

NZ Transport Agency Waka Kotahi

Tauriko West - Tupenga

**Flood Effects, Stormwater Management, and
Streams, Bridges and Culverts**

July 2026





Document control

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Qualifications, Experience and Code of Conduct

Eugene Paul Vojdanský

My name is Eugene Paul Vojdanský. I am a Principal Water Resource Engineer at Bloxam Burnett and Olliver (BBO), a company of consulting engineers, project managers, planners and surveyors based in Hamilton and Tauranga. I joined BBO in 2013 to establish the development of the water resource discipline at BBO.

My qualifications are Bachelor of Science (Montana State University in Bozeman Montana) and Graduate studies in Water Resource Engineering at the University of Colorado (at Denver). I am a chartered member of Engineering New Zealand and am a licensed Professional Engineer in the United States (Colorado). I have 39 years of engineering experience, and I am a member of Water New Zealand, New Zealand Rivers Group and the New Zealand Hydrological Society. I was a member of the New Zealand Fish Passage Advisory Committee and am one of the authors of the New Zealand Fish Passage Guidelines.

My experience relevant to this Project includes:

- Water Resource/Stormwater lead on the Principal Advisor's team for the Huntly Section of the Waikato Expressway, which was a 15.5km section of the expressway which bypassed the Huntly township. I was the lead water engineer for the Principal's Advisor Team.
- Water Resource/Stormwater lead on the Principal Advisor's team for the Whirokino Trestle and Manawatu Bridge Replacement, which was the replacement of two bridges and associated highway realignment near Foxton, delivered as a design and construct project. My work included flood modelling of the Manawatu River and the Motoa Floodway to demonstrate the effects of constructing the two new bridges, as part of the specimen design, and developing the drainage section of the Principal's Requirements.
- Water Resource/Stormwater lead on the Principal Advisor's team for the Takitimu North Link Stage 1, which is a new 8km four-lane highway, delivered as a design-construct project. My work on this project included flood modelling of the Wairoa River to demonstrate the effects of constructing a highway embankment and bridge across the floodplain, as part of the specimen design for a new 6.8km four lane highway, and developing the drainage section of the Principal's Requirements.
- Water Resource/Stormwater lead on the Principal Advisor's team for the State Highway 3 Te Ahu a Turanga, realignment of State Highway 3 out of the Manawatu Gorge, between Ashhurst and Woodville. My work on this project included Hydraulic and flood modelling of the Manawatu River and confluence with the Pohangina River to demonstrate the effects of constructing a new bridge over the Manawatu River, as part of the specimen design and for use as the base model for the design and construction team, and developing the drainage section of the Principal's Requirements.
- Water Resource and Stormwater lead for the Peacocke's Waikato River Bridge project including roads, three waters infrastructure, and a new bridge over the Waikato River. The project was the largest infrastructure project undertaken by Hamilton City Council in its history. I was responsible for the oversight and coordination of design for three waters infrastructure, hydrological modelling, and hydraulic modelling of the Waikato River for flood effects and bridge hydraulics input.
- Water Resource/Stormwater lead on the Principal Advisor's team for the Takitimu North Link Stage 2 project, a new 8km four-lane highway being delivered as a hybrid measure and value and design-construct project. The project includes roads, three waters infrastructure, bridges, culverts, and stream realignments.



Although this Application is not before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses as contained in section 9 of the Environment Court Practice Note 2023. I agree to comply with that Code. My qualifications as an expert are set out above. I am satisfied that the matters which I address in this report are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

s9(2)(a)

31 July 2026

Bikesh Shrestha

My name is Bikesh Shrestha. I am a Senior Water Resource Engineer at Bloxam Burnett & Olliver (BBO), a consultancy providing engineering, project management, planning, and surveying services from offices in Hamilton and Tauranga. I joined BBO in 2021.

I hold a Bachelor of Science in Civil Engineering from Central Luzon State University, Philippines, a Master of Engineering in Water Engineering and Management from the Asian Institute of Technology, Thailand, and a Doctor of Philosophy (PhD) in Civil Engineering from the University of Canterbury, New Zealand.

I am a member of Engineering New Zealand and have over 16 years of professional engineering experience in water resources engineering. My areas of expertise include hydraulic modelling, flood risk assessment, bridge hydraulics, bridge scour, stormwater management, hydrology, river engineering, and hydraulic design. I am also a member of Water New Zealand, the New Zealand Rivers Group, and the New Zealand Hydrological Society.

My experience relevant to this Project includes:

- **Water Resource Engineer – Tauriko West Project.** I undertook hydraulic modelling of the Kōpūrererua Catchment to assess the flood effects of the Project. I also carried out hydraulic modelling to inform the design and refinement of the three stream realignments (Kōpūrererua Stream, Nanako Stream, and Stream 3), together with design work for the stormwater management devices, including treatment wetlands, treatment and attenuation wetlands, and attenuation ponds.
- **Water Resource Engineer – Tiniroto Road Hangaroa Bluffs Bypass Project.** I undertook bridge scour assessments, bridge hydraulic load calculations, and non-Newtonian flow analyses. I also carried out an independent technical review of the project's hydraulic modelling.
- **Water Resource Engineer – SH25 Ramarama Bridge Replacement Project.** I completed hydrological, bridge hydraulic, and scour assessments and undertook hydraulic modelling to assess the flood effects of the Project. I also prepared the stormwater management report in support of the resource consent application.
- **Water Resource Engineer – Takitimu North Link Stage 2.** I undertook the design of the stormwater management system, including numerous treatment wetlands, treatment and attenuation wetlands, and treatment swales. I also prepared the stormwater management report in support of the fast-track application.



- Water Resource Engineer – Takitimu North Link Stage 1. I undertook hydraulic modelling to assess the downstream flood effects associated with the Takitimu North Link Stage 1 embankment through the Te Mete Valley. I also completed a dam-break analysis for the project embankment at Culvert 15 and carried out a hydraulic review of the Hakao Stream Bridge. In addition, I prepared technical reports, memoranda, and engineering notes.

Although this Application is not before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses as contained in section 9 of the Environment Court Practice Note 2023. I agree to comply with that Code. My qualifications as an expert are set out above. I am satisfied that the matters which I address in this report are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

s9(2)(a)

31 July 2026



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- Annexure A:** Kōpūrererua, Wairoa River, and Waimapu Catchments Drawing
- Annexure B:** Stormwater Management Indicative Design Drawings
- Annexure C:** Stream Realignment Detailed Design Drawings



Glossary of Acronyms and Abbreviations

Acronym / Abbreviation	Term
ARI	Annual Recurrence Interval storm
BBO	Bloxam Burnett & Olliver
BOPRC	Bay of Plenty Regional Council
EPA	United States Environmental Protection Agency
FTAA	Fast-track Approvals Act 2024
GAP	General All Passing metal
HEC-RAS	Hydrologic Engineering Centre's River Analysis System hydraulic model
HIRDS	NIWA's High Intensity Rainfall Design System version 4
MfE	Ministry for the Environment
m/s	Metres per second
NES-FW	Resource Management National Environmental Standards for Freshwater Regulations 2020
NZTA	NZ Transport Agency Waka Kotahi
P46	NZTA Waka Kotahi P46 Stormwater Management and Minor Stream Diversion Design Specification
RoNS	Roads of National Significance
SAR	Substantive Application Report
SH29	State Highway 29
SH29A	State Highway 29A
SH36	State Highway 36
SWMM	Stormwater Management Model Version 5
TCC	Tauranga City Council
TCC-509	TCC Wairoa River flood model
TCP	Tauranga City Plan
TUFLOW	Two-dimensional Unsteady Flow hydraulic model
WBOPDC	Western Bay of Plenty District Council



1. Executive Summary

This report assesses the operational flood, stormwater and watercourse effects of the Tauriko West – Tupenga Project (the Project). It also describes the design approach for the Project’s stormwater management system, three stream realignments, bridges and culverts.

1.1 Flooding

The Project will introduce approximately 21ha of additional impervious surface across the Wairoa River, Kōpūrererua and Waimapu catchments. It will also require works within existing floodplain areas and the realignment of sections of the Kōpūrererua Stream, Nanako Stream and an unnamed stream near Belk Road (Stream 3). The assessment has therefore considered potential changes to stormwater runoff, flood levels and extents, floodplain storage and conveyance, stream stability, aquatic habitat and fish passage.

Flood modelling has been undertaken for the 10-year Annual Recurrence Interval (ARI) and 100-year ARI design storm, including climate change allowances to 2130. The assessment concludes that flood effects within the Wairoa River and Waimapu catchments will be less than minor. Within the Kōpūrererua Catchment, effects will also be less than minor, except at two properties on Marshall Avenue in the 100-year ARI design storm where flood levels are expected to increase by approximately 43mm. The detached garage at 98 Marshall Avenue and the dwelling at 108 Marshall Avenue will have flood freeboard over the 100-year ARI flood without accounting for climate change post-Project, but will be flooded both pre-Project and post-Project when accounting for climate change. The flooding of these two buildings is therefore attributable to climate change rather than the comparatively small increase resulting from the Project. The flood effects on these two Marshall Avenue properties are assessed as a minor adverse effect.

1.2 Stormwater

The indicative stormwater design demonstrates one feasible means of achieving the required water quality and quantity outcomes for the Project. Runoff from new impervious road surfaces will be treated before discharge, principally through treatment swales and treatment wetlands. Attenuation or extended detention will be provided where required to manage peak flows or erosion effects.

1.3 Streams, Bridges and Culverts

The Project requires the realignment of sections of the Kōpūrererua Stream, Nanako Stream and Stream 3 near Belk Road. These are historically straightened or otherwise modified channels with limited existing habitat diversity. The designs of the realigned stream sections aim to maintain channel capacity and stability while providing more naturalised channel forms, improved stream–floodplain connectivity, lower flow velocities and increased opportunities for riparian and wetland planting.

The Kōpūrererua Stream and Nanako Stream realignments will materially increase the length of the affected reaches and provide more varied channel widths, depths, bends and habitat conditions. The Stream 3 realignment is more constrained by the available corridor, flat topography and existing mitigation works, but will still provide improved capacity, wider vegetated benches, more varied aquatic habitat and approximately 30m of stream daylighting. Across all three realignments, the designs will increase the extent and diversity of habitat available to native fish and improve the ability of vegetation to establish along the channel banks.

The proposed stream bridges design has been approached in conjunction with the stream realignments so that they accommodate stream processes and fish-passage flows, minimise upstream flooding and avoid significant channel constriction.



Three culverts are proposed within the Takitimu Drive interchange area. They provide for cross-drainage and flood conveyance, and may provide fish passage should they connect with potential upstream aquatic habitat. Smaller culverts will also be required elsewhere for local overland drainage and will be confirmed through detailed design.

1.4 Conclusion

Overall, the assessment concludes that:

- Operational flood effects will be less than minor within the Wairoa River and Waimapu catchments and throughout the Kōpūrerua Catchment, except at the two affected Marshall Avenue properties where effects will be a minor adverse effect;
- Stormwater effects can be appropriately managed through treatment, attenuation, extended detention and erosion protection;
- The effects of the bridges and culverts on stream processes, fish passage flows and flooding will be negligible; and
- The stream realignments will result in significant ecological, hydraulic and cultural benefits compared with the existing modified channels.



2. Introduction

The Tauriko West - Tupenga Project (the Project) is a nationally significant transport infrastructure initiative within Tauranga's Western Corridor and forms part of the Government's Roads of National Significance (RoNS) programme.

The Project extends from Ōmanawa Road in the southwest to Barkes Corner in the northeast and includes the construction of new offline four-lane corridors for State Highway 29 (SH29) and State Highway 29A (SH29A), together with associated grade-separated interchanges, local road connections, and supporting transport network improvements to improve safety, reliability and freight efficiency and to enable planned urban growth in Tauriko West.

A comprehensive description of the Project is provided in the Substantive Application Report (SAR).

2.1 Purpose and overview

The purpose of this report is to:

- Describe the freshwater resources of the existing environment in which the Project will be constructed in.
- Assess the potential effects of the Project on that environment, in relation to stormwater, hydraulics, hydrology, and flooding.
- Describe the approach to design for the Project.

This report also addresses how the potential effects of the Project will be managed through design and management measures.

There are a range of stormwater and hydrology guidelines and standards that have been produced by Bay of Plenty Regional Council (BOPRC) and NZTA to manage the adverse stormwater and hydrological effects of development (including highway infrastructure) in a consistent manner. These guidelines and standards are considered standard practice and are referenced as relevant throughout this report.

This report addresses only the operational stormwater effects of the Project. Construction stormwater effects are addressed in the "Construction Water Assessment", groundwater effects are addressed in the "Preliminary Groundwater Assessment" and ecological effects are addressed in the "Ecological Impact Assessment".

The technical details underlying this assessment are contained in the following documents:

- Tauriko West – Tupenga - Stormwater Management Technical Memo; 1 July 2026.
- Tauriko West – Tupenga - Culverts, Bridges and Streams Technical Memo; 1 July 2026.
- Tauriko West Consent Level Design – Flood Effects Assessment Technical Memo; 1 July 2026.



3. Flood Effects Assessment

3.1 Scope – Potential Flood Effects

This assessment focuses on the following relevant flooding issues:

- Increased stormwater runoff from new impervious surfaces;
- Works within or near existing floodplain areas;
- Potential changes to flood levels, floodplain storage and flow conveyance;
- Potential changes to upstream and downstream flood risk; and
- The potential effects on sensitive receiving environments.

This report assesses the potential flood effects of the Project within the Kōpūrererua, Wairoa River, and Waimapu catchments, being the three catchments traversed by the Project alignment (refer **Figure 3.1** (below) and the catchment drawing in **Annexure A**).

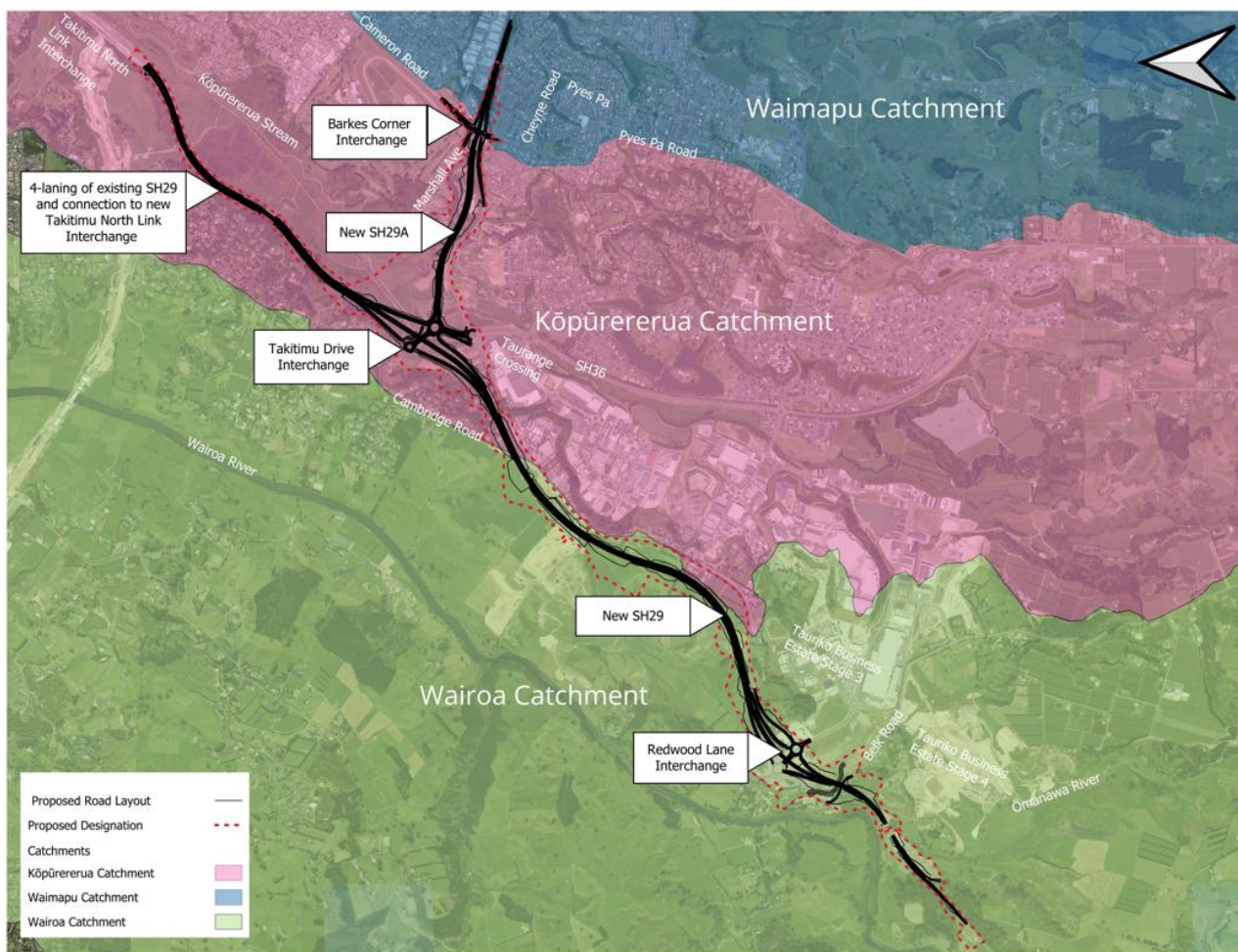


Figure 3.1: Project Alignment and Catchments



3.2 Catchment Descriptions

The following sub-sections describe each of the three catchments.

3.2.1 Wairoa River Catchment

The Wairoa River catchment is approximately 463km² and extends from the Kaimai and Mamaku ranges to the Tauranga Harbour. Around 9km² of the catchment is within the Tauranga City Council (TCC) boundary and is predominantly rural and semi-rural in character. The remainder of the catchment is located within the Western Bay of Plenty District Council (WBOPDC) boundary and is largely rural. Based on the 2023 Land Cover Database, the land use type (**Figure 3.2**) within the Wairoa River catchment is dominated by forest (68%) and pasture (29%). The urban area is less than 1% of the total catchment.

The Wairoa River is the largest river system discharging into Tauranga Harbour and receives flow from several major tributaries, including the Mangapapa, Omanawa, and Waitekohe Streams. The catchment experiences relatively high rainfall, particularly in the Kaimai Range, resulting in significant runoff generation and rapid river response during storm events.

There are four hydro-electric power stations in the catchment. The Ruahihi Power Station, which discharges into the upper tidal limit of the Wairoa River approximately 12km from the river mouth, is the largest and furthest downstream power station. The Ruahihi Power Station significantly influences river flow downstream from it.

