ROTOKAURI NORTH

Green Seed Consultants Limited

Sub-Catchment Integrated Catchment Management Plan

September 2021

DOCUMENT CONTROL RECORD

PROJECT:	Rotokauri North Private Plan Change – Sub-Catchment ICMP
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CONTENTS:

Acronym Table:

Acronym	Definition
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
B6Z	Business 6 Zone
BPOs	Best Practicable Options
DSI	Detailed Site Investigation
FUZ	Future Urban Zone
FWI	Far Western Interceptor
GSCL	Green Seed Consultants Ltd
HAIL	Hazardous Activities and Industries List
HCC	Hamilton City Council
HCDP	Hamilton City District Plan
ICMP	Rotokauri North Sub-Catchment Integrated Catchment Management Plan
LASS	Waikato Local Area Shared Services
LOS	Level of Service
MDRZ	Medium Density Residential Zone
Morphum	Morphum Environmental Ltd
NPS-FM	National Policy Statement for Freshwater Management
OLFP	Overland Flowpath
PPC	Private Plan Change
PSI	Preliminary Site Investigation
RITS	Regional Infrastructure Technical Standards
RMA	Resource Management Act 1991
RNSP	Rotokauri North Structure Plan
Rotokauri ICMP	Rotokauri Integrated Catchment Management Plan
RPS	Waikato Regional Policy Statement
Settlement Act	Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010
SH39	State Highway 39
SNA	Significant Natural Area
THaWK	Te Haa o te whenua o Kirikiriroa
WDC	Waikato District Council
WRC	Waikato Regional Council
WRP	Waikato Regional Plan
WRPS	Waikato Regional Policy Statement
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

This Sub-Catchment Integrated Catchment Management Plan ("ICMP") report has been prepared to support a request for a Private Plan Change ("PPC") to the Hamilton City District Plan ("HCDP"), by Green Seed Consultants Ltd ("GSCL") for an area of land identified as "Rotokauri North" in the north-west of Hamilton City.

Rotokauri North comprises approximately 140ha of land proposed to be zoned for urban activities, specifically;

- 137.6 hectares is proposed as a Medium Density Residential zone ("MDRZ");
- 1.2 Hectares is proposed as a Business 6 zone (Neighbourhood) ("B6Z");
- 0.5 hectares will retain its current zone as a Significant Natural Area ("SNA"), i.e. no change from the operative provisions.

Based on the PPC area, the development could yield approximately 2,000 houses.

The majority (approximately 133 ha) of the area, falls within land holdings falling under the GSCL umbrella.

This ICMP also includes 63.5 hectares of Rotokauri land which will retain its Future Urban zoning ("FUZ"), but as that land falls within the catchment subject to this application, it has been included within this ICMP.

1.1 Sub-Catchment ICMP Scope and Area

The land, to which this ICMP relates, is located in an area south of Te Kowhai Road (State Highway 39 "SH39") and east of Exelby Road to the northwest of Hamilton City, as shown in Figure 2 below.

This document is a "sub-catchment" ICMP focused specifically on the Rotokauri North area. Although a very small part of the catchment extends beyond the HCC territorial boundary, this IMCP only covers land within the HCC territorial boundary (technical assessments have covered the catchments as a whole).

As development at Rotokauri North has been anticipated and envisaged for some time, the land was included in the adopted Rotokauri Integrated Catchment Management Plan ("Rotokauri ICMP"), which covers the Rotokauri Structure Plan area identified in Chapter 3 of the HCDP (approximately 196 hectares) and within the Mangaheka ICMP (approximately 15 hectares identified as area "G" within the Mangaheka ICMP).

The Rotokauri North area, therefore, constitutes a "sub-catchment" within the wider Rotokauri Catchment, and as such, this document is prepared a "Sub-Catchment ICMP" to be read as part of the Rotokauri ICMP and the Mangaheka ICMP.

