

IN THE MATTER OF

the Fast-track Approvals Act 2024 ("FTAA")

AND

IN THE MATTER OF

an application for approvals by **NZ Transport Agency Waka Kotahi** to construct, operate and maintain the State Highway 1 Wellington Improvements project

**STATE HIGHWAY 1 WELLINGTON IMPROVEMENTS PROJECT
TECHNICAL REPORT #15 - STORMWATER REPORT**

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1. INTRODUCTION

1. My name is Tom Bassett, and I am the Stormwater Specialist assessing the State Highway 1 Wellington Improvements Project (Project).
2. I have been assisted in preparing this assessment by colleagues at Tonkin + Taylor (T+T), in particular Sam Reed, a Senior Engineer and the Water Engineering Discipline Manager in Auckland.
3. This stormwater assessment is based on the proposed stormwater concept design developed by Jayesh Dhanjee, Technical Principal and Harrison Stroud, Water Engineer with WSP. The design includes the stormwater collection, conveyance, and water quality treatment infrastructure proposed for the Project. The assessment is supported by stormwater analyses including modelling of contaminant loads in stormwater runoff, and modelling of flooding and flood hazard in the Project area.
4. I have assessed the potential Project stormwater quality impacts using a contaminant load model (CLM) developed under my supervision. This CLM has been used to model pre- and post-Project contaminant loads in stormwater runoff.

Qualifications and experience

5. I am a Principal and Senior Water Resources Consultant employed at T+T with over 40 years' post-graduate experience in water resources engineering and planning.
6. I hold a Master of Engineering (1983) and a Bachelor of Engineering with Honours, Civil (1981) both conferred by University of Auckland, and a Master of Business Administration (2003) conferred by the University of Otago. I am a Chartered Engineer (CEng, 1989) and I am currently a member of Engineering Council (UK), Institution of Civil Engineers (UK), New Zealand Hydrological Society, and Water New Zealand.
7. My experience includes all stages of project assessment and implementation, including:
 - i. Resource assessment and determination of design (flow) parameters
 - ii. Hydrological and hydraulic modelling investigations
 - iii. Concept scheme identification
 - iv. The formal planning process including public meetings, consent hearings and expert evidence in Environment Court proceedings
 - v. All stages of design including peer review
 - vi. Contract administration and construction supervision
8. I have been involved in the following recent projects for NZTA including:
 - vii. Mount Messenger Alliance as stormwater reviewer and design verifier
 - viii. Pekapeka to Ōtaki Expressway as stormwater reviewer and design verifier
 - ix. Waterview SH20 as drainage design lead
9. I have provided evidence and inputs for recent Environment Court and Fast-Track projects including:
 - i. Advisory technical support for Fast-Track panels, when I have provided independent specialist stormwater advice to Expert Consenting Panels in relation to assessment of sundry Fast-Track consent applications, including:
 - Moy Estate, Ōtaki (FTC 2611), Technical Advice - Hydrology and stormwater
 - Auckland Surf Park (FTC 2683), Technical Advice - Hydrology and flood risk

- Plimmerton Farm (FTC 109), Technical Advice - Stormwater management
 - Summerset Villages (Rotorua, FTC 2800), Technical Advice - Stormwater and flooding matters
 - ii. Waihoehoe Precinct Stormwater Management where I was responsible for the preparation of the Stormwater Implementation Management Plan, prepared in accordance with fast-track approved resource consent conditions
 - iii. Matatā Regeneration Project where I led investigations into debris flow, river management and consenting for Matatā and presenting evidence at planning hearings and in the Environment Court
10. I have visited the Project area and walked the Project alignment with the stormwater designers in September 2025 to understand more clearly the terrain and Project constraints.
11. I have maintained regular communication with the WSP design team throughout the development of the stormwater design to understand constraints better and to contribute to the proposed design approach. Where potential water quality impacts have been identified, I have discussed treatment options with the designers.

Code of conduct

12. I confirm that I have read the code of conduct for expert witnesses contained in the Environment Court Practice Note 2023. This assessment has been prepared in compliance with that code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Project description

13. As described in the AEE, the State Highway 1 Wellington Improvements is a Road of National Significance (RoNS) project that aims to enhance over 5 km of SH1 in Wellington City. Key features include duplication of the Terrace and Mount Victoria tunnels, a redesigned Basin Reserve layout, and upgrades along SH1 from east of the Mount Victoria Tunnel to the intersection of Cobham Drive and Evans Bay Parade. The Project seeks to improve SH1 efficiency and reliability, attract traffic from other routes, relieve highway bottlenecks, support local access, and enable public transport growth.
14. The stormwater works for the Project include the installation of new stormwater infrastructure and the upgrade of existing systems in targeted areas. The works are proposed to manage runoff from newly created impervious surfaces, with a focus on providing stormwater treatment to improve water quality where practicable recognising existing constraints along the Project route.

Scope of assessment

15. My assessment addresses the following matters:
- i. The methodology I have used to assess the effects of the Project
 - ii. The existing environment
 - iii. The proposed concept design
 - iv. The benefits of the Project
 - v. The operational effects of the Project
 - vi. Recommended measures to avoid, remedy or mitigate adverse effects

16. This report assesses the magnitude of effects of the operational phase of the Project, including for discharges to the freshwater and marine receiving environments. The modelled changes in water quality and hydrology described in this report have, in part, informed the Ecology Assessment Reports prepared by others.
17. The Resilience Assessment for the Project also separately addresses flooding, in that it considers the resilience of the existing and proposed State Highway to flood hazards. My assessment primarily considers flooding in relation to the effects on the upstream and downstream environments.

Assumptions and exclusions in this assessment

18. This assessment is based on proposed concept stormwater design and associated flood modelling by the design team.
19. The effects of the Project during construction are addressed by the Erosion and Sediment Control Assessment prepared separately by Rob Van der Munckhof.

2. EXECUTIVE SUMMARY

Existing environment

20. The Project has been considered as five distinct areas based on the existing topography and development along the SH1 route across Wellington city, being:
 - i. Terrace Tunnel
 - ii. Te Aro
 - iii. Basin Reserve
 - iv. Mount Victoria Tunnel
 - v. Eastern Connections
21. The Project area catchments are highly urbanised, with significant impervious¹ land use typical of urban areas. There is little undeveloped open space along the Project route, especially west of the Mount Victoria Tunnel. In the Te Aro and Basin Reserve areas, the terrain is relatively flat.
22. Runoff from the Project is generally conveyed by the existing Wellington City Council stormwater networks, or flows overland when the capacity of these is exceeded. The networks discharge to Te Whanganui-a-Tara Wellington Harbour: into Lambton Harbour for the Terrace Tunnel, Te Aro, Basin Reserve and Mount Victoria Tunnel areas; and into Evans Bay for the Eastern Connections area.
23. Within the stormwater network there are various culverted streams/awa in the vicinity of the Project area, including the Kumutoto awa, Waikoukou awa, Waimapihi awa, Moturoa awa, Waitangi awa and Waipapa awa.
24. Stormwater from the existing Project area is largely untreated, except as provided by existing catchpits and devices, and/or trade waste consents for discharges from the existing Terrace, Arras and Mount Victoria tunnels.
25. Stormwater modelling indicates that the existing downstream, piped infrastructure in all areas is constrained in terms of capacity, i.e. it does not have the capacity to convey the 10 % Annual Exceedance Probability (AEP) flows (i.e. the 10-year Average Recurrence Interval, or Return Period, flood event). This is the typical minimum primary stormwater system level of service for Wellington City stormwater assets. These capacity constraints will become more significant with increased rainfall expected from future climate change effects.

Potential benefits of the Project

26. I have assessed that the potential stormwater benefits of the Project include:
 - i. Generally improved water quality of stormwater discharges from the state highway to the Kumutoto, Waimapihi, Waitangi and Waipapa awa from the construction of treatment devices and installation of filter inserts in stormwater catchpits
 - ii. Reduction of some contaminants in discharges to the Waimapihi and Moturoa awa
 - iii. Overall improvement in water quality of runoff discharged to Te Whanganui-a-Tara/Wellington Harbour from the state highway for the 2033 Project compared to the estimated existing (2026) Baseline, with an overall reduction in Total Suspended Solids

¹ Impervious surfaces, as defined by Wellington Water draft Stormwater Management Strategy, are those areas which prevent or impede the infiltration of stormwater into the soil, such as roads, paved areas, compacted soils or rock and buildings as it entered in natural conditions prior to development.

(TSS, -39%), Zinc (-12%), Copper (-23%), and Total Petroleum Hydrocarbons (TPH, -31%)

- iv. Localised flooding improvements, particularly in the Eastern Connections area due to new stormwater infrastructure to increase capacity for stormwater flows

Potential adverse effects without mitigation

27. Mitigation for the potential Project effects on stormwater is incorporated into the Project design, principally runoff treatment to reduce contaminant loads to the receiving environments and increased capacity provided by a new pipeline in the Eastern Connections area. Without those design treatment measures I have assessed that the potential adverse stormwater effects of the Project would be:
 - i. Reduced water quality for all runoff with increased contaminant loads from the state highway into the stormwater systems discharging to Lambton Harbour and Evans Bay. Noting that the state highway is a small proportion of the total catchment area, overall contaminant loads from the state highway to Te Whanganui-a-Tara would increase by 20% to 30% without mitigation
 - ii. Overall, I consider the effects of the Project on water quality without the treatment measures incorporated in the design to be Moderate adverse. However, with the treatment measures incorporated I consider the effects of the Project on stormwater quality will overall be Low positive
 - iii. Flood impacts due to changes in topography and increased imperviousness in some locations along the Project route with increased flood depths principally along the state highway carriageway. As these adverse effects will be offset to some extent by reduced depths on other parts of the highway, and given flooding issues in proximity to the existing highway, I consider these will be Low adverse effects

Proposed measures to avoid, remedy or mitigate adverse effects, including conditions

28. Stormwater treatment is proposed in the design where possible, recognising existing space and level constraints and flat terrain in the Te Aro and Basin Reserve areas. Treatment will be provided by including filter inserts in existing and new catchpits and incorporating bioretention (rain gardens) and proprietary devices in the stormwater system. These devices will improve stormwater discharge quality, even with expected increased traffic volumes.
29. In some areas there may be Moderate adverse effects from increased contaminant loading in stormwater runoff. However, due to improvements to existing and proposed treatment systems by the insertion of filters to existing and new catchpits and the significant treatment proposed from new devices in the Basin Reserve and Eastern Connections areas and for the tunnels I consider that the overall impact on quality of stormwater runoff from the Project area to be a Low positive effect for the quality of stormwater discharged to the receiving marine environments.
30. In the Eastern Connections area, stormwater infrastructure upgrades are proposed in the design to mitigate potential flood impacts of increased flows due to the new impervious areas, which will result in a Moderate to High positive effect in this area.
31. In other areas including the Terrace Tunnel southern portal and Basin areas, the geometric alignment has been designed to reduce potential flooding resulting from changes in ground levels. The Project will result in reduced flood depths in some areas. There will also be some localised increases to flood depth principally along the state highway corridor, though not always associated with increased flood levels. I consider the Project will have an overall Low positive effect on flooding.

32. I consider that the measures included in the design are appropriate to mitigate the effects, and represent the Best Practical Option given the constraints of the existing urban environment through which SH1 is aligned.
33. I recommend that the detailed design of stormwater infrastructure for the Project is completed in accordance with NZTA's P46 Stormwater Specification and the requirements of Wellington Water's Water Sensitive Urban Design Guidelines and Regional Standards for Water Services (noting also other guidance documents discussed in this report).
34. I also recommend that the geometric design of the highway is refined during detailed design (subject to other design considerations), considering pre- and post-development flood hazard to optimise the achievable level of service for the highway during heavy rainfall. This is also relevant to localised flooding issues at the southern Terrace Tunnel portal, in the vicinity of the Basin Reserve and in the Eastern Connections area near Kilbirnie Park.
35. I note that routine and post-event maintenance will be an essential part of the proposed stormwater treatment strategy. I recommend that devices be regularly maintained in accordance with the Wellington Water, Water Sensitive Design Technical Guidance (2019, Appendix A) and with the manufacturers' guidance for proprietary devices. I recommend that a stormwater maintenance plan setting out requirements for operations and maintenance of the systems to ensure ongoing efficiency and effectiveness of water quality treatment be prepared.

3. ASSESSMENT FRAMEWORK

Planning context

36. Under the FTAA, considerations under the Resource Management Act 1991 (**RMA**) are relevant. The RMA regulates activities that may affect the environment, including stormwater discharges. Sections 14 and 15 are the governing sections of the RMA in relation to use of and discharges to water. The RMA is given effect to by national environmental standards, national policy statements, regional policy statements and regional and district plans. Section 107 of the RMA places restrictions on the granting of certain discharge permits.
37. The National Policy Statement for Freshwater Management 2020 (**NPS-FM**) contains an objective and policies relating to water quality, water quantity and monitoring, among other matters.
38. The NPS-FM is given effect predominantly through the regional provisions of the Natural Resources Plan for the Wellington Region including Proposed Plan Change 1 to that document.

NZTA technical publications or guidance documents

39. The following NZTA documents have been used to inform the stormwater assessment.
 - iv. P46 Stormwater management and minor stream diversion design specification (2025), specifically:
 - Section 6.3 Treatment – The requirements for treating road runoff are typically governed by local or regional requirements, often implemented as resource consent conditions. Where treatment is required, P46 provides additional requirements for NZTA projects, requiring design in accordance with the NZTA Stormwater Treatment Standard for State Highway Infrastructure unless a regional standard prescribes a higher standard, in which case the regional standard applies
 - Section 6.6 Flooding - Requires consideration of regional/catchment scale flood issues and not creating unacceptable adverse effects on upstream and downstream properties up to the 1 % AEP event. It also requires consideration of hydraulic hazard to pedestrians and vehicles using Australian Rainfall and Runoff, Book 6 – Flood Hydraulics Figure 6.7.9
 - v. Stormwater Treatment Standard for State Highway Infrastructure (2010)
 - vi. Various NZTA standard specifications for materials and workmanship for the design and construction of pipe culverts and subsoil drainage (i.e. NZTA F/2 to F/7)

Industry best practice or management guidance

40. I have considered the following industry best practice or management guidance documents relevant to this assessment:
 - vii. Water Sensitive Design for Stormwater: Treatment Device Design Guidelines (Wellington Water, 2019). This document provides technical guidance for design of bioretention devices (i.e. rain gardens) in the Wellington region
 - viii. Reference Guide for Design Storm Hydrology (Wellington Water, 2019a). This document provides a guide for estimate flood hydrology for small ungauged urban catchments in the region managed by Wellington Water Limited
 - ix. Regional Standard for Water Services (Version 3.0, Wellington Water, December 2021) and the Regional Specification for Water Services (Wellington Water, 2024) provide the minimum standards for stormwater infrastructure design and construction that will be vested in Wellington City Council. This includes performance criteria, design methods, and specifications for proposed developments and upgrades

- x. Austroads Guide to Road Design Part 5: Drainage - General and Hydrology Considerations (Edition 4, January 2023) and Part 5A: Drainage - Road Surface, Networks, Basins and Subsurface (Edition 2.1, January 2023) provides guidance on urban stormwater management principles and water sensitive urban/road design

Relevant consents

- 41. The following stormwater discharge consents are relevant to this stormwater assessment.
 - i. NZTA global stormwater discharge consent – this consent is for state highways in the Wellington Region authorising discharge of stormwater from routine operational use of the state highway network
 - ii. Wellington Water global stormwater consent specifically excludes discharges from the state highway network

4. ASSESSMENT METHODOLOGY

Introduction

42. This section describes the methodology used to assess the potential effects of the Project on the environment including a summary of the methodologies, models and assessment tools used to support the assessment.
43. The assessment matters for operational stormwater water are summarised as:
- i. Water sensitive design
 - ii. Best Practicable Option approach
 - iii. Effects on water quality
 - iv. Effects from flooding
44. The assessment of the Project effects on stormwater has been prepared based on the following Project areas, and identifying intermediary and ultimate receiving environments (i.e. streams/culverted awa in the Wellington City stormwater system and harbour outfalls):
- i. Terrace Tunnel
 - ii. Te Aro
 - iii. Basin Reserve
 - iv. Mount Victoria Tunnel
 - v. Eastern Connections

Approach to assessing effects

45. The key potential stormwater effects of the operational Project relate to contaminants contained in stormwater discharges, and the volume of discharges and associated flood impacts. The impacts to stormwater water quality and to flooding have been categorised in accordance with Table 1.

Table 1 – Effects assessment terminology

Effect	Description
Very high	Total loss of, or very major alteration to, the existing baseline conditions, such that the environment post-development will be fundamentally changed. Long-term impacts that may be irreversible.
High	Major loss or major alteration to the existing baseline conditions such that the post-development environment will be fundamentally changed compared to the pre-development environment.
Moderate	Material change from existing baseline conditions in the short, medium or long term.
Low	Minor change from existing baseline conditions. Temporary or short-term impacts or long-term change will be noticeable, but environment will be overall similar to pre-development conditions.
Negligible	Very slight change from the existing baseline conditions. Change not (or barely) discernible.

Water sensitive design

46. Wellington Water defines Water Sensitive Design (WSD) as “*a best practice approach for the management of stormwater to reduce run-off volume and contamination*”. It is a management approach in urban environments that addresses both water quantity and quality issues. It seeks to integrate natural water systems with built form and landscapes, minimising

impervious surfaces and utilising vegetation and natural elements to capture and remove contaminants.

47. The proposed design seeks to incorporate a WSD approach. However, recognising the existing urban environment constraints including available space, existing services constraints, and safety and ease of maintenance, a Best Practicable Option (**BPO**) approach is required.

Best Practicable Option approach

48. The BPO (as defined in section 2 of the RMA) criteria relate to the “*best method for preventing or minimising the adverse effects on the environment*” regarding:
 - i. *The nature of the discharge ...and sensitivity of the receiving environment to adverse effects*
 - ii. *The financial implications, and the effects on the environment of that option, compared with other options*
 - iii. *The current state of technical knowledge and likelihood that the option can be successfully applied*
49. For a state highway upgrade/redevelopment, I consider that the following hierarchy would be appropriate for a BPO approach for treatment (considering individual devices) with a WSD approach prioritised where possible:
 - i. Wetlands
 - ii. Bioretention devices (i.e. rain gardens)
 - iii. Proprietary treatment devices where site constraints preclude the use of wetlands and bioretention
 - iv. Catchpits with filter inserts where infrastructure constraints mean a positive/gravity drainage system cannot be achieved with other devices
 - v. Catchpits only, without filter inserts
50. The hierarchy above is ranked by descending treatment efficiency, with bioretention measures preferred as a low impact design measure where space enables.
51. Stormwater wetlands are typically used as part of the BPO for new state highways in greenfield areas, as the preferred device for NZTA for stormwater management given they provide high Whole of Life value and consistent treatment and attenuation. However, given the urban environment and space constraints of this Project I do not consider wetlands to be a feasible option for stormwater treatment along the Project route.
52. In the context of this Project, I consider that most suitable forms of treatment for the Project runoff, given the space and level constraints of the existing urban environment along the route, are the following hierarchy:
 - i. Bioretention treatment devices, and catchpits with filter inserts
 - ii. Proprietary treatment devices, and catchpits with filter inserts
 - iii. Catchpits with filter inserts only

Effects on water quality

53. The expected increased traffic along the Project route will result in reduced water quality of runoff due to sediment from the road carriageway as well as heavy metals such as Copper and Zinc, fuels and oils from vehicles. The CLM has been developed to simulate contaminant load generated from the state highway for present day and future Project scenarios. The

spreadsheet-based model uses as input data daily traffic volumes modelled for the Project, typical contaminant load yield data, and road areas based on component lengths along the route. The following water quality parameters have been modelled:

- i. Total suspended solids (TSS)
 - ii. Total zinc
 - iii. Total copper
 - iv. Total petroleum hydrocarbons (TPH)
54. Comparison of modelled annual average contaminant loads for different design and traffic scenarios enables the changes in loads to be determined, and potential effects on receiving environments to be identified.
55. The CLM calculates the contaminant loads using the following formula:

$$\text{Source load} = \text{source area} \times \text{source yield} \times \text{load reduction factor} \times \text{area fraction managed}$$

The source yield is the estimated quantity of contaminants generated by an area of 1 m² over one year, as in following table reproduced from Development of Contaminant Model report (Auckland Regional Council (ARC) Technical Report (TR) 4, Timperley et al, 2010).

Table 2 – Stormwater contaminant yields from roads

Traffic category (vehicles per day)	Yield (g/m ² /year)			
	TSS	Zinc	Copper	TPH
Fewer than 1,000	21	0.0044	0.0015	0.0335
1,000 to 5,000	28	0.0266	0.0089	0.2013
5,000 to 20,000	53	0.1108	0.0369	0.8387
20,000 to 50,000	96	0.2574	0.0858	1.9474
50,000 to 100,000	158	0.4711	0.1570	3.5645
More than 100,000	234	0.7294	0.2431	5.5192

56. Traffic loadings for the assessment are based on daily vehicle values from the traffic modelling outputs for the following scenarios:
- i. Present day scenario (i.e. 2026), represented by the average of the traffic modelling results for the 2018 and Do Minimum year 2033 (DM33) traffic scenarios
 - ii. DM33 scenario, modelled future traffic volumes in 2033 without the Project
 - iii. Option year 2033 (Opt33) scenario, modelled future traffic volumes in 2033 with the Project
57. The CLM uses five-day traffic averages modelled for the Project.
58. Along the Project route, most of the existing and post-Project traffic volumes are in the range of 20,000 to 50,000 vehicles per day. Due to the coarseness of the yield categories above, I have developed a trend relationship for contaminant yield values for the Project assessment. I consider this is appropriate for effects assessment as we would expect a gradual change in contaminant loading rather than either a step change between traffic categories, or no change for increasing traffic within a particular traffic category as tabulated above.
59. The contaminant load generated from a road is a function of the number of vehicles for a particular part of the route, and the corresponding area of the road. To calculate the annual contaminant loads for a particular traffic volume based on the source yield data, the road areas have been calculated using the measured Project road lengths and for consistency with CLM methodology the standard road width corresponding to the model traffic volume rather

than the actual road width. These standard widths are included in ARC TR4 (2010) and shown below in Table 3.

Table 3 – CLM road widths

Traffic volume (vehicles per day)	Road width (m)
Fewer than 1,000	17
1,000 to 5,000	17
5,000 to 20,000	17
20,000 to 50,000	21
50,000 to 100,000	24
More than 100,000	31

60. Load reduction factors (**LRF**) have been applied to model the contaminant removal capacity of the proposed water quality treatment devices. These factors represent the fraction by which a treatment device reduces the contaminant load in the stormwater runoff flowing through. The long-term treatment efficiencies presented in Table 4 are used in the CLM, which are based on ARC TR4 (2010). LRF for bioretention (rain garden) devices are based on NZTA Stormwater Treatment Standard for State Highway Infrastructure 2010 and the expectations set in Plan Change 1 (PC1) to the Wellington Natural Resources Plan (Farrant 2023, Minimum Stormwater Contaminant Treatment Requirement for New Urban Development and Redevelopment – PC1 NRP).

Table 4 – Contaminant load reduction factors

Stormwater treatment device	Load reduction factors			
	TSS	Zinc	Copper	TPH
Bioretention (rain garden)	0.90	0.90	0.90	0.80
Proprietary treatment device	0.75	0.40	0.65	0.75
Catchpits with filter inserts	0.40	0.20	0.25	0.30
Catchpits without filter inserts	0.20	0.11	0.15	0.15

61. Where multiple treatment devices are proposed in series (i.e. as a treatment train), the LRF is adjusted to account for reduced effectiveness of successive devices (i.e. the efficiency of the downstream devices in a treatment train is reduced given the cleaner stormwater discharged by the upstream treatment device(s)). The existing and post-Project scenarios for the CLM include the following treatment devices, either individually or combined in a treatment train:
- Catchpits only
 - Catchpits with and without filter inserts only
 - Catchpits with and without filter inserts, then a proprietary device
 - Catchpits with filter inserts, then a rain garden
62. Results of the CLM are presented in Section 7. The following limitations should be noted:
- The modelled loads should be considered only as relative indicators between the existing and post-Project loads with and without the proposed design measures
 - The CLM models contaminants from SH1 Project areas only, i.e. generally the state highway only. The Project areas are small parts (typically only 0 to 2%) of much larger urban catchment areas. Contaminants in stormwater runoff are generated in other parts of those greater catchments. Therefore, whilst Project changes may show moderate changes, I expect that the overall change on the total contaminant loads transported by stormwater to the harbour outfalls will be relatively small
 - Indicative treatment areas are based on the concept stormwater design and are subject to design development. I have assumed that in detailed design devices will be appropriately sized for the Project catchments they serve in accordance with local guidance (Wellington Water 2019)

- iv. The CLM models average annual loads from a catchment, rather than the concentration of a particular contaminant in the stormwater. The results can be used to inform our understanding of the relative changes in the accumulation of contaminants but cannot be used to compare directly against ecological guideline trigger values
 - v. Model accuracy is influenced by some uncertainty in load reduction factors for different treatment devices and in particular, combinations of devices in a treatment train
 - vi. The method assumes that contaminant load yields from future roads remain the same as from existing, i.e. no changes in the nature of contaminants collected by the roads due to for instance developments in motor vehicle design
63. The water quality assessment for the Project has modelled the direct loadings from the state highway, and not the total loads from the greater catchments draining to Lambton Harbour and Evans Bay. Greater Wellington Regional Council (GWRC) has developed a CLM for the region (PC1 Annual Contaminant Load Modelling, March 2025). I consider whilst updating the GWRC model may not reflect the Project changes due to the coarseness of the yield load categories considering the traffic changes, the total catchment contaminant loading from the model would be useful to give context to the changes from the proposed state highway upgrades.

Effects on flooding

64. To assess the potential flooding effects on the environment, stormwater flows have been modelled to assess pre- and post-Project flood levels and extents for various rainfall events.
65. The Project may result in changes to flood hazard upstream and downstream of the Project due to:
- i. Changes in impervious areas, and thus discharge rates and volumes
 - ii. Changes in ground levels in existing flood plains
 - iii. Proposed stormwater infrastructure upgrades to increase existing capacity
66. The flooding effects associated with the operational phase including the permanent structures have been modelled and assessed for events up to the 1% AEP flood event.
67. Flood modelling has used Wellington Water's InfoWorks ICM (Integrated Catchment Model) stormwater model. The pre- and post-Project flood extents and levels have been assessed for the 10% and 1% AEP events with a Representative Concentration Pathway (RCP) 6.0 climate change scenario² (per NZTA P46 Specification, 2025).
68. Flood depth differences (i.e. post-Project flood depths minus pre-Project flood depths) have been mapped to show the effects of the Project on flooding.

Effects on culverted awa

69. With reference to the Schedule 7 – Sites and Areas of Significance to Māori of the Wellington City Council District Plan and discussions with Mana Whenua representatives, I understand that the following culverted awa are relevant to the Project (as shown on Figure 1 – Culverted awa in the Project area Figure 1):
- i. Kumutoto awa, at the northern portal of the Terrace Tunnel
 - ii. Waikoukou awa, at the southern portal of the Terrace Tunnel

² RCP 6.0 is a climate stabilisation scenario identified by the Inter-governmental Panel on Climate Change. This scenario anticipates increased CO₂ emissions until 2080, and then a decline in emissions. For this scenario GWRC anticipates approximately 0.5° C increase in mean temperature in central Wellington by 2040, and approximately 1° C by 2090.

- iii. Waimapihi and Moturoa awa, in Te Aro area and which flow beneath sections of Karo Drive and Vivian Street into the stormwater systems generally along Cuba Street and Taranaki Street respectively
 - iv. Waitangi awa, which flows under the Basin Reserve and beneath Kent/Cambridge Terraces
 - v. Waipapa awa, flowing generally along the Eastern Connections route between SH1 and Moxham Avenue and beneath Wellington Road
70. I understand from discussions with iwi representatives that protecting and improving the health of Kumutoto awa is of particular importance to Mana Whenua.
71. The water quality and baseflow water level effects on these culverted awa are considered in the Freshwater Ecology specialist assessment prepared by Josh Markham.

