Te Tumu Urban Growth Area - Stormwater Management Strategy

Prepared for Tumu Kaituna 14 Trust; Totara Farm Park JV interests; Ford Land Holdings Pty Ltd & the Tauranga City Council
Prepared by Beca Limited

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Revision History

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Action	Name	Signed	Date
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on behalf of	Beca Limited		

Executive Summary

This Stormwater Management Strategy (SMS) forms part of the documentation supporting the Structure Plan for development of the Te Tumu Urban Growth Area. It has been prepared in conjunction with the Structure Plan and land use planning studies, and will influence the final Te Tumu Structure Plan, and the resulting Plan Change that will be associated with opening Te Tumu for future urban development.

The Tauranga City Council holds a comprehensive stormwater discharge consent for Papamoa East. This consent sets the parameters, via consent conditions, for how stormwater is to be managed within Te Tumu (and the wider Papamoa East area).

The approach proposed for stormwater management of a future urban Te Tumu derives from the 2006 concept plans prepared for inclusion in the Papamoa Catchment Management Plan, which was developed by Tauranga City Council at the time. That Te Tumu stormwater management concept and the Catchment Management Plan formed the basis for the comprehensive stormwater discharge consent (No. 63636) for urban runoff from the Wairakei Stream catchment that was granted by the Bay of Plenty Regional Council in 2009. The Comprehensive Stormwater Discharge Consent was varied in 2015, and the Catchment Management Plan subsequently updated to reflect that variation in 2016.

The Papamoa catchment is unusual in having no natural outlet to a receiving water body at its downstream end. Rather, within Te Tumu day-to-day stormwater runoff soaks to ground from the main water bodies. This has significant implications for stormwater, waterways and flood hazard management under an urban land use. In particular, it means that open water level in the water bodies throughout the Te Tumu urban growth area will vary seasonally and in response to storms over a range of 1.5 m or more, with water holding at high levels for weeks or months (as distinct from a normal stream which will recede in hours or days following a flood). In large flood events the water level could rise by up to a further 1 m but this further rise would recede in a similar way to a normal stream. Further, it means that climate change induced sea level rise will increase groundwater levels, which will over time affect the base water level in all the water bodies.

Development of the SMS has involved detailed work on the landform, hazard management and urban form, and on the stormwater management approach. This has following the following phases:

- Inputs in the SMS
  - Land use Plans (concepts);
  - All technical planning documents (including earthworks digital elevation model, archaeological and cultural and heritage assessments and natural hazard assessments.
- SMS Development
  - Stormwater flood modelling (undertaken by Aurecon using the TCC Papamoa East Flood Model developed by Aurecon);
  - Kaituna River Flood model (undertaken by Aurecon using the BoPRC Kaituna River Flood Model developed by DHI);
  - Development of a Broad Stormwater Concept (developed from those provided as part of guidance inputs to the Catchment Management Plan and Comprehensive Stormwater Discharge Consent);
  - Development of a Technical Report as an unpublished internal working document, which set out the results of the conceptual design, including the underlying assumptions, definition and sizing (including depth) of the required infrastructure, operational and amenity considerations, and sketch plans that show size and location;
  - Development of the Stormwater Management Strategy.

This strategy provides confirmation of compliance with the consent conditions of the Comprehensive Stormwater Consent in regard to stormwater quality and quantity for Te Tumu. Some aspects of this SMS concept meet the intent and objectives for stormwater management as outlined in 2006 concepts and referenced in consent conditions, but using slightly different design details to those originally documented in the Consent.

The structure of this SMS has the following elements:

- Background to the planned development of Te Tumu, including some of the history of studies and design concepts, context in terms of associated documents, and a summary of land ownership;
- A description of the physical environment, particularly as it affects stormwater management;
- The nature of the proposed development is outlined, both in terms of land use and urban form, and in terms of the stormwater management approach and the associated infrastructure assets that will be required;
- The functionality of the stormwater system is described, and compliance with the Comprehensive Stormwater Consent is confirmed (through implementation of the SMS);
- Implementation is described, both in terms of the design and approval processes, and staging;
- Stormwater infrastructure cost estimates are provided;
- Long term operational considerations are outlined.

The strategy provides documentation of stormwater management for the purposes of supporting the Plan Change, structure plan and outlining how compliance with the Comprehensive Stormwater Consent is able to be achieved, through the delivery of future subdivision and land use.

It also provides guidance for the design and development phases of Te Tumu land use, subdivision construction and stormwater infrastructure as detailed in Appendix F, and for long term operational considerations.

1 Background

1.1 Purpose of Stormwater Management Strategy

The purpose of this Stormwater Management Strategy (SMS) is to guide the stormwater management and implementation of future development in the Te Tumu Urban Growth Area. This includes not just the stormwater capture, reticulation and treatment, but also the hydrological and hydraulic aspects of the function of the Wairakei Stream and of a number of other water bodies that will form part of the development. It forms part of the technical and management input to the Te Tumu Structure Plan ('the Structure Plan' or 'SP') and the Plan Change (PC).

This SMS

- Sets out the assumptions and stormwater management philosophy;
- Proposes key stormwater infrastructure, and expected aesthetics, amenity, functionality, and water quality and hydraulic performance, including management of water levels in the Wairakei Stream, and all flood storage basins;
- Sets out how the strategy would be implemented through the development phases of Te Tumu, including broad staging relative to individual land holdings;
- Any cross-boundary considerations between Papamoa East parts 1 and 2, and between individual landholdings;
- Summarises how the proposed management approach satisfies the existing Comprehensive Stormwater Discharge Consent (**CSC**) No. 63636 (granted by the Bay of Plenty Regional Council to Tauranga City Council), including managing flood risk management from flood flows within the Kaituna River;
- Identifies any matters needing to be addressed in the SP and PC, particularly in relation to those parts of Te Tumu that are outside the direct Wairakei Stream catchment and identifying any consents that would be required to build principal stormwater infrastructure.

1.2 Scope

The scope of the SMS includes:

- Managing the stormwater that flows into the growth area from the Wairakei Stream;
- Managing the stormwater generated by future development within the growth area;
- Addressing flood risk management;
- Coordination with the wider structure plan development so that stormwater management and flood risk reduction are consistent with Tauranga City Council (**TCC**) policies and practice and meet higher order statutory planning requirements (i.e. Operative Bay of Plenty Regional Policy Statement and associated policies and methods), and
- Confirming compliance with the CSC.

Modelling of flood risk and conceptual design of the high level flood overflow path from the Wairakei Stream to the Kaituna River are integral to the SMS. Modelling of these matters was undertaken by Aurecon Ltd. The outcomes of that work are key inputs as part of the phases of the development of the SMS. The modelling was undertaken prior to confirmation of the stormwater management concept and will need to be updated to fully reflect the concepts set out in the SMS.

The SMS takes account of technical assessment that has been carried out in support of the development of the SP including the management of ecology and environment; statutory planning; tsunami risk; and liquefaction and lateral spread risk.

1.3 History

Papamoa has been progressively developing eastwards along the coastal margin for many decades. Land in Papamoa East has been identified for future urban development for many years. The overall Papamoa area which the CSC covers, and the extent of the Papamoa catchment, are illustrated in Figure 1. Te Tumu, and the area which the SMS applies is that land marked "PART TWO" in Figure 1.

In 2003 work began on concept development for Papamoa East Part 1 (Wairakei). This covered an area inland from the coastal fringe development which at that stage extended to the end of Papamoa Beach Road, at Marjorie Lane. The Papamoa Catchment Management Plan (CMP) was prepared, and flood modelling undertaken for the whole Papamoa catchment. This was intended to become a basis for applying for a comprehensive stormwater discharge consent for discharge of stormwater to the Wairakei Stream.

The eastern end – Papamoa East Part 2 (Te Tumu) – was considered as rural in initial CMP work, but liaison between the three largest land block owners and TCC resulted in acknowledgement of the benefits of including a future Te Tumu development in the CMP. A key factor in this is that the upstream development has a significant hydrological effect on Te Tumu as there is no natural stormwater outlet in the east, and therefore the full long-term development of Papamoa East needed to be considered together in the CMP and CSC. A broad development concept was prepared for Te Tumu (Beca 2006), and the future Te Tumu development was included into the CMP and consent application.

The CSC (No. 63636) was originally granted in 2009. There has been a subsequent variation to the CSC conditions to account for a changed approach to flood storage provision in development areas of Wairakei and Te Tumu. The change of conditions altered the requirement from 100% storage to 40% storage of pre-development run off rates. The change of conditions was granted by the Environment Court (NZEnvC 2015) on 20 November 2015.

Development has progressed through much of Part 1 (Wairakei) with work now proceeding on a Structure Plan for Part 2 (Te Tumu). The Te Tumu development must comply with the CSC. This SMS shows how compliance is to be achieved.

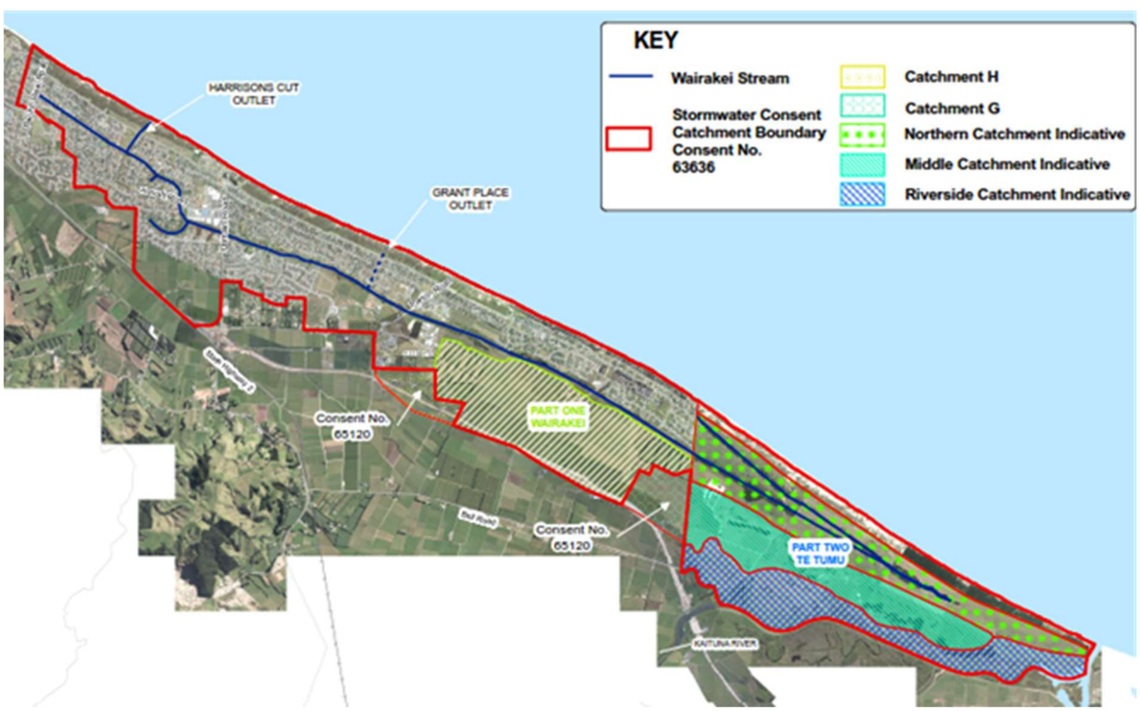

Figure 1 – Overview of Papamoa catchment (from Papamoa CMP)

1.4 Related background documents

The following technical reports and documents were used as background to the preparation of this SMS.

- Structure Plan base map (Appendix A);
- Stormwater technical report (Beca 2018);
- Aurecon modelling report (Aurecon 2018a);
- Aurecon high level flood overflow design (Aurecon 2018b);
- Boffa Miskell Evaluation of Potential Ecological Effects of Te Tumu Stormwater Infrastructure - Wairakei Stream Wetland (Boffa Miskell, May 2019);
- Boffa Miskell Wetland Ecological Survey report (Boffa Miskell May 2020).

1.5 Relationships to other documents

The SMS is to be interpreted and applied in conjunction with the key documents as outlined below. The relationships between these documents is illustrated in Figure 3. These documents guide development and stormwater management in Papamoa which is governed through the requirements of the CSC. The CSC also includes requirements for the Te Tumu future urban stormwater management and discharge, which the SMS complies with.

1.5.1 Te Tumu Structure Plan

The SP for the Te Tumu Urban Growth Area sets out the land use and functionality of the future urban development in Te Tumu. It both informs, and is informed by, the SMS. The Wairakei Stream, Elizabeth Wetland, high level flood overflow and additional constructed water bodies and infrastructure corridors are set aside in the SP for stormwater management, based upon the outcomes of the SMS.

Sizing of stormwater management infrastructure is based on the proposed land use and areas set out in the SP.

1.5.2 Papamoa Catchment Management Plan

The Papamoa Catchment Management Plan (CMP) was developed in 2007 to support the original Comprehensive Stormwater Consent (CSC) application (consent number 63636). It was updated in 2010 following granting of the CSC, as well as in 2016 following approval of a variation. It covers the approach to stormwater management throughout the Papamoa catchment, including the 2006 Te Tumu high-level development concept and stormwater management approach.

This SMS for Te Tumu sits under the CMP, and is intended to focus on urban development and stormwater management implementation for the Te Tumu growth area.

The Papamoa CMP addresses the identified catchments within Te Tumu, being the Coastal, Northern (which includes the Wairakei Stream), Middle and Riverside catchments. The catchments are indicatively shown in Figure 1.

1.5.3 Papamoa Comprehensive Stormwater Discharge Consent (CSC)

Related to the CMP is the CSC that was originally granted in 2009 and subsequently varied in 2015. This consent:

- Sets the stormwater management philosophy, based upon consent conditions for Papamoa East, including Te Tumu;

- Sets how water levels are to be managed in the Wairakei Stream (to manage flooding effects of existing and planned developed in the wider Papamoa East catchment);
- Identifies how the catchments within Te Tumu, are to operate and overall parameters which apply to each;
- Identifies where and how stormwater has been approved through the CSC to be discharged into the Kaituna River from high flow events in the Wairakei Stream, and directly at a number of other points from the Riverside catchment;
- Defines minimum water quality requirements.

1.6 Land ownership

The landowner or Trust groups (of Maori Land) are listed in Table 1.

Table 1 - Landowners and catchments

Landowner	Approximate Total land area	Approximate Unconstrained land area	Catchments covered (as identified in the original supporting document of the CSC)
Tumu Kaituna 14 Trust (TK14)	240.3	162.4	Coastal/Northern/Middle/Riverside
TCC / WBoPDC Totara Farm Park Joint Venture	168.4	94.3	Northern//Middle; Riverside
Tumu Kaituna 7B1 & 7B2 Trusts (TK7B1 & TK7B2)	21.0	3.3	Coastal/Middle
Tumu Kaituna 8B1 Trust (TK8B1)	37.8	19.5	Coastal/Northern/Middle
Hawridge Developments Limited	15.7	1.7	Riverside
Ford Land Holdings Pty Ltd (FLH)	243	117.1	Coastal/Northern/Middle/Riverside
Tumu Kaituna 11B2 Trust (TK11B2)	5.6	2.0	Coastal/Northern
Tauranga City Council (TCC)	0.8	0.8	Middle;
R Love	2.1	0.8	Middle
G Hickson	0.8	0.8	Middle
Edwards	1.2	0	Riverside
K Wendt	6.6	0	Riverside
TOTAL	**743.3**	**402.7 ha**	

Note: Land areas for each property provided by TCC, June 2020.

2 Context

2.1 Physical Environment (Existing)

This section summaries the existing physical environment for the Wairakei Stream, Te Tumu and the Kaituna River.

2.1.1 Topography, landscape and surface water catchments

The current topography of Te Tumu consists of a sand dune system forming a long spit between the ocean on the northern side, and the Kaituna River on the southern side, with the Kaituna River outlet to the east and the Papamoa East Wairakei development to the west (refer to Appendix A for maps). The Wairakei Stream flows west to east between dunes to approximately the mid-point of Te Tumu. Historically it used to then turn north-west to exit to the sea at Taylor Reserve. That entry and exit to the stream was closed by development many years ago, leaving the Wairakei Stream with no outlet at its eastern end, but with the “back arm” channel retained.

The coastal dune system varies in height between approximately 2 mRL and 12 mRL[1]. There are three main dune ridges running west to east along the Te Tumu peninsula with natural basins forming between them. The area is a mix of farming and undeveloped land, with only a few dwellings.

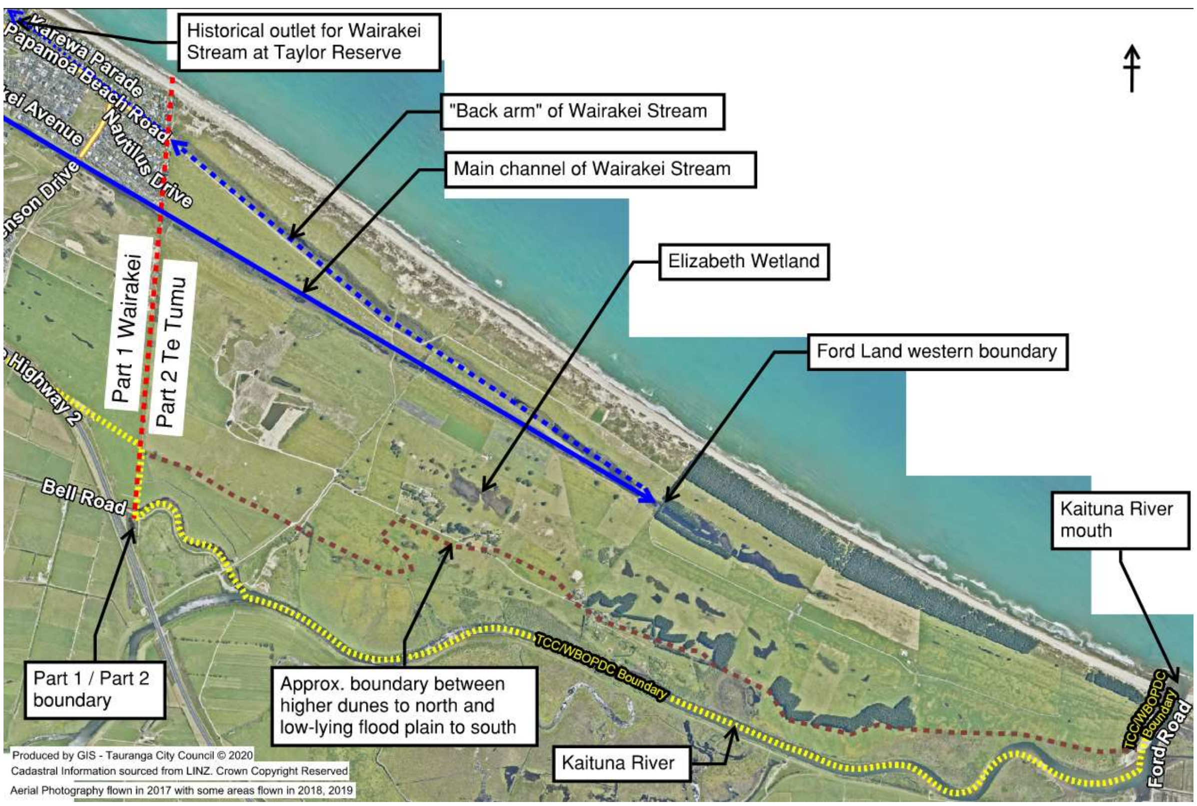

Figure 2 – Overview of Papamoa East Part 2 (Te Tumu) (adapted from TCC on-line GIS)

[1] Reduced Level (RL) is the specified height above the local datum – in this case Moturiki Vertical Datum 1953. Levels are provided in metres above RL (mRL).

In terms of stormwater management, Te Tumu was split into four different "catchment" areas through the CSC. The current indicative catchment boundaries are illustrated in Figure A2 in Appendix A, taken from the CSC. For the development of the SMS and SP, amended catchment boundaries have been identified based on the likely management of landform to improve stormwater management, along with structure plan road corridors, potential future land uses and improved stormwater management efficiency. The selection of these catchments complies with the CSC, as the catchment boundaries have only indicatively been identified within the CSC (referenced in drawings attached to the consent and in an advice note to the consent) but are not part of the consent conditions. The catchment boundaries for the SP, and therefore the delivery of the development in Te Tumu are illustrated in drawing CA-001 in Appendix A, and are in general accordance with the drawing attached to the consent.

The catchments are defined as below:

1. Coastal Dune Catchment. Stormwater generated in this catchment (which is largely fully constrained, with no development proposed within it) will pond and/or soak within the coastal dunes. This covers about 10% of the total Te Tumu area.
2. Northern Catchment: Stormwater generated in this catchment drains to the Wairakei Stream. The Wairakei Stream currently has no outlet in Te Tumu, and water level varies seasonally from being mostly dry in summer to ponded during winter. This catchment covers approximately 40% of the total area of Te Tumu.
3. Middle Catchment: Stormwater generated in this catchment is self-contained and drains via ground soakage in the naturally formed isolated basins within the dune system. This catchment covers approximately 30% of the total area of Te Tumu.
4. Riverside Catchment: Stormwater generated in this catchment drains to the Kaituna River. This catchment covers approximately 20% of the total area of Te Tumu. It includes significant areas of constrained land that will not develop, but there are also some higher sand dune areas where development is possible.

For the purposes of this SMS, the Northern and Middle Catchments are combined, to become one overall functioning catchment, and renamed the 'Wairakei Stream Catchment.'

2.1.2 Soils

Te Tumu is predominantly made up of dune sand. A brief overview of published geological information for this area is set out in the Tonkin and Taylor Natural Hazard Risk Assessment – Liquefaction Report (T+T 2018). Information held by Landcare Research (S-Map interactive soil maps[2]) identifies that there are three different sand soils within Te Tumu:

- Kairaki in the northern coastal area;
- Waikuku north of the Wairakei Stream;
- Kairuals south from the stream to the southern margin of the dune area.

All are classed as deep, well drained sandy loam, and are hydrological soil group A. The low-lying soils on the flood plain of the Kaituna River are Omeheu, which is a deep poorly drained loam, and is hydrological soil group B/D.

Locally there will be some variability in hydrological characteristics, and some matters to be conscious of during development. Observation on site, particularly in the dune areas to the south and east of the Wairakei Stream, is that hollows collect water seasonally. In some cases, this reflects seasonally high groundwater

[2] https://soils-maps.landcareresearch.co.nz/

levels, which can result in ponding in some of the lower-lying areas. Another cause is that over time blinding of the surface can result in the formation of permanent or temporary wetlands, resulting in poor drainage. Experience in parts of Papamoa to the west is that the hollows amongst the dunes, plus other factors related to the evolution of the dune formation, can result in lenses of finer, less permeable soils below the surface, and possible localised areas where there is a perched water table or inhibited soakage.

The intent during development is that footprint of existing protected water bodies (such as Special Ecological Areas in the City Plan) will not be directly modified by development works (apart from localised areas where road crossings occur), so will retain similar soakage characteristics to current conditions. However, adjacent areas will be modified and enlarged by earthworks to allow more widespread flood ponding, which should result in improved soakage relative to current in these wider basin footprints.

Similarly, when compacted for subdivision fill during earthworks, the dune sands can become significantly less permeable than in their natural state. Therefore, care will be necessary to avoid compaction in areas where soakage to ground is important (e.g. in the larger water bodies and basins directly associated with the Wairakei Stream and flood overflow channel), and that appropriate soakage testing is undertaken after compaction where impervious area runoff is to be disposed directly to ground (i.e. on all development areas where earthworks are carried out and soakage is then being proposed).

2.1.3 Wairakei Stream catchment hydrology

The Te Tumu Urban Growth Area (commonly referred to as Papamoa East Part 2 in prior planning and CSC documents) is to the east of the Wairakei development area (Papamoa East Part 1). These two areas are connected by the Wairakei Stream, which extends about 10 km to the west of the Te Tumu boundary (refer Figure 1).

Currently the Wairakei stream has two outlets/overflows, both to the coast:

- at Harrisons Cut towards the western end, and
- at Grant Place (the most easterly outlet) which is about 4.7 km upstream of the Te Tumu boundary

From the Te Tumu boundary to the eastern end of the Wairakei Stream (at the Ford Land Holdings Pty Ltd (FLH) boundary) is a further 3 km along the stream, and there is a further 3.2 km of the Wairakei Stream back arm lying northwest from this point.

The area east of the FLH boundary serves from time to time as overflow ponding from the Wairakei Stream, in permanent wet ponds between east-west dunes.

The eastern part of the Wairakei Stream back arm is ephemerally connected to the Wairakei Stream, but the western part (in TK14 landholding) is not directly connected except during significant flood events, dues to the presence of two bunded crossings of the waterway.

There is currently no outlet from the Wairakei Stream in Te Tumu to the Kaituna River or Pacific Ocean. The Grant Place outlet has an actively controlled gate with a sill level of approximately 2.1 mRL, which opens when water level at Grant Place rises above 2.85 mRL and closes when the water level drops back to 2.45 mRL. While this outlet is well upstream of the eastern end of the Wairakei Stream, it serves to limit the long-term maximum water level in the eastern Wairakei Stream, at least during extended wet periods, or following the recession of major flood events.

There is a small pump station in the Wairakei Stream immediately west of the Te Tumu boundary. This was installed as part of the overall flood risk management approach for the Wairakei Stream under the CSC, as a means of avoiding long durations (weeks to months) of high water level in the rural eastern end of the stream over winter, as a result of increasing urban development to the west. The pump station has a capacity of 0.2 m^3/s, and is intended to progressively draw down flood water in the eastern end of the Stream during high winter water levels, or after major storms. It is consented (BoPRC consent number 65119) to start pumping when water level exceeds 2.1 mRL, and to cease pumping when the level drops back to 1.9 mRL. The pump station discharges to the Bell Road Drain immediately east of the TEL expressway. The consent requires that pumping not occur when water level in the Bell Road Drain is higher than 1.6 mRL.

Given there is no high capacity flood outlet from the eastern Wairakei Stream, for safety of development the CSC requires that before Te Tumu development can commence within the Wairakei Stream catchment (expressed as northern catchment in the consent), there must be provision of a high level flood overflow from the eastern Wairakei Stream to the Kaituna River. Advice Note 16 of the consent identifies the expected frequency of overflow to be of the order of 7 years on a long-term average basis.

A further flood safety provision recognises that in a super design event (greater than a 100 year ARI[3] flood), a "safety valve" is needed to protect large numbers of houses that have been or will be built close to the same design level. This is provided in the Papamoa East (Wairakei) development, in the form of two high-capacity overflow swales, set just above the 100 year ARI flood level, and discharging south to the Bell Road drain catchment.

From flood modelling undertaken by Aurecon in 2018 utilising the Papamoa East 2D Flood Model, the following outcomes are the result of model runs, and therefore applicable to all stormwater and flood risk management in those parts of Te Tumu affected by Wairakei Stream flood risk (subject to any updates to the modelling):

- The high level flood overflow sill as the outlet from the flood overflow channel (approx. 7 year ARI flood level fully developed, 2055 climate) will be set at 3.95 mRL;
- To achieve consent compliance in regard to flood levels (100 year ARI flood level fully developed, 2055 climate) across the wider Papamoa catchment (4.6 mRL), the modelling shows the expected flood levels in the Wairakei Stream in Te Tumu would be of the order of 4.3 mRL to 4.4 mRL;
- The modelling shows that flood levels in Te Tumu (100 year ARI flood level fully developed, 2130 climate) will be between 4.6 mRL to 4.7 mRL.

There is more detail of the catchment flood hydrology and flood modelling in the Aurecon flood modelling reports, including the flood modelling report within the CMP documentation, and also in the updated report Aurecon 2018a. However, the model will need to be updated before the final sill level is confirmed and the overflow implemented.

2.1.4 Kaituna River hydrology

The Kaituna catchment is large, and in the upper reaches the hydrology is influenced by the Rotorua lakes. It's hydrological response and timing is different to that of the Papamoa catchment (Aurecon 2014)

Te Tumu includes the Kaituna River flood plains to the south. This land is predominately existing natural wetlands at approximately 1.0 mRL and lower. The Kaituna River flood levels range from the western to eastern ends of Te Tumu from 4.1 mRL to 3.4 mRL respectively in a 100 year ARI event with 2130 climate.

2.1.5 Groundwater

The existing groundwater profile is dome shaped with the coast and river drawing down the edges, as the water level in those water bodies form the lateral hydraulic boundary conditions for groundwater profile. The highest ground water level is on the western side of Te Tumu in the TK14 land. This shape reflects that the principal groundwater source in Te Tumu is from rainfall, and from soakage to ground in the eastern end of the Wairakei Stream and isolated hollows in the sand dunes. The median groundwater level with current

[3] Average Recurrence Interval – the frequency with which an event is equalled or exceeded on a long term average basis.

climate and sea level is shown in Appendix A, Figure A4. The groundwater levels are based on work by Tonkin + Taylor Ltd for TCC. There has been no specific modelling of future (climate change) groundwater levels.

The current climate 5th percentile low ground water levels range from 1.3 mRL in the west to 1.0 mRL in the east of Te Tumu. The current climate 95th percentile ground water levels range from 2.9 mRL in the west to in the east 2.5 mRL. A long section of the Wairakei Stream from Grant Place through Te Tumu, with relevant ground and water levels in it, is provided in Appendix D. The long section also shows the levels to which Grant Place outlet is controlled, which can serve to limit sustained stream water levels above about 2.5 mRL.

With climate change to 2130, the sea level is predicted to rise. Different sea level rise scenarios will result in changes to groundwater levels. While there is a range of sea level rise scenarios, the key sea level rise scenario utilised for Te Tumu is 1.6 mRL of rise to ensure consistency with current Ministry for the Environment (MfE) coastal hazard and climate change guidance (Coastal Hazards and Climate Change: Guidance for Local Government – 2017) for greenfield development (using a climate change scenario of RCP 8.5 H+). Based on this MfE guidance document, TCC has adopted a sea level rise scenario of 1.6 mRL (year 2130 scenario) for use as the sole sea level rise scenario in all natural hazards and stormwater management.

For the purposes of this SMS, it is assumed that groundwater levels will rise in a similar profile to sea level rise (i.e. a rise of the whole groundwater surface by 1.6 mRL). This is a simplification, but not unreasonable given that the area is surrounded by the sea, or by tidally affected river, on three sides.

Over time, as further modelling of the groundwater table is carried out (in relation to how sea level rise may occur) this may result in this assumption being modified.

