Outfall MCC_108749	Discretionary treatment of existing network	GPT	Raingardens are proposed for slightly more than half of the busway and two thirds of the westbound lanes of Ti Rakau Drive. All Project stormwater for this outfall is treated by a GPT.
A new outfall	EBA BPO (Discretionary treatment of Gossamer Drive)	Raingardens	A GPT is proposed to treat 240 m of Ti Rakau Drive prior to the Ti Rakau Drive Bridge. This section of Ti Rakau Drive is outside of the Project works and discretionary treatment targeting untreated high use road is proposed.

A CLM (see Section 4.2 for methodology and analysis) for EB3R has been developed to compare treatment options with existing contaminant load contributions from roads to each outfall that receives discharges or has its catchment changed (i.e., road source areas reduced). The CLM estimates the percent change from the existing situation for TSS, zinc, copper and TPH (see Table 6).

Except for Outfall MCC_108707, all outfalls that receive EBA stormwater will have a reduction in the existing contaminant loads for each contaminant assessed. As discussed in the design philosophy, the target is to reduce the existing contaminant load contributions from all roads to outfalls that interact with the Project on an overall basis. In addition, the final outcomes will be influenced by ongoing joint EBA and Healthy Waters hui with mana whenua. The CLM currently predicts EB3R achieving an overall improvement for each of the contaminants assessed (see Table 6). Outfall MCC_108707 is predicted to have an increase in contaminant load due to a 100% increase in road catchment area, with 300 m of east and westbound carriageway being diverted to its network from the network of MCC_108713. In part, this is because the network between Ti Rakau Drive and outfall MCC_108713 would be difficult to upgrade as the pipeline goes under and immediately adjacent to numerous houses.

Table 6: Summary of EB3R predicted change in contaminant loads

Outfall	TSS[1] (%)	Zinc[1] (%)	Copper[1] (%)	TPH (%)
Outfall MCC_108703	-75%	-74%	-76%	-78%
Outfall MCC_108707	-1%	74%	62%	49%
Outfalls MCC_108713	-100%	-100%	-100%	-100%
Outfall MCC_108718 & 108719	-30%	-15%	-19%	-23%
Outfall MCC_108738	-80%	-68%	-71%	-74%
Outfall MCC_108748	-61%	-40%	-45%	-51%
Outfall MCC_108746 and MCC_108749 and New Outfall	-65%	-59%	-66%	-72%
Total EB3R	-59%	-43%	-48%	-53%

Note: [1] Refer to Section 4.2.1 for general level of uncertainty associated with the CLM outputs.

2.4.5 Flood Management

A comprehensive flood model for EB3R (includes EB2 for assessing cumulative effects) has been developed for the Project based on an existing AC flood model for the Tāmaki River – Pakuranga Catchment Boundary. The methodology of the modification of the model is discussed in Section 4.3. The results of the flood modelling for the existing situation (the 'base case') are discussed in Sections 5.2.5 (assessment of flooding) and 5.2.6 (assessment of overland flow path capacity). The results for the design case are discussed in Sections 6.2.3 (assessment of flooding) and 6.2.4 (assessment of overland flow path capacity).

3 Specialist Assessment

Chapter Summary
Summary of key points/ findings • *EBA proposes to use Healthy Waters NDC to authorise EB2 and EB3R discharges of stormwater* • *This stormwater assessment covers stormwater discharges, flooding and overland flow path capacity* • *EBA works for EB2 and EB3R exceed 1,000 m^2 of new and modified impervious carriageway on high use roads and 5,000 m^2 on other roads thereby triggering category 3 NDC requirements* • *EBA will meet the category 3 connection requirements under schedule 4 of the NDC to obtain connection approval by AC* • *The EBA works will modify entry and exit points and capacity of overland flow paths due to geometric design changes to existing roads to accommodate the busway and other Project elements*

3.1 Assessment Content

This report describes the assessment of stormwater effects associated with the operation of EB2 and EB3R sections of the Project. The Project proposes to use the NDC to authorise stormwater discharges to new and existing outfalls. Schedule 4 of the NDC outlines the requirements for connection approval and this report is structured to demonstrate the Project meets these requirements. The connection approval process is part of the EPA process that approves the final detail design rather than up front during the resource consent application process. As the Project has adopted a BPO approach a SMP is required to be prepared and submitted for approval as part of the connection approval process.

Stormwater effects being assessed include permanent discharge of stormwater, and associated flooding and overland flow path capacity management. This report includes the completion of the WRR stormwater network which will replace the temporary connection to the existing 900 mm pipe covered in the WRR early works consenting package.

This stormwater assessment covers:

- Permanent (post-construction) stormwater discharges
- Permanent (post-construction) flooding
- Permanent (post-construction) overland flow path capacity.

This stormwater technical assessment excludes an assessment of:

- Construction of the stormwater system
- Temporary discharges of stormwater during construction phase (refer to technical assessment for erosion and sediment control)
- Removal and modification of asbestos cement pipes during construction (refer to technical assessments for construction and contaminated land)
- Potential effects on marine ecology (refer to the Marine Ecology and Coastal Avifauna Effects Assessment)
- Potential effects on natural wetlands (refer to the Terrestrial and Freshwater Ecological Effects Assessment).

3.2 Specific Project Elements

The elements of the proposal that are relevant to this technical assessment are:

- The road design for the busway and all associated cycleways and pedestrian paths
- The design of the RRF in relation to the downpipes into raingardens along Reeves Road

- The design of the stormwater system for EB2 and EB3R including stormwater treatment systems, and flood and overland flow management measures
- New or the redevelopment of existing impervious carriageway areas greater than 1,000 m^2 of high use roads, and greater than 5,000 m^2 of other roads
- The development of BPO (ongoing), contaminant load modelling and life cycle cost analysis will be documented in the final Stormwater Management Options and BPO Report which will be included in the SMP
- The existing flooding and overland flow paths and the flood modelling methods and model development is documented in the Flood Model Build Report provided in Appendix 4.

3.3 NDC Connection Requirements

3.3.1 Overview

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

The proposed stormwater networks and their connections and discharge of stormwater to existing outfalls are proposed to be authorised under the Healthy Waters NDC. Under the NDC, AT Projects are covered under a special section for AT, Kiwi Rail and Waka Kotahi in Schedule 4 which outlines connection requirements for four different size or risk categories. These categories are:

- Category 1 - small Projects up to 1,000 m^2 of new impervious area
- Category 2 - off-pedestrian and cycling facilities and ferry terminal facilities. New Impervious area greater than 1,000 m^2
- Category 3 - development of new/redevelopment of impervious area for:
    - existing high use roads that include new impervious area greater than 1,000 m^2
    - other roads that include new impervious area greater than 5,000 m^2
    - rail corridor Projects with new impervious area greater than 1,000 m^2
- Category 4 - development/redevelopment of a high contaminant generating carpark (new/redeveloped area greater than 1,000 m^2).

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

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

3.3.2 NDC Requirements for Category 3

The following section assesses the proposed EB2 and EB3R stormwater system against the NDC connection requirements for Category 3 of schedule 4. The category 3 connection requirements are summarised in Table 7 with only the applicable requirements included based on the Project area:

- Is not within an adopted SMP and is therefore covered by 'in other areas'
- Is not within a Stormwater Management Area Flow (SMAF) zone
- Has more than 5,000 m^2 of new impervious area.

The analysis of the Project against the category 3 connection requirements is provided in Section 4.4

Table 7: Summary of NDC Schedule 4 connection requirements for category 3

Issue/Receiving Environment	Connection Requirements
Catchment/Area	C1 No new/additional habitable floor affected by flooding in 1% ARP event and no increase in frequency of existing flooding
	C2 No significant increase in risk to the operation and structural integrity of other infrastructure in 1% AEP event
	C3 No increase in inundation that affects a building on a property in 10% AEP
	C4 No loss in overland flow path capacity, unless provided by other means
	C5 Where these requirements cannot be met, a SMP that includes supporting information to justify an alternative as the BPO for the Project is required
Water Quality	WQ1 Treatment of new road area and any existing road area directed to same point by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants **OR** WQ2 Treatment of equivalent area of high use road within same catchment by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants **OR** WQ3 An alternative level of mitigation determined through a SMP that: - applies an Integrated Stormwater Management Approach (as per above) - meets the NDC Objectives and Outcomes in Schedule 2 - is the BPO for the given Project.
Stream Hydrology	SH1 Where discharge is to a stream via public stormwater network outside of SMAF there is no additional requirements to those in the AUP(OP) and general requirements above.
Flooding (10% AEP)	F1 Ensure that there is sufficient capacity within the pipe network downstream of the connection point (at maximum probable development of the contributing catchment) to cater for the additional stormwater runoff associated with the new impervious area in a 10% AEP event **OR** F2 Attenuate stormwater flows and volume such that there is no increase in peak flow in a 10% AEP event from the total road impervious area draining to the pipe network downstream of the connection point to that prior to the new impervious area **OR** F3 Demonstrate that flows in excess of the pipe capacity in a 10% AEP event downstream of the connection point will not increase flooding of any other property and will not create a nuisance or hazard.

Assets	A1 All new stormwater assets to be operated by Healthy Waters are to be built in accordance with the Stormwater Code of Practice.

3.4 Auckland Unitary Plan (Operative in Part)

The entry and exit point, as well as the capacity of several overland flow paths will be modified by the proposed road alignment. Several overland flow paths will be partly or entirely piped to offset the loss of overland flow path capacities. Overland flow paths in Ti Rakau Park will be partly redirected within the park to a new culvert across Ti Rakau Drive (Outfall MCC_108699).

Changes to entry and exit points of overland flow paths for EB2 are covered by the NoR. Changes to entry and exit points, as well as the capacity of overland flow paths for EB3R trigger the need for a resource consent[1]. These minor changes have been mitigated by providing additional piped drainage capacity with the pipe size, which has been determined by flood modelling for the 10 and 100-year events with pipe blockages applied in accordance with the AC Stormwater Code of Practice (Version 3).

