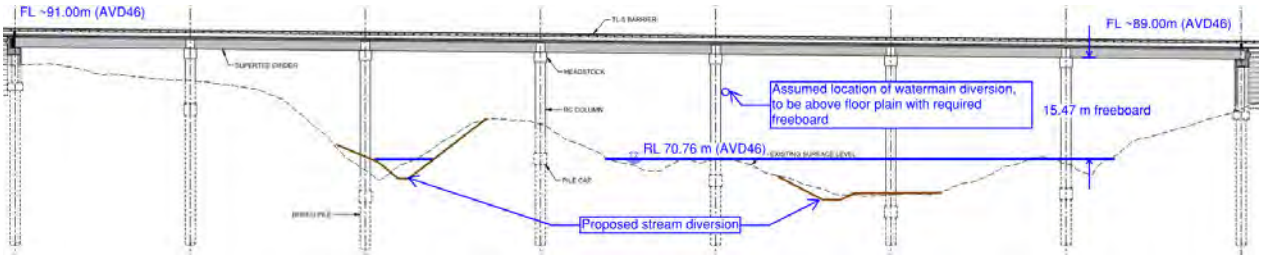


Figure 16: Puhinui Gully Bridge Freeboard (1% AEP flood event, +260mm conversion to AVD46)

Cheesman's Bush Bridge

a) Floodplain data was obtained from the published Papakura floodplain data (AC GeoMaps);

b) The estimated flood level is approximately RL 71.2m (NZVD2016) / RL 71.46 m (AVD46); and

c) Includes allowance for 3.8°C climate change.

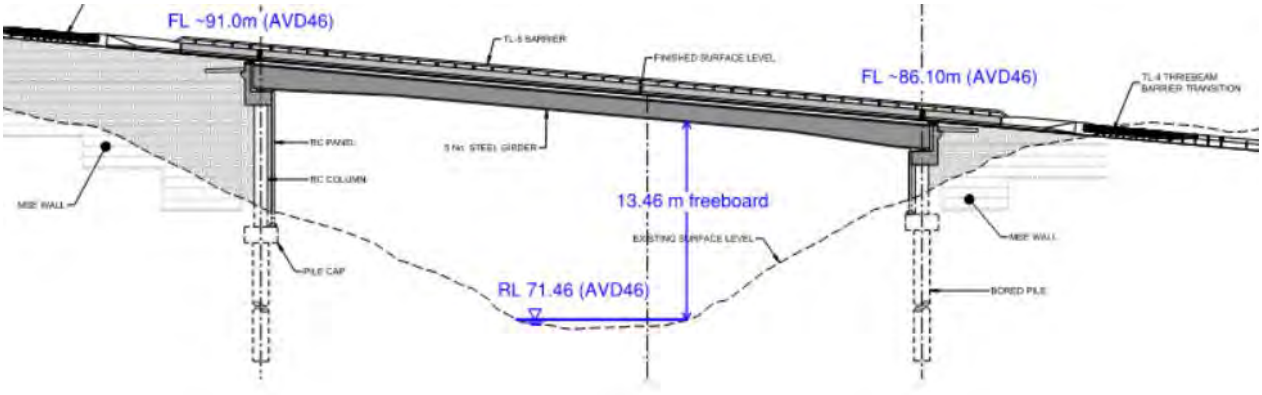


Figure 17: Cheesman's Bush Bridge (1% AEP flood event, +260mm conversion to AVD46)

As shown above, the new Puhinui Gully Bridge and Cheesman's Bush Bridge spans are well clear of the existing stream and the 1% AEP flood plain and are set above the flood level by ample amount of freeboard (13m and more) due to ecological reasons. Therefore, the new bridges can accommodate the 1% AEP without increase flood levels.

Culverts and fish passage

The design includes multiple new cross culverts for the rural section, with circular culverts ranging between ≤0.6m diameter and 1.65m diameter in size and box culverts up to 1m(H) x 8m(W). New culvert crossings have been designed to convey overland flow from the 1% AEP rainfall event, allowing for 3.8°C climate change. New culverts located south of Cheesman's Bush Bridge also provide for fish passage due to the identification of fish habitat by the Project ecologists.

Most culverts discharge to tributaries of the Puhinui Creek within Tōtara Park or within the Papakura Stream catchment discharging to existing streams through rural land. As noted previously, these are large open spaces where we expect flow to be contained within the existing channel and there is minimal risk to people and property if flood water levels do increase either from afflux upstream of culverts or increased flow downstream.

We have also completed a high-level assessment of effects at culverts located adjacent to properties with existing dwellings by estimating existing floor level from survey and LiDAR and comparing with calculated headwater levels at new culvert crossings. The assessment found that the ground levels at adjacent

properties were well above the water level, with the worst case being 700mm above the water level – refer to **Table 8**.

Table 8: Assessment of flood effects at culvert crossings

Culvert ID	Designed Headwater Level (RL m)	Estimated minimum ground level at adjacent property (RL m)	Estimated Freeboard (m)
CUL MM02	99.00	105.0	6.00
CUL MM02A	102.70	103.4	0.70
CUL MM03	95.44	100.0	4.56
CUL MM03AA	94.50	97.0	2.50
CUL MM03A	68.53	73.0	4.47

This assessment included major culverts only. Culverts at driveway crossings or conveying minor overland flow paths will be sized to not create upstream or downstream flood effects. Two locations of existing flood risk to the road were identified as assessed in greater detail as below:

a) Culvert CUL MM10 which is not compliant with NZTA's P46 requirement for cover and conveyance capacity due to the road vertical level at the tie-in point and an existing catchment wide flooding issue (refer to Section 6.2.4.3 on the impact of the Project in this location); and

b) Culvert CUL MM04B (assessed further in Section 6.2.4.4) as the culvert will provide improved flood resilience achieved by Ranfurly Road at this location.

6.2.4.3 Flood risk area – Mill Road southern tie-in with 1% AEP flood plain

As noted in Section 4.3.2, approximately 350m of new carriageway (CH 16750 and CH 17100) that ties into the existing Mill Road (southern extent of site) will be located within a 1% AEP flood plain. Based on existing ground levels and the flood plain extent, the water surface elevation is estimated to be RL 20.3m. The proposed road elevation is between CH 16750 and CH 17100 ranges between RL 22.6m and 19.7m. The road level remains within the flood plain so that it ties into existing levels at the end of the designation.

Several properties adjacent to the southern extent of the Project are within the Papakura Stream catchment and the associated 1% AEP flood plain and most of the existing dwellings could be inundated under the existing scenario. The volume of displaced flood plain resulting from the new road alignment is approximately between 2,000 to 3,600 m^3. This will be partially offset by swales on either side of the carriageway which will store approximately 1,200 m^3 of floodwaters leaving a residual volume of approximately up to 2,400 m^3 of displaced floodwaters. The area of flood plain coinciding with the new road alignment is a small proportion of the overall Papakura Stream 1% AEP flood plain, which has a total contributing catchment of approximately 56km^2 with 265 m^3/s peak flow in the 1% AEP event.

Flood effects observed at this location are mostly a result of catchment-wide issues, predominately caused by a series of constrictions at Great South Road, SH1 and KiwiRail bridges and a lack of channel capacity along the lower reaches cause flooding in the lower catchment.

The residual flood volume offset by the Project of 2,400 m^3 has negligible impact on the existing flood risk

6.2.4.4 Flood risk area – Ranfurly Road culvert

As noted in Section 4.3.3, under the existing scenario the road overtops in the 10% AEP event or lower. The proposed works include regrading of the road sag point above the existing culvert, changing both the minimum road level and the shape of the area where the culvert overtops.

Due to the change in road level and requirement to improve fish passage design at this location, an opportunity was created to improve the flood resilience of the road at this location. The box culvert was designed and assessed to be able to convey the 1% AEP event with more than 500mm freeboard provided to the new road level, which is a significant improvement to the existing situation (**Figure 18**).

It is anticipated that flow will be contained within the existing channel both upstream and downstream of the culvert and there will be no adverse flood effects to both upstream and downstream properties.

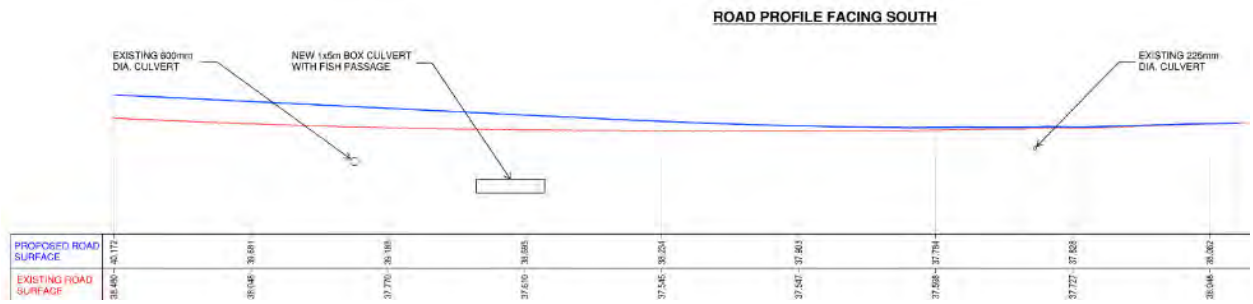


Figure 18: Ranfurly Road long section at sag point

6.2.5 Ecological considerations and receiving environment

6.2.5.1 RG MM06 - stream near Murphy Road

The proposed vertical geometry of the carriageway between Murphy Road and Mill Road will divert some catchment away from a tributary of Puhinui Creek within Tōtara Park. It is estimated that a total of 0.71 hectares of catchment could be diverted away from this stream due to the proposed primary network directing runoff to the west and into Wetland 1. Refer to **Figure 19** for the change in catchment. The green area (shown in the left image) is the existing catchment area that drains to the existing stream and the red area (shown in the right image) will be the residual of the existing catchment area that would continue to drain to this stream.

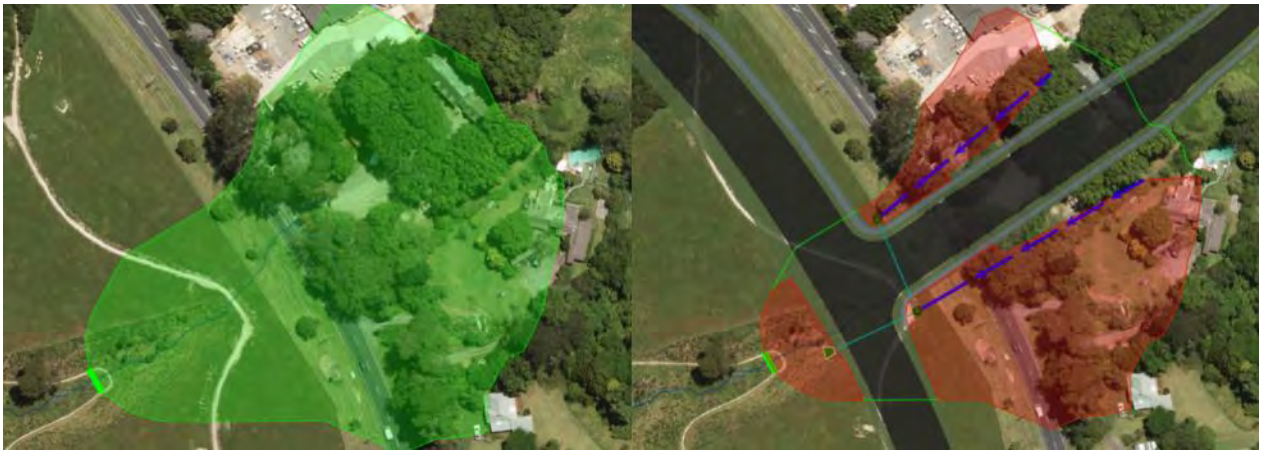


Figure 19: Change in catchment to a tributary of Puhinui Creek within Tōtara Park, by Murphys Road.

This stream is intermittent, transitioning to permanent further downstream and contains wetland habitat. The project hydrogeologist has confirmed that this stream is not fed by groundwater. As such it is proposed that the loss in catchment is offset by directing a portion of road catchment to a treatment raingarden (RG MM06) and then discharging the treated runoff to the stream to provide some baseflow.

6.2.5.2 Puhinui Creek diversions at new Puhinui Gully Bridge

Diversion of two low flow channels (stream S12 and S13) is proposed beneath the proposed Puhinui Gully Bridge to avoid the location of new bridge piers. The new stream cross section will mimic the existing and will be formed with side cut slopes of 1H:2V on the riparian margins where vegetation is expected to be re-established over time.