Previous T+T reports on groundwater levels are included as Appendix 7 to the Papamoa (CMP).

2.1.6 Climate change (specifically in regard to stormwater management)

Te Tumu, as a current landform, may be affected by climate change in regard to increased rainfall intensity and by sea level rise, unless there is appropriate setting of landform/building platform and design solutions. There are three principal components to this:

- Increased storm rainfall intensities will lead to larger flood peak flows and runoff volumes needing to be managed within the water bodies. This means ponding will occur more frequently and to high levels and will take longer to recede.
- There will be minor increases in long term average rainfall, with the greatest seasonal increase expected in the autumn.
- Sea level will increase, which will affect the groundwater table and flood risk. Based on MfE guidance, and as noted above, TCC has adopted a sea level rise scenario of 1.6 mRL (year 2130) to be used in design solutions for Te Tumu.

2.1.7 Wairakei Stream water levels

Critical to the long-term water management in the Wairakei Stream catchment is the water level characteristics of the water bodies, including the Wairakei Stream, recognising dry weather, seasonal and flood contexts. The characteristics differ markedly from most other streams, and even from the Wairakei stream further upstream to the west. Earlier sections of this SMS outline some of the factors that influence this, including lack of a normal flow outlet, soakage of most runoff to ground, direct influence from groundwater levels, future development and climate change effects. While groundwater is a significant factor, the interconnected nature of the Wairakei Stream water body means that the stream water level most of the time will be relatively similar across the Te Tumu development area. Further, the surface water level behaves differently at seasonal high levels and during storms. Appendix B.1 provides a series of photos of the Wairakei Stream in Te Tumu which illustrate the variability in water level, and also the implications for vegetation, stream bed form and aesthetics.

The following are key contexts:

- **Dry weather flow – summer**. Currently much of the Wairakei Stream in Te Tumu can dry out in a particularly dry summer, with only some persistent deeper pools remaining. The 5th percentile groundwater levels in the east is about 1.0 mRL, while stream bed typically varies from 0.5 mRL to 1.5 mRL.
- **Wet season flow – winter**. During winter there can at times be minimal water ponded in the eastern Wairakei Stream, although extended wet periods can see the water level rise to around 2.0 mRL and can take weeks or months to drain down again through soakage to groundwater. Water level higher than 2.0 mRL can be managed to achieve a more rapid recession by use of the Wairakei pump station, in order to protect inundated pasture. When water levels rise above 2.45 mRL (rare historically, but becoming more frequent with development and climate change), then the Grant Place outlet assists in restoring water levels back to that level, with the Wairakei pump station allowing them to be lowered further to about 2.0 mRL and discharge to ground lowering them further over time.
- **Minor floods (<7 year ARI)**. This type of event is relevant for future development when the high level flood overflow is in place. In storm events up to the 7 year ARI flood, water will be contained at levels up to the high level flood overflow weir level (currently designed at 3.95 mRL), and will drain down through the Grant Place outlet to about 2.45 mRL, and then continue to drain down as for wet season flows.
- **Major floods (> 7 year ARI)**. In larger floods the water level through Te Tumu will rise up as high as about 4.4 mRL and significant discharge will occur to the Kaituna River, but the water level will drain down relatively quickly (over hours or days) to the (to be constructed) high level flood overflow weir level. From there it will follow the pattern for smaller storm recession.
- **Climate change** will increase the minimum levels, but not change to upper limits that are controlled by the to be constructed high level flood overflow weir, the Grant Place outlet and the Wairakei PS (if it continues operation).

Some elements of these hydrological characteristics are illustrated in an annotated extract from historical water level records for the eastern end of the Wairakei Stream, in Te Tumu, in Appendix C. These hydrological characteristics reflect coastal development only in Papamoa East Part 1 (Wairakei) and no development in Te Tumu, so show lower levels than expected for longer term hydrology.

Appendix D provides a partial long-section of the Wairakei Stream from Grant Place down to the FLH boundary in Te Tumu. This illustrates the relationship between operating levels at Grant Place outlet, and stream bed and groundwater level ranges in Te Tumu.

Table 2 shows recommended design ranges for water level. This assumes that the high level flood overflow to the Kaituna River is in place prior to development proceeding in the northern catchment, as required by the CSC.

Table 2 - Typical Wairakei Stream water level ranges

Context	Current climate (mRL)	2130 climate – sea level rise 1.6 m
Summer range	1 to 1.7 typically	2.5 typically
Winter and small storms	1.5 to 2.0 typically Up to 2.5 in storms, receding over weeks	2.5 typically Up to 3 in storms, receding over weeks
Larger storms (every few years)	Rising to as high as 3.95, receding over several days to 2.5, then more slowly as for small storms	As for current climate, but occurring more often and for longer due to higher base water level
Major storms (rare)	Rising to 4.4, receding over hours/days to 3.95, then more slowly as for more frequent storms	As for current climate, but occurring more often and for longer due to higher base water level

Given that median ground water level is expected to rise to about 3 m in Te Tumu with climate change and recognising the influence of the Grant Place outlet, a recommended "high water level" of 2.5 mRL has been adopted as the upper level for typical water level variation (outside significant flood events) and as a base water level for future climate flood modelling. Water levels above that should recede relatively quickly, while below that they could remain high for periods long enough to affect terrestrial vegetation viability and therefore the design of water body margins.

The levels outlined in Table 2 are best estimates based on historical records, and need to be updated when a water balance model has been completed and future effects of development and climate change have been investigated using that model.

2.1.8 Water quality

The Wairakei Stream is currently ephemeral in Te Tumu, and water quality influences are a mix of urban (Wairakei & Papamoa to the west) and rural (Te Tumu) activities.

Water quality is addressed in some detail in the Papamoa CMP. There are water quality performance requirements in the CSC and CMP addressing discharge of contaminants to Wairakei Stream and the Kaituna River, and also to the Pacific Ocean (not directly relevant for Te Tumu). The only parameter that is quantified in the CSC is sediment concentration, which must not exceed 150 g/m^3 in the discharge for events up to the 10 year ARI storm.

There are also monitoring conditions in the CSC, for the Wairakei Stream, the high level flood overflow and discharges from the Riverside catchment, via Riverside treatment wetlands.

In effect, Te Tumu is the ultimate receiving environment for any solid, particulate or attached contaminants passing down the Wairakei Stream, at least in events up to the trigger for discharge to the Kaituna River (about a 7 year average recurrence interval storm) via the high level flood overflow. Any dissolved contaminants will likely discharge to groundwater via soakage.

2.1.9 Ecology

There are three main water body areas within the growth area that have been identified as having important ecological values. These are covered in the City Plan and are scheduled as Special Ecological Areas (SEA).

- Wairakei Stream corridor, including both the main stream through to the Ford Boundary, and the "back arm" of the stream (refer to Figure 2);
- Elizabeth wetland, a dune lake south of the Wairakei Stream;
- Kaituna River flood plain, where there is a mix of low-lying farmed areas, and natural wetlands.

Boffa Miskell have undertaken three ecological assessments of natural wetlands within Te Tumu to document plants, fish, indigenous birds and bats along with water and sediment sampling and habitat observations. The findings from the most recent of these assessments, being Boffa Miskell (2020), are outlined below:

"The Wairakei Wetlands are artificially induced wetlands (originally coastal lowland stream habitat) within a historic stream corridor that traverse the sand plains from the urban/rural boundary towards the Kaituna River before then turning back towards Papamoa parallel to the coastal dunes. The wetland corridor has diverse habitats and supports a high diversity of indigenous plants. Rare or threatened plant species previously observed were not found but yellow bladderwort (threat status - Nationally Critical) was detected for the first time in abundance. The wetland supports a high diversity of indigenous birds including Threatened and At Risk species. Bittern (threat status – Nationally Critical) are present and likely breed in the wetland. The wetland provides habitat for native fish except in the western reach of the coastal arm which has limited hydrological connection to the wetland. Sediment is not impacted by toxicants. Water quality throughout the wetland is variable; most of the wetland has low nutrient and metal concentrations and high water clarity, while the western survey sites are impacted by high nutrients, metals and algal loads, and low water clarity. The overall ecological significance of the Wairakei Wetlands corridor is assessed as being high, providing a diverse wetland ecosystem supporting two Nationally Critical threatened species.

The Elizabeth Wetland is a natural dune lake wetland in a paleochannel of the Wairakei Stream. It has moderate habitat values, and supports few native plant species, a moderate number of indigenous bird species and no fish. However, the wetland provides breeding habitat for bittern which have a threat status of Nationally Critical, and six adult bittern were detected in the wetland. The wetland is impacted by livestock damage around the margins which would be easily remedied through fencing, and water quality is impacted by high nutrient, metal and algal loads, and low water clarity. The overall ecological significance of the Elizabeth Wetland is assessed as being moderate-high, with impacts on botanical values and water quality, but being a large unmodified example of a threatened ecosystem supporting a Nationally Critical threatened species.

Both wetlands are part of a sub-regional mosaic that provides significant food resources and habitat for a diverse range of species, and both are refugia for indigenous ecological values within the rural Te Tumu landscape. Although the presence of two indigenous birds (marsh crake, fernbird) requires further survey, this work has addressed the information gaps identified to assist with long term habitat management of the Wairakei Wetlands and Elizabeth Wetland."

2.2 Social and Cultural Environment

There are important social and cultural aspects to the area and water bodies which have a strong influence on the SMS and the approach to management of stormwater and water bodies. There is ongoing work on this, but one background resource is to refer to relevant Iwi/Hapu Resource Management Plans, Cultural Impact Assessments, Cultural Management Plans and Treaty Settlements.

A list of iwi and hapu management plans received by Bay of Plenty Regional Council is located on their website. The following IMPs have been identified as potentially relevant to the Te Tumu project.

- Waitaha Iwi Management Plan
- Tauranga Moana Iwi Management Plan 2016-2026 - A joint Environmental Plan for Ngāti Ranginui, Ngāi Te Rangi and Ngāti Pūkenga
- Te Awanui: Tauranga Harbour Iwi Management Plan 2008 - Tauranga
- Ngāti Pūkenga Iwi ki Tauranga Trust Iwi Management Plan 2013
- Ngāti Whakaue ki Maketu Hapu Iwi Resource Management Plan 2009
- Draft Ngāti Whakaue Hapu Iwi Resource Management Plan 2018
- Ngāti Pūkenga Resource Management Plan, 1993 - Western Bay of Plenty
- Ngā Aukati Taonga o Tapuika me Waitaha, 1993 - Te Puke/Maketu

- Ngaiterangi Iwi Resource Management Plan, 1995 - Western Bay of Plenty/Tauranga
- Voices Ngā Kōrero Whakahiahia o Ngaiterangi me Ngāti Pukenga, 1999 - Western Bay of Plenty/Tauranga
- Ngāpotiki Environmental Management Plan (Draft), 2001 - Western Bay of Plenty/Papamoa

The legislation and statutory documents identified include:

- Tapuika Settlement Claims Act 2014
- Tapuika Deed of Settlement 2012
- Waitaha Claims Settlement Act 2013
- Waitaha Deed of Settlement 2011
- Affiliate Te Arawa Iwi and Hapu Claims Settlement Act 2008
- Affiliate Te Arawa Deed of Settlement 2008
- Ngāti Rangiteaorere Claims Settlement Act 2014
- Ngāti Rangiteaorere Deed of Settlement 2013
- The Kaituna River Document: Kaituna he taonga tuku iho - a treasure handed down
- Ngai Te Rangi and Nga Potiki Deed of Settlement 2013
- Tauranga Moana Iwi Collective Deed of Settlement 2015
- Tauranga Maori Trust Board Act 1981

The cultural impact assessments and other documentation include:

- Ngāti Whakaue ki Maketu Kaituna Re-diversion CIA 2014
- Tapuika CIA for Wairākei Stormwater Consents
- Tapuika CIA for Kaituna Re-diversion 2014
- Waitaha, Ngāti Makino, Ngāti Pikiao & Ngāti Tunohopu CIA for Kaituna re-diversion and wetland project 2014
- Ngāti Whakaue CIA for SmartGrowth
- Mauao ki Papamoa Rena Kaitiaki Impact Assessment 2012

The cultural impact assessments for the Te Tumu project have been developed by:

- Ngāti Pūkenga represented by Ngāti Pūkenga ki Tauranga Trust
- Tapuika represented by Tapuika Iwi Authority
- Waitaha represented by Te Kapu o Waitaha
- Ngāti Whakaue ki Maketu represented by Te Rūnanga o Ngāti Whakaue ki Maketu (in draft)
- Te Ure O Uenukukopako represented by Ngāti Uenukukopako Iwi Trust

TCC has completed a cultural values literature assessment (Te Onewa, 2018) which includes consideration of the documentation set out above. There are some specific features that should be noted in regard to some water bodies, which need to be taken into account in regard to final design or future engagement (as required).

2.2.1 Kaituna River

The Kaituna River is of particular note as a potential receiving environment and has been the subject of considerable focus on water quality improvement and the partial re-diversion of the river back through the Maketū estuary. This work is separate to the work associated with Te Tumu Urban Growth Area and Wairakei Stream projects and consenting. Because of this focus on the Kaituna River water quality, frequent direct discharge from the Wairakei Stream and from most of the Te Tumu Urban Growth Area to the Kaituna River has been avoided. The CSC does provide for some stormwater discharge to the Kaituna River. The recognition of how often this is expected to occur is only during flood events greater than approximately the

7 year ARI. Direct discharge from within Te Tumu to the Kaituna River can only occur from development within the Riverside catchment.

2.2.2 Wairakei Stream

The Wairakei Stream also has important cultural values, which are recognised in the CSC and the Structure Plan. In particular, the consent requires the preparation of a landscape plan (WSCLP) for the Wairakei Stream corridor, which will address (among other matters) cultural matters of relevance to iwi groups listed in the CSC. The extent of this is from the Wairakei / Te Tumu boundary through to where the Wairakei Stream terminates in the back arm.

The landscape plan parameters are established in the CSC, and is to be developed in two parts, being application to the Wairakei Stream outside (west of) Te Tumu, and then for Te Tumu within 2 years of the land being rezoned for urban purposes.

2.2.3 Archaeology

There are a number of archaeological sites identified in Te Tumu. These are recognised in the SP. In particular (but not exclusively) they occur along the coastal dune areas, and the riverside margins of Te Tumu, and constrain the areas available for development, and for location of infrastructure.

All identified preservation areas, as identified by the Archaeology BOP report, are considered to be constrained, and not provided for urban development (and therefore are protected).

2.3 Options considered

2.3.1 Catchment-wide options considered (CSC)

High-level options for stormwater management in the then Northern and Middle catchments were considered for the original Papamoa CMP and CSC application. An underlying assumption was that there would be urban development in Te Tumu at some future date, so the stormwater management options consideration was primarily related to safety of the development, and discharge of stormwater from the wider Papamoa catchment, including Te Tumu. Options considered specifically through the CSC process for ‘ultimate' stormwater discharge from the eastern Wairakei Stream were:

- Discharge to ground (status quo). This option was adopted in principle for the CMP and CSC, but in itself did not provide security in regard to flood risk management, either for Te Tumu or for the areas in Papamoa to the west of Te Tumu. The runoff quantities in major storm events, both from Te Tumu and from upstream in Papamoa East means it would not be feasible to full contain large storms (greater that a 7 year ARI event). A key factor in this is that much of Papamoa is already built to a common building platform and floor level, as required in the City Plan, and the risk associated with not having a secure high level flood overflow to protect existing property would not be acceptable. This overflow provision was a key factor in the granting of the CSC.
- Discharge to the coast. Tauranga City currently has two discharges to the coast from the Papamoa catchment, at Harrisons Cut, and at Grant Place. However, these have limited capacity, and present operational and aesthetic challenges and risk related to coastal erosion. The bulk of Papamoa stormwater runoff in moderate to large storms at present reaches Te Tumu area and ponds until it soaks away to ground. Prior to Papamoa development, there was a coastal discharge via the back arm and out through Taylor Reserve, but this has been closed for many years by urban development. For the CMP and CSC, an assessment was made or the possibility of creating a new coastal outlet in Te Tumu, sufficient to convey discharge in a major flood event, and provide the necessary flood security for Wairakei and Te Tumu development. The conclusion was that this was not a viable option, following investigation and assessment (Opus 2007). Nevertheless, Advice note 10 in the CSC states "*It is*

recommended that the consent holder continue to explore the options for a further coastal outfall structure throughout the term of the consent and consider this in terms of the overall permanent stormwater management for the catchment."

- Discharge (directly) to the Kaituna River. This was not a suitable option for routine discharge of urban stormwater and contaminants from Te Tumu, due to cultural considerations. The Kaituna River and Maketū Estuary are of great significance to iwi, and considerable effort has been put recently into improving the quality of both water bodies. However, occasional discharge as a high level flood overflow was determined to be acceptable and have a minimal effect (currently estimated to be a 7 year average recurrence interval). This provides the opportunity to protect both existing and future development in Papamoa from the risk associated with flooding of dwellings. The CSC also allows for limited areas in the southern part of Te Tumu, which naturally drains to the Kaituna River already, to be developed and to discharge to the Kaituna River at a number of points after water quality treatment.

Note: The Wairakei pump station does provide a mechanism for discharge of stormwater from the eastern end of the Wairakei Stream. However, the intention of this pump station, and its associated consent, is the management of water levels when they are seasonally high, and not as the total discharge solution or for flood discharge. There are limits on its operational level which mean it cannot control water level lower than about 1.9 mRL due to hydraulic constraints to the east. Further, as a matter of policy, TCC does not wish to be dependent on a long-term pumping solution for stormwater discharge from Wairakei.

2.3.2 Te Tumu stormwater management options considered

Options considered for general stormwater management at the time of development of the CSC where:

- Conventional piped stormwater management. There will be some areas where a conventional piped system is required to direct runoff to the main water bodies. However, for compliance with TCC guidelines in regard to low impact design, and because there is no direct stormwater outfall available from Te Tumu, there are limitations on the use of this approach.
- Full discharge to ground. Discharge to ground at source will be feasible in many areas and is consistent with TCC guidelines and current practice elsewhere in Papamoa. However, discussion with TCC, and experience from other parts of Papamoa already developed, mean that TCC does not consider discharge to ground can cover all storm events. They have adopted the provisions contained in the NZ Building Code, *Acceptable Solutions and Verification Methods for Clause E1 Surface Water*, although the standard in the Infrastructure Development Code (**IDC**) is slightly higher, requiring the discharge of the 10 year ARI storm for all durations. A higher standard than this for discharge to ground is likely to result in ongoing drainage problems.
- Low impact design. The use of low impact design is a requirement of both the CSC and the TCC design guidelines and will be reflected in the Te Tumu development. However, there are aspects of the hydrological context of Te Tumu which mean that there are other matters that also need consideration.
- Hybrid low impact approach. This approach would make use of low impact design where appropriate within the development, but would recognise that local site constraints, including implications of the significant runoff volumes discharged into the area from the wider Papamoa East area would mean that there is a need for more conventional tools such as pipe systems in some areas, and the use of large flood storage basins, communal discharge to ground and major flood overflow provisions. This is effectively the approach adopted for Te Tumu in this SMS.

2.4 Statutory Context

2.4.1 Te Maru o Kaituna River Authority and the Kaituna River Document

The Te Maru o Kaituna River Authority and the Kaituna River Document are relevant to considerations of any interactions with or discharges to the Kaituna River.

2.4.2 Regional Policy Statement and Regional Plans

There are a number of regional documents that have an influence on the Te Tumu Urban Growth Area and how it develops, and also influence the approach to how stormwater is managed. These particularly include the Operative Regional Policy Statement (RPS), the Regional Natural Resources Plan, and the Regional Coastal Environment Plan (which also incorporates regional implementation of the New Zealand Coastal Policy Statement).

These higher order documents are required to either be given effect to, or to have regard to, in the plan making process for Te Tumu. Included in the RPS are required natural hazard policies, water quality policies and a policy relating to climate change.

2.4.3 City Plan

The Tauranga City Plan currently has zoned Te Tumu as Future Urban. The purpose of this is to signal the future development of Te Tumu within the Plan, while maintaining an existing rural land use. As part of the progression of Te Tumu, it will be proposed to be rezoned for urban land use, which will be supported by the draft Structure Plan. In relation to stormwater, current rules relating to subdivision within the Wairakei Urban Growth Area (see Rule 12B.3.1.12 and 12B.3.1.13 of the Operative City Plan) reflect requirements in the stormwater consent (refer 2.4.4) for the Wairakei urban growth area, and similar rules are likely to apply to stormwater in Te Tumu.

Further, there are general rules related to stormwater that are contained in Appendix 12B: Performance Standard, Stormwater, and within the IDC.

2.4.4 Stormwater Consents

All development works are to meet the existing CSC. This consent describes the storage requirements and allowable flood levels in the Wairakei Stream, along with water quality and monitoring requirements.

From a flood risk management perspective, the consent requires Te Tumu development to meet the following conditions:

- Condition 5.2 *"…ensure the Top Water level in the Wairakei Stream Corridor within the Papamoa Catchment outside the Part 1 (Wairakei) and Part 2 (Te Tumu) areas, does not exceed a height of 4.5 m RL (relative to Moturiki Datum) in a 1 in 50 year (2% AEP) 48 hour rainfall event…"*
- Condition 5.3 *"…Northern Catchment of Part 2 (Te Tumu)... provide storage to equal to 40% of the difference in volume between the 1 in 100 year (1% AEP) 48 hours rainfall event runoff hydrograph in its modelled undeveloped state and the 1 in 100 year (1% AEP) 48 hour rainfall event runoff hydrograph in its developed state".*
- Condition 5.4 *"…Wairakei Stream Corridor… within the Part 1 (Wairakei) and Part 2 (Te Tumu) areas does not exceed a height of 4.6 m RL in a 1 in 100 year (1% AEP) 48 hour rainfall event."*
- Condition 5.6 requires that all areas in Part 1 and Part 2 (Te Tumu) area, for which there are no privately held discharge consents at the time of granting this consent are to meet condition 5.3 and identifies devices to consider.
- Condition 5.7 references the Papamoa Comprehensive Consent Catchment Management Plan as setting out mechanisms for stormwater management.
- Advice Note 16 states that the expected frequency of spill from the high level weirs would be approximately once every 7 years on a long term average basis.

The consent does not explicitly state that rainfall event intensities are to be adjusted for climate change, although the application made by TCC did consider climate change to 2055. The position taken in this SMS is that 2055 rainfall (as used for the consent application) will be used by TCC to demonstrate Papamoa catchment compliance with the numerical conditions in the consent, i.e. using the same rainfall as the application to match the specified stream reduced levels, pre/post storage volume, and overflow frequency. However, implementation of stormwater management, including risk assessment and design for the growth area, will be based on rainfall including climate change to 2130 for the greenfield development. (e.g. development design of building platforms, pipe infrastructure, flow paths, constructed wetlands etc.) and sea level rise of 1.6 mRL.

Specific requirements in the consent are set out below.

Conveyance

There are specific provisions relating to culverts over the Wairakei Stream and back arm.

- 4.2 *"…Culverts are to be as shown as per BOPRC Plan numbers RC63636/6A and RC63636/B. Part 2 (Te Tumu) Wairakei Stream crossings is to have no more than two culverts with maximum total headloss of 130 mm located to the west of the high level weir from the Wairakei Stream."*

Water quality

Conditions under section 6 set performance requirements, but do not appear to explicitly require the use of treatment devices for discharges to the Wairakei Stream.

- 6.1 *"...suspended solids in the stormwater discharges to … the Wairakei Stream … shall not exceed 150 g/m^3 at any time expect where the design event of a 1 in 10 year (10% AEP) rainfall event is exceeded"*
- 6.2 *"…shall be substantially free of floatable solids, oil and grease."*

(Note: from developed urban areas these performance requirements can usually be met without the use of specific treatment devices.)

Consented discharge points

There are specific provisions for discharge to the Kaituna River.

- 2.2. "*Stormwater discharged to the Kaituna River shall be from maximum six discharge points via wetlands* [Riverside catchment runoff]*, including two of three optional high level weir discharge structures* [Northern and Middle catchments] *… ".*
- The consent also provides for the discharge of urban stormwater to land soakage from roofs, swales and ponds.
- The consent does not explicitly set the threshold for discharge of the high level flood overflow to the Kaituna River. However, the application for the latest variation to the consent indicated that the expected frequency would be about 7 years on a long term average basis, and this is recorded in Advice Note 16.

It should be noted that at the time of granting of consent, it was envisaged that the Middle catchment would be managed independently of the Wairakei Stream catchment, but would overflow to the Kaituna River at the same threshold event.

3 Stormwater Management Philosophy

3.1 Structure Plan

The proposed Structure Plan covers all development intended for land east of Papamoa East Part 1: Wairakei, and between the Kaituna River and the coast. It sets out future development areas, and provision for key infrastructure.

The SMS has been developed interactively with the Structure Plan and land use planning studies, and will be incorporated into the final Te Tumu Structure Plan. Stormwater management areas have been defined to provide sufficiently for managing stormwater from the proposed development, within the defined locations outlined in the Structure Plan.

3.2 Te Tumu catchments

Key principle: stormwater management principles based on catchments identified in CSC

For purposes of stormwater management, the four catchments from the CSC have generally been grouped to three principal management subcatchments:

- The Coastal catchment, discharging into dunes or direct to the foreshore and coast. Development in this catchment is expected to be minimal, if at all.
- The Wairakei Stream catchment, part of the wider Papamoa catchment and primarily discharging to ground by soakage. Following development it will include the predevelopment Northern and Middle catchments (as indicatively shown in supporting material to the CSC). This is because for flood storage management and discharge, these two will be interconnected and function together. Once water level in the Wairakei Stream reaches 2.5 mRL or above there must be functional hydraulic connection between all the main stormwater storage basins. However, for water levels below this interconnection of basins may vary, with the minimum likely connection level between basins being about 1.0 mRL, (although connection at this lower level is not explicitly required by the SMS).
- The Riverside catchment will discharge to the Kaituna River in all storm events, following water quality treatment in constructed wetlands. The western part of the catchment solely located in the TK14 landholding (west of the future Bell Road connection into TK14 along the stop bank as shown on the SP) is located within the Bell Road B pumped drainage catchment, but once developed is proposed to be discharged under the future Bell Road connection and to the River directly rather than through the Bell Road B outlet.

3.2.1 Principal development subcatchments

Coastal catchment

There is no development proposed in the coastal catchment, which is nominally the area north of the southern boundary of the coastal dune area. This area is defined as the outer extent of the range of constrained land areas, with the landward extent of the catchment defined as the mapped Special Archaeological Area, as identified in the SP. It is important to note that in large rainfall events, runoff from parts of this area that slope south may flow south into the Wairakei Stream catchment and will need to be managed as part of the stormwater design.

Where there are any special purpose structures or developments (e.g. toilets and surf lifesaving structures) proposed within what is topographically the coastal catchment, these shall either manage stormwater to ground up to the 100 year ARI storm with climate change to 2130, or the stormwater runoff shall be diverted back to the Wairakei Stream catchment and included in performance requirements of flood storage and containment.

Wairakei Stream catchment – (Northern and Middle catchments)

The Wairakei Stream catchment as defined in the SP will contain a mix of residential, light industrial, commercial and reserve land uses. Stormwater from residential roofs, and other impervious areas where practicable, will be discharged to ground up to the 10 year ARI storm, and in higher rainfall events and from other impervious and pervious areas to the Wairakei Stream.

The Wairakei Stream (including the back arm) is part of the wider Papamoa East catchment, and has many special characteristics, including that it is identified as a Significant Maori Area (**SMA**) and a Special Ecological Area (**SEA**) within the Tauranga City Plan. The SMA and SEA areas do not extend into the existing ponds and flood storage east of the FLH boundary.

The stormwater basins and storage areas in this catchment do not require changes to the waterway portions of the Wairakei Stream and back arm. Rather, works are mostly limited to land above 2.0 to 2.5 mRL which will result in cutting higher land down to this level to create a wider stormwater basin for stormwater volume management (and also provide for improved terrestrial ecological values within the corridor). It is noted that works will be required for connecting the Wairakei Stream to the high level flood overflow channel and the FLH basins, and to provide for north/south roading corridors, with culverts (two proposed on the main stream as allowed within the CSC, plus one over the back arm).

The CSC also requires preparation of a Wairakei Stream Corridor Landscape Plan (WSCLP) and Cultural Management Plan, which will be prepared separately to this SMS. The requirement in the consent is for this to be completed within 2 years after rezoning.

Riverside catchment

The Riverside catchment consists of land uses including light industrial, residential and reserve areas. There are a range of archaeological, cultural and natural wetland areas along the riverside margins. Stormwater from residential roofs, and other impervious areas where practicable, will be discharged to ground up to the 10 year ARI storm, and in higher rainfall events and from other impervious and pervious areas will discharge to treatment wetlands, and then to the Kaituna River.

The Riverside catchment is defined on Drawing CA-001.

3.3 Low Impact Design

Key principle: Stormwater design to comply with CSC requirement for low impact design, and to be delivered in accordance with CMP requirements and reflecting TCC IDC low impact design guidelines.

In accordance with the CSC, with TCC policy and guidelines, and with current good practice, low impact design (LID) will be a part of the approach taken to stormwater management associated with development in Te Tumu. The TCC guidance in the IDC and Stormwater Management Guidelines will be the point of reference for application of LID to stormwater design for subdivisions in this development area. However, there are some specific elements that will be adopted for Te Tumu to recognise the nature of the site.

In the context of Te Tumu, LID of stormwater will look different compared to most other urban contexts, due to the different nature of the catchment hydrology. All runoff from residential roofs up to the 10 year ARI storm will be discharged to ground, and all runoff from other areas up to the 7 year ARI storm will also soak to ground via overland flow paths, basins and the Wairakei Stream. There are no small watercourses where increased peak flow rate might lead to stream erosion. Effectively, the whole trunk stormwater system functions as one large flood storage and soakage basin, which is also the primary receiving environment.

Key features with a low impact emphasis are:

- Retention of significant natural water bodies and areas with ecological or archaeological significance. This is a feature of the proposed development in Te Tumu, with these areas set aside and constrained from urban development.
- As far as practicable reflect the current landform and minimise earthworks. Key features of this are:
  - The coastal dune system is retained;
  - The riverside dunes (located on the FLH block) are retained where practicable, as are the natural landforms in the Kaituna River flood plain, and natural wetland areas;
  - Flood storage is placed in or adjacent to the current natural low areas where water typically ponds.
- Disposal of residential roof water will be to soakage.
- Use of bioretention (swales and raingardens) will treat structure plan roads and paved area runoff (e.g. from large carpark areas).