Overland flow path entry, exit locations and capacity have been changed at the following locations:

- Overland Flow Path 1 along SEART (see Figure 12) will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2).
- Overland Flow Path 1 Branch 1a (see Figure 12) will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2) and mitigation at location 3 (see Figure 57) as discussed in Section 7.1.3
- Overland Flow Path 1 Branch 1bi (see Figure 12) will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2) and mitigation at location 4 (see Figure 57) as discussed in Section 7.1.3
- Overland Flow Path 1 Branch 1bii (see Figure 12) will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2) and mitigation at location 5 (see Figure 57) as discussed in Section 7.1.3
- Overland Flow Path 1 Branch 1biii (see Figure 12) will have changes to its exit location (diverted in Ti Rakau Park to Outfall MCC_108699) and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2) and mitigation at location 6 and 7 (see Figure 57) as discussed in Section 7.1.3
- Overland Flow Path 1 Branch 1c (see Figure 12) will have changes to its exit location (diverted in Ti Rakau Park to Outfall MCC_108699) and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design, including the proposed overland flow path within the park (Appendix 2) and mitigation at location 7 (see Figure 57) as discussed in Section 7.1.3
- Overland Flow Path 2 (see Figure 12) will have changes to its capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2) and mitigation at location 7 (see Figure 57) as discussed in Section 7.1.3

[1] Rule E36.4(A41) states that *"diverting the entry or exit point, piping or reducing the capacity of any part of an overland flow path"* is a restricted discretionary activity.

- Overland Flow Path 2 (see Figure 12) will have changes to its capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2) and mitigation (i.e. piped) at location 7 (see Figure 57) as discussed in Section 7.1.3
- Overland Flow Path 3 Branch 3a (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by the proposed design (see Appendix 3) and mitigation at location 8 (see Figure 57) as discussed in Section 7.2.3
- Overland Flow Path 3 Branch 3b (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by the proposed design (see Appendix 3)
- Overland Flow Path 3 Branch 3c (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by the proposed design (see Appendix 3)
- Overland Flow Path 3 Branch 3d (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by proposed design (see Appendix 3)
- Overland Flow Path 3 Branch 3e (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by proposed design (see Appendix 3)
- Overland Flow Path 3 (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by the proposed design (see Appendix 3) and mitigation at location 9 (see Figure 57) as discussed in Section 7.2.3
- Overland Flow Path 4 (see Figure 22) will have changes to its exit location and capacity (see Section 6.2.4) with the reduction in overland flow path capacity being offset by the proposed design, including the proposed overland flow path channel in Riverhills Park (see Appendix 3) and mitigation at location 19 (see Figure 57) as discussed in Section 7.2.3.

4 Methodology and Analysis

Chapter Summary
Summary of key points/ findings • *EBA has carried out flood modelling for EB2 and EB3R in one combined flood model* • *Contaminant load models have been developed to compare the total existing road contributions to each outfall within the Project extents to the future contributions* • *A water quality objective, subject to further discussions with mana whenua and Heathy Waters, of reducing existing road contributions to the overall receiving environments has been adopted* • *EB2 and EB3R can and will meet all connection requirements of the NDC for category 3 under schedule 4* • *The final connection approval for the stormwater system will be obtained through the EPA process once the design is completed which includes connection and SMP approval.*

4.1 General

The following sections outline the methodology and analysis used to assess the potential impacts of EB2 and EB3R based on the design and how the connection requirements of the NDC are achieved.

4.2 Stormwater Treatment Performance

4.2.1 Methodology

A CLM model has been developed for each Project zone based on the AC CLM Version 2. The development of the CLM is documented in Technical Report No.2010/004 (ARC, 2010A) and predicts contaminant loads for TSS, zinc, copper and TPH. The Project CLM has been developed in general accordance with Technical Report (TR) 2010/003 the CLM User Manual (ARC, 2010B) except that it only includes contributions from AT assets (i.e., roads, the busway and any car park areas proposed to receive targeted discretionary treatment to achieve the discharge quality objectives). The CLM has not been developed to attempt to quantify annual contaminant loads for each outfall, rather to allow comparison of options and changes from the existing situation and following the implementation of the design. Contaminant loads in kilograms have therefore not been reported in this report, instead the percentage change has been reported. The development of the CLM will be documented in more detail in the Stormwater Management Options and BPO report which will be included in the SMP along with a comparison of options considered in developing a BPO.

The percentage change in contaminant load from the existing situation to that predicted following implementation of the design is discussed in Sections 2.3.4 (for EB2), 2.4.4 (for EB3R) and 6.3.1 (Project wide). Further analysis of other stormwater treatment options considered in developing the BPO will be documented in the Stormwater Management Options Report which will be included in the SMP.

4.3 Flooding and Overland Flow Paths

4.3.1 Methodology

A flood assessment was undertaken for the Project in order to ascertain the existing flood risks and the effects the proposed Eastern Busway design would have across the four EB zones (EB2, EB3R, EB3C and EB4). The Eastern Busway extents has been split across the following two flood models:

- EB2 and EB3R flood model which sits within the Pakuranga – Tāmaki River catchment and Pakuranga Creek catchment (see Figure 8 for model extents)
- EB3C and EB4 flood model which sits within the Pakuranga Creek catchment (see Figure 8 for model extents)

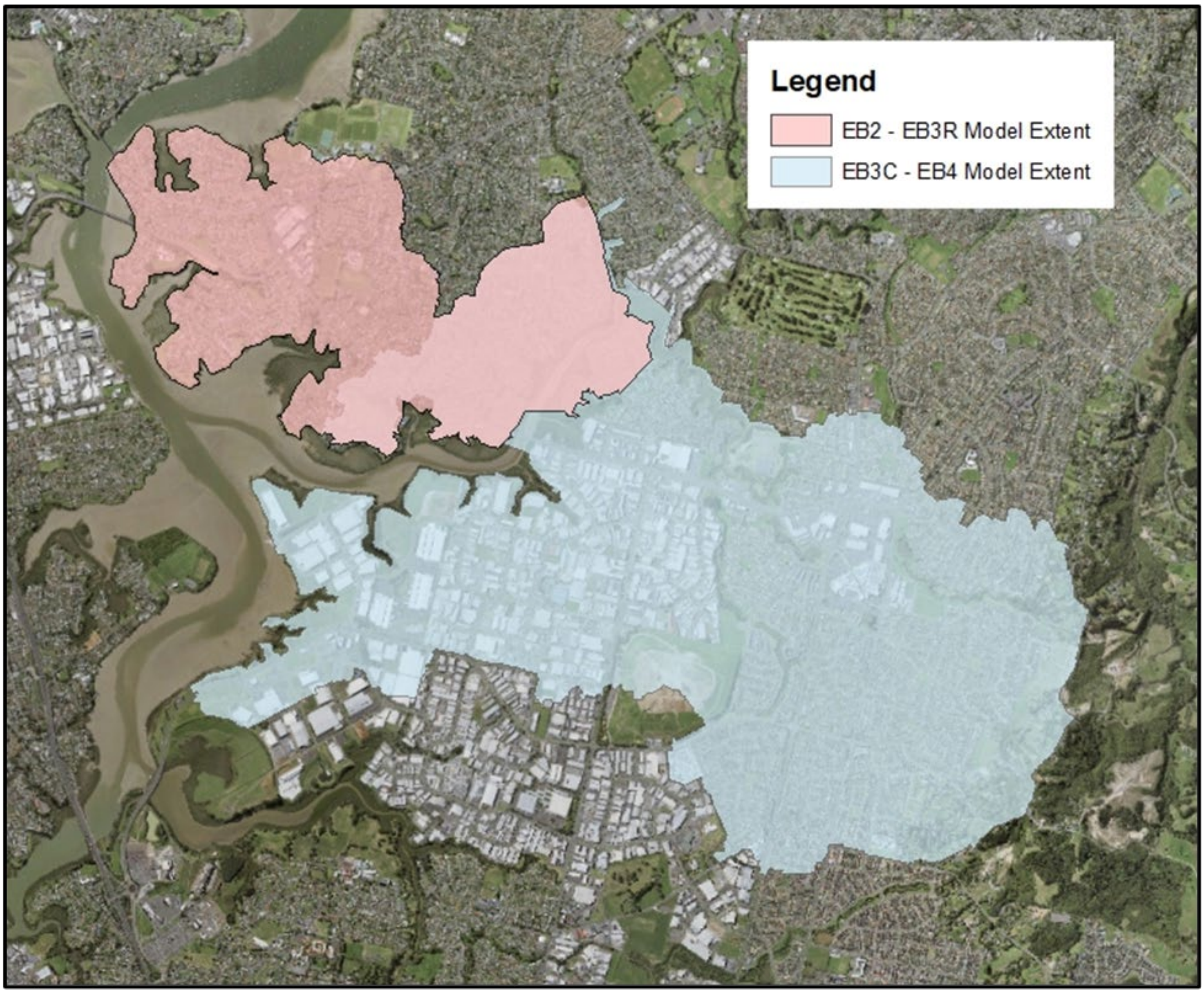

Figure 8: Eastern Busway Flood Model Extents

Flood modelling has been carried out in accordance with TP 108 – Guidelines for stormwater runoff modelling in the Auckland Region (April 1999) and the AC Modelling Methodology (Nov 2011). The current flood model build report is provided in Appendix 4.

The flood models have been used for the following two types of assessment:

- Flooding and overland flow assessment using the ground surface model (including geometric design) and the drainage design (pipes and catchpits/inlets). This scenario assesses primary stormwater systems.
- Overland flow path capacity assessment which applies pipe blockages, in accordance with the Stormwater Code of Practice, to existing and proposed pipes for the base case (i.e., existing situation) and design case. This scenario assesses secondary stormwater (flow paths) systems. The pipe blockages applied are:
    - 100% pipe blockage of pipes 600 mm or less
    - 50% reduction in pipe capacity for pipes between 600 mm and 1050 mm
    - 10% reduction in pipe capacity for pipes larger than 1050 mm

4.3.2 Analysis

The flood modelling results are discussed in the following sections:

- Section 5.1.5 for the EB2 base case (existing situation) for the flooding assessment
- Section 5.1.6 for the EB2 base case (existing situation) for the overland flow path capacity assessment (with pipe blockages applied)
- Section 5.2.5 for the EB3R base case (existing situation) for the flooding assessment
- Section 5.2.6 for the EB3R base case (existing situation) for the overland flow path capacity assessment (with pipe blockages applied)
- Section 6.1.3 for the EB2 design case and the impacts from the flooding assessment
- Section 6.1.4 for the EB2 design case and impacts from the overland flow path capacity assessment (with pipe blockages applied)
- Section 6.2.3 for the EB3R design and impacts from the flooding assessment
- Section 6.2.4 for the EB3R design case and impacts from the overland flow path capacity assessment (with pipe blockages applied)
- Section 6.2.3 for the cumulative impacts from the flooding assessment
- Section 6.2.4 for the cumulative impacts from the overland flow path capacity assessment (with pipe blockages applied)
- Sections 7.1.2 and 7.1.3 for the mitigation proposed for EB2 for flooding and overland flow path capacity impacts
- Section 7.2.2 and 7.2.3 for the mitigation proposed for EB3R for flooding and overland flow path capacity impacts

4.4 NDC Connection Requirements

4.4.1 Methodology

The methodology for assessing the stormwater design and potential impacts (water quality and quantity) has been to use water quality (CLM) and BPO development as outlined in Section 4.2 and flood modelling as outlined in 4.3 to demonstrate the design meets the NDC connection requirements outlined in Section 3.3.

