BEST FOR AUCKLAND STORMWATER OUTCOMES FOR EASTERN BUSWAY

P. May (Jacobs)

ABSTRACT

The Eastern Busway Alliance is delivering on behalf of Auckland Transport an integrated, multi-modal transport system to support population and economic growth in southeast Auckland and decarbonise transportation. The Eastern Busway project will enable investment in intensification along the busway corridor.

This paper focuses on development of the design philosophy, project outcomes and meeting Connection Requirements in Schedule 4 of the Auckland Regional Network Discharge Consent (NDC) framework. Aligned with project objectives, the stormwater design philosophy adopts a maintenance-led approach, prioritising best for Auckland outcomes through collaboration with Auckland Transport, Auckland Council, and mana whenua. The design therefore incorporates Auckland Council Healthy Water Betterment objectives, the EBA objectives and mana whenua aspirations.

To balance maintenance considerations, treatment outcomes, and project constraints, a best practicable option (BPO) stormwater treatment approach was adopted within the NDC framework. This approach evaluates options based on mana whenua aspirations, whole-life costs, and contaminant load reduction outcomes for outfalls. Mana whenua challenged the EBA to practice tiakitanga by treating stormwater better, fix flooding and generally do it once and right while keeping operations and maintenance costs affordable for the community.

The preferred BPO option for stormwater treatment involves green infrastructure (e.g. raingardens, passive irrigation channels, and swales) where feasible, with gross pollutant traps (GPT) in other areas. The GPT are sized to achieve a 50% total suspended solids (TSS) removal. Discretionary treatment targeting high contaminant generating roads and parking areas outside the project works was also incorporated and betterment including treatment of existing stormwater networks. The project is predicted to achieve overall reductions in contaminant loads to the environment from roads in the order of 40% for TSS and 20-30% for total zinc, copper, and total petroleum hydrocarbons (TPH).

Upgrading existing stormwater networks designed under the former Manukau City Council standards is a crucial aspect, these networks currently have a capacity approximately equal to a 50% Annual Exceedance Probability (AEP) event with climate change, leading to significant overland flows and flooding around the project corridor for 10% and 1% AEP events.

The agreed philosophy for incorporating betterment involves combining and upgrading the project and existing networks along the busway corridor, upgrading outfalls, and diverting existing networks into the upstream end of the new stormwater systems to reduce flooding, overland flows, and enhance infrastructure resilience. Flooding and overland flow management design elements are predicted to eliminate flooding across

the road corridor during the 10% AEP event and significantly reduce flooding crossing the busway in the 1% AEP event. No new or increased flooding is predicted on private property because of the project with improvements for most properties and roads that experienced flooding in the existing case.

Incorporating the Auckland Council Healthy Waters (Healthy Waters) Betterment works into the Eastern Busway Alliance's scope will result in best-for-Auckland solutions that meet current standards, improve resilience, provide safe and affordable maintenance activities, and reduce overall whole-of-life outcomes. Improved resilience of the road corridor to flooding helps enhance the public transport customer experience and decarbonise transportation in East Auckland.

KEYWORDS

EASTERN BUSWAY, MAINTENANCE, RESILIENCE, BPO, BEST FOR AUCKLAND, BETTERMENT

PRESENTER PROFILE

Paul is a Principal Stormwater Engineer and Technical Leader at Jacobs with 28 years' experience of providing technical leadership of major infrastructure, urban catchment management and large complex industrial projects throughout New Zealand. Paul is currently the Stormwater Technical Lead for Eastern Busway Alliance leading the stormwater design and stormwater effects assessments.

1 INTRODUCTION

Large infrastructure projects provide an opportunity for collaboration with councils, mana whenua and other stake holders to achieve better community outcomes than what the project can achieve on its own. This requires all parties to be open to listening to other perspectives, allow all parties to achieve their goals while agreeing to achieving best for community outcomes. Incorporating betterment and asset renewals as part of the project can save significant future costs, increase resiliency to climate change, reduce disruption to communities and achieve better outcomes.

2 EASTERN BUSWAY PROJECT OVERVIEW

The Eastern Busway project represents a significant infrastructure initiative aimed at providing alternative transportation options for East Auckland. The project objectives are to make local trips easier and more efficient by providing sustainable travel options for walkers, cyclists, motorists, bus, and train customers connections to central Auckland. The design philosophy has been developed to incorporate mana whenua and Healthy Waters aspirations for the project area.

Upon completion, the busway is projected to accommodate 18,000 passengers per day by 2028 which equates to more than four times the 3,700 passengers per day before Covid-19. This number is expected to increase to 24,000 passengers per day by 2048.

The Eastern Busway project will provide 5km of busway between Pakūranga and Botany (refer to Figure 1) fully separated from other traffic allowing reliable bus trips along with five new bus stations. The project will also provide 12 km of safe and separated walking and cycling routes providing alternative sustainable travel options. The Eastern Busway

project will connect travellers to Pakūranga station where train connections to Central Auckland will provide sustainable and reliable transport options.