It is recognised that substantial earthworks will be required across Te Tumu to facilitate effective development and to manage natural hazard risks to achieve minimum building platforms.

Water re-use could be considered, but is not explicitly mandated in the SMS. A key reason for this is that the amenity and aesthetics of the Wairakei Stream and the larger water bodies, including identified ecological areas, are dependent on groundwater levels being retained and enhanced. Any significant reduction of recharge to ground by diverting to other purposes has the potential to adversely affect these systems. Therefore, while it is able to be considered, it is not a recommendation that this be progressed as part of the development planning for Te Tumu and therefore water services should be provided through planned potable water networks.

3.4 Water level management

Key principle: management of top water level during and after flood event as per CSC

3.4.1 High level flood overflow to Kaituna River

The high level flood overflow to the Kaituna River is a key component of the safe urban development of the Papamoa catchment, particularly for the stage where Te Tumu urban growth occurs. It is therefore critical to the structure plan and SMS.

The high level flood overflow function differs with hydrological conditions. During dry weather conditions it functions as an amenity area with public access, paths, amenity planting and constructed wetlands. In floods up to the 7 year ARI storm it functions to collect stormwater from some catchments, and also as a flood storage basin. In larger floods, it progressively evolves from flood storage to flood conveyance, as the high level flood overflow starts to function.

3.4.2 Grant Place weir

As water levels in the Wairakei Stream at Grant Place weir rise above 2.85 mRL in response to storm events, the gate will open and there will be discharge to the coast. This will reduce the quantity of runoff reaching Te Tumu from the western parts of the catchment in such storms. The gate will remain open until water level has reduced to 2.45 mRL, which will assist in keeping sustained water levels in Te Tumu water bodies below about 2.5 mRL.

3.4.3 Wairakei pump station

This existing pump station provides for the management of sustained higher water levels in the Wairakei Stream under current conditions, where Te Tumu farmland is potentially affected by additional runoff from upstream developed catchments under the present-day situation. The pump station provides an additional tool for controlling water levels in Te Tumu to levels lower than is possible through the Grant Place outlet. However, TCC has indicated that they do not wish to rely on using this for water level management in future, once Te Tumu is developed.

3.5 Volume management

Key principles:

- Provide areas of mitigation storage volume to manage storage in flood events as per the CSC;
- Create a connected functional system for flood management of the growth area;
- Incorporate ecological, amenity, design considerations etc.

Stormwater volume management is an issue which is required to be dealt with in this SMS, and therefore on the ground in master planning and subdivision design. Stormwater from at least residential roofs, and from other areas where practicable, will be discharged to ground in accordance with the NZ Building Code[4], with further design parameters set out in the TCC IDC[5].

Apart from this, the volume-related requirements of the CSC in Te Tumu apply only to the Wairakei Stream catchment. In the Coastal catchment there should be no development, and in the Riverside catchment there is no volume-related requirement in the CSC for runoff management.

There are a number of aspects to volume management that need to be addressed for Wairakei Stream Catchment. These are:

- 40% of the 100 year ARI 48 hour duration runoff volume difference between pre and post development is managed as extra volume beside the Wairakei Stream or in new water bodies (referred to in this SMS as the “40% rule”). The required volume is calculated based on volumetric runoff change from each development. For the purposes of this SMS, and as provided for in the SP to deliver the most efficient stormwater management approach for Te Tumu, the delivery of the ‘40% rule’ is obtained by creating additional storage by removing a two strips of land within the TCC / WBoPDC Totara Farm Park Joint Venture and TK14 land blocks between the Wairakei Stream and the back arm, along the northern side of the back arm, and also from excavation for the flood overflow channel. This provides sufficient volume mitigation to cover a significant proportion of the requirements for development in the three main landowner blocks. Management of this approach is to be achieved by way of volume “trading” between landowners. The SMS sets out the indicative volumes required of each development to meet the ‘40% rule’ but does not explicitly define which developers would “trade”, or the quantity involved. An indicative basis for sharing is provided in Appendix E.
- Total water body storage also needs to accommodate up to 7 year runoff volume (2055 climate), including the whole Papamoa catchment runoff that reaches Te Tumu. This is a balance between storage within the storage footprint provided, and frequency of overflow via the high level flood overflow weir level. Modelling to date has defined this containment level as 3.95 mRL. However, the modelling needs to be updated to reflect this SMS and the most recent landform proposals, which might result in this weir level being further optimised.
- It should be noted that for the above calculations, soakage to ground has not been included, i.e. it is assumed that in extreme multi-day storm events soakage capacity may already be compromised. This conservative approach is also justified given the sensitivity of the eastern end of the Wairakei Stream to high water levels and the high reliance on soakage for ultimate discharge from the Stream.

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[4] NZBC Handbook and Approved Document Section E1 – Surface Water

[5] TCC IDC – DS-5.7.2 Ground Soakage Discharge

3.6 Connectivity, functionality and form

The connectivity between the basins is a key element of how the basin system for the Wairakei Stream catchment will function. There are several considerations:

- Dry weather conditions, including seasonality (lower water levels in summer, higher in winter), which affect aesthetics and amenity, which may vary between different areas;
- Flood conditions when the basins are expected to function together;
- Ecological constraints, including such aspects as limits on direct stormwater interaction with the Elizabeth Wetland while retaining groundwater levels and hydrological characteristics.

The key water bodies identified for consideration in this relationship are described below, and illustrated in Appendix A, drawing CA-001.

Wairakei Stream and back arm

- These water bodies are intended to function together as they currently do, with limited change to the stream channel and immediate corridor, except as may arise during the development of the WSCLP.
- The sand spit between the mainstream and the back arm will be excavated from about 250 m west of the TK14 boundary, through to the eastern end of the spit, and down to a level of between 2.0 mRL and 2.5 mRL. This will maintain the current waterway form, but allow additional flood storage in the wider stream corridor. Similarly, there will be widening of a strip of the northern bank of the back arm in TCC/WBoPDC – TFP JV interests land to create additional flood storage outside the current water body. This additional area will be about 800 m long and up to about 50 m wide, again to a level of 2.0 mRL to 2.5 mRL.

High level flood overflow channel

- The proposed approach to this is set out in more detail in Aurecon 2018b, and the outlet form is shown in this SMS in Appendix A drawing CA-007. The intention is that this will not normally have flowing water in it and will consist of a range of invert levels. Some areas will have bed level at about 0 mRL and will have wetland planting. These zones will be permanently wet, although the wet depth will vary due to seasonal variation in groundwater level. Other areas will have a bed level in the range about 1 mRL to 2.5 mRL depending on whether they are intended to be free of inundation most of the time (at or above 2.5 mRL) or be intermittently flooded and allow interchange of water along the channel under dry weather conditions (at about 1 mRL). The current Aurecon design has these higher zones at 2.5 mRL.

Elizabeth Wetland

- The design in this area is strongly influenced by ecological constraints. The natural wetland itself will be protected from day-to-day stormwater runoff, and the design will seek to retain the current typical water level at the natural wetland margin of 2 mRL. Natural ground (possibly with some bunding if needed) will be retained around the full margin so that the natural wetland only connects with the rest of the stormwater system when water level exceeds about 3 mRL. This level will need further consideration once ecological protection requirements for the natural wetland have been further resolved .
- The natural wetland will be supplied by groundwater, as it is at present. The layout for this is shown in more detail in Appendix A drawing CA-004.
- In areas alongside the contained natural wetland, stormwater wetlands will be constructed with permanent water level at about 2 mRL or above to treat subcatchment runoff before discharging it to the flood overflow channel (bypassing the natural wetland). These treatment wetlands will in some cases be narrow longitudinal planted swales, or discrete basins connected by pipes, where there are opportunities to fit them between the development footprint and the margin of the Elizabeth wetland. They will be connected by pipes, and will discharge to the flood overflow channel.
- In storm events where the flood level in the Wairakei Stream and flood overflow channel rises above 3 mRL, the stored flood water will overtop the containing bund, initially at designed overflow points, and the natural wetland will become part of the overall flood storage.

Ford northern basin

- This basin will be extended beyond the current flooded footprint to increase available flood storage volume. The intention is that the bed of this basin may be excavated lower than current invert to provide permanent water depth over much of the basin. The possibility that this might have some form of hard edging might be considered, subject to specific approval by TCC. Current TCC policy is to avoid hard edges.

Ford southern basin

- This basin is a new flood storage area, in what has historically been an isolated ephemeral basin fully contained within sand dunes and consisting mostly of pasture. The new basin may have a more urban form, with the invert below low groundwater level to provide for permanent water, and a mix of hard and soft margins designed to accommodate the variability of water levels (subject to TCC approval).

3.7 Stormwater conveyance

Key principle: develop an integrated landform with primary and secondary stormwater systems for the safe management of runoff within the development

The management of stormwater shall adhere to the TCC IDC and the SMS, noting the following key aspects being:

- Stormwater system will be designed for primary flow (up to 10 year ARI rainfall) and secondary flow (up to 100 year ARI rainfall). Design shall be based on climate change (sea level rise and rainfall intensity) to 2130.
- Wherever practicable, discharge of residential roof runoff will be to ground.
- In order to maintain groundwater levels, and meet TCC's LID principles, discharge from other areas (such as roads and non-residential areas) could also be to ground via raingardens.
- Primary flow will be conveyed either through piped systems, or open channels or swales specifically designed for primary conveyance. Swales may be used for primary conveyance along collector roads, with specific agreement of TCC.
- Secondary flow will follow the designed landform and will use public stormwater reserve areas and roads for conveyance, within design safety limits in accordance with the IDC and Austroads.

3.8 Water quality management

Key principles:

- Treatment of discharges to the Wairakei Stream to achieve water quality requirements of the CSC;
- Create constructed wetlands to treat discharges from the riverside catchment as per the CSC.

There are two receiving environments for the stormwater runoff from development as provided for in this SMS and SP:

- The Wairakei Stream for all runoff from Papamoa and the Wairakei Stream catchment;
- The Kaituna River for Riverside runoff; and from the Wairakei Stream when the high level flood overflow to the Kaituna River is functioning (set to occur as per the CSC advice note at a frequency of about 7 years ARI on a long term average basis).

The approach to water quality management is described below for the two main development catchments.

Wairakei Stream Catchment

In the Wairakei Stream catchment, primary flow in more frequent "water quality" storms will be from roads, paved areas and non-residential roof areas (residential roofs will generally be discharged to ground). The following measures are set in this SMS for treatment, with discharge post-treatment either to ground (wherever practicable) or to a primary piped system discharging to the Wairakei Stream.

- For arterial roads (and where practicable for lower-trafficked roads), use of low-impact design approaches, including swales (grassed or planted) and raingardens for water quality treatment. These requirements need to be provided for in the cross section design of the arterial road corridors. These are defined for the purposes of this SMS as the Boulevard and Te Okuroa Drive.
- For commercial and industry runoff from trafficked or otherwise contaminated surfaces (as defined in the IDC and other TCC guidelines), treatment is required on site or small groups of sites, using raingardens, planted swales or proprietary devices.
- There are to be no discharges directly to the Elizabeth wetland (which should only receive ponded water during large flood events), with any piped stormwater to discharge to constructed wetlands adjacent, then discharge to the flood overflow channel.

Riverside Catchment

- All primary flow from the Riverside catchment will be treated by flow through forebays and then into constructed wetlands prior to discharge, in accordance with the CSC and the TCC IDC. These wetlands are located near the various scattered areas of development in the catchment and placed to avoid ecological and archaeological areas, all of which are provided for and shown on the SP.
- The outlet from the high level flood overflow is a separate discharge location from all Riverside catchment treatment wetland outlets.

4 Development and Infrastructure Design

There are a number of core infrastructure items that need to be implemented to provide for development while mitigating flood risk, and providing for appropriate environmental outcomes. These are to be developed in accordance with the current TCC Infrastructure Development Code, Stormwater Management Guideline and any other relevant TCC guidelines or codes that might apply at the time. Below are specific design considerations relating to Te Tumu and this SMS. Refer also to maintenance considerations (SMS Section 7.1) to be incorporated into infrastructure design.

For passage of major flood flows from the urban growth area and from the upstream Papamoa catchment, the following key infrastructure items are required:

- Provide a high level flood overflow from the Papamoa catchment to the Kaituna River;
- Provide flood storage in existing and proposed future water bodies within the Te Tumu urban growth area to contain runoff volume from floods and limit the frequency of discharge to the Kaituna River;
- Provide road culverts across the main flow paths of sufficient capacity.

For stormwater management within individual developments, the following key elements are required:

- Discharge of stormwater to ground where appropriate;
- Conveyance of runoff safely to receiving waterways, including both primary (pipe, swale) and secondary (overland flow) conveyance;
- Provide for stormwater treatment where required;
- Outline design requirements for individual sites.

Further, there needs to be consideration of safety and amenity for all the stormwater management designs implemented.

4.1 High level flood overflow

The primary purpose of the overflow is to provide a flood management connection from the Wairakei Stream to the Kaituna River. It is to be designed to limit water body connection between the Wairakei Stream catchment and the Kaituna River outside of major flood events. The flood overflow channel will also operate as part of the water stormwater storage requirements to meet the ‘40% rule’.

The high level flood overflow is described in more detail in Aurecon 2018b, and subject to detailed design (as Aurecon 2018b was for a preliminary design). The function of this channel will differ depending on the conditions. The built form and function are outlined below.

- The banks and base will be landscaped, with a mix of hard and soft elements, and there will be public access along and across it at levels above 2.5 mRL.
- Under dry weather flow it will be a grassed floodway with constructed wetland areas scattered along its length.
- It will receive and hold day-to-day runoff from the adjacent land and from the catchment surrounding Elizabeth Wetland.
- In moderate floods (every few years) it will contain water over most of its footprint and there will be ponding over a number of days that might affect paths at lower levels.
- In floods larger than 7 year ARI it will become a significant floodway, conveying excess Wairakei Stream flood flow to the high level flood overflow weir and thence to the Kaituna River.
- Safety of the public during flood events will need to be proactively provided for, in much the same way as for any stream/river corridor.

4.2 Principal storage basins

4.2.1 Volume requirements

The principal storage basins proposed are for containment and peak flood level management in the Wairakei Stream up to the 100 year ARI storm of 48 hour duration with 2130 climate (377 mm rainfall). These are shown on plan CA-001 (Appendix A), which also shows the Riverside catchment treatment wetlands, which do not form part of this storage basin volume calculation. The storage basin areas and locations shown on both CA-001 and the SP are indicative only and will be subject to refinement during detailed design.

The storage volumes have been based on storage required within the Wairakei Stream catchment as determined from the modelling by Aurecon, and in accordance with conditions in the CSC. The performance requirements on which the storages have been determined are:

- Provide for flood storage for Te Tumu runoff, in accordance with the "40% rule" provisions of the CSC, that is additional to existing flood storage in the Wairakei Stream (including the flooded footprint that extends east onto FLH). This storage is to be provided between 2.5 mRL and a nominal 100-year ARI flood level of 4.4 mRL. This rule applies to all individual subdivisions.
- Provide for total storage, up to the high level flood overflow weir crest (currently proposed at 3.95 mRL), to contain the 7 year ARI flow from the entire Wairakei Stream catchment (including any flow from upstream of Te Tumu) without overflow to the Kaituna River, using a combined storage including existing Wairakei flood storage; additional storage constructed alongside the Wairakei Stream plus two basins in Ford Land Pty; flooding over the Elizabeth Wetland; and in the flood overflow channel. This storage is to be provided between 2.5 mRL and the proposed high level flood overflow weir level currently at a modelled 7 year ARI level of 3.95 mRL. The performance against this criterion will be managed by TCC using the flood model and the proposed landform.

An indication of the required volumes for each principal landowner to provide, and where these volumes could optimally be located (including provision for trading volumes between landowners) is shown in Appendix E. The appendix table sets out a "sample solution" based on the current state of concept design for development, consistent with the Structure Plan, but the finer details will need to be refined over time as development proceeds.

The following clarifications relate to the table details.

- There are a number of small land parcels included in the table. They have relatively modest storage requirements, and it may not be efficient to create standalone storages on all of these individual land holdings. While the same requirements will apply to them as to other land holdings when development occurs, they may best be met either by trading their requirements against surplus storage on other properties, or (in the case of Love and Hickson) creating additional storage along their boundaries adjacent to the Elizabeth wetland. Similarly, while basins are shown on the TK7B1/7B2 and the TK8B1 land, these could alternatively be met by trading volumes, or by creating additional storage along the margin of the Wairakei Stream.
- There are a number of areas where flood storage occurs that is an inevitable outcome of the principal stormwater infrastructure and other subdivision requirements, rather than only created to meet the "40% rule". These include the flood overflow channel, and ponding over the Elizabeth Wetland. There are also areas created for other subdivision purposes, including the removal of the spit between Wairakei and the back arm, and the widening north of the back arm. These all contribute to the volumes accounted for in the "40% rule", but they predominantly occur on the TCC/WBoPDC – TFP JV interests land, and result in greater created volume on this property than is needed to offset on-property development mitigation.
- The total volume of additional flood storage proposed in basins, at 544,371 m^3, is greater than the strict application of the "40% rule", at between 285,000 and 294,000 m^3 (refer to Appendix E). While this

appears to mean an over-provision of flood storage, this is not the case. Firstly, there still needs to be sufficient storage provided overall to meet the 7 year ARI storm containment requirement of CSC Advice note 16. Further, the Aurecon flood model is based on modelled storage volumes at the 100 year ARI flood level, and for a landform and waterway design that differs from that now adopted for the SMS. Any reduction in flood storage volume from that in the 2018 modelling could lead to increased peak flow rates and flood levels. If there are changes in landform and storage volumes, and changes to stormwater conveyance levels, the available storage and frequency of overflow would need to first be validated by further modelling.

- The required volume to contain the 7 year storm is exceeded by about 90,000 m^3. This is about an 11% over-provision. For this stage of the development process such a margin is appropriate. In the event that future review of the Papamoa CMP and modelling of the catchment shows less volume is needed or it can be achieved at a lower level, then lowering of the high level flood overflow weir is likely to be the most appropriate response.

4.2.2 Connections between flood management areas

Key connection points for consideration are outlined below. In each case a sill level is provided, but the intent is that the nominal sill level would apply over most of the width of the connecting waterway, to provide good flood flow connection. Recommended sill levels should be refined after a water balance model has been developed to assist in better understanding the dynamics of the Wairakei Stream surface water/groundwater hydrology and how this will change with development and climate change. Further, the design should be such that the sill levels are relatively easy to change (up or down), as operational experience and evolving changes in hydrology and climate are better understood.

- **Wairakei Stream to flood overflow channel**. This needs to function with high capacity during major flood events but does not need to connect to the flood overflow channel during dry weather flow. A sill level at this junction of between 1.0 mRL and 2.0 mRL is proposed, with the lower end of the range preferred.
- **Elizabeth Wetland to flood overflow channel.** This connection must be set at approximately 2.0 mRL, or possibly up as high as 2.5 mRL, to maintain similar hydrological conditions around the Elizabeth wetland as currently exist. Further local groundwater and development effects studies, along with ecological evaluation, should be undertaken before this level is set.
- **Ford northern basin to Wairakei Stream**. This connection needs to provide flood capacity from the Ford basins back to the Wairakei Stream and the flood overflow channel. It is currently connected through a causeway by way of a concrete pipe. A sill level of between 1.0 mRL and 2.0 mRL is proposed, depending on how frequently connecting flow is required.
- **Ford southern to northern basin**. This connection needs to be at a level that maintains water in the southern basin for amenity purposes. The sill level is proposed to be between 1.5 mRL and 2.0 mRL.

One other key connection is along the Wairakei Stream from the west. Maintaining flow to Te Tumu will be important for its hydrological function and amenity, particularly in summer dry periods. Similarly, maintaining flow capacity west to the Grant Place outlet following floods will be important. As is evident in the Stream long section in Appendix C, there is a culvert west of Te Tumu with a high invert level that constrains flow to the east. The long section also suggests that there may be high levels in the Stream bed in the vicinity of the Part 1 / Part 2 boundary that is constraining flow to the east. As development proceeds, these constraints in the stream flow to the east need to be removed.

4.2.3 Soakage requirements

Soakage out of the basins is a key element of the operation of the stormwater system, as it is the principal means of day-to-day stormwater discharge. It will be important that this functions effectively over the long term. Groundwater level at the basin locations varies seasonally (as described in the groundwater report in the CMP) and is typically above the bed level of the existing water bodies in winter, and close to bed level in summer. Over time these groundwater levels will increase relative to current levels, due to sea level rise and the close proximity of Te Tumu to the coast and the Kaituna River. Therefore, soakage will function less like a conventional stormwater soakage basin (discharging vertically into unsaturated soil above the water table), and more as a natural interaction between surface water bodies and groundwater, with hydraulic gradient of the groundwater surface governing the rate of transmission of water laterally from the water bodies to the sea or river.

For reasons of operation and aesthetics, it is anticipated that the constructed water bodies will be built with bed levels below the current climate low groundwater level, to maintain permanent water. It will also be important to establish that there are no finer soil layers below the beds of these water bodies that might inhibit drainage to groundwater. This might require over-excavation during construction and backfill with suitable free-draining sand.

The beds of the SEA water bodies (Wairakei Stream and Elizabeth Wetland) will not be changed, so will function much as they do currently.

It will also be important to consider the implications of any ground improvement measures adopted on the water body margins to address the risk of liquefaction and lateral spread. The potential effects of such ground improvement measures on the ability of water in the water bodies to drain laterally through the margins and subsurface along natural groundwater flow paths needs to be considered. Subsurface drainage must remain sufficient to allow stormwater discharge to ground from the basin and waterways, and not impact on groundwater flow paths.

Of note is that in the event that soakage capacity is significantly reduced, the Grant Place outlet will provide a means for maintaining water level at or below 2.5 mRL during dry weather conditions, and to drain down over time after larger storms. However, Grant Place was not originally designed with the intention of being the permanent outlet for all runoff from developed land in Te Tumu and the catchments to the west.

4.2.4 Design considerations

The water bodies will form a significant part of the Te Tumu development, and their functionality and aesthetics will influence the success of the development. For that reason, it is important that they are well designed and integrated into the development and are able to provide amenity as well their stormwater functions.

They should have a mix of permanently wet areas (particularly in constructed wetlands and basins) with either shallow water planted as wetlands, or open water with enough depth to limit summer heating. There will also be normally dry areas (for major flood storage above the normal water level range) which will need to be above 2.5 mRL to avoid the risk of extended periods of inundation in floods.

The normal water levels in the water bodies will largely reflect groundwater levels. The water levels will vary seasonally, and with current climate will be very shallow or confined to pools in the Wairakei Steam. Depending on baseflow rates from upstream (which reduce to almost nothing in summer) there will be almost no throughflow of water in the Wairakei Stream or the other water bodies in summer, and with use of soakage for most roof runoff, even small to moderate storms are unlikely to contribute much runoff (although they should assist in maintaining groundwater level (and therefore ecological values).

The edge treatment will vary throughout the development, depending on whether they are protected waterways (e.g. Wairakei Stream, back arm and Elizabeth wetland) which will have a more natural form, or are more urban margins in some of the constructed water bodies. Ecological consideration will also be important, as will Crime Prevention through Environmental Design (CPTED) principles. Photographs of a range of examples of water bodies in similar contexts to Te Tumu are provided in Appendix B.2.

4.2.5 Lateral spread

Lateral spread risk will need to be addressed for all water bodies. Liquefaction is a phenomenon occurring during earthquakes, where susceptible soil (loose silts and sands) combined with a high groundwater table lose strength and stiffness as a result of ground shaking. Where these conditions exist and there is an open slope or face to a water body ("free face"), the land can fail laterally into the water body, known as lateral spreading. This can be mitigated by either ground strengthening, or by setting buffer zones from free faces so that infrastructure and development is not adversely affected by any land movement in an earthquake.

The risk of liquefaction and related lateral spread are addressed in T+T 2018.

4.3 Major waterway crossings

The SP layout requires roads across principal waterways, and the CSC allows for this. The proposed SP layout has evolved over time through design and engagement with stakeholders and iwi, however the basic functionality is the same as per the original Aurecon 2018 modelling. Based on the modelling results, and further consideration of the functionality of the drainage system and the management of flood flows, culvert size recommendation for all water body crossings, as set out in Table 3. The locations of these crossings are shown in Appendix A drawing CA-001.

These crossings are the principal ones required to meet SP road connectivity. Further crossings could be built, but would need to be tested first in terms of any loss of flood storage that might result from the fill footprint, and also to confirm in the flood model that flood levels are not comprised anywhere within Te Tumu or in the wider the Papamoa catchment to the west.

These crossings have been assumed as culverts in the SMS and in modelling undertaken by Aurecon. However, TCC is still considering options in the context of safety, and there might be a requirement that some be built as bridges (particularly on the flood overflow channel). This is to be confirmed by TCC independently of this SMS.

If built as culverts these crossings need to be designed to be set low relative to groundwater levels and current waterway inverts, for the following reasons related to their functionality and long term operational flexibility. (Similar invert level considerations will apply to bridges but application may differ.)

- Culvert invert levels are not to be used to control the interaction between basins, because that would constrain future flexibility for water management as the catchment development and hydrology evolve, and as climate change effects also occur.
- Setting the inverts low allows full hydraulic efficiency of the waterway to be mobilised during flood events.
- The lower level increases the cover available over the top for services to be passed across culverts.
- Lower inverts mean that the culverts do not become a constraint on fish passage. If fish passage does need to be constrained, then it can be more appropriately managed in the waterways outside the culvert structure.

The proposed culvert or crossing invert levels will be similar throughout, and typically in the range from 0.0 mRL to 1.0 mRL, with a recommendation to set these towards the lower end of the range. Design of culverts and water bodies shall also provide for sufficient open channel either side of the culvert to provide for good connection to groundwater so that the water level in the culverts can function with the balance of the catchment and groundwater hydrology.

Table 3 - Recommended culvert crossings of waterways

Crossing	Peak catchment runoff (m^3/s)	Peak flow through link (m^3/s) [2]	Modelled Culvert Size (Aurecon 2018b) (m)	Recommended culvert Size (m)
Wairakei Stream Catchment				
Western (main arm) [1]		17.5	3 @ 4 x 2	**3 @ 4 x 2.5**
TK14 (main arm) [1]		32.0	3 @ 4 x 2	**4 @ 4 x 2.5**
TK14 (back arm)		3.5	2 @ 4 x 2	**1 @ 3 x 2**
FLH Pty Wairakei		21.0	2 @ 4 x 2	**3 @ 4 x 2.5**
Elizabeth wetland	27.9	16.6	5 m dia	**3 @ 4 x 2**
FLH link arm	22.2	12.1	3 m dia	**3 @ 4 x 2**
Flood overflow channel				
Upstream (northern crossing -The Boulevard)		48.0	6 @ 4 x 2	**6 @ 4 x 3**
Downstream (southern crossing - Te Okuroa Drive)		56.0	6 @ 4 x 2	**6 @ 4 x 3**

Notes

1 The CSC provides for two culverts over the Wairakei Stream in Te Tumu with a maximum head loss of 130 mm between the Te Tumu boundary and the high level flood overflow weir. The purpose of this condition is to provide adequate flood flow capacity to the overflow weir. The proposed culverts listed in Table 3 include two on the main Wairakei Stream west of the overflow, but also two across the flood overflow channel (which in the CSC plan would have been downstream of the high level flood overflow weir). Meeting the intent of the CSC can be confirmed using the flood model.

2 These design flows are from the modelling undertake for Aurecon 2018b, and will change with any updates to that modelling to reflect the current SP layout.

The principal waterway crossings outlined above differ from other conveyance systems (pipes/ culverts or swales) that will be required within development areas for conveyance to the main truck water bodies.

4.4 Landform and stormwater conveyance design

4.4.1 Landform

Landform will need to be designed to achieve certain criteria from a stormwater and flood risk perspective.

- Maintain suitable platform level to be above design flood level;
- Maintain suitable levels around the margins to address the risk of tsunami;
- Provide for suitable fall for primary drainage systems and secondary flow paths.

4.4.2 Secondary flow paths

Secondary flow paths will need to be provided that follow the modified landform and convey excess flood flow to the basins (or other safe receiving environment). These will preferably be placed within public land under the control of TCC. The exception to this would be where land ownership is retained across infrastructure. In this case, protection of these flow paths will need to be provided through other appropriate legal mechanisms such as long term leases. The flow paths will generally be in stormwater reserves (which can have multiple use functionality) or appropriate road corridors (but note comment below for arterial roads).

Secondary flow paths in or across road corridors shall comply with Austroads safety requirements in terms of depth/velocity combination.

Use of arterial roads for conveyance shall be avoided, as far as practicable. Where planned secondary flow paths cross arterial roads, the 100 year ARI flow may need to be conveyed through an enlarged primary system to ensure IDC and Austroads provisions are complied with.

The use of wide grassed floodways will be avoided as far as practicable, except in the case of the flood overflow channel.

4.4.3 Swales

Swales may be used as part of the conveyance design, in accordance with TCC design documents, for primary and/or secondary flow.

- Refer to IDC requirements for road design, including where water quality treatment is required and for specific design considerations.
- They may be useful where there are flat grades and/or larger secondary flows, e.g. in Ford land for a significant flow path from the east.
- Vegetated swales can be used as a landscape feature of the development, while still providing a stormwater management function.

This level of detail of where they are used will be addressed at the design stage for major infrastructure.

4.4.4 Piped systems

Within developments there will be a primary piped system to convey more frequent stormwater runoff without creating nuisance, although swales may be used as an alternative for primary flow. The SMS does not address the details of pipe systems, which must be designed in accordance with the TCC IDC.

4.5 Water Quality Treatment

In accordance with the CMP, treatment of all runoff is required before discharge to the Wairakei Stream. More specifically the CSC has performance requirements on suspended solids concentrations, and requires discharges to be substantially free of floatable solids, oil and grease. Treatment should comply with the requirements of the IDC.

Given that most residential roofs will discharge to ground, the dominant remaining sources of contaminants will be roads and paved areas, and runoff from commercial or industrial areas. Treatment can be achieved using disposal to ground (with pre-treatment in areas with potential high contaminant loadings such as major roads or industrial sites), in constructed wetlands, or in bioretention devices such as grassed or planted swales and raingardens. Propriety devices that meet TCC approval may also be used.