6.2.5.3 RG MM10 – significant mature trees

The location of the treatment raingarden has been located such that the required earthworks extent avoids mature trees in the gully.

6.2.5.4 CUL MM04 and MM04A - stream diversion

The design proposes to divert an existing reach of stream near CH 15000 via culvert CUL MM04, with a new reach of stream constructed on the western side to offset the stream loss on the eastern side of the carriageway. The stream diversion design is assessed to be adequately sized to contain the 10% and 1% AEP peak event, and the low flow channel can be easily accommodated within the overall stream channel.

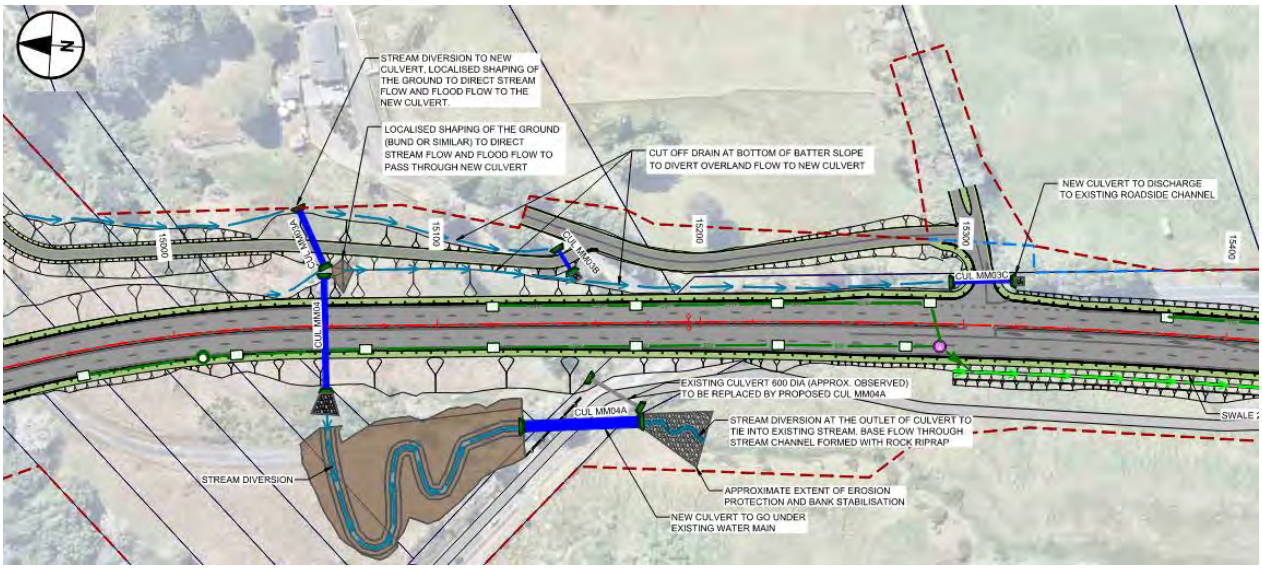


Figure 20: Proposed stream diversion between CUL MM04 and CUL MM04A

6.2.5.5 Culvert outlets

Riprap aprons, typically with headwalls are proposed at all culvert outlets for energy dissipation and scour protection. The rock sizing and apron dimensions have been designed in accordance with GD08 for the 1% AEP peak flow rate. This approach represents a conservative design approach, particularly where culvert dimensions have been sized to achieve fish passage requirements rather than flood management requirements. It is anticipated that the rock riprap extent can be reduced and concrete aprons eliminated in some cases and / or more natural erosion protection measures could be adopted through site specific detailed design.

6.3 Outcome of the assessment

We have reviewed the design of the Project and have concluded the following:

6.3.1 Positive effects

- Water quality effects will be positive for both the urban and rural sections as currently there is limited stormwater treatment provided. The Project will provide stormwater treatment of runoff from all new impervious, and some of existing areas in line with AUP;
- Stream hydrology effects are positive due to the detention volumes provided in the proposed devices for the urban section and are managed in line with the requirements of the AUP; and
- The Project will result in a reduction to flood hazard to road users at Ranfurly Road.

6.3.2 Adverse effects

- Potential adverse effects are negligible and / or managed to appropriate current standards.

6.3.3 Recommended measures to avoid, remedy, or mitigate effects

Mitigation measures detailed throughout the report will effectively manage stormwater effects associated with the Project, so that that adverse effects are avoided, remedied or mitigated. The Project will be constructed in general accordance with the stormwater plans, 60755376-SHT-DR-0100 to DR-0508, which incorporates the stormwater management system which will manage the potential adverse effects. Mitigation measures include:

a) Inclusion of recommended outcomes to be achieved by conditions as per Section 7;

b) Inclusion of flood attenuation volumes into proposed rain garden RG MM01, as shown on DR-0502, to manage increase in runoff from the Project which otherwise will exacerbate existing flooding along the SH1and Redoubt Road off-ramp;

c) Geometric design of Hollyford Drive to be refined such that the reduction to the freeboard of the adjacent nominated at-risk residential buildings is minimised; and

d) Measures to increase attenuation at or upstream of the existing Alfriston Road culvert to avoid any peak flow increase in the stream adjacent to the existing commercial buildings immediately downstream.

7. PROPOSED CONDITIONS

The proposed conditions will require construction in general accordance with the Stormwater Plans in **Appendix H1** of the substantive application. In addition, we recommend a set of stormwater specific conditions are included as part of the substantive application to address the following matters:

1. Estimation of stormwater runoff various design events is to be carried out in accordance with TP 108, with climate change adjustment factors applied in accordance with Table 1 and Table 2 of the AC SWCOP.
2. Project to provide water quality treatment of stormwater runoff for all high contaminant generating impervious areas and these should be designed in accordance with GD01. Alternative designs will be accepted provided that it is demonstrated that they will achieve an equivalent level of contaminant removal performance to that of GD01 or can be shown to be the Best Practicable Option. Pre-treatment measures should be provided to reflect Mana Whenua partnership outcomes, where practicable.

3. Hydrology mitigation volumes shall be provided by the Project for all impervious areas, per AUP SMAF rules and GD01 guidance.
4. Outlet erosion protection measures to minimise scour and erosion potential shall be designed in accordance with good practice guidance. This may include GD08 and HEC-14, or similar. Outlet geometry shall avoid perching, maintain fish passage where applicable, and dissipate energy to stable receiving environments.
5. Where erosion protection measures are in streams, the final design shall adopt green infrastructure and natural-based solutions. The use of large extent of concrete structure should be avoided where practicable.
6. The Project shall be designed to have no increase in flood risk to adjacent buildings up to the 1% AEP event, and specific flood assessments are required for the following locations identified as being subject to higher flood risk:
    a. 16 Redoubt Road
    b. 1 / 1B Aspiring Road
    c. 3/1327 Alfriston Road
7. Where the Project modifies an Overland Flow Path, the design shall provide for the continued passage of flow in a manner which manages potential effects upstream and downstream of the modified Overland Flow Path.

8. CONCLUSION

We have reviewed the proposed amendments to the designation and the current design of the Project.

The total Project area will be treated by new treatment devices including swales, raingardens and wetlands. Most of these devices will also provide hydrology mitigation volume for stream protection. Where space is limited, underground proprietary devices (or series of devices) are proposed. Pre-treatment is also proposed along the corridor through swales, catchpits and GPTs, which will result in a higher level of treatment outcome than the minimum design standard.

New freshwater ecological environments created by the proposed stream diversion will mitigate the stream loss due to the proposed road embankment near CH15,000. Fish passage is provided in new culverts where fish habitats have been identified by the Project ecologists.

Flood effects to downstream and upstream properties and dwellings resulting from the Project are negligible. This outcome is further safeguarded by the proposed conditions and mitigation recommended for the properties that have been identified as being particularly vulnerable to flood impacts. The proposed flood hazard conditions include a requirement for the design to demonstrate that there will be no increase in flood risk in a 1% AEP event at those locations.

Due to the inclusion of water quality management devices, there will be an overall positive effect on stormwater treatment. Potential adverse water quantity effects (stream hydrology and flood risk) are negligible and / or managed to appropriate current standards. Mitigation measures have either been included in the design drawings (e.g. stormwater treatment devices) or included in the proposed designation and resource consent conditions such that potential adverse effects are avoided, remedied or mitigated.

APPENDIX A STATEMENT OF QUALIFICATIONS AND EXPERIENCE AND CODE OF CONDUCT

Qualifications

My legal name is Zhirui Liu and my preferred name is Jerry Liu. I am the primary designer of the stormwater systems proposed as part of the Project and the primary author of the assessment of operational stormwater effects. I am a Senior Associate Civil Engineer with Beca Limited in Auckland, and a Chartered Professional Engineer. I have a Bachelor of Engineering with First Class Honours in Civil Engineering from the University of Auckland with 11 years post-graduate experience. I am experienced in solving stormwater management issues within urban catchments, for major infrastructure projects, land development projects and urban street upgrade. I have carried out stormwater treatment design for the Coupled Wetland Biofilter and various stormwater options assessment at the Auckland Airport. I was the lead stormwater design for the drainage design and stormwater assessment for SH16 Safety Improvements Stage 1 project for NZTA and have conducted overland flow and flooding assessments associated with many urban street upgrades and cycleway projects for Auckland Transport.

My name is Sophie Frances Emmeline Bannister. I am a designer of the stormwater systems proposed as part of the Project and the secondary author of the assessment of operational stormwater effects. I am a Senior Civil Engineer with Beca Limited in Auckland. I have a Bachelor of Engineering with Honours in Civil Engineering from the University of Auckland with 11 years post-graduate experience. I have completed detailed flood assessments and stormwater design for Auckland Airport and other urban development projects. I have a varied background in stormwater management, having done stormwater asset management at the Auckland Motorways Alliance, contributed to various state highway projects as a graduate engineer at NZTA, and provided specialist stormwater input to development proposals during her time at Auckland Council's Healthy Waters.

My name is Dale Sarah Paice. I am responsible for the overall stormwater reporting verification. I am a Technical Director in Civil Engineering with Beca Limited in Auckland. I have a Bachelor of Engineering with First Class Honours in Civil Engineering from the University of Auckland and 22 years post-graduate experience particularly in stormwater management for land development and infrastructure projects. My projects have included all aspects of stormwater management for land development projects from flood risk, pipe network drainage and stormwater quality treatment.

Code of Conduct

Although this matter is not before the Environment Court, we confirm that we have read the Code of Conduct for expert witnesses as contained in the Environment Court Practice Note 2023. We agree to comply with that Code. Our qualifications as an expert are set out above. We are satisfied that the matters which we addressed in this report are within our area of expertise. We have not omitted to consider material facts known to us that might alter or detract from the opinions we express.

s9(2)(a)

Jerry Liu

August 2026

s9(2)(a)