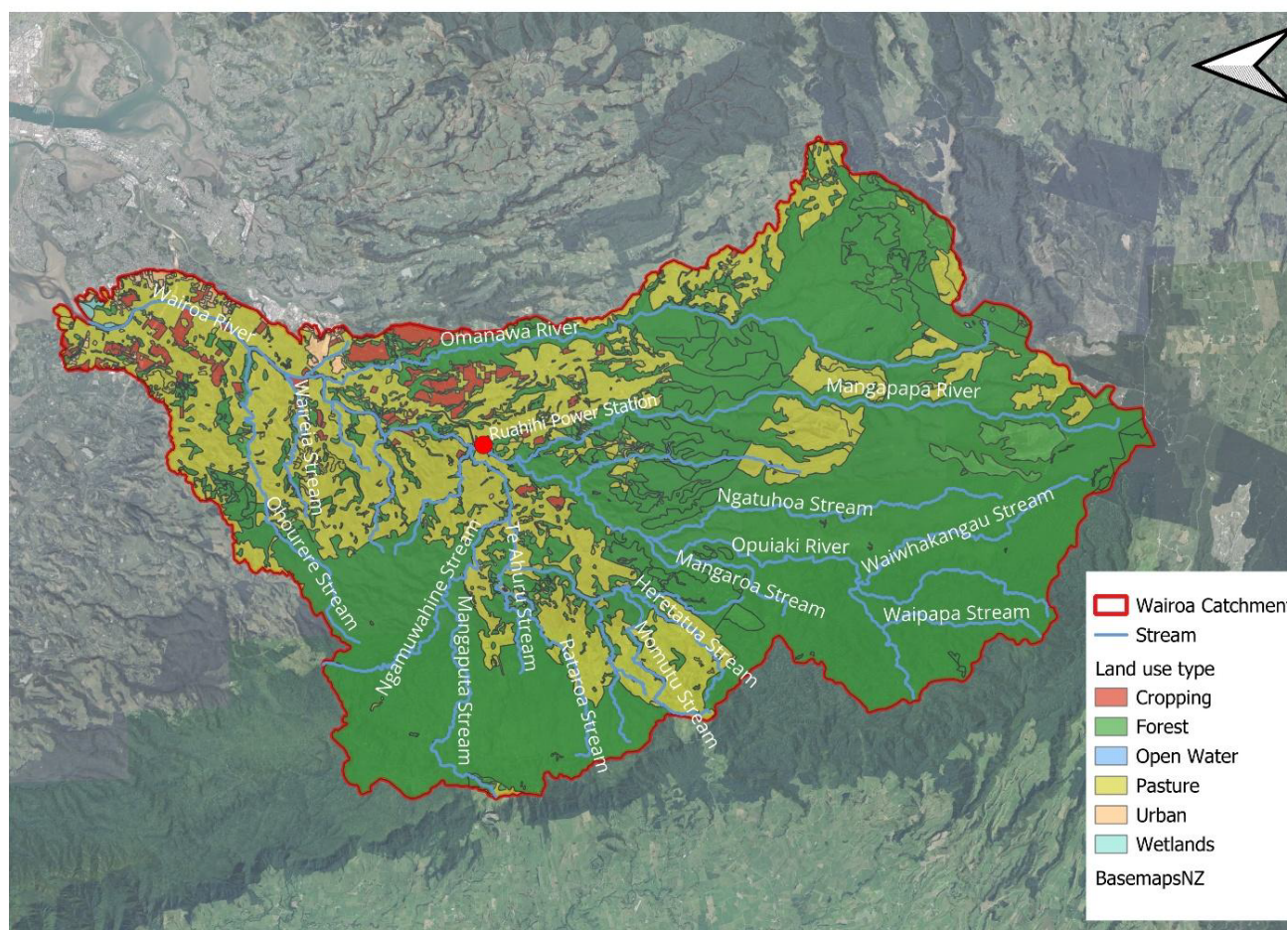


Figure 3.2: Wairoa River Catchment and Land Use



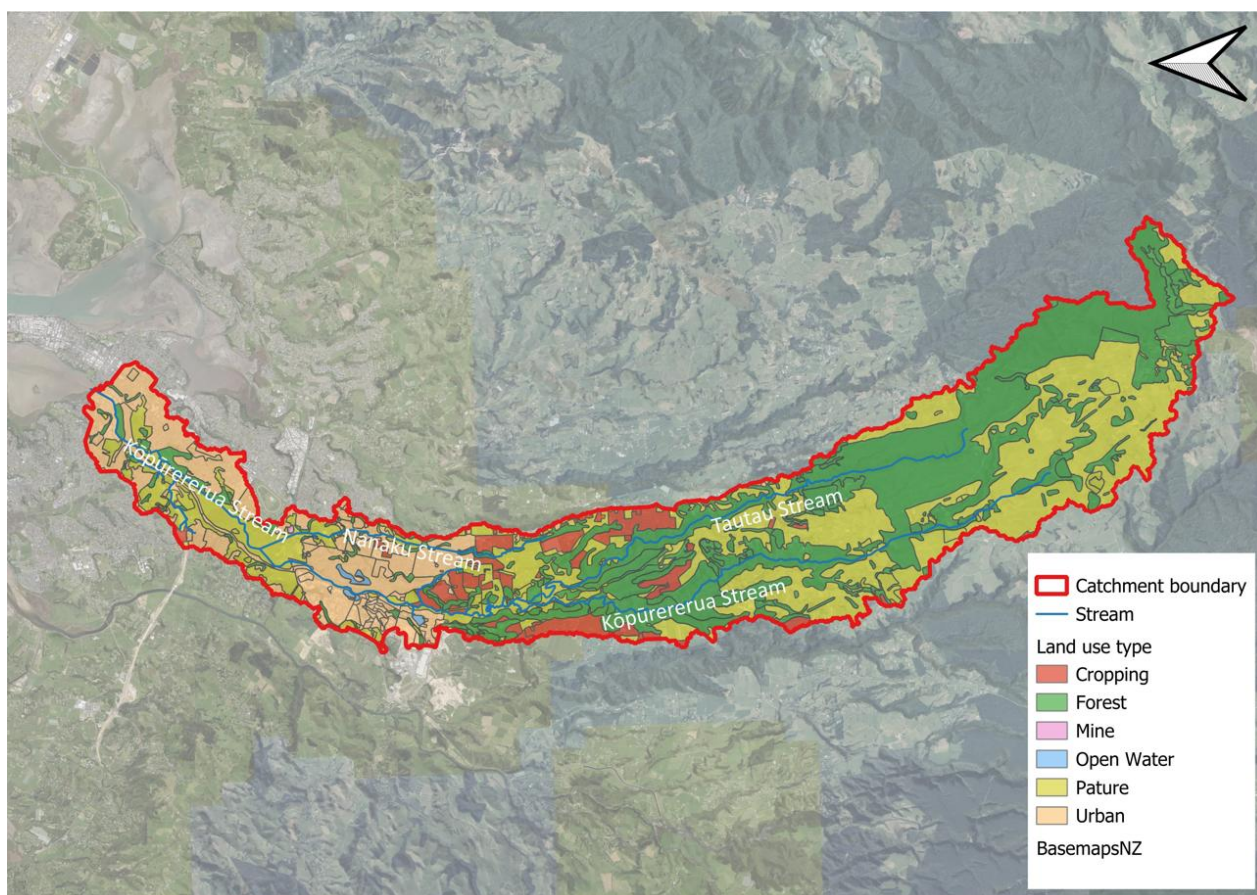
3.2.2 Kōpūrererua Catchment

The Kōpūrererua catchment extends 13km north-west of Tauranga City. The catchment is approximately 7,500 hectares and extends from the Mamaku Plateau to the Waikareao Estuary, in Tauranga Harbour, central Tauranga.

The upper part of the catchment, within the boundary of WBOPDC, consists of forest and pasture with some cropping land use, while the lower part of the catchment, within the boundary of TCC, is dominated by urban land use (**Figure 3.3**). Based on the 2023 Land Cover Database, the extent of land use types within the Kōpūrererua catchment is dominated by forest (40%) and pasture (38%). The urban area is 16%.¹ of the total catchment.

The Kōpūrererua Stream is approximately 31km long and has two major tributary streams (Tautau and Nanako), as well as numerous unnamed lesser tributaries. Commencing at its headwaters, the first 21km of the stream flows through rural land.

For the final 10km, the Kōpūrererua Stream flows through urban Tauranga. The uppermost 4km within the section through Tauranga meanders significantly. Large attenuation basins have been constructed on either side of the stream to reduce the peak flow rates generated by the urban developments in Tauriko and Pyes Pa. The embankment near Keenan Road also provides a ponding area to attenuate flow rates (**Figure 3.4**). The lower 6km through Tauranga travels through a tidal floodplain and into the Waikareao Estuary. For most of its length, the stream within the tidal floodplain has been modified, with some 2.3km being straightened. The lower 1.5km from the Waikareao Estuary is confined by the Judea industrial area.



¹ Land Cover Database version 6.0 (LCDB v6.0).

² Ibid



The Tautau Stream is approximately 18.5km long and connects with the Kōpūrerua Stream near Gasson Lane in Pyes Pa.

The Nanako Stream is approximately 7.5km in length and flows through the Pyes Pa urban area. The stream passes through a 1200mm culvert beneath the SH29A embankment and joins the main Kōpūrerua Stream approximately 840m downstream of the SH29A culvert. As part of the TCC flood management program, numerous attenuation basins and three major embankment dams (i.e. Dam 2 located upstream of Kennedy Road, Kennedy Road Embankment and Dam 5 Flood Detention Embankment) have been constructed³ on the Nanako Stream to manage flooding in the catchment (Figure 3.4). The area behind the SH29A road embankment also provides a ponding area that attenuates flow.

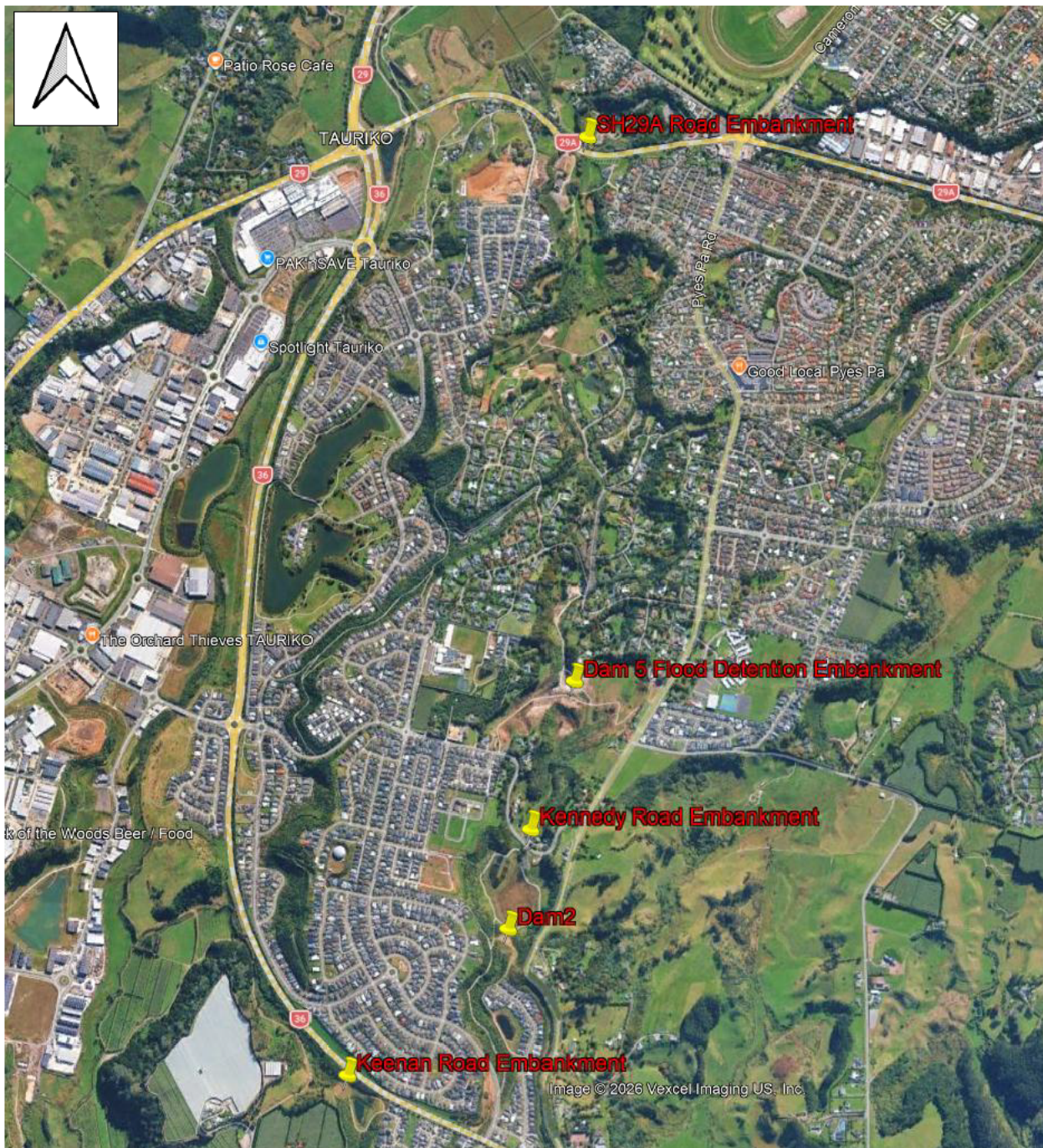


Figure 3.4: Location of major embankments for stormwater management in Tauriko and Pyes Pa

³ As part of TCC's flood management program.



3.2.3 Waimapu Catchment

The Waimapu catchment is located southeast of Tauranga Harbour. It is approximately 112km² and extends from Ōtānewainuku in the south into the harbour between Winderemere and Greerton. The catchment spans both TCC and WBOPDC territorial boundaries. The catchment includes roughly 236km of stream, including the Waimapu Stream and Waiorohi Stream. The three major tributary streams are Kirikiri, Mangarewarewa, and Pukekonui. Based on the 2023 Land Cover Database, the land use type (**Figure 3.5**) within the Waimapu catchment is dominated by pasture (48%) and forest (39%). The urban area is 8% of the total catchment. Urban areas are concentrated in the lower catchment, particularly around Oropi, Greerton and Winderemere.

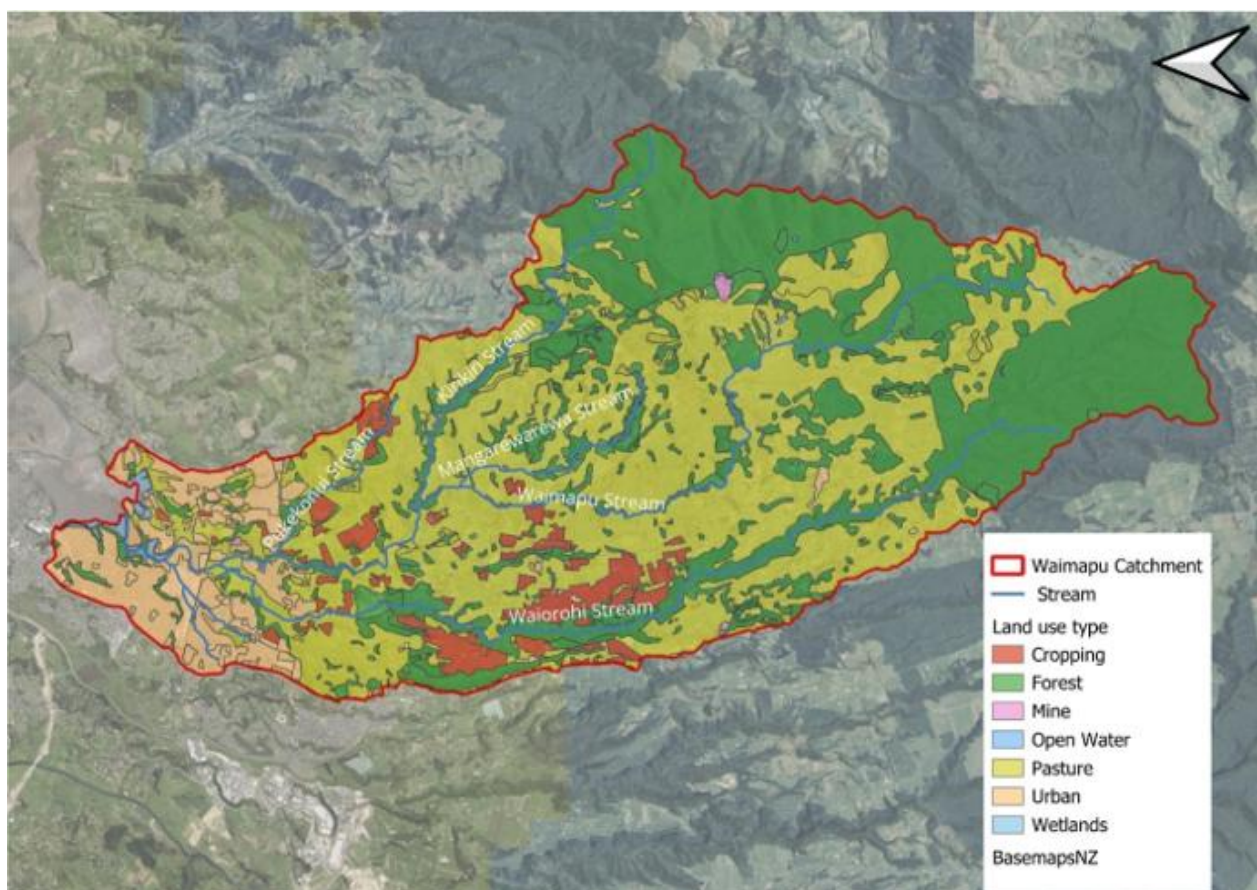


Figure 3.5: Waimapu Catchment and Land Use

3.3 Potential Effects Categories

The Project has potential effects in three main categories:

1. The Project will introduce approximately 21ha of new impervious surface across the catchments. Appropriate stormwater management is required to manage stormwater runoff volume and peak flows, so as to minimise downstream flood risk, alteration of the hydrology in sensitive receiving environments such as the Kōpūrererua valley wetland complex, and the potential for downstream erosion.
2. Within the Wairoa River catchment, the Project includes a section of highway near Belk Road, including the Redwood Lane interchange. This section of the Project will be constructed on an embankment and passes through the floodplain of an unnamed stream that is a tributary of the Wairoa River. The floodplain currently conveys flows beneath the existing SH29 through culverts near Belk Road before



discharging to the Wairoa River. The Project has the potential to displace floodplain storage and alter upstream and downstream flood behaviour in this location.

3. Within the Kōpūrerua catchment, the Project includes a new section of four-lane highway, the Takitimu Drive interchange, widening of the existing Takitimu Drive Toll Road, and a new section of SH29A from the proposed Takitimu Drive interchange to Barkes Corner. These works are located within or near floodplain areas and have the potential to affect floodplain storage, flow conveyance, and upstream and downstream flood levels.

3.4 Potential Flood Effects Assessment Criteria

Potential flood effects have been assessed with reference to the Bay of Plenty Regional Council's Standard Operational Procedure No. DAC5 – Technical Review of Resource Consent Application (2016) and the Hydrological and Hydraulic Guidelines (2012).

The Guidelines state that there are no flooding effects or less than minor flooding effects as follows:

- Where there is no change in flood level, there is considered to be **Nil Effects** or no effect.
- Where there is less than a 15mm⁴ increase in flood level, which constitutes an effect that is too small to adversely affect the environment or other persons, the effect is considered **Less Than Minor**.
- Where flood level increases exceed 15mm but are too small to adversely affect the environment or persons is also considered **Less Than Minor**.

Where the effects are noticeable, but do not cause any material effect, the effect is considered a **Minor Adverse Effect**.

An increase in flood level that is less than 15mm but changes the flood freeboard status of a structure or results in the flood level being over the floor level post-development, where the pre-development flood level was below the floor level, is considered a **More Than Minor Adverse Effect**.

This methodology has guided the assessment as to whether the flooding effects are acceptable or require mitigation. Where any increases do not meet the 'no effect' or 'less than minor' threshold, a more detailed assessment is provided.

3.5 Assessment Methodology

This section summarises the modelling methodologies utilised to assess the effects in each catchment.

3.5.1 Wairoa River Catchment

The potential effects of the Project on flooding, upstream and downstream for the Belk Road section of the Project (within the Redwood Lane Interchange area and within the Wairoa River Catchment), were assessed using the existing TCC Wairoa Catchment model, which was completed using the Two-dimensional Unsteady Flow (TUFLOW) modelling software. It was an appropriate model for this area as it is already in place and being used by TCC and no detailed representation of bridge or culvert hydraulics are required for this part of the Project.

⁴ 15mm is the maximum allowable difference between pre and post-development flood level in the BoPRC Hydrological and Hydraulic Guidelines (2012),



3.5.2 Kōpūrererua Catchment

Within the Kōpūrererua catchment, potential effects of the Project on flooding, upstream and downstream of the Project were assessed using a hydraulic model, the Hydrologic Engineering Centre's River Analysis System (HEC-RAS) model. The HEC-RAS hydraulic model was specifically developed for this assessment.

In addition, the hydrology of the Kōpūrererua Catchment was modelled using the United States Environmental Protection Agency (EPA) Stormwater Management Model Version 5 (SWMM). The primary purpose of undertaking SWMM modelling is to derive inflow boundary conditions for the more detailed two-dimensional hydraulic modelling (HEC-RAS).

As an input to the models, the existing rainfall intensities for the 72-hour duration design storm have been obtained from NIWA's High Intensity Rainfall Design System (HIRDS) version 4 for two locations: one representative of the upper catchment and the other representative of the lower catchment. The existing rainfall intensities were adjusted for climate change, incorporating a temperature increase of 3.68 °C to obtain the projected 2130 rainfall intensity as per **Figure 3.6** (which refers to Table 6 of the Ministry for the Environment (MfE) Coastal Hazards and Climate Change Guidance Report (BOPRC, 2021)). The temperature rise of 3.68°C corresponds to BOPRC Category A because the Project is “*major new infrastructure*”. This Representative Concentration Pathway (RCP) 8.5H+ climate change scenario, and sea level rise projection of 1.59m, has been adopted in all the modelling discussed in this report.

Table 6 Sea-level rise and temperature projections to 2130.

BOPRC category	BOPRC description	SLR scenario	SLR projection 2130, MVD-53	Temperature projection 2130 (for HIRDS)
A	Coastal subdivision, greenfield developments and major new infrastructure. Changes in land use.	RCP 8.5H+, median value or DAPP.	1.59 m or use all four SLR scenarios.	3.68°C
B	Redevelopment (intensification) and existing coastal development.	RCP 8.5 median value or DAPP.	1.25 m or use all four SLR scenarios.	3.68°C
C	Relocatable activities/developments.	RPS Policy NH 11B (b) or DAPP.	0.85 m or use all four SLR scenarios.	1.67°C

Figure 3.6: Table 6 of the MfE Coastal Hazards and Climate Change Guidance Report (BOPRC, 2021), indicating sea-level rise and temperature projections to 2130.

The effects of the Project on the 10-year ARI flood level were also checked, using the modelled 10-year ARI flow and the 2-year storm tide. Other than inflow and downstream tidal boundary conditions, the pre-Project and post-Project models were identical to the 100-year ARI flood modelling. The flood modelling was completed with and without accounting for climate change.

3.5.3 Waimapu Catchment

Due to the very small amount of additional impervious area (0.64ha total) being constructed as part of the Project, in relation to the total developed area within the catchment, and the tidal nature of the receiving environment, detailed flood modelling was not undertaken for the Waimapu Catchment. Instead, a high-



level desktop analysis, using TCC flood maps⁵, was carried out to assess the potential effects of the Project on the flooding of downstream properties within the Waimapu Catchment.

3.6 Model Results

The following sections describe the results of the modelling for the Wairoa River and Kōpūrerua catchments. The results are based on comparing the existing environment flood level extent, depth, and velocities (upstream and downstream of the Project) with the same parameters for the post-Project environment. The post-Project environment is based on an indicative geometric and earthworks design of the Project, and defines the extent of floodplain volume displacement in the two catchments. The flood modelling takes into account the additional runoff created by the new 21ha of impervious area.

3.6.1 Wairoa River Catchment (Belk Road and Redwood Lane Interchange Area)

A comparison of the flood levels pre- and post-Project was undertaken to assess changes upstream and downstream of the Project.

The flood model indicates an increase in flood depth of less than 15mm in the upstream and downstream areas outside of the designation boundary (**Figure 3.7**). Areas where the increase in flood depth exceeds 15mm are very limited, are small and are within the designation boundary (refer to the circled area on **Figure 3.7**).

The flood model indicates that the overall flood extent upstream and downstream of the Project alignment remains unchanged.