For the Kaituna River, treatment is required in constructed wetlands before discharge.

4.5.1 Constructed wetlands

Constructed wetlands will form an integral part of many aspects of the stormwater management. These include:

- Wetland planting around margins of the Wairakei Stream, and in parts of some basins affected by shallow or variable water levels;
- In the flood overflow channel, in specifically designed wetland features;
- For stormwater management around the margins of the Elizabeth Wetland;
- For treatment of runoff from the Riverside catchment before discharge to the Kaituna River.

For the constructed treatment wetlands in the Riverside catchment, the wetland banks shall be built above the 50 year ARI flood level in the Kaituna River to protect the wetlands from inundation from the Kaituna River.

4.5.2 Bioretention devices

Bioretention includes devices such as raingardens, grassed or vegetated swales, as well as some specific proprietary devices.

For industrial or commercial areas, the treatment should be as close to source as possible, either on individual sites (where these are large) or small groups of sites, before the runoff reaches the primary piped system.

This level of detail will be addressed at the design stage of subdivisions.

4.6 Safety

The design of infrastructure will need to take account of safety aspects throughout the life of the assets, which are set out below. The design criteria for these matters are defined in the TCC IDC, with specific emphasis on the following additional matters:

- *Batters.*
  - This may in some instances include providing flat basin batters (1V:5H or flatter), and also benching and/or steps within the range of day-to-day water levels.
  - Where there is dense planting that limits public access on batters, steeper slopes up to 1V:3H will be acceptable.
- *Depth/Velocity*
  - Depth/velocity combinations must be safe for pedestrians in secondary flow paths.
- *Hard edges along water bodies*
  - Where there are hard edge margins on water bodies, provide steps or ramps for egress, and handrails where fall heights require.
- *Safe exit points*
  - Ensure that all points along walking/cycling paths through potentially floodable areas around basins have safe exit points to above flood level in the event there is flooding up to 4.4 mRL.
- *Culverts*
  - Culverts should be such that they are not easy to access, for instance by having ponded areas at each end to a similar depth to the depth of water in the culverts.
- *Riverside Wetlands*
  - All water bodies, including the constructed treatment wetlands in the Riverside catchment, will require safe access to and around the water bodies for maintenance purposes and for operational purposes in flood events.
- *Flood Overflow Channel*
  - Road crossings over the flood overflow channel have been modelled as culverts by Aurecon. The SMS has provided waterway areas needed for appropriate flood conveyance. However, TCC may require that these crossings be bridges to provide for a factor of safety in their design, to provide for additional overflow designs (so the bridge is not overtopped), and there is a safe 'head room' space underneath the bridge down to the top water level of the design flood. The question of whether these are bridges or culverts will be determined by TCC separately from this SMS.

4.7 Site and building design

When individual developments are implemented, the following criteria must be met at an individual site level.

- Where practicable residential roofs to go to ground soakage, with a preference to apply this approach to other hard surfaces as well;
- Avoid contaminant generating roofs (copper, unpainted zinc or galvanised roof etc.);
- Site imperviousness to reflect the inputs used in sizing volume mitigation and stormwater infrastructure that is proposed for that site / development;
- At source treatment for all contaminant generating sites;
- Floor levels based on flood levels.

5 Compliance

This SMS needs to comply with the CSC and in general with other TCC guidelines, but will itself contribute to rules still to be drafted relating to the Plan Change. These matters are addressed in the following two subsections.

5.1 Existing rules and guidelines

5.1.1 Consent

The stormwater design for the Te Tumu development is to comply with the Bay of Plenty Regional Council Resource Consent Number 63636, in accordance with the Environment Court Order dated 20 November 2015. This consent covers the current Wairakei development and the future Te Tumu development.

Consent Conditions (Te Tumu):

2 Locations and Timing of Discharge Points

- *"2.2 Stormwater discharge to the Kaituna River shall be from maximum 6 discharge points via wetlands, including two of three optional high level weir discharge structures as shown on [three plans referenced]"*

The purpose of this condition is to set in place the general location of where stormwater discharge can occur from the Riverside Catchment and the discharge location from the high level flood overflows. In the CSC there are three plans attached to the consent, showing the options A, B and C, which are the consented options for use in the development of Te Tumu. The option adopted for this SMS, and the SP is Option B, although there are some changes to flood overflow channel route. The recommended option involves the flood overflow channel passing through the TCC/WBoPDC TFP JV interests land from a location close to the current "Hickson" water level recorder, but reaching the Kaituna River at the same location as in the consented Option B plan. Appendix A includes the drawing of Option B from the CSC, labelled as Figure A2.

There are five proposed outlets to the Kaituna River from the Riverside catchment, as shown in Appendix A Drawing CA-001. These are generally the same as the original CSC Option B. In the CSC one of these coincides with the high level flood overflow discharge location. As a result the SP recommendation is to move this required outlet location slightly to better reflect the current development footprint in the Riverside catchment.

Only one high level flood overflow discharge is recommended within the SP, which occurs through linking the prior middle and northern catchments (now Wairakei Stream Catchment) and landholdings through the Wairakei Stream. Therefore this outlet, when operating, takes a much larger flow than when it was spread between two high level outlets.

4 Stormwater Systems and Structures

- "*4.2…Culverts are shown as per … and sized as follows…Part 2 (Te Tumu) Wairakei Stream crossings – with no more than two culverts with maximum total headloss of 130mm located to the west of the high level weir ."*

The purpose of this condition is to manage the headloss in the Wairakei Stream by limiting culverts placed across the main channel of the Wairakei Stream, upstream of the high level weir. The proposed SP involves two crossings of the main channel of the Wairakei Stream as per the consent.

Two crossings will be required for the main structure plan road corridors which cross the high level flood overflow channel, as a consequence of moving the high level flood overflow weir to the downstream end of the flood overflow channel. This layout has been tested in the hydraulic model, and found to meet the overall flood level performance requirements of the consent. Refer modelling results (Aurecon 2018a).

The CSC Option B did not propose retaining the back arm of the Wairakei Stream. However, because it will now been retained, a culvert will be required to provide for access to the landholding proposed for a campground on the TK14 land north of the back arm.

5 Mitigation of Stormwater from Development

- *"5.2 …ensure that the top water level in the Wairakei Stream Corridor within the Papamoa Catchment... does not exceed a height of 4.5m RL … in a 1 in 50 year (2% AEP) 48 hour rainfall event"*

The purpose of this condition is to ensure that flood levels in the Wairakei Stream do not exceed a specified flood level. This in turn protects all development within Papamoa East, as building platform levels are set at a minimum of 5.1 mRL (east of Sunbrae Grove).

The modelling results from Aurecon 2018a show that this consent condition is met, as maximum flood levels west of Parton Road are less than 4.5 mRL in a 2055 climate change event (Note 2055 climate change is what the consent conditions are based on).

- *"5.3 …Northern Catchment of Part 2 (Te Tumu)... provide storage to equal to 40% of the difference in volume between the 1 in 100 year (1% AEP) 48 hours rainfall event runoff hydrograph in its modelled undeveloped state and the 1 in 100 year (1% AEP) 48 hour rainfall event runoff hydrograph in its developed state".*

The purpose of this condition is to manage stormwater storage within the Northern Catchment. To deliver the SP, it is recommended that the Northern and Middle catchments are linked for storage, and therefore this means that this condition effectively now applies to both catchments. Overall, combining all development and all storage basins, this condition is met. The SP provides for a process whereby this storage is provided for by the sharing or swapping of storage provision between developers to achieve the required total volume with an optimal development outcome.

- "*5.4 …Wairakei Stream Corridor… does not exceed a height of 4.6 m RL in a 1 in 100 year (1% AEP) 48 hour rainfall event"*

The purpose of this condition is to ensure that flood levels in the Wairakei Stream do not exceed a specified flood level. This in turn protects all development within Papamoa East, as building platform levels are set at a minimum of 5.1 mRL (east of Sunbrae Grove). The modelling results from Aurecon 2018a show that

this consent condition is meet in the 2055 climate change scenario.

6 Water Quality

- *"6.1 ... suspended solids in the stormwater discharges to … the Wairakei Stream and the Kaituna River shall not exceed 150g/m3 at any time expect where the design event of a 1 in 10 year (10% AEP) rainfall event is exceeded" and "6.2 … shall be substantially free of floatable solids, oil and grease"*

The purpose of this condition is to ensure stormwater quality is met, in regard to discharges to the Wairakei Stream and Kaituna River.

To ensure this condition is met, constructed wetlands have been designed at each outlet to the Kaituna River to BOPRC guidelines.

For the Wairakei Stream Catchment residential roofs will discharge to ground in the 10 year ARI storm, which is well above the water quality volume required to be treated. Some land uses (especially roads, industrial and commercial sites) will require treatment in bioretention devices or approved proprietary devices to meet the water quality criteria.

The Wairakei Stream catchment will contain the stormwater runoff up to a 7 year ARI 48 hour duration event and this water drains via ground soakage.

7 Hydrological Monitoring

Hydrological monitoring implementation and compliance is addressed under the SMS section 7.2.1.

8 Water Quality Monitoring

Water Quality monitoring implementation and compliance is addressed under the SMS section 7.2.2.

13 Comprehensive Stormwater Consent Catchment Management Plan

- *"13.1 …The consent holder shall ensure that the Comprehensive Stormwater Consent Catchment Management Plan, where practicable, gives effect to the following general principles of stormwater management:*
- *The use of Low Impact Design solutions as the preferred option to stormwater management where this is practicable. The aim of this is to mimic natural stormwater runoff characteristics….*
- *Use of wide grasses swales for stormwater treatment and flow storage*
- *The use of ground soakage as a preferred option for the disposal of stormwater from roofs of buildings where this is practicable…"*

The majority of the proposed works will help to mimic the natural stormwater environment. It is proposed that residential roof runoff will go to ground soakage, maintaining groundwater recharge. The arterial roads will utilise raingardens or swales for treatment and may in some cases use swales for conveyance. The details of the stormwater system in terms of soakage ability have not been investigated at this stage but it is assumed due to the sandy soils that this will be successfully utilised for roof soakage in events up to 10 year ARI rainfall in accordance with the TCC IDC and the NZ Building Code.

The basin in TCC/WBoPDC-TFP JV interests land block will have constructed wetlands adjacent to the Elizabeth wetland (the existing natural wetland will be kept separate from the water quality storm runoff). The Wairakei Stream is to mostly remain in its current form.

Landowners will be required to provide at source treatment for sites with potential containments that cannot be practically managed within shared low impact design treatment devices and the storage basins.

Advice Note 16

- *"The expected frequency of spill from the high level weirs would be approximately once every 7 years"*

The purpose of this advice note is to recognise in the consent the likely recurrence frequency expected for high level flood overflow from the Wairakei Stream Catchment to the Kaituna River. To ensure this advice note is met, this has been modelled, as set out in the Aurecon modelling results (Aurecon 2018a). No flows over the weir occurred in the 7 year 48 hour model run. This is not a condition of consent.

Riverside catchment discharge to the Kaituna River

There is no explicit limitation in consent number 63636 on the development area from which stormwater can discharge (after treatment) directly to the Kaituna River, rather than being contained and soaked away within the Papamoa Catchment. However, there is an expectation that the areas described in Beca 2006, as attached to the consent application, would provide the required guidance on how this would occur as part of future development.

Beca 2006 illustrated the development areas and catchment boundaries, including the Option B layout as attached to the CSC. This is included in Appendix A of this SMS, and shows the catchment boundaries estimated at the time, and the proposed development area. While the boundary and developed areas have moved in some areas in the SMS, the proposed developed area draining directly to the Kaituna River with treatment is similar to that in the CSC. The proposed SP is therefore in general accordance with the areas shown for development in Riverside catchment in Beca 2006, and complies with the CSC.

5.1.2 Infrastructure Development Code

All stormwater designs and implementation will comply with the requirements, methods and guidance in the IDC. There are some elements where more further specific guidance may be required to address aspects that are unique to Te Tumu, and these are addressed under section 5.2.3.

5.2 Further rules and guidelines

5.2.1 Structure plan and Plan change

The Structure Plan, Plan Change or other methods will need to address additional matters that are specific to Te Tumu. These include:

- Offset storage sharing. Optimisation of the development and flood storage means that some developments will achieve their “40% rule” compliance by using surplus storage created on another property. There needs to be provision to ensure this, and allow this to occur, and a suitably robust mechanism that allows for the required storage to be provided in the most appropriate place, and not compromise the hydrological functions such as flood risk management and frequency of operation of the high level flood overflow.
- Because Te Tumu is at the downstream end of the Papamoa catchment, flood levels in the design event are marginally lower than in some areas of Papamoa to the west. This means that potentially minimum building platforms set in the City Plan could vary slightly in height through Te Tumu. This means that at the western end of Te Tumu minimum platform levels should be similar to further west in Papamoa, but in the vicinity of the high level flood overflow they could potentially be between 100 and 200 mm lower. However, this can only be confirmed once the ground model has been updated to reflect this SMS, and the flood modelling revisited in accordance with the SMS concepts. Away from the main water bodies, building platforms will inevitably be higher to provide gradient for drainage, and must meet TCC development rules for level relative to surrounding ground.

5.2.2 Papamoa CMP

The Papamoa CMP will need to be updated as part of the next formal review, to incorporate a number of aspects of the Te Tumu development that are different to those provisions relating to the remainder of the catchment. This SMS would be the basis for such changes.

5.2.3 Infrastructure Development Code

Te Tumu will be more susceptible than other parts of Papamoa to the effects of water level holding at different levels for sustained periods of time (with the differences being as much as 1.5 m) (refer to 2.1.7 and Appendix B.1 and C). This will affect the amenity and planting requirements for basin and stream margins. It is recommended that the guidelines currently being applied further upstream in the Wairakei Stream corridor be adapted to specifically address the management of water body margins in Te Tumu.

5.3 Other consents required

In addition to earthworks and subdivision consents needed at the next stage of development, there are some specific areas where consenting requirements need to be explored further. In particular this would involve any works adjacent to the SEA areas covering Elizabeth Wetland, Wairakei Stream, and some areas within the Kaituna River flood plain. The stormwater strategy avoids direct works within these areas, but there may be matters that arise from proximity of works, or stormwater ponding over these areas, that need specific consents.

6 Implementation

6.1 Design and approval process

6.1.1 Relationships to other documents

This SMS provides an overview of the strategic approach to stormwater management in Te Tumu as it develops. It needs to be read in the context of a range of other documents, guidelines and statutory plans. How it relates to these other documents is shown schematically in Figure 3.

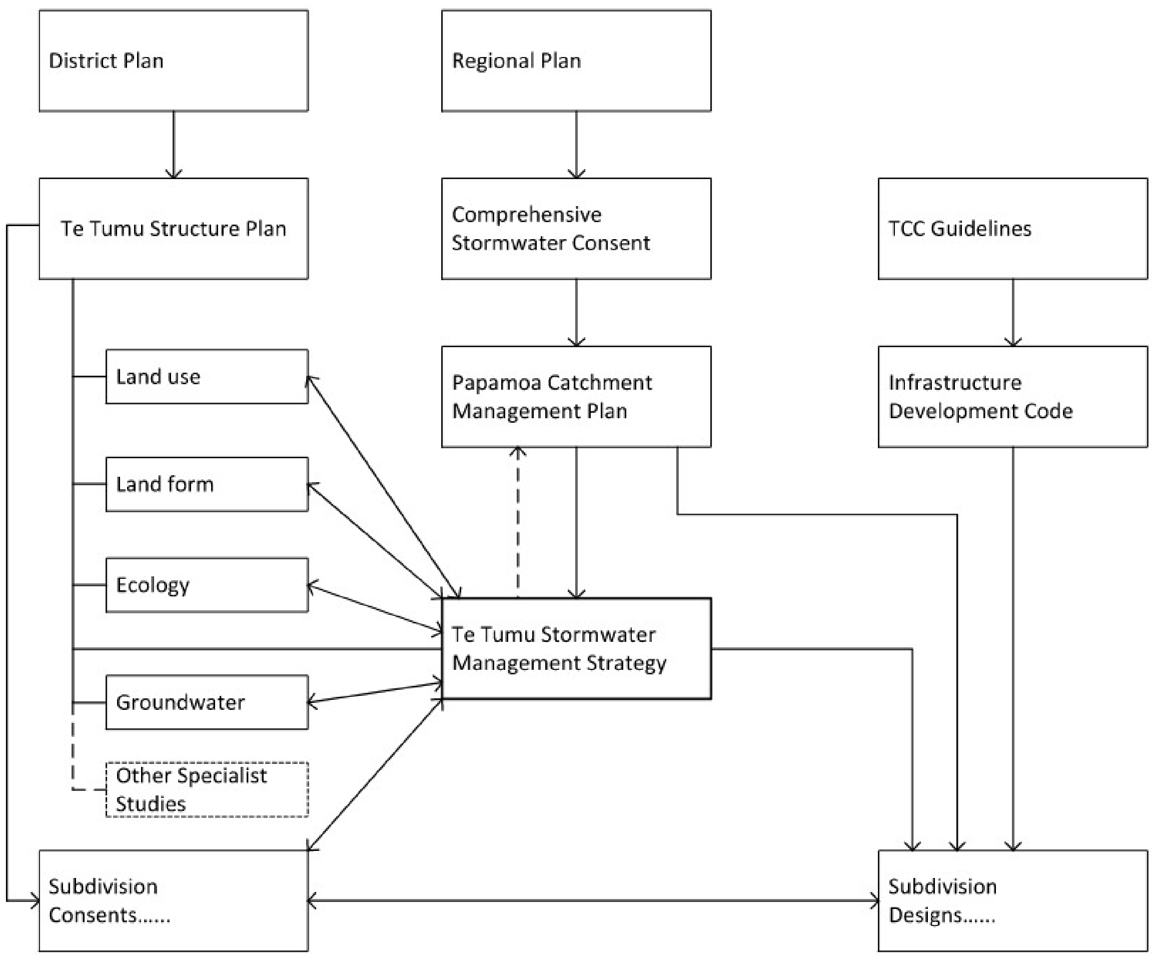

Figure 3 - Schematic diagram of SMS relationship to other documents

6.1.2 Statutory process

The process for design and approval of a subdivision through to building consent delivery in Te Tumu has been set out in a separate document by TCC, a copy of which included in Appendix F. This document provides the main steps throughout the process to be considered as part of the subdivision, land use and building consent processes, and also outlines how CSC compliance is to be met.

6.1.3 Engineering design process

A key performance criterion for subdivision design will be the provision of additional flood storage in accordance with the "40 % rule" in the CSC. This requires the provision of storage "… *equal to 40% of the difference in volume between the 1 in 100 year (1% AEP) 48 hours rainfall event runoff hydrograph in its modelled undeveloped state and the 1 in 100 year (1% AEP) 48 hour rainfall event runoff hydrograph in its developed state.*" The method for calculating this storage requirement is set out in the CMP. This requirement is to be met for all stages of development apart from those in the Riverside catchment that discharge directly to the Kaituna River, where this requirement does not apply.

The engineering design for the subdivision will likely be iterative. The expected development footprint will be determined, from which the requirement for storage provision can be calculated. Earthworks modelling for the site will then need to include creation of additional flood storage as calculated above, which is connected to the principal waterways, and is contained between 2.5 mRL and 4.4 mRL.

Where the required flood storage cannot be provided within the development, or for reasons of development efficiency is better provided elsewhere in Te Tumu, then the required volume to offset development effects must be formally secured on another property within Te Tumu, such that the overall offset requirement for the whole of Te Tumu is able to be met. This alternative offset storage in a different location must be agreed between the two parties "trading" storage, and with TCC, and must be legally documented.

Separately to individual developer requirements, TCC will need to maintain a record of whether the total storage required between 2.5 mRL and the high level flood overflow weir (3.95 mRL) is being retained, to manage the frequency of high level flood overflow to the Kaituna River.

Other aspects of engineering design will follow standard TCC requirements for subdivisions as per the operative City Plan and IDC.

6.2 Staging

6.2.1 Core drainage "spine"

The design allows for staging of stormwater management for all major land blocks, generally without dependence on neighbours. The key "spine" of the stormwater management system consists of the Wairakei Stream and its back arm, and the flood overflow channel.

While there will be enhancement of the Wairakei Stream and back arm in accordance with the WSCLP, its ability to collect stormwater is already in place. The high level flood overflow is required, by the CSC, to be in place before commencement of development in the Te Tumu northern catchment. Given that the Middle catchment is now to be linked to the Northern catchment, and the flood overflow channel is an important part of the stormwater management "spine", it will also be necessary for TCC to have the flood overflow channel in place and connected to the Wairakei Stream before Middle catchment development can occur, unless the developer can demonstrate a safe alternative outlet that complies with consents.

6.2.2 Wairakei Stream catchment

For each individual stage within the Wairakei Stream catchment, the provision of new stormwater runoff storage volume at least sufficient to address the "40% rule" will be required. Put another way, at any stage of the progressive subdivision and development of a landholding, the cumulative total of offset storage required for current cumulative development on that landholding must be in place. Further, any storage created needs to be able to connect hydraulically to either the Wairakei Stream or to the flood overflow channel. If a development is depending on trading of volumes to meet its "40% rule" requirements, then that flood storage will need to have been provided by the other party before the development can commence to discharge. In that case it will also be essential that for any stage of development, both primary and secondary flow paths are built to connect to Wairakei Stream, the storage basin, or the flood overflow channel.

6.2.3 Riverside catchment

For development in any one of the five distinct development sub-areas in the Riverside catchment, it will be necessary for the stormwater treatment wetland associated with that sub-area to be in place before any development is completed in it.

6.2.4 Individual property considerations

For **TK14** there is a substantial area that is within what was the Middle catchment, but in the absence of a specific storage basin for this catchment, stormwater will need to be drained north to the Wairakei Stream. The secondary flow path(s) for this area will need to pass under the arterial road, which will require safety considerations and agreement of TCC as the entity responsible for this road.

For **TK8B1**, the most efficient discharge point from the proposed stormwater basin would be to the flood overflow channel, which requires access for a pipe and secondary flow path through a section of TCC/WBoPDC – TFP JV interests land, most likely along the arterial road. In the event that this cannot be negotiated, then TK8B1 does have access direct to the Wairakei Stream which would allow for independent subdivision and development. However, as for the TK14 block, this would require secondary flow paths to pass under the arterial road and the same safety considerations and agreement process would apply.

Any smaller developments that are isolated from the main stormwater "spine" and have no direct access the Kaituna River will either need to dispose all runoff to ground up to the 100 year ARI 2130 climate storm, or arrange for discharge to or through a larger neighbouring property that has access to a suitable receiving environment.

For the **TCC/WBoPDC – TFP JV interests** land, it will be desirable that the catchment draining to the stormwater devices around the Elizabeth Wetland be kept to a practicable minimum, so any increase in catchment to include development in Part 1 should be avoided.

For **FLH**, if development commences in the east, then apart from a small area that is in the Riverside catchment (which will need a constructed wetland to discharge to), it will be necessary to create primary and secondary flow paths west to reach the Wairakei Stream. With appropriate design it might be possible to initially drain these areas using grass swales and/or wide grassed floodways, but ultimately it is expected that as development proceeds west the primary system would be piped and the secondary system will use designated flow paths, including on local roads. Areas not draining directly into the Wairakei Stream, will require the SP basin to be excavated and connected to the Wairakei stream in accordance with the overall SP, or for temporary swales and overland flow paths to be created directly. For any development in the east, it will still be necessary to create the additional storage required under the 40% rule in accordance with the level of subdivision and development at any time.

6.2.5 Development across Part 1 (Wairakei) and Part 2 (Te Tumu) boundary

In the event that there are drainage systems proposed that cross between Part 1 (Wairakei) and Part 2 (Te Tumu) then consideration will need to be given to where these areas discharge to. If retained within the Wairakei Stream catchment, then there should be no issue, as the same "40% rule" will apply to both.

6.3 Infrastructure Costs

High level cost estimates have been prepared for the principal elements of infrastructure associated with stormwater management. These are set out in Appendix F. The following assumptions should be noted:

- The high level flood overflow channel and high level weir are not included. This has been estimated separately by Aurecon, and implementation is being managed separately to the SMS.
- Similarly, the two road crossings of the flood overflow channel are not included in the cost estimates. This has been estimated separately by Aurecon, and implementation is being managed separately to the SMS.

6.4 Long term ownership

There are aspects of long term ownership that still need to be resolved.

- Some landowners are likely to retain ownership of land or water bodies that include key stormwater and related infrastructure, including road crossings. In that case the developer would generally build the infrastructure and Council would arrange long terms leases or similar legal agreements to allow access for stormwater management operation and maintenance purposes.
- It is envisaged that the water bodies and stormwater infrastructure in the TCC / WBoPDC TFP JV land would be built by the developer and vested in TCC.
- It is envisaged that TCC would own the land containing the flood overflow channel, high level weir and downstream wetland and outlet to the Kaituna River, and would build the infrastructure.
- TCC would install and own monitoring equipment (e.g. water level recorders)

It is envisaged that the following elements would be included in consideration of infrastructure when ownership and long term operation and maintenance is being considered.

- All waterway crossings;
- All stormwater basins including access for maintenance;
- Elizabeth wetland area, including stormwater basins and linkage to the flood overflow channel, including access for maintenance;
- Expanded margins along the Wairakei Stream corridor (e.g. as proposed on the northern side of the back arm in TCC/WBoPDC – TFP JV interests land), including all Wairakei Stream and riverside landscaping;
- Secondary flow paths (which will be in stormwater reserves or road corridors), or via other legal agreement;
- Stormwater treatment wetlands in Riverside catchment, including access for maintenance.

It is noted that where landowners retain ownership of the land and some infrastructure assets, rather than vesting stormwater assets in Council, then the requirements to meet conditions of the CSC, and implement aspects of the CMP and the SMS, would remain with that owner, but would nevertheless be under the overall responsibility of TCC as consent holder. The nature of this relationship, and assigning of individual responsibilities, would need to be negotiated between the landowner and Council in each case, and recorded in the appropriate legal agreement.

7 Operation

7.1 Maintenance

7.1.1 Stream corridors

The Wairakei Stream corridor operation and maintenance considerations will be addressed in the WSCLP, or in an equivalent context, and is not covered by the SMS.

7.1.2 Principal basins

The principal flood storage basins and the flood overflow channel will be maintained in a similar manner to the Wairakei Stream except where specific designs differ markedly from the more naturalised design for the Wairakei Stream.

Apart from the Wairakei Stream (which will be governed by the WSCLP), it will be important for reasons of temperature management in the flood storage basins to either have a good depth of water under most conditions, to have wetland planting if shallow water, or to provide the flood storage above normal seasonal water level ranges so they are mostly dry. For wet basins, TCC does use carp for control of pest plants.

Considerations in design include the risk of accumulation of silt on paved surfaces in ponded water level ranges. In general, for amenity and maintenance purposes formed paths and significant routes, as well as any viewing decks and amenity areas, should be kept above 2.5 mRL. Any significant flood sensitive infrastructure must be kept above 4.4 mRL. Based on current and expected future water level variation, inundation that might lead to silt deposition will mostly occur either seasonally, or in less frequent larger flood events, reducing the need for frequent cleaning of silt for paths and structures in the ponded water level ranges.

Vegetation selection will be critical to the success of the basin margins. In the zones where there will be relatively frequent inundation, wetland plants that can also tolerate moderately dry conditions will be appropriate. Under current climate, that will be up to about 1.5 mRL to 2.0 mRL. A transition zone will then apply up to 2.5 mRL, with plants that are normally terrestrial, but can tolerate longer duration inundation (of the order of weeks). Use of mulch in these transition zones should be avoided, as it will not remain in place during water level variations. With climate change, the wetland zone is expected to progressively transition up to about 2.5 mRL or slightly above.

For areas above 2.5 mRL vegetation that can tolerate relatively infrequent inundation for a period of a few days is recommended. Grass will generally be most suitable above about 4.0 mRL.

The water level operating range and resultant vegetation recommendations will result in a landscape form that is likely to hinder direct public access to the water edge. Therefore, if localised public access is needed closer to the water's edge for amenity purposes, the likely best means for providing this will be the use of wide paths with steps within the inundation zone, or specific hard-edge features at or above the inundation level, such as viewing decks.

7.1.3 Stormwater management devices

Management and maintenance of stormwater devices within Te Tumu will be in accordance with standard TCC processes and guidelines. This includes pipelines, culverts, basins, swales, constructed (and where appropriate natural) wetlands, raingardens and soakage devices.

All areas for stormwater management shall require vehicle access and working areas at inlet forebays and outlet structures, for a truck and a digger for maintenance purposes. Safe level walking access at a minimum is required around the width of the basins for inspection and maintenance purposes.

Constructed wetlands in the Riverside Catchment will have safe access to them and around the margins at a level above the 50 year ARI flood in the Kaituna River, with 2130 climate change.

7.2 Monitoring

Monitoring will need to be undertaken in accordance with the CSC and CMP requirements. Further matters that will need attention specifically for Te Tumu are set out below.

7.2.1 Location of the Te Tumu water level gauge

The last paragraph of Condition 7.1 of the CSC states:

> *The consent holder shall ensure that when the high level discharge from the Wairakei Stream to the Kaituna River referred to in Condition 2.3 is constructed, the water level monitoring gauge at the Hickson/Te Tumu 8B1 boundary is replaced with a permanent water level monitoring gauge in the Wairakei Stream adjacent to the weir structure of the high level discharge.*

In this context, Advice note 16 is also relevant.

> *The expected frequency of spill over the high level overflow weirs would be approximately once every 7 years on a long term average basis. For the purposes of this consent the operation of the high level discharges means a continuous flow of stormwater over the high level discharge structure over at least a 6 hour period*

Further, Condition 2.4.2 sets out performance for flood levels in the Wairakei Stream at the Hickson (now TCC/WBoPDC – TFP JV) / 8B1 boundary, reflecting acceptable flood water levels in the Wairakei Stream generally.

The concept for stormwater management in Te Tumu now proposes that the high level flood overflow weir be relocated to the southern end of the flood overflow channel, rather than at the northern (Wairakei) end. It is therefore necessary to identify how the monitoring required in Condition 7.1 is to be applied. The primary purposes of the condition are as follows:

- Providing a measure of water levels upstream of the high level flood overflow weir to assist in assessing actual performance against Condition 2.4.2;
- Monitoring water levels upstream of the high level flood overflow weir, consistent with meeting objectives around the frequency of discharge;
- The gauge is also a valuable measure of water levels in the Wairakei Stream for long term understanding of hydrological performance both in wet and dry periods.