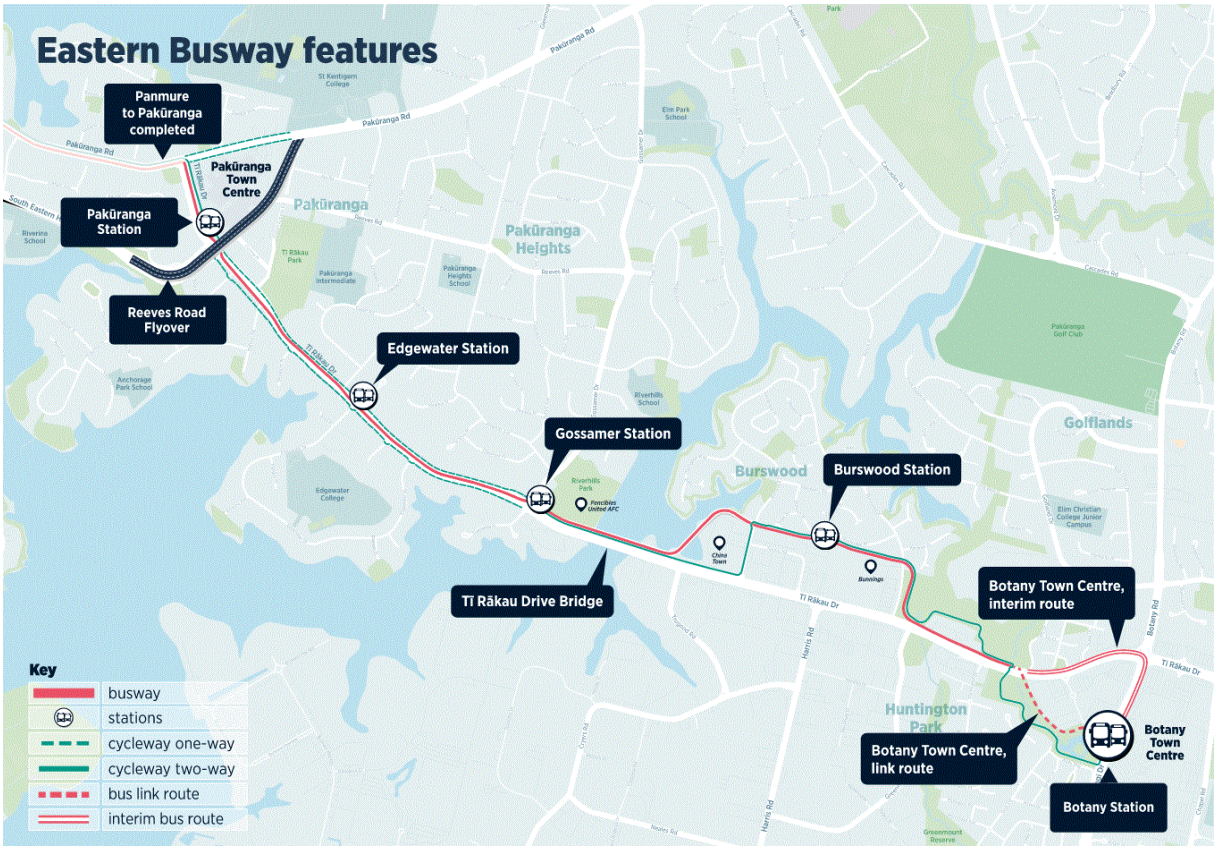

Figure 1: Eastern Busway overview.

In addition to bus lanes and cycling routes, the project includes a flyover above Reeves Road to provide a new direct connection between Pakūranga Road and the South Eastern Arterial. The flyover is expected to reduce vehicle congestion around Pakūranga Town centre.

This paper will focus on the Eastern Busway project between Pakūranga Town Centre and Ti Rākau Drive Bridge. This section of the Eastern Busway project is split between two zones:

- EB2 – Pakūranga Town Centre to Ti Rākau Park as shown in Figure 2.
- EB3R – Ti Rākau Park to Ti Rākau Drive Bridge as shown in Figure 3.

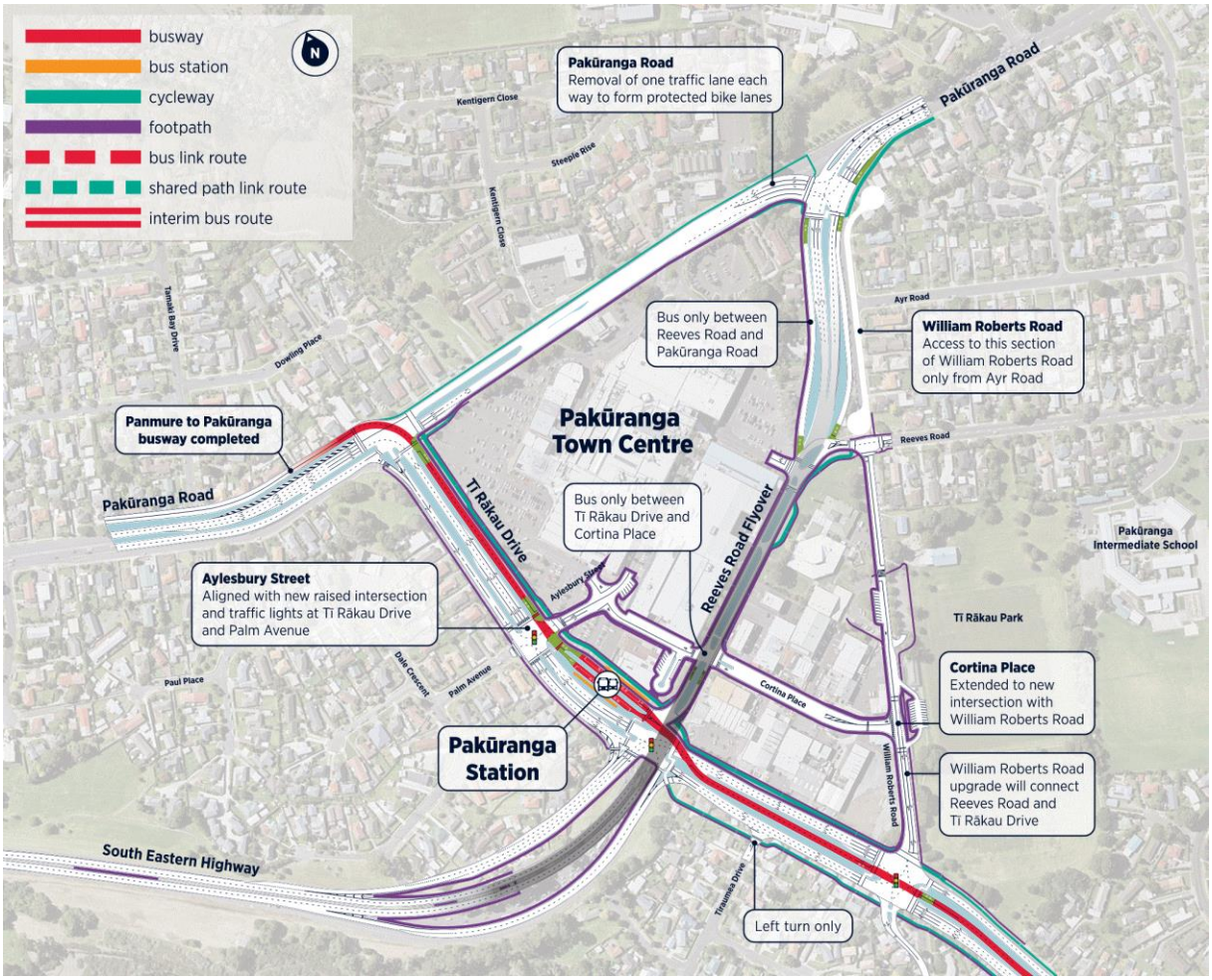

Figure 2: EB2 Overview.