Sophie Bannister

August 2026

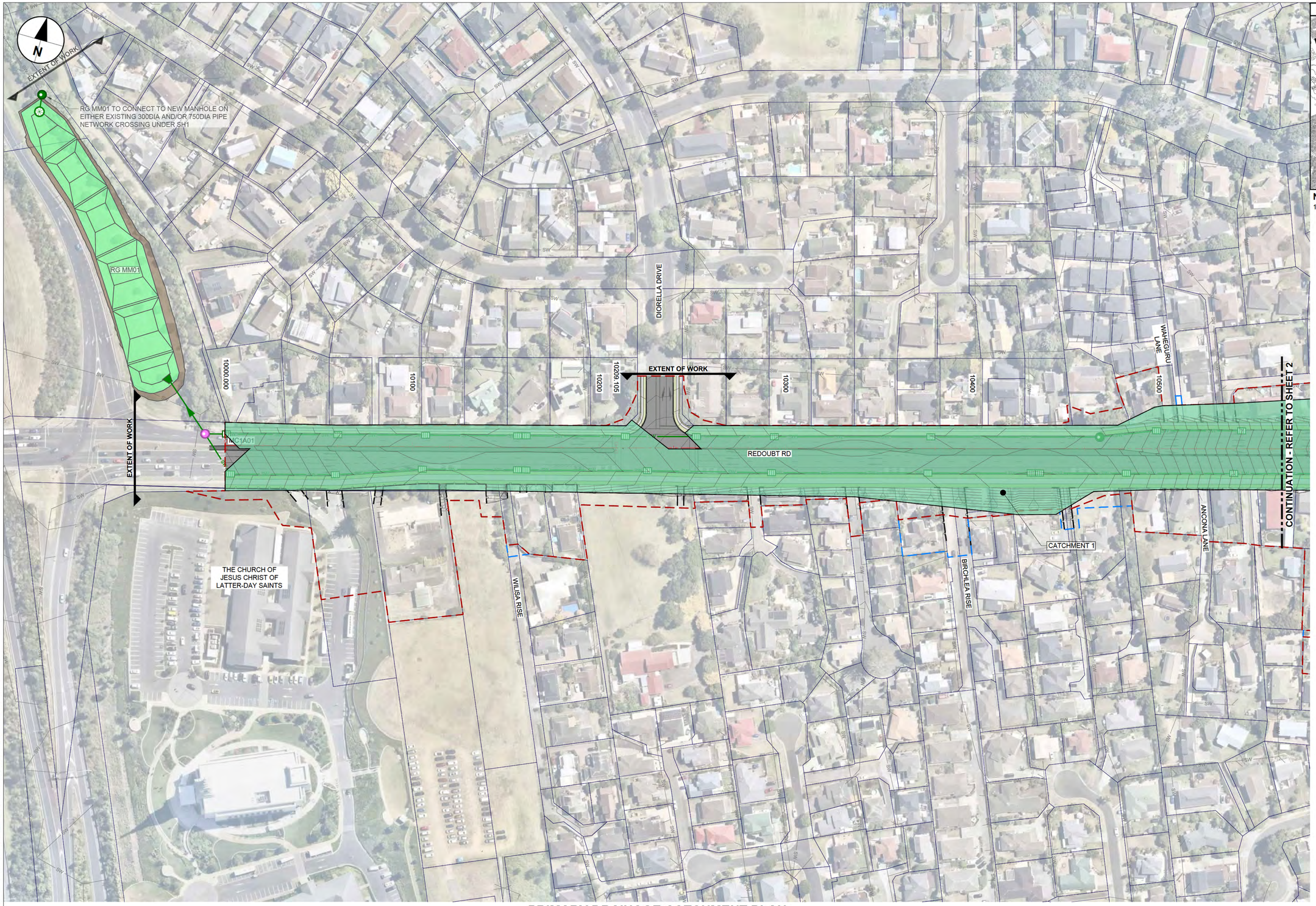
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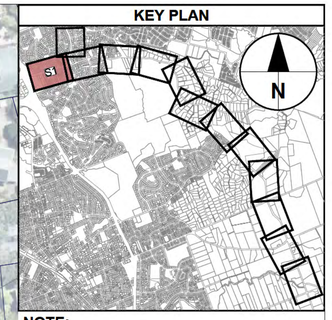
Dale Paice

August 2026

APPENDIX B STORMWATER CATCHMENT PLANS

ISO A1 594mm x 841mm





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PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

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1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

D	03.02.26	REVISED FOR INFORMATION
C	27.11.25	REVISED FOR INFORMATION
B	21.11.25	REVISED FOR INFORMATION
A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

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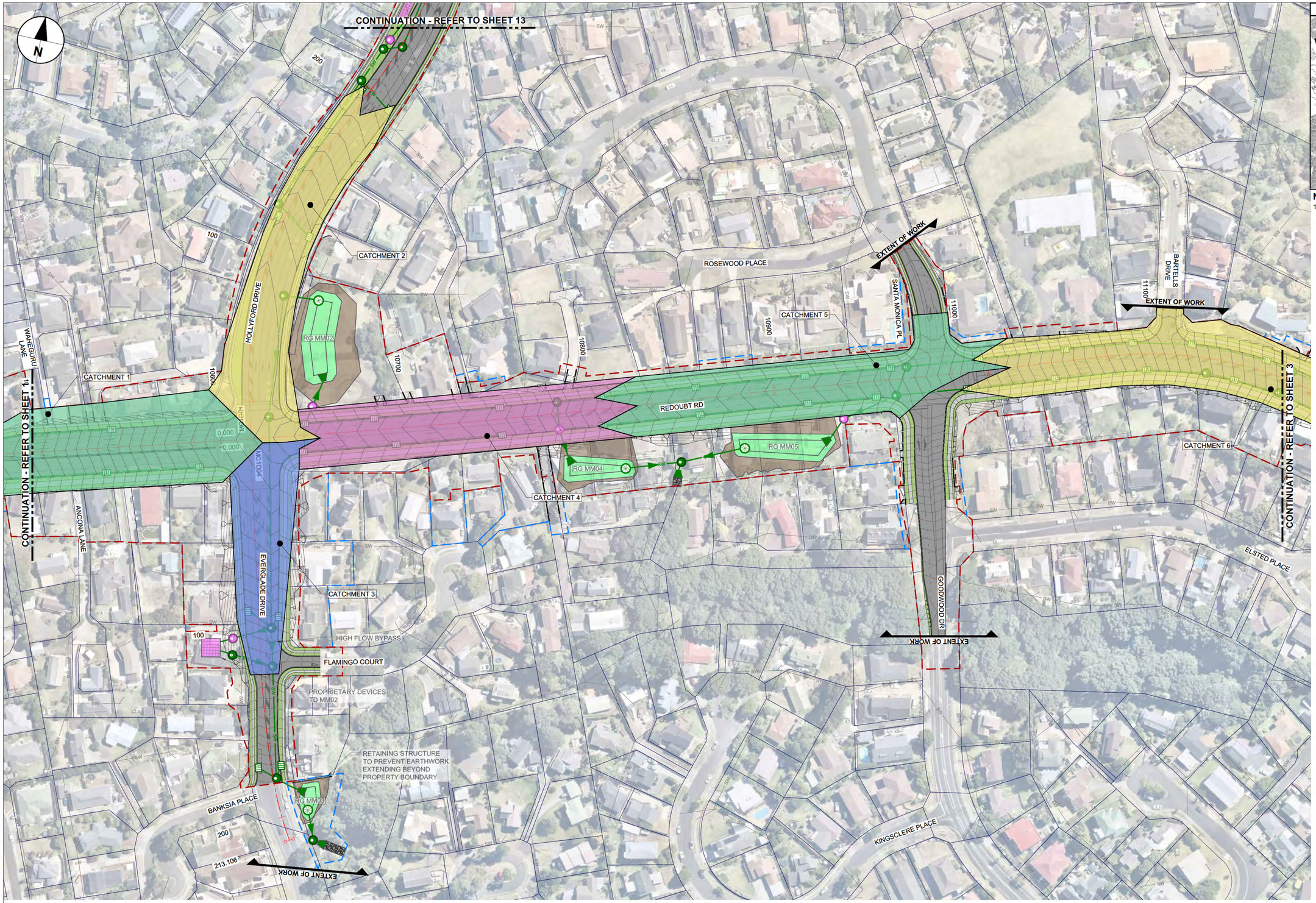
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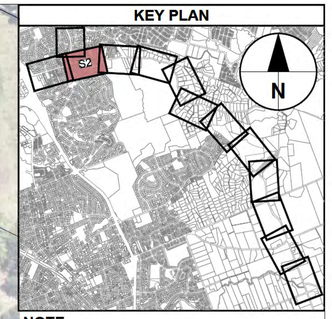
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Sheet 1

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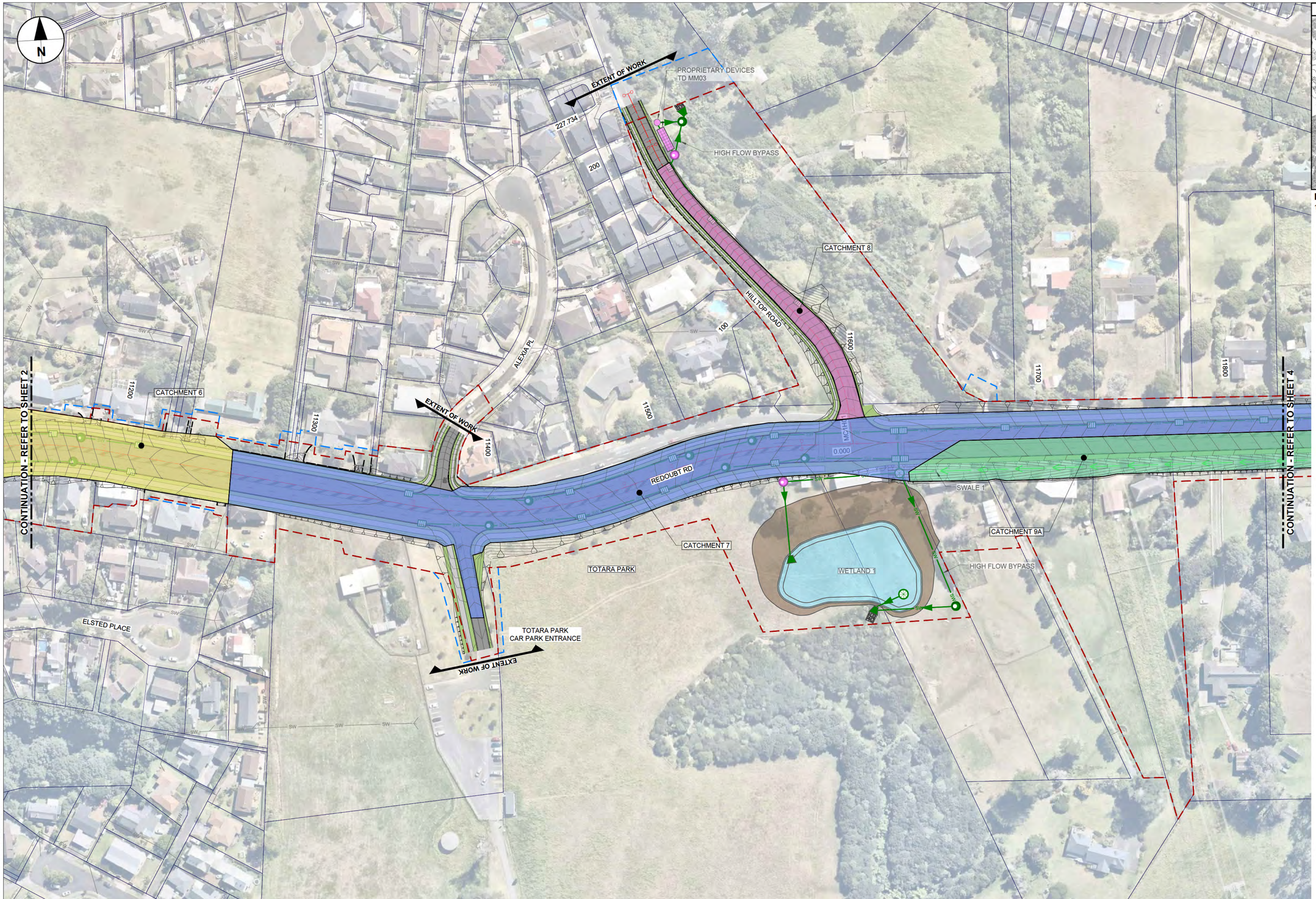
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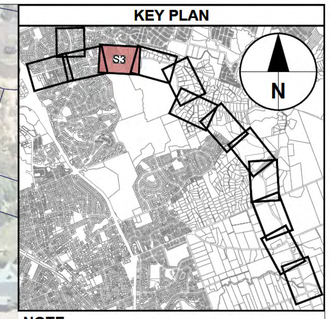
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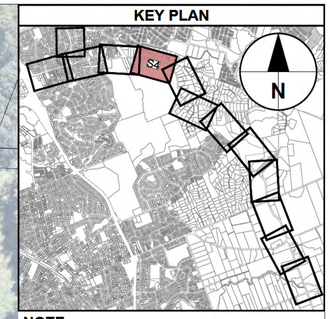
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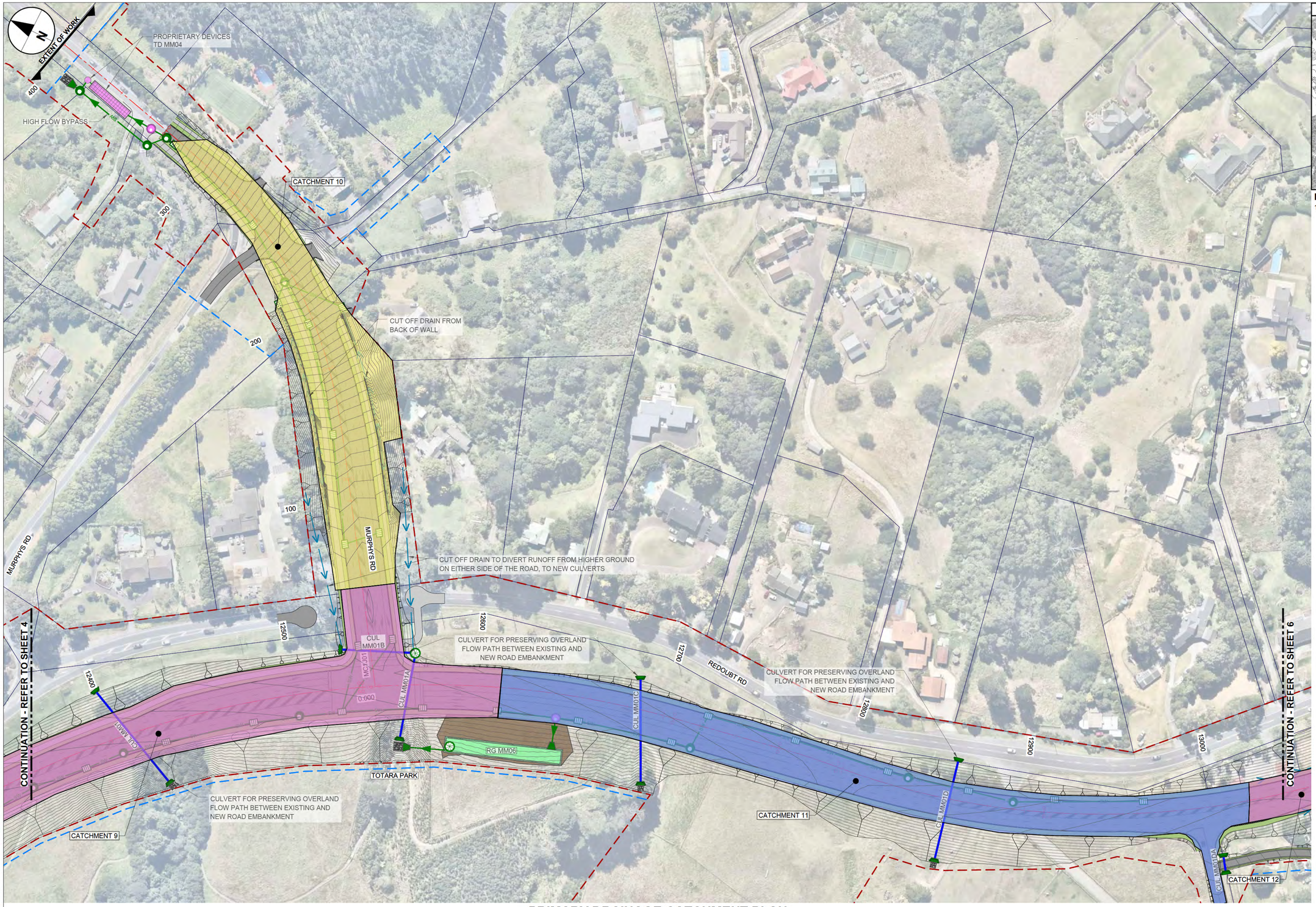
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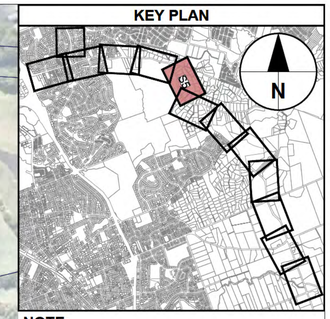
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KEY PLAN