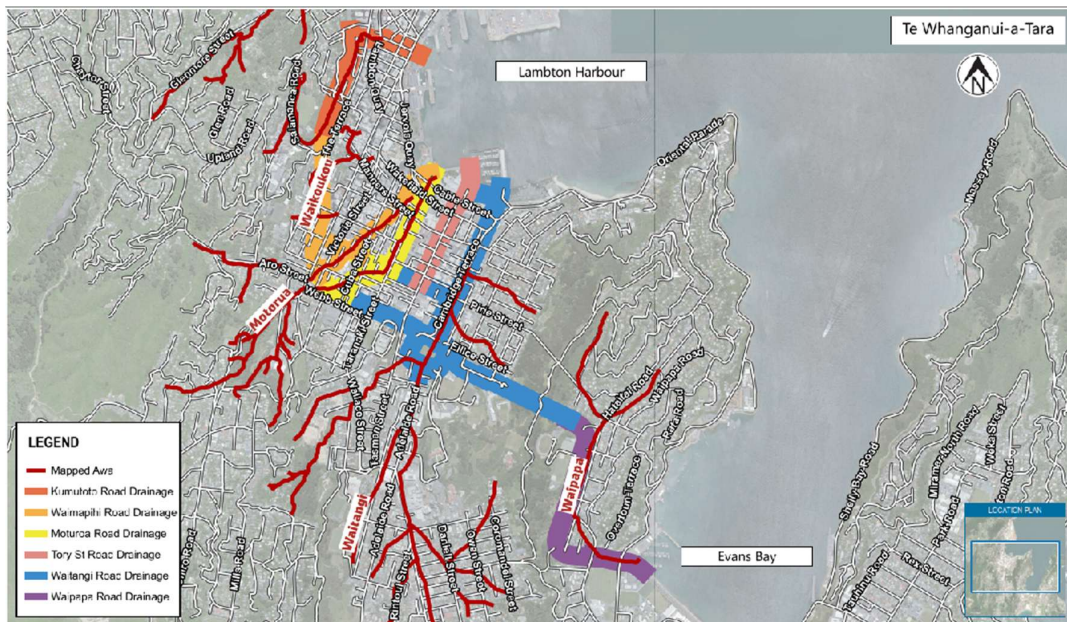


Figure 1 – Culverted awa in the Project area

Effects on coastal receiving environments

72. As noted earlier, stormwater runoff from the Terrace Tunnel, Te Aro, Basin Reserve and Mount Victoria Tunnel areas ultimately discharges via stormwater networks and culverted awa to Lambton Harbour. The Eastern Connections area discharges to Evans Bay.
73. The water quality and flood effects of the Project on the coastal receiving environments are considered in the Marine Ecology specialist assessment prepared by Marcus Cameron.

5. EXISTING ENVIRONMENT

Introduction

74. The existing environment was characterised through a desk-based investigation including a review of online topographical, rainfall, hydrological and flood mapping information as well as site inspections by the Project team.
75. The Project is within a highly urbanised area of Wellington. This presents challenges for stormwater management as the route passes through widespread existing flood hazard areas due to a combination of undersized and aging stormwater infrastructure and topographical constraints (i.e. low points). There is also an extensive stormwater network upstream and downstream of the Project area, at fixed levels and into which the stormwater infrastructure for the Project must connect.
76. I discuss the Project below in relation to the following areas along the Project route shown in Figure 2:
 - i. Terrace Tunnel
 - ii. Te Aro
 - iii. Basin Reserve and Mount Victoria Tunnel
 - iv. Eastern Connections

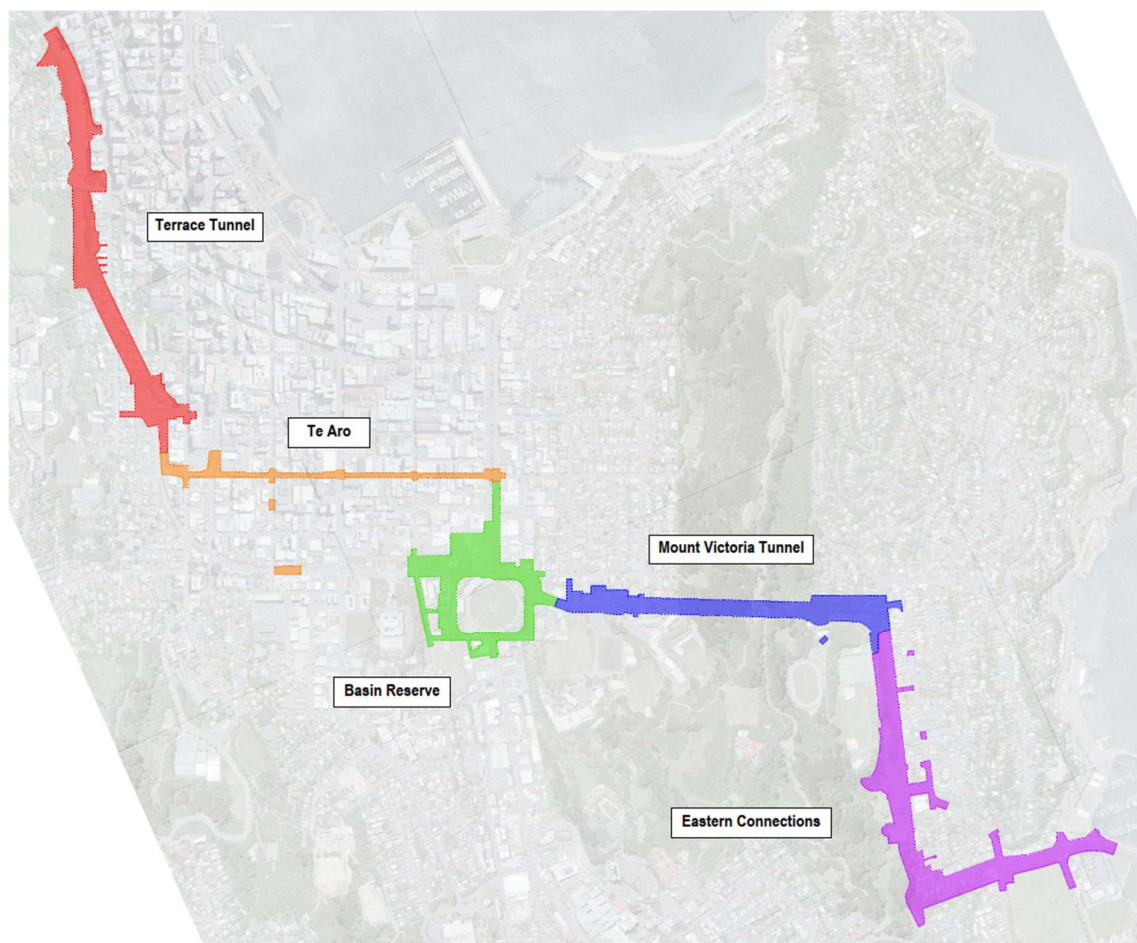


Figure 2 – Project areas

Site description

77. The existing Project area surface is largely impervious, comprising existing roads and paved surfaces (footpaths and parking areas), and buildings. Figure 3 indicates the principal stormwater pipeline routes for stormwater originating from the Project and then shows discharge locations to Te Whanganui-a-Tara. Runoff from The Terrace, Te Aro, Basin Reserve and Mount Victoria areas discharges to Lambton Harbour through the Wellington Water stormwater network including culverted awa. Stormwater runoff from the Eastern Connections area and the culverted Waipapa awa discharges to Evans Bay.

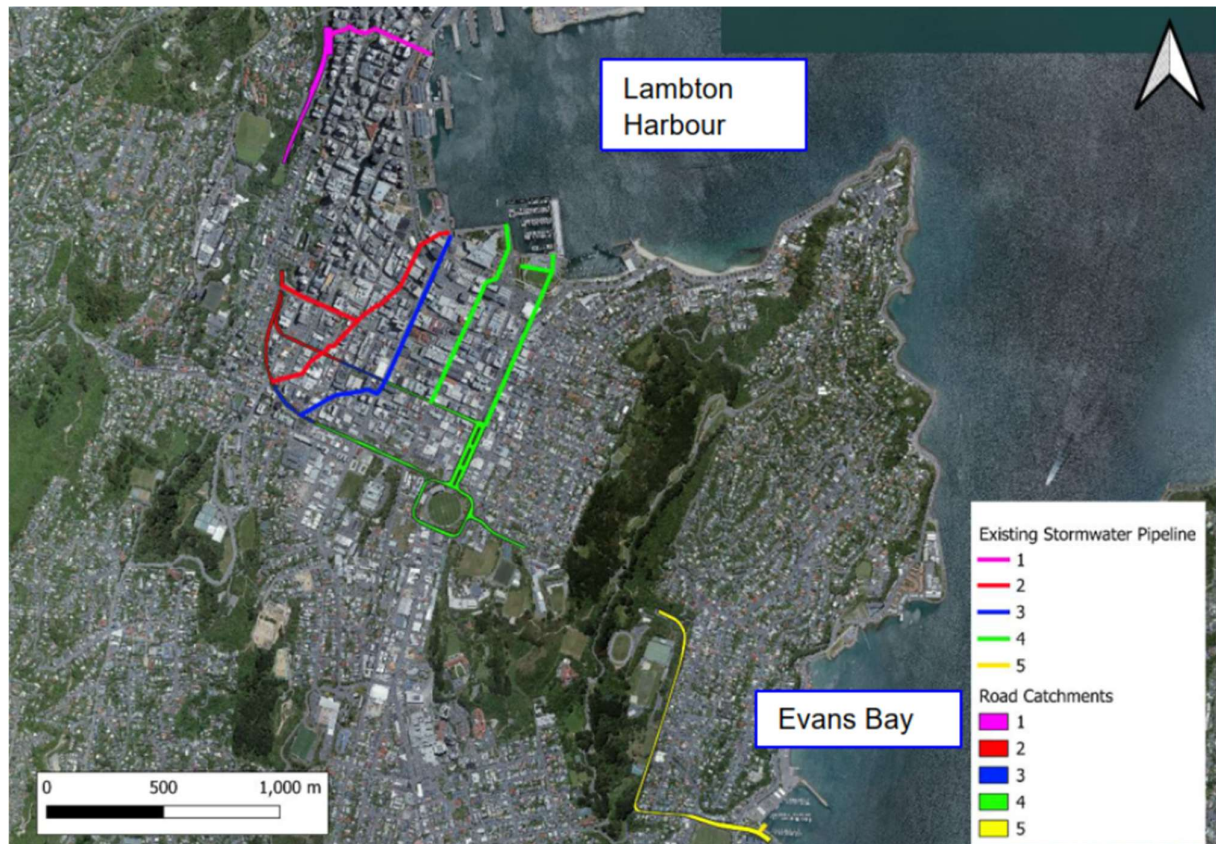


Figure 3 – Principal stormwater pipelines from the SH1 and Te Whanganui-a-Tara discharge locations (WSP, 2025)

78. As noted earlier there are six culverted awa within the Wellington stormwater network in the vicinity of the Project (refer Figure 1). One of those, the Waikoukou, does not receive stormwater from the state highway.
79. There is limited treatment of stormwater runoff from the existing State Highway 1 along the Project route. Stormwater catchpits collecting runoff along the route provide some capacity to remove typical contaminants. I note that washdown flows from the existing Terrace, Arras and Mount Victoria Tunnels are either treated in proprietary devices before discharge to the stormwater network or are discharged to the wastewater system.
80. The existing SH1 route comprises a small part of the overall awa catchment areas draining to each harbour outfall. As presented in Figure 5, the SH1 proportion of the greater catchments is greatest for the Kumutoto awa and Waipapa awa catchments (approximately 2%) compared to the other catchments (less than 1 %). Whilst the existing SH1 road generates significant contaminant loads, I expect that these will represent a small fraction of the larger overall loads from the greater catchments.

Table 5 – Existing SH1 areas as a proportion of the stormwater catchments

Catchment	Catchment area (m ²)	Existing SH1 road area (m ²)	Proportion of catchment
Kumutoto awa	520,000	12,003	2.3%
Waimapihi awa	2,584,000	11,245	0.4%
Moturoa awa	5,830,000	4,840	0.1%
Tory Street stormwater system	155,000	120	0.02%
Waitangi awa	4,603,000	36,264	0.8%
Waipapa awa	1,320,000	22,297	1.7%

Terrace Tunnel

81. The Terrace Tunnel area includes the existing tunnel and its northern and southern tunnel approaches. The Project proposes a new tunnel aligned to the east of the existing tunnel, reconfiguration of existing traffic lanes, additional southbound lanes and connections to the new tunnel.

Northern portal

82. The northern portal area falls to the south where runoff is collected in road catchpits. Stormwater is conveyed to the east via catchpit leads which connect to a 1200 mm diameter stormwater line which flows north parallel to SH1. Whilst modelling has shown that the 1200 mm diameter stormwater line has sufficient capacity at the point of connections, there are capacity issues further downstream in the existing infrastructure network.
83. Kumutoto awa, to which the northern portal area discharges, for the most part is culverted downstream. With reference to Figure 4, it has northern and southern tributaries associated with the stormwater infrastructure in Salamanca Road and Kelburn Parade. These two tributaries flow together at Kelburn Park in a surface watercourse through the Kumutoto Forest in the park. The awa is then culverted, flowing into an 11 m vertical drop chamber and then from the northern tunnel portal in the 1200 mm pipe mentioned above.
84. The stormwater network and existing flooding for the 1% AEP event is shown as Figure 5. There is shallow flooding (less than 0.1 m in depth) which appears to be associated with an overland flow path from Kelburn Park to the west which flows onto SH1.

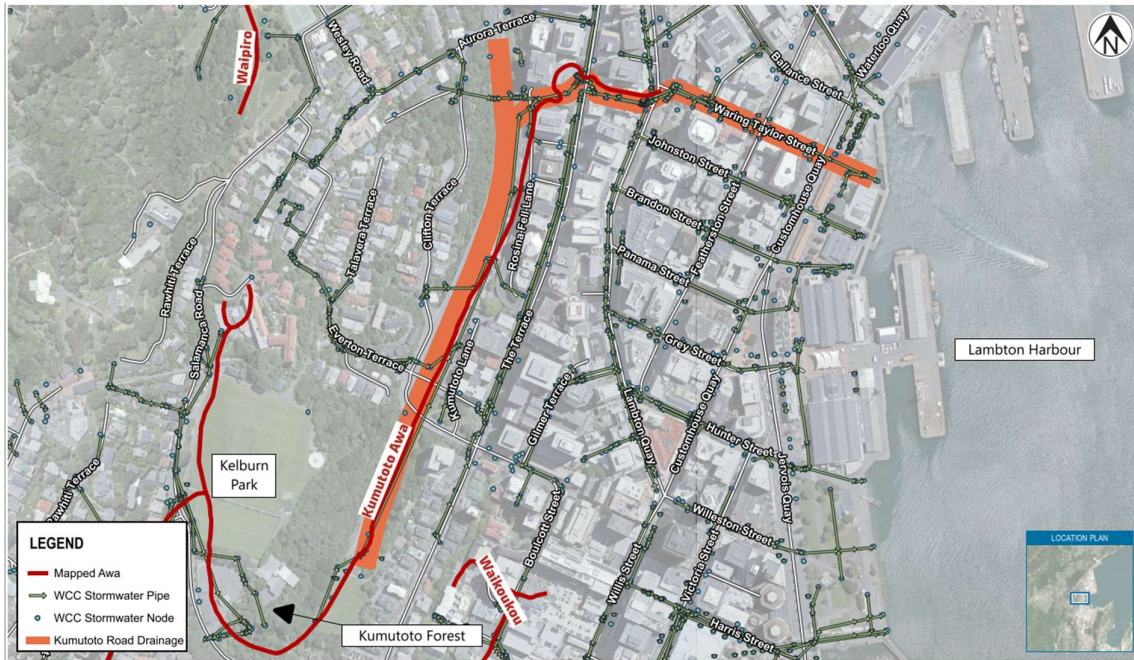


Figure 4 – Kumutoto awa at the Terrace Tunnel northern portal, and stormwater network



Figure 5 – Terrace Tunnel northern portal modelled 1% AEP flood plain

Southern portal

85. The southern portal area drains to a low point in the terrain beneath the Ghuznee Street bridge.
86. Figure 6 shows the Waikoukou awa between Boulcott Street in the north and Ghuznee Street in the south, and the Waimapihi awa flowing generally northeast from Willis Street to Wakefield Street.
87. The northern section of the Waikoukou awa appears to be associated with the stormwater infrastructure in Percival Street and Boulcott Street, and then potentially Willis Street and Mercer Street. The southern section of the Waikoukou does not clearly align with the existing stormwater infrastructure. However, I note that no stormwater system from the existing state highway is connected to the Waikoukou awa nor will stormwater be discharged to this awa as part of the proposed Project design.
88. The stormwater pipe from the southern portal low point connects to stormwater infrastructure associated with the Waimapihi awa at the intersection of Ghuznee and Cuba Streets.

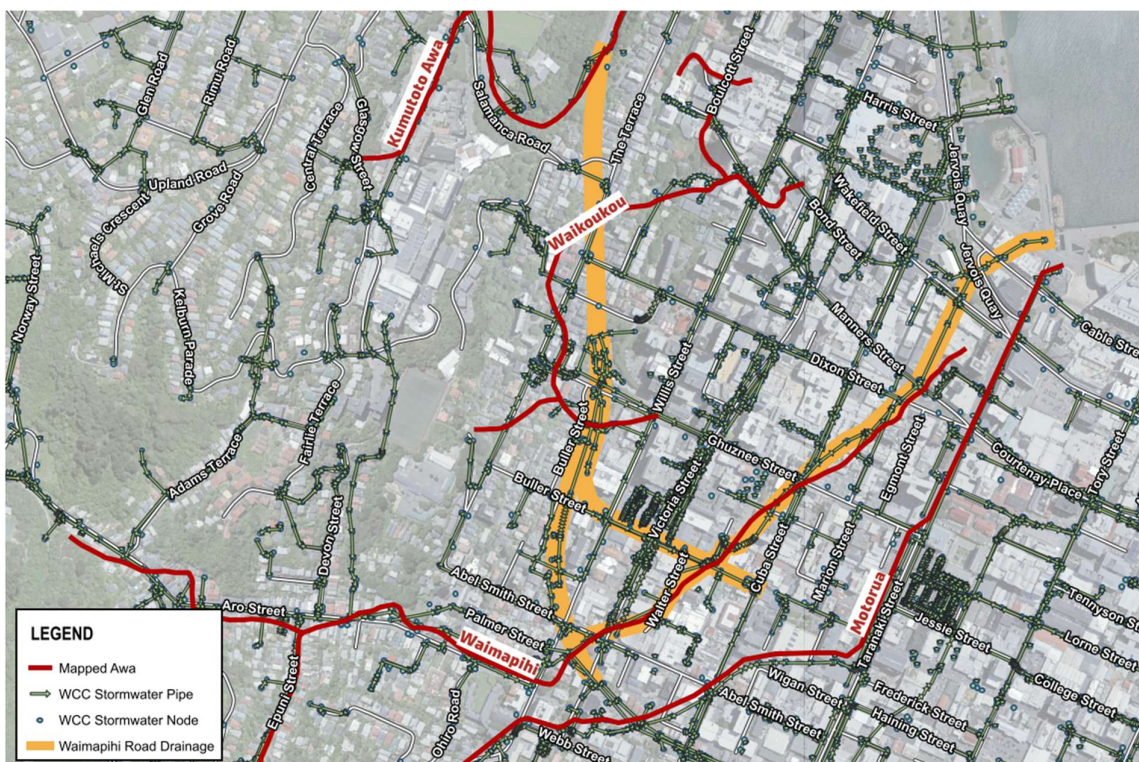


Figure 6 – Terrace Tunnel southern portal and Waikoukou, Waimapihi and Moturoa awa

89. There are existing flooding issues at the SH1 low point below Ghuznee Street, associated with stormwater infrastructure capacity constraints as well as the terrain. Flooding up to approximately 1 m deep in a 1% AEP rainfall event is expected. The existing stormwater infrastructure and modelled flood extents are shown in Figure 7. From the low point, stormwater drains to the east in a 900 mm diameter pipe along Ghuznee Street. Downstream of Victoria Street, the capacity of this pipeline is significantly constrained, with capacity to convey only approximately 57% of the design discharge for 10% AEP rainfall event.
90. I understand that water used during tunnel maintenance, and water tracked into the tunnel by vehicles, drains to an existing proprietary treatment device, before discharging either to the wastewater system or to the Ghuznee Street stormwater network.



Figure 7 – Terrace Tunnel southern portal 1% AEP flood plain (including climate change)

Te Aro

91. The Project works in the Te Aro area are focussed on the northbound and southbound tunnel approaches to Victoria Street, and on Vivian Street where it is proposed to remove parking and reconfigure the carriageway width to create three traffic lanes. As part of my assessment, I have also considered Karo Drive / Arthur Street from Victoria Street to Tory Street, where proposed traffic volumes will increase due to the Project.
92. Runoff from the Te Aro area discharges to three separate stormwater systems and their associated outfalls as shown in Figure 8:
 - i. Waimapihi awa
 - i. Moturoa awa
 - ii. To a lesser extent the Tory Street stormwater network
93. In addition to the southern Terrace Tunnel portal area which connects to the culverted Waimapihi awa, there are sections of Vivian Street (between Willis Street and Cuba Street) and Karo Drive (between Willis Street and Victoria Street) which are also part of the Waimapihi catchment. There are existing flooding issues along the culverted awa alignments due infrastructure capacity constraints in the stormwater network. The existing modelled flood plain is mapped in Figure 9.
94. Parts of Te Aro drain into the Moturoa awa via a 900 mm diameter pipe in Taranaki Street, and a 1200 diameter pipe in Tory Street to Lambton Harbour. Other areas in the east of Te Aro drain into the Waitangi awa stormwater system north and downstream of the Basin Reserve.

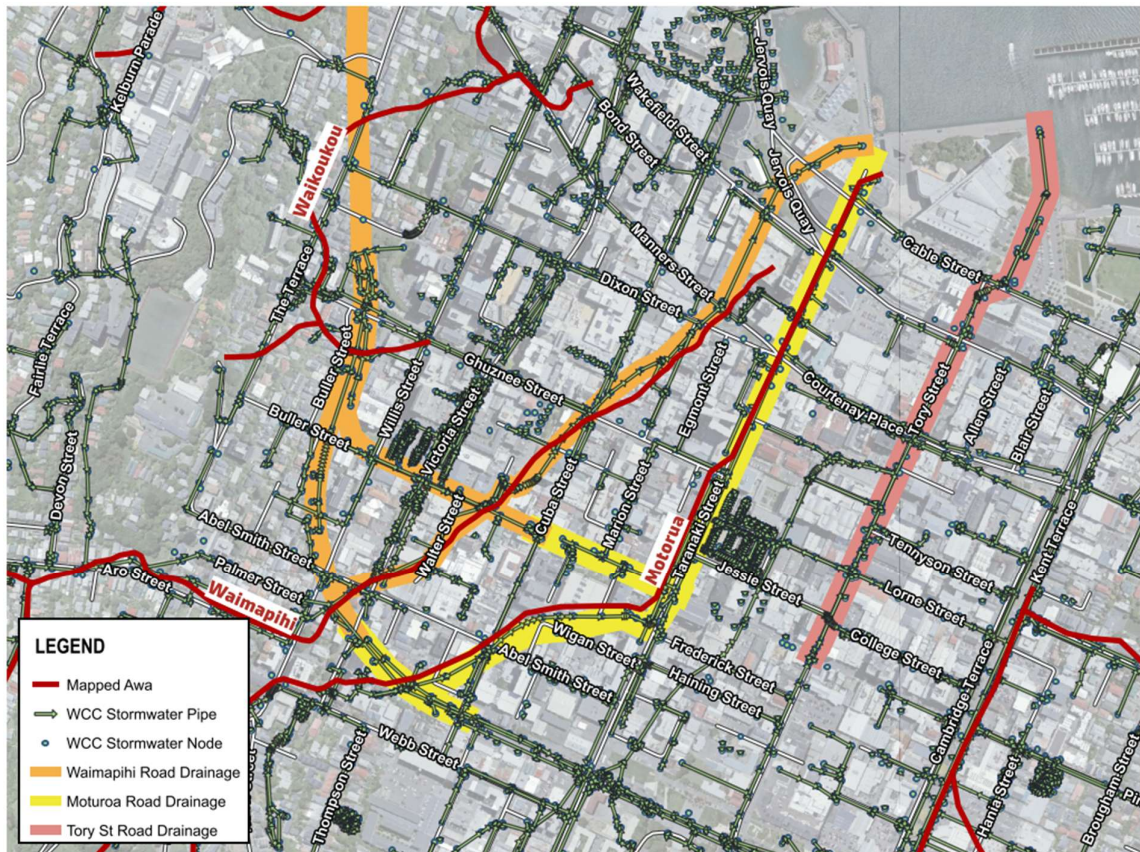


Figure 8 – Te Aro area, Waimapihi and Moturoa awa, and Tory Street stormwater



Figure 9 – Te Aro area 1% AEP floodplain

Basin Reserve and Mount Victoria Tunnel

95. Runoff from the Basin Reserve and Mount Victoria Tunnel areas is drained by two piped systems. The western half of the catchment (including the eastern extent of Te Aro) drains to an 1800 mm diameter pipe below Cambridge Terrace, and the eastern half to a 1200 mm diameter pipe below Kent Terrace, which both discharge to Lambton Harbour at Waitangi Park (refer Figure 11).
96. The Waitangi awa has been highly modified and comprises numerous tributaries from the Newtown and Mount Cook areas which flow together south of the Basin Reserve. The awa is conveyed under the Basin Reserve in three separate pipes, connecting to the stormwater pipes in Cambridge and Kent Terraces.

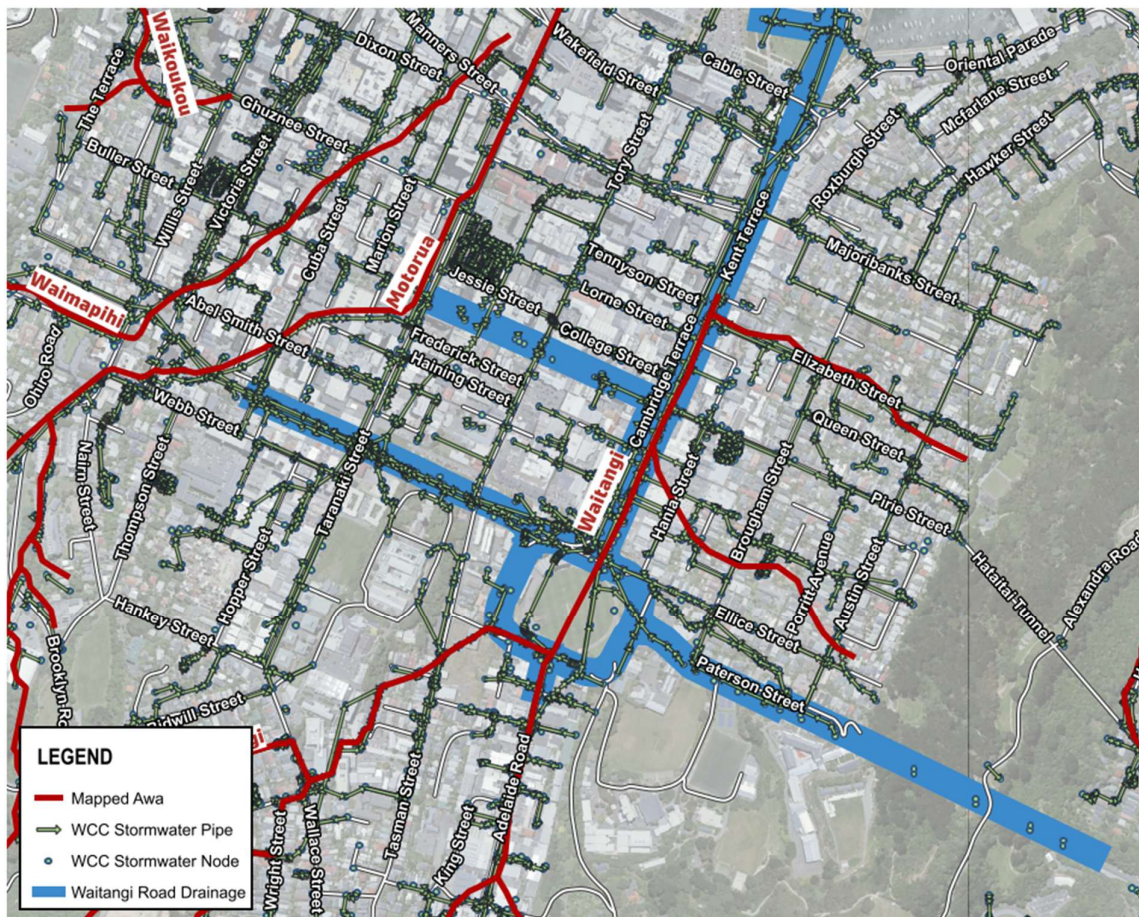


Figure 10 – Basin Reserve area and Waitangi awa

97. The existing stormwater network is already constrained for the 10% AEP rainfall event (without factoring in current climate), with several pipelines under capacity, resulting in widespread flooding within the catchment for both the 10% and 1% AEP events. Figure 11 shows the existing 10% AEP floodplain (factoring in climate change). Modelling results show that the extent of the 1% AEP floodplain is similar, though with greater flood depths.
98. I understand that stormwater runoff from the Mt Victoria tunnel typically drains to the stormwater network. During routine tunnel cleaning, however, flows are diverted to the wastewater network.