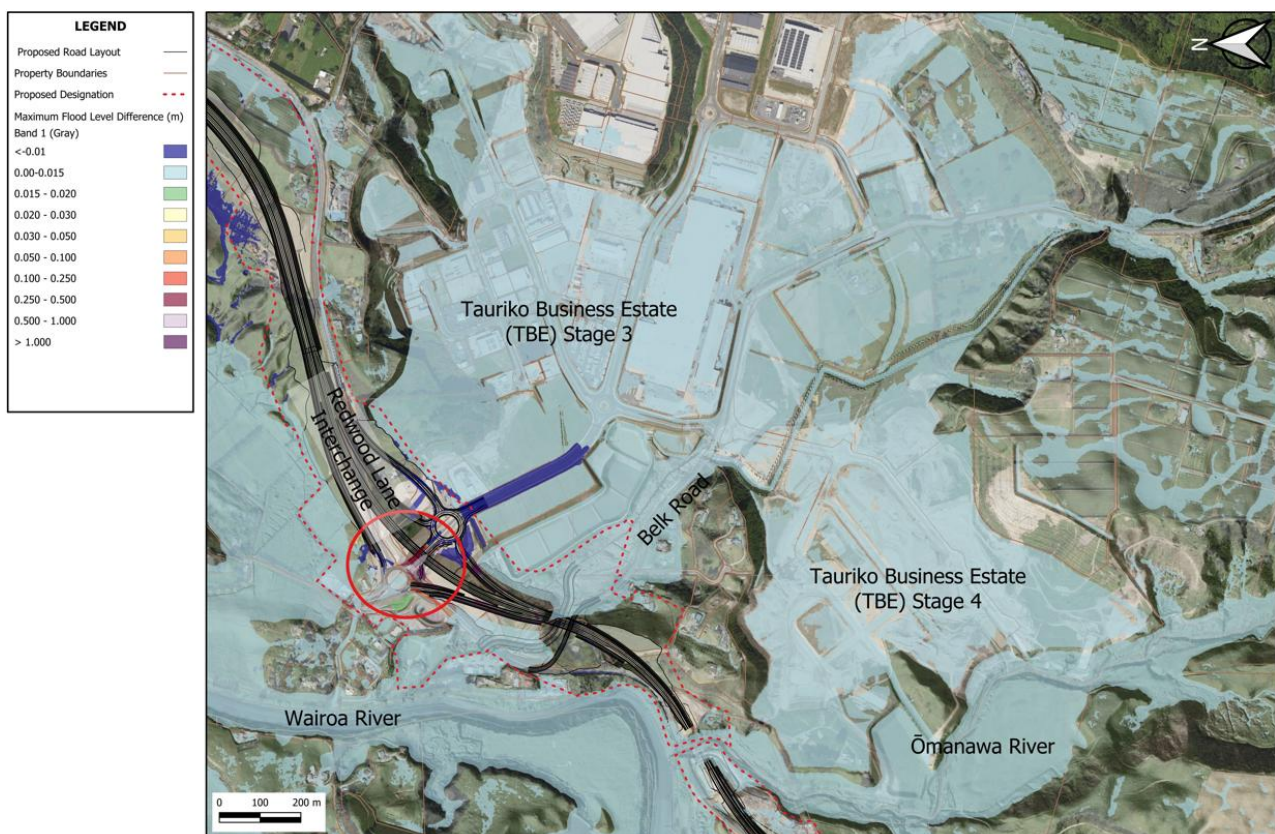


Figure No. 3.7: Maximum flood level difference at areas upstream and downstream of the project section at Belk Road and Redwood Lane Interchange for the 100-year ARI design storm, including climate change for 2130. Note: The location of the area where flood depth exceeds 15mm is circled in red.

⁵ Flooding from Rainfall (City Plan, 1% AEP year 2130 climate RCP8.5 median Scenario) accessed via Tirotiro Mapi kaunihera Council map viewer Mapi



3.6.2 Kōpūrererua Catchment

3.6.2.1 100-Year ARI Design Storm

A comparison of the flood levels pre- and post-Project was undertaken to assess changes upstream and downstream of the Project. The hydraulic modelling results for this catchment indicate several localised changes as follows:

- In the upstream urban areas south of the designation (i.e. in the Tauriko Business Estate, The Lakes and Pyes Pa) there will be an increase in flood levels of up to 8mm and no change in the flood extent for the 100-year ARI design storm including climate change (as illustrated on Figure 3.8 below).

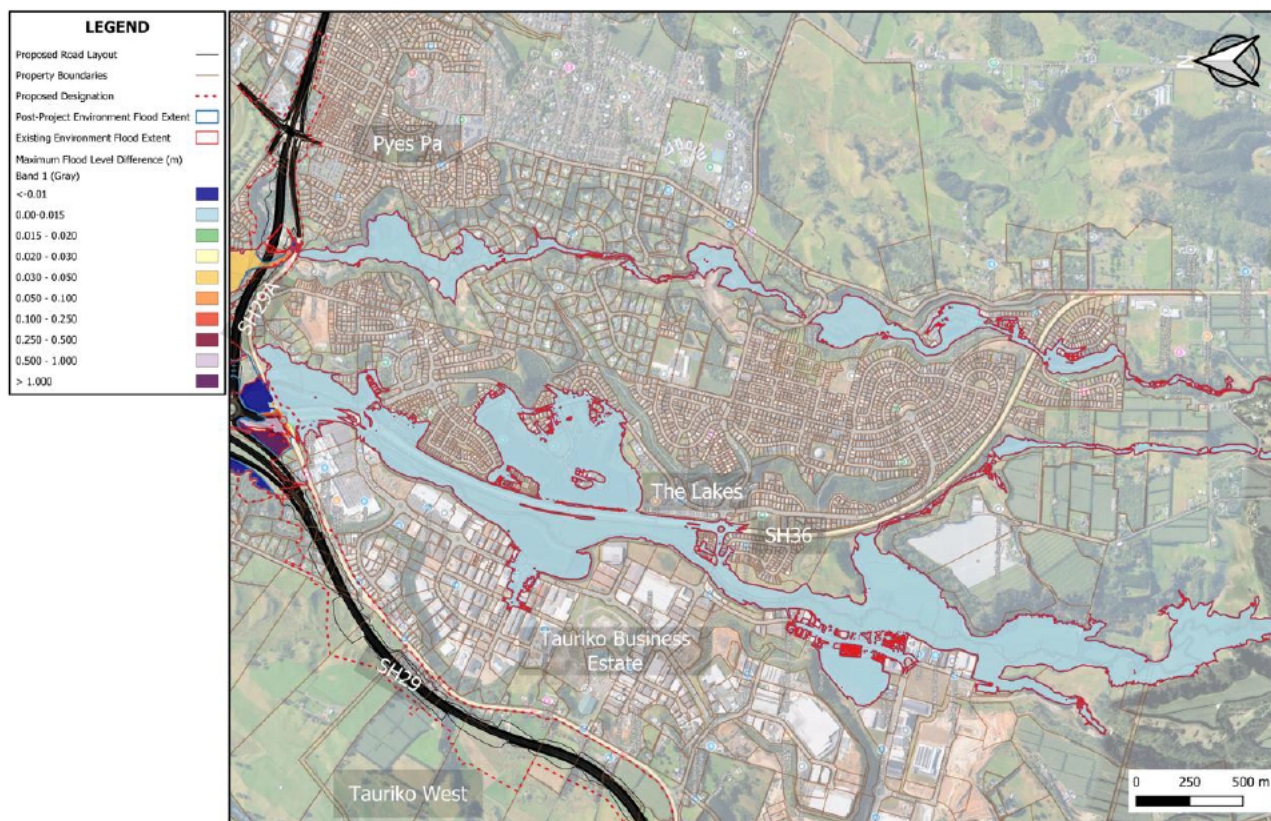


Figure No. 3.8: Maximum flood level difference in the upstream area south of SH29A, and comparison of existing environment and post Project flood extents for the 100-year ARI design storm, including climate change.

- There will be a spatially limited increase in flood depth exceeding 15mm within the downstream area north of SH29A and east of SH29 Takitimu Drive (as illustrated with green, yellow and orange shading on Figure 3.9 below). The increase in flood depth ranges from 15mm to 50mm in the impacted areas outside the Project designation, including increased flooding on four properties in Marshall Avenue.
- There will be changes in flood extent within the downstream area north of SH29A and east of SH29 Takitimu Drive (Figure 3.9 below). In most locations, the increase in flood extent is limited, typically ranging from 0.41m to approximately 2m. The spatial extent of these effects is limited to approximately 2100m downstream of the existing SH29A. Flood depth increase will be less than 15mm in areas beyond 2100m downstream of the existing SH29A.
- Larger changes in flood extent are expected immediately adjacent to the proposed bridge structures on the new SH29A (circled in purple in Figure 3.9 below) within the proposed designation boundaries. The larger flood extent is a result of localised terrain modification associated with the bridge approaches and associated infrastructure.



- There will be changes in flood extent within the downstream area north of SH29A and east of SH29 Takitimu Drive (Figure 3.9 below). In most locations, the increase in flood extent is limited, typically ranging from 0.41m to approximately 2m. The spatial extent of these effects is limited to approximately 2100m downstream of the existing SH29A. Flood depth increase will be less than 15mm in areas beyond 2100m downstream of the existing SH29A.
- Larger changes in flood extent are expected immediately adjacent to the proposed bridge structures on the new SH29A (circled in purple in Figure 3.9 below) within the proposed designation boundaries. The larger flood extent is a result of localised terrain modification associated with the bridge approaches and associated infrastructure.

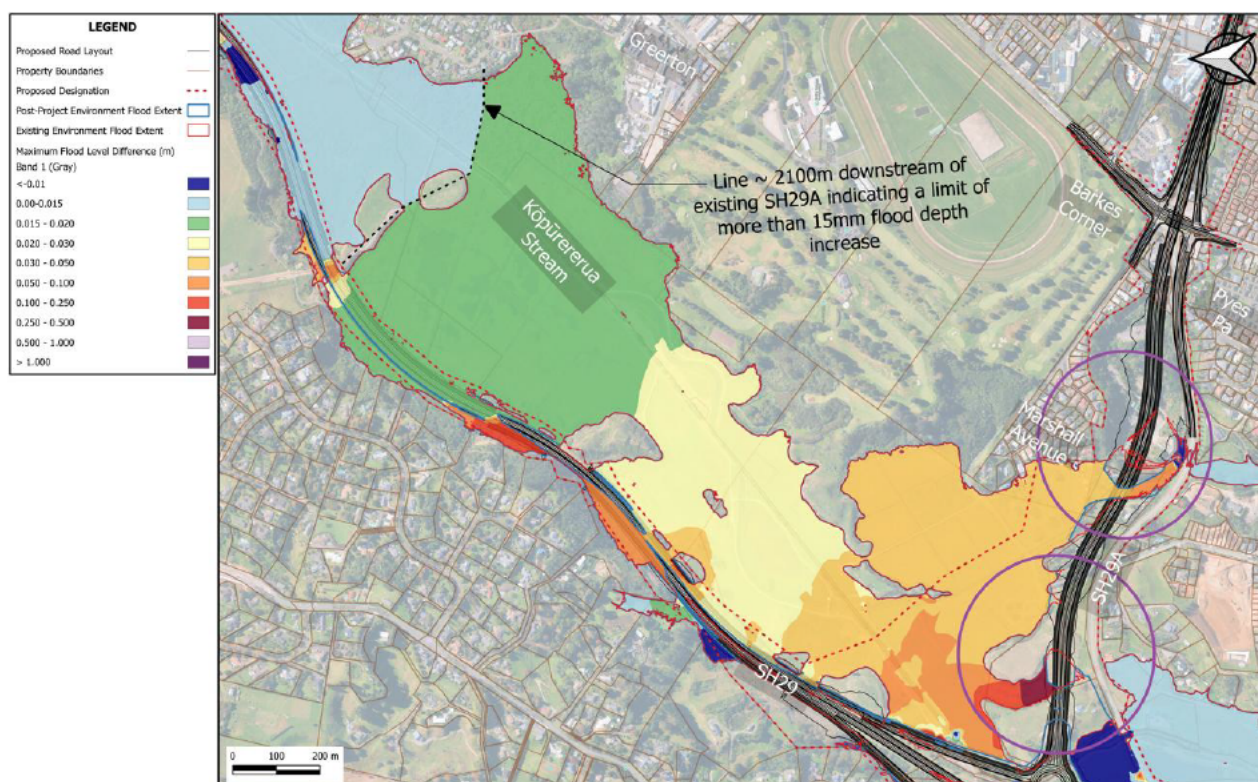


Figure No. 3.9: Maximum flood level difference in the downstream area north of SH29A and east of SH29, and comparison of existing environment and post Project flood extents for the 100-year ARI design storm, including climate change. Note: The location of the proposed bridges is circled in purple.

- A decrease in flood depth in the area west of the proposed Takitimu Drive Interchange and in the area immediately downstream of existing SH29A (as illustrated with dark blue shading on Figure 3.10 below). These areas are located within the designation boundaries.
- An increase in flood depth of more than a metre in the area to the northwest of the existing Tauriko roundabout, and also southwest of the Takitimu Drive Interchange (as illustrated with purple and pink shading on Figure 3.10 below). These low-lying areas are included within the designation boundaries.



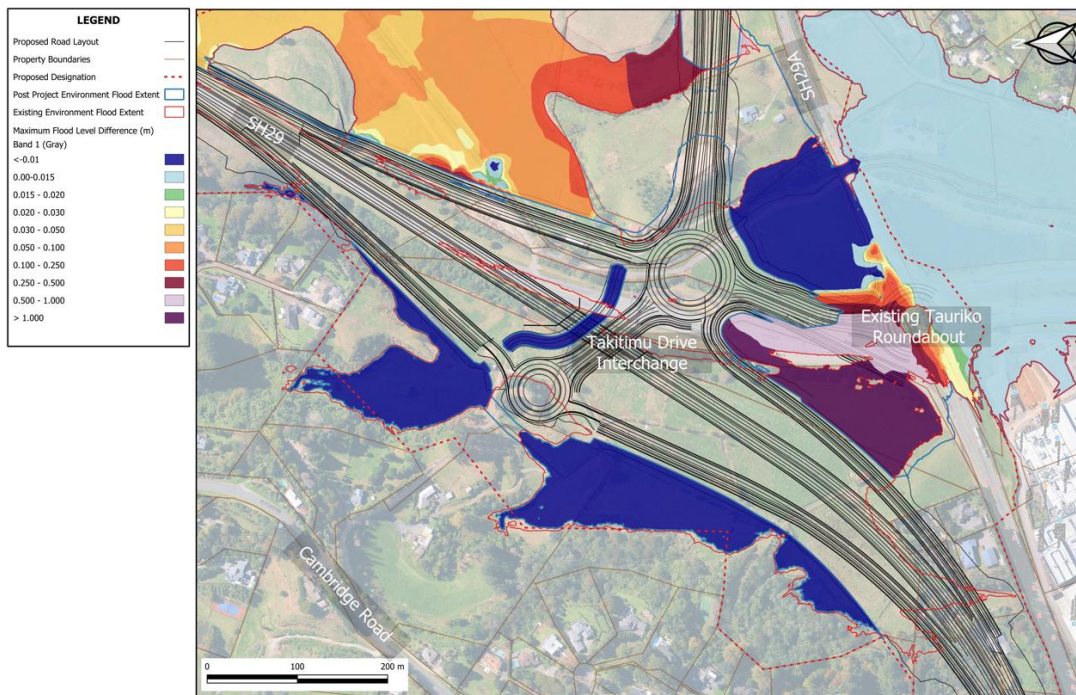


Figure No. 3.10: Maximum flood level difference at the Takitimu Drive Interchange area, and comparison of existing environment and post Project flood extents for the 100-year ARI design storm, including climate change.

- An increase in flood depth ranging from 20mm to 100mm in five isolated areas downstream and to the northwest of SH29 Takitimu Drive (circled in red on **Figure 3.11** below). Four of these areas are inside the designation boundary. The remaining area (within 20 Furniss Lane and circled in red on **Figure 3.12** below) is a low-lying gully area subject to a major overland flowpath (purple shading on **Figure 3.12** below).

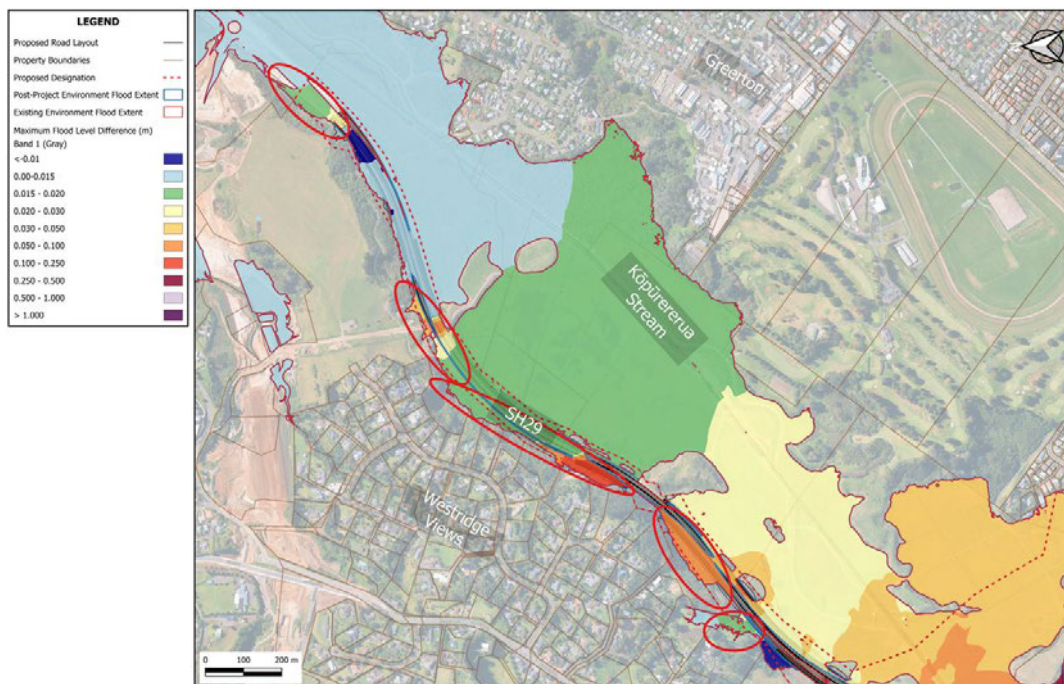


Figure No. 3.11: Maximum flood level difference at the downstream area northwest of SH29, and comparison of existing environment and post Project flood extents for the 100-year ARI design storm, including climate change.



Zones

☒ Zones - Industry

[View section](#)

Section 5 - Diagrams

☐ Financial Contribution Urban

Growth Areas - Tauranga Infill

[View section](#)