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60755376

SHEET TITLE

Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 5

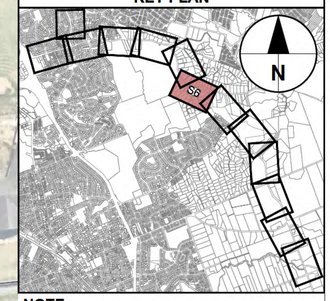
SHEET NUMBER

60755376-SKE-DR-0105

ISO A1 594mm x 841mm



KEY PLAN



NOTE:

1. THIS SET OF CATCHMENT PLANS HAS BEEN PREPARED FOR RESOURCE CONSENTING PURPOSES ONLY. IT IS TO BE READ IN CONJUNCTION WITH THE PROPOSED STORMWATER DESIGN LAYOUT AND DETAILS AS SHOWN ON DR-0100 TO DR-0113, DR-0501 TO DR-0508, AND ANY ASSOCIATED NOTES ON THE DRAWINGS.

PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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CLIENT

NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

D	03.02.26	REVISED FOR INFORMATION
C	27.11.25	REVISED FOR INFORMATION
B	21.11.25	REVISED FOR INFORMATION
A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60755376

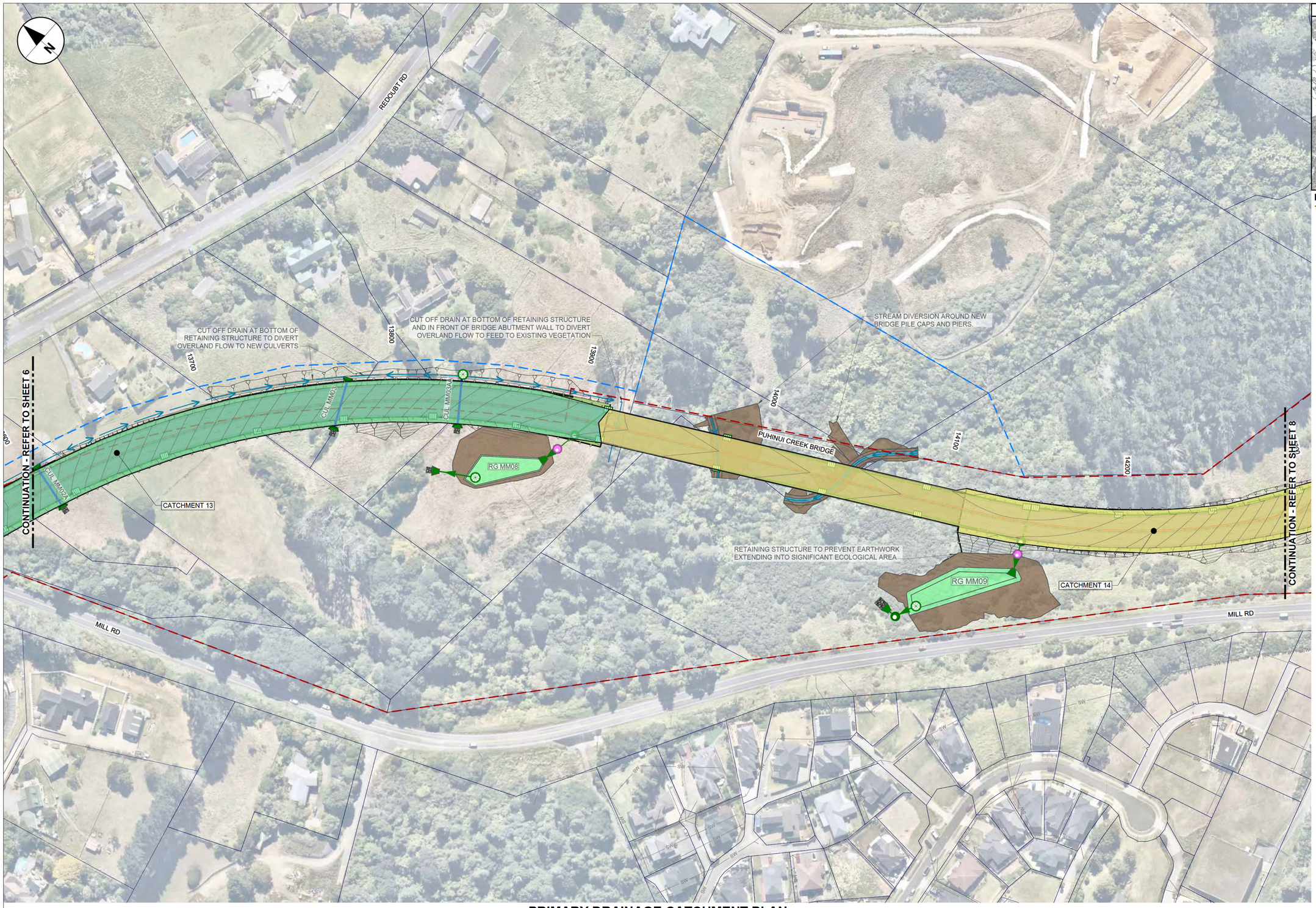
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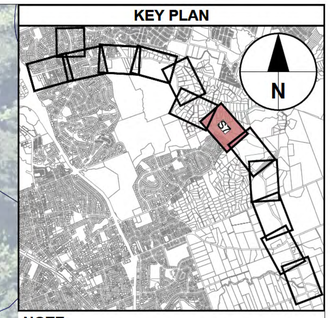
Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 6

SHEET NUMBER

60755376-SKE-DR-0106

ISO A1 594mm x 841mm





NOTE:

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PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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CLIENT

NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60755376

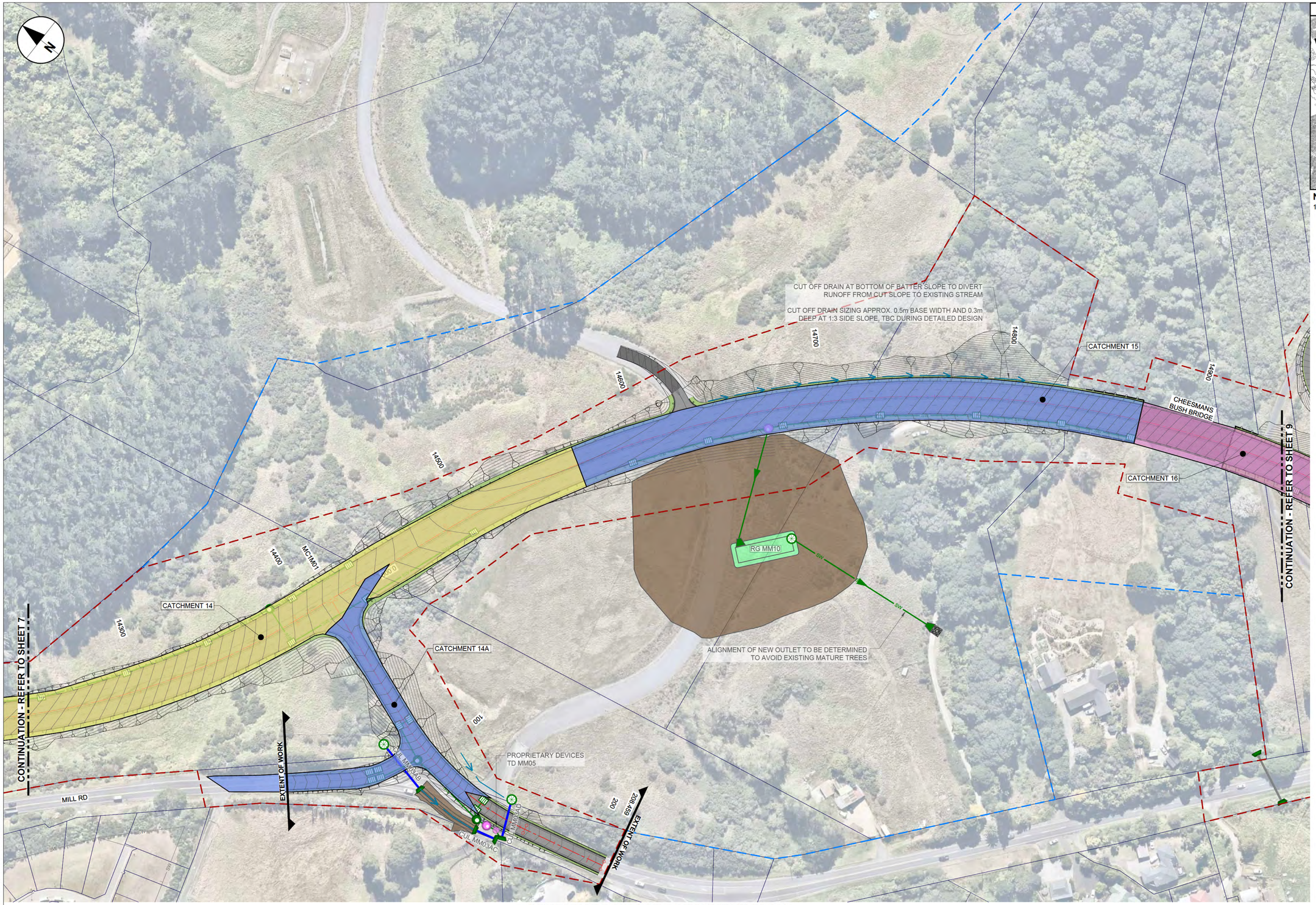
SHEET TITLE

Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 7

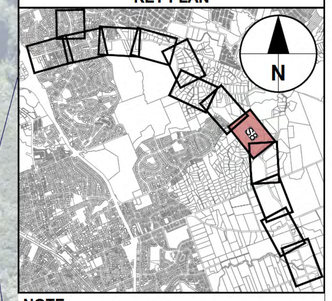
SHEET NUMBER

60755376-SKE-DR-0107

ISO A1 594mm x 841mm



KEY PLAN



NOTE:

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PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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CONSULTANT

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CLIENT

NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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PROJECT NUMBER

60755376

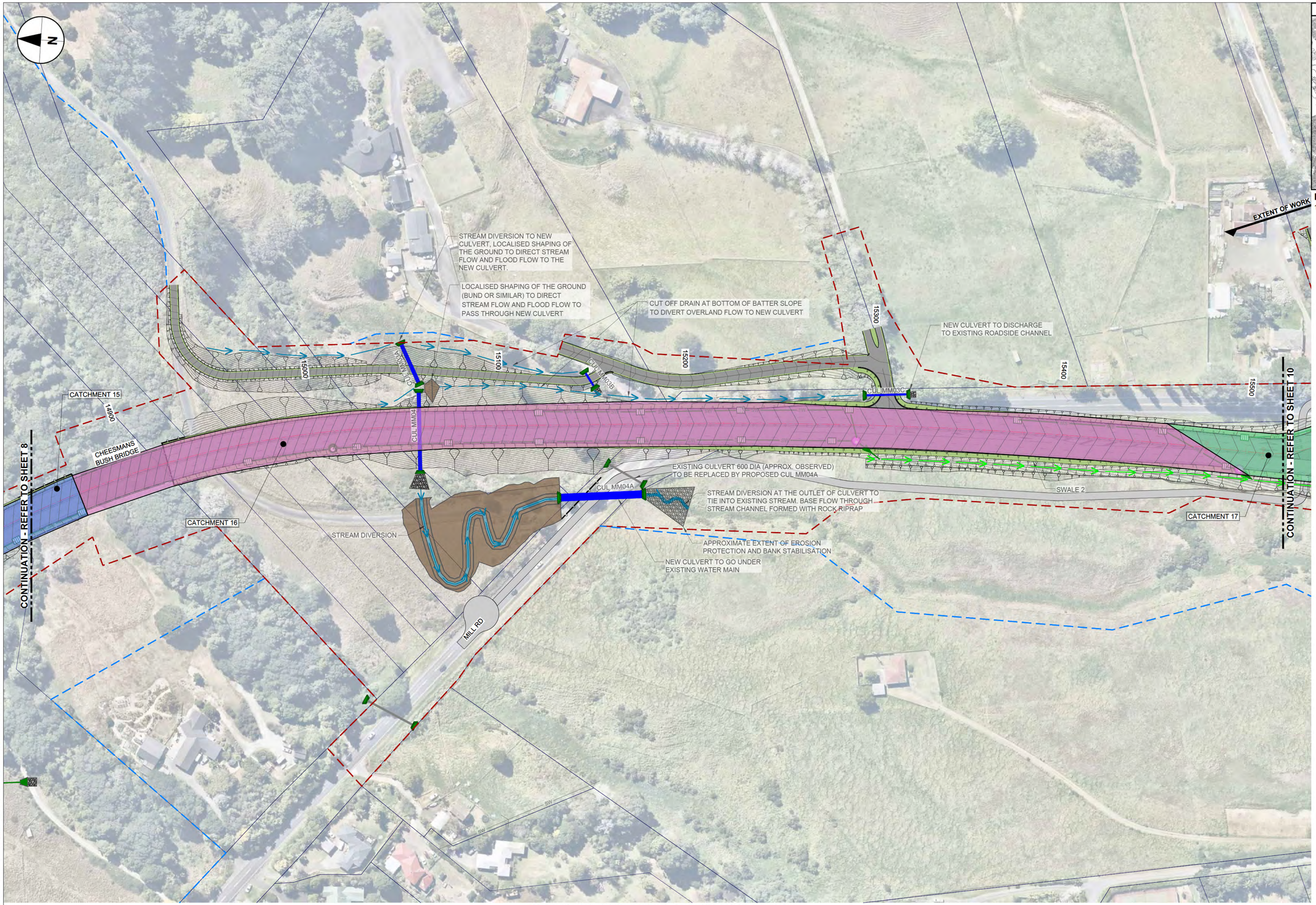
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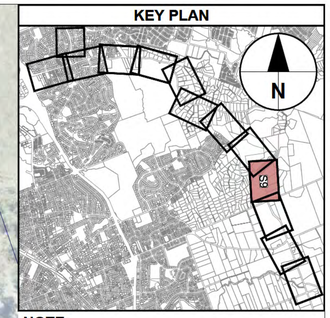
Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 8

SHEET NUMBER

60755376-SKE-DR-0108

ISO A1 594mm x 841mm





NOTE:

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PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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I/R	DATE	DESCRIPTION

PROJECT NUMBER

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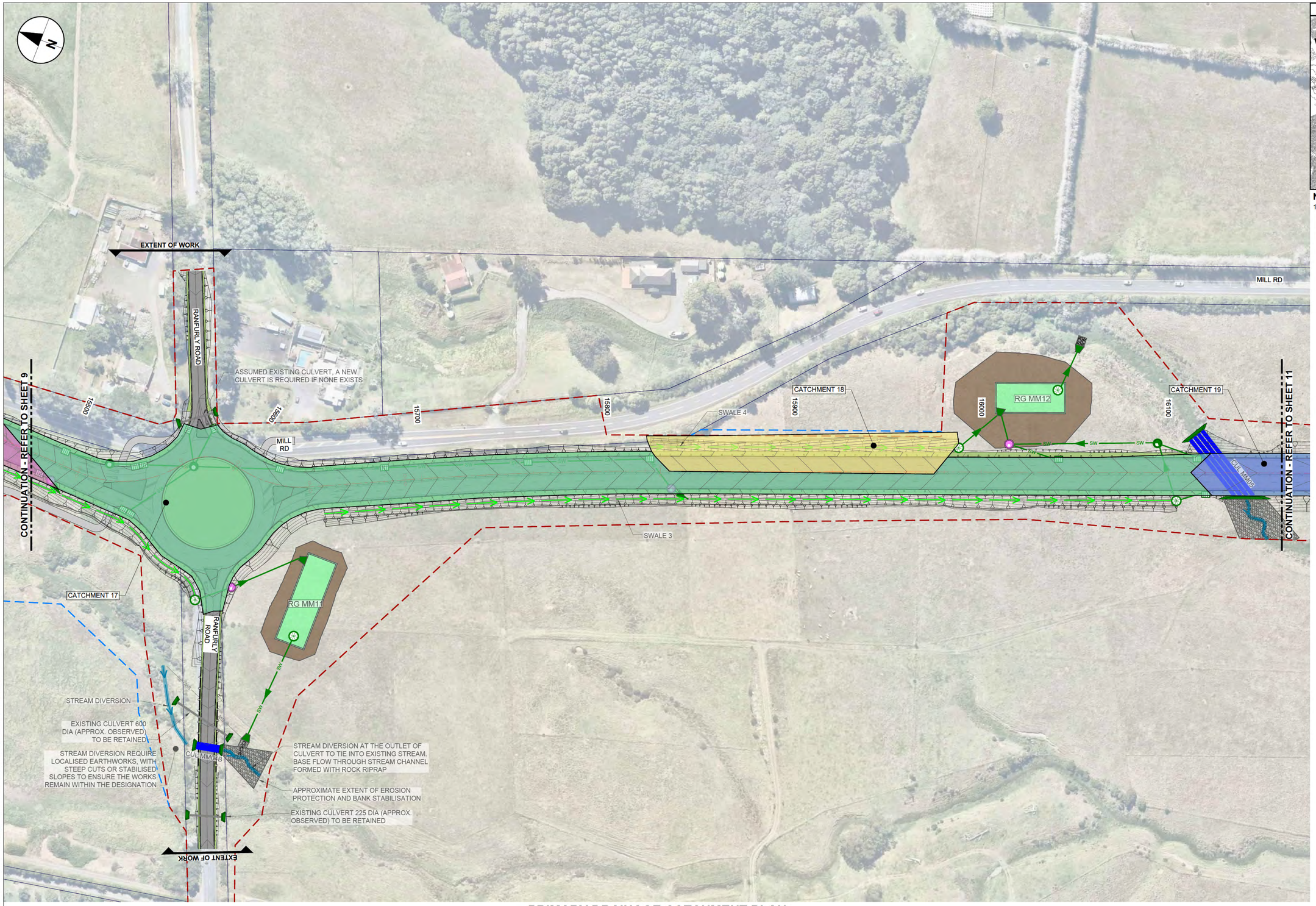
SHEET TITLE

Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 9

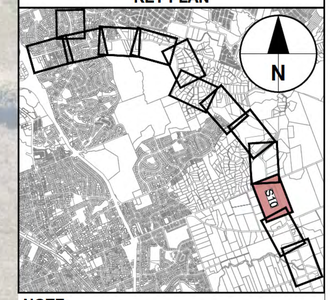
SHEET NUMBER

60755376-SKE-DR-0109

ISO A1 594mm x 841mm



KEY PLAN



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PRIMARY DRAINAGE CATCHMENT PLAN

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PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

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PROJECT NUMBER

60755376

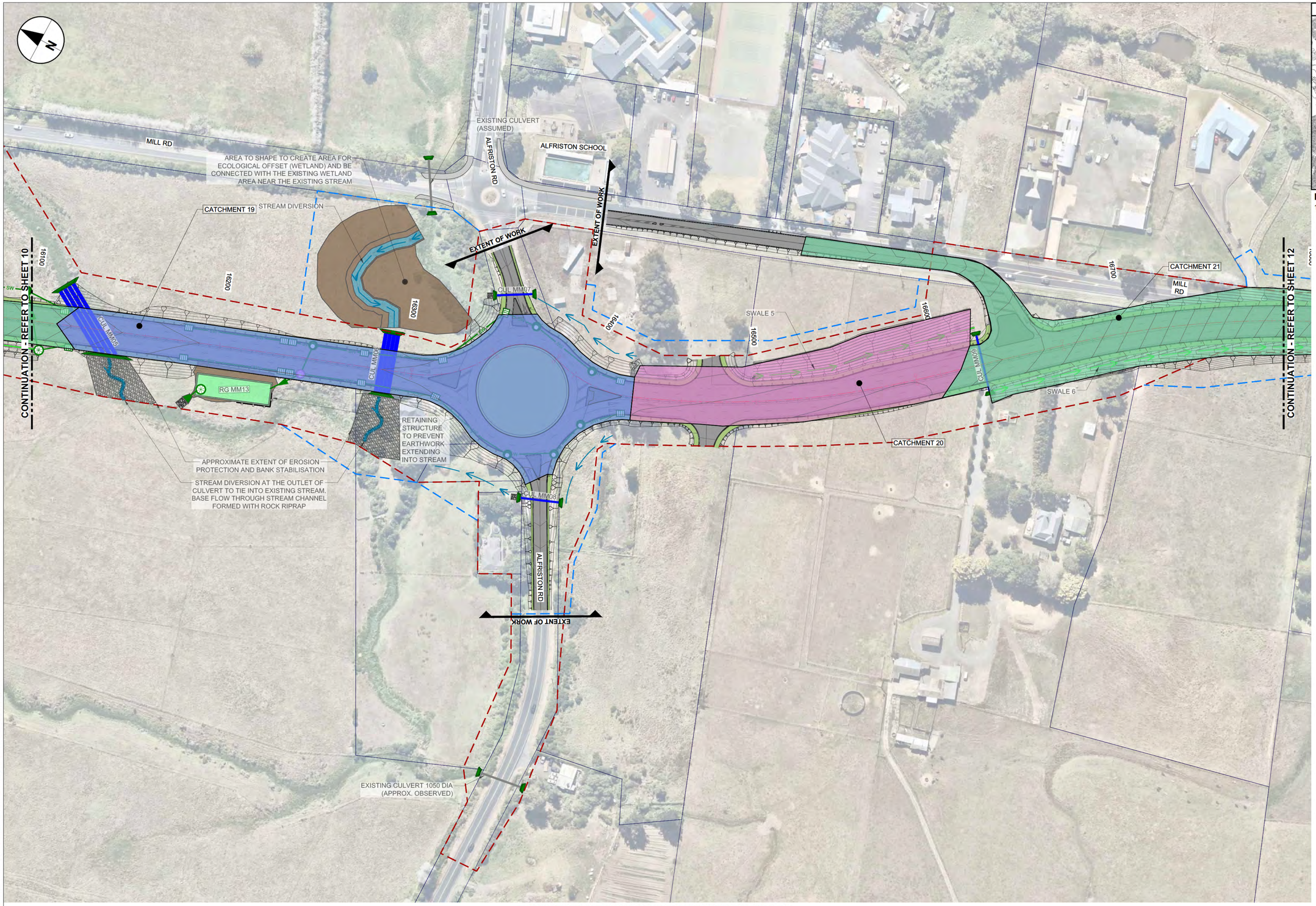
SHEET TITLE

Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 10

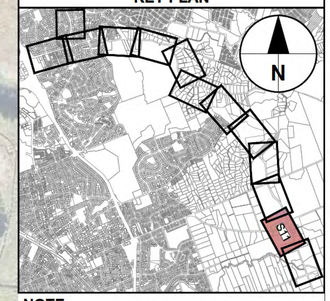
SHEET NUMBER

60755376-SKE-DR-0110

ISO A1 594mm x 841mm



KEY PLAN



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PRIMARY DRAINAGE CATCHMENT PLAN