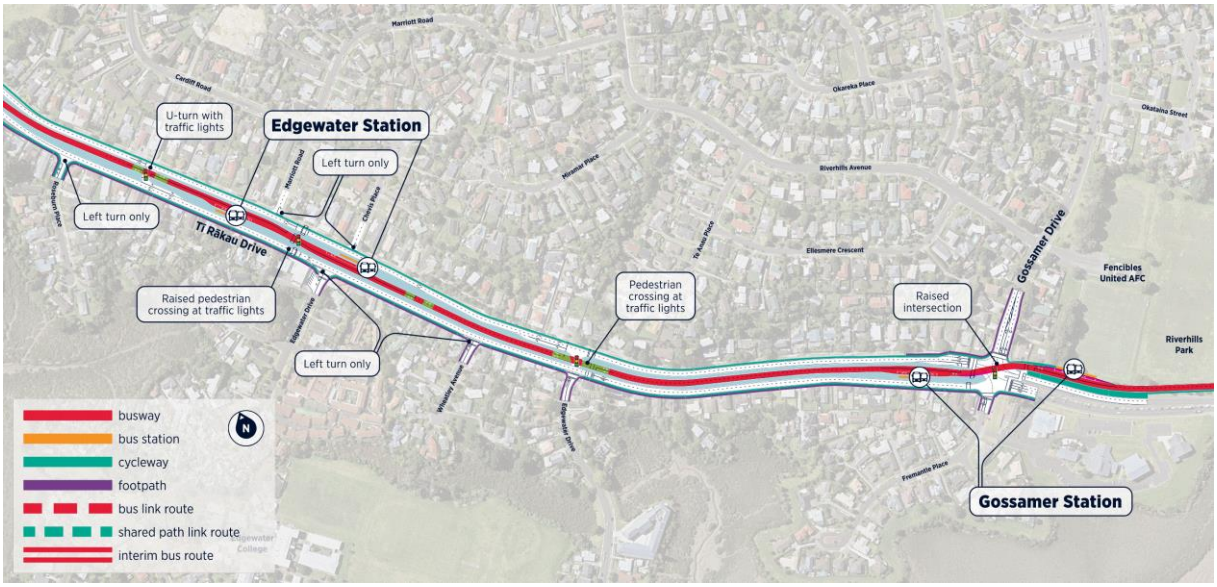

Figure 3: EB3R Overview.

3 DESIGN PHILOSOPHY

The design philosophy for the drainage and treatment systems for the Eastern Busway is a 'maintenance-led' approach, seeking to reduce maintenance and operational costs to

Auckland Transport and ultimately, to Auckland ratepayers. The design philosophy has been developed to incorporate mana whenua and Healthy Waters aspirations for the Project area. There have been regular discussions between Auckland Transport, the Eastern Busway Alliance, and Healthy Waters on their aspirations for Project-wide renewals and upgrades of their assets as part of the Project. These discussions led to the opportunity for best-for-Auckland solutions to overland flows, flooding, and stormwater treatment. In parallel, Eastern Busway Alliance and Healthy Waters are meeting with mana whenua the projects key partners, to discuss their aspirations at ongoing hui.

The philosophy adopts a BPO approach for water quality treatment and does not follow Stormwater Management Devices Guidance Document 2019/01 (GD01) (Auckland Council 2017) in the Auckland Region as the default position. The project corridor is highly constrained with utilities, intelligent transport systems and topography leaving little room for large footprint treatment solutions. The philosophy is a risk-based approach, providing treatment efficiencies and options that are proportional to the contaminant generating risk. The use of a BPO approach is balanced by the target of achieving an overall reduction in existing contaminant contributions from carriageway, following completion of the Project. The target is assessed using the Auckland Council Contaminant Load Model (CLM) (Auckland Regional Council 2019) to estimate loads for TSS, total zinc, total copper, and TPH generated from roads. Success was based on the total (sum of all outfalls) contaminant load generated from roads (for each contaminant assessed in the CLM) for all outfalls that interact with the Project reducing from the existing levels. Providing discretionary treatment that focusses on high contaminant generating carriageways and parking areas outside of the Project works is a key element of achieving this target.

The proposed stormwater networks and their connections and discharge of stormwater to existing outfalls are proposed to be authorised under the Healthy Waters NDC.

4 KEY PARTNERS AND COLLABORATION

4.1 AUCKLAND COUNCIL HEALTHY WATERS

Engagement with Auckland Council has been at a project overview level (project alignment) without specific discussions on stormwater including EPA processes. In addition, weekly technical discussions and were carried out with Healthy Waters representatives for catchment management, design, and operations and maintenance. Engagement with the Regulatory departments of Auckland Council occurred throughout the resource consent application process that provided certainty on when resource consent and EPA applications will be lodged and how they can be efficiently managed by Auckland Council and Eastern Busway Alliance.

Healthy Waters indicated a strong expectation that stormwater is appropriately treated and managed whilst ensuring operational and maintenance costs are minimised. Healthy Waters and Eastern Busway Alliance collaboration resulted in a BPO and detailed design that provided cost effective maintenance with access that is safe and not requiring traffic management or at least minimises costs.

Healthy Waters gained approval of a business case to incorporate Betterment of the existing networks into the Eastern Busway design on a best for Auckland basis. The Betterment generally involves diversion of existing stormwater networks into the

proposed Eastern Busway stormwater networks at the upstream project boundary and then upgrading pipe sizes of the Eastern Busway networks and abandonment of existing networks.

Effective engagement and collaboration with Healthy Waters was critical to achieving best for Auckland outcomes that reduce flooding, increase resilience, achieve a reduction in existing contaminants discharged to the outfalls while meeting aspirational whole of life outcomes.

4.2 MANA WHENUA

Mana whenua is a project partner of the Eastern Busway Alliance with a representative on the Project Alliance Board. Auckland Transport, Eastern Busway Alliance and Healthy Waters are using the opportunity to build relationships with mana whenua by providing genuine opportunity to provide input into the Project and influence outcomes. Stormwater is a key area of interest to mana whenua with potential for stormwater management to impact the mauri of water and surrounding areas. Mana whenua has been very clear that they have high expectations in terms of stormwater treatment and have specifically asked the Eastern Busway Alliance to address water quality as part of the project. Therefore, incorporating their knowledge, ideas and resolving concerns form a critical element of the project for the Alliance. So far, engagement with mana whenua has occurred through monthly hui and will continue throughout the project including during construction. Mana whenua have also indicated they have strong preferences for stormwater treatment devices that do not burden ratepayers with high operation and maintenance costs.