Figure 11 – Basin Reserve 10% AEP floodplain (including climate change)

Eastern Connections

99. Stormwater runoff from this area presently drains initially to the south under residential properties to the east of Ruahine Street through a large diameter stormwater pipeline (ranging in size from 600 to 1800 mm) associated with the Waipapa awa, as indicated in Figure 12. This system discharges to the harbour at the Evans Bay Marina.



Figure 12 – Waipapa awa and Eastern Connections stormwater systems

100. As evident in Figure 13, several parts of the network do not have capacity to convey runoff from the 10% AEP rainfall event. The combination of the existing capacity constraints and the topography near the intersection of Goa and Ruahine Street results in significant localised flooding of over 1 m deep at this location.
101. Figure 14 shows the existing 1% AEP flood extents across the Eastern Connections area, which is subject to extensive flooding. This is associated with an overland flow path generally aligned with the Waipapa awa, running south along Moxham Ave, then southeast to the intersection of Ruahine Street, Wellington and Hamilton Roads and Kilbirnie Crescent. It then flows east along Wellington Road and spills into Evans Bay. Flooding extends into Kilbirnie Park, which also receives flow from the greater catchment to the south and southwest.

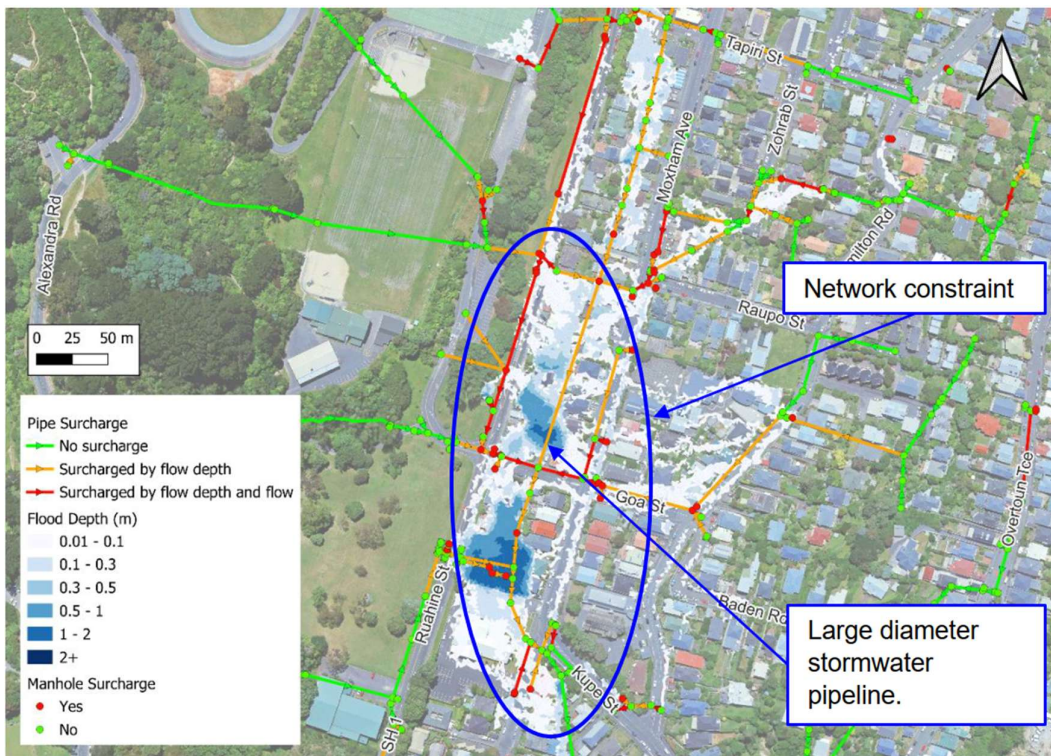


Figure 13 – Eastern Connections 10% AEP flood plain

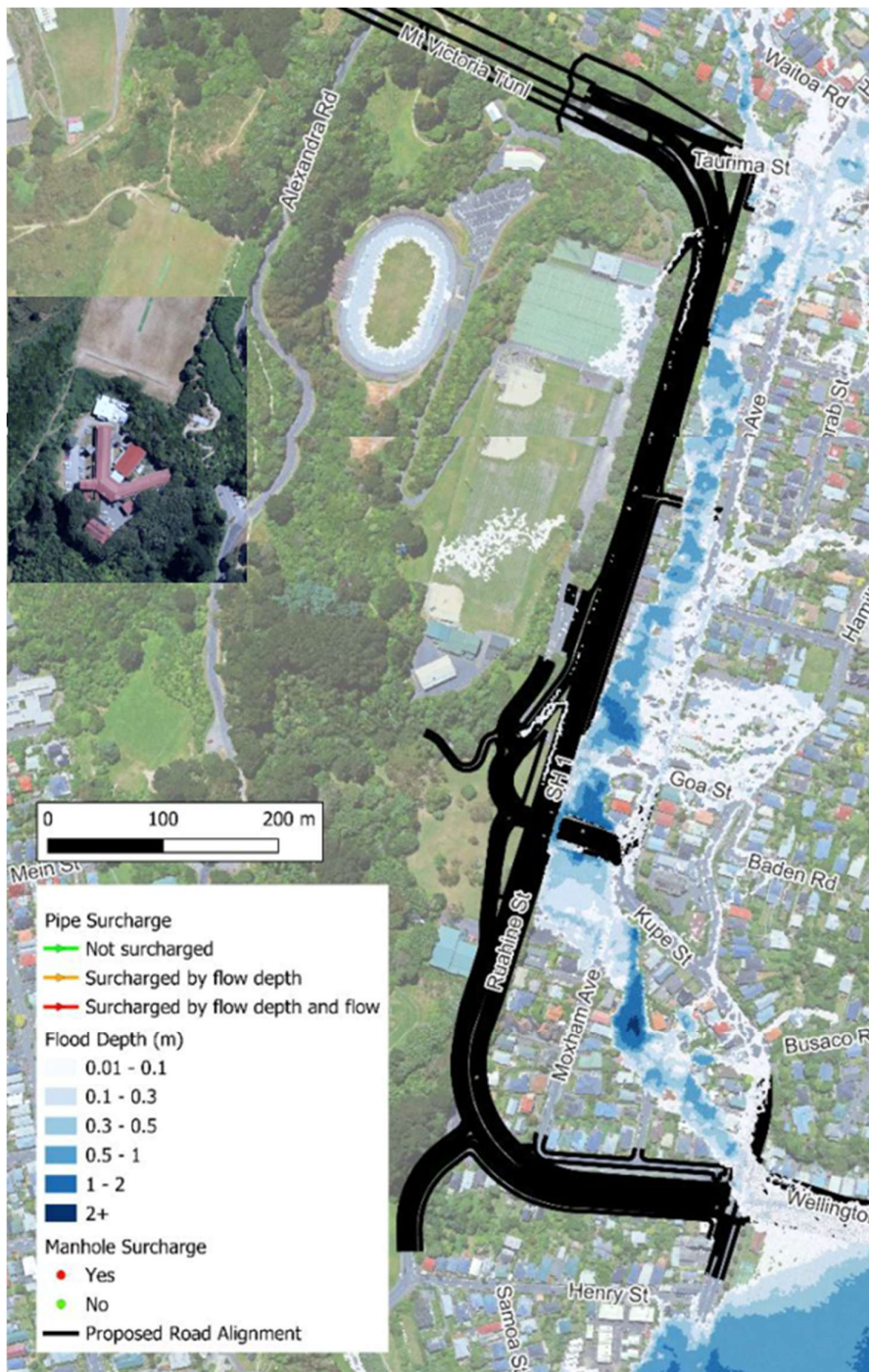


Figure 14 – Eastern Connections 1% AEP flood plain (including climate change)

Future environment (without Project)

102. Without the proposed Project upgrades to the state highway, increased traffic and growing congestion along the main route are likely to worsen environmental impacts, particularly in relation to quality of stormwater runoff discharged downstream. The increased traffic will contribute to higher loads of TSS, Zinc, Copper and TPH. These will be transported to receiving waterways and downstream to the Te Whanganui-a-Tara outfalls, potentially increasing adverse effects to aquatic ecosystems.

103. In terms of flooding, without the Project existing flood plains will be unchanged, except as they are expected to increase with the effects of climate change on rainfall. These are already relatively significant across the city between the Terrace and Mount Victora tunnels, and in the Eastern Connections area. The flood plain extents are defined to some extent by limited capacity in the existing piped stormwater systems, which means a greater proportion of storm flood runoff is conveyed as overland flow.

6. PROPOSED CONCEPT DESIGN

104. This stormwater assessment is based on the proposed stormwater concept design developed by the design team. The design includes the stormwater collection, conveyance, and water quality treatment infrastructure for the Project.
105. The treatment design for the Project includes:
 - i. Catchpit filter inserts to be added to all existing and new catchpits within the Project
 - ii. Bioretention devices (i.e. rain gardens) where space and level constraints allow (in the vicinity of the Basin Reserve)
 - iii. Proprietary devices where space constraints prevent the use of rain gardens, but levels allow
106. Details of the proposed bioretention and proprietary stormwater treatment devices including locations, road catchment areas treated, and indicative sizes are provided in Annexure A of this assessment, together with figures showing the device catchments including the road surface areas treated. Key features of the design are:
 - i. 100% of the state highway runoff draining to catchpits with filter inserts
 - ii. Runoff from 43,800 m² of state highway treated in rain gardens or proprietary devices before discharge to the awa and Wellington Water stormwater infrastructure
 - iii. Additionally, runoff from 28,850 m² of local urban road surfaces treated in rain gardens or proprietary devices
107. In relation to flooding, the design includes:
 - i. Coordination with the geometrics designers to minimise flood effects
 - ii. Storage tanks at the Tunnel Terrace northern and southern portals
 - iii. In the Eastern Connections area, a new 1500 mm stormwater line along the state highway alignment discharging to the existing outfall at Evans Bay and a flood conveyance opening under the ramp to the Ruahine Street overpass
108. The Consent Design Drawings included with the application show the outline details of the proposed new stormwater infrastructure, including pipes, storage tanks and treatment devices along the Project route.

7. BENEFITS OF THE PROJECT (POSITIVE EFFECTS)

109. Although traffic and therefore contaminant loads from the Project will increase, the Project will improve the water quality of stormwater discharges by improving catchpits' treatment capacity and providing water quality treatment devices described and assessed in Section 8.
110. All catchpits along the Project route (i.e. existing and new) will have filter inserts installed. These inserts increase the treatment efficiency of catchpits for removal of TSS, Zinc, Copper and TPH by between 67 % and 100 %, with overall load reduction of these contaminants in the stormwater runoff between 30 % and 40 % (refer Table 4). All runoff from the SH carriageways will be treated in catchpits with filter inserts.
111. Additionally, runoff from nearly half (46 %) the SH carriageway will be additionally treated in rain gardens or proprietary devices before discharge to the Kumutoto Waimapihi, Waitangi and Waipapa awa.
112. Furthermore, runoff from 28,850 m² of local roads (i.e. not part of the State Highway) will be treated in catchpits with filter inserts, and then also in rain gardens or proprietary devices before discharge to the awa.
113. With the proposed treatment design in place, an overall improvement in the total contaminant loads to the Te Whanganui-a-Tara marine environments is expected post-Project in 2033 compared to the present-day existing SH1 scenario. This is based on modelling which shows 39% reduction in TSS, 12% reduction in Total Zinc, 23% reduction in Total Copper, 31% reduction in TPH loads to Te Whanganui-a-Tara.
114. These positive effects, in the context of the wider catchment drainage systems, are locally but not regionally significant.
115. In the Eastern Connections area, significant flood hazard improvements are anticipated due to the upgrading of existing stormwater infrastructure to increase capacity as described and assessed in Section 8.

8. ASSESSMENT OF OPERATIONAL EFFECTS

Proposed concept design

116. Recognising the significant existing space and existing infrastructure constraints, the concept stormwater design incorporates a WSD approach where possible within an overall BPO approach, given:
 - i. The nature of the runoff from the state highway as a small part of significantly urbanised greater catchments draining to Te-Whanganui-a-Tara
 - ii. The potential effects on the awa and the marine receiving environments given the greater catchment flows
 - iii. The limitations on design presented by the existing urban environment in terms of space, and in terms of connection to the existing Wellington City stormwater systems
117. The key features of the proposed Project design for operational stormwater management³ are:
 - i. Stormwater reticulation to collect stormwater runoff from the road and convey these flows to treatment devices where proposed
 - ii. Filter inserts for all (existing and new) catchpits within the Project area
 - iii. Bioretention devices (i.e. rain gardens) as treatment devices where space and level constraints permit (in the vicinity of the Basin Reserve), and proprietary treatment devices where space constraints prevent the use of rain gardens, but levels enable connection to existing pipe systems downstream
 - iv. Stormwater upgrades in the Eastern Connections area, where there is a significant increase in impervious area proposed
118. For tunnel drainage:
 - i. To mitigate the potential effects of the new lane to the northern Terrace Tunnel portal, runoff will be collected and conveyed to a storage tank constructed beneath the carriageway at the portal. This tank will attenuate the increased runoff and avoid any increased peak flows to the downstream stormwater system and the Kumutoto awa. Stormwater stored in the tank will be discharged to the awa after treatment in a proprietary device
 - ii. An additional network is proposed to manage Terrace Tunnel deluge flows and runoff at the southern portal. Stormwater will be pumped from a sump to surface detention tanks located east of the Tunnel. Discharges from the tanks will be directed either to the wastewater network or to the stormwater system, depending on contaminant levels. If discharged to the stormwater network, flow will be treated prior to entering the network, in a gross pollutant trap and a proprietary device
 - iii. The proposed design includes a separate stormwater network to accommodate deluge runoff from the new Mount Victoria Tunnel. Deluge water will be conveyed to a detention tank beneath the southbound lane of SH1 at the western tunnel portal to provide initial attenuation, then directed either to the wastewater network or to the stormwater system, depending on contaminant levels. Before discharge to the stormwater network a proprietary treatment device is proposed, consistent with the approach adopted for the Terrace Tunnel

³ Refer State Highway 1 Wellington Improvements Drawings SH1WI-DES-00-DNG-DRG Sheets 01110 to 01148, Revision B dated 30 January 2026

Effects on water quality

119. The CLM I described in Section 4 has been used to assess the potential water quality effects of the Project. The assessment has been based on traffic volumes for the present-day existing state highway and the post-Project concept stormwater design.
120. I have summarised the potential effects on stormwater discharges from the 2033 Project without the treatment measures incorporated in the design, in Table 6 and Table 7. Annexure B presents a detailed summary of modelling results comparing the Project 2033 scenario with the present-day (2026) existing state highway and the Do-Minimum 2033 scenarios.
121. The water quality information in my assessment is modelled at the point of discharge from the Project drainage systems to the Wellington City stormwater infrastructure network and the culverted awa. For all systems draining to Lambton Harbour, there are significant additional catchment areas both upstream and downstream of the Project area, which generate additional runoff and contaminants. Although I have not modelled the greater catchment areas as part of investigations for the Project, given the state highway areas are typically less than 2.5 % of the greater catchments at the point of discharge to the coastal receiving environment the changes due to the Project will be significantly diluted.
122. Overall, I have assessed the untreated effects of the Project on water quality to be Moderate, notwithstanding some significant increases in contaminant loading from future higher traffic volumes. This is because of the small contribution of the Project area to the total catchments draining to the awa and the harbour environments

Table 6 – Untreated Project effects on TSS, Zinc, Copper and TPH in SH1 stormwater

Coastal receiving environment	Culverted awa or piped receiving environment	Present-day stormwater contaminant loading (kg/year)				Untreated Project impact			
		TSS	Zinc	Copper	TPH	TSS	Zinc	Copper	TPH
	Kumutoto awa	1,638	5.3	1.7	38.1	+16%	+18%	+18%	+18%
	Waimapihi awa	1,498	6.1	1.7	35.2	+7%	+15%	+11%	+9%
	Moturoa awa	403	1.3	0.4	9.1	+30%	+34%	+34%	+34%
	Tory Street stormwater network	13	0.04	0.01	0.3	+45%	+50%	+50%	+50%
	Waitangi awa	3,048	11.3	3.2	69.7	+26%	+22%	+22%	+21%
Lambton Harbour Total		6,600	24.0	7.0	152.4	+20%	+20%	+19%	+18%
Evans Bay	Waipapa awa	2,522	7.8	2.5	56.6	+28%	+32%	+32%	+32%
Project Total		9,123	31.8	9.5	208.9	+22%	+23%	+22%	+22%

Table 7 – Unmitigated Project effects on water quality in awa

Coastal receiving environment	Culverted awa or piped receiving environment	Water quality effects assessment
Lambton Harbour	Kumutoto awa	Moderate Adverse effect
	Waikoukou awa	No effect
	Waimapihi awa	Moderate Adverse effect
	Moturoa awa	Moderate Adverse effect
	Tory Street stormwater network	Moderate Adverse effect
	Waitangi awa	Moderate Adverse effect
	Total	Moderate Adverse effect
Evans Bay	Waipapa awa	Moderate Adverse effect
Overall		Moderate Adverse effect

123. Table 8 outlines the proposed water quality treatment in relation to the culverted awa and coastal receiving environments. All runoff from the Project area will be treated in catchpits with filter inserts, with additional treatment devices concentrated in the areas of significant physical works where there are better opportunities to incorporate new devices.
124. As well as the proprietary devices proposed for the new Terrace and Mount Victoria tunnels, these will also be provided in the Basin Reserve and Eastern Connections areas (refer also Annexure A).

Table 8 – Concept design water quality treatment

Coastal receiving environment	Culverted awa or piped receiving environment	Location	Proposed treatment	Approximate road area (m ²)		Proportion of Project area receiving treatment
				SH1	Local road	
Lambton Harbour	Kumutoto awa	Terrace Tunnel northern portal	Catchpit filter inserts and proprietary treatment device at northern tunnel portal	12,430	-	100%
	Waikoukou awa	Terrace Tunnel	Not applicable, no runoff from state highway	-	-	Not applicable
	Waimapihi awa	Terrace Tunnel southern portal	Catchpit filter inserts and proprietary treatment devices at southern tunnel portals	16,625	-	100%
	Moturoa awa	Te Aro	Catchpit filter inserts	4,840	-	100%
	Tory Street stormwater network	Te Aro	Catchpit filter inserts	120	-	100%
	Waitangi awa	Te Aro/Basin Reserve / Mount Victoria Tunnel	Catchpit filters, rain gardens and proprietary treatment devices	32,420	10,170	100%
Evans Bay	Waipapa awa	Eastern Connections	Catchpit filters and proprietary treatment device	26,760	18,680	100%

125. Table 9 summarises the changes in contaminant loadings and water quality from the Project area (as modelled in 2033) due to the water quality treatment measures incorporated in the proposed design.

126. I note that routine and post-event maintenance will be an essential part of the proposed stormwater treatment strategy. I recommend that devices be regularly maintained in accordance with the Wellington Water, Water Sensitive Design Technical Guidance (2019, Appendix A) and with the manufacturer's guidance for proprietary devices. I also recommend that a stormwater maintenance plan is prepared for the Project, to set out the operation and maintenance requirements for the long-term management of stormwater systems to ensure ongoing efficiency and effectiveness of water quality treatment for stormwater runoff from the Project.

Table 9 – 2026 contaminant loads and 2033 mitigated water quality from proposed Project Design

Coastal receiving environment	Culverted awa or piped receiving environment	Present-day (2026) loading from state highway (kg/year)				2033 Project impact on contaminant load			
		TSS	Zinc	Copper	TPH	TSS	Zinc	Copper	TPH
Lambton Harbour	Kumutoto awa	1,638	5.3	1.7	38.1	-24%	-2%	-8%	-15%
	Waimapihi awa	1,498	6.1	1.7	35.2	-15%	+8%	+2%	-6%
	Moturoa awa	403	1.3	0.4	9.1	-2%	+20%	+18%	+10%
	Tory Street stormwater network	13	0.04	0.01	0.3	+9%	+35%	+32%	+22%
	Waitangi awa	3,048	11.3	3.2	69.7	-48%	-26%	-36%	-40%
	Total	6,600	24.0	7.0	152.4	-32%	-9%	-17%	-23%
Evans Bay	Waipapa awa	2,522	7.8	2.5	56.6	-59%	-18%	-42%	-54%
Project Total		9,123	31.8	9.5	208.9	-39%	-12%	-23%	-31%

127. I note a general positive effect of the Project on water quality, except for stormwater discharged to the Waimapihi and Moturoa awa, and the Tory Street stormwater system. For the Waimapihi awa, modelling shows there will be some increase in Zinc, notwithstanding the treatment of Terrace Tunnel flows and the increased level of treatment to be provided by filter inserts in existing catchpits. For the Moturoa awa, modelling shows there will be some increase in Zinc and Copper, also despite installation of filter inserts in existing catchpits. In the Tory Street stormwater system there will be increases in all contaminants modelled, though I note that the area of the Project draining to this system is small (120 m²) and so the absolute increase in contaminant loading will also be very small.
128. I consider that overall, the Project will have a Low positive effect on water quality of runoff discharged to the coastal environments, and I have summarised the Project effects in Table 10.

Table 10 – Effects of proposed design for stormwater quality

Coastal receiving environment	Culverted awa or piped receiving environment	Water quality effects assessment
Lambton Harbour	Kumutoto awa	Low Positive effect
	Waimapihi awa	Low Adverse effect at point of discharge Negligible effect at marine outfall
	Moturoa awa	Low Adverse effect at point of discharge Negligible effect at marine outfall
	Tory Street stormwater network	Low Adverse effect at point of discharge Negligible effect at marine outfall
	Waitangi awa	Moderate Positive effect
	Total	Low Positive effect
Evans Bay	Waipapa awa/stormwater network	Moderate Positive effect
Overall		Low Positive effect

Effects on flooding

129. In the Eastern Connections area, the proposed Project design incorporates stormwater infrastructure upgrades to increase the limited capacity of the existing stormwater system and to mitigate potential flood impacts of the increased impervious area. In other areas, the geometric design has been developed to minimise potential flood impacts from changes in ground levels along the SH1 route.
130. The Project area has been modelled for various rainfall events to assess pre- and post-Project flood levels and extents. Annexure C provides flood model outputs including post-Project flood depth maps for the 1% and 10% AEP events, as well as flood depth difference maps. In these maps reduced peak flood levels are shown in blue, and increases in red. Minor changes, i.e. plus or minus 0.05 m (50 mm) are not shown.
131. The modelling has been used to assess how flooding may change as a result of increased impervious areas, alterations to ground levels within existing flood plains, and proposed stormwater infrastructure upgrades to improve capacity.
132. Where increased flood depths are the result of lowered ground levels (e.g. at the southern Terrace Tunnel portal and north of the Basin Reserve) rather than increased imperviousness, this generally does not correspond to increased flood levels (and therefore flood hazard) to properties outside the Project Designation. The resulting post-development flood level is more relevant when determining the effects on flooding. That is, the flood level governed by wider flood plain hydraulic processes may not change significantly even though there is a localised increased flood depth due to changes in ground level.

Terrace Tunnel

133. At the Terrace Tunnel northern portal, there will be 3,840 m² increased impervious area (which represents less than 2% of the total Kumutoto catchment road area of 138,000 m²). Modelling results show increased flood depths at the portal (refer Figure 15). However, these are due to the modelling terrain not accurately representing the tunnel openings, which are represented as a solid wall in the model. This flow will drain into the tunnel to be captured by the catchpits within the existing and proposed tunnels. As discussed earlier, the design includes a tank at the portal to store stormwater runoff and avoid increased peak flows downstream.

134. On this basis I consider the flood effects at the northern Terrace Tunnel portal to be Negligible.



Figure 15 – Terrace Tunnel Northern Portal 1% AEP flood depth difference map (including climate change)

135. At the southern portal, along the proposed southbound alignment from the new tunnel ground levels will be lowered next to the low point on the existing State Highway under the Ghuznee Street Bridge. As a result, the existing 1% AEP flood plain will extend further to the east across the new southbound State Highway carriageway. There will be a reduction in flood depth of up to 0.5 m on the existing (to be northbound lanes), and (new) flooding of up to 0.75 m depth on the new southbound lanes. Although the flood extents will increase, these are confined within the SH1 designation and there will be a balancing of flooding across the existing northbound and new southbound carriageways (refer Figure 16 and Figure 17, and Figures C.3 and C.4 in Annexure C).
136. The impervious area at the southern portal highway approaches will be increased by 3,050 m² (which represents less than 1% of the total Waimapihi catchment road area of 451,000 m²). To mitigate the flooding issues at the southern portal (during large storms up to the 1% AEP) flood waters will be pumped to the proposed tunnel deluge storage tanks. Additional design work is needed to confirm this approach, including review of pump rates and peak inflows to

be considered in detailed design. However, preliminary calculations indicate the proposed 1,200 m³ deluge tank provides adequate capacity to store the runoff, attenuate peak flows, and avoid adverse effects on the capacity of the Waimapihi stormwater network and existing flooding downstream.