4.4.2 Analysis

The following section summarises the analysis of the stormwater design proposed for EB2 and EB3R against the NDC connection requirements for category 3 (see Table 8). The analysis will be updated as design progresses through detailed design and incorporated into the EPA documentation for the submission of the final detailed design. The summary of compliance with Schedule 4 is provided in Table 8 and has been assessed based on the following EBA decisions where options are provided for in the NDC connection requirements:

- The Stormwater Management Option and BPO Report which will be finalised and included in the SMP demonstrates treatment in accordance with GD01/TP 10 is not possible for all Project areas or elsewhere in the catchment and therefore EBA have selected the BPO option for water quality
- As a result of existing flooding and overland flow activation during 10-year events as a result of the existing stormwater networks being under sized, EBA has chosen to demonstrate that flows in excess of the pipe capacity in a 10% AEP event downstream of the connection point will not increase flooding of any other property and will not create a nuisance or hazard.

Table 8: Summary of compliance with NDC Schedule 4 connection requirements for category 3

NDC Requirements	Achieves EB2	Achieves EB3R	Comment
Catchment/Area			
C1 (see Table 7)	✓	✓	Sections 6.1.3 and 6.1.4 in conjunction with the mitigation proposed in Section 7.1 demonstrates the EB2 design meets this requirement. Sections 6.2.2 and 6.2.3 in conjunction with the mitigation proposed in Section 7.2 demonstrates the EB3R design meets this requirement.
C2 (see Table 7)	✓	✓	
C3 (see Table 7)	✓	✓	
C4 (see Table 7)	✓	✓	
C5 (see Table 7)	n/a	n/a	A SMP is proposed to be developed, due to adoption of a BPO approach for water quality. The SMP will be provided as part of submission of the final detailed design to the EPA process.
Water Quality			
WQ3 (see Table 7)	✓	✓	The development of adoption of the BPO, will be documented in the final Stormwater Management Option and BPO Report which will be included in the SMP. This report demonstrates the development of the BPO applied an integrated stormwater management approach and meets the objectives and outcomes of schedule 2. A SMP will be developed and provided as part of the final detailed design submission to the EPA process. EBA will work with Auckland Transport, Healthy Waters and mana whenua in developing the SMP to ensure it meets the aspirations of mana whenua and requirements of Auckland Transport and Healthy Waters.
Stream Hydrology			
SH1 (see Table 7)	✓	✓	The Project is not within a SMAF on the planning maps of the AUP(OP) and the discharges from EB2 and EB3R are to or adjacent to the CMA and not to streams.
Flooding – 10% AEP event			
F3 (see Table 7)	✓	✓	Sections 6.1.3 and 6.1.4 in conjunction with the mitigation proposed in Section 7.1 demonstrates the EB2 design meets this requirement. Sections 6.2.2 and 6.2.3 in conjunction with the mitigation proposed in Section 7.2 demonstrates the EB3R design meets this requirement.
Assets			
A1 (see Table 7)	✓	✓	EBA will work with AT and Healthy Waters to confirm which assets will be operated by each organisation. Healthy Waters assets will be designed to the Stormwater Code of Practice. AT assets will be designed to the Engineering Code of Practice and where this code provides no guidance for elements of the design the Stormwater Code of Practice will be followed. EBA and Healthy Waters will meet regularly to discuss design development and Project stormwater outcomes. Final detailed design approval will be via the EPA process with an 'in principal approval' obtained prior to the EPA process to minimise risks associated with dual AT and Healthy Waters approval of the detailed design for construction.

5 Existing Environment

Chapter Summary
EB2 summary of key points/ findings • *EB2 has several overland flow paths running through its extents which cross roads in the 10 and 100-year ARI events* • *The existing stormwater networks were designed for a 5-year event which is equivalent to a capacity of a 2-year event when allowing for climate change (increased rainfall and sea level rise)* • *There is extensive flooding during the 10 and 100-year ARI events with similar extents due to the under sized networks* • *Flood depths within the EB2 Project area ranges from shallow (10-40 mm) to deep (100-600 mm) in the 10-year ARI event and in the 100-year ARI event the areas with deeper flooding increase in extent* • *Large parts of the existing outfall catchments have no stormwater treatment, except for MCC_108633 which has Tetra Traps within some catchpits and an Ecosol unit (GPT 41350) within the Bus Stop Reserve.* *EB3R summary of key points/ findings* • *EB3R crosses or follows several overland flow paths. Overland flow paths cross Ti Rakau Drive in several locations during the 10 and 100-year ARI events* • *The existing stormwater networks were designed for a 5-year event which is equivalent to a capacity of a 2-year event when allowing for climate change (increased rainfall and sea level rise)* • *There is extensive flooding during the 10 and 100-year ARI events with similar extents due to the under sized networks* • *Flood depths within the EB3R Project area ranges from shallow (10-40 mm) to deep (100-600 mm) in the 10-year ARI event and in the 100-year ARI event the areas with deeper flooding increase in extent* • *There is no existing treatment of stormwater within EB3R.*

5.1 EB2

5.1.1 Climate and Geology

EB2 is in the Tāmaki River - Pakuranga Catchment (see Figure 9). The geology of the Project area is characterised by sandstone, siltstone, minor limestone with basaltic scoria cones, tuff rings, lava flows and some small areas of alluvium. Soils in the District are mainly composed of volcanic ash soils and are generally silty, friable, and free draining (McEwen, 1987). The Project area experiences warm, humid summers and relatively mild winters. Rainfall is typically plentiful throughout the year, with sporadic heavy falls, with a total rainfall of approximately 1,100 to 1,450 mm per annum (Chappell, 2012). The sub-catchments of the Tāmaki River - Pakuranga Catchment are shown on Figure 10.

5.1.2 Topography

The topography of EB2 (see Figure 11) along SEART is higher at the west and dips to the east from reduced level (RL)10.0 m at Millen Avenue to RL4.0 m at the southeast end of Paul Place Reserve (adjacent to Seven Oaks Drive). The highway then rises slightly to RL8.0 m at the intersection with Ti Rakau Drive. The topography of Ti Rakau Drive along EB2 is relatively flat at approximately RL8.5 m at the intersection with Reeves Road and SEART on and off ramps increasing to RL9.0 m to the north (Pakuranga Road) and south (at the EB2 and EB3R boundary). Along WRR, the topography decreases from RL19.0 m at the intersection with Pakuranga Road to RL15.0 m at the intersection with Reeves Road. In this area the topography continues falling along WRR towards Ti Rakau Drive and along Reeves Road towards SEART on and off ramps.