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NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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B	21.11.25	REVISED FOR INFORMATION
A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60755376

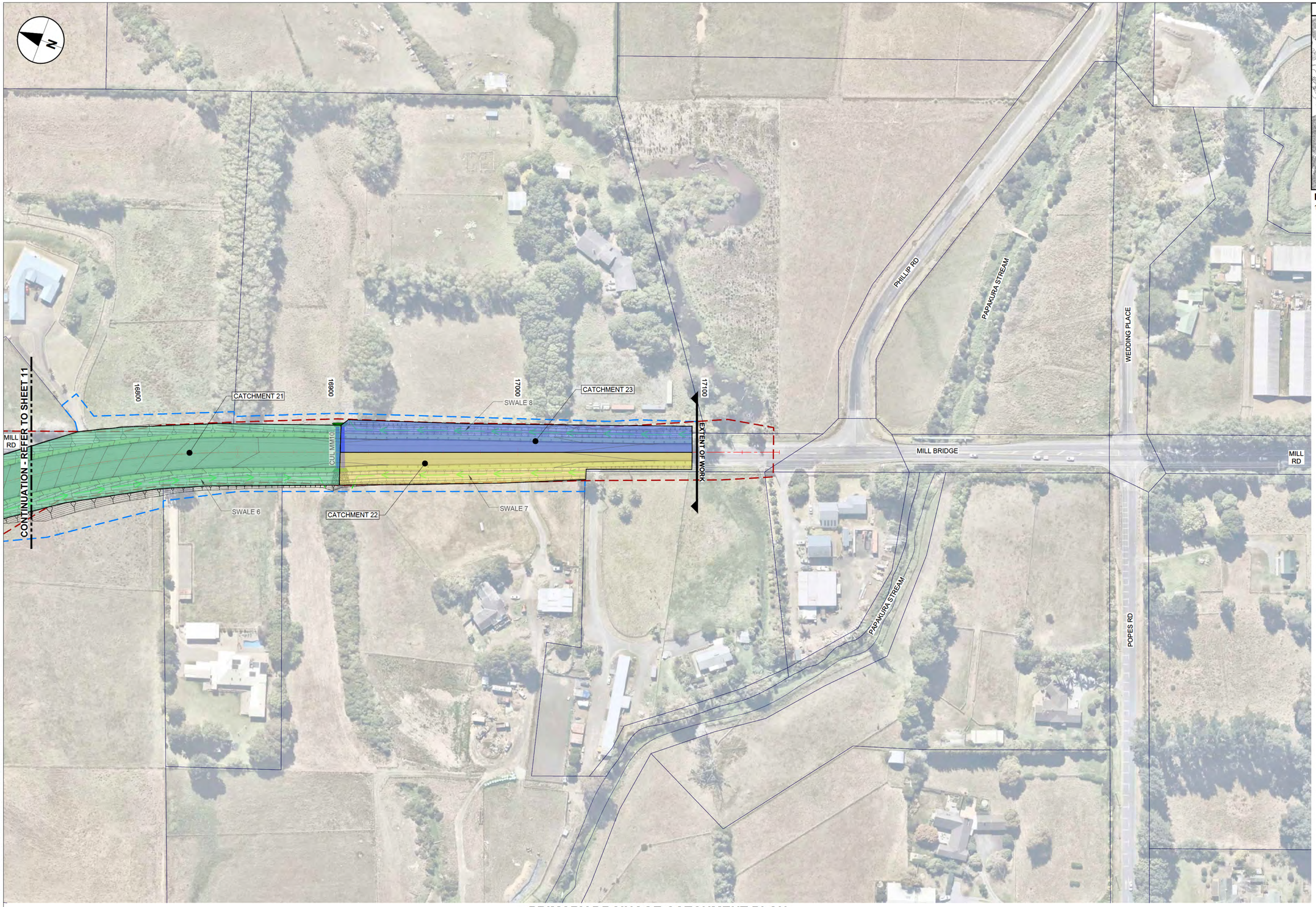
SHEET TITLE

Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 11

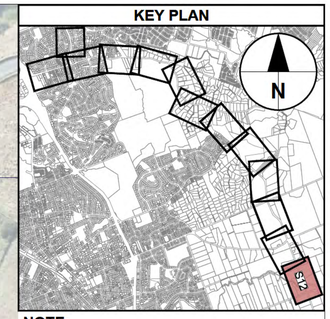
SHEET NUMBER

60755376-SKE-DR-0111

ISO A1 594mm x 841mm



KEY PLAN



NOTE:

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PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

PROJECT NUMBER

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SHEET TITLE

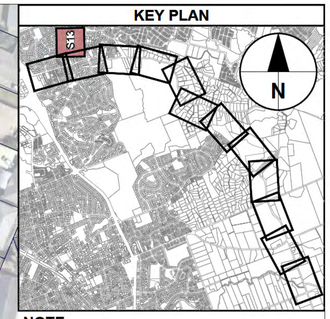
Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 12

SHEET NUMBER

60755376-SKE-DR-0112

ISO A1 594mm x 841mm





NOTE:

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PRIMARY DRAINAGE CATCHMENT PLAN

Scale 1:1000m @ A1

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PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 25 50 m
1:1000

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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B	21.11.25	REVISED FOR INFORMATION
A	26.09.25	ISSUED FOR INFORMATION

PROJECT NUMBER

60755376

SHEET TITLE

Mill Road RoNS Stage 1 FTA
Primary Drainage Catchment Plan
Sheet 13

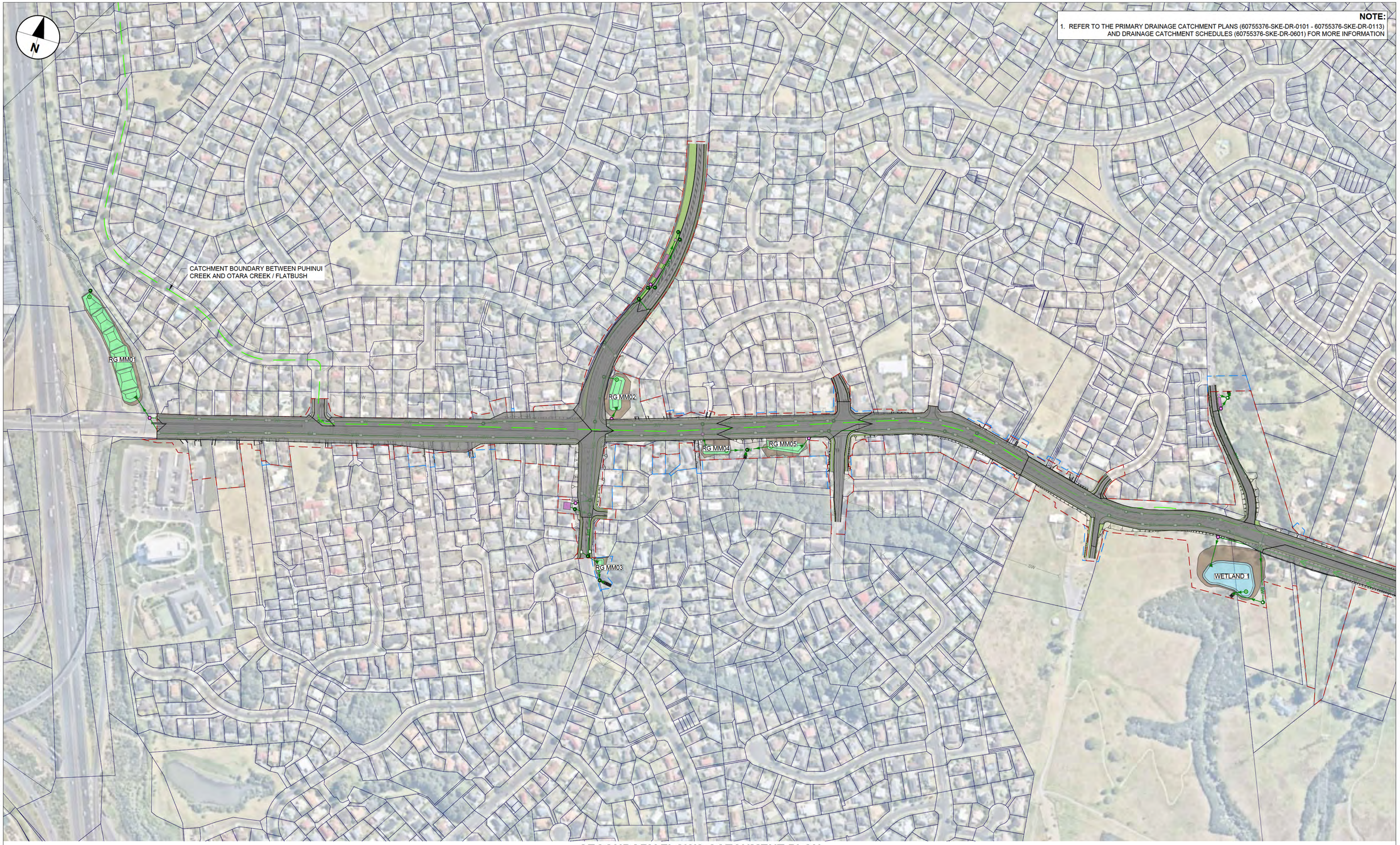
SHEET NUMBER

60755376-SKE-DR-0113

ISO A1 594mm x 841mm

NOTE:

1. REFER TO THE PRIMARY DRAINAGE CATCHMENT PLANS (60755376-SKE-DR-0101 - 60755376-SKE-DR-0113) AND DRAINAGE CATCHMENT SCHEDULES (60755376-SKE-DR-0601) FOR MORE INFORMATION



SECONDARY FLOWS CATCHMENT PLAN

Scale 1:2500m @ A1

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CLIENT

NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 62.5 125 m
1:2500

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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A	26.09.25	ISSUED FOR INFORMATION