137. Based on the above, I consider the flood effects at the southern Terrace Tunnel portal to be Low.

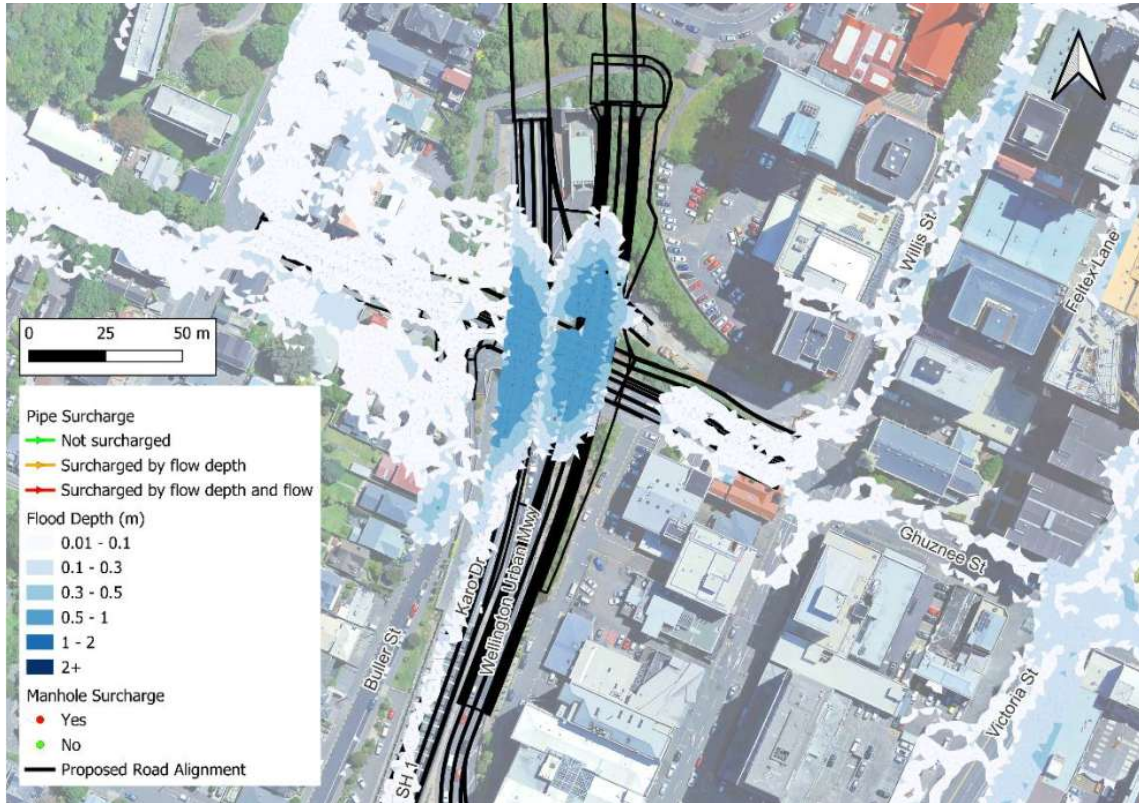


Figure 16 – Terrace Tunnel Southern Portal 1% AEP flood depths (including climate change)

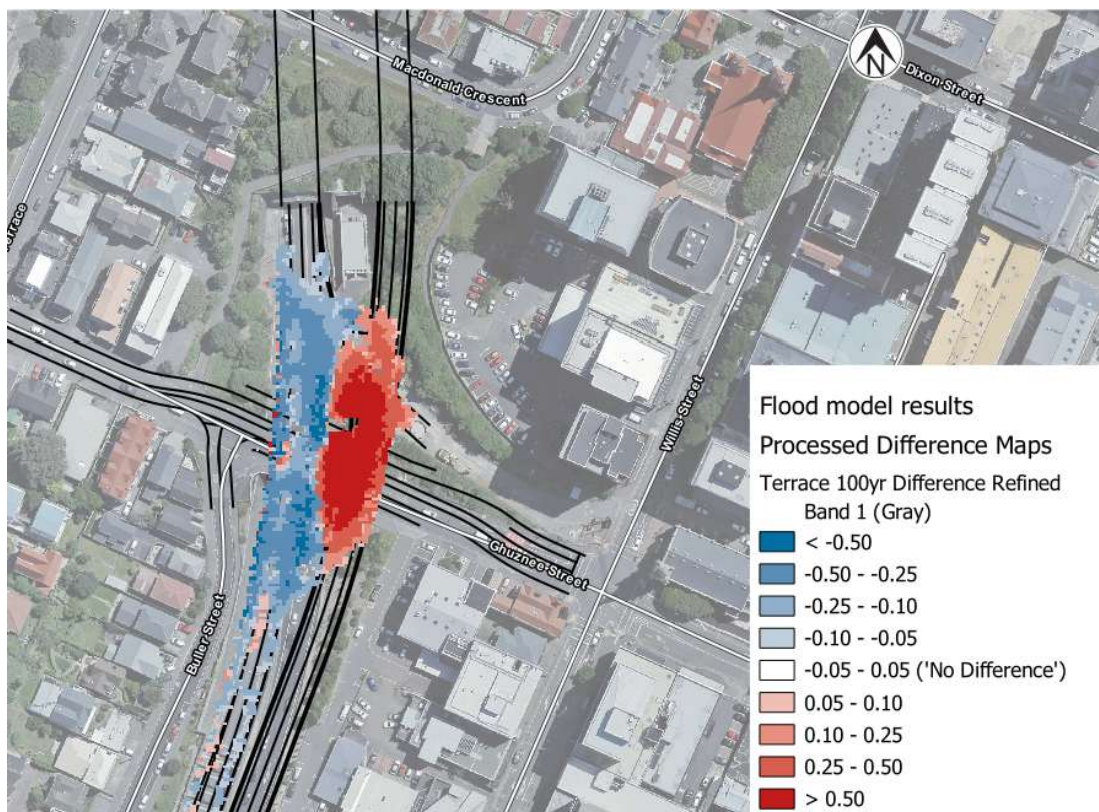


Figure 17 – Terrace Tunnel Southern Portal 1% AEP flood depth difference map (including climate change)

Te Aro

138. In the Te Aro area, there will be no increase in impervious surface as part of the Project and only minor changes to ground levels. The flood model results generally show no change to flooding patterns, and I consider that there will be Negligible effects of the Project on flooding in this area.

Basin Reserve and Mount Victoria Tunnel

139. Around the Basin Reserve, there will be a net increase in impervious area of approximately 1,980 m² compared to existing Project road area of 45,270 m². Due to these changes and the reconfiguration of traffic lanes which will modify ground levels, there will be some impact on existing flooding patterns along the Project route within the Project designation.
140. Flood depth difference maps comparing the pre- and post-Project peak flood depths in the 10% and 1% AEP flood events are shown in Figure 18 and Figure 19 (refer also Figures C.5, C.6, C.13 and C.14 in Annexure C). For both events, there are some areas within the Project designation with localised increase flood levels; particularly at the new Sussex Street underpass connection to Cambridge Terrace and in the northeast corner of the Basin traffic system (northbound and southbound).
141. At the Cambridge Terrace connection, the proposed underpass alignment is lower than existing ground levels. Therefore, an increase in flood depth is expected. In the north and southbound lanes in the northeast corner of the Basin the increased flood depths are also associated with a lowering of ground levels. There are several areas where minor flood depth

reductions are modelled including along Kent Terrace, as well as some areas with minor improvements including to the north and south of the Basin.

142. Increases in flood depths are generally limited within the Project designation, and are due to lowered ground levels for new roads and connections along the route, rather than adverse effects of the Project. Some parts of the existing state highway will have reduced flood depths. On this basis I consider that effects of flooding in this area are Low, although there will be some impact for the resilience of the state highway during extreme rainfall (as there is for the existing state highway route, refer Figure 7, Figure 9 and Figure 14).

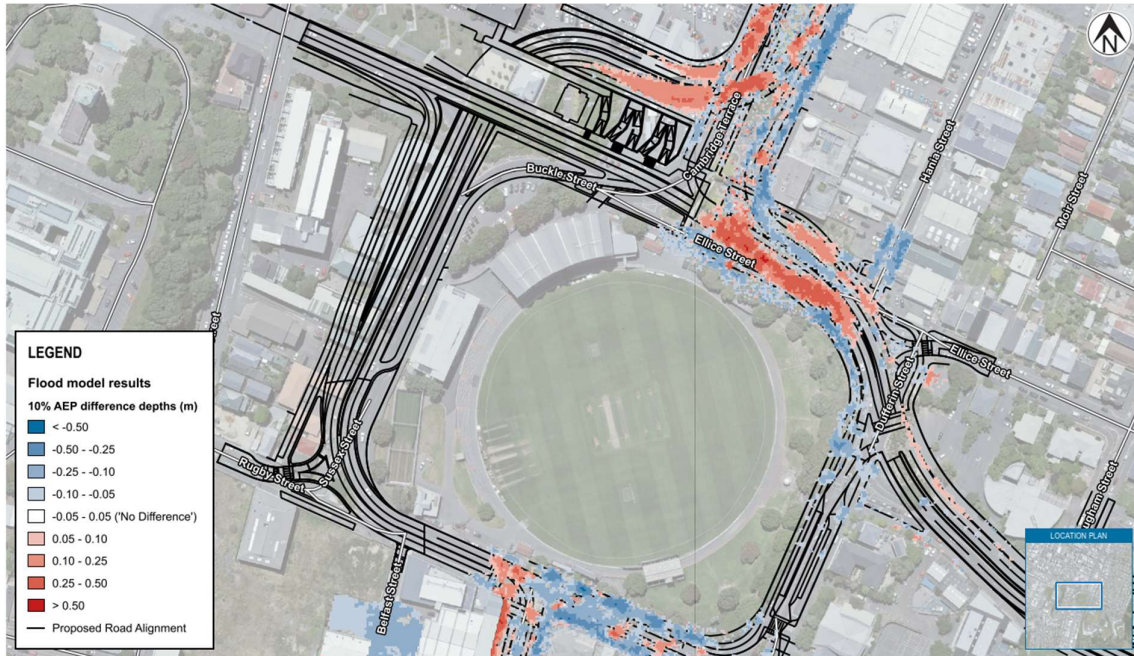


Figure 18 – Basin Reserve 10% AEP flood depth difference map

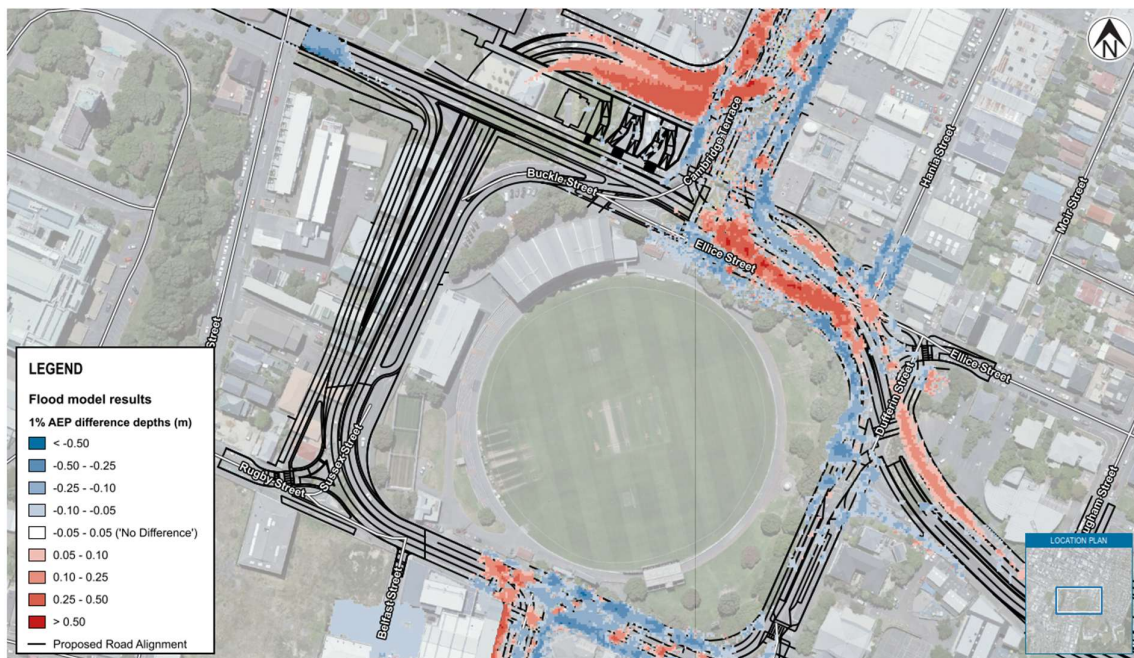


Figure 19 – Basin Reserve 1% AEP flood depth difference map

Eastern Connections

143. The Project will increase the impervious area in the Eastern Connections catchment, which will increase stormwater runoff. There will be approximately 14,360 m² increased impervious area, compared to the existing Project road area of 30,880 m² and total Waipapa catchment road area 275,000 m²). Given the existing flood issues and infrastructure constraints described in Section 5, this is expected to worsen the existing flood hazard in the area if not mitigated in design.
144. Due to the increased impervious areas created by the Project, a new pipe is proposed to increase the capacity of the existing stormwater infrastructure. The Project design includes a 1500 mm diameter pipe which follows the SH1 alignment, south beneath Ruahine Street and then east along Wellington Road, to combine with the existing network and discharge at the existing Evans Bay Marina outfall as shown in Figure 20.
145. This pipe along the SH1 route is generally parallel to the existing stormwater network that conveys the Waipapa awa. The new pipe is designed to convey stormwater runoff from SH1 and the slopes to the west, thereby separating highway-derived runoff from the pipe system associated with the Waipapa awa.
146. Figure 21 and Figure 22 show that the effect of the new pipe will be to reduce significantly overland flows and flooding from the Ruahine Street low point to the south of Goa Street towards the intersection of Ruahine Street, Wellington and Hamilton Roads and Kilbirnie Crescent.

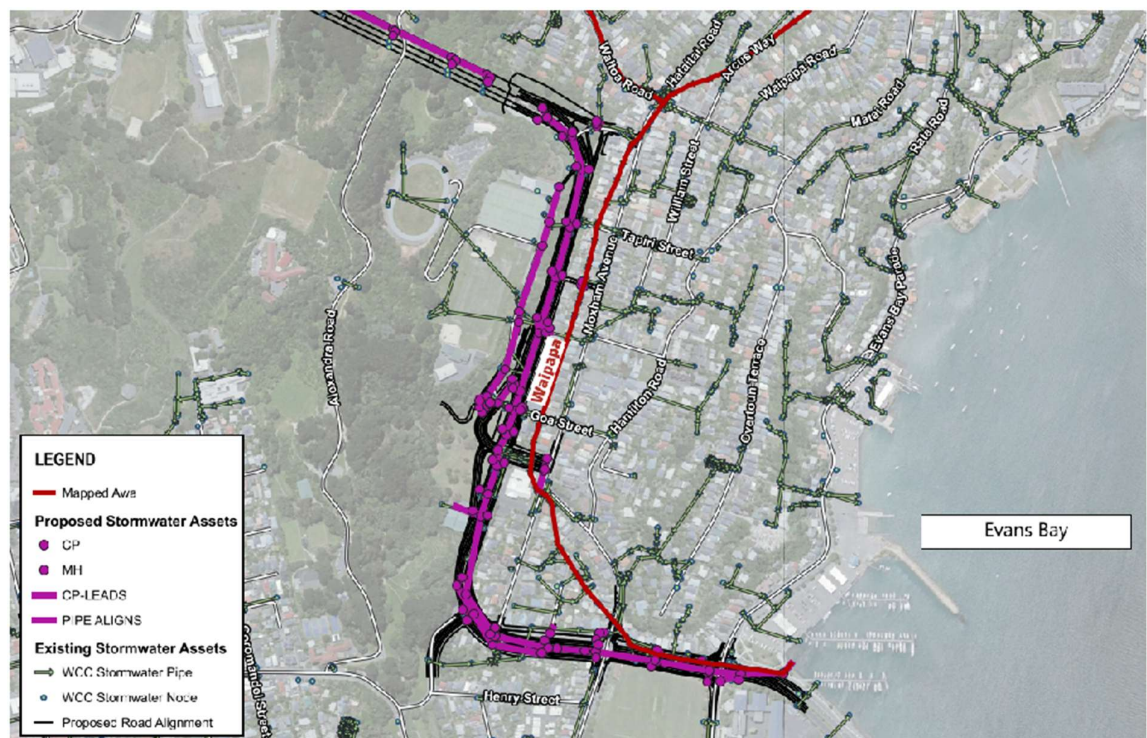


Figure 20 – Eastern Connections stormwater upgrades

147. The Project design includes a SH1 overpass from Moxham Avenue, and the associated embankment on the eastern side is within the low point in the existing flooding plain. The proposed embankment displaces flood storage and intercepts an overland flow path which

flows from north to south. To mitigate potential effects of the embankment and provide floodplain continuity, the design includes a flood conveyance path through the embankment. The proposed opening largely mitigates potentially adverse flood effects as shown in the figures below.

148. Increased flood depths are shown on SH1 between Kilbirnie Crescent and Evans Bay Parade, as well as on Evans Bay Parade to the south of the Wellington Road junction. To the west of the Junction (i.e. on Wellington Road) the increased depths are associated with new lanes for the widened highway (and which clearly do not currently flood). At the junction there is extensive existing flooding. My interrogation of the modelling results with the design team indicates that whereas the modelled flood depths to the south of the junction increase, the flood level does not change significantly, with the increased depths resulting from lowered ground levels for the new highway within the road corridor. The modelled increased flood depths are within the Project Designation.
149. I consider that the proposed Eastern Connections infrastructure upgrades are likely to bring about a Moderate Improvement in terms of flooding (compared to the existing situation where there are existing flood hazards for the residential areas to the east of Ruahine Street, which will be reduced, and for the lower-lying terrain at the junction of Wellington Road and Evans Bay Parade).



Figure 21 – Eastern Connections 10% AEP flood difference map (including climate change)

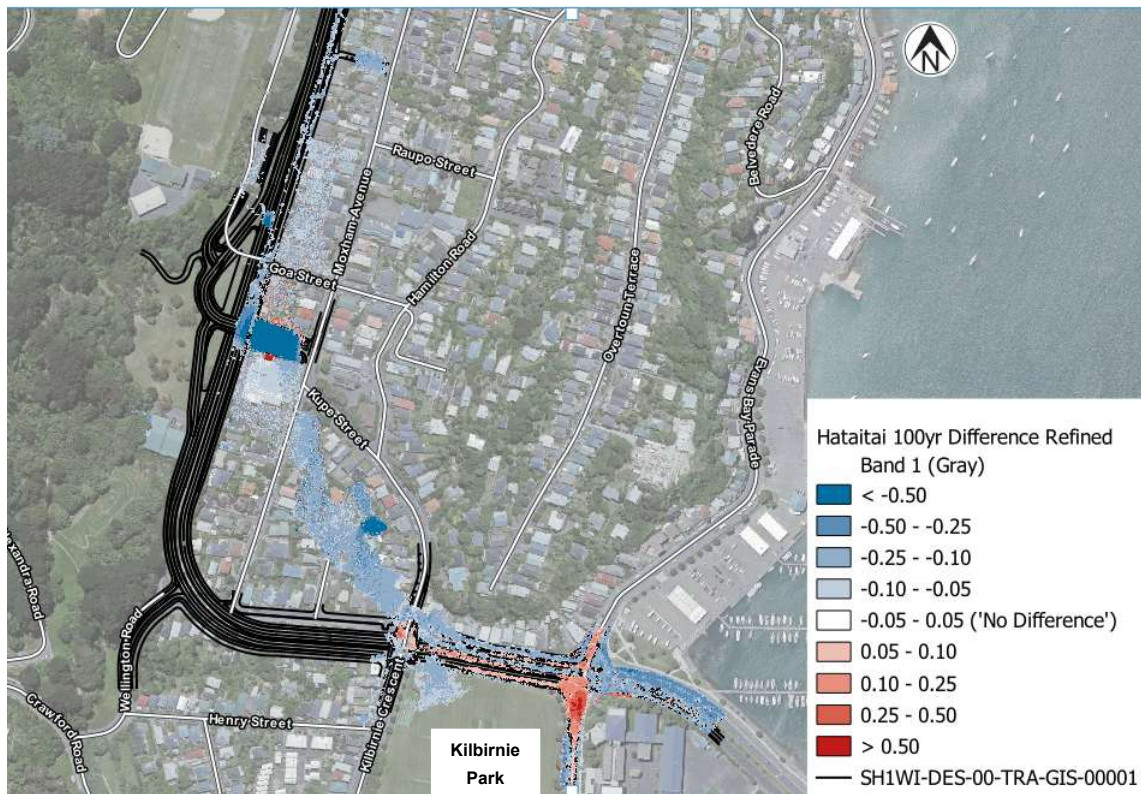


Figure 22 – Eastern Connections 1% AEP flood difference map (including climate change)

Summary

150. I consider the effects of the proposed Project design on flooding will be as summarised in Table 11 below.

Table 11 – Effects of Project on flood hazard

Area	Flood effects
Terrace Tunnel	Low to Negligible adverse effect
Te Aro	Negligible effect
Basin Reserve and Mount Victoria Tunnel	Low effect (some areas of both reduced and increased flood levels)
Eastern Connections	Moderate positive effect
Overall	Low positive effect

9. ASSESSMENT OF CONSTRUCTION EFFECTS

151. The assessment of construction effects, in terms of potential discharges, is covered by the erosion and sediment control specialist assessment prepared by Rob Van der Munckhof.

10. MEASURES TO AVOID, REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE EFFECTS

Measures to avoid, remedy or mitigate effects during operation

- 152. As I have described in Section 8, the proposed Project design incorporates measures to manage the water quality of runoff from the improved state highway and mitigate the effects on the downstream receiving environments during operation.
- 153. To ensure the ongoing efficient and effective operation of these, I recommend that devices be regularly maintained in accordance with the Wellington Water, Water Sensitive Design Technical Guidance (2019, Appendix A) and with the manufacturer's guidance for proprietary devices. A stormwater maintenance plan should be prepared to set out requirements for operations and maintenance of the systems to ensure ongoing efficiency and effectiveness of water quality treatment.
- 154. In terms of the limited and localised effects on flooding, I recommend that the geometric design of the new SH improvements is refined during detailed design, to reduce post-Project flood depths and mitigate flood hazard where possible recognising terrain constraints and connection to the existing road network.

Measures to avoid, remedy or mitigate effects during construction

- 155. The proposed measures to avoid, remedy or mitigate construction discharge are covered in the erosion and sediment control specialist assessment prepared by Rob Van der Munckhof.

11. ENGAGEMENT WITH REGULATOR

156. As part of my assessment, I have met with GWRC and its advisors to discuss matters arising from its review of an earlier version of this assessment.
157. The principal matters raised by GWRC related to:
- i. Request for stormwater design statement and calculations, treatment device layout plans including access, catchment areas for each treatment device
 - ii. Operation and maintenance plan
 - iii. CLM modelling assumptions and detail
 - iv. Clarification on open watercourse extent, opportunities for daylighting, provision for hydrological controls in design/assessment

Stormwater design details

158. The Consent Design Drawings included with the application show the outline details of the proposed new stormwater infrastructure, including pipes, storage tanks and treatment devices along the Project route.
159. Details of the proposed bioretention and proprietary stormwater treatment devices including location, road catchment area treated, and indicative size are provided in Annexure B of this assessment. Annexure B also includes figures showing the catchment areas raining to each device, which have been prepared to provide greater clarity regarding device catchments, in response to review comments and discussion with GWRC.

Operation and Maintenance Plan

160. GWRC requested a stormwater operations and maintenance plan be supplied with the application. As agreed through discussions, I have provided a general maintenance summary for each proposed device type (inspection, cleaning, debris, management, access) and a general description on maintenance access and feasibility at a conceptual level in Annexure A. This will need to be refined as part of detailed design. I have also recommended that a stormwater maintenance plan be prepared post-consent approval, once the detailed design information is confirmed.

Contaminant load modelling

161. GWRC requested clarity on the range of assumptions regarding contaminant yields, load reduction factors, and existing and projected traffic volumes.
162. This assessment includes in Section 4 the assumptions included in the development of the model. Annexure D includes output from the CLM model for effects of the Project in 2033 compared to both the present-day (2026) and Do-Minimum 2033 traffic scenarios for the existing state highway route. Annexure D also includes the modelled traffic volumes along the route for the three scenarios.

Open watercourses

163. GWRC requested that the sections of open watercourse should be clearly documented (including any opportunities for stream daylighting), and that the provision of hydrological controls should be considered as part of the Project.
164. However, stormwater runoff from the Project will only be discharged to the piped Wellington Water network and then directly to the harbour coastal environments. No part of the stormwater network is constructed as open channel watercourses. In this respect, because there will be no discharges to freshwater bodies, hydrological control is not relevant.

12. CONCLUSION AND RECOMMENDATIONS

165. The proposed treatment measures, including improved catchpit functionality across the Project area, and treatment devices for the tunnels, the Basin Reserve and Eastern Connections area will deliver water quality benefits with an overall reduction in contaminants to the Te Whanganui-a-Tara marine environments notwithstanding the expected increased future traffic volumes.
166. In terms of flooding, while some adverse effects have been modelled along the Project route in terms of localised flood depth increases, these are generally contained within the Project Designation and are associated with design road levels rather than increased flood levels. The proposed new stormwater pipeline for the Eastern Connections route will increase the capacity of existing stormwater infrastructure to convey runoff and so reduce water depths in the flood plain and overland flow paths to the east of Ruahine Street.
167. Overall, I consider the overall impact on stormwater quality and flooding will be beneficial, with improvements more than compensating for reduced water quality from some project areas and limited localised increased flood depths.
168. I consider that the proposed stormwater design incorporates a water sensitive design approach to the extent possible to deliver a BPO outcome, given:
- i. The nature of the runoff from the state highway as a small part of significantly urbanised greater catchments draining to Te Whanganui-a-Tara
 - ii. The potential effects on the awa and the marine receiving environments as a proportion of the greater catchment flows
 - iii. The limitations on design presented by the existing urban environment in terms of space, and in terms of connection to the existing Wellington City stormwater systems and transport network
169. I recommend that:
- i. The detailed design of stormwater infrastructure for the Project is completed in accordance with NZTA's P46 Stormwater Specification and the requirements of WWL Water Sensitive Urban Design Guidelines and Regional Standards for Water Services (noting also the other guidance documents identified earlier in my evidence)
 - ii. The geometric design of the new SH improvements is refined during detailed design, to reduce post-Project flood depths where possible recognising terrain constraints and the connection points to the existing road network
170. As part of future planning and detailed design, I recommend that a stormwater maintenance plan is prepared for the Project.

ANNEXURE A – Treatment devices

- **Table A.1 SH1WI Consent Design: Stormwater Treatment Devices**
 - **Figure A.1 Northern Portal (Terrace Tunnel) proprietary treatment device catchment**
 - **Figure A.2 Southern Portal (Terrace Tunnel) proprietary treatment device catchment**
 - **Figure A.3 Basin Reserve 1 proprietary treatment device catchment**
 - **Figure A.4 Basin Reserve 2 proprietary treatment device catchment**
 - **Figure A.5 Basin Reserve 3 proprietary treatment device catchment**
 - **Figure A.6 Basin Reserve 4 proprietary treatment device catchment**
 - **Figure A.7 Basin Reserve 5 rain garden treatment device catchment**
 - **Figure A.8 Basin Reserve 6 rain garden treatment device catchment**
 - **Figure A.9 Basin Reserve 7 rain garden treatment device catchment**
 - **Figure A.10 Basin Reserve 8 (Mount Victoria Tunnel) proprietary treatment device catchment**
 - **Figure A.11 Eastern Connections proprietary treatment device catchment**
- **Stormwater Treatment Device Maintenance**

Table A.1 SH1WI Consent Design: Stormwater Treatment Devices

Location	Treatment Device	Total device catchment (m ²)	Road treated (m ²)		Indicative size (m ²)
			SH	Local	
Terrace Tunnel North	Stormwater Proprietary Device Figure A.1 (refer also Drawing Sheet 01111)	11,470	1,560	-	10
Terrace Tunnel South	Stormwater Proprietary Device Figure A.2 (refer also Drawing Sheets 01114 and 01149)	10,270	6,050	-	8.0
Basin Reserve 1	Cambridge Terrace Stormwater Proprietary Device Figure A.3 (refer also Drawing Sheet 01123)	6,030	-	4,260	7.5
Basin Reserve 2	Intersection of Rugby Street and Adelaide Road Stormwater Proprietary Device Figure A.4 (refer also Drawing Sheet 01121)	6,070	-	2,780	7.5
Basin Reserve 3	Rugby Street East Stormwater Proprietary Device Figure A.5 (refer also Drawing Sheet 01121)	2,710	-	970	4.5
Basin Reserve 4	Patterson Street/Brougham Street Stormwater Proprietary Device Figure A.6 (refer also Drawing Sheet 01127)	1,500	-	670	3.0
Basin Reserve 5	Cambridge Terrace/Buckle Street/Kent Terrace Raingarden Figure A.7 (refer also Drawing Sheet 01124)	7,700	1,110	600	170
Basin Reserve 6	Between Hania Street and Kent Terrace Raingarden Figure A.8 (refer also Drawing Sheet 01126)	8,280	2,760	890	220
Basin Reserve 7	SH1 - Basin Reserve East Raingarden Figure A.9 (refer also Drawing Sheet 01127)	10,200	3,880	-	380
Basin Reserve 8	Duplicate Mt Victoria Tunnel Stormwater Proprietary Device Figure A.10 (refer also Drawing Sheet 01128)	5,070	5,070	-	15
Eastern Connections	Wellington Road Stormwater Proprietary Device Figure A.11 (refer also Drawing Sheet 01139)	332,200	23,410	18,680	176
Note	All surfaces draining to these devices, and all other surfaces, on the SH1 route, will have treatment in the form of filter inserts installed in catchpits.				