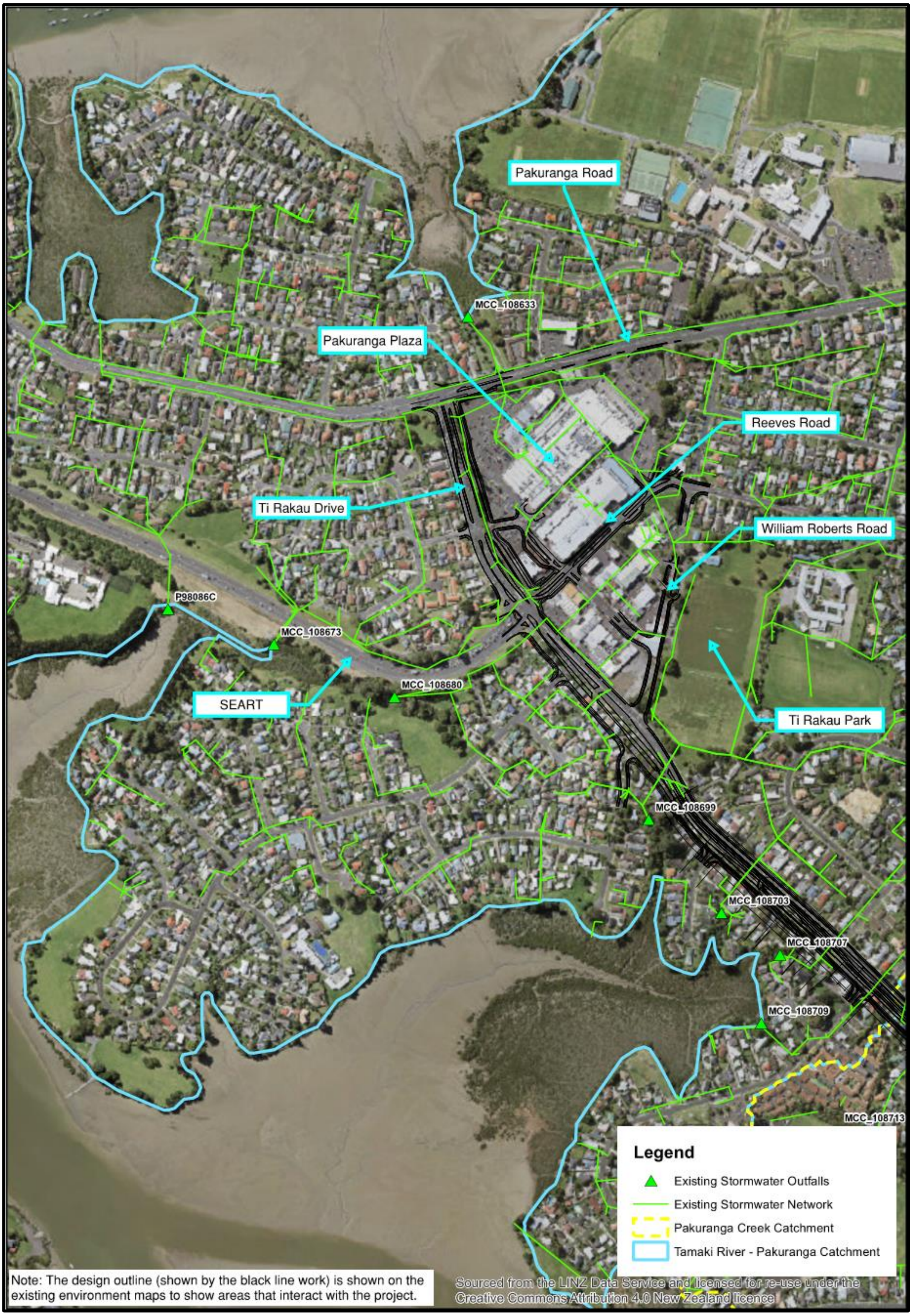

Figure 9: Tāmaki River – Pakuranga Catchment Boundary

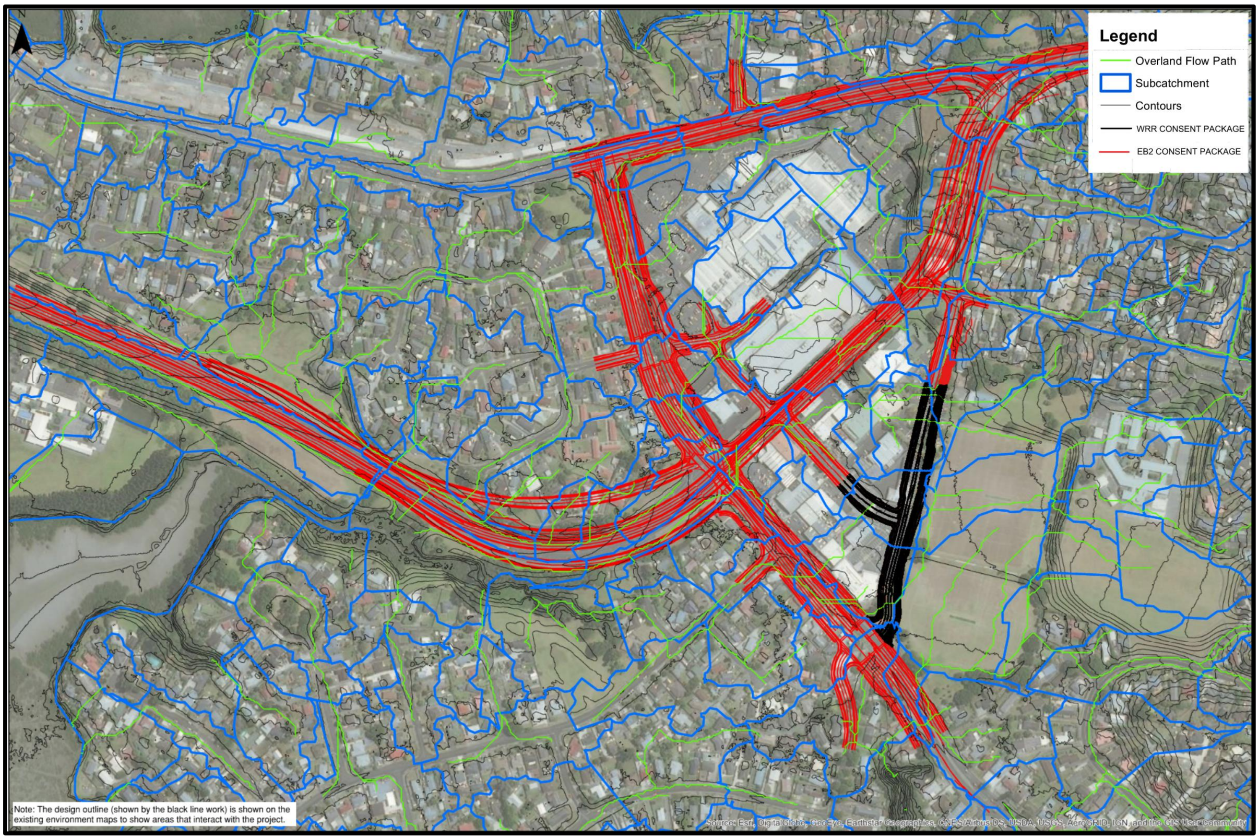

Figure 10: EB2 sub-catchments

Figure 11: EB2 topography

5.1.3 Existing Stormwater Networks and Outfalls

Runoff from the existing EB2 area is currently collected via a kerb and channel system and conveyed to the following five coastal outfalls (see Figure 9):

- Outfall MCC_108633 within Bus Stop Reserve off Pakuranga Road receives stormwater from Pakuranga Plaza and residential areas to the west, east and southeast
- Outfall MCC_108680 south of the SEART on ramp receives stormwater from a commercial area between Reeves Road, WRR, Ti Rakau Road and a small residential area to the southeast
- Outfall MCC_108673 receives stormwater from a residential area to the north and part of the SEART
- Outfall P98086C receives stormwater from a residential area to the north
- Outfall MCC_108699 receives stormwater from residential areas to the northeast and east.

The pipe network was constructed primarily in the late 1950s, with some pipes made of asbestos cement material. The existing stormwater reticulation network within the Project extent was historically designed to the now defunct Manukau City Council's standards (i.e., to a 5-year ARI event with no allowance for climate change). This is a significantly lower requirement than the standard that superseded it, the current Stormwater Code of Practice Version 3 (Jan 2022), which requires 10-year ARI flow capacity with allowance for climate change. The required climate change scenario in the Stormwater Code of Practice is a 2.1 degrees Celsius temperature increase by 2090 (i.e., a 13.2 and 16.8 per cent increase in rainfall with a duration of 24 hours for the 10% and 1% AEP events respectively) and one metre of sea level rise. AC has completed a catchment-wide study of the performance of the existing stormwater network in the Pakuranga-Tāmaki River catchment. The study confirmed the extent and consequences of the existing network capacity issue within the catchment. The existing network is significantly undersized and there are large secondary overland flows (refer to Section 5.1.5).

The existing stormwater network and associated discharges are authorised by the Healthy Waters NDC which supports growth in line with the Auckland Plan 2050 and AUP(OP). The NDC defines clear targets to lift water quality, reduce flooding and protect streams and other water assets.

5.1.4 Stormwater Treatment

The existing five stormwater networks that service the EB2 Project area have the following stormwater treatment:

- Outfall MCC_108633 (see Figure 9) in Bus Stop Reserve receives stormwater treatment from catchpits with trash screens (TetraTraps) and a GPT (Ecosol unit GPT 41350), within Bus Stop Reserve, that serves approximately 31.3 ha
- Outfall MCC_108680 south of the SEART on ramp receives no formal stormwater treatment although it discharges to a natural wetland
- Outfall MCC_108673 receives no stormwater treatment
- Outfall P98086C receives no stormwater treatment
- Outfall MCC_108699 receives no stormwater treatment.

5.1.5 Overland Flow Paths and Flooding

EB2 has the following two overland flow paths (see Figure 12):

- Overland Flow Path 1 - SEART to the CMA which has the following three branches:

- Branch 1a - Ti Rakau Drive (north) that starts on the northern boundary of Pakuranga Plaza and follows Pakuranga Road and then down the eastern side of Ti Rakau Drive. From here the branch turns and follows the southern side of the SEART on ramp until it joins with the CMA
- Branch 1b_i - Reeves Road subbranch which starts along the southern side of Pakuranga Road until it turns into WRR before crossing into properties on the western side. The subbranch then flows through the Pakuranga Town Centre carpark to Reeves Road until it joins Branch 1a at the Ti Rakau Drive and Reeves Road intersection
- Branch 1b_ii - Reeves Road subbranch which starts at Grassways Avenue and then runs through residential property to Lewis Road then Reeves Road until its intersection with Ti Rakau Drive where it joins Branch 1a
- Branch 1b_iii – Reeves Road subbranch starts in Ti Rakau Park and crosses WRR and commercial properties to Cortina Place then Reeves Road. From here it follows Reeves Road to where it joins Branch 1a at the Reeves Road and Ti Rakau Drive intersection
- Branch 1c - Ti Rakau Park branch which starts near the intersection of Reeves Road and Cardiff Road. It runs within residential properties until it reaches Elizabeth Street, then runs through the Howick School of Music grounds and Ti Rakau Park until it reaches the western boundary of Ti Rakau Park. The overland flow path then flows to the south along the western boundary before crossing Ti Rakau Drive and running along the southern side of Ti Rakau Drive to Tiraumea Drive. Finally, it run along Bolina Crescent to join the main branch.

- Overland Flow Path 2 - Ti Rakau Park overland flow path has two sub-branches that start in Carole Crescent and Cardiff Road respectively before combining in Cardiff Road at its intersection with Carole Crescent and then the combined overland flow runs along Cindy Place to Ti Rakau Park before crossing Ti Rakau Drive through residential properties before discharging into the CMA.

A large percent of overland flow is runoff that is not intercepted by the primary reticulated drainage system or cannot enter due to capacity constraints within the existing stormwater network, as discussed in Section 5.1.3.

As a result of the limited capacity of the existing stormwater networks, very little of the 10-year ARI event is intercepted and captured by the existing networks, as is demonstrated in Figure 13, where the 10-year and 100-year ARI events have similar flood extents. The existing flood extents are extensive for the 10-year and 100-year events, with overland flow crossing Ti Rakau Drive where the busway is proposed.

The existing depths of flooding within EB2 for the 10-year and 100-year ARI events are similar as shown in Figure 14 and Figure 15 respectively. The overland flows crossing Ti Rakau Drive are extensive and deep (see Figure 14 and Figure 15), with depths greater than 600 mm in the low points of each overland flow crossing point. Outside of the low points large areas of general traffic lanes have flood depths of between 200 and 600 mm. These overland flows represent potential safety risks to all modes of transport as well as environmental risks associated with erosion, scouring and deposition of debris. These risks do not relate to insufficient capacity in the road drainage, but rather insufficient capacity in the catchment-wide drainage.