As a project partner, Mana whenua has been integrally involved through the design process, including selection of the BPO and setting high expectations for the Eastern Busway Alliance and Healthy Waters working collaboratively to achieve better outcomes. Mana whenua have been involved in driving flooding improvements in the design, including improvement flood outcomes at the Gossamer Drive intersection, water quality outcomes, and best for Auckland solutions where Healthy Waters have agreed to fund Betterment (i.e. the combining of the existing and Eastern Busway stormwater networks and further increasing pipe sizes). The betterment followed a joint Eastern Busway Alliance and Healthy Waters Hui where a joint commitment was made to work together and deliver best for Auckland solutions.

5 NETWORK DISCHARGE CONSENT

The existing stormwater network and associated discharges are authorised by the Healthy Waters NDC (AC Reference: DIS60069613). The NDC replaced 116 different consents and multiple authorisations with a single consent containing a comprehensive set of requirements for use across Auckland. The NDC defines clear targets to lift water quality, reduce flooding and protect streams and other water assets.

The Eastern Busway Alliance proposes to authorise all stormwater networks, their connections, and the discharge of stormwater to existing and new outfalls under the NDC. Under the NDC Schedule 4, in a section that covers Auckland Transport (AT), KiwiRail and Waka Kotahi projects, connection requirements for four different sizes or risk categories are outlined.

The Auckland Unitary Plan Operative in part (AUP(OP)) defines a 'high use road' as "A road, motorway or state highway that carries more than 5,000 vehicles per day, excluding cycle lanes, footpaths and ancillary areas that do not receive stormwater runoff from the road carriageway."

The EB2 and EB3R works modify seven roads (Ti Rākau Drive, SEART, Pakūranga Road, Reeves Road/Reeves Road Flyover, Edgewater Drive, Gossamer Drive and Marriot Road) that meet the definition of 'high use road'. The busway is not a 'high use road' with approximately 700 bus movements a day. Both EB2 and EB3R include new or redevelopment of impervious carriageway area greater than 1,000 m^2 on high use roads, and/or areas greater than 5,000 m^2 on other roads. Therefore, EB2 and EB3R meet the thresholds for Category 3 connection requirements (individually and combined) of Schedule 4 connection requirements for the Healthy Waters NDC.

The project is not located within an area with an adopted SMP, therefore has to meet general catchment/area performance requirements for other areas. The project conducted detailed flood modelling demonstrating the general performance criteria was met conservatively by ensuring:

- No new or additional flooding on private property during 10% and 100% AEP events.
- No new or additional flooding on private property during 10% and 100% AEP events as a result in changes to overland flow path capacity (i.e. pipe blockage factors were added to the flood model).

For water quality the project Minimum Requirements, Design Philosophy and constraints required an alternative level of mitigation determined through a SMP that:

- applies an Integrated Stormwater Management Approach
- meets the NDC Objectives and Outcomes in Schedule 2
- is the BPO for the given Project.

The Eastern Busway Project is not located within a Stormwater Management Area Flow (SMAF) zone, therefore there are no additional stream hydrology requirements to those in the AUP(OP).

For flooding during the 10% AEP the existing networks do not have sufficient capacity within the pipe network downstream of the connection points (at maximum probable development of the contributing catchment) to cater for additional stormwater runoff associated with the new impervious area from Eastern Busway. There is insufficient room to attenuate stormwater flows and volumes, therefore the project upgraded the pipe networks downstream of the connection points.

6 BEST PRACTICABLE OPTION

6.1 APPROACH

The approach adopted for BPO development included evaluation of all stormwater management requirements and options to assist in selecting a proposed BPO for the Eastern Busway. The evaluation considered stormwater requirements and outcomes for treatment options, including aspirations of Healthy Waters and mana whenua. The

approach documented consideration of alternative options and development of the BPO under the Healthy Waters NDC framework.

The philosophy for designing the drainage and treatment system for the entire Project, in accordance with the Minimum Requirements in the Project Alliance Agreement, is a 'maintenance-led' approach, seeking to reduce maintenance and operational costs to Auckland Transport and, ultimately, Auckland ratepayers. The design philosophy has been developed to incorporate aspirations of Healthy Waters and mana whenua for the Project area. The philosophy adopts an approach for water quality treatment that does not follow GD01 as the default position. Instead, a BPO (an alternative level of mitigation under the NDC framework) was adopted based on a risk-based approach, providing treatment efficiencies and options that are proportional to the contaminant-generating risk. The use of a BPO under the NDC triggers the requirement to develop a Stormwater Management Plan (SMP) using an integrated management approach that meets the NDC Schedule 2 Objectives and Outcomes.

The SMP is required to be submitted during the NDC connection approval process, which is part of the Engineering Plan Approval (EPA) process. Therefore, the SMP was developed based on the final detailed design, with SMP approvals obtained following completion of the detailed design rather than during the projects resource consent application process.

6.2 WHOLE OF LIFE OUTCOMES

To achieve the aspirational whole-of-life outcomes of Auckland Transport, Healthy Waters and mana whenua, life cycle costs (LCC) (as net present value) were calculated for each treatment option. The LCC were based on the Auckland Council's life cycle cost report (Moores et al., 2019). The purpose of the LCC approach is to compare the relative differences between options and not to predict the exact costs of a particular device or option. For this reason, the capital cost was not considered separately to operational and maintenance costs as assessment criteria in the BPO option analysis.

For the whole-of-life assessment, maintenance of raingardens in medians was based on the use of the busway during nightly shutdown for access and avoiding lane closures and costly traffic management. Maintenance of raingardens in berms is to be carried out using the footpath/cycleway for access that reduces traffic management to that required for pedestrians and cyclists. For the whole-of-life assessment of GPT and Filtration devices, maintenance assess was via the footpath/cycleway for access and maintenance activities were based on maintenance pads adjacent to devices. LCC for Filtration devices included capital, operational and maintenance costs of including a GPT upstream with subsequent reduced maintenance interval for the Filtration device maintenance (increase from yearly to once every two years).

6.3 WATER QUALITY

Auckland Transport, Eastern Busway Alliance, Healthy Waters, and mana whenua all aspire to improved water quality following project completion. Achieving the aspirational target requires a change from the standard approach where a project aims to have a no more than minor effect (i.e. an acceptably small increase) on water quality. Following regular discussions with Auckland Transport, Healthy Waters, and mana whenua during the Reference Design stage it was agreed a target of improving water quality would be adopted.