Non statutory layers - Flooding from intense rainfall

☒ Major Overland Flowpath

☒ Minor Overland Flowpath

☒ Flood Prone Area

Flood depth 300mm or more

☒ Flood Prone Area

Flood depth 100mm-299mm

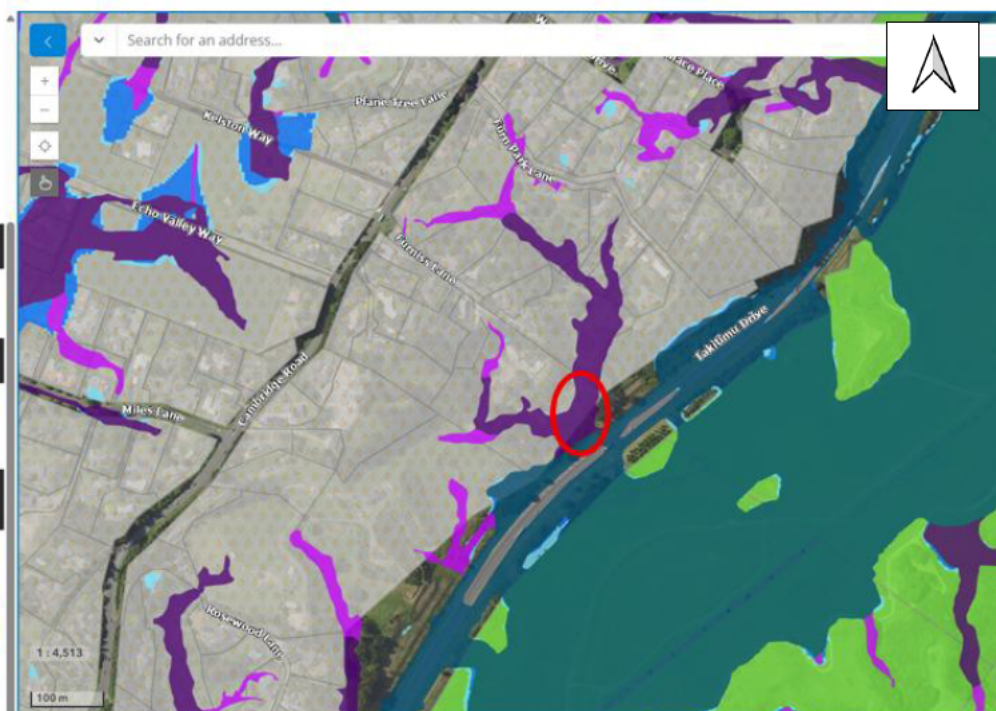


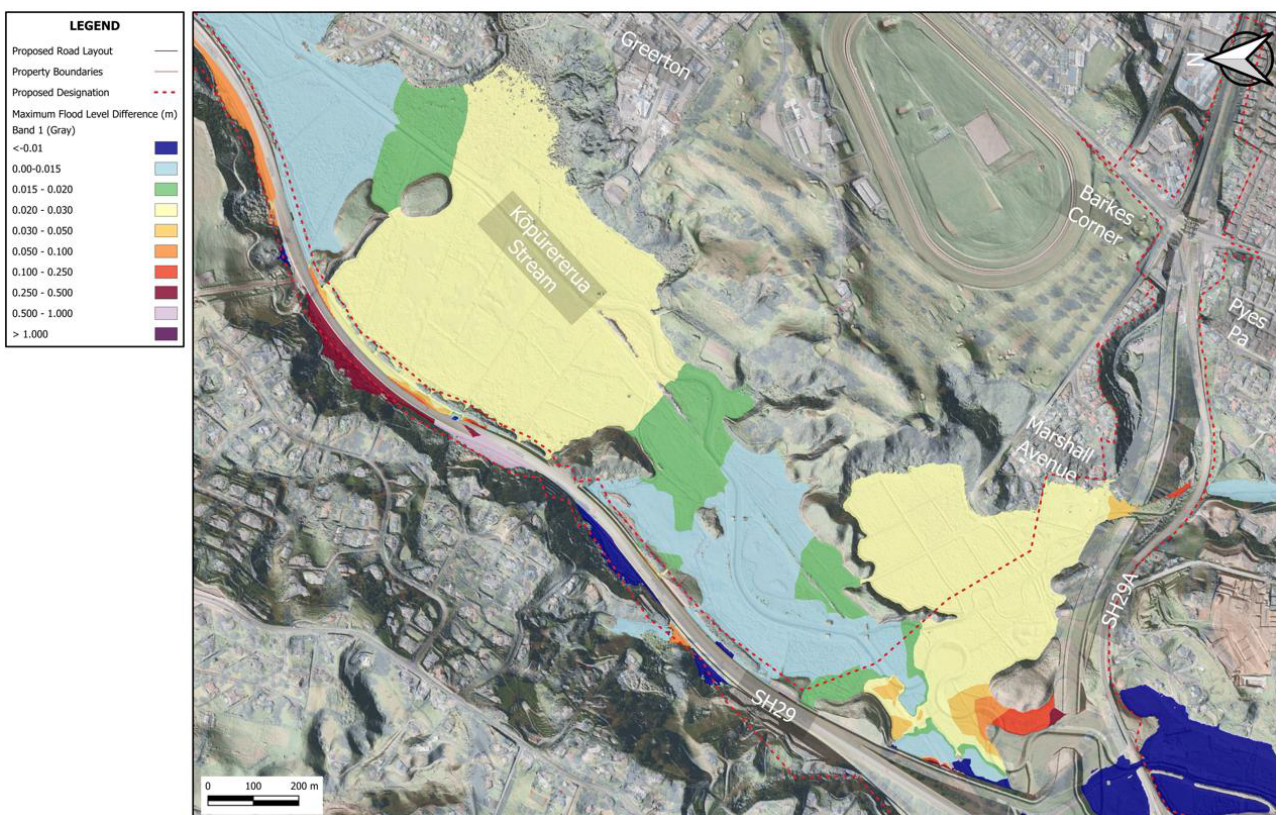
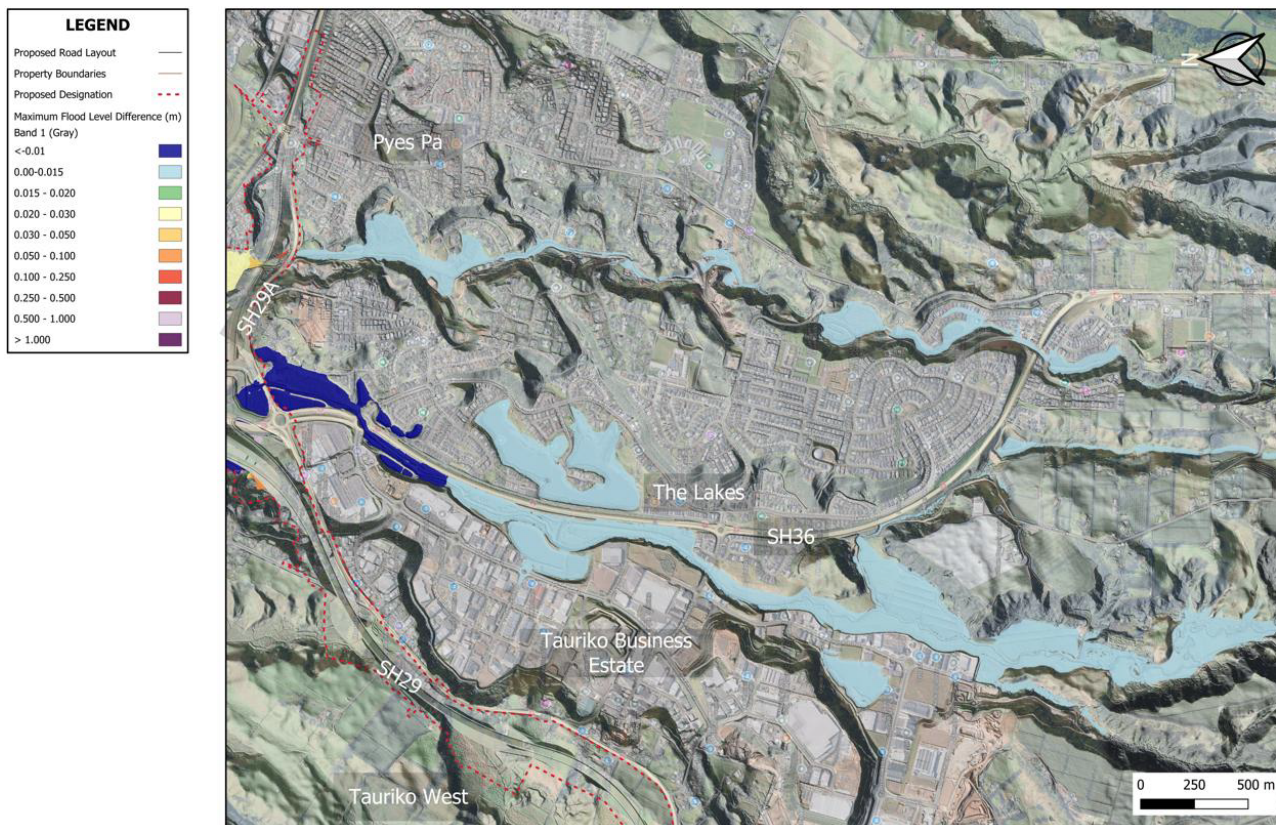
Figure No. 3.12: Tauranga City Plan flood map. Note: The location of the area where flood depth exceeds 15mm at 20 Furniss Lane is circled in red.

3.6.2.2 10-Year ARI Design Storm

A comparison of the flood levels pre-Project and post-Project was undertaken to assess changes upstream and downstream of the Project. The hydraulic modelling results for the Kōpūrererua catchment indicate several localised changes as follows:

- In the upstream urban areas south of the designation (i.e. in the Tauriko Business Estate, The Lakes and Pyes Pa), the 10-year flood levels decrease, upstream of the proposed Kōpūrererua Bridge, by 146mm immediately upstream of the bridge, tapering down to 0mm approximately 900m upstream of the bridge. In the rest of the upstream area, flood levels will increase by up to 1.4mm (as illustrated on Figure 3.13 below).
- There will be a spatially limited increase in flood depth exceeding 15mm within the downstream area north of SH29A and east of SH29 Takitimu Drive (as illustrated with green and yellow shading on Figure 3.14 below). The increase in flood depth ranges from 15mm to 30mm in the impacted areas outside the Project designation. The post-Project 10-year ARI flood level near Marshall Avenue is 820mm lower than the pre-Project 100-year ARI flood level, both accounting for climate change.
- For the Kōpūrererua floodplain area downstream of Wylie Street, including the Judea area, the increase in flood depth is less than 15mm (as shown in Figure 3.15 below). In the Judea area, flood levels will increase by up to 5.6mm.





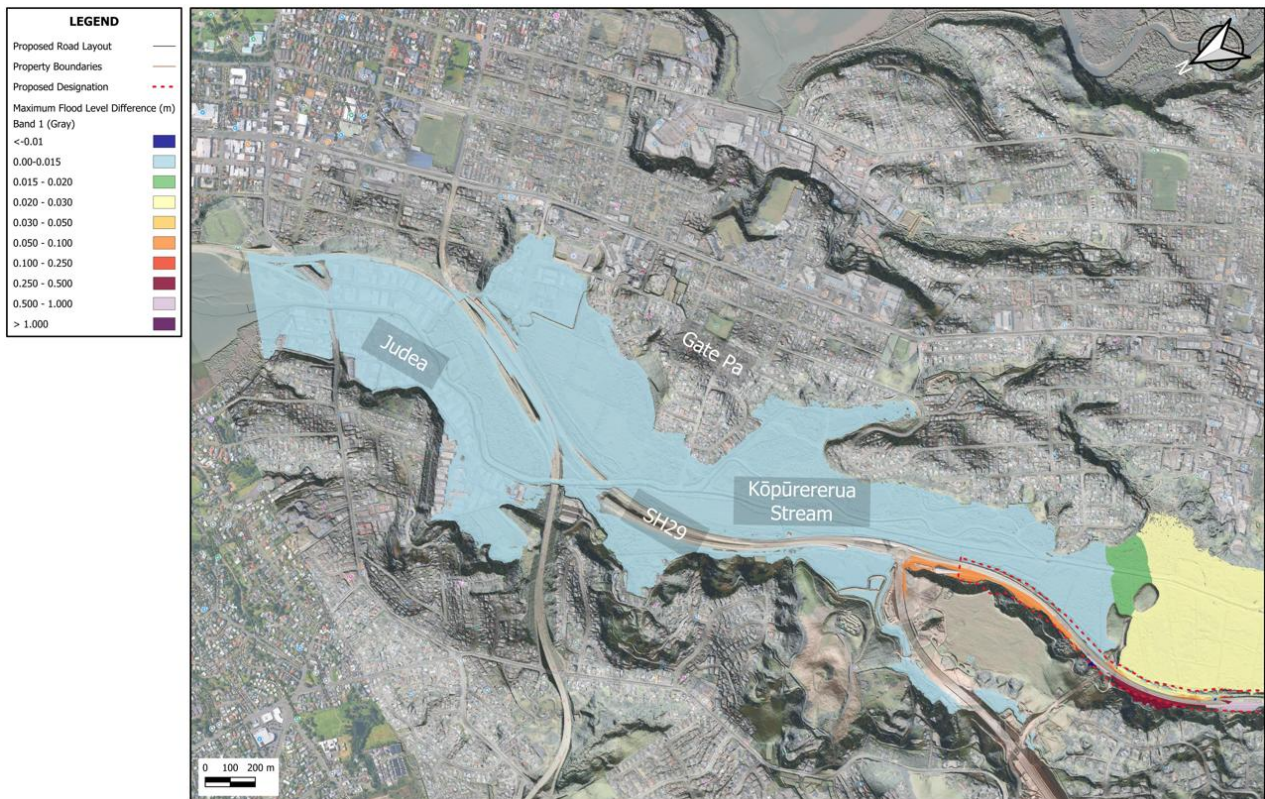


Figure No. 3.15: Maximum flood level difference in the Kōpūrerua floodplain area downstream of Wylie Street for the 10-year ARI design storm, including climate change.

- An increase in flood depth ranging from 20mm to 51 mm in four isolated areas downstream and to the northwest of the SH29 Takitimu Drive Toll Road (circled in red on **Figure 3.16** below). Three of these areas are inside the designation boundary. The remaining area is within the Takitimu North Link Stage 1 road designation. In this area, the model indicates an increase in flood depth of up to 100mm. This increase is attributable to the existing culverts not being incorporated in the model. The area where the model indicates an increase in flood depth of up to 512mm can be mitigated through the provision of suitable culverts, as part of detailed design. It should be noted that the current modelling does not incorporate any culverts in this area.



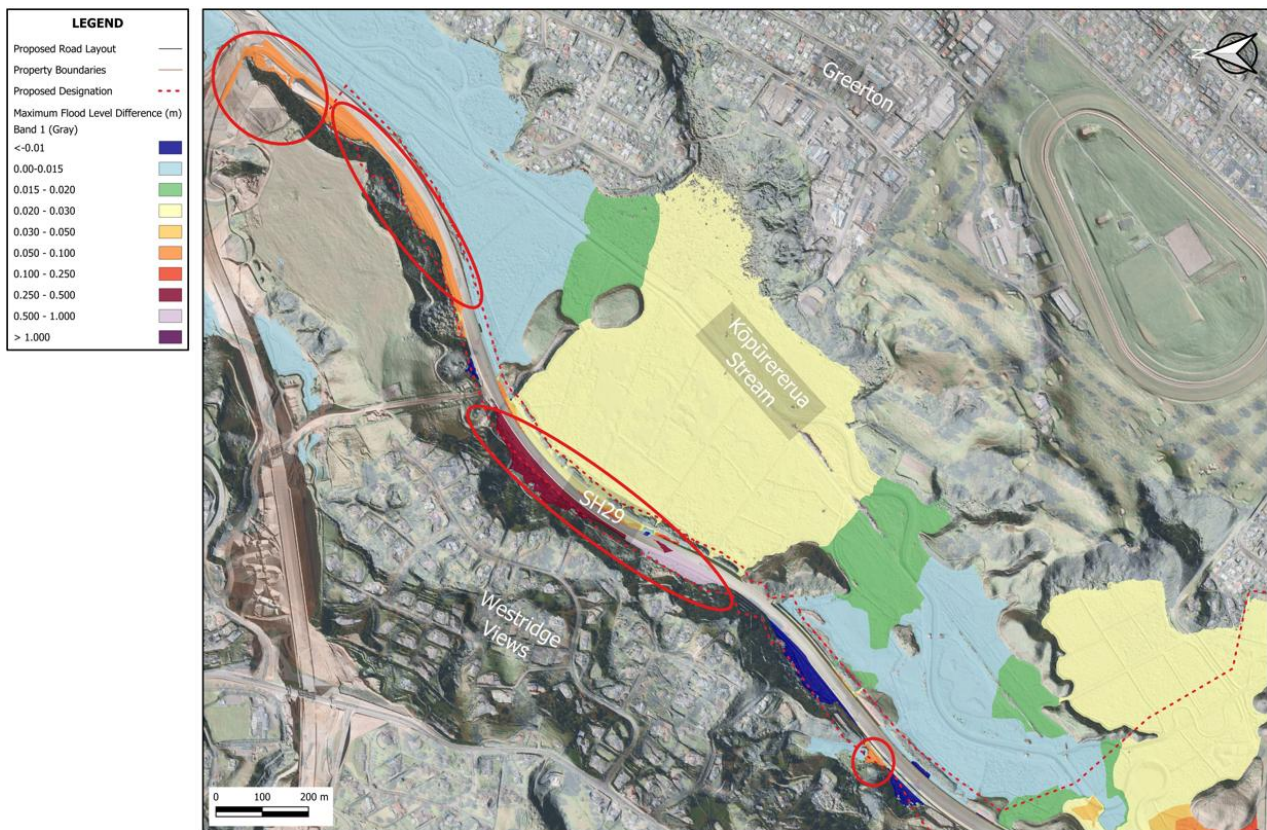


Figure No. 3.16: Maximum flood level difference at the downstream area northwest of SH29 for the 10-year ARI design storm, including climate change.

3.7 Flood Effects Assessment

This section assesses the potential flood effects in each catchment. As set out in section 3.4 above, the following assessment is more detailed where any flood level increase does not meet the ‘no effect’ or ‘less than minor’ threshold.

3.7.1 Wairoa River Catchment (Belk Road and Redwood Lane Interchange Area)

Based on the TCC Wairoa River flood modelling (TCC-509), a 100-year ARI flood near Belk Road is primarily driven by backwater from the Wairoa River. The modelled backwater flooding extends approximately 900m upstream of existing SH29 in the existing environment (**Figure 3.17** and **Figure 3.18** below).

When the indicative design, including the removal of the existing stream culverts and existing SH29 embankment at the stream crossing, are input to the model, the post-Project model demonstrates that the 100-year ARI flood level increases by 6mm once the Project is constructed. This 6mm change is less than minor.

The 100-year ARI flooding will still be primarily due to backwater from the Wairoa River post-Project and will not be materially changed by the Project. This backwater will still extend approximately 900m upstream of the existing SH29 (**Figure 3.17** below).



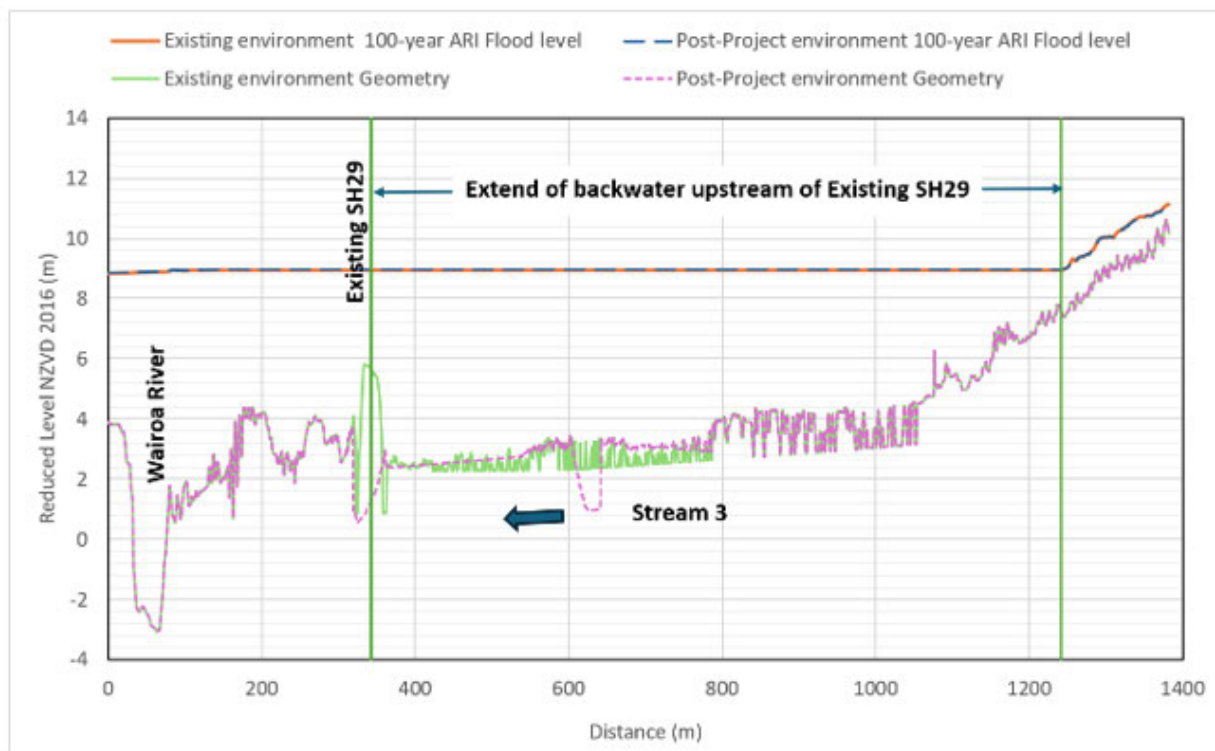


Figure No. 3.17: Comparison of existing and post-project environment backwater profiles along the tributary (Stream 3) for 100-year ARI storm event, including climate change.

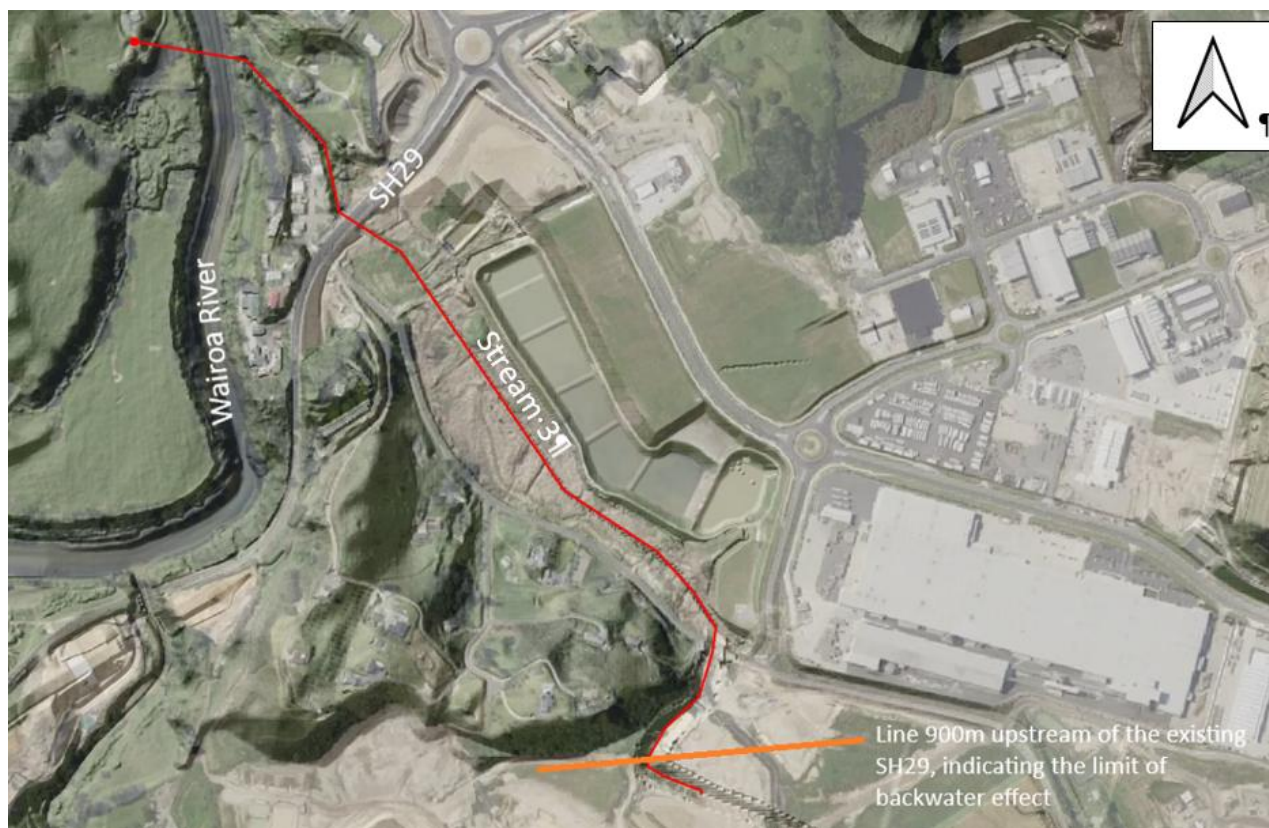


Figure No. 3.18: Location of the extent of the backwater effect upstream of the existing SH29 in the existing and post-project environment.



3.7.2 Kōpūrererua Catchment

The 100-year ARI modelling indicates a less than 15mm increase in flood levels and no measurable change in flood extent in the upstream urban areas (Tauriko Business Estate, The Lakes and Pyes Pa) south of SH29A. The flood effects of the Project on upstream properties are therefore less than minor.

Four of the five small areas downstream to the northwest of SH29 Takitimu Drive (as illustrated by the circled areas on **Figure 3.11** above) where flood modelling indicates an increase in flood depth exceeding 15mm are within an existing floodplain⁶ and is zoned Passive Open Space in the Tauranga City Plan. The Project is not increasing the frequency of the flooding in these areas, just the level of flooding. However, the magnitude of the flood level change, due to the Project, is very small (up to 100mm) and does not affect the passive recreational use, as the areas already flood in the pre-Project situation. Furthermore, being floodplain and open space (reserve), these four small areas have limited to no development potential involving habitable structures and do not impact any existing dwellings or other buildings. Therefore, flood effects in these areas are considered less than minor.

The remaining small area downstream to the northwest of SH29 Takitimu Drive (as illustrated by the circled area on **Figure 3.12** above) where flood modelling indicates an increase in flood depth exceeding 15mm, is within private vacant land (20 Furniss Lane). The property is zoned Rural Residential in the Tauranga City Plan. However, the area where flood modelling indicates an increase in flood depth (of between 15mm to 20mm) is subject to a 'Major Overland Flowpath' in the Tauranga City Plan. Major Overland Flowpaths are required to be maintained in the Tauranga City Plan to safely convey flood water and to maintain storage capacity. Any new structure built within a Major Overland Flowpath must be so designed so there is no risk to life and property (i.e. through minimum floor levels). In this case there are no structures within the area and should a new structure be proposed in the future, the up to 20mm increase in flood level can be easily accommodated within the minimum freeboard level (being 500mm freeboard for a dwelling/habitable structure design). Therefore, flood effects in this area are also considered less than minor.

In the downstream areas north of SH29A and east of SH29 Takitimu Drive, flood modelling indicates an increase in flood depth exceeding 15mm. These downstream areas are within the designation or land owned by TCC within the Floodplain and zoned Passive Open Space (Kōpūrererua Valley). Again, the Project is not increasing the frequency of the flooding of this land (as it is already being flooded in the pre-Project state), just increasing the flood level. The potential flood effects of the Project on the downstream properties within the designation or land owned by TCC will not directly affect a residence, business, or other habitable structure and are within land identified for flooding storage and are therefore less than minor.