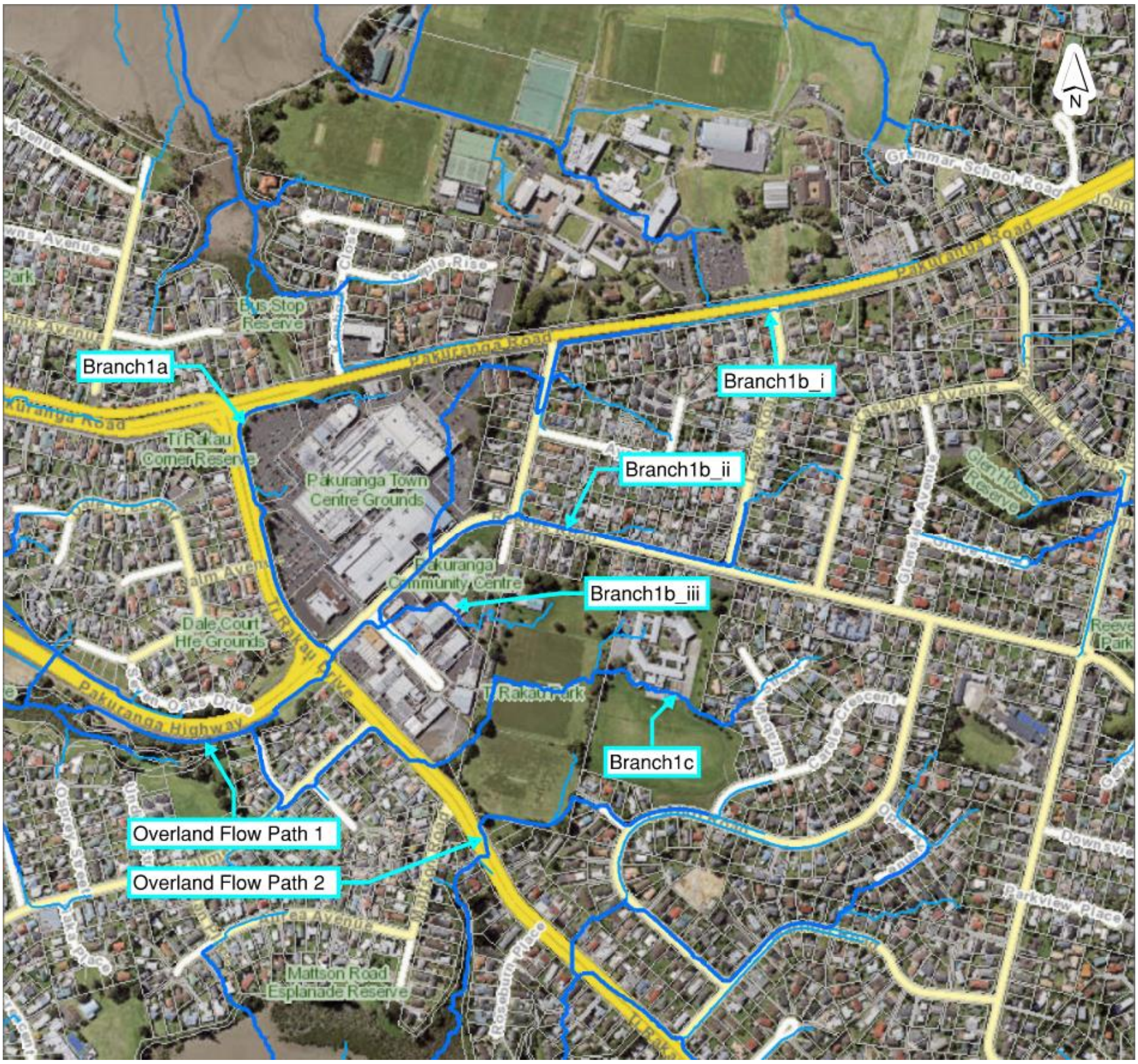

Figure 12: EB2 existing overland flow paths (source AC Geomaps March 2022)