For assessment of the high level flood overflow operation for Condition 2.4.2 and Advice Note 16, it would be appropriate to move the gauge to immediately upstream of the high level flood overflow weir when that is built. Close proximity to the weir is the reason condition 7.1 recommends moving the gauge once the weir is built.

Ongoing monitoring of the Wairakei Stream hydrology will require retention of a monitoring gauge at or close to the current site, to reflect water level in the Wairakei Stream. This is because under dry weather conditions it is unlikely that there will be a contiguous water body between the Wairakei Stream and the high level flood overflow weir, meaning water levels will differ for much of the time.

This SMS recommends retaining the existing gauge, and installing a new one at the high level flood overflow weir.

7.2.2 Water quality monitoring of discharges to the Kaituna River

Condition 8.3 of the CSC states:

> *The consent holder shall ensure that when the high level discharge from the Wairakei Stream to the Kaituna River referred to in Condition 2.3 is constructed, water quality monitoring at the Hickson/Te Tumu 8B1 boundary ceases and is replaced with monitoring within the swale immediately downstream of the high level overflow weir structure. Samples within the swale are to be taken in flowing water (not ponded), at a distance no greater than 10m from the weir structure.*

The purpose of this condition is to understand the quality of water leaving the Wairakei Stream catchment and discharging to the Kaituna River. It is important to note that the conditions under which such monitoring will be undertaken are likely to be challenging, being during a major storm event (of more than 7 year ARI), when there is heavy rain and (once the weir is operating) potentially significant flow in the flood overflow channel and across the weir on a wide front. In terms of sampling location to meet the intent of the consent condition, it will be necessary to make provision in the weir design for a location and method for safely sampling the flow. This will likely be at one end of the weir, either immediately upstream of the weir or at the toe of the weir face as flow enters the natural wetland on the flood plain. The upstream site is likely to be more appropriate.

Condition 8.4 of the CSC states:

> *The consent holder shall ensure that when the outfalls from the Part 2 (Te Tumu) area to the Kaituna River become operative, water quality monitoring is also undertaken at the two of the six outfalls to the Kaituna River. The selection of the two outfalls to be used for water quality monitoring will be made in consultation with Te Maru O Kaituna, and with its member Iwi/Hapu groups, including their own representative organisations/trusts/groups and is subject to the approval of the Chief Executive of the Regional Council, or delegate.*

The selection of the two sites for sampling water quality should reflect the potential higher risk areas for contaminants to be discharged. They should also reflect discharge that is more likely to enter the Maketū Estuary, i.e. be upstream of the Kaituna re-diversion. The following sites are recommended:

- The discharge from TK14, in the west near Bell Road. This is the largest Riverside subcatchment, and the proposed land use is light industrial.
- The next largest sub-catchment is the next one downstream, in the TCC/WBoPDC – TFP JV interests land. This is proposed as residential land, with a likely lower potential contaminant load.

The other sub-catchment with non-residential land use is the eastern end of the Ford Land Pty Ltd property, where the development zoning is a mix of residential, light industrial and commercial land uses. This discharge is close to the mouth of the Kaituna River, well downstream of the inlet to the Kaituna re-diversion, and most discharge would be directly into the high-energy coastal environment. This is therefore less critical for monitoring.

8 Summary and Recommendations

This SMS sets out the background to stormwater in the Te Tumu area, and shows how it can be managed to allow urban growth. It demonstrates that the proposed approach set out in this SMS, and the associated Structure Plan for future development, meets the consent conditions of the comprehensive stormwater consent number 63636.

8.1 Summary of strategy outcomes

The design philosophy for Te Tumu from this SMS for all aspects, in summary is as below.

8.1.1 Infrastructure Development Code

The IDC provides technical and process information to ensure that landforms and infrastructure developed in Tauranga achieve appropriate outcomes, whilst considering co-stakeholders and the community's needs.

- All development and design shall be undertaken in accordance with the IDC. Any departures from the IDC need to be approved through the IDC departure process.

8.1.2 Flood Levels (Wairakei)

In regard to flood levels within the Wairakei Stream, and to maintain consent compliance, the following are relevant:

- Once water level in the Wairakei Stream reaches 2.5 mRL or above there must be functional hydraulic connection between all the main stormwater storage basins. However, for water levels below this interconnection of basins may vary, with the minimum likely connection level between basins being about 1.0 mRL (although connection at this lower level is not explicitly required by the SMS).
- The modelling predicts that in the 100 year ARI fully developed (2055 climate) storm scenario the flood levels in the Wairakei Stream in Te Tumu would be about 4.3 mRL to 4.4 mRL.
- The design flood level (100 year ARI flood level fully developed, 2130 climate) in the Wairakei Stream in Te Tumu is predicted to be between 4.6 mRL to 4.7 mRL.
- The Aurecon modelling indicates that the high level flood overflow weir sill (approx. 7 year ARI flood level fully developed, 2055 climate) would be at or about 3.95 mRL.

8.1.3 Flood Risk and Development Levels

Flood risk, both within the site and off-site should be managed to minimise the risk to infrastructure, loss of life and property damage and meet the requirements of the Bay of Plenty Regional Policy Statement. A Flood Risk Assessment (FRA) is required to be undertaken to assess the severity of both pre- and post-development flood risks and determine any adverse impact on population, properties and infrastructure as a result of the proposed development scenario(s). The results of this assessment may require specific mitigation to be applied. At the time of writing this SMS, the FRA is yet to be undertaken. The outputs of this SMS are to be used to undertake the FRA.

8.1.4 Building Platforms

Minimum Building Platforms shall be calculated as the highest of:

- Minimum of 5.1 mRL;
- The 100 year ARI 2130 climate (1% AEP) 48-hour duration rainfall event combined with a 20 year ARI tidal event in the Kaituna River, plus 0.5m freeboard;
- The 100 year ARI 2130 climate (1% AEP) Kaituna River flood event combined with a 20 year tidal event, plus 0.5m freeboard;

- Climate change assumptions are to be based in line with MFE Coastal Hazards and Climate Change Report (BOPRC, 2019), which requires the consideration of the RCP 8.5H+ sea level rise scenario for greenfield developments (1.6 mRL sea level rise);
- At least 1 m above the 95 percentile, groundwater levels for the time period 2130, with 1.6 mRL sea level rise.

Note: Minimum building platform levels, set at 5.1 mRL may change, following the outcomes of the FRA, re-running of flood models or through specific design at the subdivision stage.

8.1.5 Roads

- Minimum roading levels shall be set 0.5 mRL above the 95 percentile, groundwater levels for the time period 2130, with 1.6 mRL sea level rise.
- Major waterway crossings shall have the functionality and capacity as set out in Section 4.3 and Table 3.

8.1.6 Wairakei Stream Levels

The following are recommended as design ranges for water levels within the Wairakei Stream and connected water bodies. This assumes that the high level flood overflow is in place.

Table 4 - Typical Wairakei Stream water level ranges

Context	Current climate (mRL)	2130 climate – sea level rise of 1.6 m
Summer range	1 to 1.7 typically	2.5 typically
Winter and small storms	1.5 to 2.0 typically Up to 2.5 in storms, receding over weeks	2.5 typically Up to 3 in storms, receding over weeks
Larger storms (every few years)	Rising to as high as 3.95, receding over several days to 2.5, then more slowly as for small storms	As for current climate, but occurring more often and for longer due to higher base water level
Major storms (rare)	Rising to 4.4, receding over hours/days to 3.95, then more slowly as for more frequent storms	As for current climate, but occurring more often and for longer due to higher base water level

Given that median groundwater level is expected to rise to about 3.0 mRL in Te Tumu with climate change and recognising the influence of the Grant Place outlet, a recommended “high water level” of 2.5 mRL has been adopted as the upper level for typical water level variation (outside significant flood events) and as a base water level for future climate flood modelling.

8.1.7 Volume Management

Coastal Catchment

There are no specific volume management requirements for development in the Coastal catchment, other than the requirement that all residential roof runoff to be discharged to ground where practicable.

Wairakei Stream Catchment

There are a number of aspects to volume management that need to be addressed for Wairakei Stream Catchment. These are:

- 40% of the 100 year ARI 48 hour duration runoff volume difference between pre and post development is managed as extra volume beside the Wairakei Stream or in new water bodies (referred to in this SMS as the “40% rule”). The required volume is calculated based on volumetric runoff change of each development. For the purposes of this SMS, and provided for in the SP to deliver the most efficient stormwater management approach for Te Tumu the delivery of the 40% rule is obtained within the Wairakei Stream by lowering a large area within the TCC/WBoPDC – TFP JV interests land, resulting in volume mitigation being provided for the 3 main landowner blocks. Management of this approach is via volume “trading” between landowners. The SMS sets out the indicative volumes required of each development to meet the 40% rule but does not explicitly define which developers would "trade", or the quantity involved. An indicative basis for sharing is provided in Appendix E.

- Total water body storage needs to accommodate up to 7 year runoff volume (2055 climate), including the whole Papamoa catchment runoff. This is a balance between storage footprint provided, and high level flood overflow weir level. Modelling to date has defined this containment level as 3.95 mRL.
- All residential roof runoff to be discharged to ground where practicable. The IDC sets out a design basis for this.

Riverside Catchment

There are no specific volume management requirements for development Riverside catchment (discharging direct to the Kaituna River), other than the requirement that all residential roof runoff to be discharged to ground where practicable. The IDC sets out a design basis for this.

8.1.8 Flood Management

To minimise capital and maintenance costs, multi-purpose solutions are preferred. It is expected that stormwater management elements will be incorporated in the landscape design of the development and multiple usage of green infrastructure is encouraged (e.g. land for overland flow paths could be utilised for walking and cycling connections).

- Overland flow paths need to be provided for and should be designed to cater for 100 year ARI flows, including provisions for climate change, taking a view out to over 100 years (i.e. 2130).
- Where a secondary flow path must cross an arterial or collector road, the 1% AEP shall be passed using a pipe under the road, and there shall be provision (in the event of pipe blockage or over-design events) for flow to safely pass across the road without flooding properties.
- Minor overland flow paths can be located in the road with a maximum flood depths and velocities in line with IDC and Austroads ("Guide to Road Design Part 5a", Table 5.2).
- Larger flows are expected to be located within designated off-road overland flow paths, which are directed into the principal water bodies.
- Natural low lying areas should be utilised for stormwater and flood flows as far as possible.

8.1.9 Impervious / Post-development runoff

For the purposes of stormwater management design:

- Assumptions have been made about imperviousness for the purposes of preparing the basin sizing for the Structure Plan, in accordance with TCC modelling guidelines. This is to be confirmed through consenting of developments, reflected in the sizing of infrastructure, and managed throughout development to ensure assumptions are not exceeded.
- Appropriate soakage testing is required after compaction where impervious area runoff is to be disposed directly to ground to ensure maintenance of soakage to meet minimum IDC and Building Code compliance requirements.

8.1.10 Low Impact Design (LID)

The aim of Low Impact Design (**LID**) is to minimise impacts, work with natural systems as much as possible, to protect and enhance natural freshwater systems, sustainably manage water resources, and mimic natural processes to achieve enhanced outcomes for ecosystems and our communities. A LID approach shall be taken in the design of the development and associated stormwater management consistent with the Stormwater Management Guideline for the CSC. The following principles shall be applied to the extent practicable:

- At source stormwater reduction/retention through:
  - Minimising the creation and extent of impervious surfaces to that required;

  - Infiltration of day-to-day stormwater runoff into the ground, where possible and geotechnically feasible;
  - Using unlined stormwater devices, where appropriate, to allow infiltration;
  - Utilisation of green infrastructure for primary flows to achieve multiple benefits of conveyance, treatment and amenity.
- Treatment devices required as part of this design approach are to become features of the development and consideration should be given to locating these devices in the road corridor/reserves (i.e. public spaces);
- Bioretention devices, for example raingardens and constructed treatment wetlands, should be used in preference to other stormwater management and treatment devices.

8.1.11 Water Quality Treatment

Water quality treatment is required for runoff from areas that generate elevated levels of contaminants (e.g. roads, car parks, etc) prior to discharge to rivers, streams and other natural water bodies (including a natural wetland). At or near source and natural infrastructure solutions are preferred over end of pipe stormwater management where practicable.

- Hydraulic and other requirements in the IDC should be adopted in the design of treatment devices.
- All development should be clad in inert building materials, (for example no unpainted zinc roofs).
- At source treatment (preferably bioretention) should be applied to high traffic roads and large car parking areas, hardstand and paved areas in accordance with the IDC.;
- Overland flow swale systems should be designed to provide an additional level of water quality treatment through the use of appropriate planting.

8.1.12 Wetlands

New (constructed) wetlands are required within the Riverside catchment for quality treatment. The following level criteria apply.

- The top of bund on the constructed wetlands shall be located above the Kaituna River 50 year flood level.
- Where a constructed wetland is required to be located below the Kaituna River 50 year flood level, it shall be assessed in regard to its functionality in that specific location, including the potential for the following to occur:
  - filling up of wetland storage space through sediments from the Kaituna River, which would shorten the timespan for maintenance and renewals;
  - flushing out of sediments previously trapped in the wetland in locations with high flow velocities;
  - the potential for more frequent physical damage to the wetland structure.

Existing natural wetlands (as identified as SEAs in the operative City Plan) are not to be used for stormwater quality treatment but can receive treated stormwater (including water that comes from areas where treatment is not required due to LID).

8.1.13 Safety

The design of infrastructure will need to take account of safety aspects throughout the life of the assets, which are set out below. The design criteria for these matters are defined in the TCC IDC, with specific emphasis on the following additional matters.

Batters

- This may in some instances include providing flat basin batters (1V:5H or flatter), and also benching and/or steps within the range of day-to-day water levels.
- Where there is dense planting that limits public access on batters, steeper slopes up to 1V:3H will be acceptable.

Depth/Velocity

- Depth/velocity combinations in secondary flow paths must be safe for pedestrians.

Hard edges along water bodies

- Where there are hard edge margins on water bodies, provide steps or ramps for egress, and handrails where fall heights require.

Safe exit points

- Ensure that all points along walking/cycling paths through potentially floodable areas around basins have safe exit points to above flood level in the event there is flooding up to 4.4 mRL.

Culverts

- Culverts should be such that they are not easy to access, for instance by having ponded areas at each end to a similar depth to the depth of water in the culverts.

Riverside Wetlands

- All water bodies, including the treatment wetlands in the Riverside catchment, will require safe access to and around the water bodies for maintenance purposes and for operational purposes in flood events.

High level flood overflow

- Road crossings over the flood overflow channel have been modelled as culverts by Aurecon. The SMS has provided waterway areas needed for appropriate flood conveyance. However, TCC may require that these crossings be bridges to provide for a factor of safety in their design, to provide for additional overflow designs (so the bridge is not overtopped), and there is a safe 'head room' space underneath the bridge down to the top water level of the design flood. The question of whether these are bridges or culverts will be determined by TCC separately from this SMS.

8.1.14 Maintenance of Assets

- All options for stormwater management/ecological restoration are required to be maintainable by the Tauranga City Council.
- Safe access for maintenance must be provided to all stormwater devices, including constructed wetlands and raingardens used for stormwater treatment.

8.2 Recommended Ongoing Work to refine SMS and inform future stormwater design

There is ongoing work, not part of the scope of this SMS, that is necessary to refine some of the levels, volumes and performance outcomes set out in the SMS, and to address all matters relating to ongoing successful management of stormwater in Te Tumu, largely in relation to specific design solutions. These are as below.

- Update and re-run the Papamoa East Flood Model to incorporate the structure plan, earthworks model, and key hydraulic infrastructure set out in this SMS, to confirm critical flood overflow levels, waterway capacity and flood levels, and to aid in future subdivision and development civil designs.
- Confirm interactions between stormwater system (including storage basins) and the sustainability of important ecological areas, and refine this SMS (if needed) in the light of these. This would occur through open space and landscape planning processes.
- Develop a water balance model sufficient to understand how the hydrology of the catchment, and the water levels in the Wairakei Stream and the stormwater basins, will function following development. This needs to consider seasonal variability, response in a range of frequent to major storms, duration of ponding and rate of drawdown, and effects of climate change.

References

Archaeology BOP	[DRAFT] *2018 Survey Results and Updated Assessments of Recorded Archaeological Sites within the Te Tumu Strategic Planning Study Area, Papamoa East, Tauranga*. Prepared for Tauranga City Council. Ken Phillips, June 2019.
Aurecon 2014	*Papamoa Comprehensive Stormwater Consent 63636 – Variation to Condition. Hydraulic Modelling Summary Report*. Prepared for Tauranga City Council. Ref 222177. Rev 0. 31 October 2014
Aurecon 2018a	*Te Tumu Structure Plan. Hydraulic Modelling Report*. Prepared for Tauranga City Council. Ref 256470. Rev 0. 28 February 2018
Aurecon 2018b	*Te Tumu Overflow Channel. Design Statement.* Prepared for Tauranga City Council. Ref 502188. Rev 0. 31 May 2018
Beca 2006	*Papamoa East (Te Tumu) Part 2 – Stormwater Management Concept*. Prepared for Te Tumu Landowners Group in response to Smart Growth. 22 March 2006.
Beca 2018	*Te Tumu Urban Growth Area – Stormwater Management Report*. Prepared for Te Tumu Landowners Group and Tauranga City Council by Beca Ltd. DRAFT 24 April 2018. (Note, this report remains draft, and relevant elements were incorporated into this Stormwater Management Strategy document.)
Boffa Miskell 2020	Te Tumu Wetlands. Assessment of Ecological Values. Prepared for Tauranga City Council, May 2020.
NZEnvC, 2015	Conditions of consent 63636 from Environment Court Order dated 20 November 2015
Opus 2007	*Assessment of Environmental Effects of Coastal Stormwater Outfall Option, Motiti Reserve, Papamoa*. Prepared by Opus for Tauranga City Council. August 2007.
Te Onewa 2018	Te Tumu Cultural Values Literature Review, December 2018
TCC 2015	*Stormwater Catchment Management Plan. Module 7: Papamoa Catchment (CSC6)*. September 2015
T+T 2018	*Te Tumu Natural Hazard Risk Assessment – Liquefaction*. Prepared for Tauranga City Council. Tonkin + Taylor, June 2018. Ref. 1002034.2000

Abbreviations

ARI	Average recurrence interval – the frequency with which a particular event or occurrence is exceeded on a long term average basis
BOPRC	Bay of Plenty Regional Council
CMP	Stormwater Catchment Management Plan – Papamoa catchment
CSC	Comprehensive stormwater Consent (63636)
MfE	Ministry for the Environment
FLH	Ford Land Holdings Pty Ltd
FRA	Flood Risk Assessment
IDC	Infrastructure Development Code (TCC)
LID	Low Impact Design
mRL	metres reduced level - elevation above datum (in this case Moturiki Datum)
PC	Plan Change
SEA	Special Ecological Area
SMG	Stormwater Management Guidelines
SMS	Stormwater Management Strategy (this document)
SP	Structure Plan
T+T	Tonkin and Taylor Ltd
TCC	Tauranga City Council
TFP	Totara Farm Park
TK14, 7B1, 7B2, 8B1, 11B2	Tumu Kaituna Maori Trusts
WBOPDC	Western Bay of Plenty District Council
WSCLP	Wairakei Stream Cultural Landscape Plan

Definitions

Basin	Specifically used for all areas used as part of flood storage, and may be either natural or constructed, and normally wet or normally dry
Constructed wetland	A wetland built as part of infrastructure for stormwater management, either for treatment or as part of landscaping and operational management (also referred to as treatment or stormwater treatment wetlands)
Natural wetland	An existing wetland that is retained within the Te Tumu urban growth area
Water body	A general term for all water bodies, natural or constructed, including both streams and wetlands
Papamoa Catchment	Used in the SMS to define the wider catchment, as covered by the CMP
Wairakei Stream Catchment	Limited in this SMS to the Catchment of the Wairakei Stream within Te Tumu (including both the northern and middle catchments as described in the CSC)
High level flood overflow	Used as a generic label for the whole of the high level flood overflow system from the Wairakei Stream to the Kaituna River
High level flood overflow weir	Used specifically for the high level weir that controls the level and frequency of overflow from the Wairakei Stream to the Kaituna River
Flood overflow channel	Used specific for the channel between the Wairakei Stream and the high level flood overflow weir

A

Appendix A – Drawings

Drawing List

Figure A1 - Ecological and Cultural Constraints

Figure A2 - Outfall Locations – Option B (from Comprehensive Stormwater Consent / Beca 2006)

Figure A3 - Structure Plan – Water services

Figure A4 – Groundwater levels - three sheets (from TCC / T+T

CA-001 – Proposed Stormwater System – Overview

CA-002 – Te Tumu Stormwater Wetlands and Basins Sections

CA-004 – Te Tumu Stormwater Elizabeth Wetland Plan & Section

CA-005 – TK14 Wetland Plan

CA-006 – TCC/WBOPDC-TFP JV Interests Wetland Plan

CA-007 – Overflow Wetland (TCC/WBOPDC-TFP JV Interests) Plan

CA-008 - FLH Wetland 2 – Plan

CA-009 – FLH Wetland 2 - Plan

CA-010 – Catalyst Wetland – Plan

CA-011 – Riverside Treatment Wetland Sections

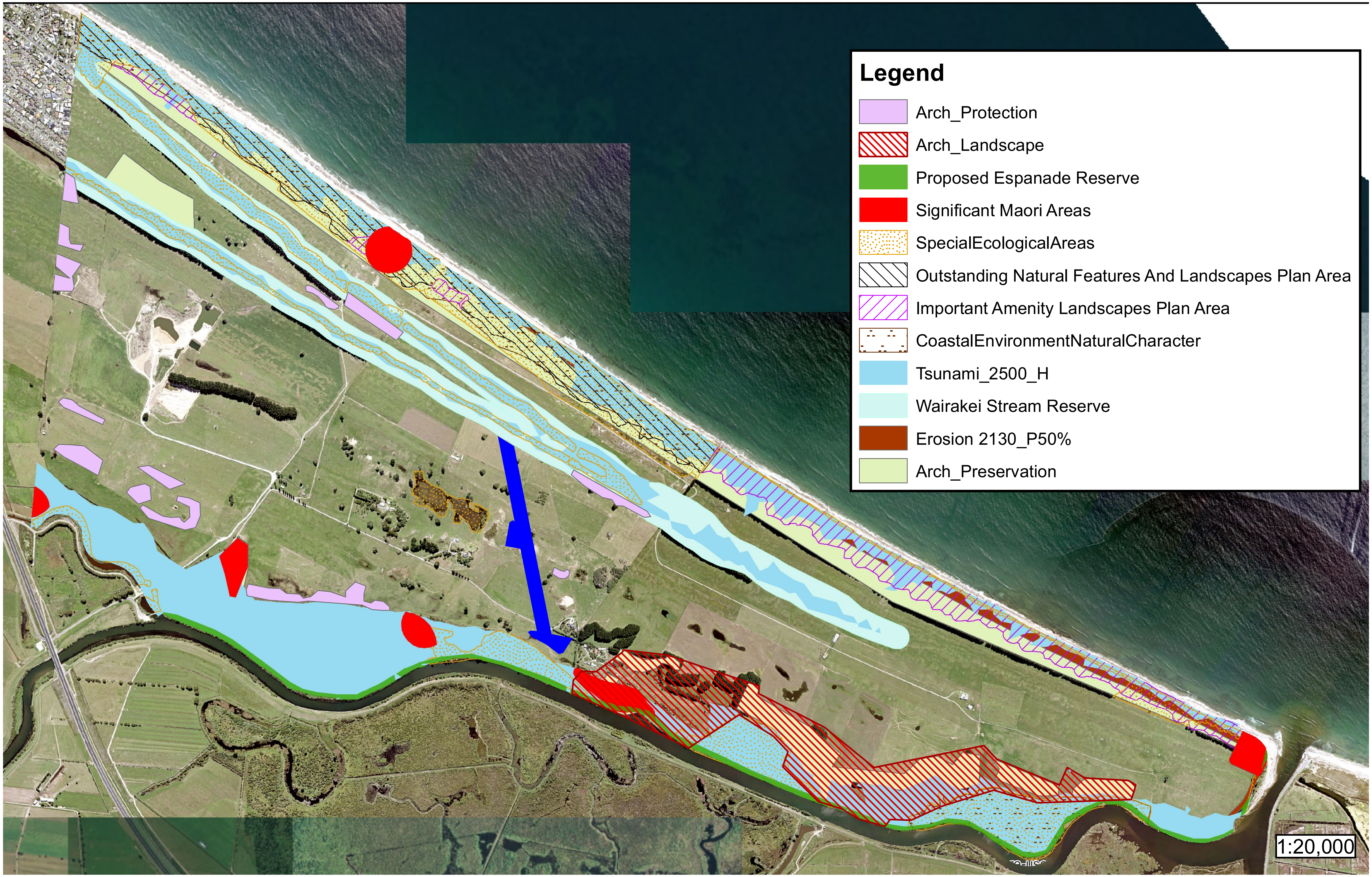

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FIGURE A1

No.	Revision	By	Chk	Appd	Date

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Original Scale (A1)
Reduced Scale (A3)

Design
Drawn
Dsg Verifier
Dwg Check
* Refer to Revision 1 for Original Signature

Client: TAURANGA CITY COUNCIL AND TE TUMU LANDOWNERS GROUP (TTLG)

Project: TE TUMU STORMWATER MANAGEMENT STRATEGY

Title: ECOLOGICAL AND CULTURAL CONSTRAINTS

Discipline: CIVIL

Drawing No.: APPENDIX A

Rev.: A

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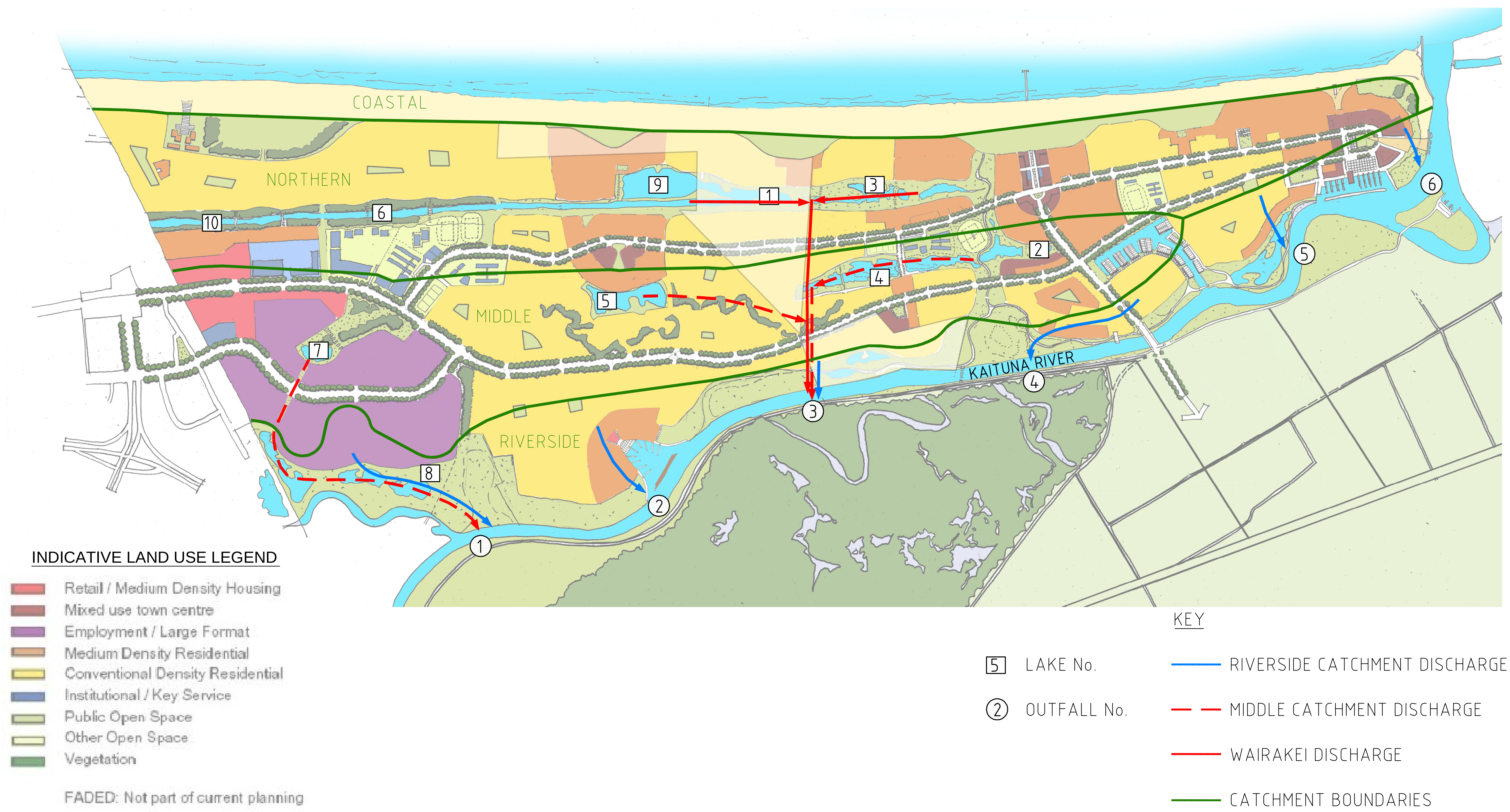
PAPAMOA EAST (TE TUMU) PART 2
STORMWATER MANAGEMENT CONCEPT



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OUTFALL LOCATIONS - OPTION B

PROJECT No.
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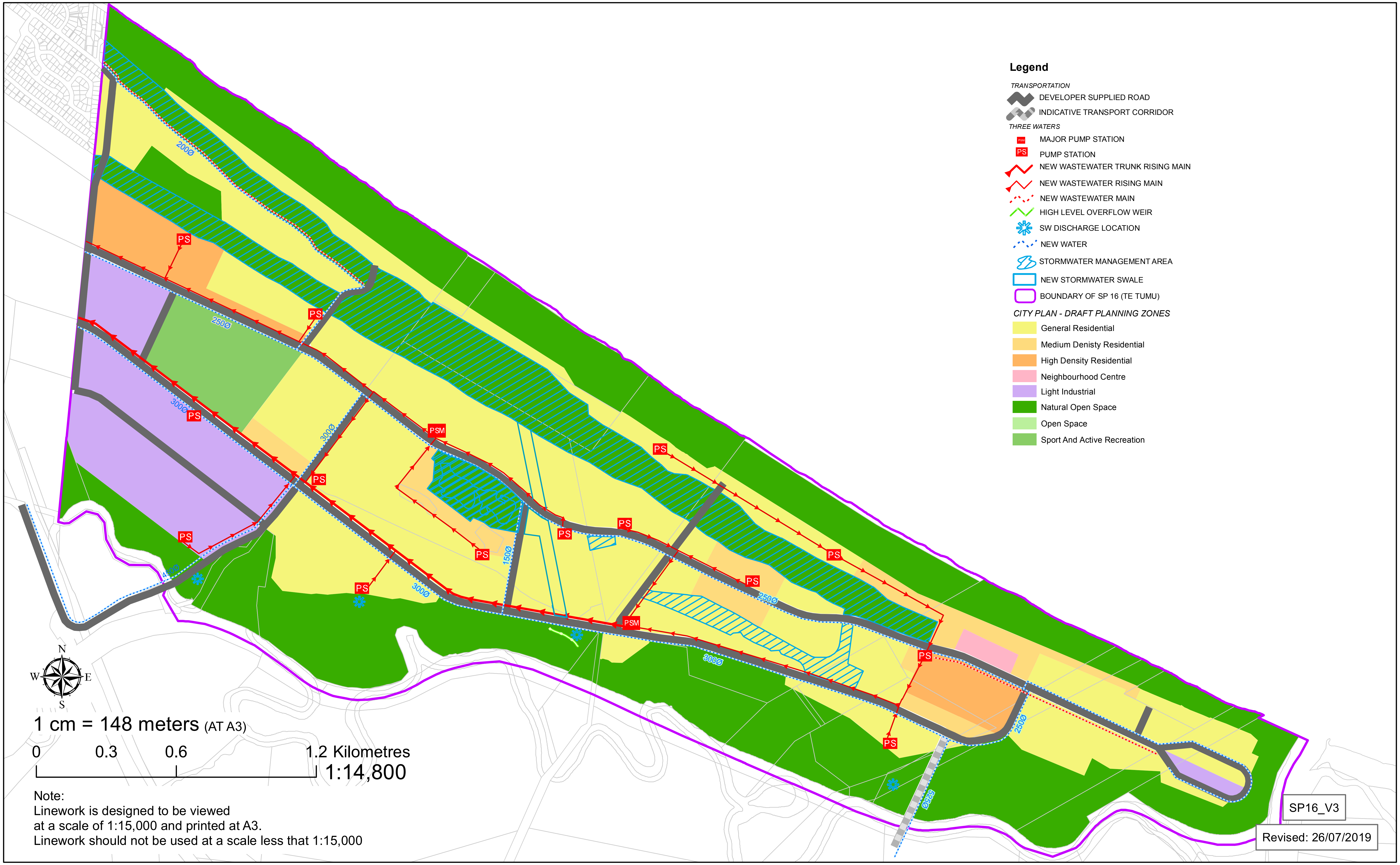
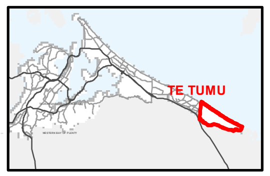
FIGURE A2





Urban Growth Area Structure Plan - Te Tumu (SP 16)

- Tauranga City Council -

Information shown on this plan is indicative only .The Council accepts no liability for its accuracy and it is your responsibility to ensure that the data contained herein is appropriate and applicable to the end use intended.