Success has been measured by ensuring the future total contaminant loads discharged from all roads (including those outside of the Eastern Busway project extents) to outfalls that Eastern Busway interacts with would be less than the existing contaminant loads from roads. This approach was adopted prior to agreements for Betterment and therefore only contaminants from roads were assessed using the CLM. Although incorporation of Betterment has resulted in treatment of entire outfall catchments, the additional improvement of treating non-road areas has not been assessed in the CLM. This is because Betterment was incorporated into the Detail Design between the preliminary and completed detailed design stages and there wasn't sufficient time to change the CLM approach to include non-road contributions to the contaminant load estimates.

6.4 OPTIONS CONSIDERED

The selection of treatment devices for Eastern Busway considered guidance provided in the Transport Design Manual's - Engineering Design Code for Road Drainage and Surface Water Control (TDM) (Auckland Transport 2020) treatment device hierarchy and the NDC framework. The TDM has the following tiered treatment device hierarchy:

- Tier 1: Grassed or vegetated swales and bioretention systems such as raingardens are acceptable to Auckland Transport.
- Tier 2: Wetlands, dry ponds, proprietary devices, catchpit filters and filter screens are acceptable to Auckland Transport on a case-by-case basis.
- Tier 3: Wet ponds will only be accepted by Auckland Transport by exception. Not a preferred option by Auckland Transport but will be considered as a last resort.

The NDC framework requires a BPO approach when water quality devices cannot be designed to GD01. Combining the Auckland Transport's tiered approach and GD01 treatment systems resulted in the following options to be considered for Eastern Busway:

- Option 1: Green infrastructure (predominantly raingardens and swales) where feasible with GPT (design to achieve a long-term average of 50% TSS removal) treatment elsewhere. In addition to treating carriageways modified by the project, other high use roads would be targeted to offset the use of a lower level of treatment from a GPT.

- Option 2: Large Raingardens adjacent to the connection point to existing networks near outfalls (i.e. one raingarden per outfall). This option would only treat stormwater from carriageways modified by the project.

- Option 3: Wetlands adjacent to the connection point to existing networks near the outfalls (i.e. one wetland per outfall). This option would only treat stormwater from carriageways modified by the project.

- Option 4 GPT and Filtration Devices (i.e. StormFilters by Stormwater360) adjacent to the connection point to existing networks near outfalls. This option would only treat stormwater from carriageways modified by the project.

The options selected for analysis were identified following a process of considering Auckland Transports, Healthy Waters and mana whenua's aspirations for water quality improvements while not burdening ratepayers with high operational and maintenance costs, site constraints (i.e. utilities and topography) and land availability (i.e. the only

large areas of land available where near outfalls but consisted of residual residential land that project objectives airmarked for high density redevelopment).

6.5 BPO SELECTION

The annual contaminant loads predicted by the CLM for the project at reference design stage (i.e. included EB2, EB3R, EB3C and EB4) are summarised in Table 1 for each scenario. The No Treatment scenario was only assessed to understand change the contaminant loads as a result of the project prior to treatment and was not considered as an option for adoption in the design.

The CLM results (refer to Table 1) show that the total contaminant loads prior to treatment from all roads discharging stormwater to project outfalls increases by 10% for TSS and 1% for total zinc, total copper and TPH once the project was constructed. This demonstrates that the busway, with low vehicle per day predictions compared to busy roads like It Rākau Drive, discharges relatively low contaminant loads.

The CLM results (refer to Table 1) show all the treatment options can reduce the total contribution from Auckland Transport Roads discharging to the project outfalls (i.e., including those roads outside of the project works extents) to less than predicted for the existing situation.

Table 1: Project-wide percent change in annual contaminant load predictions for treatment options assessed.

Scenario	TSS	Zinc	Copper	TPH
No Treatment	10%	1%	1%	1%
Option 1: Raingardens & GPT	-34%	-24%	-26%	-30%
Option 2: Large Raingardens	-16%	-13%	-16%	-19%
Option 3: Wetlands	-19%	-8%	-13%	-7%
Option 4: GPT & StormFilters	-23%	-2%	-14%	-19%

The results in Table 1 show from a water quality improvement perspective that Option 1 was the preferred option with Options 2, 3, and 4 the least preferred. The main driver for Option 1 achieving higher reductions is targeted treatment of roads outside the project area (i.e. offset mitigation) whereas the other options only consider carriageways that are modified by the project.

For each option, the life cycle cost has been assessed (refer to Table 2) using the Auckland Council (2020) life cycle cost report, that provides the life cycle cost as a net present value of the option in 2023 New Zealand dollars. Options 1 and 4 have significantly lower total LLC with significantly lower land purchase costs. However, these results need to be considered in conjunction of the CLM results in Table 1 and other considerations.

Table 2: Project-wide stormwater treatment option LLC in New Zealand dollars for 2023.

Option	Land Purchase	LLC	Total LLC

Option 1: Raingardens & GPT	$0	$10,694,000	$10,694,000
Option 2: Large Raingardens	$7,595,000	$11,803,000	$21,698,000
Option 3: Wetlands	$20,115,000	$16,742,000	$35,309,000
Option 4: GPT & StormFilters	$500,000	$7,025,000	$7,705,000

Analysis of the benefits for each option using the 'More Than Water' WSUD Assessment Tool (Moores et al., 2019) was completed, that provides graphic demonstration of benefits and cost outcomes beyond the familiar considerations of management of hydrological and water quality effects. The tool is a qualitative assessment method that visually represents the benefits based on the level, importance, and reliability. Importance and reliability were held constant, that shows a constant width and colour intensity, respectively, for the different benefits. The level of the benefits was assessed as "None", "Low", "Medium" and "High" shown as the length of the sector from the centre of the chart.

The 'More Than Water' tool benefits for Options 1 to 4 are shown in Figure 4 and generally shows greater benefits for options with more green infrastructure included. Options 2 and 3 are shown in Figure 4 to have the highest benefits followed by Option 1 then Option 4.