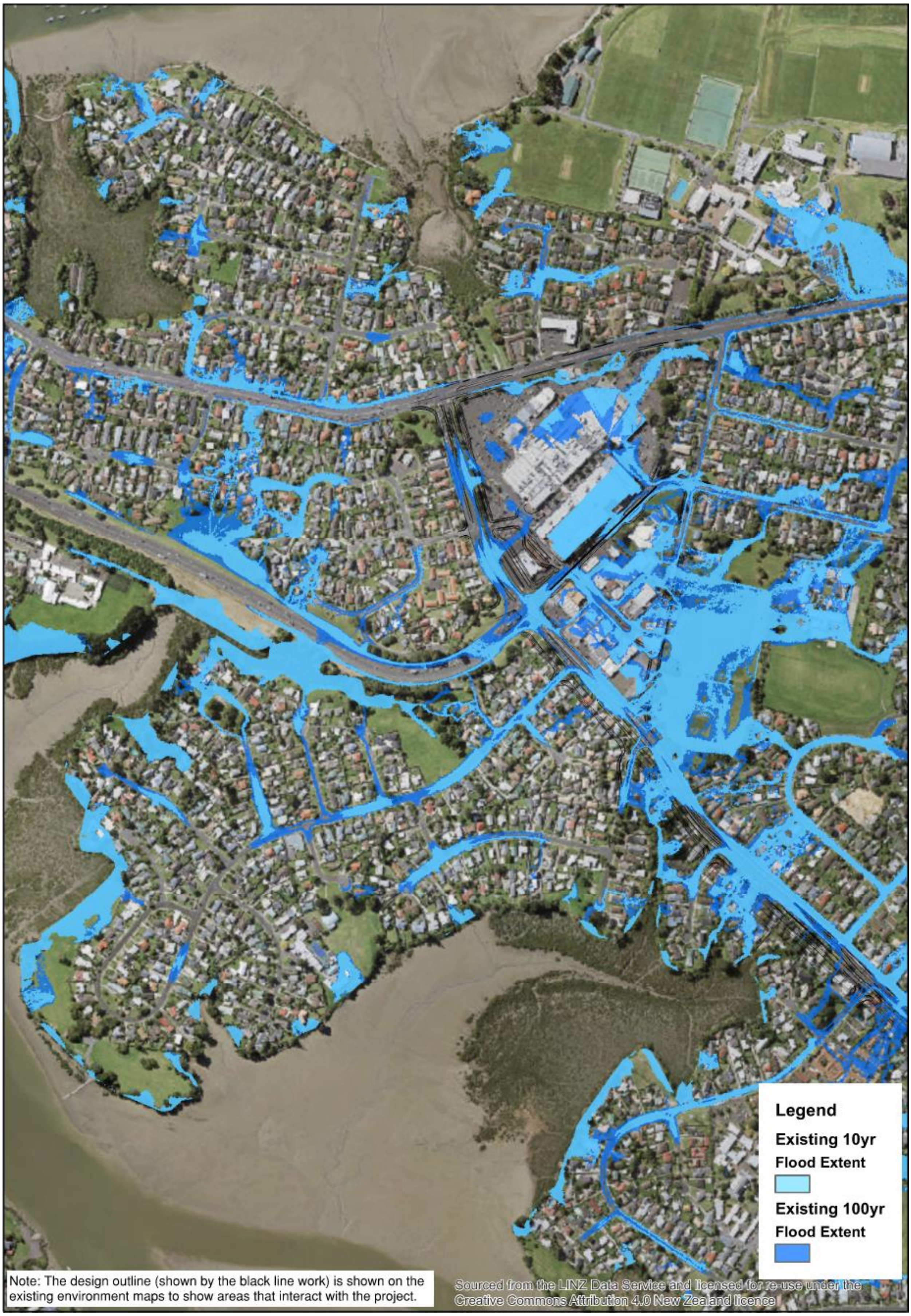

Figure 13: EB2 base case 10 and 100-year flood extents

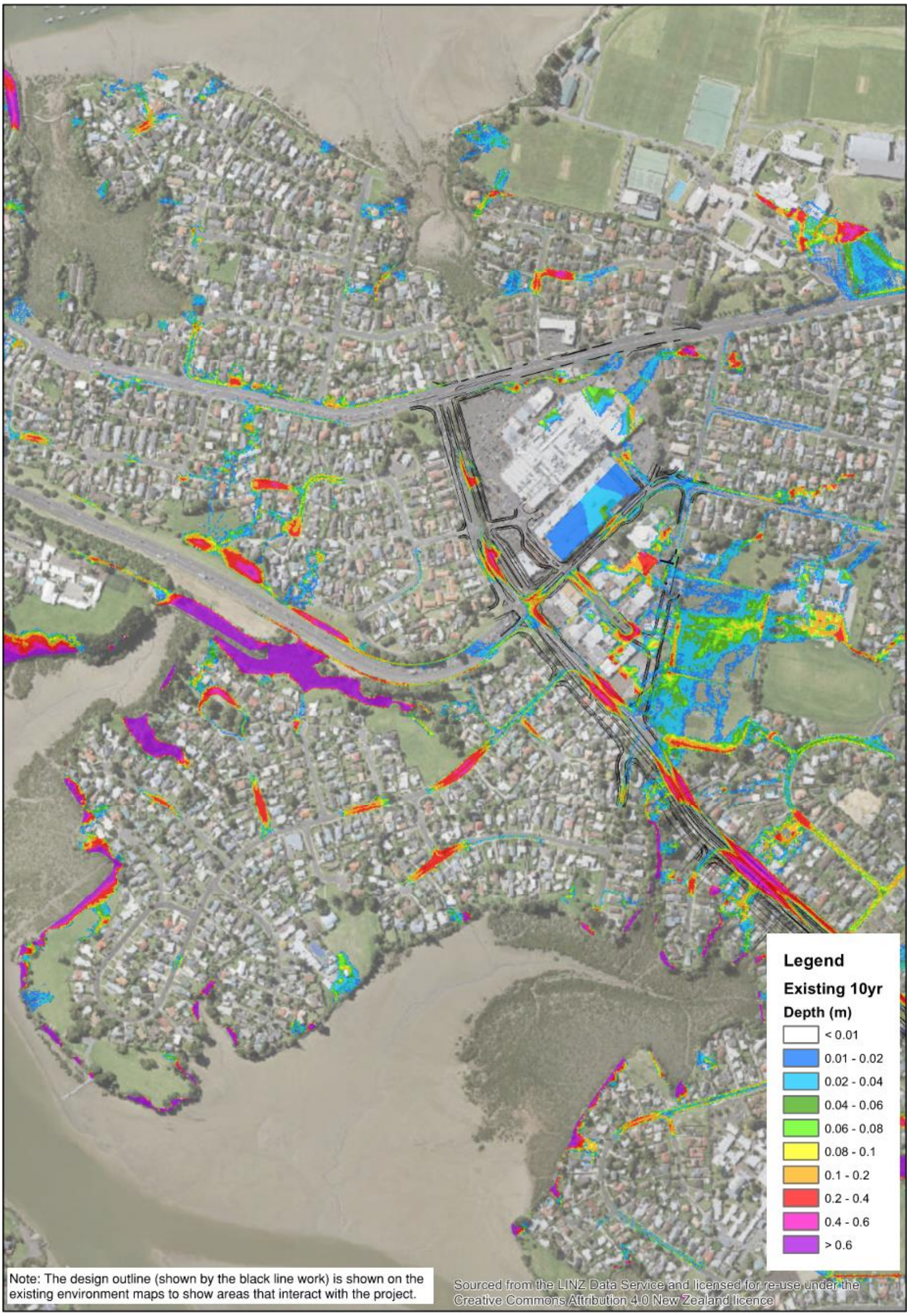

Figure 14: EB2 base case 10-year flood depths

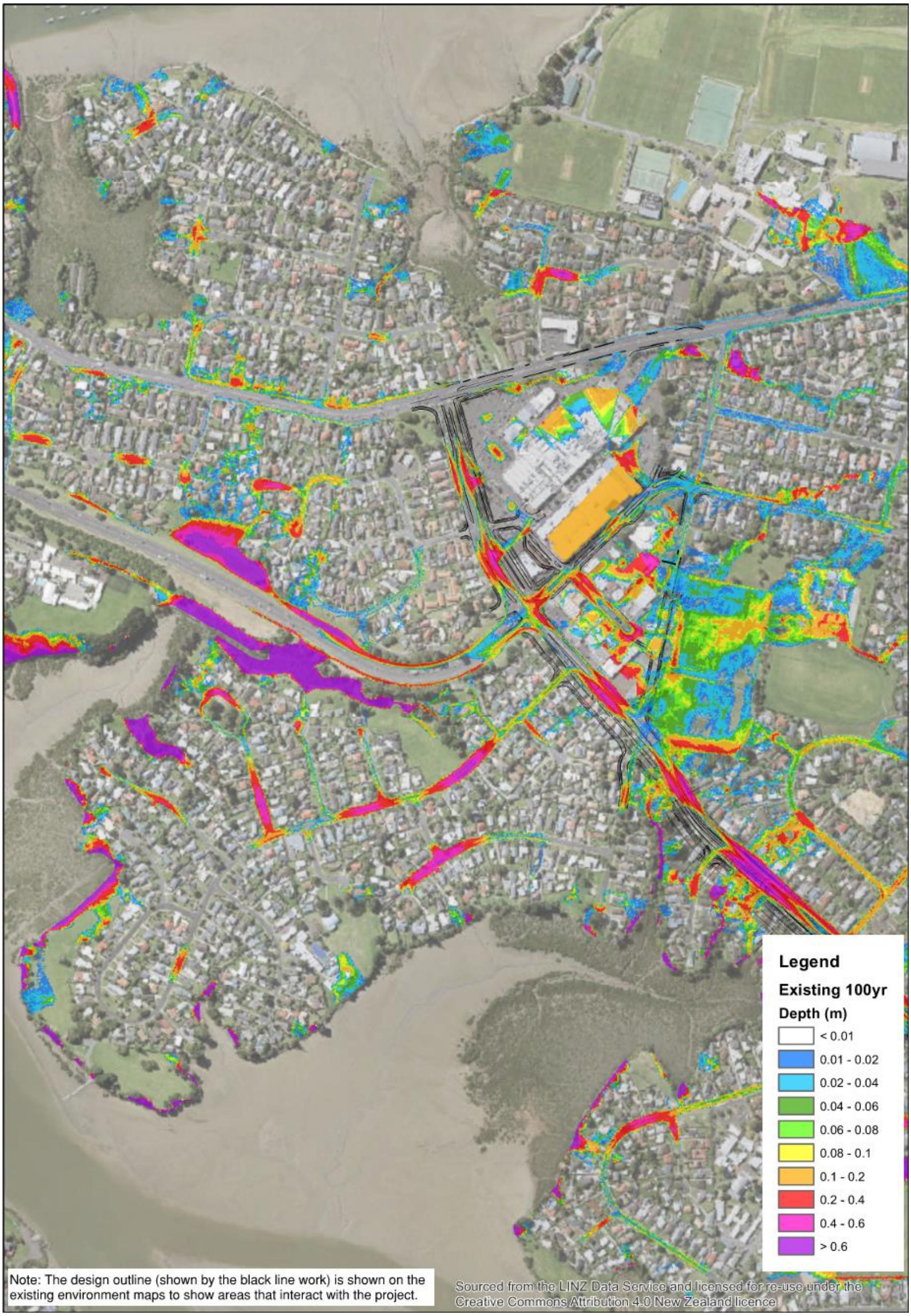

Figure 15: EB2 base case 100-year flood depths

5.1.6 Overland Flow Path Capacity

The Stormwater Code of Practice requires secondary flow (overland flow paths) design to be assessed with pipe blockages applied to the pipe networks as outlined in Section 4.3. These blockage factors have been applied to the existing pipe network in the base case flood model (see Appendix 4) and the resulting flood extents are provided in Figure 16. As expected, with the 10 and 100-year flood extents being very similar for the flooding assessment (i.e., without pipe blockages), when pipe blockages are applied (see Section 4.3 for pipe blockage details) the 10 and 100-year flood extents are more widespread for both the existing situation (i.e., base case) and for the design case. The flood depths for the 10 and 100-year ARI events are shown in Figure 17 and Figure 18 respectively. Again, as expected, the flood depths are deeper, and the extents of deeper flooding are larger than without the pipe blockages.

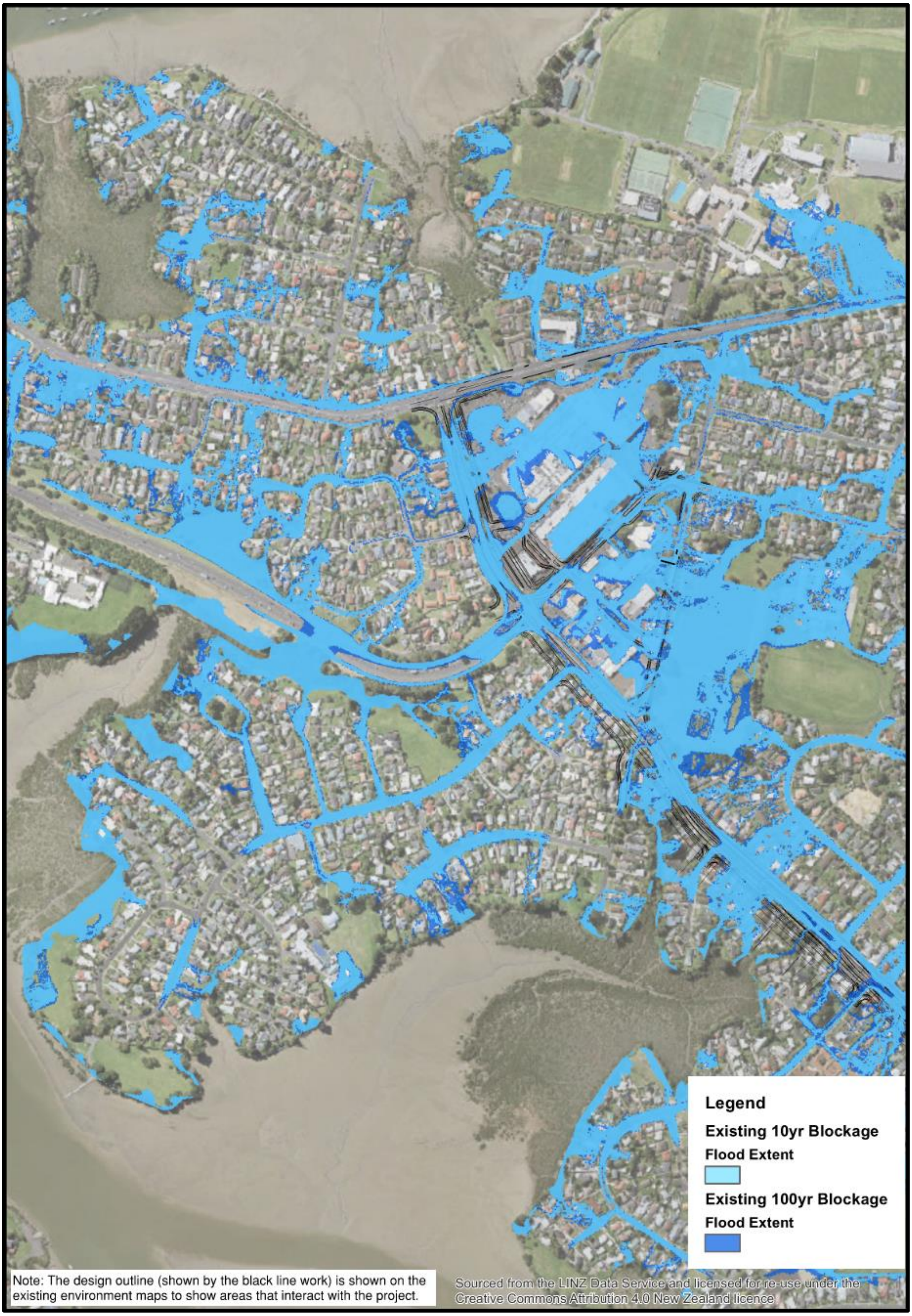

Figure 16: EB2 base case 10 and 100-year flood extents (pipe blockage)