FIGURE A3

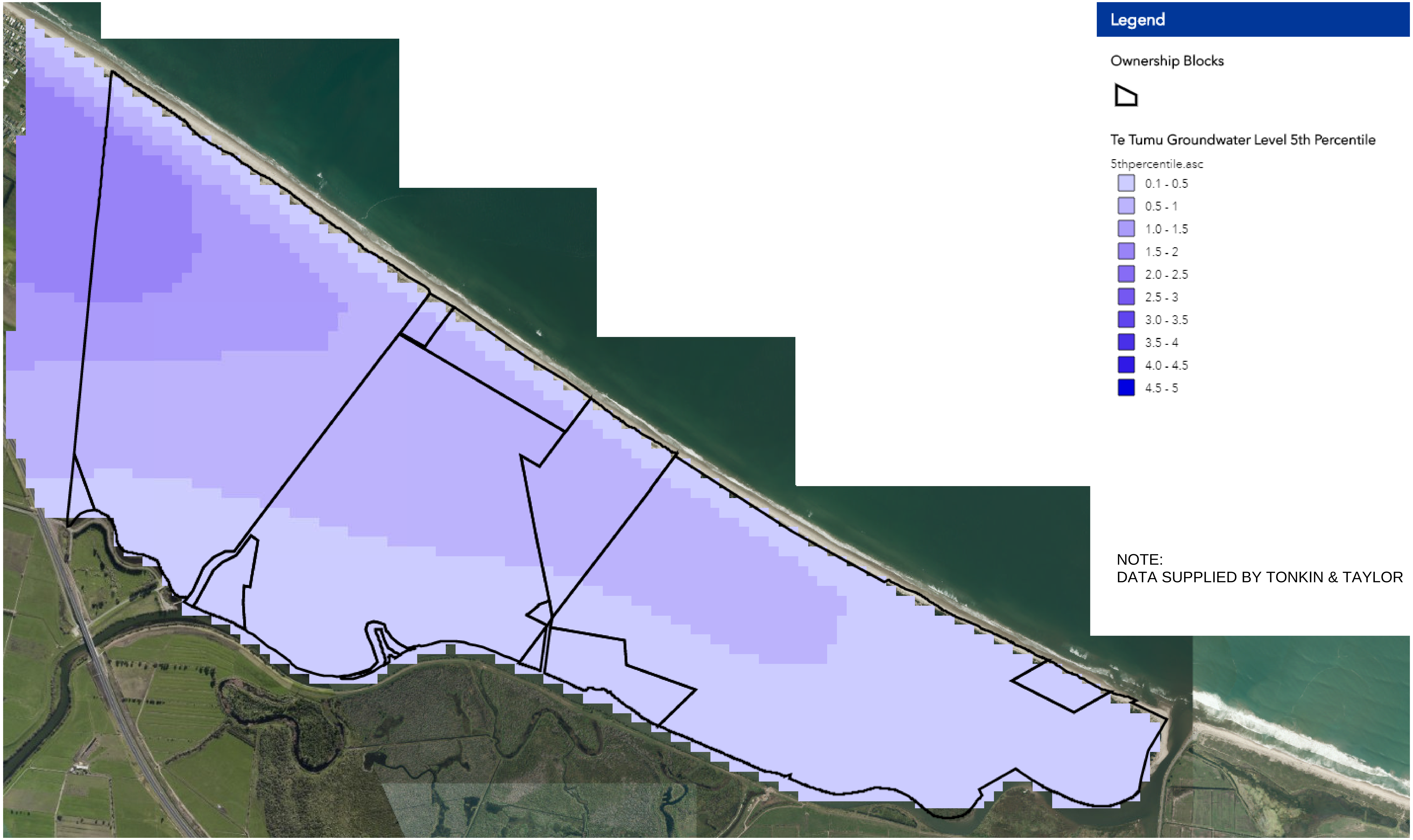


Figure A4 - A

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* Refer to Revision 1 for Original Signature

Client: TAURANGA CITY COUNCIL AND TE TUMU LANDOWNERS GROUP (TTLG)

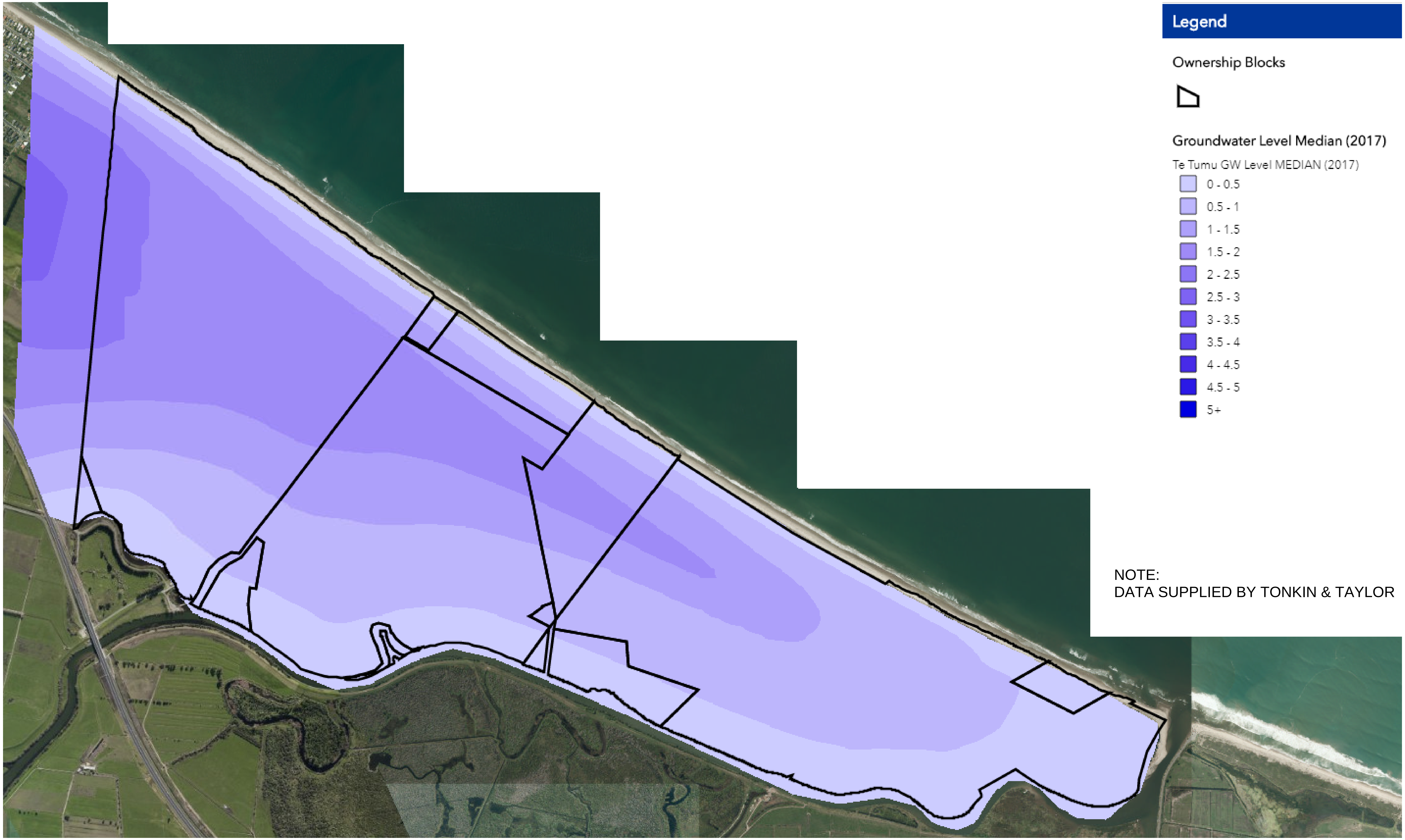
Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: GROUND WATER LEVEL 5% PERCENTILE 2017

Discipline: CIVIL

Drawing No.: B(1)

Rev.: A



NOTE:
DATA SUPPLIED BY TONKIN & TAYLOR

Figure A4 - B

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Drawing Originator: Beca

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Design	
Drawn	
Dsg Verifier	
Dwg Check	

* Refer to Revision 1 for Original Signature

Client: TAURANGA CITY COUNCIL AND TE TUMU LANDOWNERS GROUP (TTLG)

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: GROUND WATER LEVEL MEDIAN 2017

Discipline: CIVIL

Drawing No. B(2)

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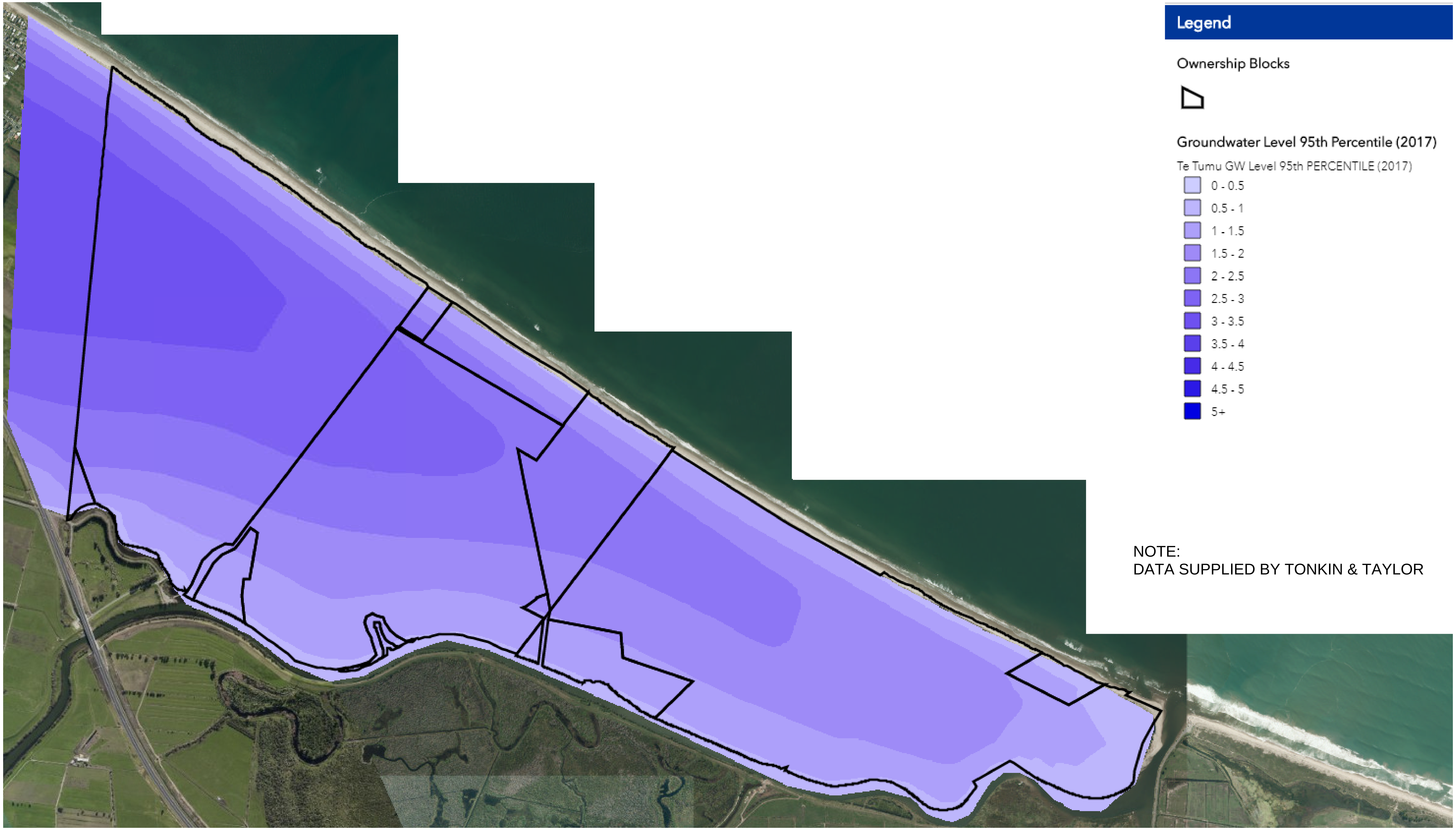

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Figure A4 - C

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Original Scale (A1) | Reduced Scale (A3) | Design | Drawn | Dsg Verifier | Dwg Check | * Refer to Revision 1 for Original Signature

Client: TAURANGA CITY COUNCIL AND TE TUMU LANDOWNERS GROUP (TTLG)

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: GROUND WATER LEVEL 95% PERCENTILE 2017

Discipline: CIVIL

Drawing No.: B(3)

Rev.: A

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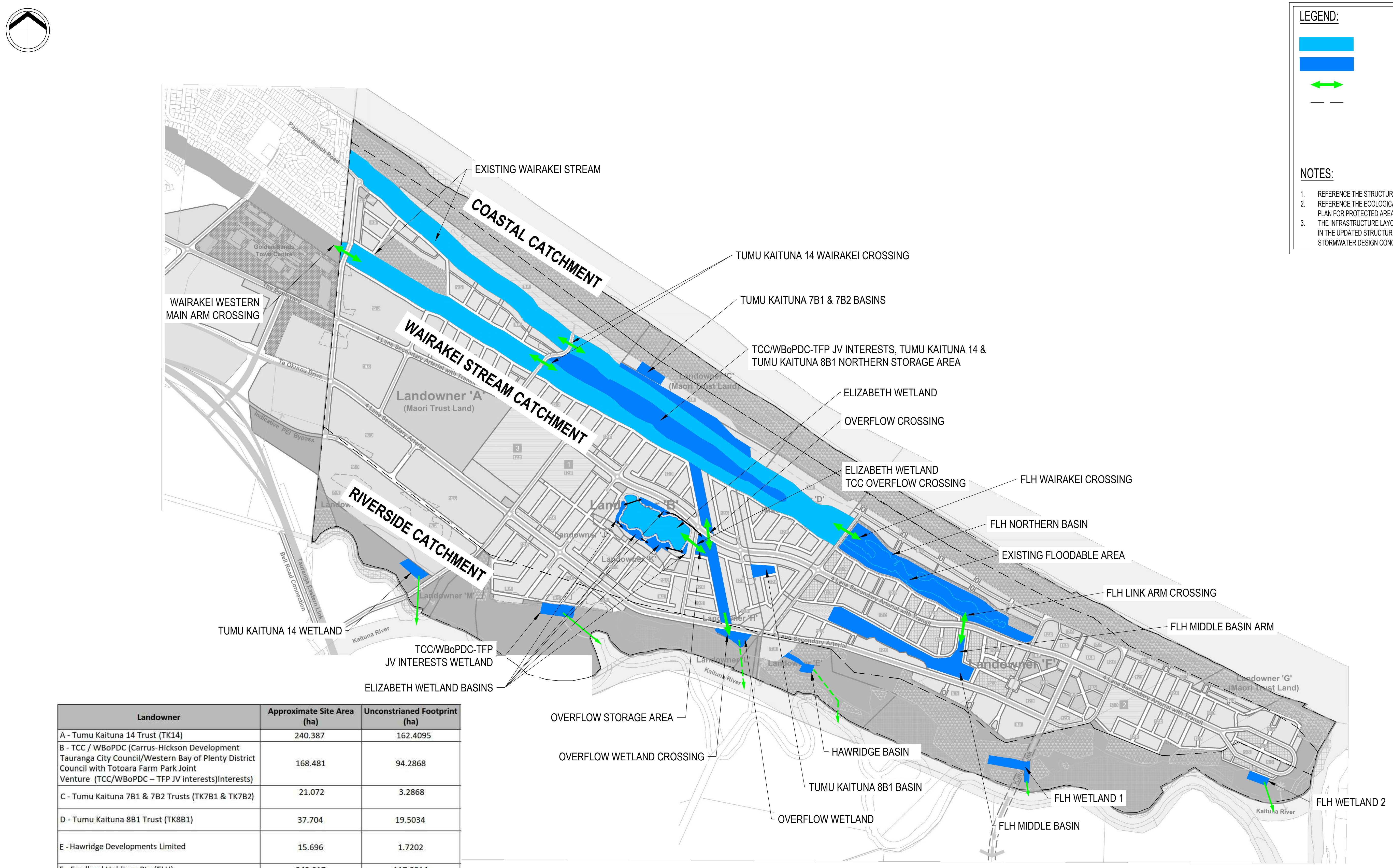

Landowner	Approximate Site Area (ha)	Unconstrianed Footprint (ha)
A - Tumu Kaituna 14 Trust (TK14)	240.387	162.4095
B - TCC / WBoPDC (Carrus-Hickson Development Tauranga City Council/Western Bay of Plenty District Council with Totoara Farm Park Joint Venture (TCC/WBoPDC – TFP JV interests)Interests)	168.481	94.2868
C - Tumu Kaituna 7B1 & 7B2 Trusts (TK7B1 & TK7B2)	21.072	3.2868
D - Tumu Kaituna 8B1 Trust (TK8B1)	37.704	19.5034
E - Hawridge Developments Limited	15.696	1.7202
F - Fordland Holdings Pty (FLH)	243.017	117.0814
G - Tumu Kaituna 11B2 Trust (TK11B2)	5.574	1.9895
H - Tauranga City Council (TCC)	0.801	0.8012
I - Tauranga City Council (TCC)	2.092	0
J -R Love	0.801	0.8008
K- G Hickson	0.801	0.801
L - Edwards	1.174	0
M - K Wendt	6.651	0
Total	744.251	402.6806

LEGEND:

- EXISTING PROTECTED WATER BODY
- NEW WATER BODY
- FLOW LINKS
- CATCHMENT BOUNDARIES

NOTES:

1. REFERENCE THE STRUCTURAL PLAN LAYOUT FOR LAND USES.
2. REFERENCE THE ECOLOGICAL AND CULTURAL CONSTRAINTS PLAN FOR PROTECTED AREAS.
3. THE INFRASTRUCTURE LAYOUT DIFFERS SLIGHTLY FROM THAT IN THE UPDATED STRUCTURE PLAN LAYOUT BUT THE STORMWATER DESIGN CONCEPT IS UNCHANGED

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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	CDS	KNW	GL	12.10.2020

Drawing Originator: Beca

Original Scale (A1) 1:100 | Reduced Scale (A3) 1:200 | Design | Drawn | Dsg Verifier | Dwg Check | Approved For Construction* | Date | * Refer to Revision 1 for Original Signature

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: PROPOSED STORMWATER SYSTEM - OVERVIEW

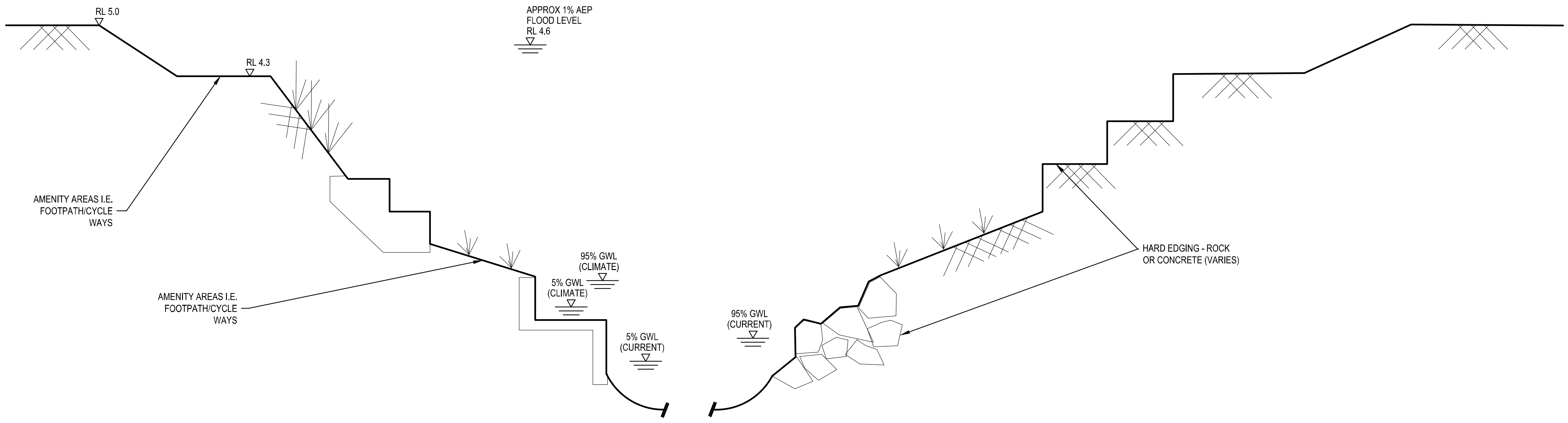
Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-001 | Rev. A

Document No. 4284941-CA-001.DWG

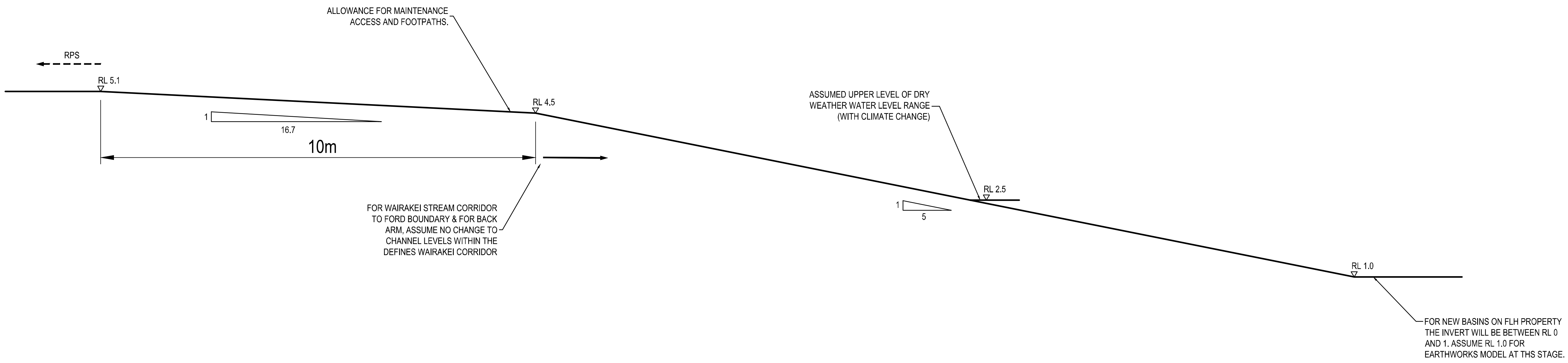
DO NOT SCALE

IF IN DOUBT ASK.



1 - TYPICAL HARD EDGED SECTION (FORDS AND OVERFLOW)

NTS



2 - TYPICAL BASIN BATTER (GENERAL)

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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	CDS	KNW	GL	12.10.2020

Drawing Originator: Beca

Original Scale (A1) NTS; Reduced Scale (A3) NTS

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Approved For Construction*

Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: TE TUMU STORMWATER WETLANDS & BASINS SECTIONS

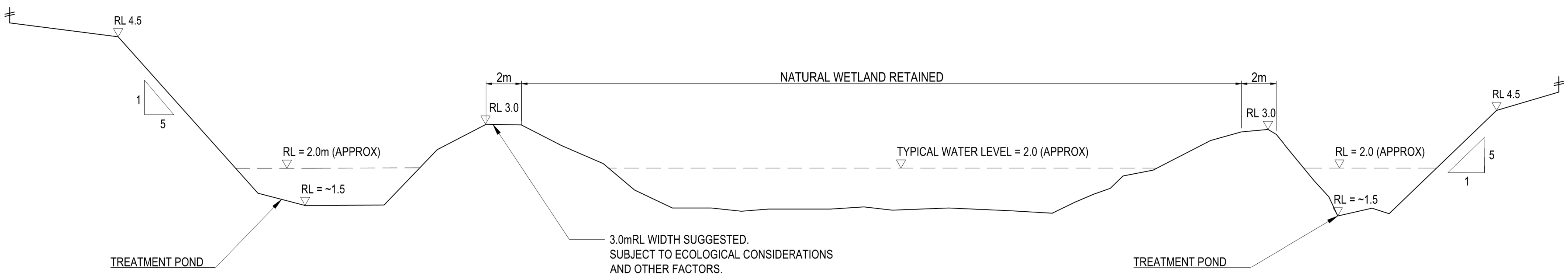
Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-002 Rev. A

Document No. 4284941-CA-002.DWG

ELIZABETH WETLAND PLAN VIEW

NTS



3 ELIZABETH WETLAND CROSS SECTION

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No.	Revision	By	Chk	Appd	Date
*	UNDER REVISION	CDS			

Drawing Originator: Beca

Original Scale (A1): NTS
Reduced Scale (A3): NTS

Design / Drawn / Dsg Verifier / Dwg Check

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Approved For Construction*

Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: TE TUMU STORMWATER ELIZABETH WETLAND PLAN AND CROSS-SECTION

Discipline: CIVIL ENGINEERING

Drawing No.: 4284941-CA-004

Rev.: A

Document No. 4284941-CA-004.DWG

Drawing Plotted: 12 Oct 2020 9:17 AM

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Drawing Originator: Beca

Original Scale (A1) 1:500
Reduced Scale (A3) 1:1000

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* Refer to Revision 1 for Original Signature
Approved For Construction*
Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: TUMU KAITUNA 14 WETLAND PLAN SECTION

Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-005

Rev. A

Document No. 4284941-CA-005.DWG

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Drawing Plotted: 12 Oct 2020 9:18 AM

- WETLAND AREA SIZED FOR 2% OF THE TCC/WBOPDC-TFP JV INTERESTS AREA (BOPRC MANAGEMENT GUIDELINES).
- TCC/WBOPDC-TFP JV INTERESTS WETLAND AREA = 9550m2.
- SIZING APPROACH BASED ON TREATMENT.
- NO MODIFICATION OF CATEGORY 2 ECOLOGICAL AREAS

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Drawing Originator: Beca

Original Scale (A1) 1:500
Reduced Scale (A3) 1:1000

Design / Drawn / Dsg Verifier / Dwg Check
* Refer to Revision 1 for Original Signature

Approved For Construction* / Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: TCC/WBOPDC-TFP JV INTERESTS WETLAND PLAN VIEW

Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-006 Rev. A

Document No. 4284941-CA-006.DWG

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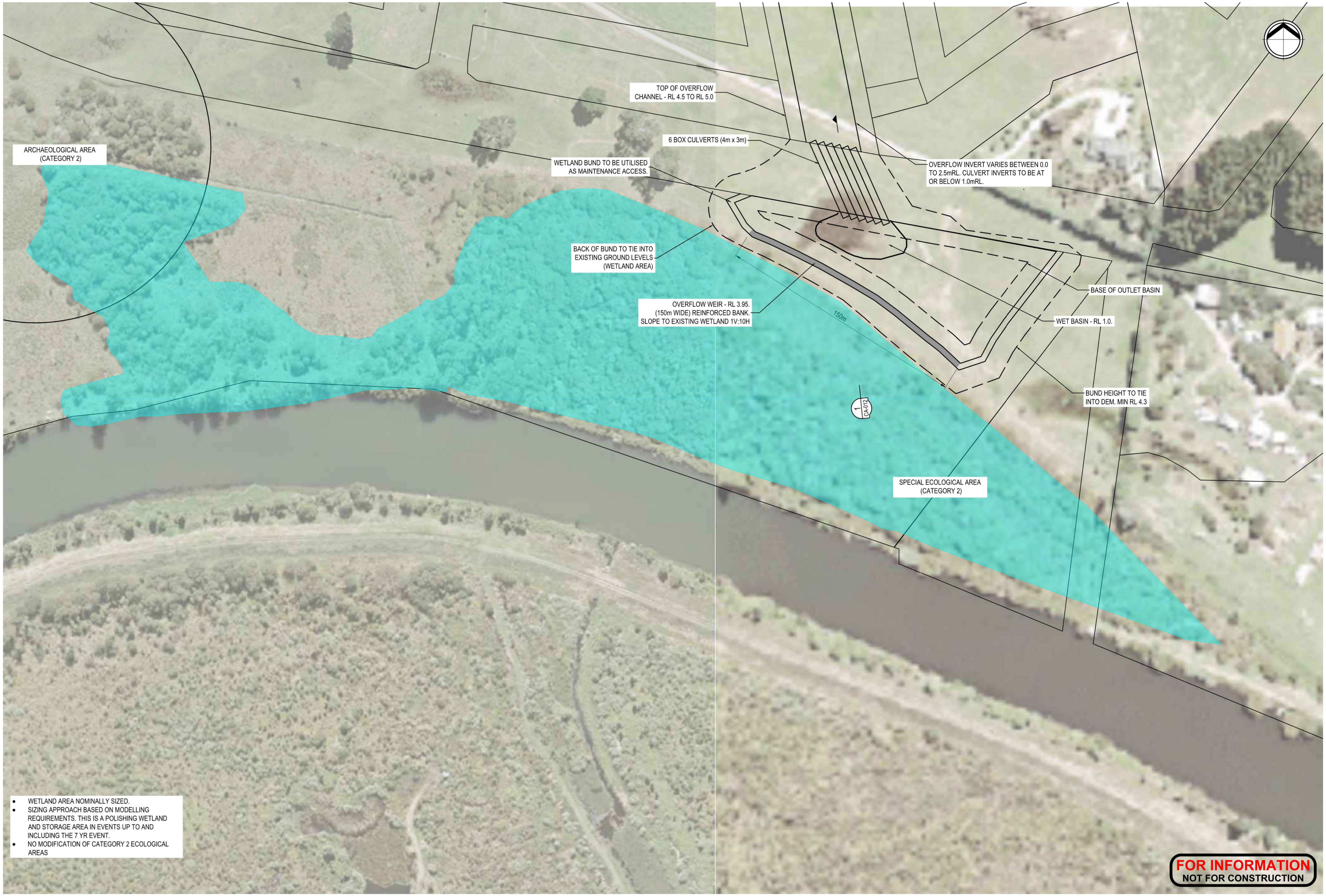
IF IN DOUBT ASK.