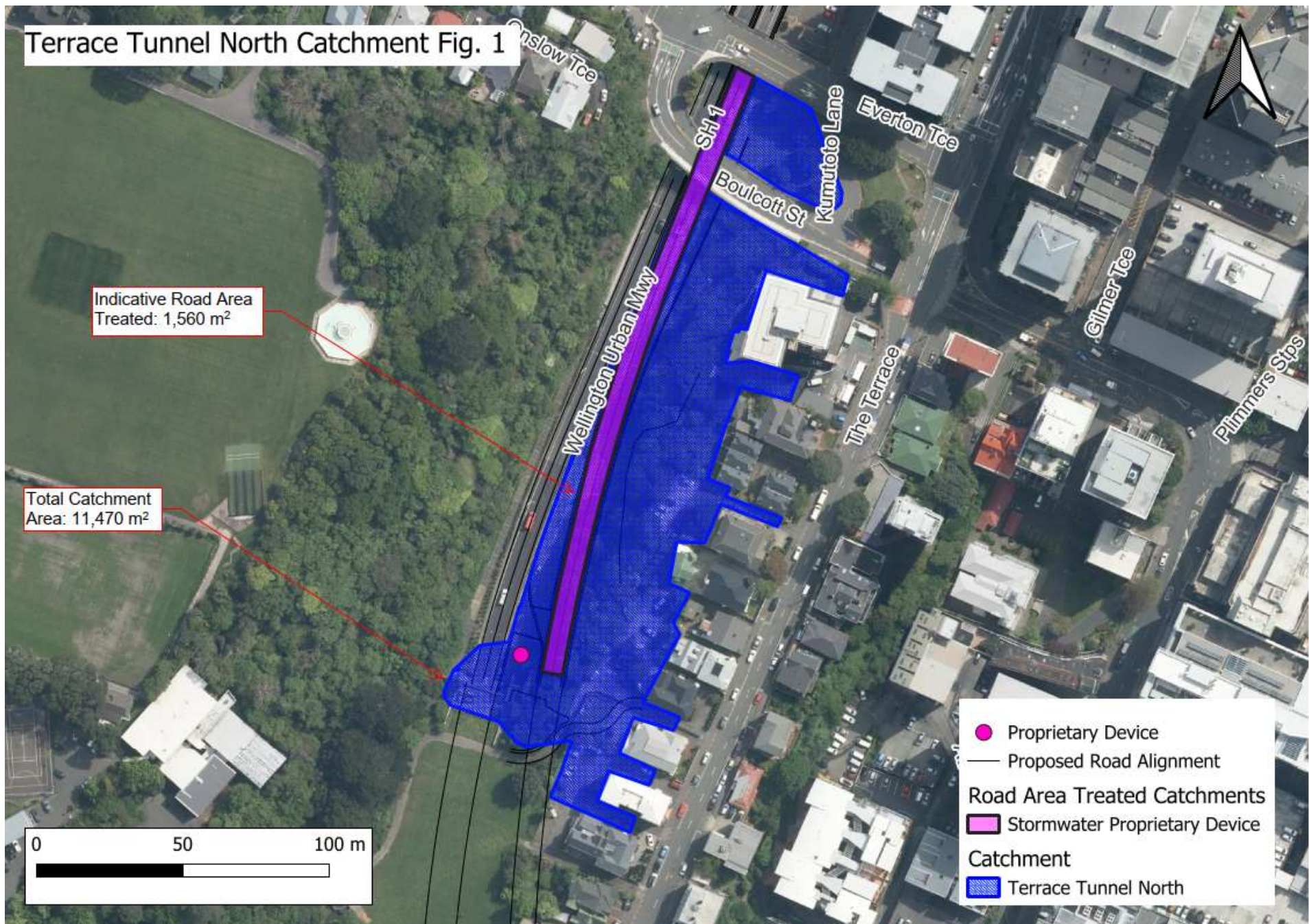


Figure A.1 Northern Portal (Terrace Tunnel) proprietary treatment device catchment

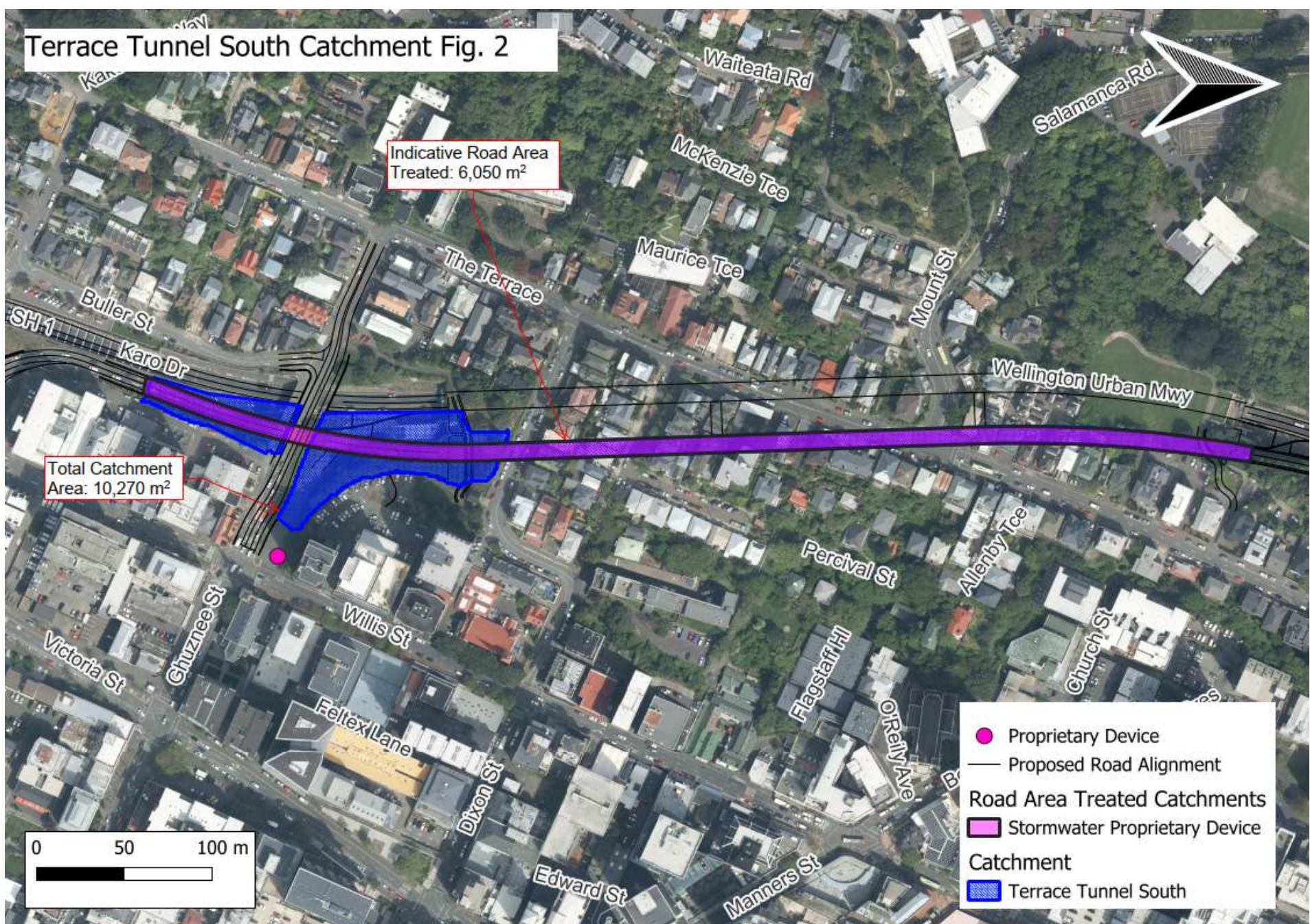


Figure A.2 Southern Portal (Terrace Tunnel) proprietary treatment device catchment