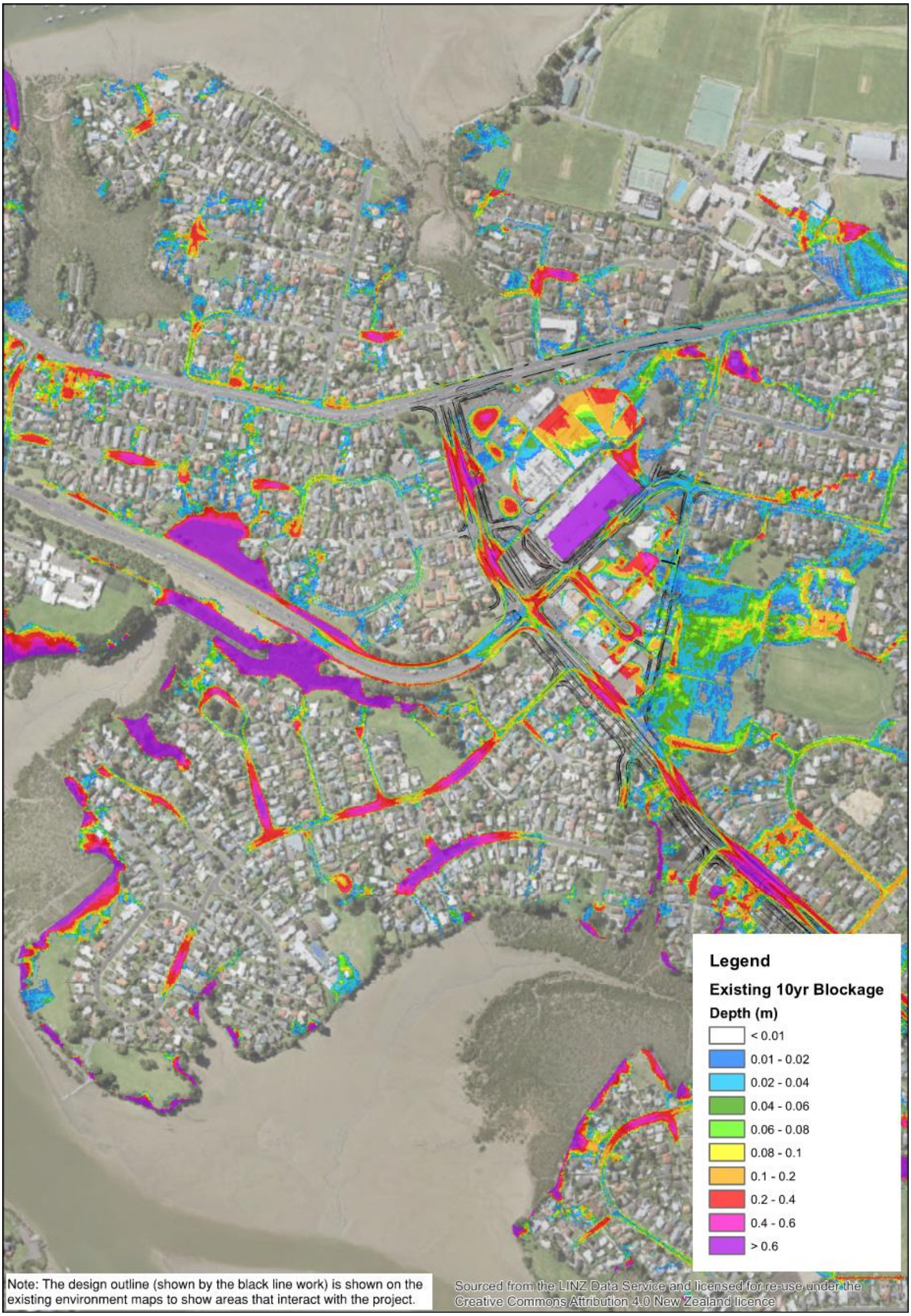

Figure 17: EB2 base case 10-year flood depths (pipe blockage)

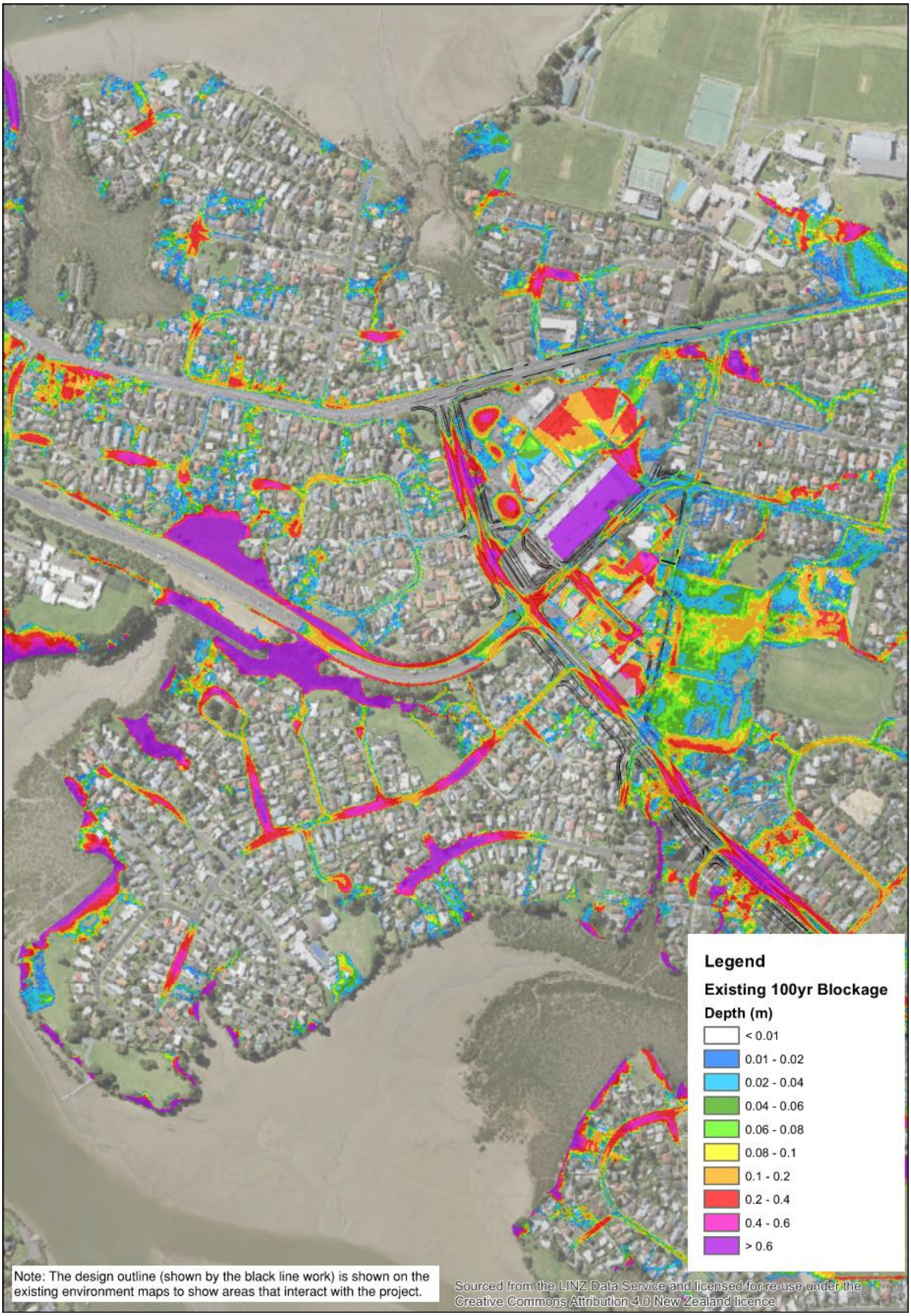

Figure 18: EB2 base case 100-year flood depths (pipe blockage)

5.2 EB3R

5.2.1 Climate and Geology

As with EB2, EB3R is located in the Tāmaki River - Pakuranga Catchment (see Figure 9) as well as the Pakuranga Creek Catchment (see Figure 19). The geology of the Project area is characterised by sandstone, siltstone and minor limestone with basaltic scoria cones, tuff rings, lava flows and some small areas of alluvium. Soils in the District are mainly composed of volcanic ash soils and are generally silty, friable, and free draining (McEwen, 1987). The Project area experiences warm, humid summers and relatively mild winters. Rainfall is typically plentiful throughout the year, with sporadic heavy falls. Rainfall is approximately 1,100 to 1,450 mm per annum (Chappell, 2012). The EB3R sub-catchments are shown in Figure 20.

5.2.2 Topography

The topography (see Figure 21) along EB3R is higher to the north with the peak at RL50 m. The northern slopes drain towards Ti Rakau Drive, which is relatively flat at RL10 m longitudinally, and down the southern side of Ti Rakau Drive to the coastal boundary at approximately RL2 m.

Figure 19: Pakuranga Creek Catchment Boundary

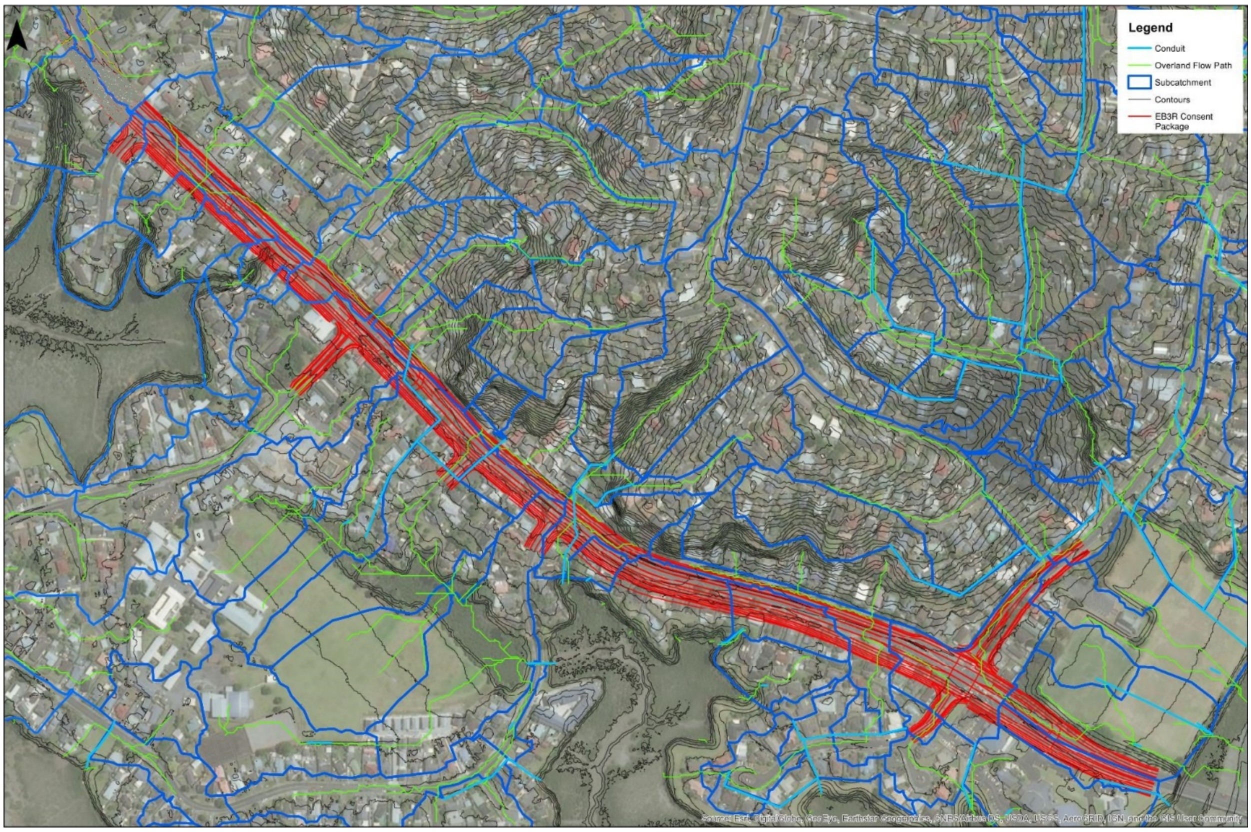

Figure 20: EB3R sub-catchments

Figure 21: EB3R topography

5.2.3 Existing Stormwater Networks and Outfalls

Runoff from the existing EB3R Project area is currently collected via a kerb and channel system and conveyed to the following ten coastal outfalls (see Figure 19):