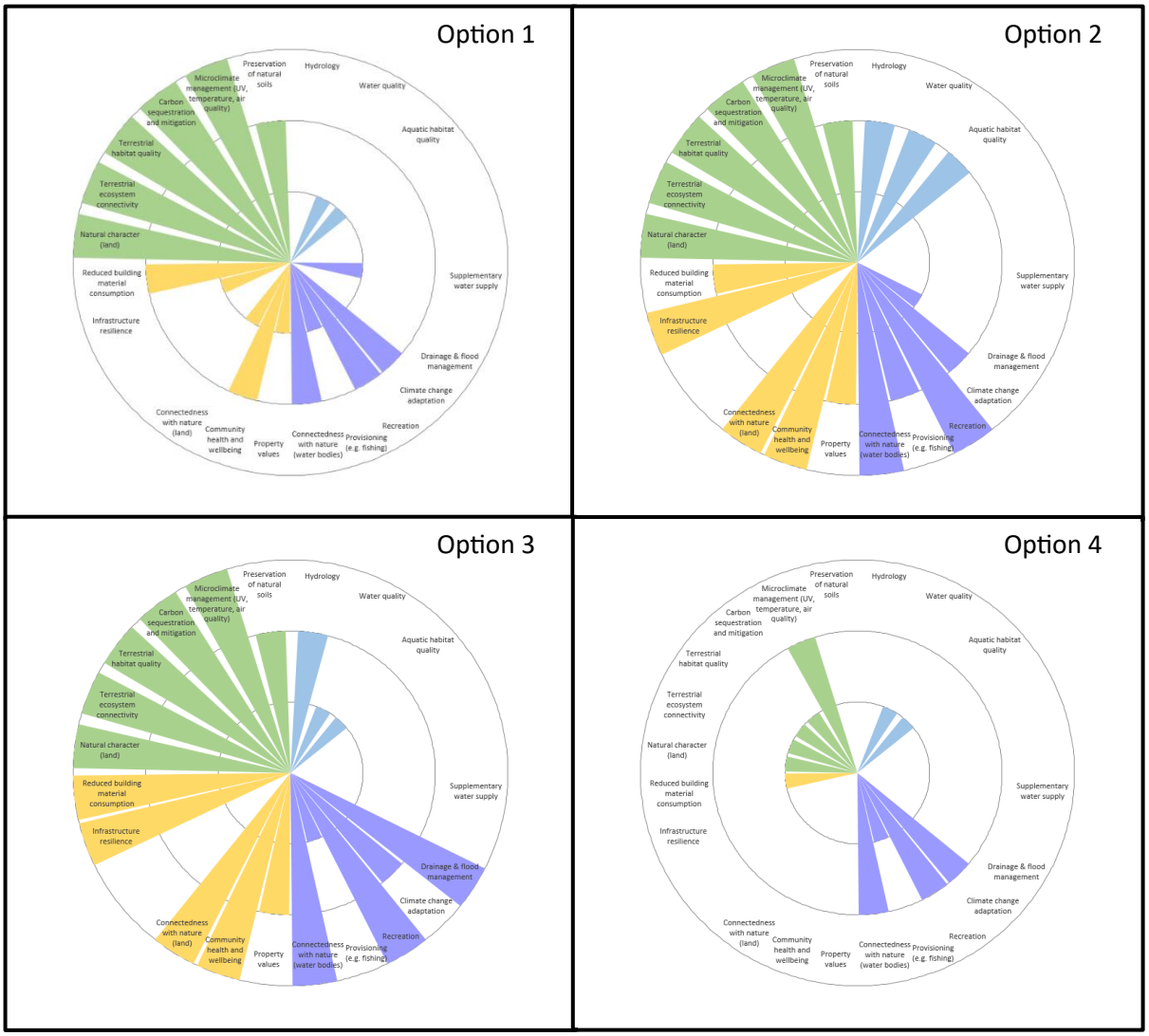

Figure 4: More Than Water Assessment Tool Results for each option.

Outcomes of the option assessment is summarised in Table 3 each assessment: cost, the whole of life, more than water, water quality outcomes, sustainability, and add-in effects of constraints on options.

Table 3: Summary of the evaluation of options.

Aspect evaluated	**Outcome of evaluation**	**Justification**
mana whenua	Option 1	Options 2 and 3 have been discounted due to the large cost, therefore burden on rate payers. Option 4 is not an option mana whenua support which is consistent with Auckland Transports view.
Project Objectives	Option 1 then 4	Options 2 and 3 require the acquisition of large areas of residual residential land which is contrary to Objective 2 of the project (support a quality, compact urban form) which promotes higher-density urban development.
NDC	Option 1	Whilst Option 1 is in the lower level of mitigation category and therefore requires a BPO selection and a SMP, it delivers the largest reduction in contaminant loads discharged to the environment and therefore is the most consistent with the objectives of the NDC.
Sustainability	Options 1	Option 1 has the best water quality outcomes. Options 1 and 4 have more concrete usage. Options 2 and 3 have lower contaminant reductions, lower concrete usage and higher rip rap, geotextile, and liner usage.
Water Quality	Options 1	Option 1 has the highest reductions (24 to 34%) while the other options are in the 2% to 23% range).
Whole of Life Outcomes	Option 4 then Option 1	Options 1 and 4 have a significantly lower LCC compared to Options 2 and 3. Option 1 treats a larger catchment area and achieves better contaminant reductions so the LCC for Options 4 and 1 are considered similar.
Constraints	Option 1 then Option 4	Option 1 and 4 have less constraints and more flexibility. Option 1 (one device per

		outfall) is slightly better than Option 4 (two devices per outfall).
More than Water	Options 2 and 3	Options 2 and 3 have the most natural values with Option 1 having slightly less natural value. Option 4 is the lowest value option.
Safety in Design	Options 2 and 3	Options 2 and 3 are entirely out of the road corridor. Option 1 has GPT out of the road corridor, however, raingardens are within medians and berms. Option 4 has GPT and Filtration devices out of road corridor but includes confined spaces entry for maintenance.

Based on the evaluation of options the selected BPO is Option 1 (Green infrastructure where feasible and GPT elsewhere).

7 PROJECT OUTCOMES

7.1 BEST FOR AUCKLAND

As a guiding design principle while incorporating Healthy Waters Betterment, upgrading existing networks was evaluated against alternatives such as combining the existing stormwater network with the proposed Eastern Busway Network. In addition, the combined pipe size was further increased to ensure the networks pipe capacity met the Stormwater Code of Practice and required flooding outcomes. The outcome of which is reduced costs, less underground assets competition for space and often better overall solutions for stormwater and other utilities such as watermain. It is also noted that some or all the overland flow has been captured and piped to offset reductions in overland flow path capacity as a result of changes to ground levels within the road corridor to accommodate the busway. This has resulted in less overland flow crossing the road corridor and a more resilient transport route.

Eastern Busway Alliance design and Healthy Water representatives meet weekly to discuss design process, options for incorporating Healthy Waters Betterment aspirations and whole of life outcomes. The process eliminating parallel running stormwater pipes and achieved best for Auckland outcomes including treating entire outfall catchments that have Eastern Busway network connection. In addition, location and maintenance access to catchpits, manholes, GPT and green infrastructure discussed to achieve best whole of life outcomes.