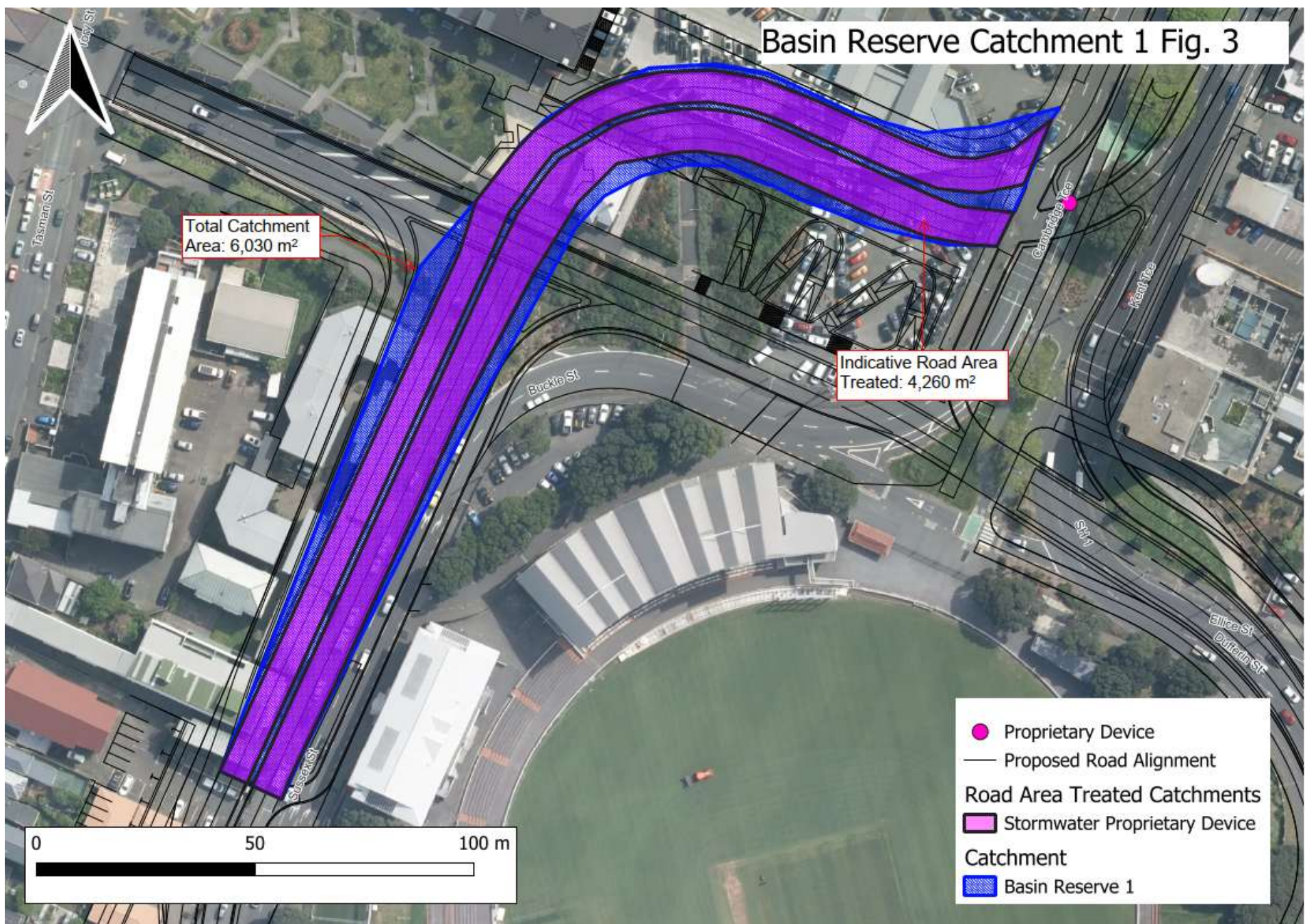


Figure A.3 Basin Reserve 1 proprietary treatment device catchment

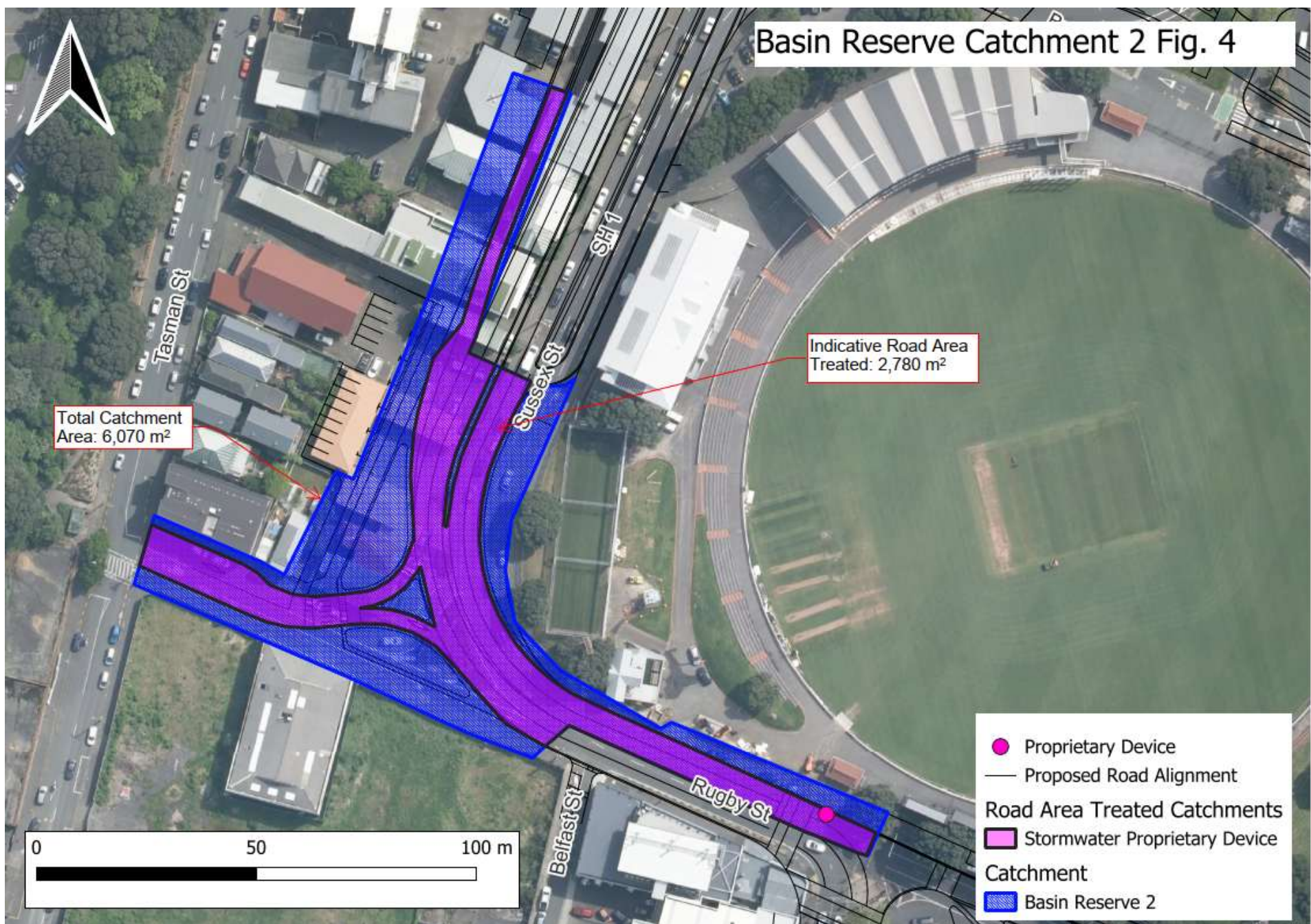


Figure A.4 Basin Reserve 2 proprietary treatment device catchment

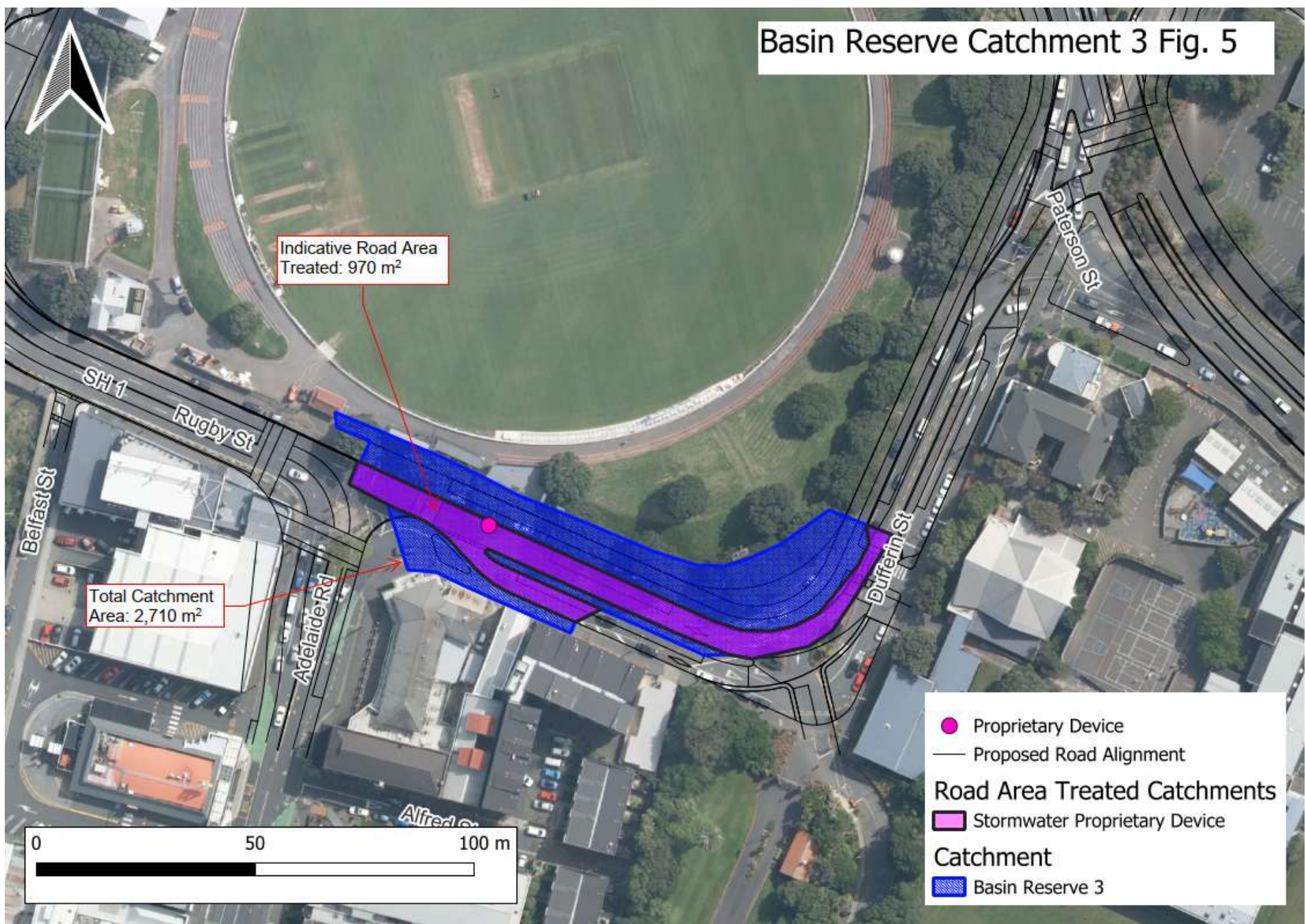


Figure A.5 Basin Reserve 3 proprietary treatment device catchment

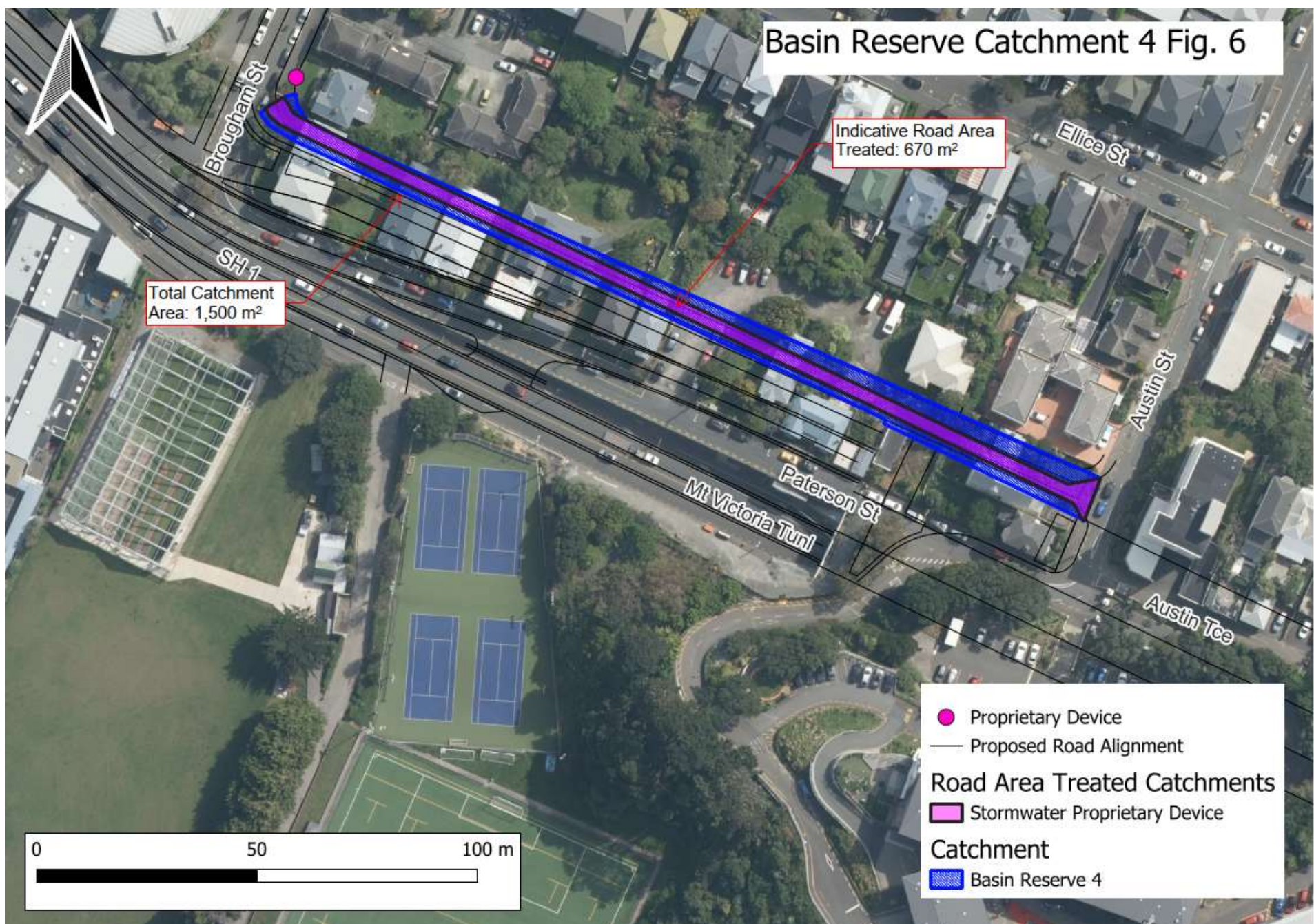


Figure A.6 Basin Reserve 4 proprietary treatment device catchment

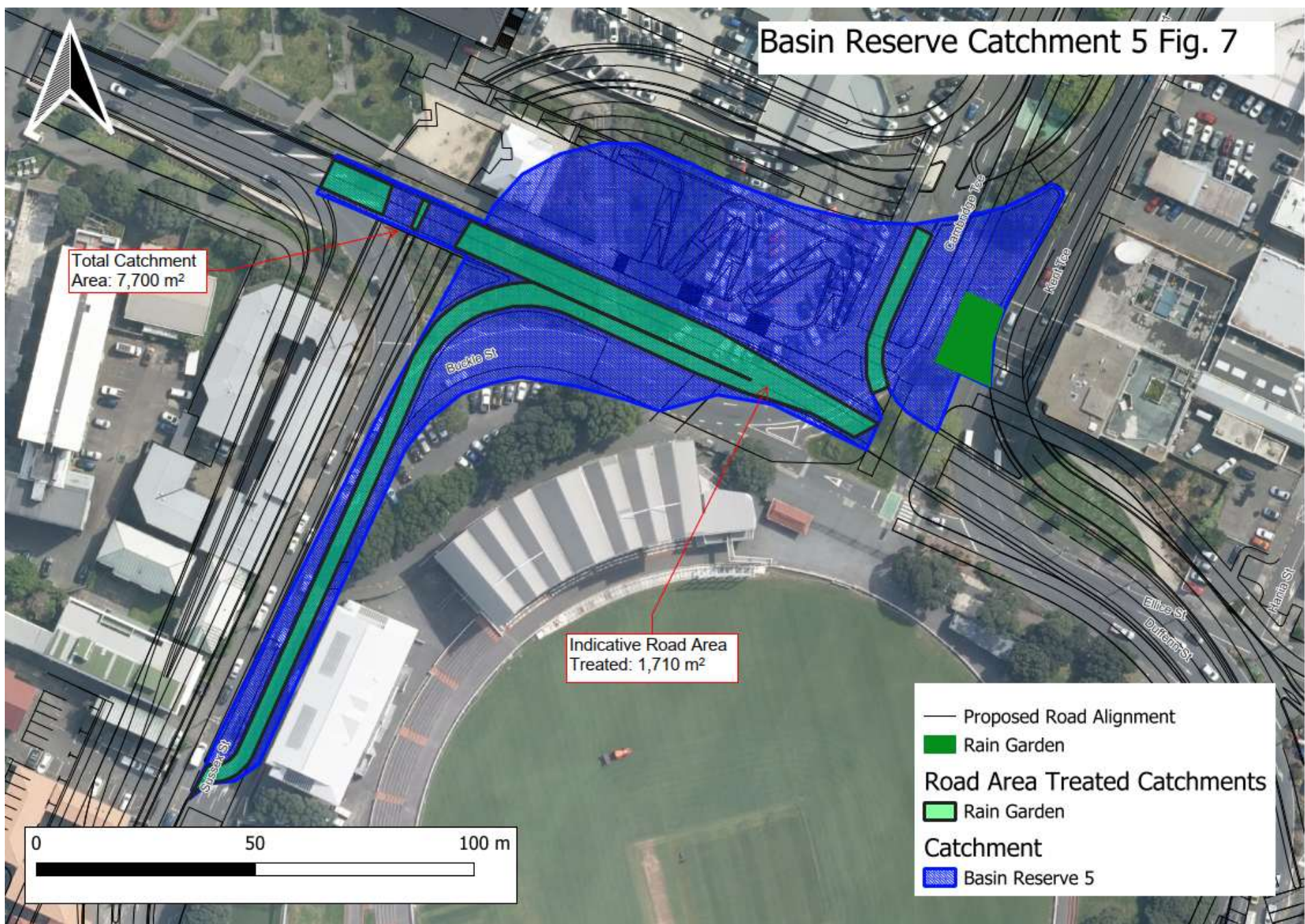


Figure A.7 Basin Reserve 5 rain garden treatment device catchment

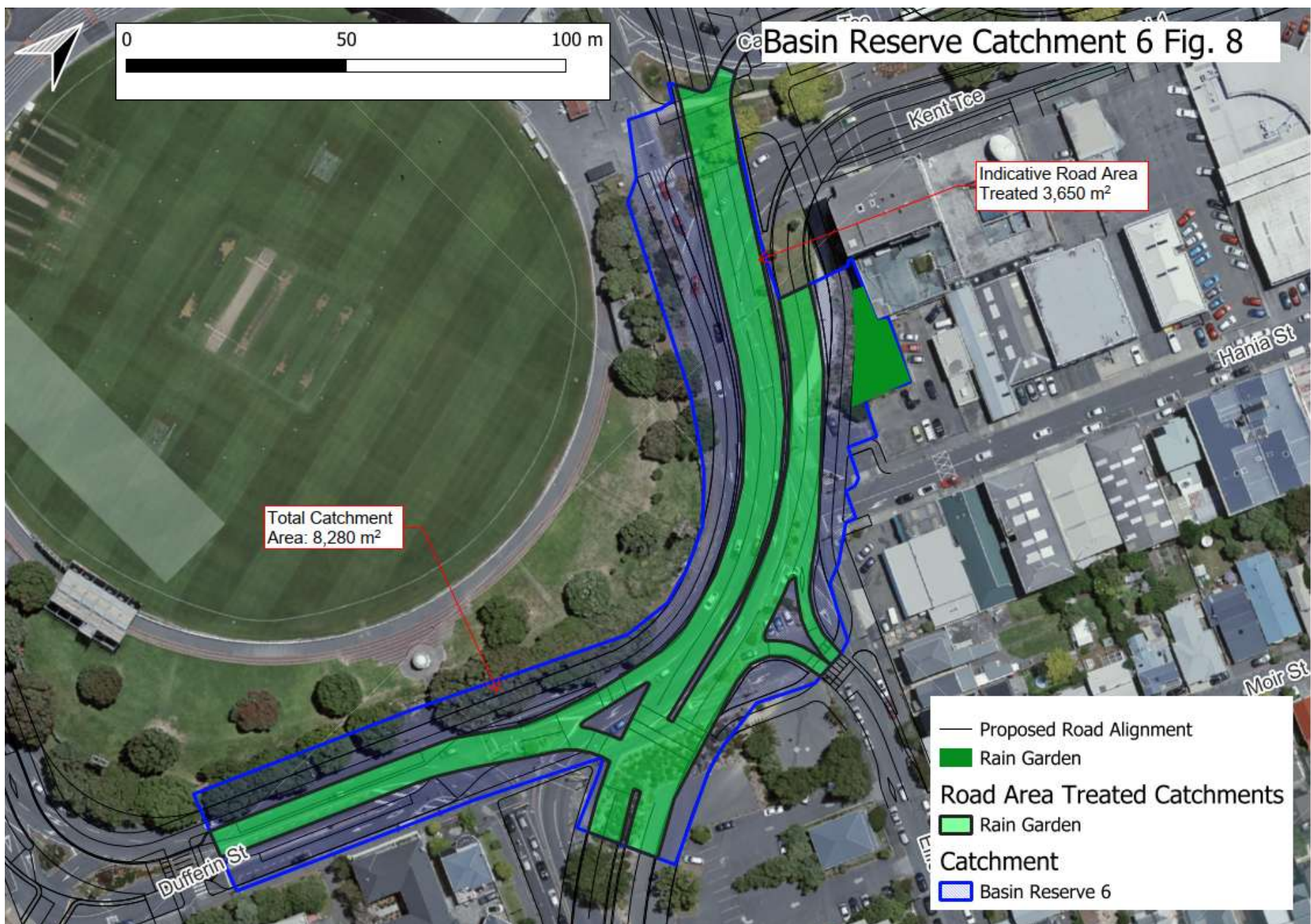


Figure A.8 Basin Reserve 6 rain garden treatment device catchment

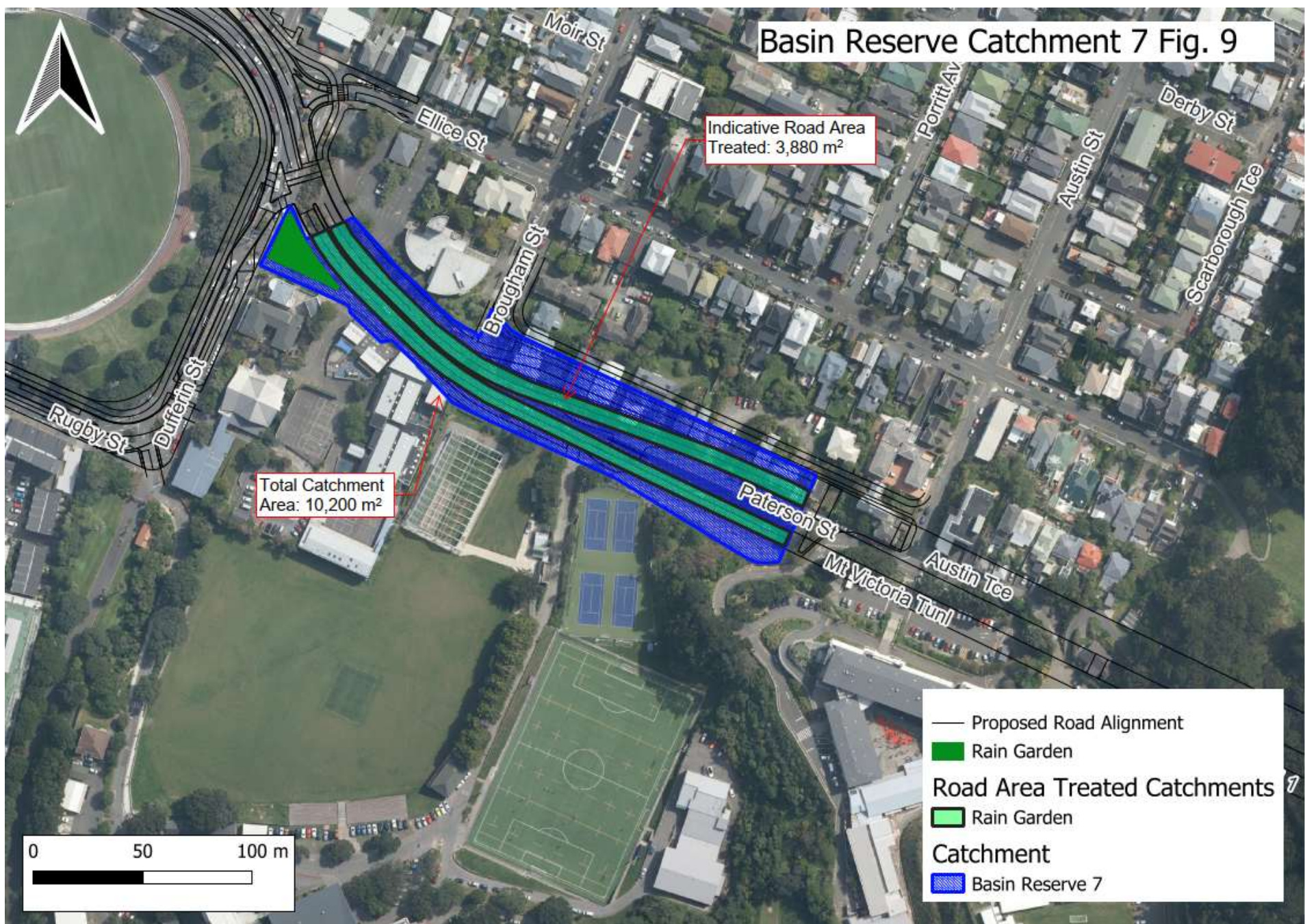


Figure A.9 Basin Reserve 7 rain garden treatment device catchment

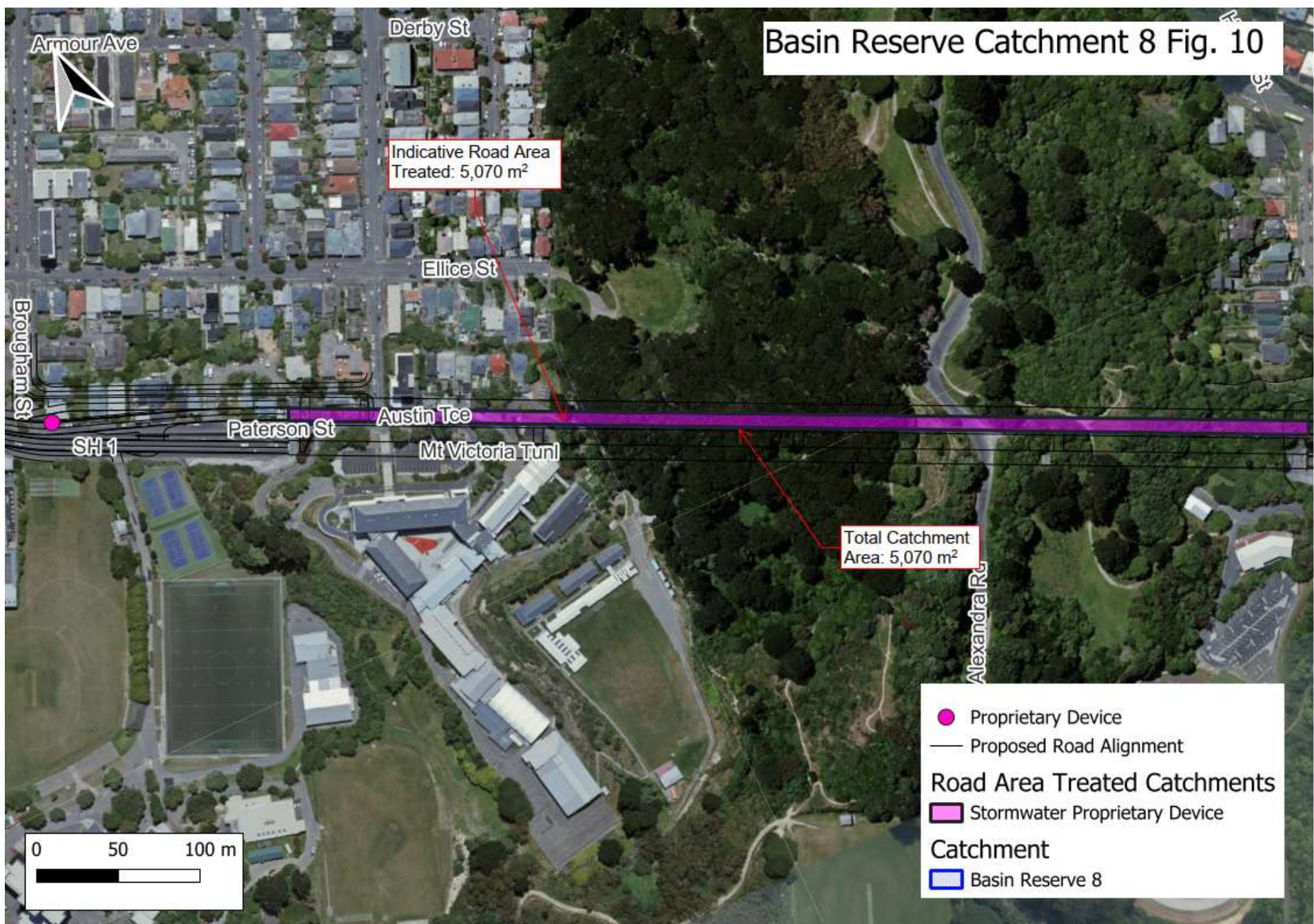


Figure A.10 Basin Reserve 8 (Mount Victoria Tunnel) proprietary treatment device catchment

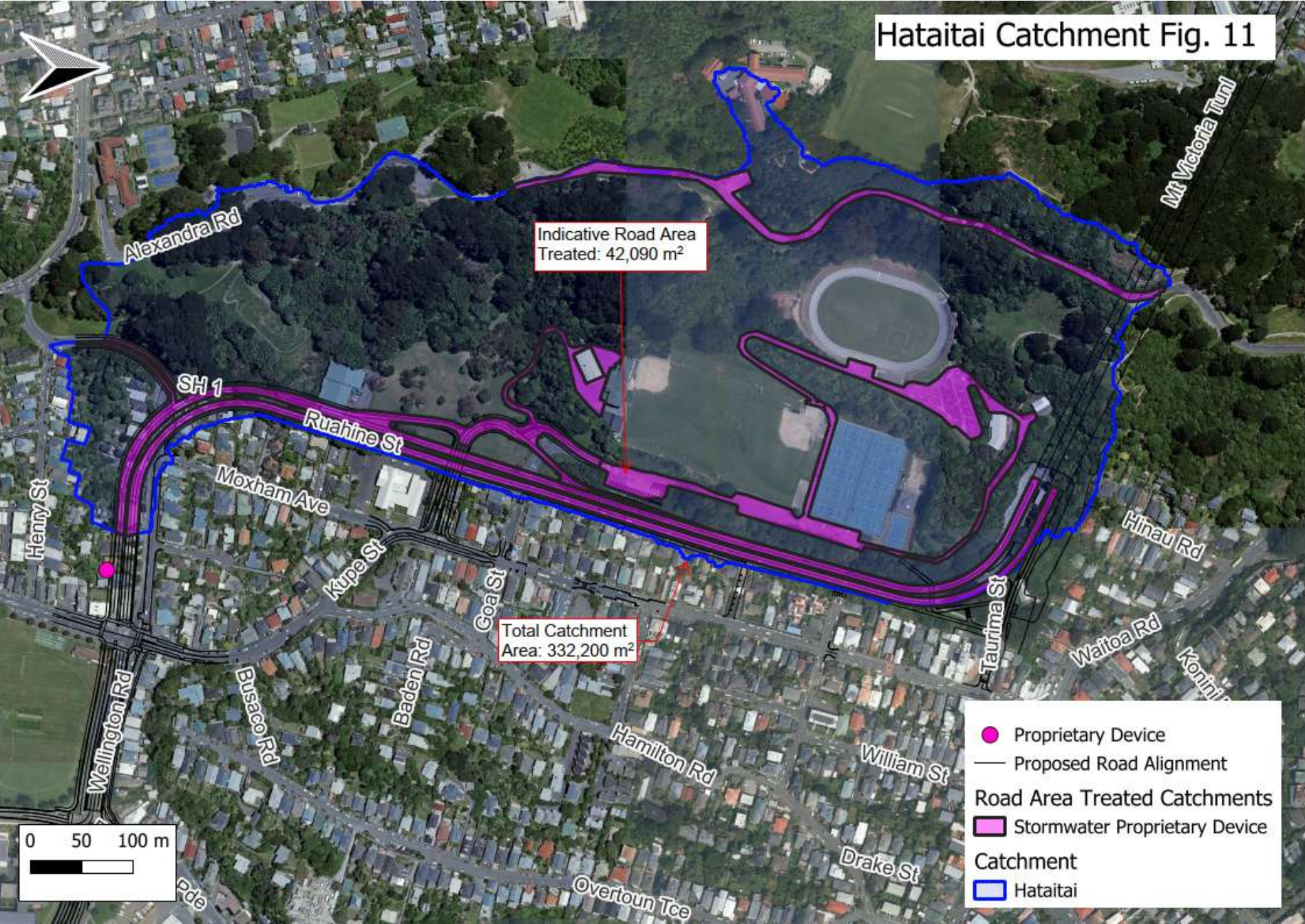


Figure A.11 Eastern Connections proprietary treatment device catchment

Stormwater Treatment Device Maintenance

All treatment devices will be located along the State Highway route, and or connecting urban local roads. Access provisions to these for maintenance will be incorporated in the final design of the stormwater infrastructure for the Project. Maintenance activities (including to catchpits along the route, installed with filter inserts) must be planned to identify the appropriate traffic management measures and procedures to ensure safety on maintenance crews, and control of traffic flows in the vicinity, e.g. traffic lane (and possibly road) closure (static or mobile works).

The devices incorporated in the design comprise raingardens or proprietary treatment devices.

Maintenance requirements and expected frequency of maintenance activities are provided in Water Sensitive Design for Stormwater: Treatment Device Design Guideline, Version 1.1, Wellington Water (December 2019), and manufacturer's guidelines. The typical requirements are set out below. As planning and design proceeds, with device configurations confirmed, a stormwater maintenance plan will be prepared detailing the procedures for the specific devices.

- **Raingardens**
 - Routine landscape maintenance (four times annually)
 - o General landscaping inspections, removing litter, maintaining vegetation, weeding:
 - Maintaining vegetation, ensuring plants are trimmed to ensure inflows, overflows and outflows are clear to the extent design capacity is maintained
 - Replanting or re-mulching as required, and checks to determine if irrigation is needed during unusually dry conditions
 - Trimming vegetation infringing on footpaths or roads
 - Inspections and clearance of debris at inlets
 - Functional drainage maintenance (twice annually)
 - o Flush out drainage
 - Traffic control costs and traffic management (as needed)
 - Initial aftercare of plants (first 3 years, four times annually)
 - Corrective maintenance
 - o As needed:
 - Removal of deciduous leaves
 - Additional trimming of vegetation
 - Surface removal of silt/fine sediment that will impact either infiltration or plant performance
 - Removing dead vegetation due to ponding
 - Forking of surface to relieve compaction and restore permeability

- Fixing erosion of outlets
- Road closures for 'centre road' rain garden maintenance
- o Condition assessment/performance audit, 5 yearly
- o Removal and disposal of sediments (including media replacement), 20 yearly
- o Complete replanting, 10 yearly
- o Major drainage system maintenance/replacement, 50 yearly

- **Proprietary Treatment devices**

Maintenance typically includes cartridge recharging, and disposal of materials that require consideration of regulatory guidelines.

- Cartridges and device housing
 - o Trash and Debris Removal
 - o Floatable objects or other trash is present in the filter.
 - o Remove to avoid hindrance of filtration and eliminate unsightly debris and trash.
 - o Permanent removal from storm system.
- Cartridge Replacement and Sediment Removal
 - o Media has been contaminated by high levels of pollutants, such as after a spill.
 - o New media can effectively treat stormwater.
- Drainage System Piping
 - o Flushing with Water
 - Drainage system is obstructed by debris or sediment.
 - o Outflow is not restricted.
- Frequency
 - o Twice yearly in first three years
 - o Thereafter annually
 - o Following significant rainfall (more than 25 mm in 24 hours)

ANNEXURE B – SH1WI Stormwater Contaminant Load Modelling Results

■ Unmitigated Project 2033 compared to Present Day existing SH1 and Do-Minimum 2033

Coastal receiving environment	Culverted awa or piped receiving environment	Project 2033 change unMitigated (+-%)							
		Present Day (2026)				Do Minimum (2033)			
		TSS	Zinc	Copper	TPH	TSS	Zinc	Copper	TPH
	Kumutoto awa	16%	18%	18%	18%	15%	16%	16%	16%
	Waikoukou awa	-	-	-	-	-	-	-	-
	Waimapihi awa	7%	15%	11%	9%	2%	10%	6%	4%
	Moturoa awa	30%	34%	34%	34%	27%	30%	30%	30%
	Tory Street	45%	50%	50%	50%	42%	46%	46%	46%
	Waitangi awa	26%	22%	22%	21%	22%	20%	20%	19%
Lambton Harbour		20%	20%	19%	18%	16%	17%	16%	15%
Evans Bay	Waipapa awa	28%	32%	32%	32%	26%	29%	29%	29%
Project Total		22%	23%	22%	22%	19%	20%	20%	19%

Coastal receiving environment	Culverted awa or piped receiving environment	Project 2033 unMitigated loading change (kg/year)							
		Present Day (2026)				Do Minimum (2033)			
		TSS	Zinc	Copper	TPH	TSS	Zinc	Copper	TPH
	Kumutoto awa	267	0.920	0.290	6.7	249	0.860	0.270	6.2
	Waikoukou awa	-	-	-	-	-	-	-	-
	Waimapihi awa	108	0.920	0.190	3.1	38	0.660	0.110	1.4
	Moturoa awa	122	0.430	0.140	3.1	112	0.390	0.120	2.8
	Tory Street	5.7	0.020	0.010	0.140	5.4	0.020	0.010	0.130
	Waitangi awa	790	2.5	0.720	15	676	2.3	0.640	13
Lambton Harbour		1,293	4.8	1.3	28	1,081	4.2	1.2	24
Evans Bay	Waipapa awa	701	2.5	0.8	18	659	2.3	0.7	17
Project Total		1,994	7.2	2.1	46	1,740	6.5	1.9	41

▪ **Mitigated Project 2033 compared to Present Day existing SH1 and Do-Minimum 2033**

Coastal receiving environment	Culverted awa or piped receiving environment	Project 2033 change mitigated (+-%)							
		Present Day (2026)				Do Minimum (2033)			
		TSS	Zinc	Copper	TPH	TSS	Zinc	Copper	TPH
	Kumutoto awa	-24%	-2%	-8%	-15%	-25%	-3%	-9%	-16%
	Waikoukou awa	-	-	-	-	-	-	-	-
	Waimapihi awa	-15%	8%	2%	-6%	-18%	4%	-3%	-11%
	Moturoa awa	-2%	20%	18%	10%	-5%	17%	15%	7%
	Tory Street	9%	35%	32%	23%	6%	31%	28%	20%
	Waitangi awa	-48%	-26%	-36%	-40%	-49%	-26%	-36%	-40%
Lambton Harbour		-32%	-9%	-17%	-23%	-33%	-11%	-18%	-24%
Evans Bay	Waipapa awa	-59%	-18%	-42%	-54%	-60%	-20%	-43%	-55%
Project Total		-39%	-12%	-23%	-31%	-40%	-13%	-25%	-33%

Coastal receiving environment	Culverted awa or piped receiving environment	Project 2033 mitigated loading change (kg/year)							
		Present Day (2026)				Do Minimum (2033)			
		TSS	Zinc	Copper	TPH	TSS	Zinc	Copper	TPH
	Kumutoto Awa	-391	-0.1	-0.1	-5.9	-409	-0.1	-0.2	-6.4
	Waikoukou Awa	-	-	-	-	-	-	-	-
	Waimapihi Awa	-220	0.490	0.030	-2.3	-290	0.230	-0.1	-4.0
	Moturoa awa	-9.0	0.260	0.070	0.930	-19	0.220	0.060	0.700
	Tory Street	1.1	0.010	-	0.070	0.802	0.010	-	0.100
	Waitangi Awa	-1,473	-2.9	- 1.2	-28	-1,490	-3.0	-1.2	-28
Lambton Harbour		-2,092	-2.3	- 1.2	-35	-2,207	-2.7	-1.3	-38
Evans Bay	Waipapa Awa	-1,495	-1.4	- 1.0	-31	-1,538	-1.6	-1.1	-32
Project Total		-3,587	-3.7	- 2.2	-65	-3,745	-4.3	-2.4	-70

ANNEXURE C – Flood Maps

Post-Project flood mapping

1 % AEP event (including climate change)

Northern Portal (Terrace Tunnel)

Figure C.1 1 % AEP flood mapping

Figure C.2 1 % AEP flood depth differences

Southern Portal (Terrace Tunnel)

Figure C.3 1 % AEP flood mapping

Figure C.4 1 % AEP flood depth differences

Basin Reserve

Figure C.5 1 % AEP flood mapping

Figure C.6 1 % AEP flood depth differences

Eastern Connections

Figure C.7 1 % AEP flood mapping

Figure C.8 1 % AEP flood depth differences

10 % AEP event (including climate change)

Northern Portal (Terrace Tunnel)

Figure C.9 10 % AEP flood mapping

Figure C.10 10 % AEP flood depth differences

Southern Portal (Terrace Tunnel)

Figure C.11 10 % AEP flood mapping

Figure C.12 10 % AEP flood depth differences

Basin Reserve

Figure C.13 10 % AEP flood mapping

Figure C.14 10 % AEP flood depth differences

Eastern Connections

Figure C.15 10 % AEP flood mapping

Figure C.16 10 % AEP flood depth differences



Figure C.1 Northern Portal (Terrace Tunnel) post-development 1 % AEP flood mapping



Figure C.2 Northern Portal (Terrace Tunnel) post-development 1 % AEP flood depth differences



Figure C.3 Southern Portal (Terrace Tunnel) post-development 1 % AEP flood mapping



Figure C.4 Southern Portal (Terrace Tunnel) post-development 1 % AEP flood depth differences