- Coastal outfall MCC_108703 receives stormwater from Ti Rakau Drive, Cardiff Road and the surrounding residential area
- Outfall MCC_108707 receives stormwater from Marriott Road, Opal Avenue and the surrounding residential area
- Outfall MCC_108709 receives stormwater from Edgewater Drive, Chevis Place, Miramar Place, and the surrounding residential land
- Outfall MCC_108713 receives stormwater from Ti Rakau Drive and residential areas to the north and south of Ti Rakau Drive
- Outfall MCC_108718 receives stormwater from residential areas to the north including Ti Rakau Drive and Te Anau Place
- Outfall MCC_108719 receives stormwater from a few residential properties on the southern side of Ti Rakau Drive
- Outfall MCC_108738 receives stormwater from Ti Rakau Drive and a small residential area to the north on the southern side of Ti Rakau Drive
- Outfall MCC_108748 receives stormwater from Ti Rakau Drive and residential areas to the north including from Gossamer Drive
- Outfall MCC_108746 receives stormwater from Ti Rakau Drive just prior to Ti Rakau Bridge with the outfall discharging to Pakuranga Creek
- Outfall MCC_108749 receives stormwater from Ti Rakau Drive adjacent Riverhills Park with the outfall discharging to Pakuranga Creek.

The pipe network was constructed primarily in the 1960s, with significant quantities of asbestos cement pipe material. The use of asbestos cement was used significantly for pipe connections (i.e., catchpit leads), as well as stormwater mains at the eastern end of EB3R. The existing stormwater reticulation network within the Project extent has been historically designed to the now defunct Manukau City Council's standards (i.e., to a 5-year ARI event with no allowance for climate change). This is a significantly lower requirement than the standard that superseded it, the current Stormwater Code of Practice, which requires 10-year ARI flow capacity with allowance for climate change. The required climate change scenario in the Stormwater Code of Practice is a 2.1 degrees Celsius temperature increase by 2090 (i.e., a 13.2 and 16.8 percent increase in rainfall with a duration of 24 hours for the 10% and 1% AEP events respectively) and one metre of sea level rise. The existing stormwater network is significantly undersized and there are large secondary overland flows (refer to Section 5.2.5).

The existing stormwater network and associated discharges are authorised by the Healthy Waters NDC which supports growth in line with the Auckland Plan 2050 and AUP(OP). The NDC defines clear targets to lift water quality, reduce flooding and protect streams and other water assets.

5.2.4 Stormwater Treatment

The existing stormwater networks that service EB3R have no existing stormwater treatment devices.

5.2.5 Overland Flow Paths and Flooding

EB3R has the following three overland flow paths (see Figure 22):

- Overland Flow Path 3 Ti Rakau Drive to the CMA which has the following main branches:

- Branch 3a – starts adjacent to 124 Udys Road and runs south to Riverhills Avenue where it crosses the carriageway and flows down a gully through private property to Ti Rakau Drive. From here the overland flow path runs along the northern kerb of Ti Rakau Drive until it reaches 118 Ti Rakau Drive where it transitions to the median and then crosses the westbound carriageway and through private properties south of Ti Rakau Drive to the CMA
- Branch 3b – starts at 10 Miramar Place and runs along the carriageway then down through private property until Ti Rakau Drive where it joins Branch 3a
- Branch 3c – starts above Chevis place and runs down to and long the eastern side of Chevis Place until it joins Branch 3a at Ti Rakau Drive
- Branch 3d – starts adjacent to 59 Marriott Road and runs down the hill along the southern/eastern kerb until is joins Branch 3a at Ti Rakau Drive
- Branch 3e_i – subbranch starts at Pakuranga Heights Primary School and runs down through private properties to Opel Avenue then through more private properties to Marriott Road. From here it runs along the northern/western kerb onto Cardiff Road where it runs along the northern kerb. At 63 Cardiff Road it runs down through private property until Ti Rakau Drive where it crosses the road and joins Branch 3a
- Branch 3e_ii – subbranch starts on Cardiff Road near Reeves Road and runs along the southbound kerb until it joins subbranch 3e_i at 63 Cardiff Road.

- Overland Flow Path 4 – starts at 186 Ti Rakau Drive and runs along the northern kerb until adjacent to 206 Ti Rakau Drive where it crosses the carriageway and runs along the southern kerb towards the east until Fremantle Place. From here it runs down to Paradise Place then through private property to the CMA
- Overland Flow Path 5 - starts at 16 Riverhills Avenue and runs down the hill to Ellesmere Crescent where it meets a small flow branch before continuing down Riverhills Avenue to Gossamer Drive, where it then runs toward Ti Rakau Drive. It then follows the northern kerb before entering Riverhills Park and then Pakuranga Creek.

A large percent of overland flow is runoff that is not intercepted by the primary reticulated drainage system or cannot enter due to capacity constraints within the existing stormwater network as discussed in Section 5.2.3. As a result of the limited capacity of the existing stormwater networks, very little of the 10-year ARI event is intercepted and captured by the existing networks as is demonstrated in Figure 23, where the 10-year and 100-year ARI events have similar flood extents. The existing flood extents are extensive for the 10 and 100-year events with overland flow crossing Ti Rakau Drive where the busway is proposed.

The existing depths of flooding within EB3R for the 10-year and 100-year ARI events are similar as shown in Figure 24 and Figure 25 respectively. The overland flows crossing Ti Rakau Drive are extensive and deep (see Figure 10 and Figure 11), with depths greater than 600 mm in the low point where the first overland flow path crosses Ti Rakau Drive, east of Roseburn Place. Flood depths along the northern kerb range from 80 mm to 400 mm outside of the main low point. These overland flows represent potential safety risks to all modes of transport and environmental risks associated with erosion, scouring and build-up of litter and debris. These risks do not relate to insufficient capacity in the road drainage, but rather insufficient capacity in the catchment-wide drainage.

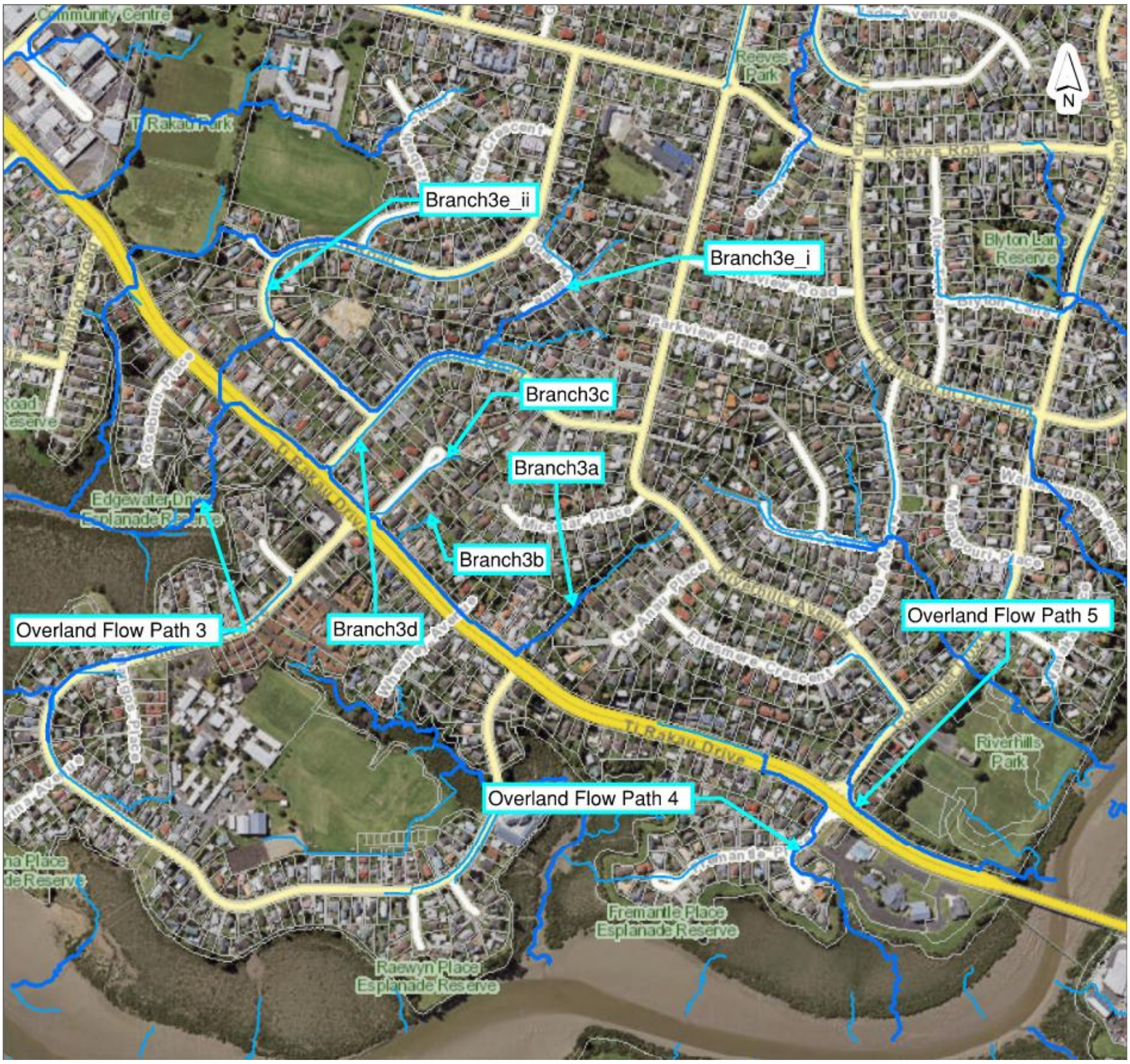

Figure 22: EB3R existing overland flow paths (source AC Geomaps March 2022)