7.2 WATER QUALITY

Following completion of the BPO development, selection process and completion of EB2 and EB3R detailed design stages the CLM for the selected BPO has been updated for the SMP submissions. The updated CLM results for EB2, EB3R and an updated interim project-wide estimate (i.e. EB2 and EB3R at final design and EB3C and EB4 at Reference Design stage) are summarised in Table 4 that are similar to the original BPO selection assessment (refer to Table 1). The results show the projects reduces existing contaminant loads discharges to outfalls rather than a no more than minor increase.

Although the results in Table 4 are only for the contributions from roads to the project outfalls, as a result of Betterment being incorporating into the final design for EB2 and EB3R the entire catchments of the projects outfalls are now treated by GPT (i.e. residential, commercial and industrial areas within outfall catchments).

Table 4: Updated Percent change in annual contaminant load predictions for treatment following final design of EB2 and EB3R.

Zone	TSS	Total Zinc	Total Copper	TPH
Final EB2	-41%	-24%	-30%	-31%
Final EB3R	-48%	-28%	-34%	-39%
Interim Project-Wide	-34%	-21%	-25%	-25%

7.3 FLOODING

Existing stormwater networks within the Eastern Busway corridor were designed under the former Manukau City Council standards and currently have a capacity approximately equal to a 50% AEP event with climate change, leading to significant overland flows and flooding surrounding the project corridor for the 10% and 1% AEP events.

As a result of the existing stormwater networks limited capacity, very little of the 10% AEP event is intercepted and captured by the existing networks. This is demonstrated in Figure 5 for EB2 and Figure 6 EB3R, where the 10% and 1% AEP events have similar flood extents. The existing flood extents are extensive for the 10% and 1% AEP events, with overland flow crossing Ti Rākau Drive where the busway is proposed (on the lanes adjacent Pakūranga Plaza until the Reeves Road intersection then centre running until Gossamer Drive intersection where is moves to the northern lanes adjacent Riverhills Park).

The extensive existing flood extents were problematic for the Eastern Busway project in terms of reducing reliability and resilience of the busway and general traffic including emergency vehicle access. In addition, the existing flood extents represented a significant risk that the road geometric design changes to existing ground levels associated with accommodating the additional lanes for the busway is likely to impact overland flow path capacity and private property. The existing flood extents further increase when assessing overland flow path capacity and pipe blockage factors are added to the flood model in accordance with the Stormwater Code of Practice (Auckland Council 2022).

The final design with Betterment incorporated, has achieved significant reductions in flood extents as shown in Figure 7 for EB2 and Figure 8 for EB3R by combining the two networks and increasing their combined capacity. The design of Betterment was assessed in the Flood Model to ensure the combined networks achieved compliance with the Stormwater Code of Practice and required flooding outcomes. There are no locations where flooding is predicted on the Busway in a 10% AEP event and the only overland flow crossing the busway during 1% AEP event is at the Gossamer Drive intersection. However, as shown in Figure 9 for the 1% AEP event, the overland flow crossing the busway at the Gossamer Drive intersection is shallow (i.e. in the range of 10 mm to 50 mm).

The final design, including Betterment, results in flood depth reductions in the 10% AEP event for EB2 and EB3R as shown in Figure 10 and Figure 11 respectively. In EB2 (refer to Figure 10) the Pakūranga Plaza and surrounding commercial land have reduced depths of up to 100 mm. For Ti Rākau drive and surrounding roads in EB2 and EB3R have reduced depths (Figure 10 and Figure 11) at low points of 100 mm to 500 mm with some small areas greater than 500 mm reduced depths. For the 1% AEP event for EB2 and EB3R as shown in Figure 12 and Figure 13 respectively. In EB2 Pakūranga Plaza significant parts of the site has reduced depths between 30 mm and 500 mm. Ti Rākau Drive and surrounding roads in EB2 and EB3R have significantly reduced depths at low points of 100 mm to 500 mm with significant areas with greater than 500 mm reduced depths.

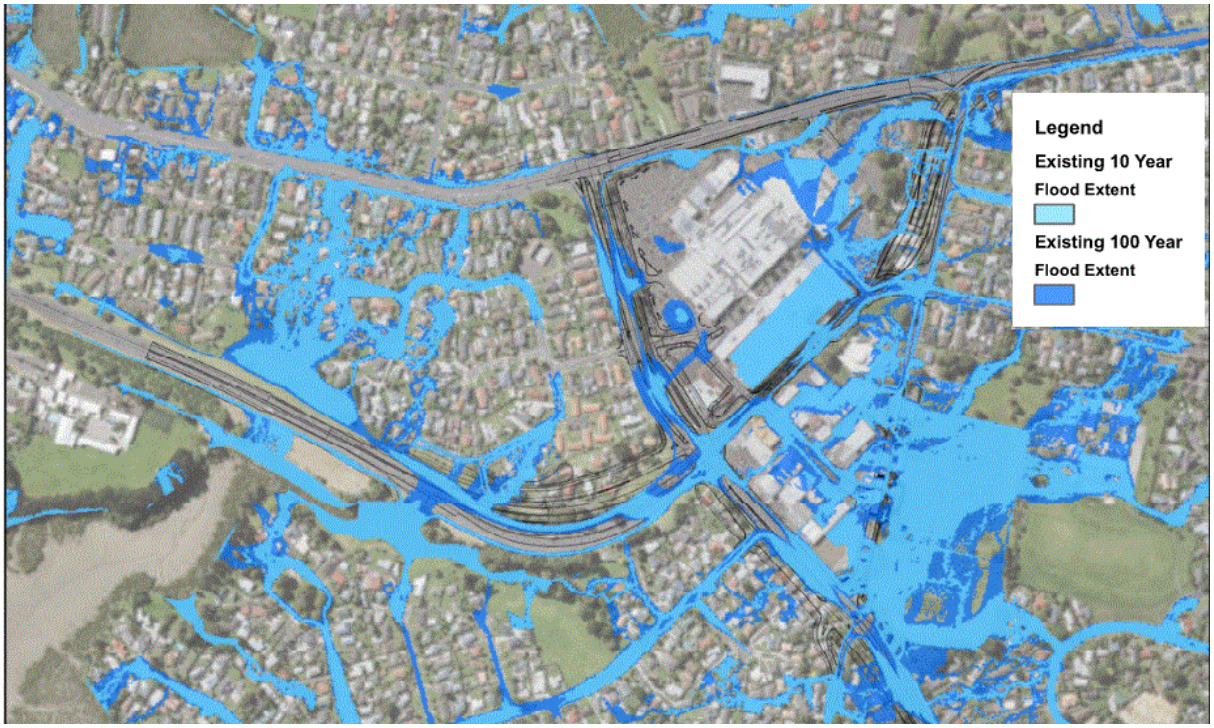

Figure 5: EB2 base case 10% and 1% AEP flood extents.