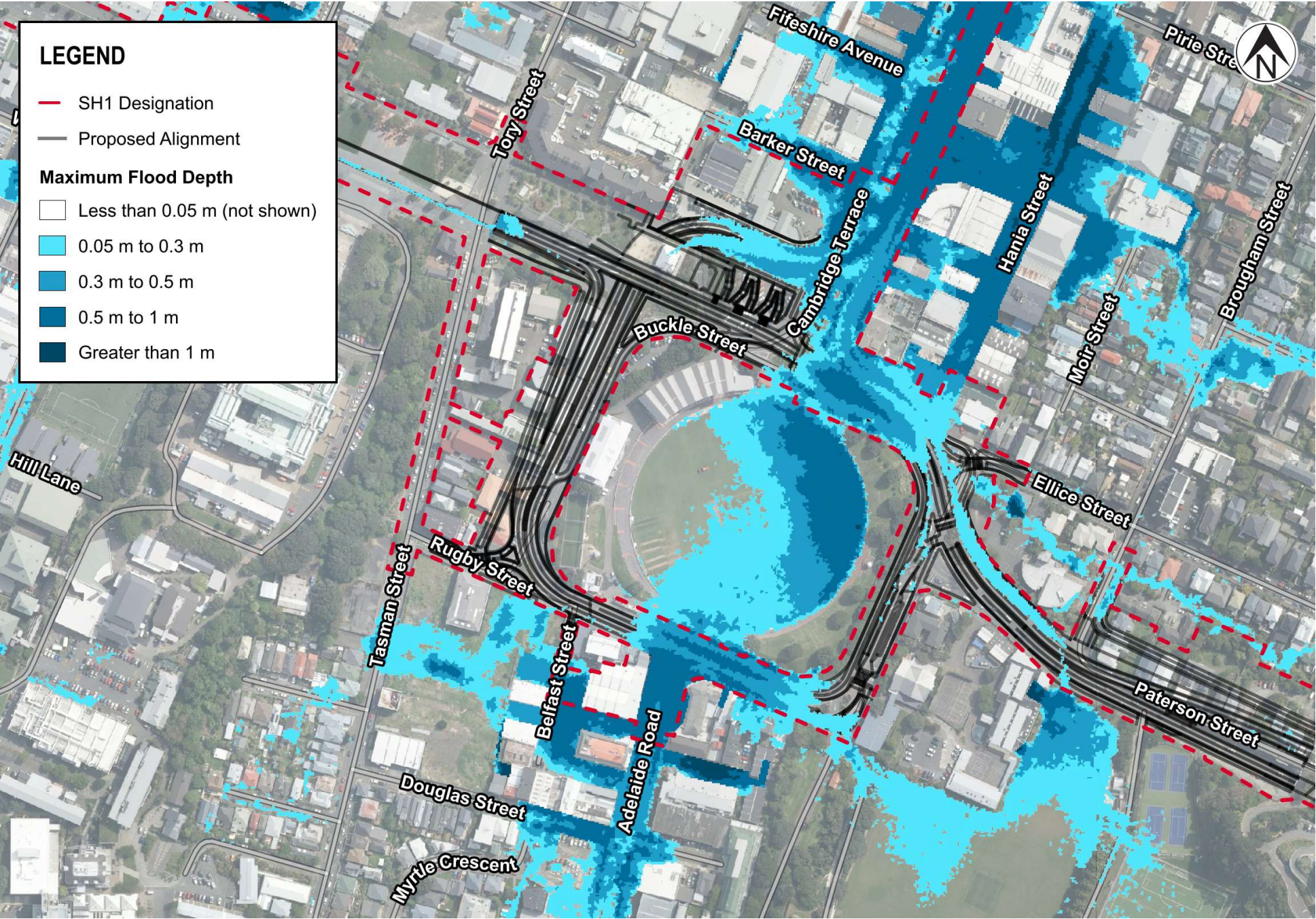


Figure C.5 Basin Reserve post-development 1 % AEP flood mapping

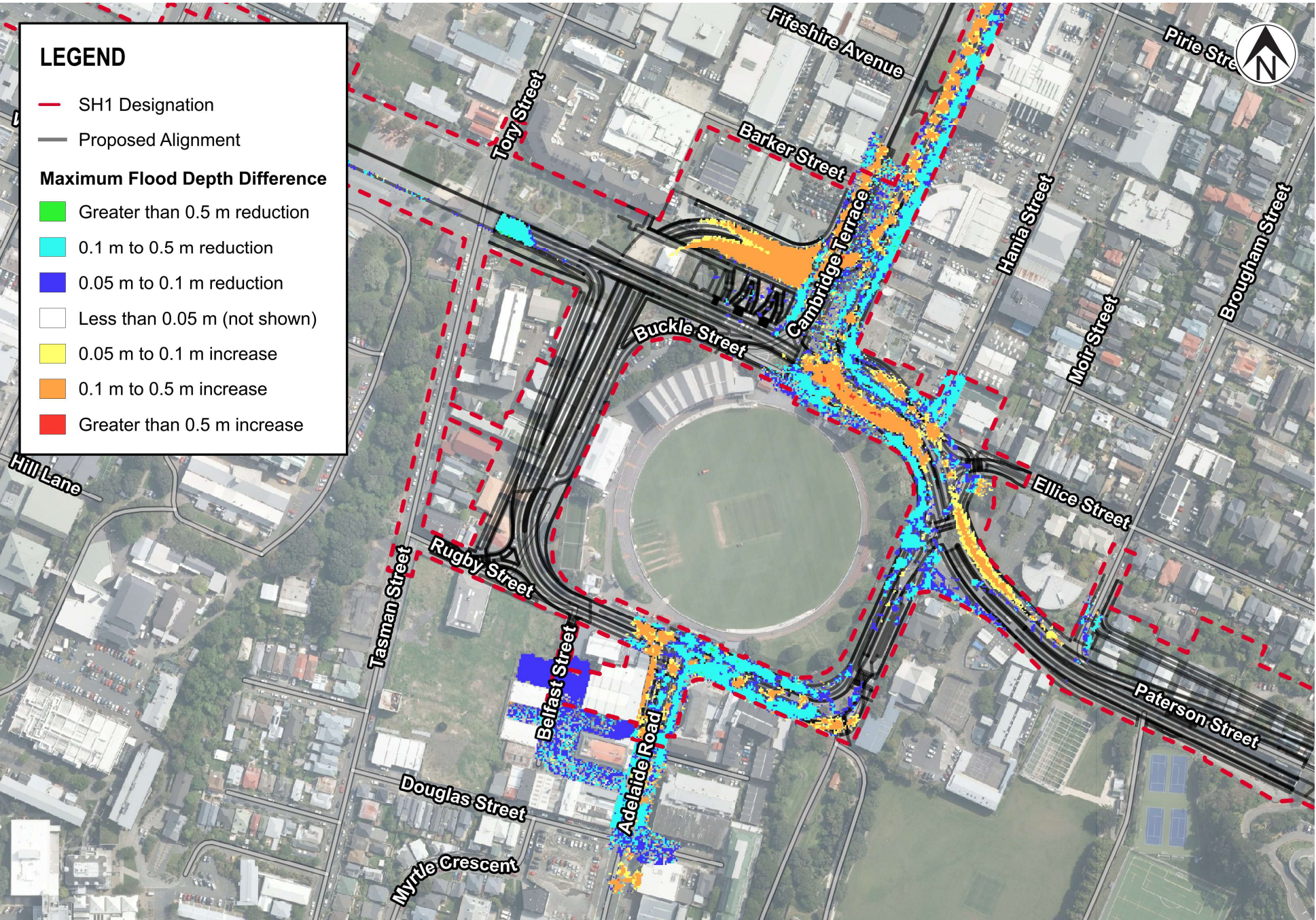


Figure C.6 Basin Reserve post-development 1 % AEP flood depth differences

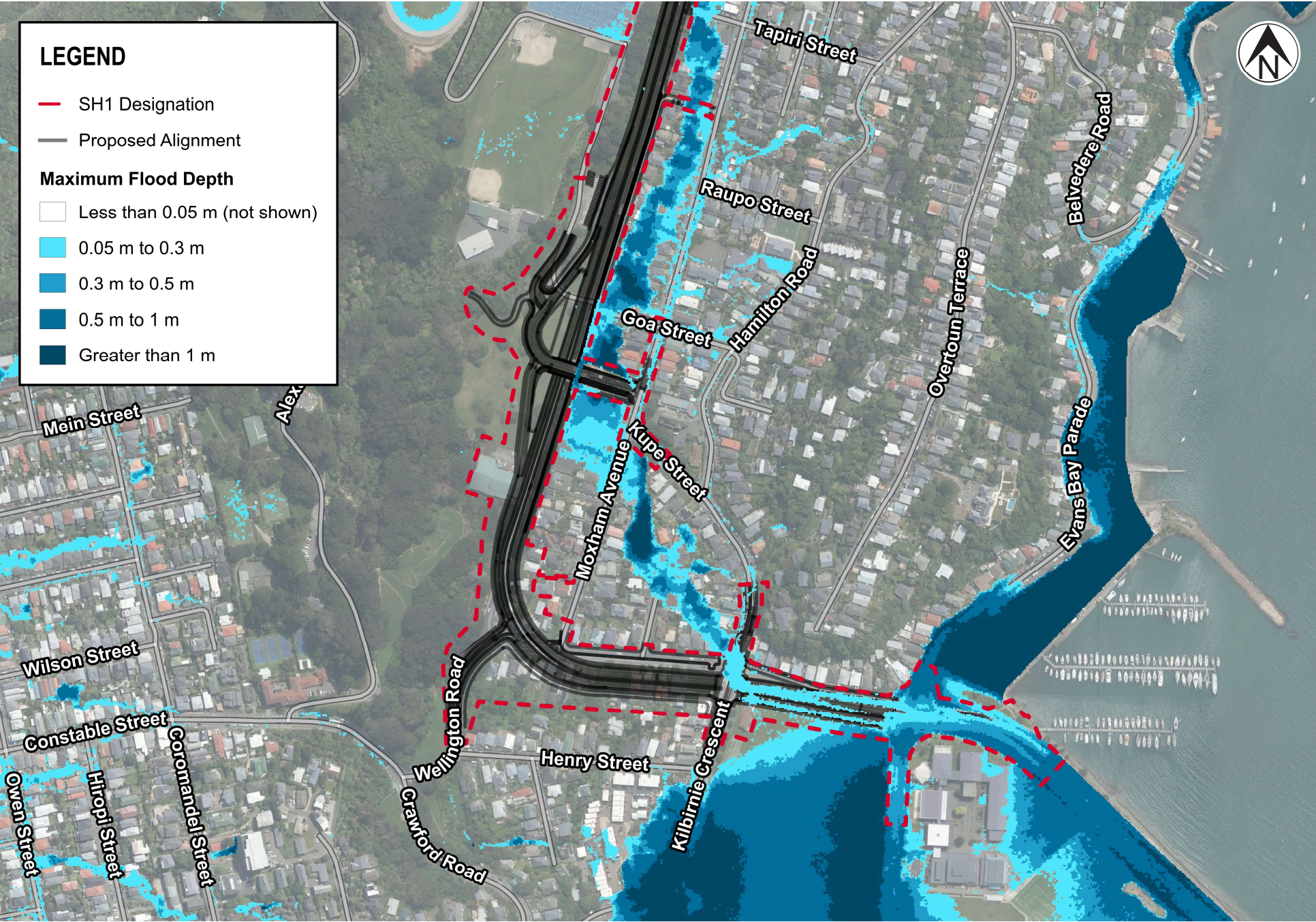


Figure C.7 Eastern Connections post-development 1 % AEP flood mapping

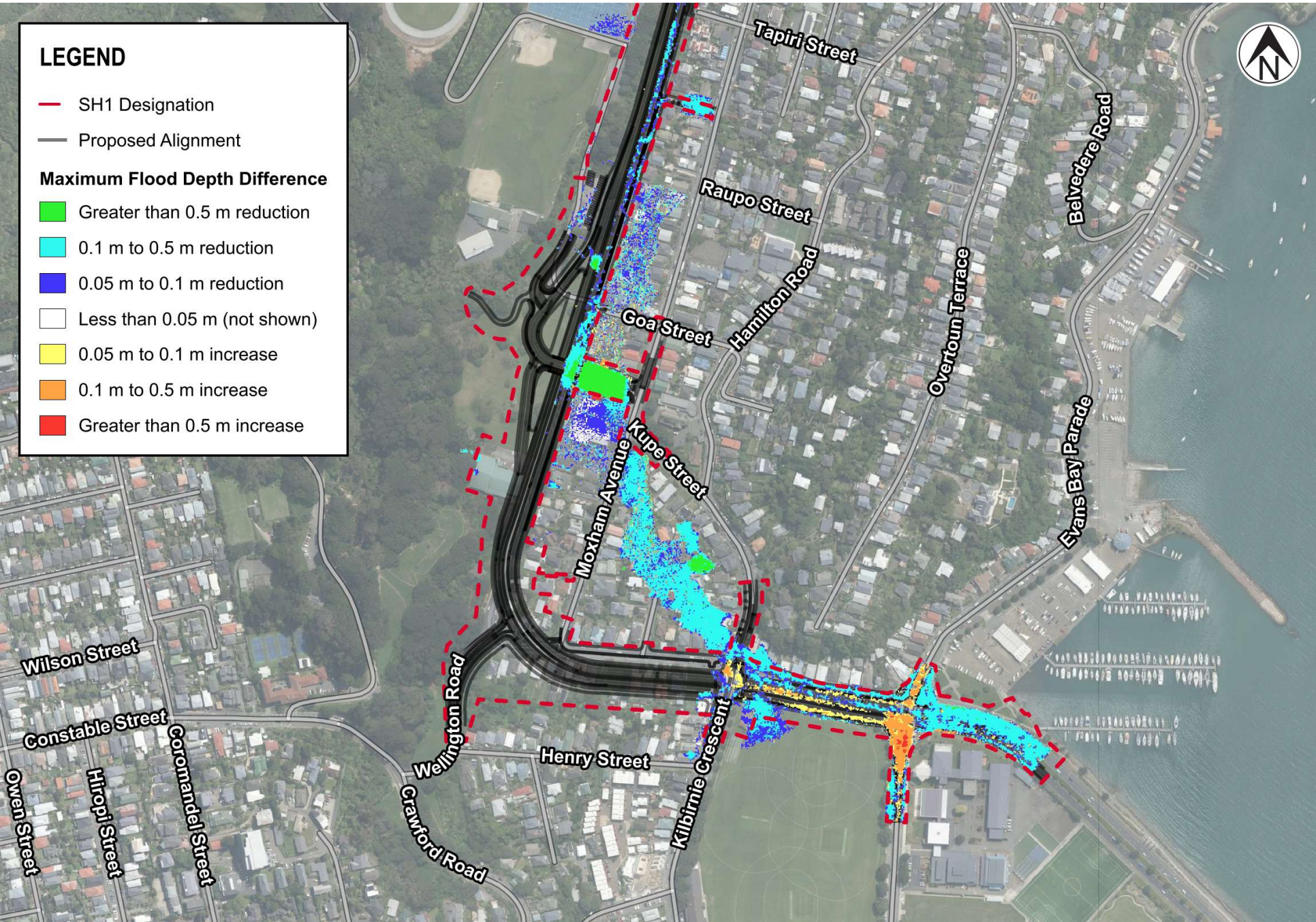


Figure C.8 Eastern Connections post-development 1 % AEP flood depth differences



Figure C.9 Northern Portal (Terrace Tunnel) post-development 10 % AEP flood mapping



Figure C.10 Northern Portal (Terrace Tunnel) post-development 10 % AEP flood depth differences



Figure C.11 Southern Portal (Terrace Tunnel) post-development 10 % AEP flood mapping



Figure C.12 Southern Portal (Terrace Tunnel) post-development 10 % AEP flood depth differences

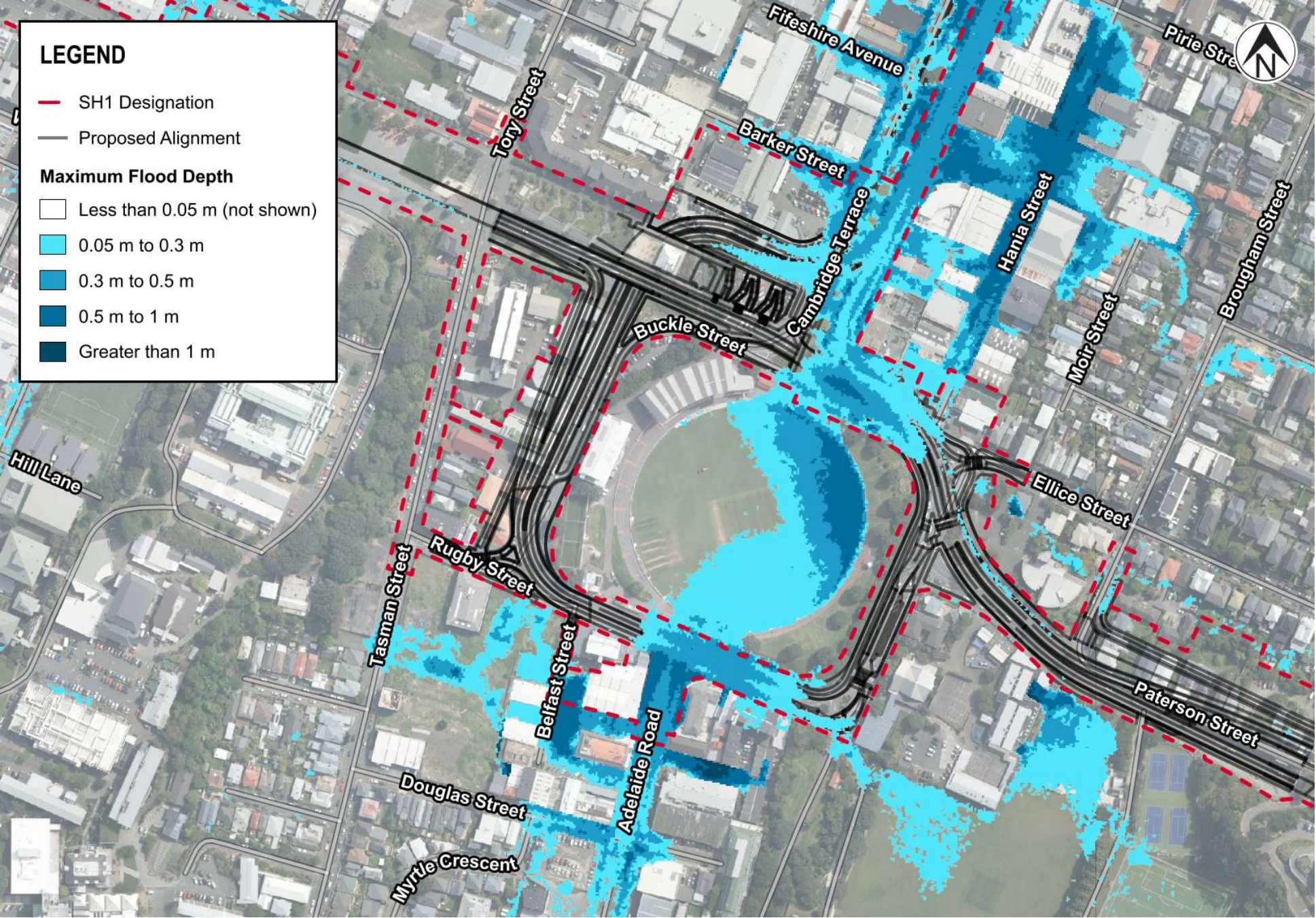


Figure C.13 Basin Reserve post-development 10 % AEP flood mapping

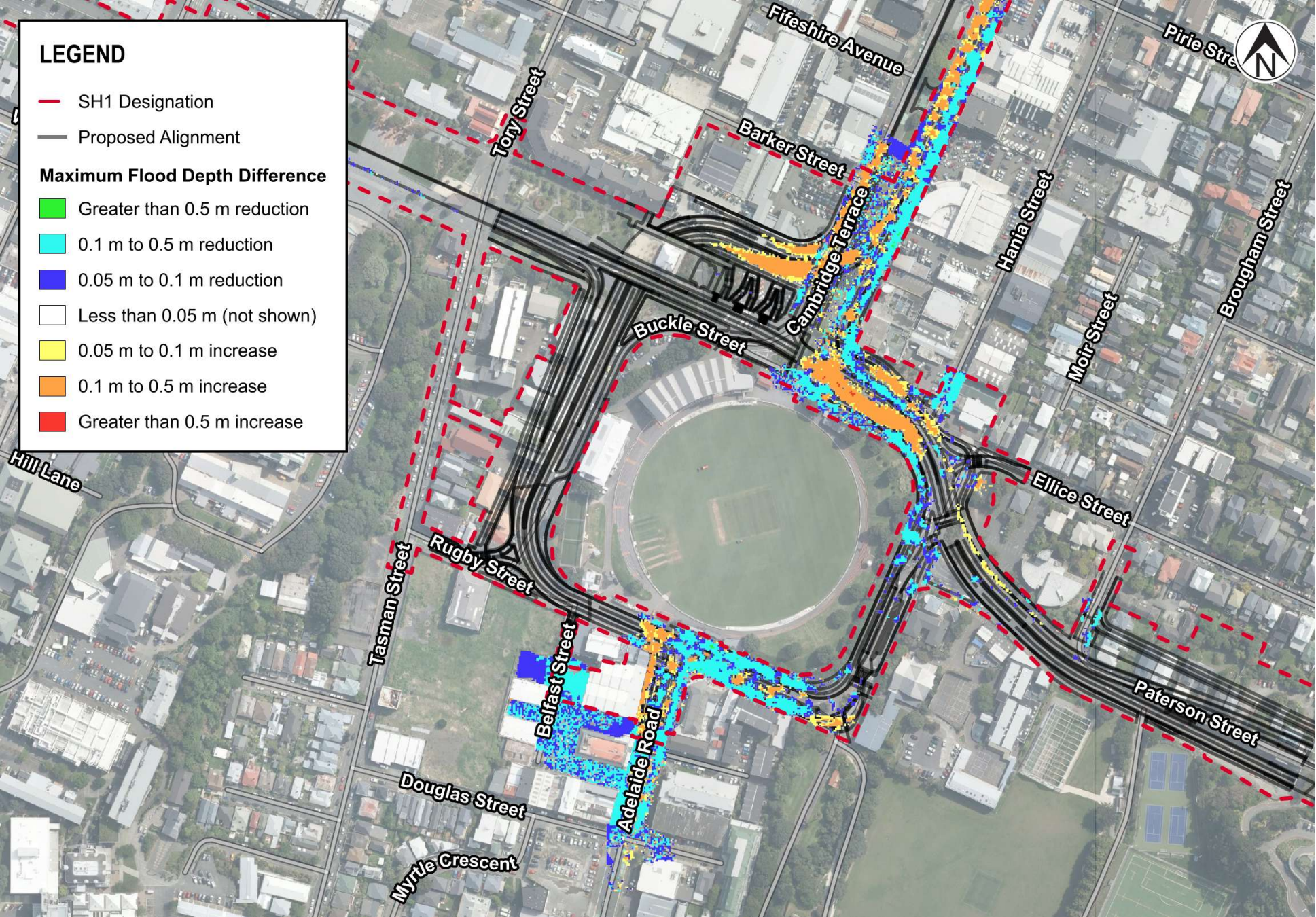


Figure C.14 Basin Reserve post-development 10 % AEP flood depth differences



Figure C.15 Eastern Connections post-development 10 % AEP flood mapping

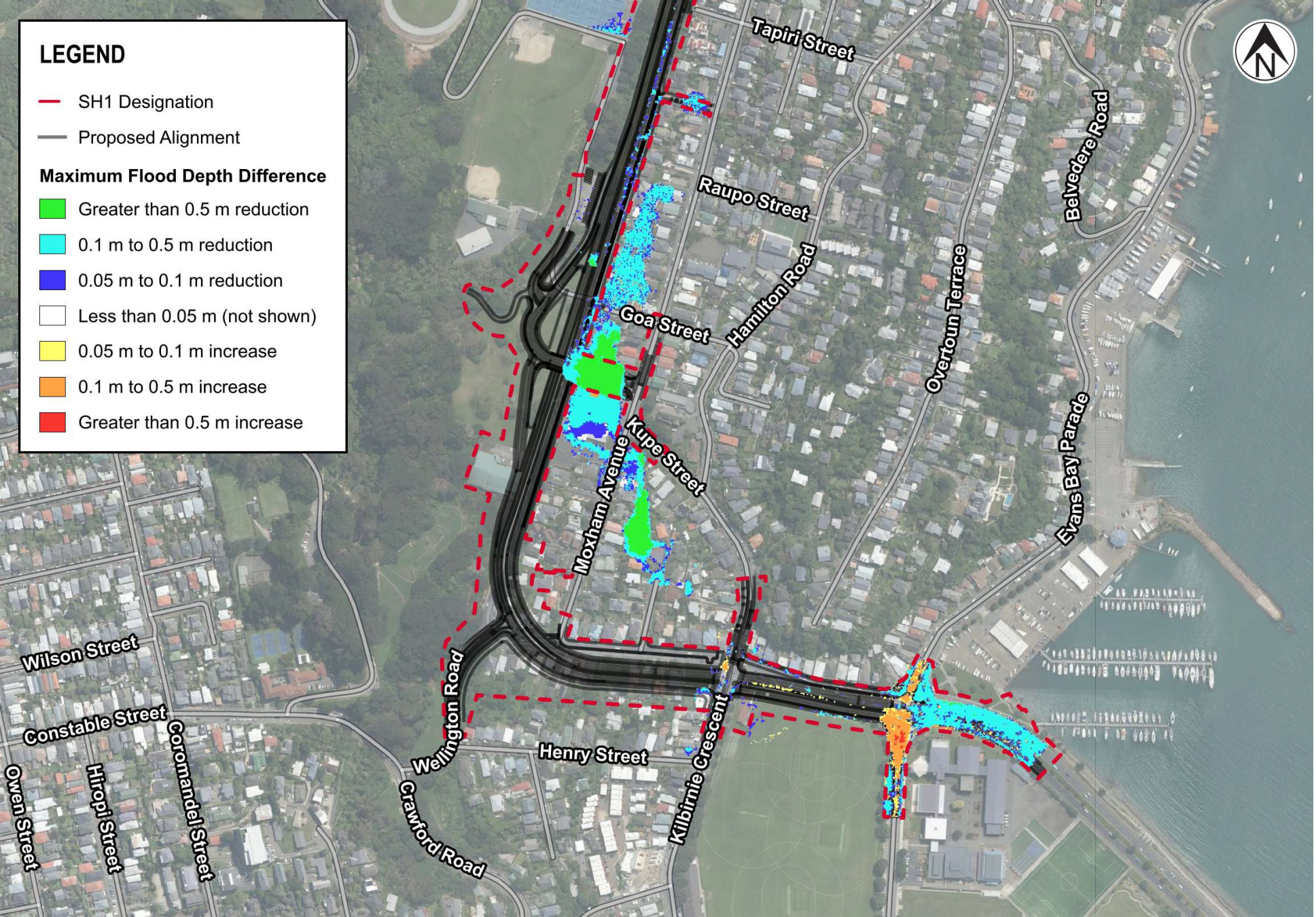


Figure C.16 Eastern Connections post-development 10 % AEP flood depth differences

ANNEXURE D – SH1WI CLM scenario modelling output

- **Mitigated Project 2033 compared to Present Day existing SH1**
- **Mitigated Project 2033 compared to Unmitigated Project 2033**

SH1WI Concept Design				Present Day																Opt 33 (unmitigated, but with catchpits)												Unm		
Area/ Receiving environment	Road name		2026 Design Traffic volume vpd	Effective Traffic loading vpd	Road characteristics				Treatment		Load reduction factor (catchpits)				Annual contaminant load (g/year)				Design Traffic volume vpd	Traffic loading vpd	Increased Traffic	Road characteristics				Annual contaminant load (g/year)				Δ Load (g/				
					CLY Road width	Effective Road width	Road length	Road area	Area treated	Device	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH				CLY Road width	Effective Road width	Road length	Road area	TSS	Zn	Cu	TPH	TSS	Zn			
Lambton Harbour	Kumototo Awa	Terrace Tunnel to Western project extents (Aurora Tce)	Tw	55,082	55,082	24	24	656	15,744	100%	Catchpit	0.20	0.11	0.15	0.15	1,637,986	5,268	1,677	38,068	68,650	68,650	24.6%	24	24	656	15,744	1,904,701	6,191	1,971	44,741	266,716	923		
	Waimapihi	One Terrace Tunnel	Tw	55,252	55,252	24	24	457	10,968	100%	Cpit/Prop	0.85	0.52	0.74	0.83	214,414	1,984	362	5,473															
		Terrace Tunnel NB	Ow																	33,720	67,440	22.1%	24		12	457	5,484	122,914	1,149	209	3,168	91,499	835	
		Terrace Tunnel SB	Ow																	34,930	69,860	New route	24		12	450	5,400	123,939	1,160	211	3,199	123,939	1,160	
		Terrace Tunnel SB southern portal to Ghuznee	Ow																	34,930	69,860	New route	24		12	177	2,124	48,749	456	83	1,258	48,749	456	
		NB Willis to Terrace Tunnel	Ow	30,333	60,665	24	12	461	5,532	100%	Catchpit	0.20	0.11	0.15	0.15	615,234	1,990	633	14,376	33,720	67,440	11.2%	24	12	461	5,532	661,280	2,148	684	15,523	46,046	159		
		NB Victoria to Willis	Ow	29,381	58,761	24	12	92	1,104	100%	Catchpit	0.20	0.11	0.15	0.15	120,114	388	123	2,802	32,980	65,960	12.3%	24	12	92	1,104	130,001	422	134	3,049	9,887	34		
		SB Terrace Tunnel to Willis, then Ghuznee to Willis	Ow	24,920	49,839	21	11	300	3,150	100%	Catchpit	0.20	0.11	0.15	0.15	305,678	976	311	7,054	34,930	69,860	40.2%	24	12	123	1,476	180,675	588	187	4,247	-	125,004	-	388
		Vivian St (Willis to Victoria St)	Ow	26,943	53,885	24	12	80	960	100%	Catchpit	0.20	0.11	0.15	0.15	98,365	316	101	2,283	37,520	75,040	39.3%	24	12	80	960	123,239	402	128	2,903	24,874	86		
		Vivian St (Victoria to Cuba St)	Ow	17,643	35,286	21	11	180	1,890	100%	Catchpit	0.20	0.11	0.15	0.15	144,202	443	141	3,201	25,900	51,800	46.8%	24	12	180	2,160	215,325	690	219	4,983	71,123	247		
		Sub-total						1,570	23,604	100%						1,498,007	6,096	1,670	35,189						2,020	24,240	1,606,122	7,013	1,856	38,330	108,115	917		
	Moturoa	Karo Dr (Cuba to Victoria St)	Ow	26,641	53,282	24	12	196	2,352	100%	Catchpit	0.20	0.11	0.15	0.15	239,115	767	244	5,545	31,020	62,040	16.4%	24	12	196	2,352	265,628	860	274	6,214	26,513	93		
		Vivian St (Cuba to Taranaki St)	Ow	16,310	32,619	21	11	216	2,268	100%	Catchpit	0.20	0.11	0.15	0.15	163,944	498	158	3,595	26,100	52,200	60.1%	24	12	216	2,592	259,779	832	265	6,016	95,835	335		
		Sub-total						412	4,620	100%						403,059	1,265	403	9,140						412	4,944	525,406	1,692	539	12,229	122,347	427		
	Tory Street SW	Vivian St / Tory St)	Ow	19,297	38,593	21	11	15	158	100%	Catchpit	0.20	0.11	0.15	0.15	12,786	40	13	287	27,110	54,220	40.5%	24	12	15	180	18,523	60	19	430	5,737	20		
		Sub-total						15	158	100%						12,786	40	13	287						15	180	18,523	60	19	430	5,737	20		
	Waitangi Awa	Vivian St (Tory St to Cambridge Tce)	Ow	20,978	41,955	21	11	246	2,583	100%	Catchpit	0.20	0.11	0.15	0.15	222,252	698	222	5,045	30,270	60,540	44.3%	24	12	246	2,952	327,838	1,060	337	7,660	105,586	362		
		Kent Tce (Pirie St to Basin Reserve) SB	Ow	27,251	54,502	24	12	440	5,280	100%	Catchpit	0.20	0.11	0.15	0.15	545,302	1,753	558	12,665								-	-	-	-	545,302	-	1,753	
		Kent Tce (Pirie St/Vivian St to Barker) SB	Ow																	35,850	71,700	New route	24	12	165	1,980	308,275	902	301	6,825	308,275	902		
		Kent Tce (Barker to Basin Reserve) SB	Ow																	27,650	55,300	New route	24	12	115	1,380	179,959	520	173	3,937	179,959	520		
		Kent Tce to Sussex St	Ow																	8,200	16,400	New route	17	9	71	604	35,068	81	27	612	35,068	81		
		Karo Dr (Taranaki to Cuba St)	Ow	25,792	51,584	24	12	212	2,544	100%	Catchpit	0.20	0.11	0.15	0.15	252,868	810	258	5,850	31,020	62,040	20.3%	24	12	212	2,544	287,312	930	296	6,721	34,444	120		
		Vivian St (Taranaki to Tory St)	Ow	19,297	38,593	21	11	197	2,069	100%	Catchpit	0.20	0.11	0.15	0.15	167,924	522	166	3,774	27,110	54,220	40.5%	24	12	197	2,364	243,269	782	249	5,648	75,345	259		
		Mt Vic to Basin Reserve (N&S)	Tw	43,422	43,422	21	21	280	5,880	100%	Catchpit	0.20	0.11	0.15	0.15	518,224	1,634	520	11,807	58,530	58,530	34.8%	24	24	280	6,720	729,144	2,353	749	17,007	210,921	720		
		Mt Vic Tunnel	Tw	43,422	43,422	21	21	620	13,020	100%	Cpit/Prop	0.85	0.52	0.74	0.83	215,155	1,951	356	5,383															
		Mt Vic Tunnel EB	Ow																	29,190	58,380	New route	24	12	620	7,440	151,095	1,403	256	3,869	151,095	1,403		
		Mt Vic Tunnel WB	Ow																	29,340	58,680	35.1%	24	12	620	7,440	151,630	1,408	257	3,884	63,525	-	543	
		Cambridge (Basin to Vivian)	Ow	4,941	9,882	17	9	285	2,423	100%	Catchpit	0.20	0.11	0.15	0.15	85,852	181	57	1,305	5,940	11,880	20.2%	17	9	165	1,403	54,511	124	40	898	-	31,341	-	56
		Paterson to Adelaide (Rugby/Dufferin St)	Ow	27,848	55,695	24	12	209	2,508	100%	Catchpit	0.20	0.11	0.15	0.15	262,940	846	269	6,115	3,820	7,640	86.3%	17	9	209	1,777	56,048	104	33	751	-	206,892	-	742
		Adelaide St	Tw	20,107	20,107	21	21	60	1,260	100%	Catchpit	0.20	0.11	0.15	0.15	66,270	181	58	1,307	21,070	21,070	4.8%	21	21	60	1,260	68,244	189	60	1,363	1,974	8		
		Adelaide to Buckle (Sussex St)	Ow	34,904	69,808	24	12	285	3,420	100%	Catchpit	0.20	0.11	0.15	0.15	418,428	1,361	433	9,834															
		Adelaide to Buckle (Sussex St)	Tw																	21,530	21,530	New route	21	21	285	5,985	410,772	1,026	342	7,767	7,655	-	334	
		Sussex to Cambridge	Ow	5,542	11,084	17	9	97	825	100%	Catchpit	0.20	0.11	0.15	0.15	30,924	68	22	495	890	1,780	83.9%	17	9	88	748	15,832	11	4	81	-	15,092	-	57
		Sussex to Cambridge	Tw																	10,510	10,510	New route	17	17	150	2,550	116,410	226	75	1,712	116,410	226		
		Cambridge to Kent	Ow	1,102	2,204	17	9	65	553	100%	Catchpit	0.20	0.11	0.15	0.15	12,115	10	3	73															
		Kent to Paterson	Ow	29,838	59,675	24	12	126	1,512	100%	Catchpit	0.20	0.11	0.15	0.15	166,263	537	171	3,882	28,450	56,900	-4.7%	24	12	126	1,512	160,887	518	165	3,747	-	5,376	-	19
		Basin to Sussex	Ow																	26,110	52,220	New route	24	12	105	1,260	157,894	455	152	3,441	157,894	455		
		Paterson to Basin	Ow																	30,680	61,360	New route	24	12	160	1,920	269,009	782	261	5,920	269,009	782		
		Basin to Cambridge	Ow																	3,680	7,360	New route	17	9	53	451	17,491	29	10	216	17,491	29		
		Arras Tunnel (Sussex to Taranaki)	Ow	29,092	58,184	24	12																											