In the floodplain downstream area north of SH29A near Marshall Avenue, the 100-year ARI flood depth is indicated to increase by approximately 43mm. This increase will affect four privately owned dwellings/buildings (at 96, 98, 100 and 108 Marshall Avenue) as illustrated below in **Figure 3.19**.

⁶ Floodplain in the Tauranga City Plan means the land near a stream or river channel, susceptible to flooding in the 1% annual exceedance probability (AEP) rainfall event concurrent with a 5% annual exceedance probability (AEP) storm-tide event, taking into account the effects of climate change on rainfall and sea level based on the RCP 8.5 median scenario as of the year 2130.



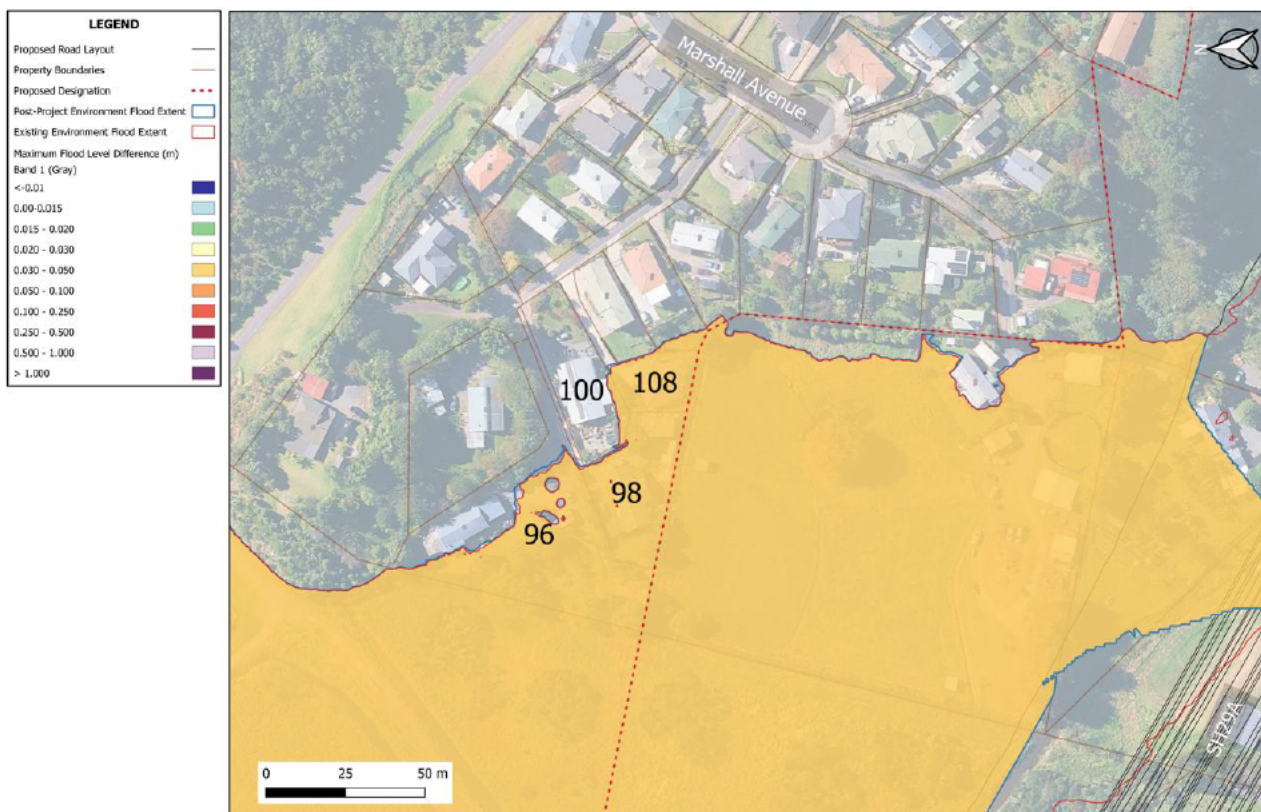


Figure No. 3.19: Residential properties at Marshall Avenue potentially affected by the project.

Table 3.1 summarises the effects on the Marshall Avenue properties, with the effect measured against 100-year ARI flood levels based on climate change and without climate change. The climate change allowance is to 2130 to be consistent with TCC's current flood mapping and the current BOPRC Hydraulic Modelling Guideline (2024).

Table No 3.1: Details on the specific status of affected Marshall Avenue properties.

ITEMS	PROPERTY ID									
	96 Marshall Avenue		98 Marshall Avenue				100 Marshall Avenue		108 Marshall Avenue	
			Main Building		Detached garage					
	Climate Change	No Climate Change	Climate Change	No Climate Change	Climate Change	No Climate Change	Climate Change	No Climate Change	Climate Change	No Climate Change
Floor level (NZVD2016)	5.43		5.15		4.74		5.85		4.57	
Pre-Project Environment										
Flood level (m)	5.04	4.41	5.04	4.41	5.04	4.41	5.04	4.41	5.04	4.41
Freeboard (mm)	390	1020	110	740	-300	330	810	1440	-470	160
Floor level flooded	No	No	No	No	Yes	No	No	No	Yes	No
Freeboard less than 500mm	Yes	No	Yes	No	-	No	No	No	-	Yes
Post Project Environment										
Flood level (m)	5.08	4.45	5.08	4.45	5.08	4.45	5.08	4.45	5.08	4.45
Freeboard(mm)	350	980	70	700	-340	290	770	1400	-510	120
Floor level flooded	No	No	No	No	Yes	No	No	No	Yes	No
Freeboard less than 500mm	Yes	No	Yes	No	-	No	No	No	-	Yes
Flood effected	-	No	-	No	No	No	-	No	No	No
Freeboard effected	No	No	No	No	-	No	No	No	-	No



The conclusions drawn from **Table 3.1** are:

- The floor level of the dwelling at 96 Marshall Avenue is 5.43m. In the without climate change scenario the freeboard for the dwelling is 1020mm in the pre-Project and 980mm in the post-Project. Thus, without accounting for climate change, the freeboard for the dwelling exceeds the 500mm of freeboard over the 100-year ARI required by BoPRC and TCC. When assessed with climate change the freeboard for the dwelling is 390mm in the pre-Project and 350mm in the post-Project. Thus, accounting for climate change, the floor level of the dwelling will remain **above** the 100-year ARI flood level, although the freeboard is less than 500mm.
- Flood freeboard over the 100-year ARI flood for the dwelling at 98 Marshall Avenue in the without climate change scenario is 740mm in the pre-Project and 700mm in the post-Project. Thus, without accounting for climate change, the freeboard for the dwelling exceeds the 500mm of freeboard over the 100-year ARI. When assessed with climate change the freeboard for the dwelling is 110mm in the pre-Project and 70mm in the post-Project. Thus, in considering climate change, the floor level of the dwelling will remain **above** the 100-year ARI flood level, although the freeboard is less than 500mm.
- The detached garage at 98 Marshall Avenue is not subject to flooding over the finished floor level in the 100-year ARI flood, (both in the with or without Project scenarios and when climate change is not accounted for in the flood model). However, the detached garage does not meet the 500mm freeboard requirement (when not accounting for climate change and in both the with and without Project scenarios). When climate change is accounted for, the detached garage will be flooded in the 100-year ARI flood, with or without the construction of the Project. Based on the flood modelling, the flooding effect is the result of climate change, rather than the small increase in flood level resulting from the construction of the Project.
- While freeboard is reduced for the dwelling at 100 Marshall Avenue in the worst-case post-Project with climate change, the floor level (at 770mm) remains greater than the 500mm of flood freeboard and therefore is not materially affected.
- The dwelling at 108 Marshall Avenue is not subject to flooding in the 100-year ARI flood, over the finished floor levels, with or without the construction of the Project, when climate change is not accounted for in the flood model. Noting that the dwelling does not meet the 500mm freeboard requirement when not accounting for climate change. When climate change is accounted for, the dwelling will be flooded in the 100-year ARI flood, by 510mm with or by 470mm without the construction of the Project. Based on the flood modelling, the flooding effect is the result of climate change, rather than the small increase in flood level resulting from the construction of the Project.

In conclusion, the adverse effects on these four Marshall Avenue properties are considered a **Minor Adverse Effect**. The dwellings at 96, 98 and 100 Marshall Avenue will continue to have flood freeboard over the 100-year ARI flood when climate change is accounted for post-Project. The detached garage at 98 Marshall Avenue and the dwelling at 108 Marshall Avenue will have flood freeboard over the 100-year ARI flood without accounting for climate change post-Project, but will be flooded in both the pre-Project and post-Project when accounting for climate change. Accordingly, the flooding effect on the detached garage at 98 Marshall Avenue and the dwelling at 108 Marshall Avenue is the result of climate change, rather than the small increase in flood level resulting from the construction of the Project.



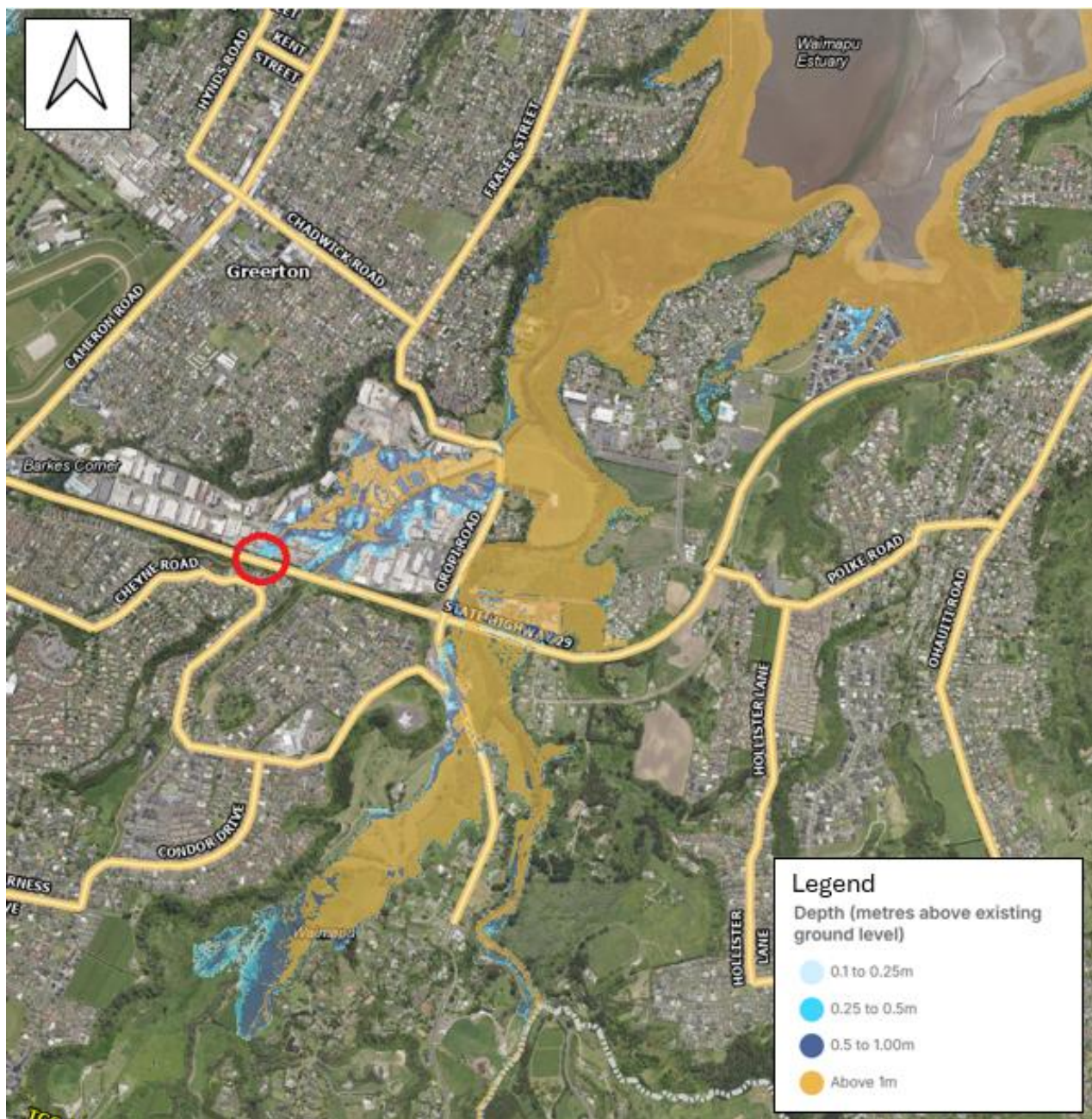


Figure No. 3.21: BoPRC inundation mapping for coast and harbour under sea level rise of 1.05m and storm event likelihood of 1% AEP for 2130 (Source: <https://gis.tauranga.govt.nz/coastalinundation/>) The red circle is the highway discharge point.

3.8 Conclusion

This flood effects assessment has evaluated the potential impacts of the Project on surrounding properties and land within the Wairoa River Catchment and Kōpūrererua Catchment under the 100-year ARI design storm, including climate change allowances to 2130 and the 20-yr ARI tidal boundary (sea level rise of 1.59m).

In the Belk Road and Redwood Lane area (within the Wairoa River Catchment), the flood modelling indicates an increase in flood level of less than 15mm and no noticeable change in flood extent. Thus, the flood effects within the Wairoa River Catchment will be **Less than Minor**.

In the Kōpūrererua Catchment, upstream and downstream flood impacts are less than minor due to the very small increases or the land use and classification of the affected properties. The exception is four affected properties on Marshall Avenue. Flood modelling indicates an increase in flood depth of up to 43mm for the



four affected properties, however the overall flood hazard status of these properties remains unchanged, as described in Section 3.7.2. While the flood increase is noticeable, it does not result in a material effect or impact on the structure and hence on this basis the adverse effects on these properties are considered **No More than Minor**.

Within the Waimapu Catchment, flood level increase in downstream properties is 1.8mm with no noticeable change in extent, resulting in **Less than Minor** effects.



4. Stormwater Management

4.1 Scope and Background

The principal potential stormwater effects relate to increased contaminant loads from new road runoff, increased stormwater runoff volumes and higher peak flows in the receiving environment. If not appropriately managed, these changes can result in water pollution, downstream flooding effects, and potential erosion or scour within the receiving environment.

Stormwater runoff from the existing sections of SH29, including Takitimu Drive, within the Project extents, is generally released into the receiving environment without stormwater quality treatment or peak flow attenuation. The recent Tauriko West Enabling Works projects⁷ includes stormwater management facilities for the runoff generated by those works. These facilities have been sized to accommodate the associated enabling works only and will remain unchanged or be incorporated into the overall Project stormwater system.

This section outlines the design approach to management of potential stormwater effects. Those are a decrease in water quality, an increase in flooding and an increase in erosion.

An indicative stormwater management system is shown in the drawings in **Annexure B**. The indicative design was informed by relevant 'best practice' design methods from industry, NZTA and BOPRC design standards, guidelines and specifications. It demonstrates one feasible means of achieving managing stormwater quality and quantity effects.

4.2 Receiving Environments

The Project will increase the impervious area by approximately 21ha. Stormwater runoff from this additional impervious area is proposed to be discharged to receiving environments within the Wairoa River, Kōpūrererua and Waimapu Catchments. The catchments are described above in section 3.2 and illustrated above in **Figures 3.2, 3.3 and 3.5**.

The Wairoa River Catchment includes the Ōmanawa River and tributaries that will receive runoff from the western part of the Project. In some locations the receiving environment is tidally influenced, and in other locations the contributing Project catchments are small relative to the wider receiving catchment.

The Kōpūrererua Catchment includes the Kōpūrererua Stream floodplain, the Nanako Stream and associated modified drainage and wetland environments. This catchment is sensitive from both a flooding and freshwater receiving environment perspective.

The Waimapu Catchment will receive runoff from the eastern end of the Project. The contributing Project impervious area (at 0.64ha) is small relative to the 112km² catchment, and the downstream receiving environment is tidally influenced.

⁷ SH29/Tauriko Village upgrades, SH29/Redwood lane Roundabout and SH29 Ōmanawa Bridge replacement projects.



4.3 Stormwater Design Philosophy

The Project will appropriately manage potential stormwater-related effects caused by increased flows, volumes, and contaminants arising from the road. To achieve this, the design follows these key principles:

- Best practice: Reference to best practice design principles from industry, NZTA and BOPRC design standards, guidelines and specifications.
- Whole-of-life planning: Stormwater systems will function throughout the life of the Project.
- Environmental awareness: The Project will seek to achieve good environmental outcomes.
- Flood risk reduction: The Project will avoid or mitigate flooding effects.
- Outfall and erosion control: During detailed design, each stormwater outlet will be checked, and erosion control will be added if needed, without impeding fish passage where applicable.
- Fish passage: Culverts will be designed and built to allow native fish to move through unimpeded where suitable upstream habitat is available (as determined by a SQP Freshwater Ecologist), where practicable.
- Overland flow paths: During detailed design, consideration will be given to flow paths that will activate in the event of stormwater network blockage or similar events.
- Water Quality: The design will include features such as constructed wetlands or treatment swales to help manage water flow and water quality, including through treatment of sediment and contaminants.

The indicative design is informed by the following water quality and quantity philosophy.

4.3.1 Stormwater Quality

Contaminants in road runoff entering the receiving environment have the potential to adversely affect water quality. All stormwater runoff from road surfaces will be captured through devices before discharging into the receiving environment. The devices that will be selected at the detailed design stage will depend on the final detailed design of the Project. Two types of treatment devices are proposed for receiving runoff from new impervious areas (including local roads modified as part of the project):

- Stormwater treatment wetlands; and
- Stormwater treatment swales.

The benefits of stormwater treatment wetlands include a high rate of contaminant removal and reduced traffic management requirements during maintenance, due to their off-road location. They can also provide amenity, water quality, and safety benefits in comparison to other treatment ponds or facilities.

Treatment swales provide efficient removal of sediment and associated pollutants within a smaller footprint.

Both types of treatment devices included in the Indicative Design consider device resilience, maintenance access, sediment retention and protection against sediment resuspension during flood events. All constructed wetlands are also located off-line from watercourses.

4.3.2 Stormwater Quantity

Stormwater runoff from this additional impervious area has the potential to create adverse effects from increased flooding and/or increased erosion and scour. The stormwater quantity management measures will be confirmed through detailed design having regard to the relevant receiving environment and the potential for flooding, erosion and scour effects.



Potential stormwater quantity effects will be avoided or managed through:

- Discharging directly into tidally influenced waters, where the increase in runoff volume due to additional impervious area is not expected to cause an increase in flooding.
- Discharging directly into streams and rivers where the increase in runoff due to additional impervious area represents an insignificant fraction of stream flow and is not expected to result in material effects on erosion or flooding.
- Routing runoff from additional impervious areas through stormwater attenuation devices to reduce climate-change adjusted peak discharge rates to pre-Project levels where unattenuated discharges could result in flooding or erosion effects.
- Providing extended detention or outlet erosion protection to manage downstream erosion effects where required, even where peak-flow attenuation is not otherwise required.

4.4 Stormwater Management – Individual Catchment Approach

This section describes how relevant NZTA standards and design specifications, and BoPRC guidelines have been considered for stormwater management across the Project catchments. Indicative Stormwater Management Plans are provided in Annexure B. The Indicative Design demonstrates one feasible means of achieving stormwater quality and quantity performance outcomes for each catchment.

The treatment and attenuation facilities need to be located in response to spatial and morphological restrictions, as well as the need to minimise the land required from adjacent landowners.

The following table summarises the principal assumptions used in the above approach. These assumptions allow for design flexibility in solutions that achieve the required stormwater management outcomes.

Table No 4.1: Principal design assumptions for stormwater management.

Design matter	Design basis
Water quality treatment	30mm rainfall over 24 hours.
Stormwater conveyance	10-year ARI event where a secondary overland flow path is available; 100-year ARI event where no secondary overland flow path is available.
Primary stormwater management	Conveyed via primary drainage system to receiving environment.
Major flood management	The 100-year ARI event including climate change is safely conveyed to overland receiving environment.
Attenuation assessment	2-year, 10-year and 100-year ARI events, including climate change, where attenuation is required.
Climate change horizon	2130.
Climate change allowance	3.68°C temperature increase.



4.4.1 Wairoa River Catchment

Several road catchments will drain to tributaries of the Wairoa River and include the following sections of the Project:

- Intersection improvements on SH29 at Ōmanawa Road;
- New SH29 road section between the new SH29 Ōmanawa Bridge and Cambridge Road; and
- A full diamond grade-separated interchange connecting SH29 to Redwood Lane and Kaweroa Drive.

Stormwater runoff from these catchments will be discharged into Wairoa River tributaries after passing through treatment swales, treatment wetlands, and/or treatment and attenuation wetlands. Increased runoff will be attenuated by either treatment and attenuation wetlands or attenuation ponds where increased peak discharge into the receiving environment could result in flooding or ecological effects due to erosion.

4.4.2 Kōpūrererua Catchment

Several road catchments will drain to the Kōpūrererua Stream and include the following sections of the Project:

- New SH29 road section between Cambridge Road and SH29 Takitimu Drive;
- Widening of SH29 Takitimu Drive;
- A full diamond grade-separated interchange at Takitimu Drive, connecting SH29, SH29A and SH36;
- New SH29A from SH29 Takitimu Drive to Barkes Corner; and
- A half diamond (east-facing ramps only) grade-separated interchange at Barkes Corner, connecting SH29A to Cameron Road and Pyes Pā Road.

Stormwater runoff from road catchments can be treated through treatment swales or treatment wetlands. The exception is for some of the road catchments near Barkes Corner that will discharge to ground higher than the Kōpūrererua floodplain where the Indicative Design includes treatment, extended detention and attenuation prior to the discharge reaching the floodplain.

For the majority of the road catchments, attenuation is not considered necessary. This is because locating attenuation facilities within the Kōpūrererua floodplain could reduce existing floodplain storage, and the additional runoff generated from approximately 9.53ha of new impervious area associated with these road catchments is expected to be insignificant compared to Kōpūrererua Stream flows, generated by the approximately 7,500ha catchment area.

The new impervious area within the Kōpūrererua Catchment represents approximately 0.13% of the total catchment area. However, because the Project is located within the Kōpūrererua floodplain, modifications to the floodplain may alter floodwater storage capacity during extreme rainfall events and potentially alter flooding of properties adjacent to the floodplain. A catchment-level analysis for the Kōpūrererua Stream has been carried out using a detailed two-dimensional hydraulic model to assess flooding effects associated with the Project. The results of this catchment-level analysis indicate that the potential flood effects of the Project will be less than minor in most locations and no more than minor in a small, localised area (near Marshall Avenue). The potential flooding effects within the Kōpūrererua Catchment are addressed in section 3.7.2 of this report.