Drawing Plotted: 13 Oct 2020 2:47 PM



- WETLAND AREA NOMINALLY SIZED.
- SIZING APPROACH BASED ON MODELLING REQUIREMENTS. THIS IS A POLISHING WETLAND AND STORAGE AREA IN EVENTS UP TO AND INCLUDING THE 7 YR EVENT.
- NO MODIFICATION OF CATEGORY 2 ECOLOGICAL AREAS

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No.	Revision	By	Chk	Appd	Date
*	FOR INFORMATION	CDS	KNW	GL	12.10.2020

Drawing Originator: Beca

Original Scale (A1) 1:1000
Reduced Scale (A3) 1:2000

Design | Drawn | Dsg Verifier | Dwg Check
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Approved For Construction*
Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: OVERLFOW WETLAND (TCC/WBOPDC-TFP JV INTERESTS) PLAN VIEW

Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-007 Rev. A

Document No. 4284941-CA-007.DWG

DO NOT SCALE

IF IN DOUBT ASK.

- WETLAND AREA SIZED FOR 2% OF THE SANDHILLS AREA (BOPRC MANAGEMENT GUIDELINES).
- SANDHILLS WETLAND AREA REQUIRED = 11,970m^2.
- SANDHILLS WETLAND AREA AVAILABLE = 11,050 m^2.
- DUE TO SURROUNDING ARCHAEOLOGICAL AND ECOLOGICAL AREAS. AREA AVAILABLE IS LIMITED.
- SIZING APPROACH BASED ON TREATMENT.
- NO MODIFICATION OF CATEGORY 2 ECOLOGICAL AREAS

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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	CDS	KNW	GL	12.10.2020

Drawing Originator: Beca

Original Scale (A1) 1:1000
Reduced Scale (A3) 1:2000

Design / Drawn / Dsg Verifier / Dwg Check
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Approved For Construction* / Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

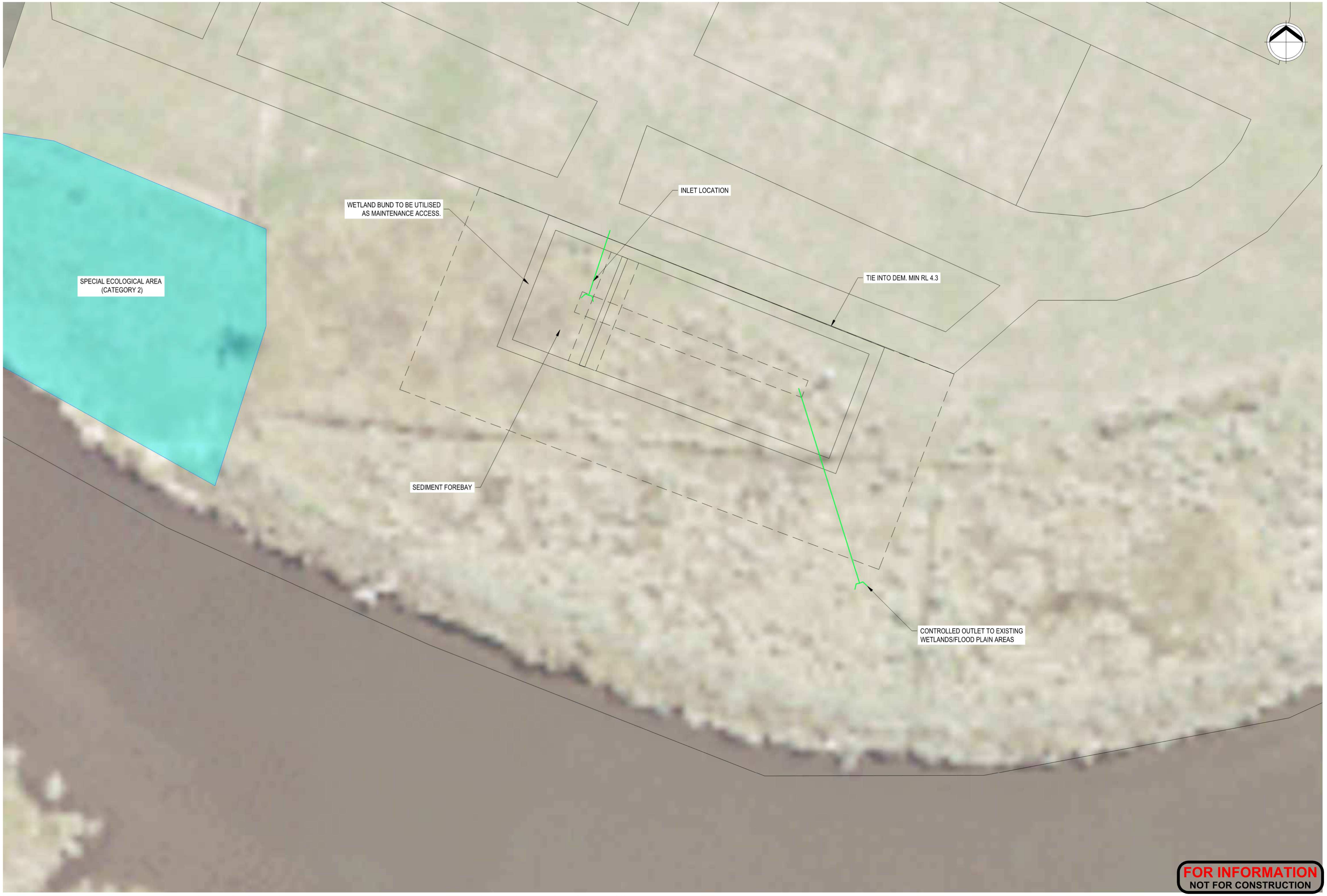
Title: FLH WETLAND 1 - PLAN VIEW

Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-008 Rev. A

Document No. 4284941-CA-008.DWG

Drawing Plotted: 12 Oct 2020 9:27 AM



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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	CDS	KNW	GL	12.10.2020

Drawing Originator: Beca

Original Scale (A1) 1:500
Reduced Scale (A3) 1:1000

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Approved For Construction*
Date

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: FLH WETLAND 2 - PLAN VIEW

Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-009

Rev. A

Document No. 4284941-CA-009.DWG

DO NOT SCALE

IF IN DOUBT ASK.

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No.	Revision	By	Chk	Appd	Date
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Drawing Originator: Beca

Original Scale (A1) 1:500
Reduced Scale (A3) 1:1000

Design / Drawn / Dsg Verifier / Dwg Check

Approved For Construction*
Date

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Client: Tauranga City

Project: TE TUMU
STORMWATER MANAGEMENT PLAN

Title: HAWRIDGE DEVELOPMENT LIMITED
WETLAND - PLAN VIEW

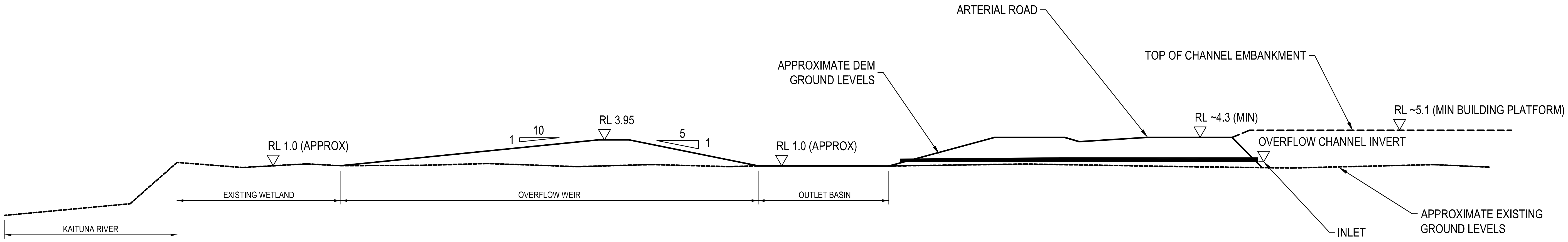
Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-010 Rev. A

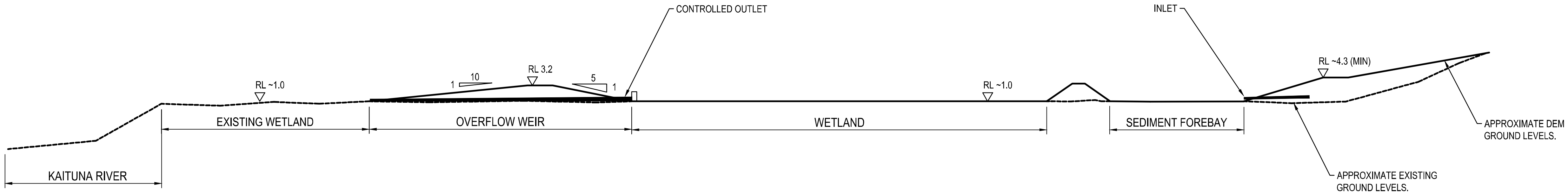
Document No. 4284941-CA-010.DWG

DO NOT SCALE

IF IN DOUBT ASK.



1 CA-007 TCC OVERFLOW OUTLET SECTION
NTS



2 TYPICAL RIVERSIDE TREATMENT WETLAND
NTS

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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	CDS	KNW	GL	12.10.2020

Drawing Originator: Beca

Original Scale (A1) NTS; Reduced Scale (A3) NTS; Design; Drawn; Dsg Verifier; Dwg Check; Approved For Construction*; Date; * Refer to Revision 1 for Original Signature

Client: Tauranga City

Project: TE TUMU STORMWATER MANAGEMENT PLAN

Title: WETLAND SECTIONS

Discipline: CIVIL ENGINEERING

Drawing No. 4284941-CA-011 Rev. A

Document No. 4284941-CA-011.DWG

B

Appendix B – Photographs

B.1 Wairakei Stream – Water level variability

15 July 2004

Wairakei Stream looking upstream from TK8B1 / FLH boundary.

Winter high water levels applied for several months.

No water level record found.

14 August 2005

Wairakei Stream looking upstream from TK8B1 / FLH boundary.

Winter high water levels associated with a particularly high flood that persisted for several months.

No water level record found.

15 March 2006

Wairakei Stream looking upstream from TK8B1 / FLH boundary.

Higher water level (1.4 mRL) than summer low, and at the end of April the water level rose by about 0.6 to 0.8 m and stayed at that level (2 to 2.2 mRL) for 5 months of winter and spring.

17 January 2007

Wairakei Stream looking upstream from TK8B1 / FLH boundary.

Summer low period. No water level record because it was below recording range (<1.3 mRL) from mid-November for at least 6 months.

1 April 2015

Wairakei Stream looking downstream from TCC/WBOP TFP JV (water level gauge site). Trees in distance are at FLH boundary.

Summer low period. No water level record because it was below recording range (<1.3 mRL) from early January to early June.

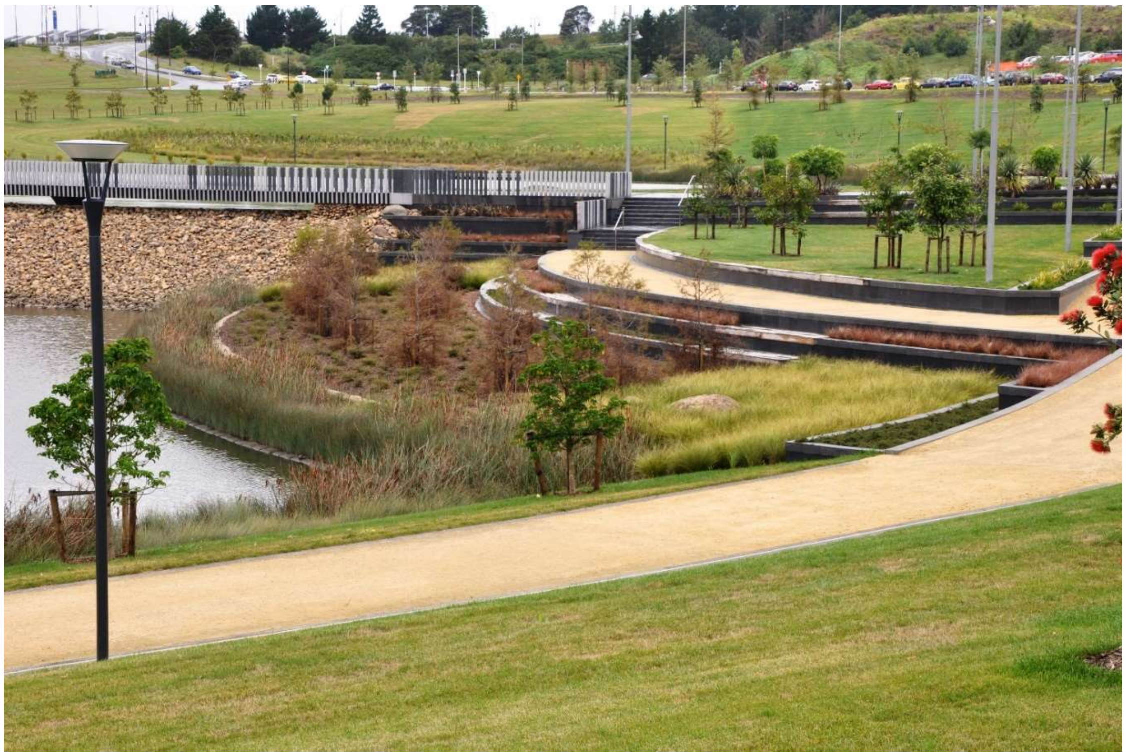
1 April 2015

Wairakei Stream at TCC/WBOP TFP JV and TK8B1 boundary.

Summer low period. No water level record because it was below recording range (<1.3 mRL) from early January to early June.

B.2 Water body edge treatments - examples

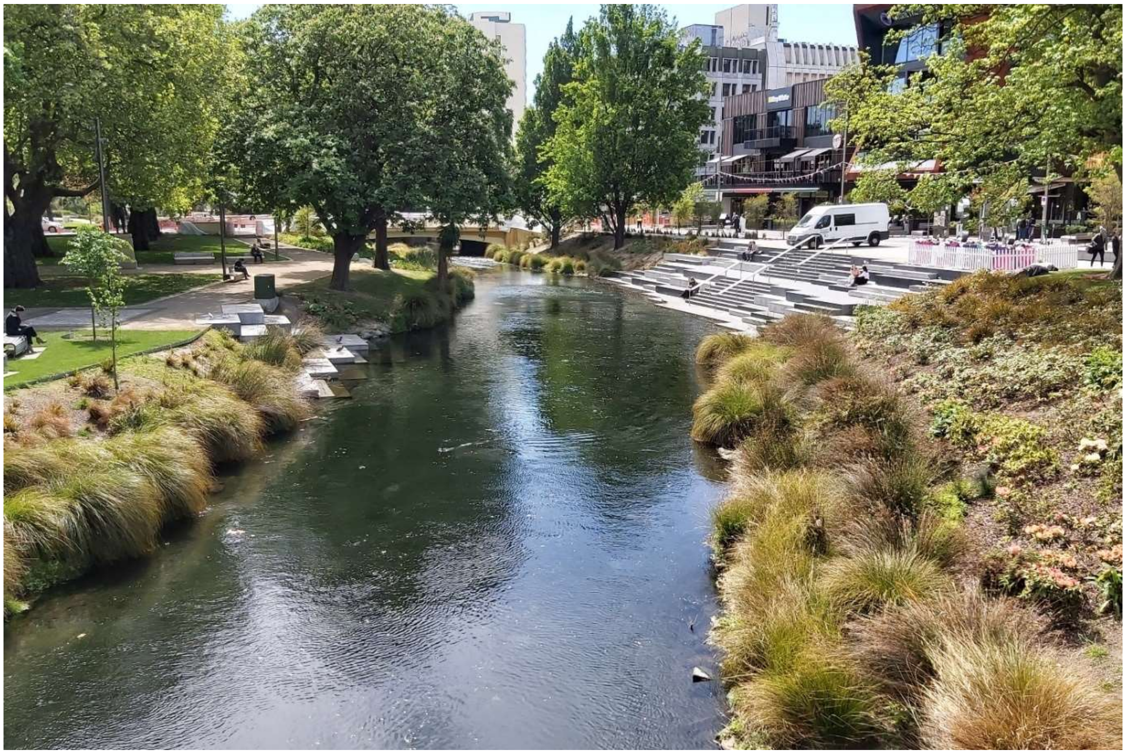
The following photographs are sourced around New Zealand, plus a few from Australia. They show various edge treatments including hard-edged, soft/natural margins, and some hybrids. Some are readily able to accommodate the sustained water levels variability that will occur in the Te Tumu water bodies. Others could be adapted to accommodate that variability by increasing the height of the edge features that are resilient to inundation (walls, hard facing, selected vegetation). Soft margins will require plants that can cope with inundation that lasts for weeks or months.



With suitable vegetation that tolerates dry through to inundated conditions, this terraced approach can accommodate a wide range of water levels in an urban context.

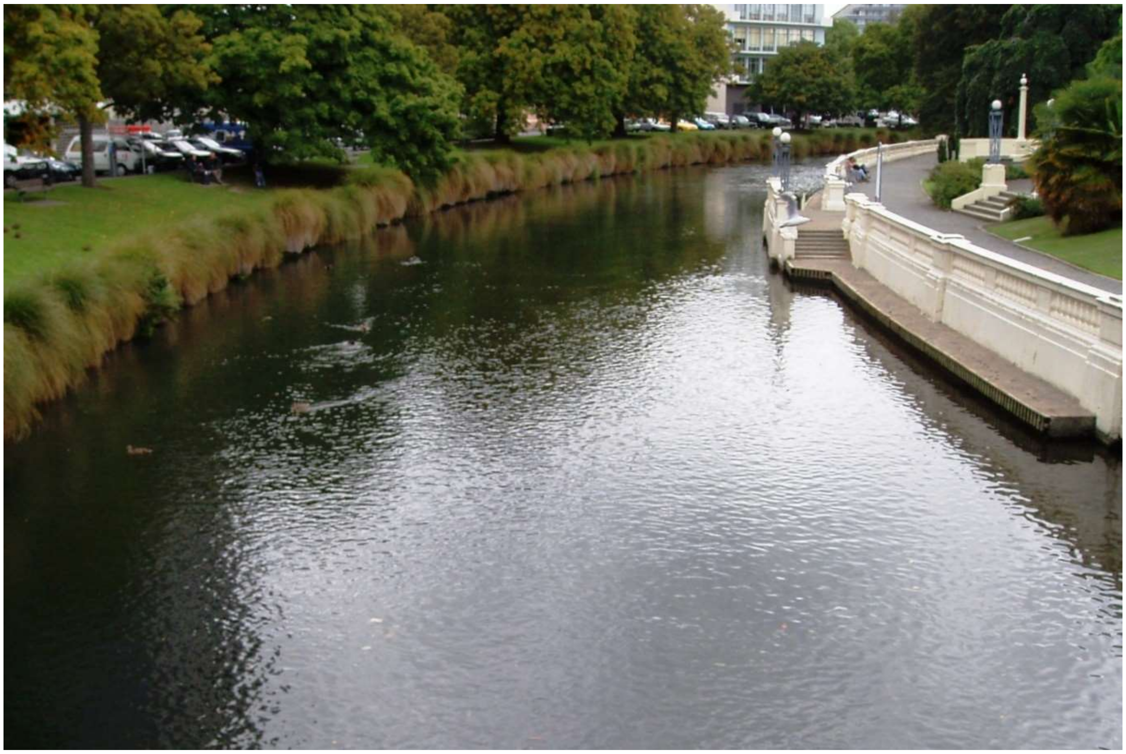
Vegetated terrace approach

There are many wall options that can provide public proximity to the water where water level varies

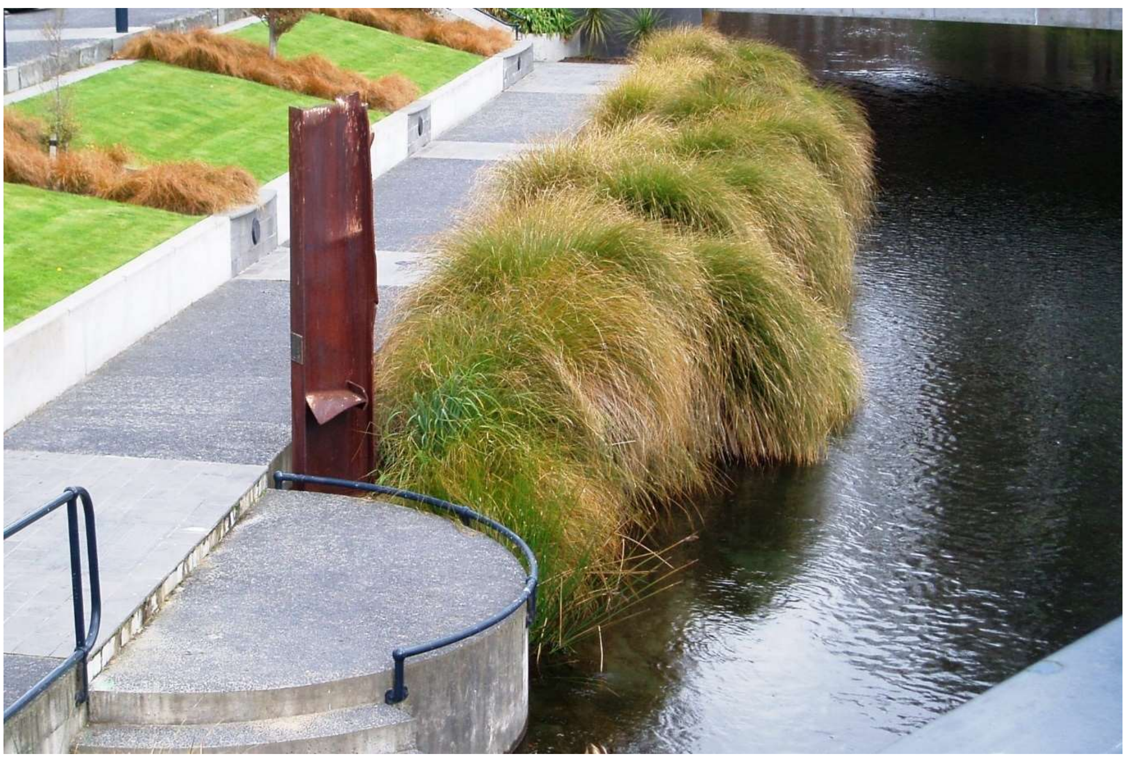


Formal terraces can provide safe public access and accommodate seasonal variability of level without unreasonably exacerbating maintenance requirements

Dense vegetation can allow for steep banks that accommodate a range of sustained water levels



Dense vegetation can allow for steep banks that accommodate a range of sustained water levels

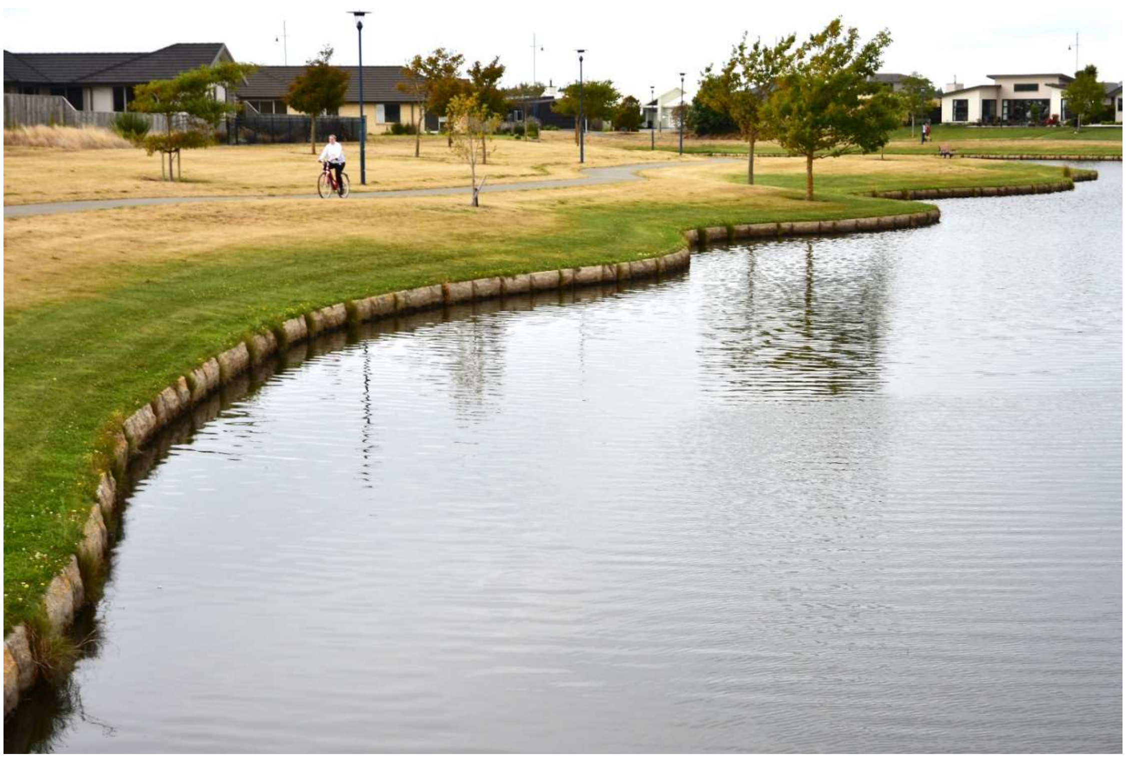


A mix of structural walls and vegetated faces can facilitate public access over a range of water levels

A highly urban structural approach to bringing properties close to the water edge, and accommodating a range of water levels

Boulders and planting can provide an urban/natural mixed margin that accommodates water level variability

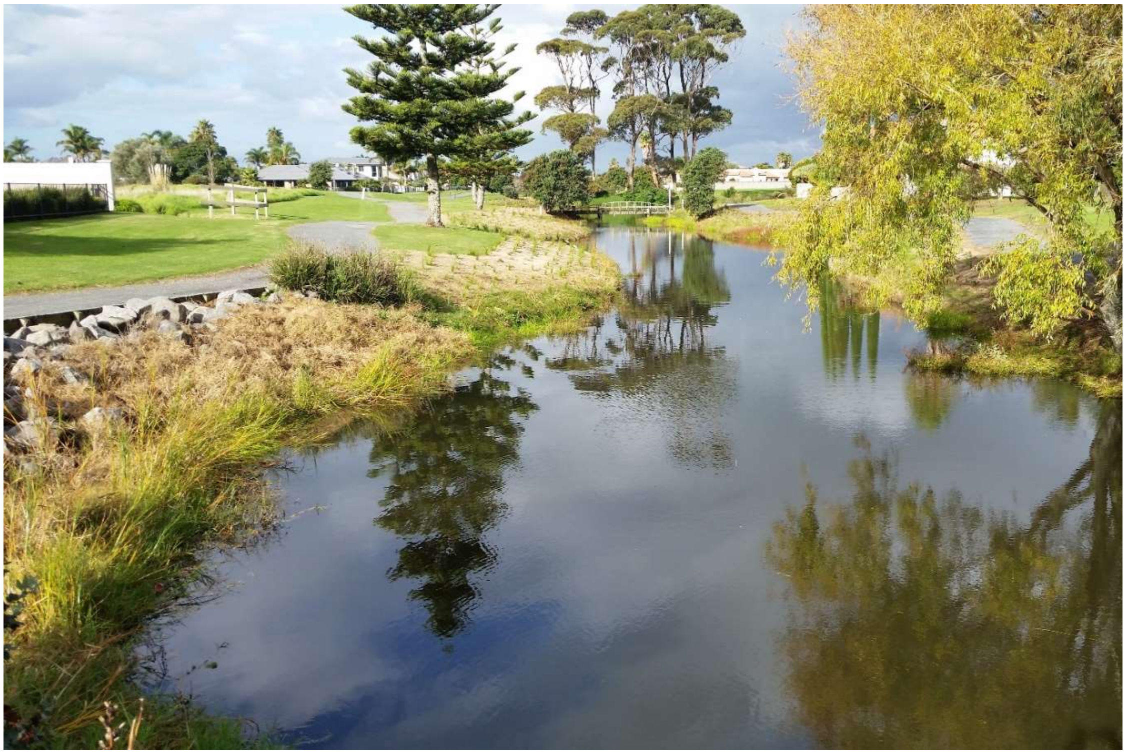
Boulders and planting can provide an urban/natural mixed margin that accommodates water level variability



This wall approach could be adjusted to a larger water level range, or incorporated into a terrace/vegetated margin

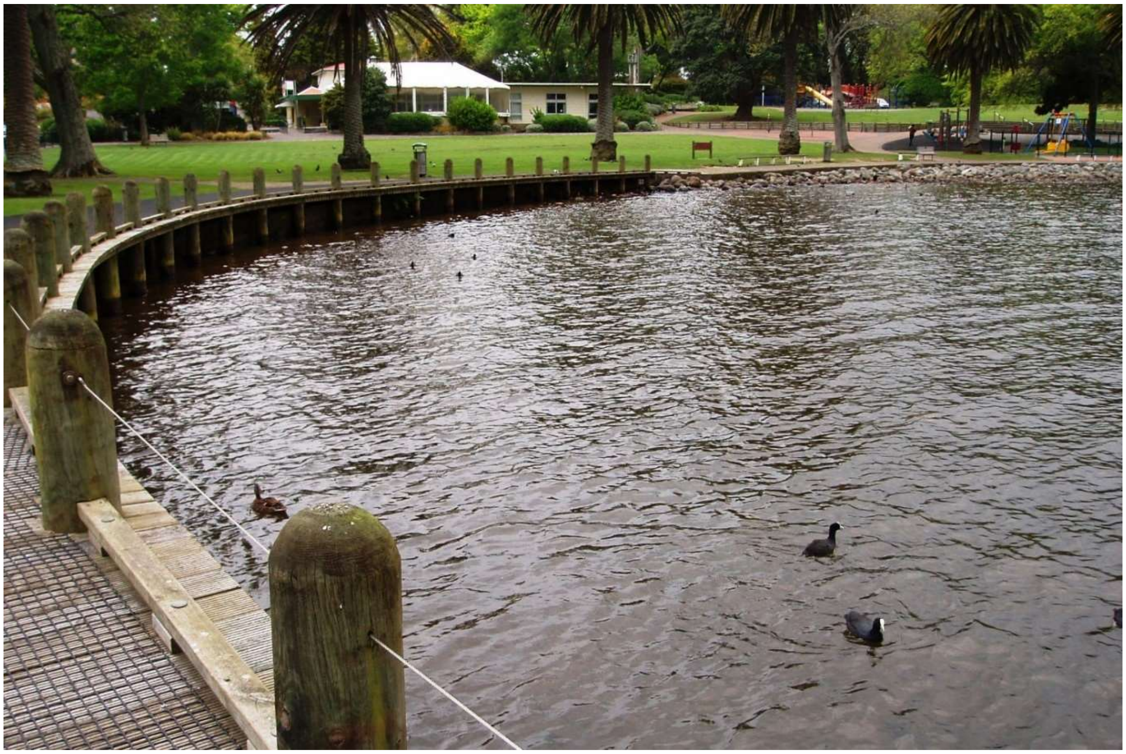
A strongly urban mix of structural walls, walkways and natural margins

A strongly urban mix of structural walls, walkways and natural margins



Upper Papamoa catchment. With suitable plant selection and steep margins this can accommodate sustained variations in water level.