Mitigated Change (v Present-day)						Opt 33 (mitigated)																		Mitigated Change (v Pre)								Change (Mitigated v Unmitigated)								Traffic
Year		Unmitigated				Treatment Device 1		Load reduction factor				Complementary treatment		Load reduction factor				Annual contaminant load (g/year)				Δ Load (g/year)				Mitigated vs Pre				Δ Yield (g/year)				Mitigated vs Unmitigated						
	Cu	TPH	TSS	Zn	Cu	TPH	Area treated	Device	TSS	Zn	Cu	TPH	Area treated	Catchpit filters	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH		
	294	6,673	16%	18%	18%	18%	17%	Stormfilter	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	1,247,238	5,189	1,548	32,170	- 390,747	- 79	- 129	- 5,898	-24%	-2%	-8%	-15%	- 657,463	- 1,003	- 423	- 12,571	-35%	-16%	-21%	-28%		
	152	2,305					100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	122,914	1,149	209	3,168	- 91,499	- 835	- 152	- 2,305	-43%	-42%	-42%	-42%	-	-	-	-	0%	0%	0%	0%	61%	
	211	3,199	15%	16%	16%	16%	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	123,939	1,160	211	3,199	- 123,939	- 1,160	- 211	- 3,199					-	-	-	-	0%	0%	0%	0%		
	83	1,258	New rout	New rout	New rout	New rout	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	48,749	456	83	1,258	- 48,749	- 456	- 83	- 1,258					-	-	-	-	0%	0%	0%	0%		
	51	1,147	7%	8%	8%	8%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	495,960	1,931	603	12,784	- 119,274	- 59	- 30	- 1,593	-19%	-3%	-5%	-11%	- 165,320	- 217	- 80	- 2,739	-25%	-10%	-12%	-18%		
	11	247	8%	9%	9%	9%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	97,501	379	119	2,511	- 22,613	- 8	- 5	- 291	-19%	-2%	-4%	-10%	- 32,500	- 43	- 16	- 538	-25%	-10%	-12%	-18%		
	124	2,807	-41%	-40%	-40%	-40%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	135,506	528	165	3,497	- 170,172	- 448	- 146	- 3,556	-56%	-46%	-47%	-50%	- 45,169	- 59	- 22	- 749	-25%	-10%	-12%	-18%		
	27	620	25%	27%	27%	27%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	92,429	361	113	2,391	- 5,935	- 45	- 12	- 108	-6%	14%	12%	5%	- 30,810	- 41	- 15	- 512	-25%	-10%	-12%	-18%		
	79	1,782	49%	56%	56%	56%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	161,494	620	194	4,104	- 17,292	- 177	- 53	- 903	12%	40%	37%	28%	- 53,831	- 70	- 26	- 879	-25%	-10%	-12%	-18%		
	186	3,142	7%	15%	11%	9%	54%												1,278,492	6,584	1,697	32,912	- 219,515	- 487	- 27	- 2,277	-15%	8%	2%	-6%	- 327,630	- 430	- 159	- 5,419	-20%	-6%	-9%	-14%		
	29	669	11%	12%	12%	12%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	199,221	773	241	5,117	- 39,894	- 6	- 3	- 428	-17%	1%	-1%	-8%	- 66,407	- 87	- 32	- 1,097	-25%	-10%	-12%	-18%		
	107	2,420	58%	67%	67%	67%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	194,834	748	234	4,954	- 30,890	- 251	- 75	- 1,359	19%	50%	48%	38%	- 64,945	- 84	- 31	- 1,062	-25%	-10%	-12%	-18%		
	136	3,089	30%	34%	34%	34%	0%												394,055	1,521	475	10,071	- 9,004	- 256	- 73	- 931	-2%	20%	18%	10%	- 131,352	- 171	- 63	- 2,158	-25%	-10%	-12%	-18%		
	6	143	45%	50%	50%	50%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	13,892	53	17	354	- 1,106	- 14	- 4	- 67	9%	35%	32%	23%	- 4,631	- 6	- 2	- 76	-25%	-10%	-12%	-18%		
	6	143	45%	50%	50%	50%	0%												13,892	53	17	354	- 1,106	- 14	- 4	- 67	9%	35%	32%	23%	- 4,631	- 6	- 2	- 76	-25%	-10%	-12%	-18%		
	115	2,615	48%	52%	52%	52%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	245,878	953	298	6,308	- 23,627	- 255	- 75	- 1,263	11%	36%	34%	25%	- 81,959	- 107	- 40	- 1,352	-25%	-10%	-12%	-18%		
	- 558	- 12,665	-100%	-100%	-100%	-100%																- 545,302	- 1,753	- 558	- 12,665					-	-	-	-							
	301	6,825	New rout	New rout	New rout	New rout							100%	Catchpit Filter	0.40	0.20	0.25	0.30	184,965	722	225	4,778	- 184,965	- 722	- 225	- 4,778					- 123,310	- 180	- 75	- 2,048	-40%	-20%	-25%	-30%		
	173	3,937	New rout	New rout	New rout	New rout	50%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	59,387	229	72	1,654	- 59,387	- 229	- 72	- 1,654					- 120,573	- 291	- 102	- 2,284	-67%	-56%	-59%	-58%		
	27	612	-4%	-14%	-10%	-10%	50%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	11,572	36	11	257	- 11,572	- 36	- 11	- 257					- 23,496	- 45	- 16	- 355	-67%	-56%	-59%	-58%		
	38	871	14%	15%	15%	15%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	215,484	836	261	5,535	- 37,384	- 26	- 4	- 315	-15%	3%	1%	-5%	- 71,828	- 94	- 35	- 1,186	-25%	-10%	-12%	-18%		
	83	1,874	45%	50%	50%	50%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	182,451	703	220	4,651	- 14,528	- 180	- 53	- 877	9%	35%	32%	23%	- 60,817	- 79	- 29	- 997	-25%	-10%	-12%	-18%		
	229	5,199	41%	44%	44%	44%	100%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	54,686	212	66	2,801	- 463,538	- 1,422	- 454	- 9,006	-89%	-87%	-87%	-76%	- 674,458	- 2,142	- 683	- 14,205	-93%	-91%	-91%	-84%		
	256	3,869	New rout	New rout	New rout	New rout	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	151,095	1,403	256	3,869	- 151,095	- 1,403	- 256	- 3,869					-	-	-	-	0%	0%	0%	0%	13%	
	- 99	- 1,499	41%	44%	44%	44%	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	151,630	1,408	257	3,884	- 63,525	- 543	- 99	- 1,499	-30%	-28%	-28%	-28%	-	-	-	-	0%	0%	0%	0%		
	- 18	- 407	-37%	-31%	-31%	-31%	0%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	40,883	112	35	739	- 44,969	- 69	- 23	- 566	-52%	-38%	-39%	-43%	- 13,628	- 13	- 5	- 158	-25%	-10%	-12%	-18%		
	- 236	- 5,364	-79%	-88%	-88%	-88%	100%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	4,204	9	3	124	- 258,736	- 837	- 266	- 5,991	-98%	-99%	-99%	-98%	- 51,844	- 95	- 30	- 627	-93%	-91%	-91%	-84%		
	2	56	3%	4%	4%	4%	0%						100%	Catchpit Filter	0.40	0.20	0.25	0.30	51,183	170	53	1,123	- 15,087	- 11	- 5	- 184	-23%	-6%	-8%	-14%	- 17,061	- 19	- 7	- 241	-25%	-10%	-12%	-18%		
			-100%	-100%	-100%	-100%																																		
	- 91	- 2,068	New rout	New rout	New rout	New rout	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	61,616	493	90	1,359	- 356,812	- 868	- 343	- 8,475	-85%	-64%	-79%	-86%	- 349,156	- 534	- 252	- 6,408	-85%	-52%	-74%	-83%		
	- 18	- 414	-49%	-84%	-84%	-84%	100%																																	

SH1WI Concept Design			DM WCC 33																Opt 33 (unmitigated, but with catchpits)														
Area/ Receiving enivronment	Road name		2033 Design Traffic volume vpd	Effective Traffic loading vpd	Road characteristics				Treatment		Load reduction factor (catchpits)				Annual contaminant load (g/year)				Design Traffic volume vpd	Traffic loading vpd	Increased Traffic	Road characteristics				Annual contaminant load (g/year)				Δ Load (g/			
					CLY Road width	Effective Road width	Road length	Road area	Area treated	Device	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH				CLY Road width	Effective Road width	Road length	Road area	TSS	Zn	Cu	TPH	TSS	Zn		
Lambton Harbour	Kumototo Awa	Terrace Tunnel to Western project extents (Aurora Tce)	Tw	55,950	55,950	24	24	656	15,744	100%	Catchpit	0.20	0.11	0.15	0.15	1,655,843	5,331	1,697	38,520	68,650	68,650	22.7%	24	24	656	15,744	1,904,701	6,191	1,971	44,741	248,858	861	
	Waimapihi	One Terrace Tunnel	Tw	56,290	56,290	24	24	457	10,968	100%	Cpit/Prop	0.85	0.52	0.74	0.83	217,198	2,012	367	5,550														
		Terrace Tunnel NB	Ow																	33,720	67,440	New 100%	24		12	457	5,484	122,914	1,149	209	3,168	94,284	863
		Terrace Tunnel SB	Ow																	34,930	69,860	New 100%	24		12	450	5,400	123,939	1,160	211	3,199	123,939	1,160
		Terrace Tunnel SB southern portal to Ghuznee	Ow													-	-	-	-	34,930	69,860	New 100%	24		12	177	2,124	48,749	456	83	1,258	48,749	456
		NB Willis to Terrace Tunnel	Ow	31,130	62,260	24	12	461	5,532	100%	Catchpit	0.20	0.11	0.15	0.15	626,284	2,028	645	14,653	33,720	67,440	8.3%	24		12	461	5,532	661,280	2,148	684	15,523	34,996	120
		NB Victoria to Willis	Ow	29,960	59,920	24	12	92	1,104	100%	Catchpit	0.20	0.11	0.15	0.15	121,741	393	125	2,843	32,980	65,960	10.1%	24		12	92	1,104	130,001	422	134	3,049	8,260	29
		SB Terrace Tunnel to Willis, then Ghuznee to Willis	Ow	25,160	50,320	24	12	300	3,600	100%	Catchpit	0.20	0.11	0.15	0.15	351,696	1,124	358	8,122	34,930	69,860	38.8%	24		12	123	1,476	180,675	588	187	4,247	171,021	536
		Vivian St (Willis to Victoria St)	Ow	27,620	55,240	24	12	80	960	100%	Catchpit	0.20	0.11	0.15	0.15	100,076	322	102	2,326	37,520	75,040	35.8%	24		12	80	960	123,239	402	128	2,903	23,163	80
		Vivian St (Victoria to Cuba St)	Ow	18,940	37,880	21	11	180	1,890	100%	Catchpit	0.20	0.11	0.15	0.15	151,459	470	150	3,396	25,900	51,800	36.7%	24		12	180	2,160	215,325	690	219	4,983	63,867	220
		Sub-total						1,570	24,054	100%						1,568,453	6,349	1,747	36,890							2,020	24,240	1,606,122	7,013	1,856	38,330	37,669	664
	Moturoa	Karo Dr (Cuba to Victoria St)	Ow	27,220	54,440	24	12	196	2,352	100%	Catchpit	0.20	0.11	0.15	0.15	242,715	780	248	5,637	31,020	62,040	14.0%	24		12	196	2,352	265,628	860	274	6,214	22,912	80
		Vivian St (Cuba to Taranaki St)	Ow	17,270	34,540	21	11	216	2,268	100%	Catchpit	0.20	0.11	0.15	0.15	170,512	522	166	3,773	26,100	52,200	31.1%	24		12	216	2,592	259,779	832	265	6,016	89,266	310
		Sub-total					412	4,620	100%							413,228	1,302	414	9,410							412	4,944	525,406	1,692	539	12,229	112,178	390
	Tory Street SW	Vivian St (Taranaki to Tory St)	Ow	19,960	39,920	21	11	15	158	100%	Catchpit	0.20	0.11	0.15	0.15	13,090	41	13	295	27,110	54,220	35.8%	24		12	15	180	18,523	60	19	430	5,433	19
		Sub-total					15	158	100%							13,090	41	13	295							15	180	18,523	60	19	430	5,433	19
	Waitangi Awa	Vivian St (Tory St to Cambridge Tce)	Ow	21,510	43,020	21	11	246	2,583	100%	Catchpit	0.20	0.11	0.15	0.15	226,174	712	227	5,148	30,270	60,540	40.7%	24		12	246	2,952	327,838	1,060	337	7,660	101,663	348
		Kent Tce (Pirie St to Basin Reserve) SB	Ow	27,140	54,280	24	12	440	5,280	100%	Catchpit	0.20	0.11	0.15	0.15	543,759	1,747	556	12,625												543,759	1,747	
		Kent Tce (Pirie St/Vivian St to Barker) SB	Ow																	35,850	71,700	New 100%	24		12	165	1,980	308,275	902	301	6,825	308,275	902
		Kent Tce (Barker to Basin Reserve) SB	Ow																	27,650	55,300	New 100%	24		12	115	1,380	179,959	520	173	3,937	179,959	520
		Kent Tce to Sussex St	Ow																	8,200	16,400	New 100%	17		9	71	604	35,068	81	27	612	35,068	81
		Karo Dr (Taranaki to Cuba St)	Ow	27,040	54,080	24	12	212	2,544	100%	Catchpit	0.20	0.11	0.15	0.15	261,322	839	267	6,066	31,020	62,040	14.7%	24		12	212	2,544	287,312	930	296	6,721	25,990	91
		Vivian St (Taranaki to Tory St)	Ow	19,960	39,920	21	11	197	2,069	100%	Catchpit	0.20	0.11	0.15	0.15	171,919	537	171	3,880	27,110	54,220	35.8%	24		12	197	2,364	243,269	782	249	5,648	71,349	245
		Mt Vic to Basin Reserve (N&S)	Tw	43,980	43,980	21	21	280	5,880	100%	Catchpit	0.20	0.11	0.15	0.15	522,866	1,651	525	11,929	58,530	58,530	33.1%	24		24	280	6,720	729,144	2,353	749	17,007	206,278	703
		Mt Vic Tunnel	Tw	43,980	43,980	21	21	620	13,020	100%	Cpit/Prop	0.85	0.52	0.74	0.83	217,083	1,971	359	5,438														
		Mt Vic Tunnel EB	Ow																	29,190	58,380	New 100%	24		12	620	7,440	151,095	1,403	256	3,869	151,095	1,403
		Mt Vic Tunnel WB	Ow																	29,340	58,680	New 100%	24		12	620	7,440	151,630	1,408	257	3,884	65,453	563
		Cambridge (Basin to Vivian)	Ow	5,100	10,200	17	9	285	2,423	100%	Catchpit	0.20	0.11	0.15	0.15	87,179	186	59	1,344	5,940	11,880	16.5%	17		9	165	1,403	54,511	124	40	898	32,668	62
		Paterson to Adelaide (Rugby/Dufferin St)	Ow	27,720	55,440	24	12	209	2,508	100%	Catchpit	0.20	0.11	0.15	0.15	262,104	843	268	6,094	3,820	7,640	86.2%	17		9	209	1,777	56,048	104	33	751	206,057	739
		Adelaide St	Tw	19,190	19,190	17	17	60	1,020	100%	Catchpit	0.20	0.11	0.15	0.15	52,118	140	45	1,015	21,070	21,070	9.8%	21		21	60	1,260	68,244	189	60	1,363	16,126	48
		Adelaide to Buckle (Sussex St)	Ow	35,770	71,540	24	12	285	3,420	100%	Catchpit	0.20	0.11	0.15	0.15	425,346	1,385	441	10,005														
		Adelaide to Buckle (Sussex St)	Tw																	21,530	21,530	New 100%	21		21	285	5,985	328,618	914	291	6,602	96,728	471
		Sussex to Cambridge	Ow	6,020	12,040	17	9	97	825	100%	Catchpit	0.20	0.11	0.15	0.15	32,271	74	24	534	890	1,780	85.2%	17		9	88	748	15,832	11	4	81	16,439	63
		Sussex to Cambridge	Tw																	10,510	10,510	New 100%	17		17	150	2,550	93,128	201	64	1,455	93,128	201
		Cambridge to Kent	Ow	1,180	2,360	17	9	65	553	100%	Catchpit	0.20	0.11	0.15	0.15	12,270	11	3	77												12,270	11	
		Kent to Paterson	Ow	29,840	59,680	24	12	126	1,512	100%	Catchpit	0.20	0.11	0.15	0.15	166,272	537	171	3,882	28,450	56,900	-4.7%	24		12	126	1,512	160,887	518	165	3,747	5,386	19
		Basin to Sussex	Ow																	28,450	56,900	New 100%	24		12	105	1,260	167,590	485	162	3,673	167,590	485
		Paterson to Basin	Ow																	30,680	61,360	New 100%	24		12	160	1,920	269,009	782	261	5,920	269,009	782
		Basin to Cambridge	Ow																	3,680	7,360	New 100%	17		9	53	451	17,491	29	10	216	17,491	29
		Arras Tunnel (Sussex Tunnel																															

year)	Change (v Pre)						Opt 33 (mitigated)										Change (Mitigated v Pre)								Change (Mitigated v Unmitigated)																					
	Unmitigated						Treatment Device 1		Load reduction factor				Complementary treatment		Load reduction factor				Annual contaminant load (g/year)				Δ Yield (g/year)				Mitigated vs Pre				Δ Load (g/year)				Mitigated vs Unmitigated				Traffic							
	Cu	TPH	TSS	ZN	Cu	TPH	Area treated	Device	TSS	Zn	Cu	TPH	Area treated	Catchpit filters	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	Zn	Cu	TPH	TSS	ZN	Cu	TPH								
	274	6,220	15%	16%	16%	16%	17%	Stormfilter	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	1,247,238	5,189	1,548	32,170	-	408,605	-	142	-	149	-	6,351	-25%	-3%	-9%	-16%	657,463	-	1,003	-	423	-	12,571	-35%	-16%	-21%	-28%	
																																							60%							
-	157	2,382	-43%	-43%	-43%	-43%	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	122,914	1,149	209	3,168	-	122,914	-	1,149	-	209	-	3,168					-	-	-	-	-	0%	0%	0%	0%			
	211	3,199	New route	New route	New route	New route	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	123,939	1,160	211	3,199	-	93,260	-	852	-	155	-	2,352	-43%	-42%	-42%	-42%	-	-	-	-	-	0%	0%	0%	0%			
	83	1,258	New route	New route	New route	New route	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	48,749	456	83	1,258	-	48,749	-	456	-	83	-	1,258					-	-	-	-	-	0%	0%	0%	0%			
	38	870	6%	6%	6%	6%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	495,960	1,931	603	12,784	-	130,324	-	97	-	42	-	1,869	-21%	-5%	-7%	-13%	165,320	-	217	-	80	-	2,739	-25%	-10%	-12%	-18%	
	9	206	7%	7%	7%	7%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	97,501	379	119	2,511	-	24,240	-	14	-	7	-	332	-20%	-4%	-5%	-12%	32,500	-	43	-	16	-	538	-25%	-10%	-12%	-18%	
-	171	-	3,875	-49%	-48%	-48%	100%	Catchpit Filter	0.40	0.20	0.25	0.30	100%	Catchpit Filter	0.40	0.20	0.25	0.30	135,506	528	165	3,497	-	216,190	-	596	-	193	-	4,624	-61%	-53%	-54%	-57%	45,169	-	59	-	22	-	749	-25%	-10%	-12%	-18%	
	25	577	23%	25%	25%	25%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	92,429	361	113	2,391	-	7,647	-	39	-	10	-	65	-8%	12%	10%	3%	30,810	-	41	-	15	-	512	-25%	-10%	-12%	-18%	
	70	1,588	42%	47%	47%	47%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	161,494	620	194	4,104	-	10,035	-	150	-	44	-	708	7%	32%	29%	21%	53,831	-	70	-	26	-	879	-25%	-10%	-12%	-18%	
	109	1,441	2%	10%	6%	4%	62%								1,278,492	6,584	1,697	32,912	-	289,961	235	-	50	-	3,978	-18%	4%	-3%	-11%	-	327,630	-	430	-	159	-	5,419	-20%	-6%	-9%	-14%					
	25	577	9%	10%	10%	10%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	199,221	773	241	5,117	-	43,495	-	7	-	7	-	519	-18%	-1%	-3%	-9%	66,407	-	87	-	32	-	1,097	-25%	-10%	-12%	-18%	
	99	2,242	52%	59%	59%	59%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	194,834	748	234	4,954	-	24,322	-	226	-	68	-	1,181	14%	43%	41%	31%	64,945	-	84	-	31	-	1,062	-25%	-10%	-12%	-18%	
	124	2,820	27%	30%	30%	30%	0%						100%						394,055	1,521	475	10,071	-	19,173	-	219	-	61	-	661	-5%	17%	15%	7%	131,352	-	171	-	63	-	2,158	-25%	-10%	-12%	-18%	
	6	135	42%	46%	46%	46%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	13,892	53	17	354	-	802	-	13	-	4	-	59	6%	31%	28%	20%	4,631	-	6	-	2	-	76	-25%	-10%	-12%	-18%	
	6	135	42%	46%	46%	46%	0%								13,892	53	17	354	-	802	13	-	4	-	59	-	6%	31%	28%	20%	4,631	-	6	-	2	-	76	-25%	-10%	-12%	-18%					
	111	2,512	45%	49%	49%	49%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	245,878	953	298	6,308	-	19,704	-	240	-	71	-	1,160	9%	34%	31%	23%	81,959	-	107	-	40	-	1,352	-25%	-10%	-12%	-18%	
-	556	-	12,625																543,759	1,747	-	556	-	12,625	-																					
	301	6,825	New route	New route	New route	New route							100%	Catchpit Filter	0.40	0.20	0.25	0.30	184,965	722	225	4,778	-	184,965	-	722	-	225	-	4,778	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	123,310	-	180	-	75	-	2,048	-40%	-20%	-25%	-30%	
	173	3,937	New route	New route	New route	New route	50%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	59,387	229	72	1,654	-	59,387	-	229	-	72	-	1,654	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	120,573	-	291	-	102	-	2,284	-67%	-56%	-59%	-58%	
	27	612	New route	New route	New route	New route	50%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	11,572	36	11	257	-	11,572	-	36	-	11	-	257	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	23,496	-	45	-	16	-	355	-67%	-56%	-59%	-58%	
	29	655	10%	11%	11%	11%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	215,484	836	261	5,535	-	45,838	-	3	-	6	-	531	-18%	0%	-2%	-9%	71,828	-	94	-	35	-	1,186	-25%	-10%	-12%	-18%	
	78	1,768	42%	46%	46%	46%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	182,451	703	220	4,651	-	10,532	-	166	-	49	-	771	6%	31%	28%	20%	60,817	-	79	-	29	-	997	-25%	-10%	-12%	-18%	
	224	5,078	39%	43%	43%	43%	100%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	54,686	212	66	2,801	-	468,180	-	1,439	-	459	-	9,128	-90%	-87%	-87%	-77%	674,458	-	2,142	-	683	-	14,205	-93%	-91%	-91%	-84%	
	256	3,869	New route	New route	New route	New route	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	151,095	1,403	256	3,869	-	151,095	-	1,403	-	256	-	3,869					-	-	-	-	-	0%	0%	0%	0%			
-	103	-	1,554	-30%	-29%	-29%	100%	Proprietary	0.75	0.40	0.65	0.75	100%	Catchpit Filter	0.40	0.20	0.25	0.30	151,630	1,408	257	3,884	-	65,453	-	563	-	103	-	1,554	-30%	-29%	-29%	-29%	-	-	-	-	-	0%	0%	0%	0%			
-	20	-	447	-37%	-33%	-33%	0%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	40,883	112	35	739	-	46,296	-	74	-	24	-	605	-53%	-40%	-41%	-45%	13,628	-	13	-	5	-	158	-25%	-10%	-12%	-18%	
-	235	-	5,343	-79%	-88%	-88%	100%	Raingarden	0.90	0.90	0.90	0.80	100%	Catchpit Filter	0.40	0.20	0.25	0.30	4,204	9	3	124	-	257,901	-	834	-	265	-	5,970	-98%	-99%	-99%	-98%	51,844	-	95	-	30	-	627	-93%	-91%	-91%	-84%	
	15	349	31%	34%	34%	34%							100%	Catchpit Filter	0.40	0.20	0.25	0.30	51,183	170	53	1,123	-	935	-	29	-</																			