4.4.3 Waimapu Catchment

Two road catchments will drain to an unnamed tributary of Waimapu Stream and include the following sections of the Project:

- East-facing ramps at Barkes Corner; and
- SH29A road widening improvements east of Barkes Corner.

Stormwater runoff from these road catchments can be treated by treatment swales before draining into the unnamed Waimapu Stream tributary running along Cheyne Road in the Indicative Design. The unnamed Waimapu Stream tributary at SH29A drains a catchment area of 89.67ha. Stormwater runoff from 0.64ha of new impervious surfaces associated with the road catchments is expected to be negligible relative to the tributary flows. Further, the area downstream of the stormwater runoff release point is tidally influenced. On that basis, attenuation is not considered necessary. TCC's flood hazard map indicates there is existing tidal and storm related flooding downstream of the Project stormwater runoff release point. The volume of stormwater runoff from the additional impervious area is expected to be insignificant compared to the runoff volume generated by the wider catchment and is anticipated to not result in a measurable flooding effect.

4.5 Conclusion

The indicative stormwater management design for the Project (refer drawings in **Annexure B**) demonstrates one feasible means by which effects on the receiving environment could be appropriately avoided and/or managed, within the boundaries of the Proposed Designation. That is, potential effects will be avoided or managed through treatment of road runoff, attenuation (where required), and extended detention (where required) through:

- Treatment of runoff from the new highway in treatment swales, treatment wetlands or equivalent treatment devices before discharge to the receiving environment.
- No stormwater attenuation where stormwater is released into tidally influenced receiving environments where the additional discharge is insignificant compared to the receiving stream or river flows or where catchment analysis has been undertaken to quantify the effects of the Project.
- Stormwater attenuation where the additional imperviousness in the contributing catchment is expected to result in a material increase in unattenuated discharge.

Overall, the assessment demonstrates that the potential stormwater effects of the Project can be appropriately managed within the Proposed Designation. The final stormwater management system will be confirmed through detailed design and will be required to achieve the water quality, conveyance, attenuation, erosion and scour management outcomes secured through the proposed conditions.



5. Streams, Bridges and Culverts

5.1 Scope

This section describes the approach to the three streams that require realignment as part of the Project. It includes a summary of the potential effects on the streams from the realignment designs (illustrated in the stream realignment drawings in **Annexure C**). The designs are subject to change/refinement during subsequent design stages (i.e. due to potential changes in road layout, and final bridge and culvert size and locations).

This section also describes the design approach to avoid adverse effects on the streams for bridges over streams.

5.2 Stream Realignments

Three stream reaches have been identified as requiring realignment as part of the Project (as the Project footprint directly impacts these existing streams). These stream reaches are:

1. Approximately 728m of the Kōpūrererua Stream, extending north from the existing SH29A bridge;
2. Approximately 583m of the Nanako Stream, extending downstream (northward) from the existing culvert under SH29A; and
3. Approximately 406m of an un-named stream crossing SH29 (Stream 3) approximately 55m north of the Belk Road intersection. The affected reach of the un-named stream starts approximately 25m downstream of SH29 and extends upstream thereof.

These stream reaches are highly modified and the ecology assessment records that they have low ecological value.

5.2.1 Design Flows

Generally, it is the bank full discharge that, through a combination of velocity, depth, duration and frequency of flow, is considered the channel forming discharge, and which is the primary design flow used for developing hydraulic geometry, when designing stream channels⁸. As the existing stream channels are highly modified and affected by urban and agricultural development, an accurate bankfull flow was not able to be determined from field measurements. Hydrological modelling was therefore used to estimate the flows.

For streams the size of Kōpūrererua and smaller, the 1.5-year ARI flow is the bankfull flow. One half of the 2-year ARI flow is a reasonable approximation of the 1.5-year ARI flow and this was used as the bankfull flow. One tenth of the 2-year flow was also used as the flow resulting from more frequent heavy winter storms, consistent with the New Zealand Fish Passage Guidelines. Base flow for the Kōpūrererua Stream was sourced from BOPRC online mapping. Base flow for Nanako Stream and Stream 3 (near Belk Road) was estimated by adjusting the Kōpūrererua Stream base flow proportionally, based on relative catchment area. Therefore, the stream design flows are as follows:

- Bankfull flow (1.5-year ARI or approximately 1/2 of the 2-year)
- Typical heavy winter flow (1/10 of the 2-year)
- Base flow

⁸ Lagasse et al., 2012



Stream design flows for the post-Project scenario were adjusted for climate change. Base flow was not adjusted for climate change.

Flood flows (2-year, 10-year, 100-year) are not pertinent to the design of the streams. This is because floodplain storage volume and the sudden increase in cross-sectional area as the floodplain begins to convey flow reduces the mean velocity and lifts the highest velocities within the stream higher above the streambed and banks. Table 5.1 lists the three proposed stream realignments, with associated design flows.

Table No. 5.1– Stream Realignments Flow Characteristics

ID	Estimated Base Flow (m ³ /s)	Peak Flow Accounting for Climate Change (m ³ /s)				
		10% 2-year Flow	Bankfull Flow	2-year ARI Flow	10-year ARI Flow	100-year ARI Flow
Kōpūrererua Stream	1.5	2.36	11.82	23.63	100.62	304.57
Nanako Stream	0.09	0.46	2.3	4.6	5.61	15.67
Un-named stream near Belk Road (Stream 3)	0.08	0.77	3.83	7.66	16.77	33.11

5.3 Kōpūrererua Stream

A section of the Kōpūrererua Stream will need to be realigned to make way for the Takitimu interchange and off-line arrangement of SH29A. The affected reach of the Kōpūrererua Stream is approximately 728m of modified, straightened channel, extending downstream from the existing SH29A bridge. Figure 5.1 below shows (in red) the location and extent of the existing Kōpūrererua Stream to be realigned.



Figure No. 5.1– The reach of the Kōpūrererua Stream proposed for realignment (red line).



Based on aerial imagery from RetroLens, the current alignment of the Kōpūrererua Stream was established prior to February 1940.

The existing reach lies within the lower Kōpūrererua floodplain, and would have originally transitioned into an estuary, but now contracts into a relatively narrow channel through existing development (Judea), where much of the estuarine portion of the floodplain used to be. The lower floodplain is tidally influenced and prone to frequent flooding, which has been exacerbated by historical encroachment of development, the lower capacity of the modified stream, sea level rise, and the tendency toward more intense rainfall events due to climate change. In addition to the straightening of the Kōpūrererua Stream, a wide network of drains was constructed to enhance land drainage to accommodate agricultural development.

The affected reach of the existing Kōpūrererua Stream has steep banks and a very regular cross-section.

5.3.1 Design Objectives

The interrelated objectives for the Kōpūrererua Stream realignment are:

- Stream channel stability
- Ecological enhancement
- Cultural alignment
- Improved human habitat

The following sections provide a description of the objectives.

5.3.1.1 Stream Channel Stability

Channel stability is an important and key design objective because it underpins the long-term hydraulic and ecological performance of the new channel. An unstable channel can erode, accumulate sediment, lose habitat value and require ongoing maintenance. The proposed realignment has therefore been designed to operate without excessive erosion or sediment build-up and, given the soft alluvial soils present within the Kōpūrererua floodplain, has included targeted stabilisation measures where required to support the establishment of vegetation and maintain channel form over time. With these measures, the design will ensure the realigned channel remains stable while supporting ecological and hydraulic outcomes.

5.3.1.2 Ecological Enhancement

Improving connectivity between the Kōpūrererua Stream channel and the floodplain provides significant ecological improvement over the previously straightened existing Kōpūrererua Stream channel. While the banks of the existing stream have broken down over time, there are still steep bank areas that do not support vegetation. Also, sub-surface water along the modified stream has dropped to the base flow level, inhibiting the growth of any wetland plants along the streambanks. This condition also limits the available spawning habitat for native fish. Therefore, as set out in the ecology assessment, by re-establishing connectivity and stability through the stream realignment design proposed, wetland areas along the banks can be supported as well as increasing the quality and quantity of spawning habitat for native fish.

5.3.1.3 Cultural Alignment

The Kōpūrererua Valley is culturally significant. In recognition of this significance to mana whenua, the stream realignment will reflect the historical form of the Kōpūrererua Stream.



The Kōpūrererua Valley is also a reserve that is an important part of TCC's Nature and Biodiversity Action and Investment Plan. TCC is working with mana whenua to restore the natural appearance and ecology of the Kōpūrererua Stream and floodplain, within the reserve, and has produced a Kōpūrererua Valley Masterplan. The proposed alignment is consistent with the aspirations of that Masterplan.

5.3.2 Kōpūrererua Stream Design Approach

The following sections describe, at a high level, the approach applied to realignment design including:

- Determining a stable cross-section;
- Determining the appropriate longitudinal grade;
- Designing the plan form; and
- Taking into account the bedload and sediment transport balance, within the stream.

Design flows used are outlined in **Table 5.1** above.

5.3.2.1 Stable Cross-Section

The Kōpūrererua Stream cross-sections and alignment will accommodate expected flows while avoiding erosion and supporting long-term channel stability. The realignment incorporates a meandering form, with targeted localised bank stabilisation measures included where necessary to ensure the channel remains stable as vegetation becomes established and to support long-term performance.

5.3.2.2 Longitudinal Grade

The existing reach of the Kōpūrererua Stream channel that is proposed for realignment is 728m long. The grade of the existing reach is 0.083%, which allows the existing stream channel to convey stream flows with minimal erosion. Cross-section design indicated that the stream realignment needs a longitudinal channel grade of 0.06%, since the realigned stream will be located in unconsolidated alluvial siltloam. Additional stream channel length is thus required to achieve the needed longitudinal stream channel grade, requiring significant simulated meandering in the plan form layout of the Kōpūrererua Stream realignment (refer to drawings in **Annexure C**). The cross-section shape in the bends also reduces velocity and keeps the secondary currents away from the banks. Some reinforcing of the stream bed and banks within in-situ soil will support self-armouring, while allowing for plant growth.

5.3.2.3 Plan Form

Cultural objectives, community objectives, cross-section geometry, and longitudinal grade all influence the plan form of the Kōpūrererua Stream realignment. To achieve the required longitudinal grade, the stream length with the simulated meanders needs to be 1.70 times longer than the straight-line distance between the upstream and downstream ends of the realignment (i.e. the stream length increases by 276m from 728m to 1004m). **Figure 5.2** shows the indicative form of the realigned Kōpūrererua Stream. The figure shows the extent of the stream realignment between the banks and how the streambed changes width and shifts to the outside of the bends, reflecting design cross-sections and the transitions in between.



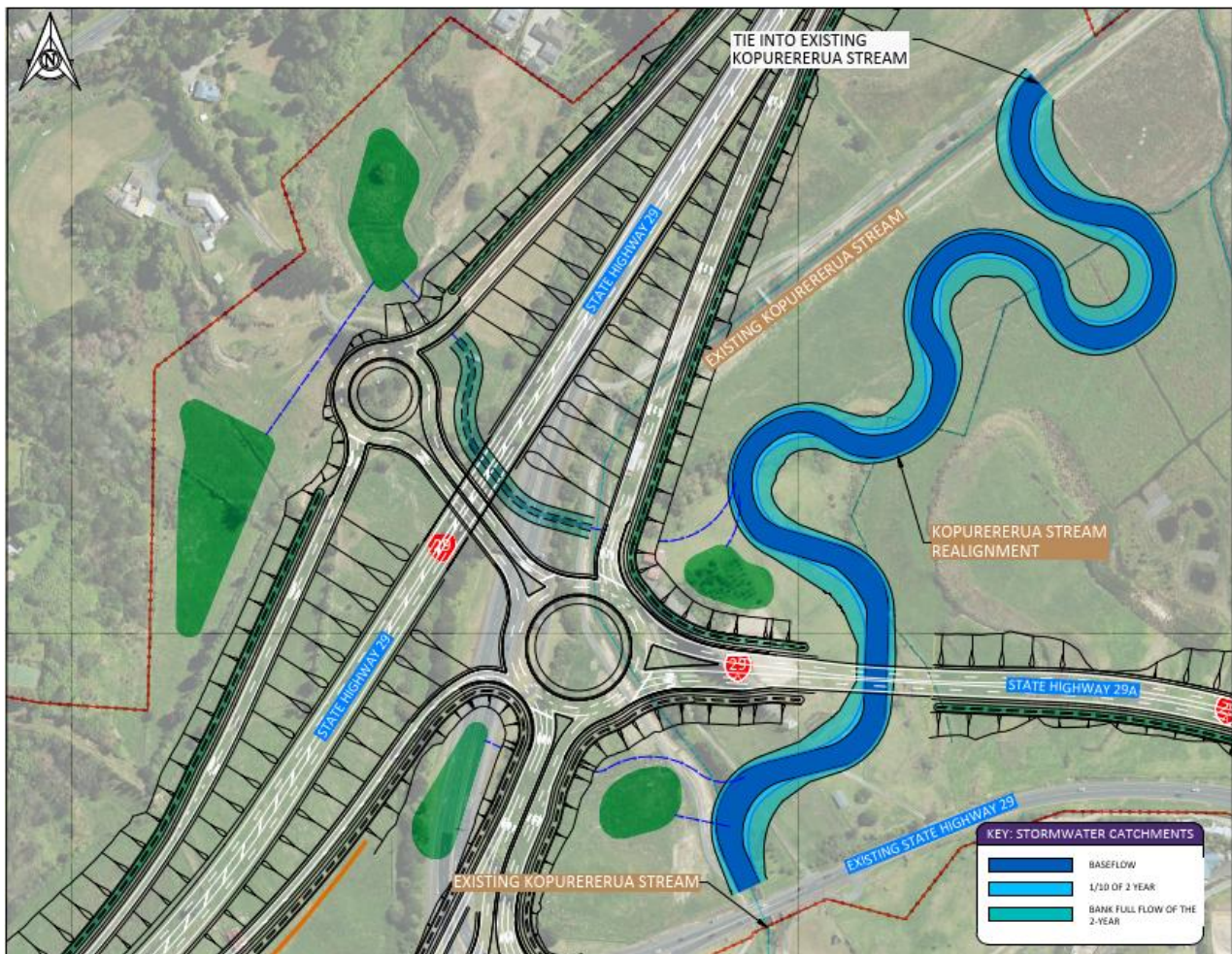


Figure No.5.2– Planform of the Kōpūrererua Stream realignment.

5.3.2.4 Bedload and Sediment Transport and Simulated Fluvial Geomorphology

The Kōpūrererua Stream is highly modified. As stated earlier, the stream was realigned prior to February 1940. The catchment has also been modified by agricultural and urban development as well as flood control dams, stormwater attenuation ponds, and water quality treatment devices. Due to urban development, stormwater attenuation ponds and water quality devices, the Project reach of the Kōpūrererua Stream is likely to have a bedload and sediment deficit (i.e. the stream is not in balance as it picks up sediment rather than deposits it). The existing stream channel has slowly adapted to the sediment and bedload deficit through self-armouring. The proposed stream realignment will not have time to self-armour and will have a higher tendency for channel erosion in the realigned channel.

The results of bedload and sediment transport analysis indicate that most of the silt loam material that makes up the Kōpūrererua floodplain will be mobile, when subjected to the bankfull flow. This means that some reinforcement of the streambed and banks will be required. As the results indicate that there will be very little movement of medium and/or coarse sand, increasing the sand component of the bed and banks, as well as adding a gravel component, will allow the stream to rapidly self-armour.

The bedload and sediment transport analysis results indicate that the stream velocity within the realignment will be sufficient to maintain suspension and/or mobility of the range of soil particle sizes conveyed by the lower Kōpūrererua Stream and that permanent sediment accumulations are not likely to form and obstruct the stream realignment.



5.3.3 Summary of the Effects Associated with Kōpūrerua Stream Realignment

Applying the design approach described above, the indicative design of the Kōpūrerua Stream (as presented in Annexure C) provides for the following outcomes:

- The overall length of the Kōpūrerua Stream reach will increase by 276m, from 728m to 1004m.
- The cross-section will contain a typical bankfull flow or ½ of the 2-year event, which exceeds the capacity of the existing stream.
- Flow velocities will be slightly lower in the realigned stream.
- The total area of spawning habitat for native fish within the reach will be increased and available through a wider range of flows.
- Streambanks within the stream realignment will sustain more vegetation, improve habitat and water quality.

Overall, these outcomes will result in a significant improvement to the stream.

5.4 Nanako Stream

Nanako Stream is a tributary of the Kōpūrerua Stream. The reach of the Nanako Stream to be realigned lies primarily within the Kōpūrerua floodplain and is shown (by the red line) in Figure 5.3 below.

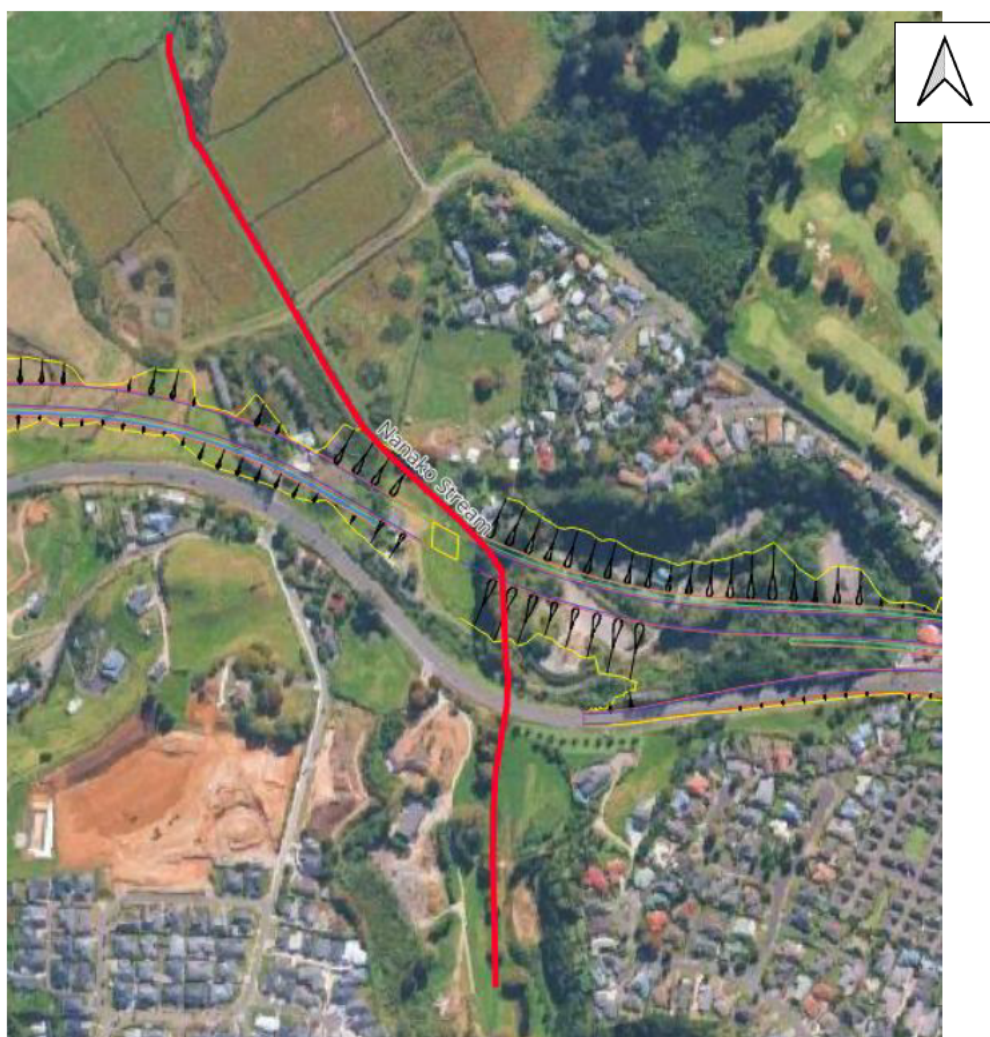


Figure No.5.3– Location of the existing reach of the Nanako Stream proposed for realignment (red line).



Like the Kōpūrererua Stream, the Nanako Stream was straightened for agricultural use as part of the land drainage system, within the Kōpūrererua floodplain. Available aerial imagery from February 1940 shows that all but a short segment of the Nanako Stream was straightened. While the short segment of unstraightened stream appears to have some sinuosity, the historical aerial image appears to show that agricultural land use encroached to at least one of the streambanks.

The reach of the Nanako Stream to be realigned has a very consistent cross-section, with steep banks. These steep banks limit stream capacity and the availability of native fish spawning habitat.

The existing modified Nanako Stream reach lies within the lower Kōpūrererua floodplain and functions as part of the Kōpūrererua floodplain drainage network. As described above, the lower Kōpūrererua floodplain is tidally influenced and prone to frequent flooding, which also influences flow within the Nanako Stream. Flooding is further influenced by historical development encroachment, reduced channel capacity, sea level rise, and more intense rainfall associated with climate change.

The Nanako Stream confluence with Kōpūrererua Stream is approximately 839m downstream of the existing SH29A bridge over the Kōpūrererua Stream.

The affected reach of the Nanako Stream is 583m in length. This realignment extends from the existing SH29A to 160m upstream of its confluence with the Kōpūrererua Stream.

5.4.1 Nanako Stream Design Approach

The design approach for the Nanako Stream realignment is very similar to the approach applied to the Kōpūrererua Stream realignment, and the following sections therefore focus on where the approaches differ. Where the approaches are the same, the above equivalent sub-sections describing the approach for the Kōpūrererua Stream realignment design approach apply. The design process involves the following:

- Determining a stable cross-section;
- Determining the appropriate longitudinal grade;
- Designing the plan form; and
- Taking into account the bedload and sediment transport balance, within the stream.

Design flows used are set out in **Table 5.1**.

5.4.1.1 Stable Cross-Section

As the proposed realignment is within the same floodplain area as the realignment of the Kōpūrererua Stream, with the same soil types, the design approach is the same as it was for the Kōpūrererua Stream, except lower design flows need to be accommodated (as set out in **Table 5.1**).

The Nanako Stream realignment is proposed with simulated meanders, for the same reasons as for the Kōpūrererua Stream.