Figure 6: EB3R base case 10% and 1% AEP flood extents.

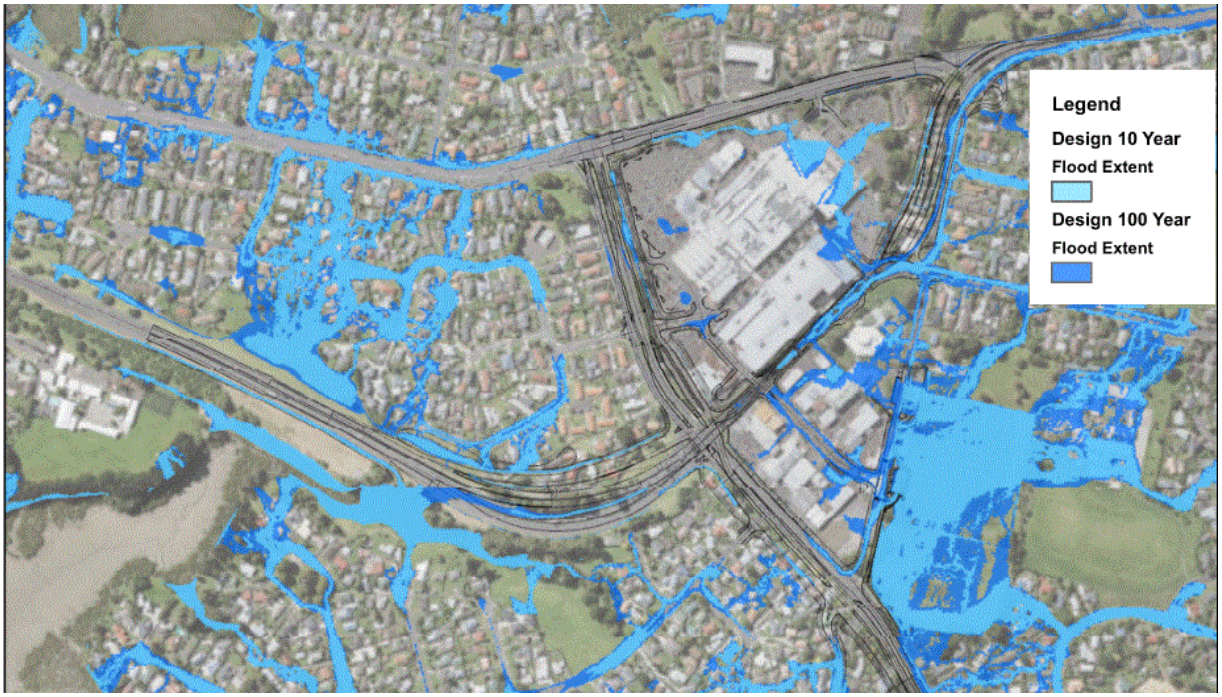

Figure 7: EB2 design case 10% and 1% AEP flood extents.

Figure 8: EB3R design case 10% and 1% AEP flood extents.

Figure 9: EB3R Design Case 100-year event flood depths.

Figure 10: EB2 design case 10% AEP event depth difference.

Figure 11: EB3R design case 10% AEP event depth difference.

Figure 12: EB2 design case 1% AEP event depth difference.

Figure 13: EB3R design case 1% AEP event depth difference.

8 CONCLUSIONS/RECOMMENDATIONS

The Eastern Busway stormwater design has been carried out in a collaborative approach with Auckland Transport, Healthy Waters, and mana whenua. The result of this collaborative approach has achieved:

- Fully integrated Healthy Waters Betterment aspirations with the projects stormwater networks to achieve best for Auckland outcomes and avoids more expensive upgrade costs after the project and associated major disruption to general traffic and the busway.
- A design developed under a maintenance-led approach, prioritising reduced maintenance solutions, safe access and reduced (or eliminated) traffic management requirements.
- Stormwater treatment of the entire, previously untreated, catchment of each outfall that the project discharges stormwater into. The project is predicted to achieve overall reductions in existing contaminant loads to the environment from all roads within outfall catchments in the order of 40% for TSS and 20-30% for total zinc, copper, and TPH.
- Significant improvements to existing flooding, including conveyance of some overland flow and a more resilient stormwater network design to current Stormwater Code of Practice (Auckland Council 2022).
- Enablement of future stormwater upgrades and improvements for catchments upstream of the project corridor as a result of upgraded downstream networks and outfalls.

ACKNOWLEDGEMENTS

Auckland Transport

Auckland Council Healthy Waters

Mana whenua (Tāmaki Collective)

- Waiohua: Ngāi Tai ki Tāmaki, Ngāti Tamaoho, Te Ākitai Waiohua, Ngāti Te Ata, Te Kawerau ā Maki
- Marutūāhu: Ngāti Maru, Ngāti Whanaunga, Te Patukirikiri, Ngāti Paoa, Ngāti Tamaterā,
- Ngāti Whātua: Ngāti Whātua o Kaipara, Ngāti Whātua Ōrākei; Te Runanga o Ngāti Whātua

REFERENCES

Auckland Council. (2017) Stormwater Management Devices in the Auckland Region, Guideline Document 2017/001

Auckland Council. (2022) The Auckland Code of Practice for Land Development and Subdivision, Chapter 4: Stormwater, Version 3.0

Auckland Regional Council. (2010) Contaminant Load Model User Manual, Technical Report No. 003

Auckland Transport. (2020) Transport Design Manual, Section 2: Detailed Technical Requirements, Engineering Design Code – Road Drainage and Surface Water Control Version 1

Moores, J., Ira, S., Batstone, C., and Simcock, R. (2020) A Total Economic Valuation Approach to Understanding Costs and Benefits of Intervention Scenarios for Auckland Council's Freshwater Management Tool, Part 1: Urban Stormwater Structure Intervention Costs

Moores, J., Ira, S., Batstone, C., and Simcock, R. (2019) The 'More Than Water' WSUD Assessment Tool