PROJECT NUMBER

60755376

SHEET TITLE

Mill Road RoNS Stage 1 FTA
Secondary Flows Catchment Plan
Sheet 1

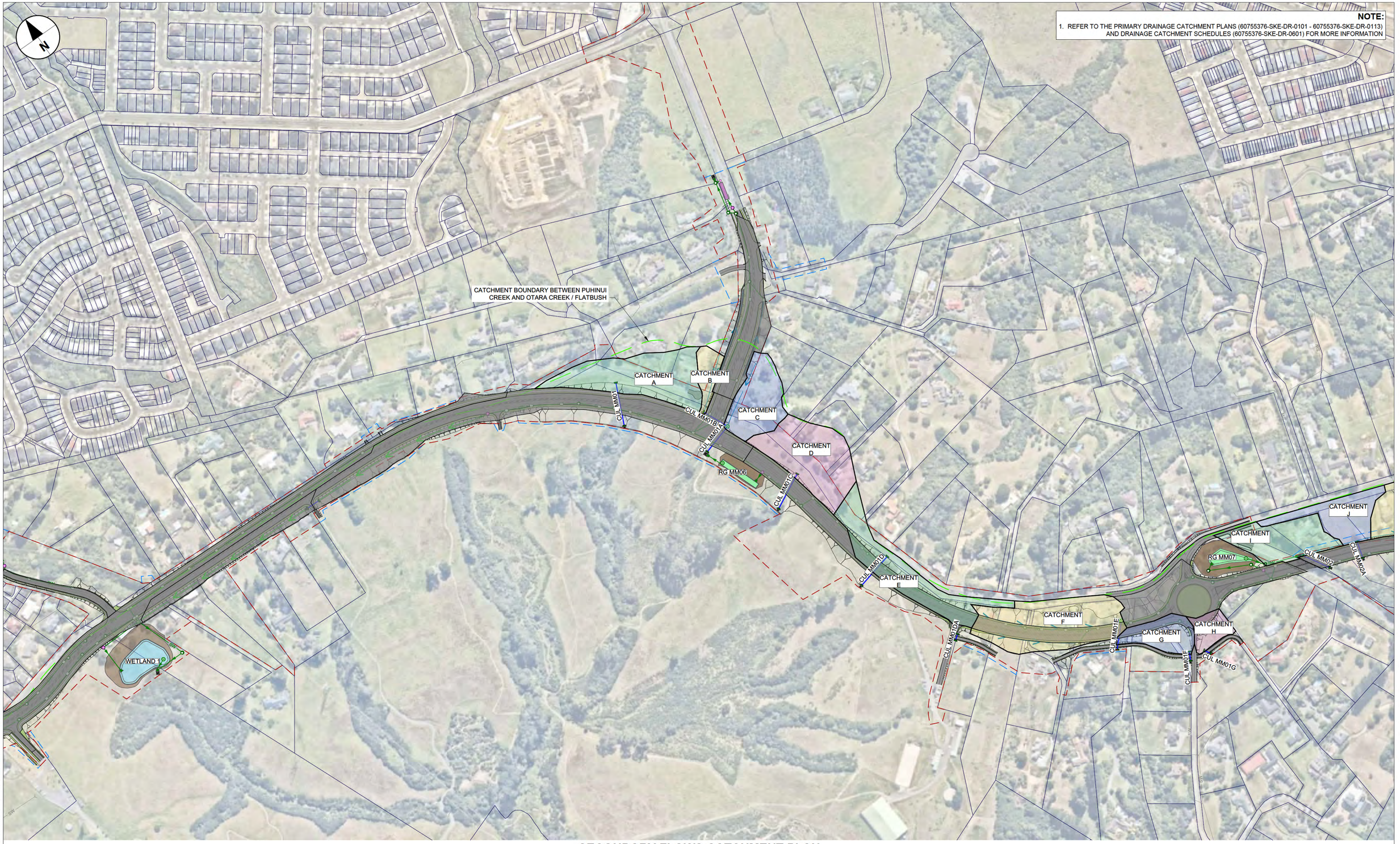
SHEET NUMBER

60755376-SKE-DR-0121

ISO A1 594mm x 841mm

NOTE:

1. REFER TO THE PRIMARY DRAINAGE CATCHMENT PLANS (60755376-SKE-DR-0101 - 60755376-SKE-DR-0113) AND DRAINAGE CATCHMENT SCHEDULES (60755376-SKE-DR-0601) FOR MORE INFORMATION



SECONDARY FLOWS CATCHMENT PLAN

Scale 1:2500m @ A1

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CLIENT

NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 62.5 125 m
1:2500

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

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A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60755376

SHEET TITLE

Mill Road RoNS Stage 1 FTA
Secondary Flows Catchment Plan
Sheet 2

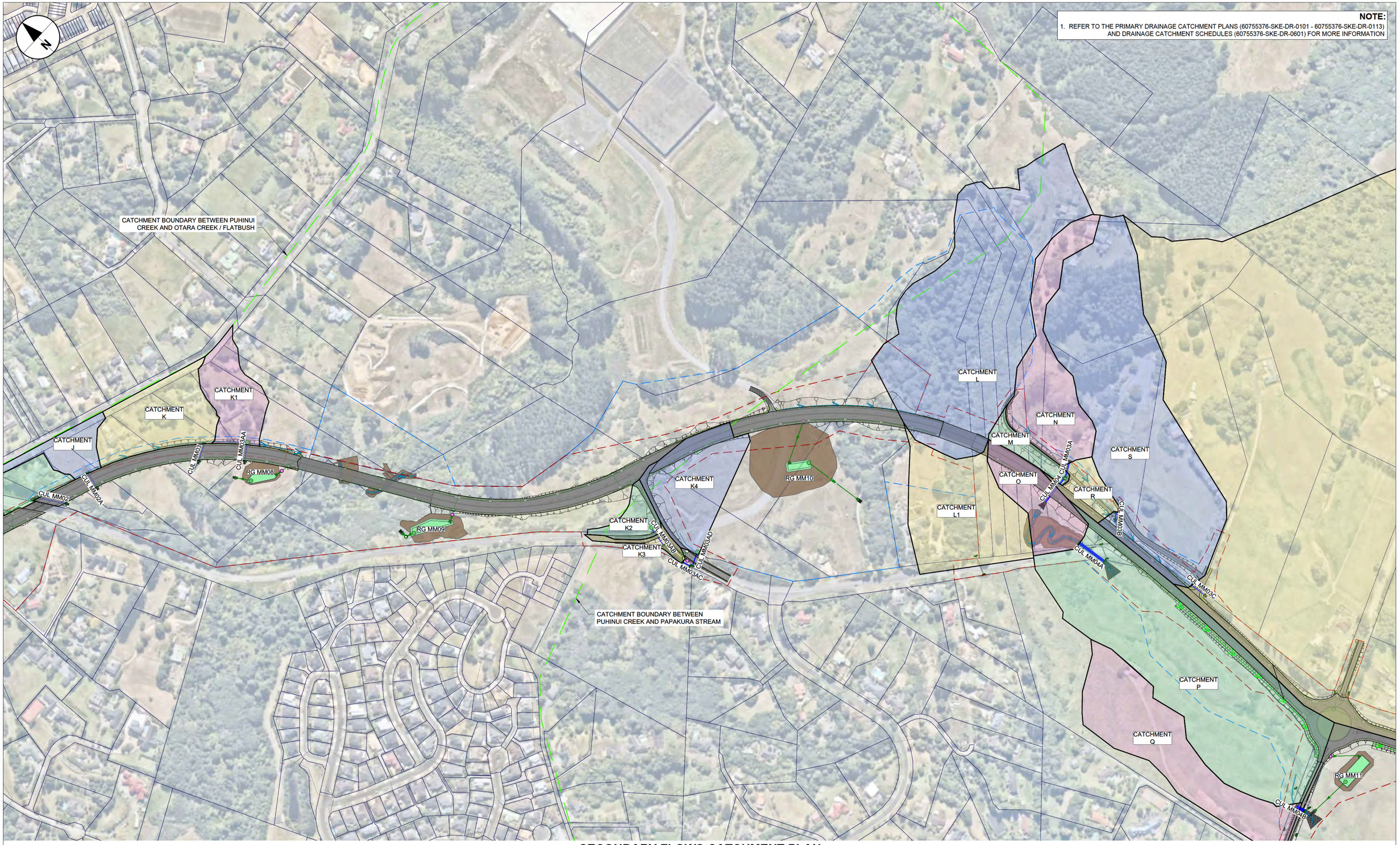
SHEET NUMBER

60755376-SKE-DR-0122

ISO A1 594mm x 841mm

NOTE:

1. REFER TO THE PRIMARY DRAINAGE CATCHMENT PLANS (60755376-SKE-DR-0101 - 60755376-SKE-DR-0113) AND DRAINAGE CATCHMENT SCHEDULES (60755376-SKE-DR-0601) FOR MORE INFORMATION



SECONDARY FLOWS CATCHMENT PLAN

Scale 1:2500m @ A1

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CLIENT

NZ TRANSPORT AGENCY WAKA KOTAHI

PROJECT

Mill Road – Stage 1
Consenting Design
Roads of National Significance

REGISTRATION

FOR INFORMATION ONLY

SCALE

0 62.5 125 m
1:2500

PROJECT MANAGEMENT INITIALS

JL	DSP	DM
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	AUK46	SURVEY	NZTM

ISSUE/REVISION

D	03.02.26	REVISED FOR INFORMATION
C	02.12.25	REVISED FOR INFORMATION
B	21.11.25	REVISED FOR INFORMATION
A	26.09.25	ISSUED FOR INFORMATION
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60755376

SHEET TITLE

Mill Road RoNS Stage 1 FTA
Secondary Flows Catchment Plan
Sheet 3

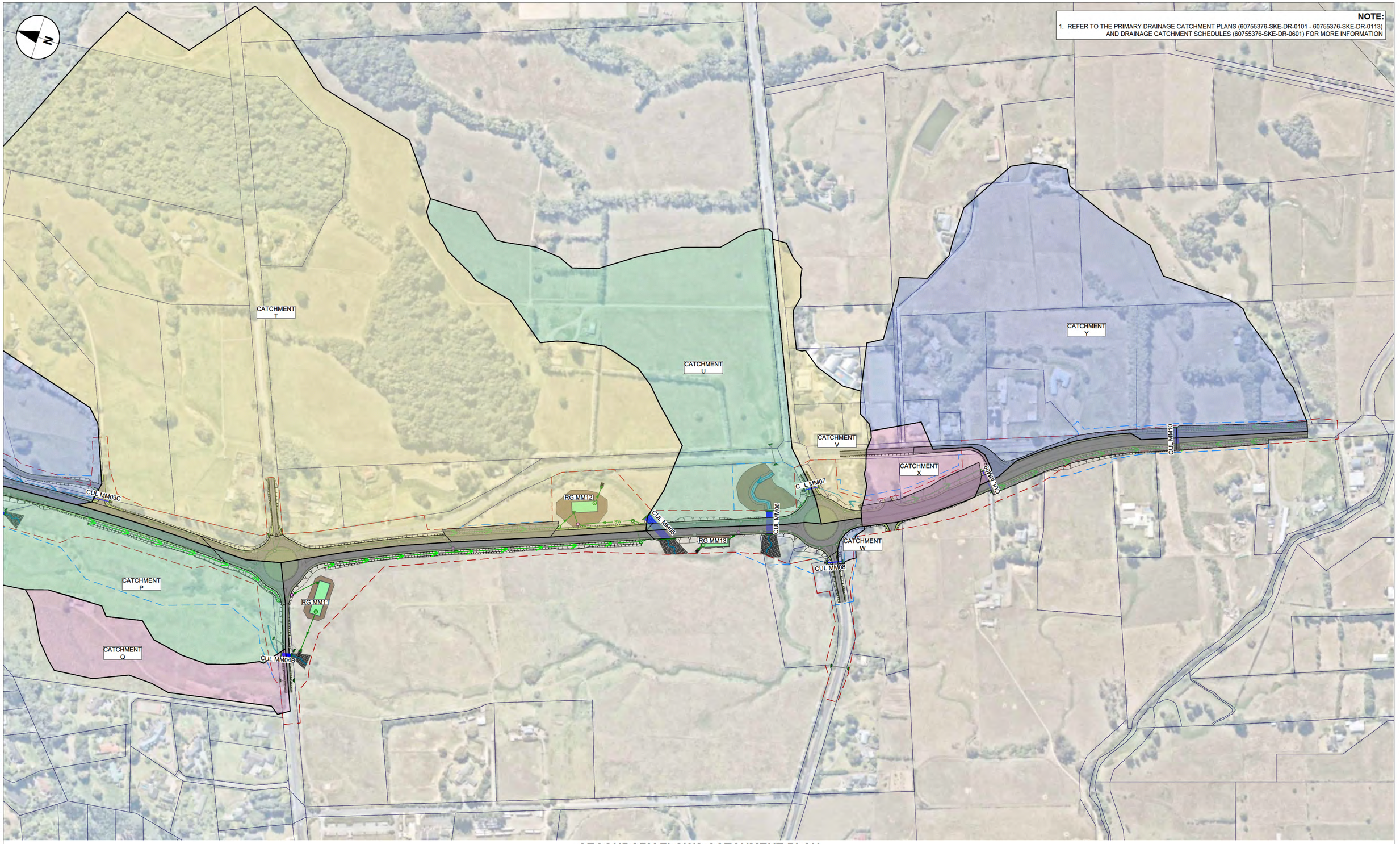
SHEET NUMBER

60755376-SKE-DR-0123

ISO A1 594mm x 841mm

NOTE:

1. REFER TO THE PRIMARY DRAINAGE CATCHMENT PLANS (60755376-SKE-DR-0101 - 60755376-SKE-DR-0113) AND DRAINAGE CATCHMENT SCHEDULES (60755376-SKE-DR-0601) FOR MORE INFORMATION



SECONDARY FLOWS CATCHMENT PLAN

Scale 1:2500m @ A1

This drawing is confidential and shall only be used for the purpose of this project. The signing of this title block confirms the design and drafting of this project have been prepared and checked in accordance with the AECOM quality assurance system to ISO 9001.

Last saved by: MARK.BRADLEY2 12/2025-12-02) Last Plotted: 2026-02-03
Filename: C:\PWWORKING\AECOM_AU_NZ\DMS11737\60755376-SKE-DR-0124.DWG

CONSULTANT

AECOM Beca

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Mill Road RoNS Stage 1 FTA
Secondary Flows Catchment Plan
Sheet 4

SHEET NUMBER

60755376-SKE-DR-0124

ISO A1 594mm x 841mm

NOTE:
1. REFER TO CATCHMENT PLANS 60755376-SKE-DR-0101 TO 60755376-SKE-DR-0124 FOR CATCHMENT AREAS.