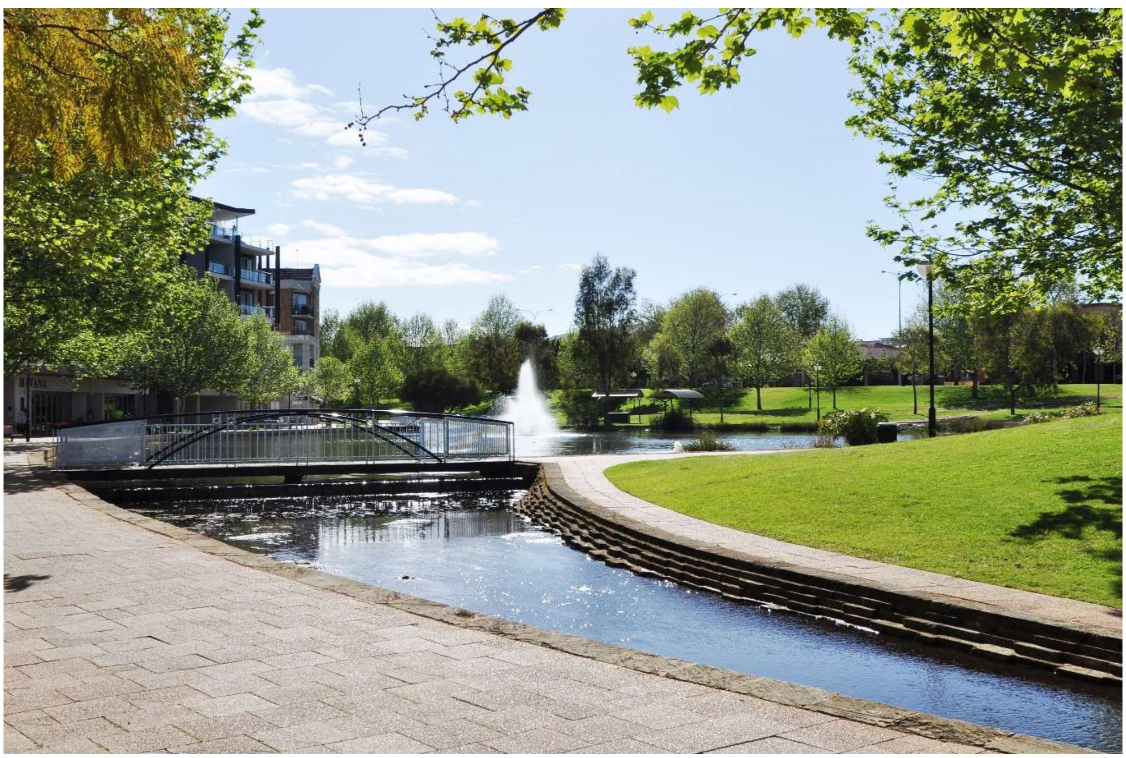
These grassed margins in Papamoa catchment would not manage sustained water level variability well, but a viewing platform like this could be designed to provide proximity to water in a Te Tumu context



An urban context solution with a wall and adjacent walkway to provide proximity to the water

A possible approach to Wairakei Stream, if plant selection tolerates sustained water level variability

Urban (tidal basin) development that could be adaptable to Te Tumu context



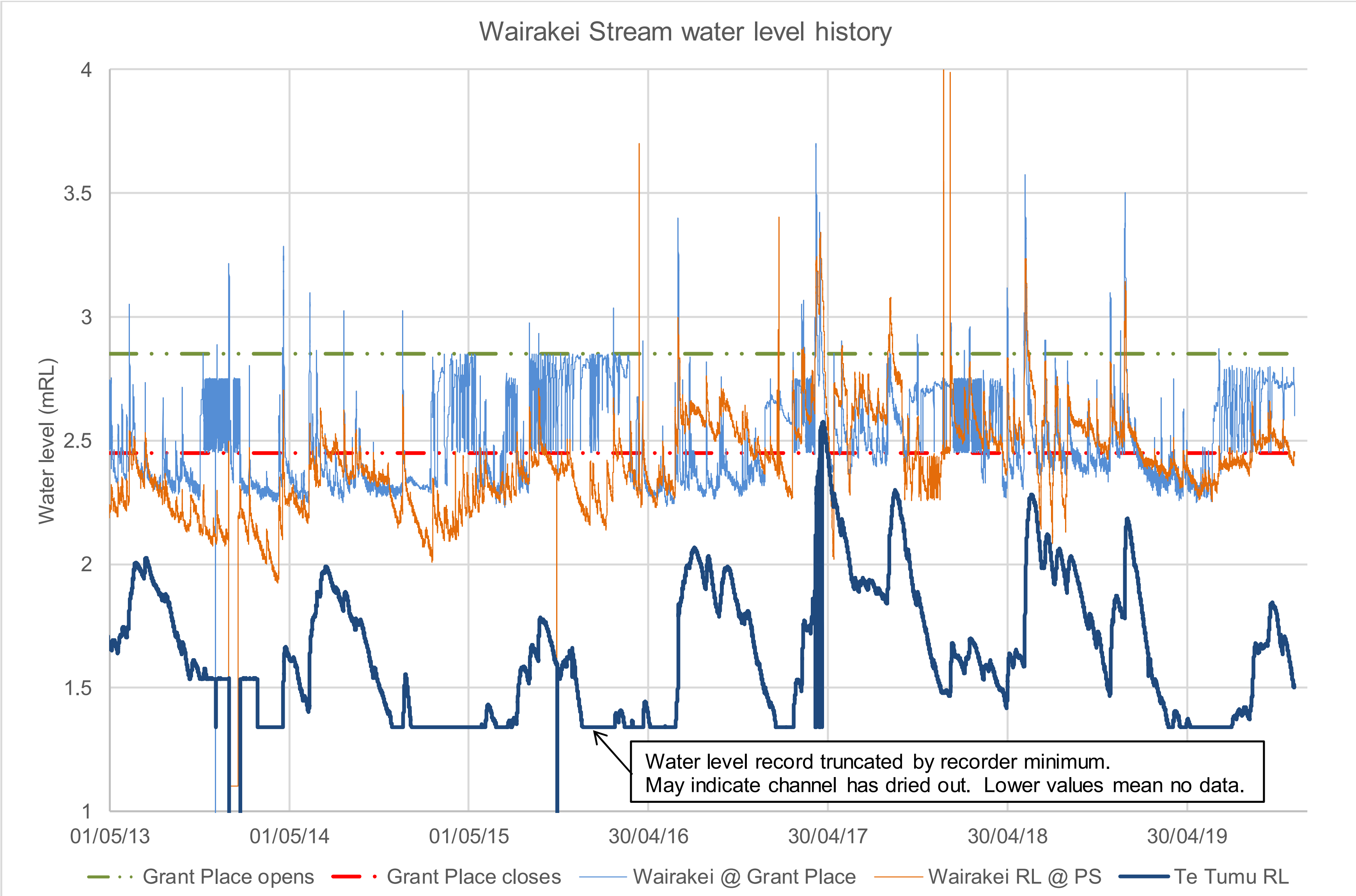
Stepped urban margin that would accommodate sustained water level variability

C

Appendix C – Historical water levels

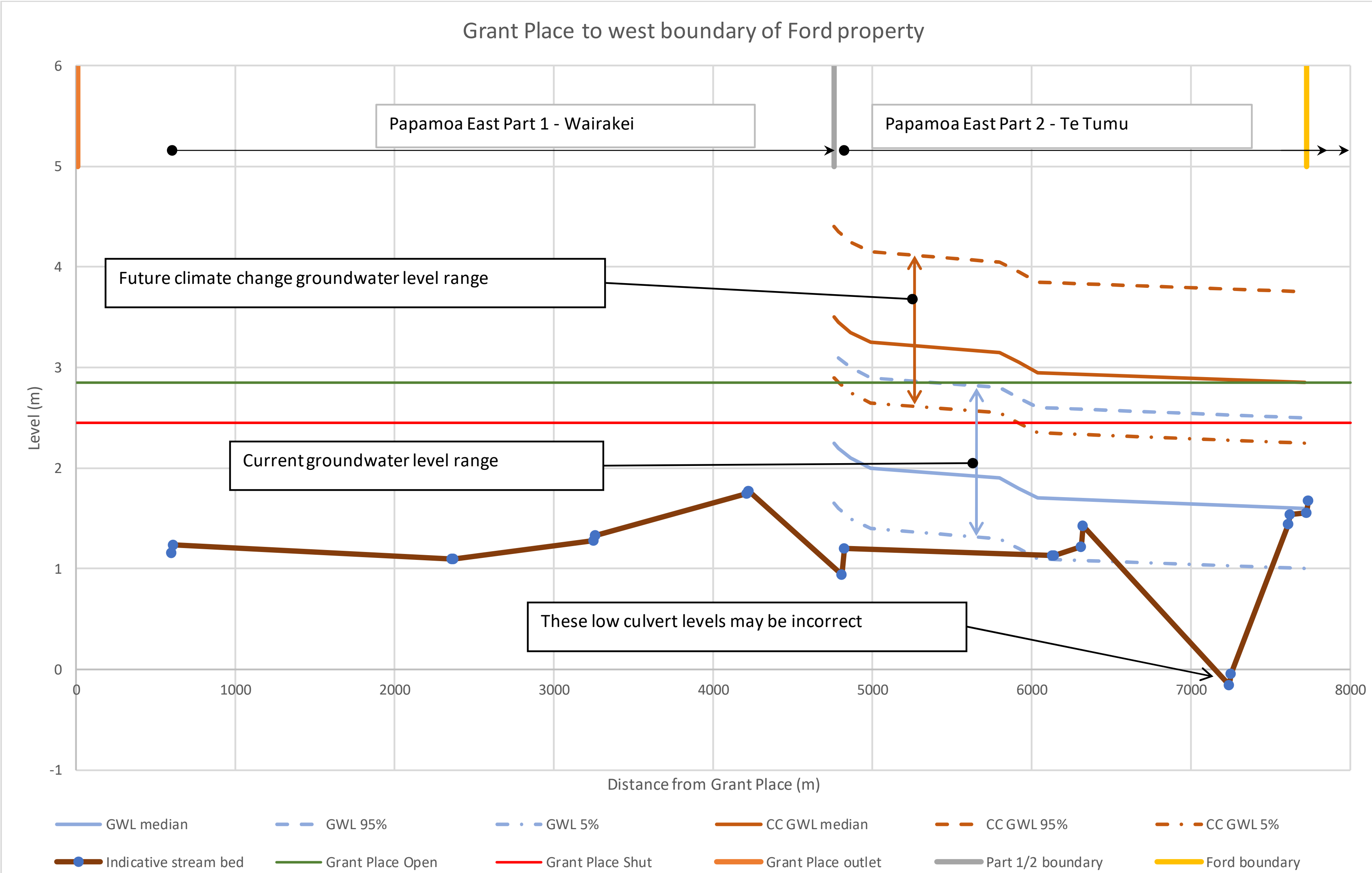

Wairakei Stream water level history - 2017 storm event
Water level (mRL)
Rainfall depth (mm - hourly data)
4
3.5
3
2.5
2
1.5
1
0
10
20
30
40
50
60
70
80
90
100
19/02/17
21/03/17
20/04/17
20/05/17
19/06/17
19/07/17
18/08/17
Grant Place water level cycling due to gate opening and closing
Te Tumu water level recession initially enhanced by Grant Place gate opening, and operation of Wairakei PS, but much slower than at other recorders
Water level at Wairakei / Te Tumu boundary drawn down by Wairakei PS operation - rebounds when pump turned off
Wairakei PS operating - not plotted to scale
Te Tumu water level recession lasts for 2 months following major storm event
Grant Place opens
Grant Place closes
Wairakei @ Grant Place
Wairakei RL @ PS
Te Tumu RL
Wairakei PS operating
Harry Close rain

Beca


Wairakei Stream water level history
Water level (mRL)
4
3.5
3
2.5
2
1.5
1
01/05/13
01/05/14
01/05/15
30/04/16
30/04/17
30/04/18
30/04/19
Water level record truncated by recorder minimum.
May indicate channel has dried out. Lower values mean no data.
Grant Place opens
Grant Place closes
Wairakei @ Grant Place
Wairakei RL @ PS
Te Tumu RL

D

Appendix D – Wairakei Stream profile



Grant Place to west boundary of Ford property
Papamoa East Part 1 - Wairakei
Papamoa East Part 2 - Te Tumu
Future climate change groundwater level range
Current groundwater level range
These low culvert levels may be incorrect
Level (m)
6
5
4
3
2
1
0
-1
0
1000
2000
3000
4000
5000
6000
7000
8000
Distance from Grant Place (m)
GWL median
GWL 95%
GWL 5%
CC GWL median
CC GWL 95%
CC GWL 5%
Indicative stream bed
Grant Place Open
Grant Place Shut
Grant Place outlet
Part 1/2 boundary
Ford boundary

E

Appendix E – Basin volumes

The table below sets out the relative sizes of basins and storage provided in the Wairakei Stream catchment, and that needed, as a possible optimised outcome for stormwater management.

	Application of "40% rule" in Te Tumu					Kaituna overflow frequency to contain 7yr ARI storm		
		Direct application of CSC rule		Simplified method in CMP				
Landowner / property	**Proposed basins in plan CA-001**	**Required Te Tumu storage**	**Compliance balance**	**Required Te Tumu storage**	**Compliance balance**	**Required storage for Te Tumu**	**Proposed basins in plan CA-001**	**Comments**
		m^3	**m^3**	**m^3**	**m^3**	**m^3**	**m^3**	
TTK14	46,479	97,515	- 51,037	100,850	- 54,371	253,599	36,022	Deficit primarily due to absence of middle catchment basin
TCC/WBoPDC – TFP JV interests	293,165	73,603	219,562	73,349	219,816	180,892	223,782	Significant surplus due to sand removal in the vicinity of the Wairakei Stream
FLH	121,659	86,644	35,015	91,947	29,711	228,154	94,973	Basins could be optimised
TTK8B1	22,943	17,582	5,360	18,299	4,644	45,274	17,267	Basin could be optimised
TTK7B1 & TTK7B2	5,025	3,016	2,219	2,885	2,140	8,475	3,396	Basin could be optimised
TCC	55,102	3,929	51,173	3,680	51,422	6,588	39,902	Significant surplus due to storage in high level overflow channel
TTK11B2	-	1,342	- 1,342	1,375	- 1,375	3,145	-	Storage could be added in each development, or traded with a site with surplus
R Love	-	566	- 566	582	- 582	1,279	-	
G Hickson	-	566	- 566	580	- 580	1,281	-	
TOTALS	**544,371**	**284,762**	**259,818**	**293,546**	**250,825**	**728,687**	**415,342**	
Consistency with flood model								
Provided in mitigation basins	544,371						415,342	
Existing Wairakei Stream & back arm	667,776						479,574	
TOTAL provided	**1,212,147**						**894,916**	
Required (Aurecon model 2017)	1,207,000						803,000	

Notes:

1. The storage volumes are in accordance with the footprints in Beca drawing CA-001. The 7 year containment column is storage up to 3.95 mRL, while in the "40% Rule" column is up to 4.4 mRL.
2. The two calculation methods reflect slightly different approaches to characterising the required volume. The direct method calculates the pre and post runoff volumes and takes 40% of the difference. The CMP method applies a formula based solely on developed impervious area. Of note is that the SP will provide sufficient storage to meet either method. Final volumes assessment will require specific design of each subdivision.
3. The calculations show that there is adequate storage to meet the 7 year ARI frequency of spill to the Kaituna, with some margin for optimisation at a detailed design stage.

F

Appendix F – Implementation steps

Key Steps and Expectations for Staged Implementation of the

Te Tumu Stormwater Management Strategy.

Master planning of each land block

(Non-RMA, Relationship Agreement)

To be prepared prior to any development of a landholding. Aim to demonstrate overall concept and ability to comply with the development principles and stormwater management concepts and principles. Oversight/approval of masterplans by TCC, in accordance with Te Tumu Consent Process Map

Concepts Establishment

- Identify areas of ecological, landscape, natural features and landscapes, and archaeological and heritage sites, and natural hazard susceptibility and how these are to be managed/retained/protected.
- Identify areas to be used for flood storage, and demonstrate that volumes to be provided will comply with the CSC storage mitigation requirements and CMP[1] [2].
- Develop overall landform concept and identify catchment boundaries, flowpaths, and any interaction with neighbouring developments.
- Identify road corridors and concept design for water quality treatment and secondary flow conveyance.
- Set levels of road corridors and building platforms to achieve required protection from natural hazards and stormwater management.
- Identify the proposed stages of development and the required sequencing to align development with stormwater management, landscape plan and infrastructure funding agreements.[3]

[1]Note: This storage may be provided within the block to be master planned, or confirmation provided that this is to be provided within another master planned area of Te Tumu, with infrastructure funding agreements (or other mechanisms) outlining how process, timing and staging of works will be undertaken to provide compliance with CSC.

[2] Gives effect to condition 5.3 "*developments…provide storage equal to 40% of the difference in volume between the 1 in 100 year (1%AEP) 48 hour rainfall event runoff….*" and condition 5.6 *"the consent holder shall require that for all new urban developments… flood storage areas sufficient to meet the requirements of 5.3 above are provided for"*

[3] Note: Sequencing may be dependent on implementation outside the masterplan area, such as provision of the Kaituna overflow, flood mitigation storage being provided in another development, connections made through a neighbouring development etc.

Subdivision/Landuse Consent

(or equivalent for leased land)

To be prepared prior to any development of a stage as outlined in the master plan. Aim to demonstrate preliminary design and the ability to deliver the development to comply with CSC and TCC infrastructure requirements. For review and approval by TCC as part of consenting process.

Preliminary Design

- Present design layout of parcels, road corridors, primary and secondary stormwater conveyance infrastructure, water quality treatment features *(e.g. rain gardens and swales),* areas of landscape and cultural management plan implementation.[4]
- Identify land to be vested (note: always TCC preference) or otherwise preserved for the required stormwater function *(e.g. overland flowpaths, water quality treatment areas).*
- Demonstrate compliance with infrastructure design standards *(for example pipe design and capacity; location, capacity and safety (i.e DxV) of secondary flowpaths; green infrastructure design).*[5]
- Set levels of road corridors and building platforms to achieve required protection from natural hazards.
- Demonstrate the feasibility of required infiltration and soakage through site testing, and consideration of any earthworks/compaction and space constraints as part of the proposed stage development.[6]

Development Works Approval

To be prepared prior to construction with the aim to certify the detailed design

Detailed Design

- Verify design is consistent with stage approval and meets infrastructure codes and standards.
- Confirm appropriate supervision and testing is in place to ensure quality of the works.
- Confirm pre-requisite infrastructure required prior to commencement of any development works is constructed and operational *(e.g. the Kaituna overflow, sufficient volume mitigation exists to cover the construction of roads and other impervious areas as part of the land development).*[7]
- Provide confirmation other approvals are in place to commence works e.g. archaeological authorities, Regional Council consents etc.

[4] Gives effect to condition 9.9 *"The consent holder shall commence implementation of The Stage 2 Wairakei Stream Corridor Landscape Plan such implementation being commensurate with each subsequent stage of development adjacent to the Wairakei Stream"* and condition 13.1 *"the use of Low Impact Design solutions as a preferred option to stormwater management where this is practicable etc."*

[5] Gives effect to condition 6.4 *"the consent holder shall ensure that stormwater ponds grassed swales and wetlands are designed, constructed, operated and maintained in a manner consistent with the Papamoa CSC CMP and subsequent approved revisions"* CMP must therefore refer to design guidance docs (and their subsequent revisions).

[6] Gives effect to condition 13.1, seeking to confirm at this stage the "where practicable" requirement *"the use of ground soakage as a preferred option for the disposal of stormwater from roofs of buildings where this is practicable. Groundwater soakage shall be required for residential buildings (where practicable) and encouraged for commercial buildings."*

[7] Gives effect to condition 2.4 *"The consent holder shall ensure that the selected high level discharge from the Wairakei Stream to the Kaituna river is constructed and operational at the earliest of either: the commencement of development as a result of urban rezoning within the Northern Catchment of Part 2…"*

Certification

Final sign off/asbuilts/224 etc.

To be approved prior to vesting of assets, survey plan approval and habitation of property. Aim to verify that the construction is consistent with approved works and of sufficient quality to comply with CSC , CMP and associated standards. For approval by TCC.

- Confirm sufficient flood storage volume for future lot development of the stage has been provided to comply with CSC and CMP[8] *(i.e. sufficient mitigation storage must be in place to enable full build out of the approved stage).*
- Confirm all pre-requisites are in place for the building code compliance processing of the stage *(e.g. downstream stormwater network in place, connections made through adjacent developments etc.)*
- Confirm quality and as-builts of constructed infrastructure.[9]
- Confirm buildings platform levels comply with any conditions set.
- Confirm all consent conditions are satisfied *(i.e landscape plan implementation staging).*Verification soakage/infiltration post works is in line with design assumptions *(otherwise additional works may be required to manage surface water).*

House Build

Building Consents

To ensure development of individual buildings is consistent with the previously approved masterplan and stage plans, thereby giving effect to the CSC and CMP.

- Demonstrate that soakage to ground complies with code and is consistent with any conditions for the stage (i.e. verify giving effect to CSC condition directing use of soakage for residential buildings).[10]
- Demonstrate building floor level complies with consent requirements.

[8] Gives effect to condition 5.3 "*developments…provide storage equal to t40% of the difference in volume between the 1 in 100 year (1%AEP) 48 hour rainfall event runoff….*"and condition 5.6 *"the consent holder shall require that for all new urban developments… flood storage areas sufficient to meet the requirements of 5.3 above are provided for."*

[9] Gives effect to condition 6.4 *"the consent holder shall ensure that stormwater ponds grassed swales and wetlands are designed, constructed, operated and maintained in a manner consistent with the Papamoa CSC CMP and subsequent approved revisions."*

[10] Gives effect to condition 13.1 *"the use of ground soakage as a preferred option for the disposal of stormwater from roofs of buildings where this is practicable. Groundwater soakage shall be required for residential buildings (where practicable) and encouraged for commercial buildings."*

G

Appendix G – Cost estimates

High Level Cost Estimate - Te Tumu Stormwater- October 2020	**Basin Form**	**Unit**	**Qty**	**Rate**	**Amount**
Wetlands					
Rates to include: Wetpond/wetland/drypond - Stripping topsoil, Cut to fill bulk earthworks, reinstate of topsoil layer and planting - assume wetland grasses/reeds at 0.5m spacing Hardedged - as per wetland except 50%, 50% rockriprap/concrete edging and planting. Excludes ground improvements Excludes overflow channel					
Wairakei Stream Catchment					
TK14 - Between Wairakei and back arm	**Flood Storage Basin**	**m^3**	**50,000**	**$ 19.43**	**$ 971,708**
TCC/WBOPDC - TFP JV interests - alongside Wairakei and back arm	**Flood Storage Basin**	**m^3**	**200,000**	**$ 19.32**	**$ 3,863,416**
FLH - northern basin	**Flood Storage Basin - mixed soft and hard edging**	**m^3**	**40,000**	**$ 20.96**	**$ 838,500**
TK8B1 - between Wairakei and back arm	**Flood Storage Basin**	**m^3**	**16,000**	**$ 19.55**	**$ 312,795**
TK7B1 & TK7B2 - basin	**Treatment/storage wetland**	**m^3**	**5,000**	**$ 19.42**	**$ 97,121**
TCC/WBoPDC – TFP JV interests - Treatment ponds	**Treatment/storage wetland**	**m^3**	**15,000**	**$ 19.58**	**$ 293,674**
TCC/WBoPDC – TFP JV interests - Pond connection to channel	**Flood storage basin / conveyance**	**m^3**	**96,000**	**$ 19.36**	**$ 1,858,295**
FLH	**Flood Storage Basin - mixed soft and hard edging**	**m^3**	**117,000**	**$ 20.91**	**$ 2,446,074**
TTK8B1	**Treatment/storage wetland**	**m^3**	**11,000**	**$ 19.74**	**$ 217,146**
Riverside Catchment					
TK14	**Treatment wetland**	**m^3**	**4,630**	**$ 19.44**	**$ 90,011**
TCC/WBoPDC – TFP JV interests	**Treatment wetland**	**m^3**	**4,710**	**$ 19.44**	**$ 91,549**
FLH - Wetland 1	**Treatment wetland**	**m^3**	**2,100**	**$ 19.65**	**$ 41,275**
FLH - Wetland 2	**Treatment wetland**	**m^3**	**2,070**	**$ 19.66**	**$ 40,695**
Hawridge wetland	**Treatment wetland**	**m^3**	**1,900**	**$ 19.69**	**$ 37,408**
Subtotal					$ 11,199,668
Crossings					
Rates to include: Supply and installation of culverts. Allow for 250mm thick compacted GAP65 base. All culverts 18m long (4 lane road crossing)	**Culvert sizing**	**Unit**	**Qty**	**Rate**	**Amount**
Culvert crossing					
Western Crossing (main arm)	**18m x 4m x 2.5m box culvert**	**No.**	**3**	**$ 148,031**	**$ 444,092**
TK14 (main arm)	**18m x 4m x 2.5m box culvert**	**No.**	**4**	**$ 146,535**	**$ 586,138**
TK14 (back arm)	**18m x 3m x 2m box culvert**	**No.**	**1**	**$ 136,976**	**$ 136,976**
FLH - Wairakei crossing	**18m x 4m x 2.5m box culvert**	**No.**	**3**	**$ 151,697**	**$ 455,092**
TCC/WBoPDC – TFP JV interests - Elizabeth Wetland / overflow	**18m x 4m x 2m box culvert**	**No.**	**3**	**$ 143,297**	**$ 429,892**
FLH - link arm	**18m x 4m x 2m box culvert**	**No.**	**3**	**$ 143,297**	**$ 429,892**
Subtotal					$ 2,482,082
TOTAL PHYSICAL WORKS - SUBTOTAL					**$ 13,681,750**
Allowance for Preliminaries and General		LS	1.00	10%	$ 1,368,175
Allowance for Margins		LS	1.00	10%	$ 1,504,993
Allowance for Professional Fees		LS	1.00	12%	$ 1,986,590
Allowance for Land purchase costs		LS	1.00	Excluded	$ -
Allowance for Construction Contingencies		LS	1.00	30%	$ 5,562,452
SUBTOTAL					**$ 24,103,960**
Inflation to 2025 (3% Annual) - Accumulated from 2018 to 2025		LS	1.00	3% p.a.	$ 5,540,870
Rounding		LS	1.00		$ 5,169
TOTAL					**$ 29,650,000**
This is a High Level Cost Estimate that has been prepared from conceptual information. Further design, investigation and safety reviews are required to confirm the project scope and corresponding budget. Accordingly this estimate has a probability accuracy range that is within +/-30%					