5.4.1.2 Longitudinal Grade

The existing reach of the Nanako Stream channel proposed for realignment is 583m long. The grade of the existing reach is 0.077%, which allows the existing stream channel to convey stream flows with minimal erosion. Cross-section design indicated that the stream realignment needs a longitudinal channel grade of 0.06%, since the realigned stream will be located in unconsolidated alluvial loam. Additional stream channel length is required to achieve the needed longitudinal stream channel grade, which will be achieved through simulated meandering (as for the Kōpūrererua Stream realignment).



5.4.1.3 Plan Form

As with the Kōpūrurua Stream realignment, cultural objectives, cross-section geometry, and longitudinal grade all influence the approach to the Nanako Stream realignment. To achieve the required longitudinal grade, the stream length is proposed to be increased with simulated meanders by a factor of 1.38 of the straight-line distance between the upstream and downstream ends of the realignment (i.e. the stream length was increased by 165m from 583m to 748m). **Figure 5.4** below shows the proposed form of the Nanako Stream realignment, with the extent of the stream realignment between the banks and how the streambed changes width and shifts to the outside of the bends, reflecting the cross-sections and the transitions in between. The stream will need to be aligned to accommodate an existing access track crossing.

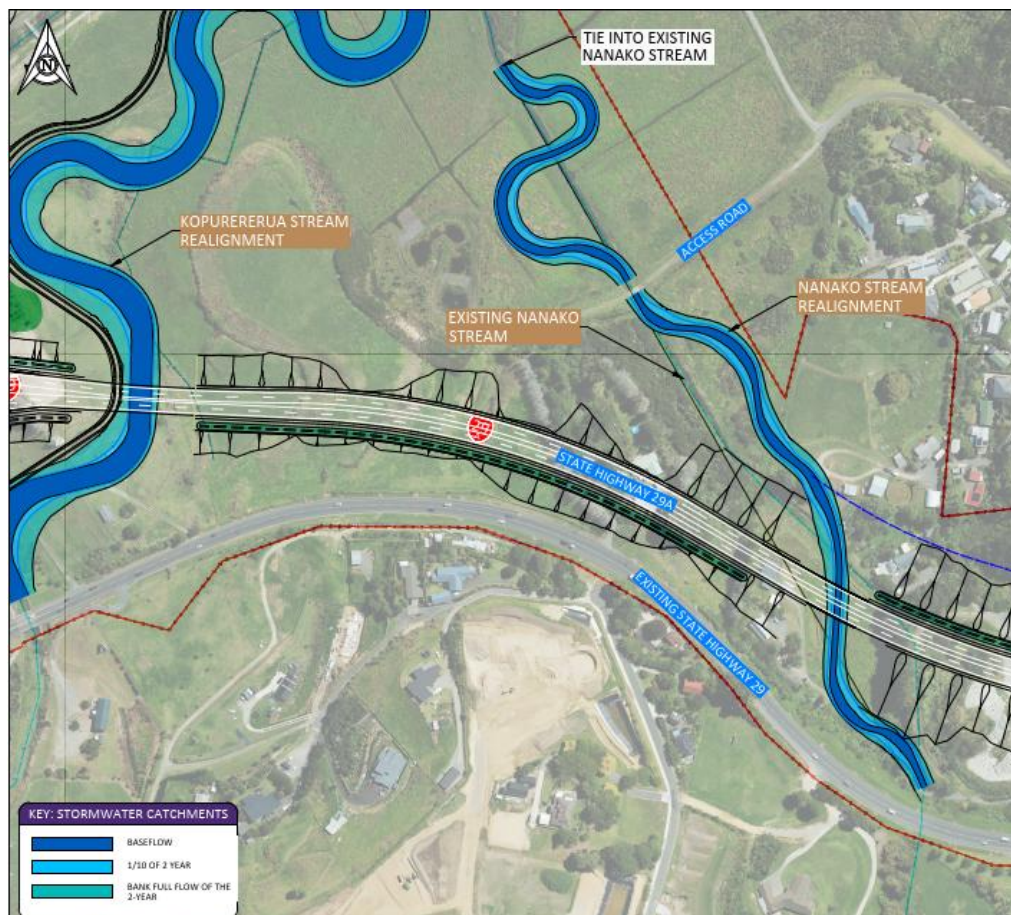


Figure No. 5.4– Proposed realigned reach of Nanako Stream.

5.4.1.4 Bedload and Sediment Transport

Upstream of the proposed realignment, the Nanako Stream has four major on-line flood control dams, a long section of the stream that is piped, and numerous off-line stormwater attenuation facilities. Due to these flood management and stormwater facilities, combined with the surrounding urban development, the reach of the Nanako Stream proposed for realignment is bedload and sediment starved. Therefore, it is appropriate to apply a velocity threshold methodology for the design of the stream realignment, without any concern for significant aggregation. Based on normal flow calculations, the bankfull flow velocity is 0.25m/s in the straight sections and 0.19m/s in the bend apexes, which is well within the velocity threshold for the soil type of 0.7m/s⁹.

⁹ Julien, 2010



5.4.2 Summary of Effects Associated with the Nanako Stream Realignment

Applying the approach described above, the indicative design (shown in **Annexure C**) provides for the following outcomes:

- The overall length of the Nanako Stream reach will increase by 165m, from 583m to 748m.
- The cross-section will contain ½ of the 2-year event, which exceeds the capacity of the existing stream.
- Flow velocities will be slightly lower in the realigned stream.
- Available aquatic habitat within the reach will increase and be more diverse, and the total area of spawning habitat for native fish within the reach will be increased and available through a wider range of flows.
- Streambanks within the stream realignment will sustain more vegetation, improve habitat and water quality.

Overall, these outcomes will result in a significant improvement to the stream.

5.5 Stream 3 (Near Belk Road)

Stream 3 conveys runoff from a 305ha catchment. Land use within the catchment is industrial and agricultural (primarily kiwifruit orchards), with some lifestyle blocks and farmstead land. Very little of the catchment is vegetated. Like the Kōpūrerua and Nanako Streams, the reach of Stream 3 that will need to be realigned due to the road embankments of the Project was straightened before 1943 and part of it became part of a floodplain drainage network around 1966.

More recently, additional works have been undertaken in this area by Tauriko Business Estate as part of their development. This has included creating an additional meandering stream channel. The straightened stream alignment from the early 1940s has been left in place, and a secondary channel has been created, creating two stream channels, next to each other (refer to **Figure 5.5** below). Based on the Tauriko Business Estate Offset Mitigation drawing (as set out in the development's approved Ecological Management Plan), the meandering mitigation channel does not appear to connect to the straightened 1940s stream, at its upstream end. At the downstream end of the meandering stream mitigation channel, a rock ramp type drop structure ties the mitigation channel into the 1940s straightened stream alignment, creating a small tributary, rather than a diversion.

Figure 5.5 also shows a meandering stormwater outfall channel associated with a stormwater pond, within the Tauriko Business Estate. The meandering stormwater outfall channel is also part of the Tauriko Business Estate offset mitigation package.

Stream 3 is currently conveyed under the existing SH29 via two 1200mm culverts, set at different levels and grades. These culverts are undersized for the flow that they will need to convey under climate change-influenced flows.

The overall grade of Stream 3, between the Wairoa River and upstream limit of the stream reach affected by the Project, is flat. The Wairoa River is tidally influenced at the Stream 3 confluence, and thus Stream 3 is tidally influenced. Based on the aerial images that have been reviewed, high tide causes water to back up in the stream beyond the upstream designation boundary. The 1940s stream realignment does not appear to have the capacity to convey a typical bankfull flow, resulting in frequent flooding.

The banks of the 1940s stream realignment and the meandering mitigation channel are steep, with a cross-section similar to a typical land drainage channel. Based on topographic survey information, the invert of the meandering mitigation stream is approximately 1.3m higher than the invert of the 1940s stream realignment.



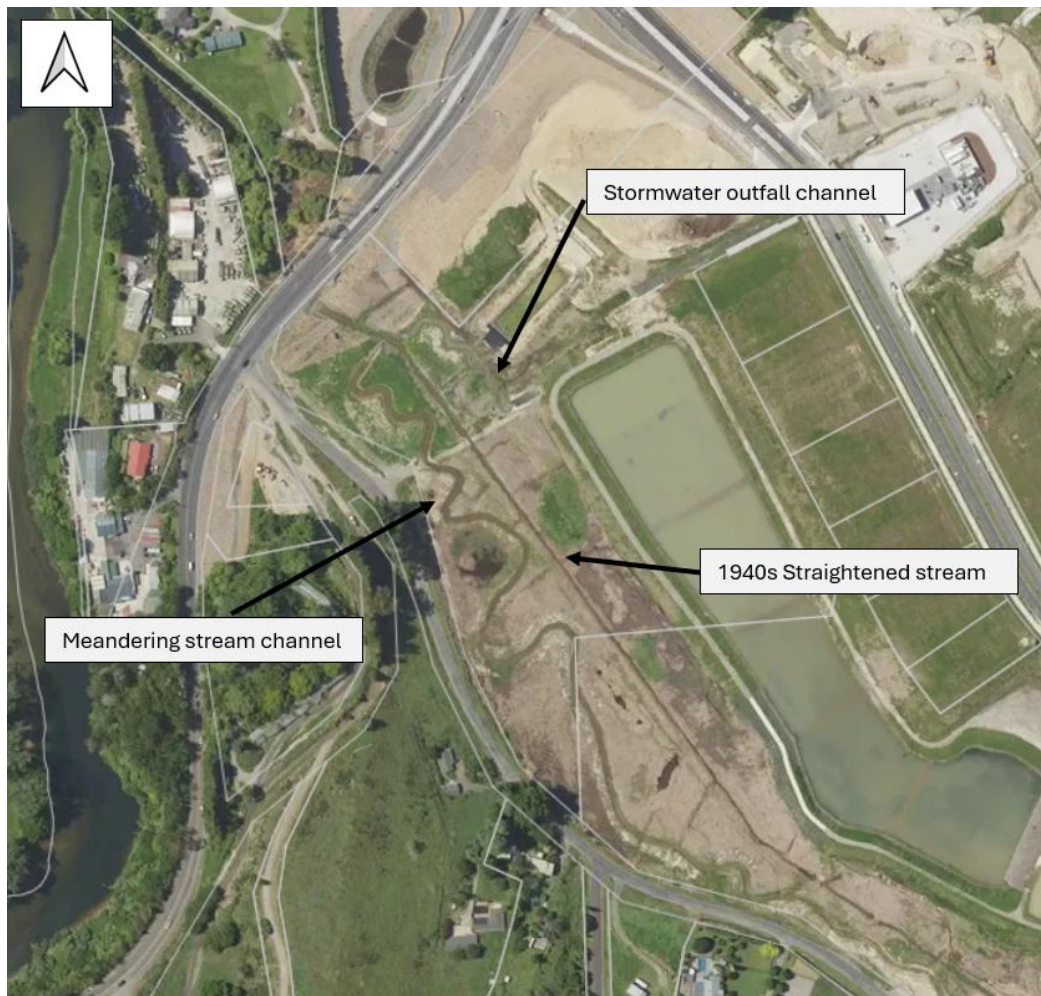


Figure No. 5.5– A 2026 aerial image, showing the recent stream realignment, the historically straightened stream, and the stormwater outfall channel.

Upstream and downstream of existing SH29, Land Care Research S-Map indicates that the soils are loam, with a thin layer of gravelly loam approximately 200mm below the surface. Upstream of existing SH29, the loam is saturated and potentially unconsolidated. Based on the information in S-Map, the loam soils, downstream of SH29, are not saturated or unconsolidated and should be somewhat more erosion resistant.

5.5.1 Stream 3 Design Approach

The following sections describe, at a high level, the design approach for the proposed Stream 3 realignment. Unlike the other two stream realignments, this realignment must connect to the existing stream and the meandering mitigation channel, which have a difference in invert elevation of 1.3m at the upstream end of the Stream 3 realignment. The design process involved the following:

- Determining a stable cross-section;
- Determining the appropriate longitudinal grade;
- Designing the plan form;
- Taking into account the bedload and sediment transport balance, within the stream; and
- Facilitate a stable and ecologically viable connection to the existing development mitigation channel.

Design flows used are set out in **Table 5.1**.



5.5.1.1 Stable Cross-Section

Stream 3 conveys runoff from a 305ha catchment, and the existing reach proposed for realignment has an extremely flat longitudinal grade. In addition, there is very little available depth for the stream channel. Therefore, the Stream 3 cross-section design is primarily focused on capacity, within the vertical constraints (i.e. the design is an irregular channel of gentle bends and deeper pools (to increase habitat diversity for aquatic species) with wide benches alongside the stream (to support wetland vegetation)).

5.5.1.2 Determining the Appropriate Longitudinal Grade

The grade from the upstream end of the proposed Stream 3 realignment and the downstream end of the proposed realignment is fixed due to the characteristics of the existing stream.

5.5.1.3 Plan Form

Because of the flat topography and limited space available, it is not possible to create a fully meandering stream in this location. Instead, the design approach for Stream 3 is to introduce variation in the channel alignment, width and depth to create a more natural stream environment and a wider range of aquatic habitat. A small pool/stilling basin has been proposed where the existing mitigation channel enters the realigned stream to help manage sediment and reduce the risk of erosion. **Figure 5.6** below shows the plan form layout of Stream 3.

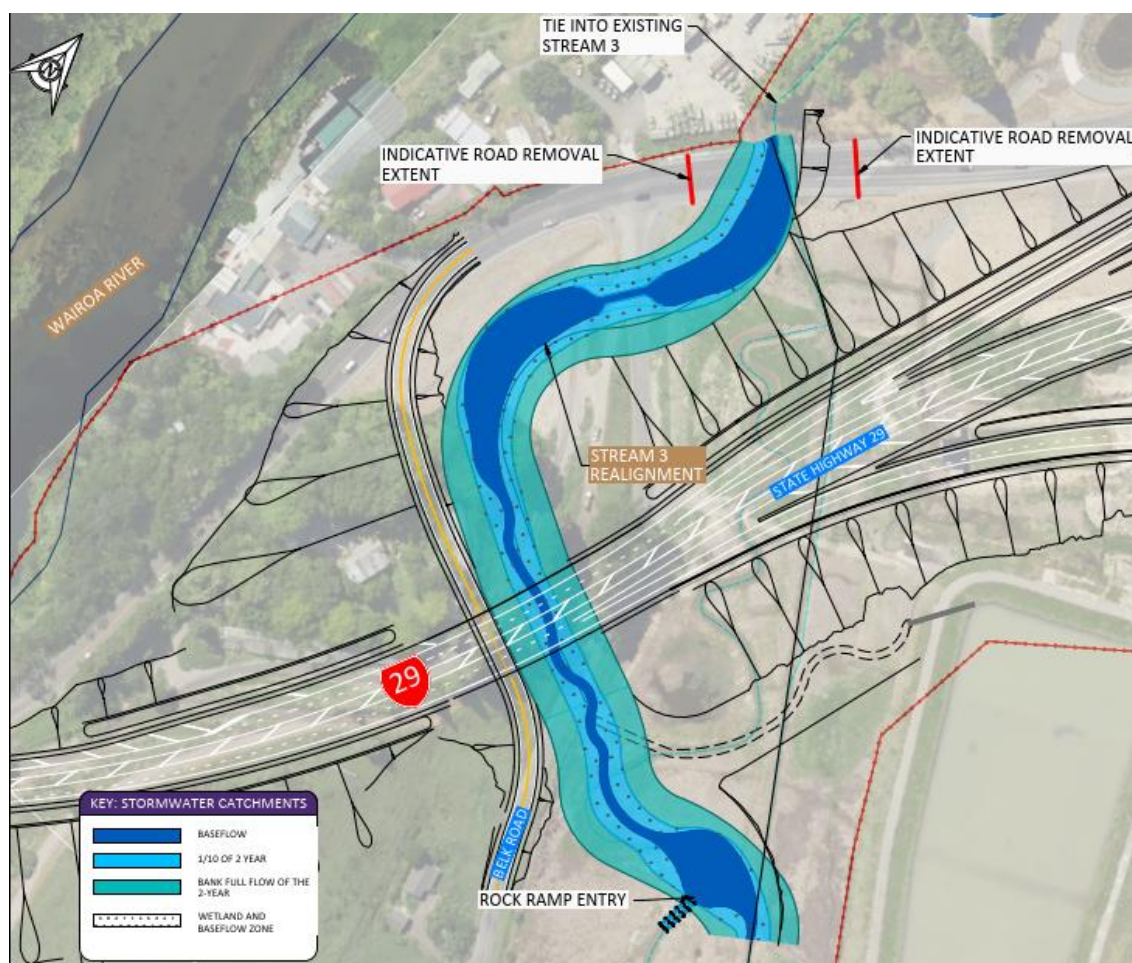


Figure No. 5.6– Proposed realigned reach of Stream 3.



5.5.1.4 Bedload and Sediment Transport

The reach upstream of the proposed Stream 3 realignment extends approximately 460m, is very flat and includes a broad constructed mitigation wetland floodplain (50m – 116m wide). These conditions mean that any flow greater than the base flow overtops the stream channel banks and sheet flow through the floodplain, naturally slowing the water flow and trapping sediment before it reaches the Project area. As a result, the realigned Stream 3 is not expected to experience significant erosion or sediment build-up.

A small pool/stilling basin has been included in the design to capture any sediment that may be carried downstream following unusually large erosion events. In capturing the sediment, the pool/stilling basin allows the stream upstream of the Project area to restabilise without gathering sediment in the new stream.

5.5.1.5 Other Watercourses and Aquatic Habitat

The Project impacts on a stream and two watercourses/channels (both of which were developed recently as part of the mitigation for consenting of the Tauriko Business Estate) in the area near Belk Road. Table 5.2 outlines the change in stream and other watercourse length resulting from the Project, as currently designed.

Table No. 5.2 – Proposed change in Stream 3 and other watercourse length near Belk Road

Stream and Other Watercourse Length Balance near Belk Road			
	Existing Length (m)	Realigned Length (m)	Difference (m)
Stream 3	406	425	19
Existing Drain/Previous Stream covered by new highway	165	0	-165
Stormwater Outfall Channel	109	140	31
Total Near Belk Road	680	565	-115

5.5.2 Summary of Effects Associated with the Stream 3 Realignment

Applying the design approach described above the indicative design (as presented in Annexure C) provides for the following outcomes:

- The overall length of the Stream 3 reach will increase 19m, after accounting for the daylighting of 30m of stream. The effect on total watercourse length in the works area will however, be a net reduction of 115m.
- The cross-section will contain ½ of the 2-year event, which exceeds the capacity of the existing stream.
- Aquatic habitat within the reach will increase and be more diverse, and the total area of spawning habitat for native fish within the reach will be increased and available through a wider range of flows.
- Streambanks within the stream realignment will sustain more vegetation, improve habitat and water quality, as well as reducing thermal gain within the stream.

Overall, these outcomes will result in a significant improvement to the stream.

5.6 Aquatic Habitat Function Improvement

The design approach for the realigned and/or stabilised reaches of all three streams, coupled with the riparian planting on the floodplain and overbanks and wetland plantings above the base flow within the main channel, was coordinated with the Project Ecologist to ensure improvement to the aquatic habitat value of



the stream. That is, the ecological and habitat values of the realigned stream reaches will be improved (compared to the existing stream) by including the localised stream enhancement features (pools, large rocks, rootwads, and tree stakes) and planting present in the design.

5.7 Fish Passable Rock Ramp Drop Structures for the Steep Stream 3 Connection

One rock ramp drop structure, at the upstream end of the Stream 3 realignment near Belk Road, will be required for the Project (refer to Stream 3 realignment drawings within **Annexure C**). If establishment of wetland or additional aquatic habitat requires a steeper channel than is stable or fish passable, additional rock ramps will likely be required.

The NZ Fish Passage Guidelines (Franklin et al., 2024) refers to O'Connor et al (2015) as the source for design information on fish ramp design. O'Connor et al. (2015) is primarily focused on rivers, which have very different flow characteristics compared to Stream 3 (which has a small base flow). Therefore, the indicative rock ramp design for Stream 3 is very similar to the full width river rock ramp fishway presented in O'Connor et al. (2015), however there are a few important differences, namely:

- a low-flow channel was added to accommodate the base flow that the (small) stream has;
- a series of ridges, pools, and baffles are created on either side of the low flow channel so that the low flow channel can carry more of the total migration flow; and
- stilling basins are added upstream and downstream of the ramp to provide resting opportunities for the fish at the upstream and downstream ends of the ramp.

5.8 Bridges

The Project crosses three streams: the Kōpūrerua Stream, the Nanako Stream, and an unnamed stream near Belk Road (Stream 3). All three of these streams will be crossed by bridges. Each of the stream bridges will be within the realigned reaches of the relevant stream (as described above).

One stormwater drainageway, under the proposed SH29, within the Takitimu interchange, will also be crossed via a bridge.

5.8.1 Kōpūrerua Stream Bridge

The indicative bridge design over the realigned Kōpūrerua Stream is 75m long with three 25m spans. The bridge length and length of each span minimise the extent of upstream flood effect and allow the stream to pass under the bridge. The piers extend approximately 400mm into the bankfull flow, on either side of the stream. The centres of the piers are outside of the bankfull flow width. The piers do not have a measurable hydraulic or ecological effect on the Kōpūrerua Stream. Scour protection is required for the 100-year flows. Scour protection will consist of either soil riprap (where there is adequate sunlight for plants) and/or voids filled riprap (where excessive shading prevents sustainable plant growth). **Figure 5.7** provides an illustrative view of the bridge and how the stream fits within a single span.

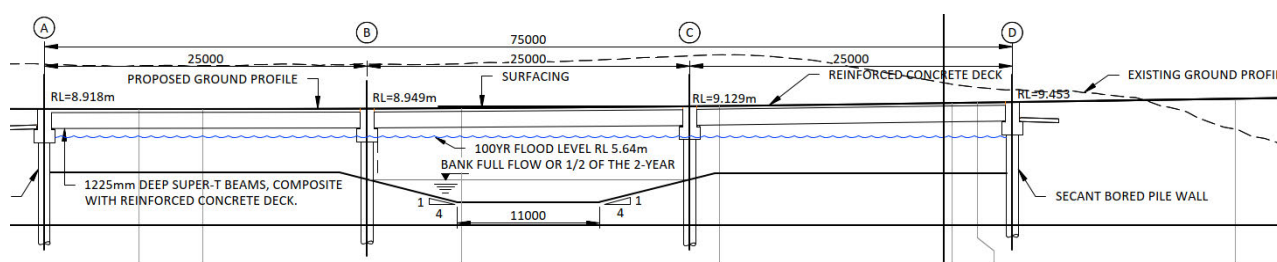


Figure No. 5.7– Indicative Kōpūrerua Stream Bridge.