PRIMARY DRAINAGE CATCHMENT SCHEDULE

CATCHMENT ID	DISCHARGE POINT ID	CATCHMENT AREA (m^2)	CATCHMENT AREA (ha)
1	RG MM01	24,000	2.40
2	TD MM01	6,000	0.60
3	TD MM02; RG 03	3,500	0.35
4	RG MM02	5,500	0.55
5	RG MM04	6,300	0.63
6	RG MM05	8,200	0.82
7	WETLAND 1	19,200	1.92
8	TD MM03	1,600	0.16
9	SWALE 1; WETLAND 1	22,200	2.22
9A	SWALE 1; WETLAND 1	6,200	0.62
10	TD MM04	8,900	0.89
11	RG MM06	10,300	1.03
12	RG MM07	17,200	1.72
13	RG MM08	8,600	0.86
14	RG MM09	14,450	1.45
14A	TD MM05	2,700	0.27
15	RG MM10	7,000	0.70
16	RG MM11	12,800	1.28
17	SWALE 3; RG MM12	16,000	1.60
18	SWALE 4; RG MM12	3,200	0.32
19	RG MM13	10,300	1.03
20	SWALE 5	6,500	0.65
21	SWALE 6	11,200	1.12
22	SWALE 7	2,800	0.28
23	SWALE 8	2,800	0.28

SECONDARY FLOWS CATCHMENT SCHEDULE

CATCHMENT ID	DISCHARGE POINT ID	CATCHMENT AREA (m^2)	CATCHMENT AREA (ha)
A	CUL MM01	11,700	1.17
B	CUL MM01B; CUL MM01A	2,300	0.23
C	CUL MM01A	7,100	0.71
D	CUL MM01C	4,800	0.48
E	CUL MM01D	8,700	0.87
F	CUL MM01E	14,000	1.40
G	CUL MM01F	4,300	0.43
H	CUL MM01G	2,400	0.24
I	CUL MM02	9,000	0.90
J	CUL MM02A	4,700	0.47
K	CUL MM03	29,700	2.97
K1	CUL MM03AA	9,900	0.99
K2	CUL MM03AB; CUL MM03AC	4,000	0.40
K3	CUL MM03AC	1,700	0.17
K4	CUL MM03AD	16,300	1.63
L	CUL MM04A; CUL MM04B	68,000	6.80
L1	CUL MM04A; CUL MM04B	24,900	2.49
M	CUL MM03A; CUL MM04; CUL MM04A; CUL MM04B	3,400	0.34
N	CUL MM04; CUL MM04A; CUL MM04B	20,600	2.06
O	CUL MM04A; CUL MM04B	10,800	1.08
P	CUL MM04B	67,700	6.77
Q	CUL MM04B	27,800	2.78
R	CUL MM03B; CUL MM03C; CUL MM05	4,600	0.46
S	CUL MM03C; CUL MM05	66,600	6.66
T	CUL MM05	514,600	51.46
U	CUL MM06	111,200	11.12
V	CUL MM07; CUL MM06	24,900	2.49
W	CUL MM08	1,100	0.11
X	CUL MM09	18,800	1.88
Y	CUL MM10	167,300	16.73

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60755376

SHEET TITLE
Mill Road RoNS Stage 1 FTA
Drainage Catchment Schedules

SHEET NUMBER
60755376-SKE-DR-0601

APPENDIX C ASSESSMENT METHODOLOGY

Preparation

Preparation for design and assessment of effects has included the following activities:

- Site visits between 23 May to 03 June 2025
- Review of 2014 AEE, Redoubt Road-Mill Road Corridor Project, in particular Volume 2.1 and Appendix U: Preliminary Design Report Volume 2.6.
- Regular meetings with the wider project design teams.
- Meetings with Auckland Council and a site walkover between June to September 2025
- Regular interactions with designers and assessors particularly ecology, landscape architecture, groundwater disciplines.

Statutory framework and guidelines

The following documents have informed the assessment of stormwater effects.

- Auckland Unitary Plan
- Auckland Regional Council, TP 108: Guidelines for stormwater runoff modelling in the Auckland Region, April 1999
- Auckland Council, Code of Practice for Land Development and Subdivision: Chapter 4 – Stormwater, Version 4, July 2025
- Auckland Council, GD01 - Stormwater Management Devices in the Auckland Region, Version 2, February 2020
- Auckland Council, GD08 - Design of Inlets, Outlets and Coastal Outfalls in the Auckland Region, Version 1, Draft, July 2025
- Resource Management (National Environmental Standards for Freshwater) Regulations 2020
- NIWA, New Zealand Fish Passage Guidelines, Version 2.0, June 2024
- NZTA, P46 Stormwater management and minor stream diversion design specification, February 2025

Methodology for existing environment assessment

The existing environment with respect to stormwater quality and quantity was characterised through the following methods:

- Auckland Council GIS database for the existing Auckland stormwater network and information on flood storage volumes of topographical depressions (accessed May to September 2025)
- Review the Flatbush Stormwater Management Plan – Appendix I and review draft flood plain data for Otara Flat and Puhinui, supplied by Auckland Council Healthy Waters, May 2025
- NZ Transport Agency CCTV, PDF and paper drawings of as-built and design drawings for the stormwater systems for State Highway 1 provided by Auckland System Management (ASM)
- Review of NZTA's RAMM database (managed by ASM) for existing drainage asset information along SH1/Redoubt Road interchange
- Aerial mapping including historical aerials
- 2016 LiDAR existing ground contour data, and subsequent updated LiDAR flown for the Project in 2025
- Manhole survey information from earlier Mill Road investigations (October to November 2022)

Methodology for water quality assessment

It is common practice to express treatment device efficacy in as a percentage reduction of contaminant load. In Auckland, the typical standard applied is 75% removal of total suspended solids (TSS) on an annual average basis. TSS reduction indicates a reduction in other contaminants of interest (e.g. hydrocarbons, lead, zinc and copper) which often adhere to suspended solids but is much simpler to quantify than other pollutants. Therefore, that measure has been adopted for design of treatment devices throughout the Project.

The proposed stormwater treatment devices were designed using GD01 guidance. The assessment of effects included checking device size to catchment area ratios is as per GD01 guidance.

Methodology for primary network capacity assessment

Primary network capacity is assessed generally by the following:

- Rainfall-runoff models to predict stormwater flows and volumes using TP108 methodology and the Rational Method.
- Consideration of the existing climate situation and the allowance to historical rainfall due to climate change for the 2.1°C scenario is considered in accordance with Auckland Council's Stormwater Code of Practice (CoP).
- Hydraulic grade line of existing network using CoP design criteria to determine existing capacity. The analysis considers pipes, overland flow paths and open channel capacity calculations allowing for losses through outlets, inlets, manholes and pipes.

Methodology for overland flow path and flood risk assessment

Overland flow path and flood risk assessment has been assessed as follows:

- TP108 methodology to assess rainfall runoff and stormwater rates and volumes.
- Secondary flow and flood risk assessed for 3.8°C climate change scenario in accordance with Auckland Council's Stormwater COP (v4, July 2025).
- Published peak flow rates from Auckland Council's GeoMaps overland flow path layer were also referenced.
- The capacity of pipes, overland flow paths and open channels was calculated using hydraulic grade and Manning's open channel calculation. Cross drainage culvert capacity was checked using HY-8 Culvert Analysis software.
- Flood extents from Auckland Council's GeoMaps floodplain layer and draft recent flood mapping results provided by Auckland Council were also consulted, including with when flood elevations needed to be determined.

While detailed hydrological and hydraulic modelling methods may be adopted for detailed design (to enable refinement of the reticulation system and device sizing) it was not necessary for assessment of effects.

Adopted design and assessment criteria

Table C1 below shows key design criteria and assumptions are adopted for the assessment:

Table C1: Adopted key design criteria

<table>
<tr><th>Item</th><th>Criteria</th></tr>
<tr><td colspan="2">Design events</td></tr>
<tr><td>Hydrological method</td><td>For flow and volume-based / secondary system design
Auckland Regional Council 1998, Technical Publication 108 ‘Guidelines for stormwater runoff modelling in the Auckland Region’.
Auckland Council Code of Practice v4 (July 2025) for climate change adjustments to hyetograph and rainfall depths.
Curve Number (CN) adopted:
• Impervious area = 98
• Pervious area = 74 (between SH1 to Cheesman’s Bush, weathered Waitemata – Group C)
• Pervious area = 61 (south of Cheesman’s Bush, alluvial sediments – Group B)
For flow-based / primary system design (for runoff from road surface)
Rational Method to estimate peak runoff, as per New Zealand Building Code E1/VM1
Runoff coefficient (C) adopted:
• Carriageway = 0.85
• Road berm = 0.55
• Residential site = 0.60
• Reserve and park = 0.35</td></tr>
<tr><td>TP108 rainfall (24-hour depth)</td><td>
<table>
<tr><th rowspan="2">AEP</th><th colspan="2">Climate change scenario, % increase</th><th colspan="3">24-hr rainfall depth (mm)</th></tr>
<tr><th>2.1°C</th><th>3.8°C</th><th>Historical</th><th>2.1°C</th><th>3.8°C</th></tr>
<tr><td>50%</td><td>15.1%</td><td>27.4%</td><td>78</td><td>90</td><td>99</td></tr>
<tr><td>20%</td><td>16.4%</td><td>29.6%</td><td>115</td><td>134</td><td>149</td></tr>
<tr><td>10%</td><td>17.0%</td><td>30.8%</td><td>145</td><td>170</td><td>190</td></tr>
<tr><td>1%</td><td>18.1%</td><td>32.7%</td><td>223</td><td>263</td><td>296</td></tr>
</table>
90th percentile = 25mm
95th percentile = 34mm</td></tr>
<tr><td>HIRDS 10min rainfall intensity</td><td>
<table>
<tr><th rowspan="2">AEP</th><th colspan="3">10min rainfall intensity (mm/hr)</th></tr>
<tr><th>Historical</th><th>RCP 6.0</th><th>RCP 8.5</th></tr>
<tr><td>50%</td><td>65</td><td>78</td><td>86</td></tr>
<tr><td>20%</td><td>83</td><td>100</td><td>110</td></tr>
<tr><td>10%</td><td>95</td><td>115</td><td>127</td></tr>
<tr><td>1%</td><td>138</td><td>169</td><td>187</td></tr>
</table></td></tr>
<tr><td>Imperviousness - proposed road corridor</td><td>Road reserve (carriageway + berm)</td><td>For the urban section: refer to Table 2 of the Assessment of Stormwater (Operational) Effects.
For the rural section: 80% imperviousness</td></tr>
<tr><td>Imperviousness - upstream catchment</td><td>Road reserve
Residential sites – urban
Farmland sites - rural
Reserve and park land</td><td>100% impervious
60% impervious
10% impervious
35% impervious</td></tr>
</table>

Item	Criteria	
Design criteria		
Retention	Impervious area	Where discharge of runoff from impervious area under SMAF overlay or directly to a stream receiving environment is proposed: Retention (volume reduction) of 5mm runoff depth for the impervious area for which hydrology mitigation is required. Equivalent volume can be provided as detention where retention through reuse or infiltration to ground is not achievable.
Detention	Impervious area	Where discharge of runoff from impervious area under SMAF overlay or directly to a stream receiving environment is proposed: Detention (temporary storage) and 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 5mm retention volume, over the impervious area for which hydrology mitigation is required
Quality	All road carriageway	Treatment of runoff to a device or system designed in accordance with GD01. Where alternative devices are proposed, the device must: - be designed to achieve an equivalent level of contaminant removal performance to that of GD01, or - be designed to achieve 75%TSS removal, or - be the Best Practicable Option for the situation. Green infrastructure is preferred wherever practicable.
Conveyance	Primary	10% AEP with 2.1°C climate change allowance, with 300mm freeboard to ground.
	Secondary	1% AEP with 3.8°C climate change allowance. Only less primary network capacity for pipes of 600mm dia and above with specified blockage factor, as per AC SWCOP.
Flood risk	Offsite properties	No increase to nuisance flooding of properties in up to the 10% AEP event.
	Offsite buildings	No increase to inundation of buildings in the 1% AEP event. 0.5m freeboard for more vulnerable activities and dwellings with habitable floors, from the 1% AEP flood plain. 0.3m freeboard for less vulnerable activities, from the 1% AEP flood plain.