5.8.2 Nanako Stream Bridge

The indicative bridge design over the realigned Nanako Stream provides for a single 25m span bridge. The bridge span will minimise upstream flood effects and the bankfull stream will easily fit within the 25m span. Scour protection is required for the 100-year flows. Scour protection will consist of either soil riprap (where there is adequate sunlight for plants) and/or voids filled riprap (where excessive shading prevents sustainable plant growth). **Figure 5.8** illustrates these features.

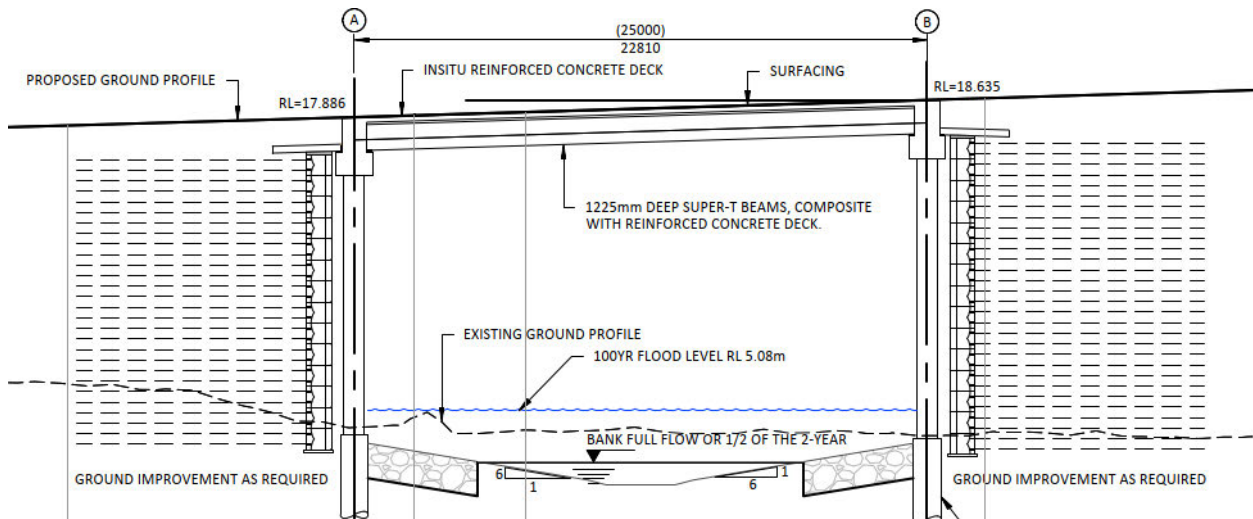


Figure No. 5.8– Indicative Nanako Stream Bridge.

5.8.3 Belk Road Underpass and Stream 3 Bridge

The indicative bridge design over the realigned Belk Road and Stream 3 is an approximately 62m two span bridge with 31m spans. The bridge span will accommodate both the realignment of Belk Road and Stream 3, each under an individual span, and will convey the 10-year ARI flood, without any flooding over Belk Road. The 100-year ARI flood will cause some shallow flooding over Belk Road, within the bridge limits. The 100-year flood freeboard will exceed the bridge manual requirement of 1.2m. **Figure 5.9** below illustrates the indicative bridge design and how the stream fits within it.

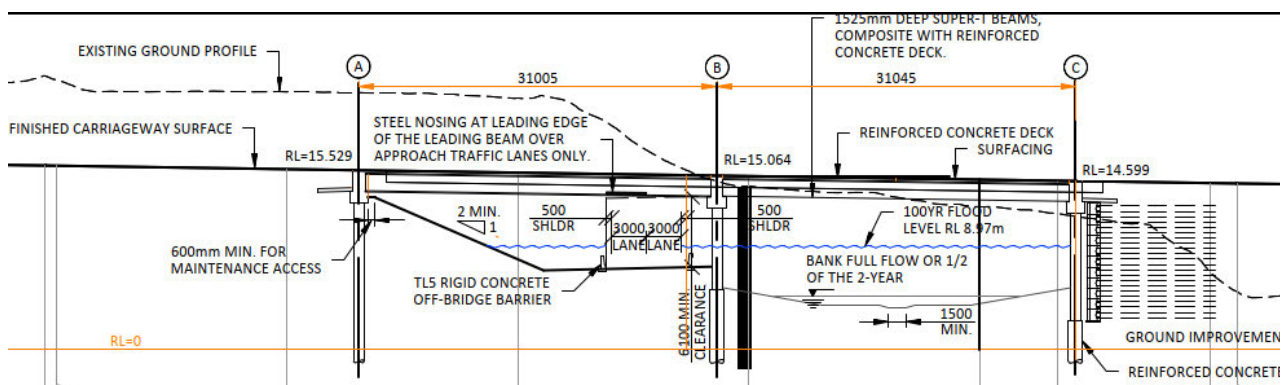


Figure No. 5.9– Indicative bridge over the Belk Road underpass, and Stream 3.-



5.8.4 Takitimu Drive Interchange Bridge

The indicative Takitimu Drive Interchange bridge spans over the SH29A Link in the Takitimu Interchange and flood conveyance and drainage channel, that may provide a connection to aquatic habitat. The indicative bridge design consists of two 25m spans, one over the SH29A Link Road and one over the flood conveyance channel. The bridge conveys the 100-year ARI flood, without any flooding over the Takitimu Interchange SH29 Link, including climate change. The 100-year flood freeboard will exceed 10m. **Figure 5.10** illustrates these features.

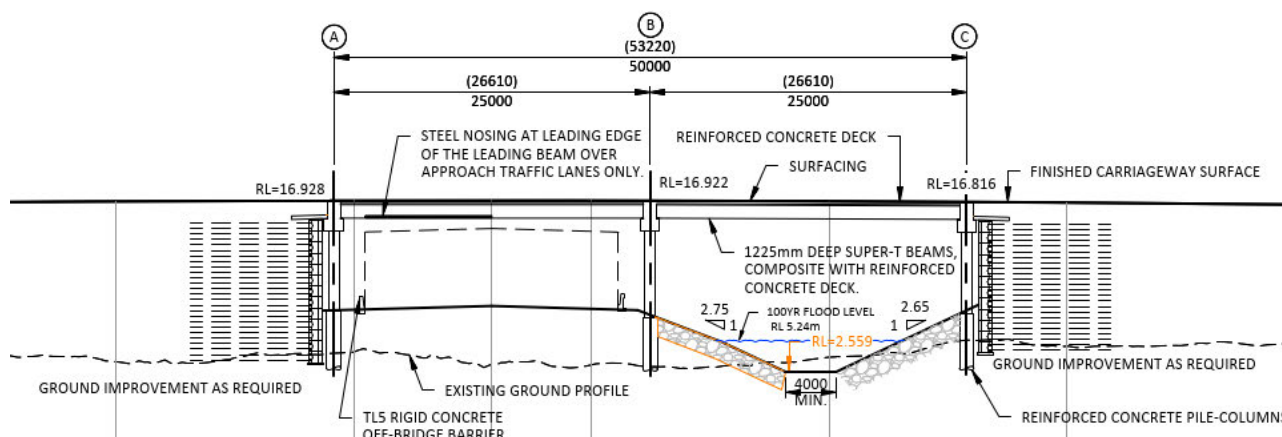


Figure No. 5.10– Indicative Takitimu Drive Interchange Bridge.

5.8.5 Summary of the Effects Associated with Bridges

In order to ensure that the potential effects of the proposed bridges are appropriately addressed, the detailed design for the bridges should achieve the following outcomes:

- The bridges provide for conveyance of watercourse flows.
- The structure will not cause erosion, scour or instability of the bed or banks of the watercourse.
- The bridges will not impede the passage or migration of native fish.
- The bridges will not cause increased flood levels that adversely affect existing upstream habitable buildings.

As outlined above, the indicative bridge designs provide an illustration of one way these objectives could be achieved.

Overall, provided the outcomes above are achieved, the proposed bridges will have negligible effects on the streams, native fish and less than minor effects on upstream flood levels.

5.9 Major Culverts

This section addresses major culverts, being a culvert that is large enough that it must meet the NZTA Bridge Manual requirements (i.e. a culvert that has an opening area of 3.4m² or more).

Smaller culverts for simple cross drainage that do not potentially affect aquatic habitat will be located and sized during detailed design, and are therefore not considered in this assessment.

The indicative stormwater design shows three major culverts located within the Kōpūrerua Valley area which form part of the indicative design for the Takitimu Drive interchange. **Figure 5.11** below shows the



indicative location of the three culverts. None of these culverts conveys an existing stream. Culverts TI-01 and TI-02 are box culverts that convey cross drainage trapped by the Takitimu Interchange and the water within attenuation ponds that form part of the indicative design stormwater management system of the interchange. Similarly, the primary purpose of Culvert TI-03 is to prevent the blocking of flood flow in the Kōpūrererua floodplain and to convey water treated by an attenuation pond that forms part of the indicative design stormwater management system of the interchange.

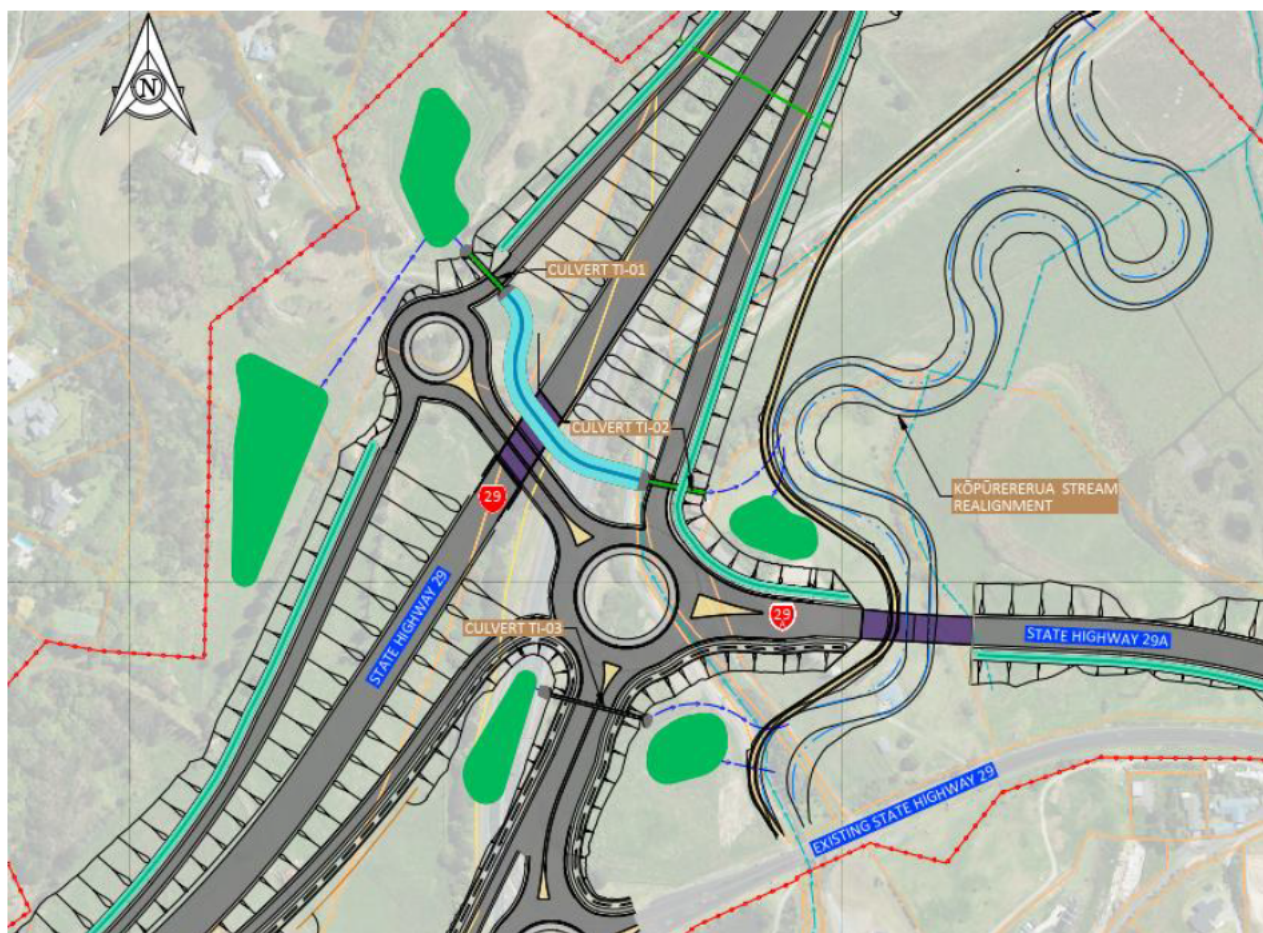


Figure No.5.11– Locations of the three major culverts within the Tauriko West project.

Flood flows and road geometry were the main design factors considered for the three culverts. Culverts TI-01 and TI-02 were sized to have the capacity to convey the 100-year flow with climate change, while taking high tailwater into account. Culverts TI-01 and TI-02 will be fish passable should the upstream catchment have aquatic habitat. Table 5.3 provides a summary of indicative design culvert characteristics and function.

Table No.5.3– Major Drainage Culverts

	Box Height	Box Span	Embedment Depth	Effective Height	Length	Q_{100}	$Q_{bankfull}$	Longitudinal Grade	Fish Passable	100-year Freeboard
	m	m	m	m	m	m ³ /s	m ³ /s	%	Y or N	m
TI-01	4	4	0.5	3.5	25.46	20.94	3.01	0.2	Y	1.2*
TI-02	4	4	0.5	3.5	35.86	20.94	3.01	0.2	Y	0.68*
TI-03	2	3	N/A	2	40.2	19.49	N/A	0.4	N	1.17**

* Freeboard from box culvert soffit
 **Freeboard from edge of roadway seal



5.9.1 Summary of Effects Related to Major Culverts

Culverts can constrict flow, when used to convey streams, resulting in upstream flooding and high velocity flows within the culvert and immediately downstream. The increased velocities can also prevent fish passage essentially closing off habitat, upstream of the culvert and interrupting the upstream migratory portion of the life cycle of native fish species. The indicative design for the major culverts within the Project positively addresses these effects by:

- Sizing Culverts TI-01 and TI-02 to convey the 100-year ARI flow without overtopping the roadway embankment;
- Sizing Culverts TI-01 and TI-02 to avoid upstream flooding;
- Sizing Culvert TI-03 to prevent the trapping of 100-year flood flows behind the SH36 extension as identified in the flood modelling undertaken; and
- Consistency with the NZ Fish Passage Guidelines (2024).

5.10 Conclusion

The Project requires the realignment of three highly modified stream reaches and the construction of associated bridges and culverts. While these works will alter the existing watercourses, the assessment demonstrates that the proposed stream realignment and indicative stormwater, bridges and culvert designs will maintain hydraulic function, provide for fish passage, improve channel stability, and enhance ecological and cultural values where practicable.

The Kōpūrerua Stream and Nanako Stream realignment designs replace historically straightened drainage channels with longer, more naturalised stream forms that better reflect the character of the surrounding floodplain. The proposed outcomes will increase channel length, improve the diversity and extent of aquatic habitat, increase opportunities for riparian and wetland vegetation establishment, and provide a wider range of habitat conditions for native fish species. The Stream 3 realignment will also provide habitat and water quality improvements, despite being constrained by the limited corridor width, flat topography and the need to integrate with the mitigation works for existing development in the area.

Importantly, the proposed stream realignments will ensure that channel capacity, sediment transport processes and stream stability are maintained, while also accommodating projected climate change effects. The proposed channels provide greater capacity than the existing stream reaches and are expected to operate more effectively than the existing modified drainage channels that currently occupy the Project area.

The bridge structure outcomes above take into account the proposed stream realignments, to avoid significant hydraulic or ecological effects. Bridge spans will be sufficient to accommodate stream processes, while minimising afflux and flood impacts upstream. The major culverts will provide the required flood conveyance functions and, where relevant, enable fish passage.

The proposed stream realignments, bridges and culverts, together with the fish passage and habitat enhancement features (and future riparian planting), will result in a substantial improvement in the functional and ecological condition of the affected stream reaches compared with the existing environment. Although the Project necessitates works within existing watercourses, the overall outcome is expected to be positive, with enhanced aquatic habitat, improved riparian condition, maintained hydraulic performance, and better alignment with cultural and environmental restoration objectives for the wider Kōpūrerua Valley.

Accordingly, the overall adverse effects of the proposed stream realignments, bridges and culverts are assessed to be negligible, while the resulting positive outcomes are assessed to be significant.



**Annexure A – Kōpūrererua, Wairoa River, and Waimapu
Catchments Drawing**

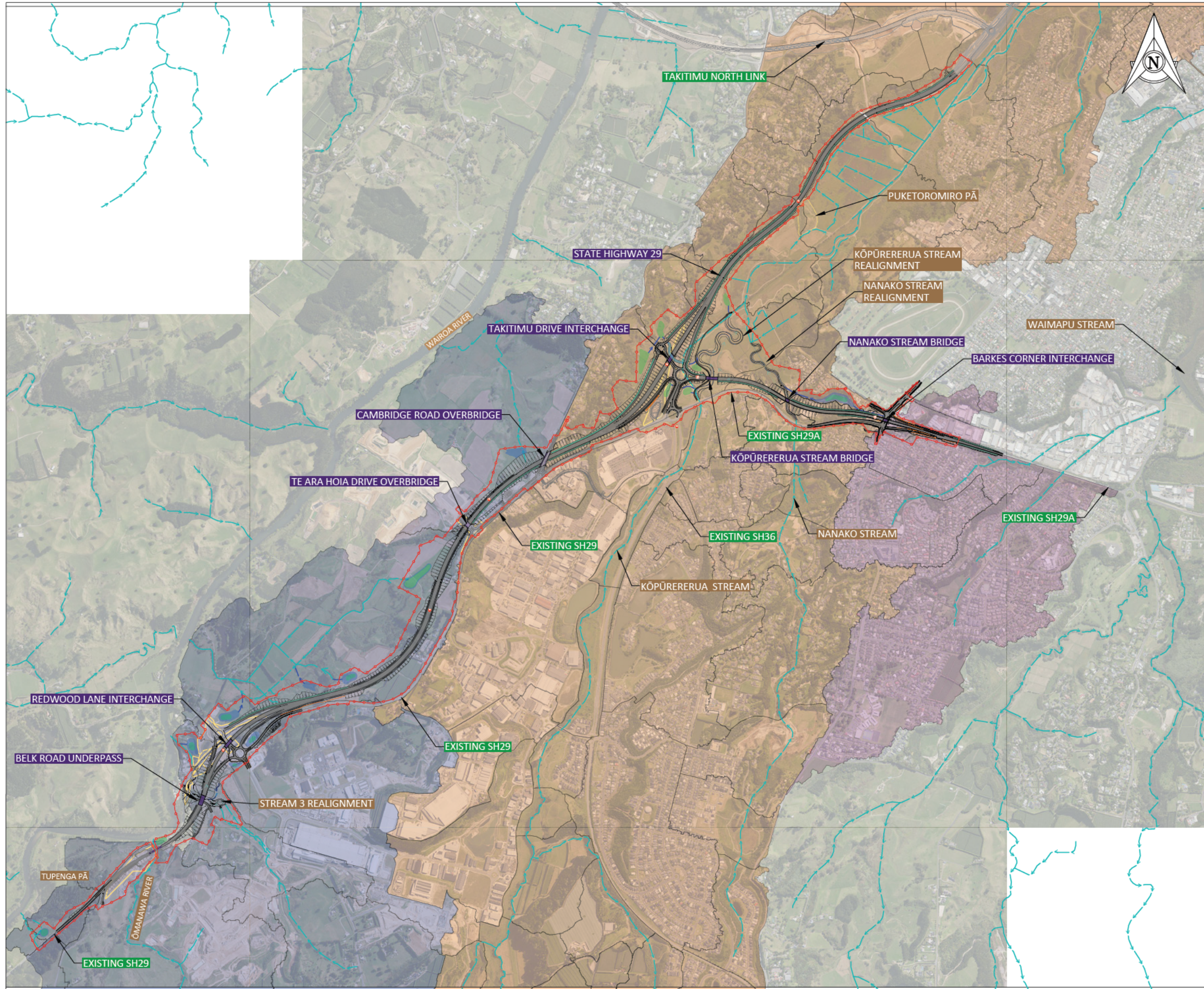


100mm

SCALE FOR VALIDATING SIZE OF A3 PLOT ONLY

0

C:\1245\Mapa\10.7.120.14\150000- Tauriko West_6550\03 Wp\03 Drawings\001\1922-29-14-SW-DRW-BBO-2100.dwg 30/7/2026 9:25 am erichardson Plotted: 30 Jul 2026 9:25 am



KEY: STORMWATER CATCHMENTS

- BOUNDARIES
- PROPOSED DESIGNATION
- CUT BATTER
- CARRIAGEWAY
- CONVEYANCE SWALE
- WATER QUALITY TREATMENT SWALE
- FILL BATTER
- EXISTING WATERCOURSE
- INDICATIVE CONNECTION
- TREATMENT WETLAND
- ATTENUATION POND
- TREATMENT AND ATTENUATION WETLAND
- BRIDGE
- WALLS
- WAIROA RIVER OFFSITE CATCHMENT BOUNDARY
- KŌPŪRERERUA STREAM OFFSITE CATCHMENT BOUNDARY
- WAIMAPU STREAM OFFSITE CATCHMENT BOUNDARY

REV	DATE	DESCRIPTION	BY	DES	CHK	APPR
P3	29.07.2026	INDICATIVE DESIGN	ER	JRL	EV	JG
P2	27.02.2026	PRELIMINARY CONSENT LEVEL DESIGN	JM	JM	EV	JG

APPROVAL:
J GIBBONS
NAME: JG
SIGNATURE:
29.07.2026
DATE:
NOTE: THIS DRAWING IS NOT APPROVED
UNLESS ALL FIELDS ARE SIGNED.



CLIENT:
PROJECT:
TAURIKO WEST - TUPENGA

DRAWING:
STORMWATER CATCHMENT
OVERVIEW PLAN

DRAWING ISSUED FOR:			NOT APPROVED FOR CONSTRUCTION		
SHARED					
HORIZONTAL DATUM	NZTM2000	SCALE (A3)			
VERTICAL DATUM	NZVD16				
DRAWING NUMBER:	11922-29-14-SW-DRW-BBO-2100	REVISION:	P3		

Annexure B – Stormwater Management Indicative Design Drawings



Annexure C – Steam Realignment Detailed Design Drawings