1.2 Other Supporting Documents

This ICMP is supported by the following technical reports which are provided as attachments to this report:

(a) Rotokauri North Catchment Stormwater Modelling Report prepared by Aecom [October 2018 DRAFT]

(b) Flood Impact Assessment prepared by Opus [February 2019]

(c) Rotokauri North Development Area: Technical review of stream classifications prepared by Tonkin & Taylor Ltd, dated 7 December 2018.

(d) Receiving Environment and Rapid Erosion Assessment Rotokauri North Sub-Catchment prepared by Morphum Environmental Ltd November 2018 DRAFT ("Morphum")

(e) Rotokauri North SHA: Archaeological Assessment prepared by CFH Heritage dated 3 December 2018

(f) Rotokauri North SHA Geotechnical Assessment Report prepared by HDGeo dated 25 October 2018

(g) Rotokauri North SHA – Response to HCC Peer Review prepared by HDGeo dated 27 February 2019

(h) Rotokauri North Preliminary Site Investigation by HDGeo dated 11 July 2018

(i) Rotokauri North ICMP: Desktop Review of Hydrogeological Conditions Influencing Stormwater Design prepared by Beca dated 17 July 2018 DRAFT

(j) Rotokauri North Sub-Catchment ICMP Water and Wastewater System Report by BBO dated 18 June 2021

(k) Rotokauri North Sub-Catchment ICMP Stormwater System Report by BBO dated 18 June 2021

This ICMP is also supported by the following technical reports (which are not provided as attachments to this report but can be provided upon request).

(l) Rotokauri ICMP prepared by Hamilton City Council; and

(m) Mangaheka ICMP prepared by Beca

1.3 Purpose of the Sub-Catchment ICMP

The purpose of this sub-catchment ICMP is:

- To provide an integrated management approach based upon best practicable option(s) ("BPOs") to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater activities in the sub-catchment;
- To provide guidance on how water, wastewater and stormwater within the catchment will be managed in an integrated way and in accordance with proposed land uses that occur within the site;
- To ensure the effects of stormwater discharges are mitigated in accordance with the requirements of the Rotokauri and Mangaheka ICMP, discharge consents held/to be obtained and Waikato Regional Council ("WRC") guidance;
- To provide a platform for considering the implementation of water sensitive principles of (including but not limited to) reduction in demand for water, minimise wastewater generation, and minimise the need for three waters infrastructure where appropriate.
- Investigating how Level of Service ("LOS") and industry best practice can be met; and
- Investigating whether and how ICMP specific issues can be addressed.

This ICMP will be read in conjunction with the adopted Rotokauri ICMP document and Mangaheka ICMP document, and on-going decision making, and will be required for integrated management of the three waters infrastructure in the catchment and specific information to provide further detail and clarification to developing land within the ICMP's.

It is anticipated that this ICMP will undergo periodic review (including that required by a condition of a discharge consent) by GSCL (or its successor), to maintain relevance to national, regional, and local policy. It is also recognised that monitoring of possible changes within the sub-catchment will be required as the development progresses.

1.4 Key Infrastructure Projects

Roading

No new upgrades to the state highway network are required for the planned development (apart from intersections). New collector and minor arterial roads, identified in the Rotokauri North Structure Plan ("RNSP") will be progressively developed to support the transport network.

Wastewater

The Hamilton City Council ("HCC") Long-term Infrastructure Strategy 2015-2045 defines the future direction of the bulk wastewater network within the City. This document illustrates the Council's strategy to service Rotokauri through the development of a reticulated network, that will require transfer pump stations and reticulation infrastructure. It is acknowledged that the development proposed is occurring prior to the planned date for servicing the Rotokauri North area.

Water Supply

The HCC Long-term Infrastructure Strategy 2015-2045 defines the future direction of the bulk water supply network within the City. This document illustrates the Council's intention to accommodate future growth by extending the reticulated network into Rotokauri. It is acknowledged that the development proposed is occurring prior to the originally planned date for servicing the Rotokauri North area.

1.5 Outcomes

In addition to the Rotokauri and Mangaheka ICMP's this ICMP outcomes are to:

- Set best practicable integrated three water management options for stormwater, water and wastewater within the catchment that are environmentally, culturally, socially, and economically sustainable (particularly given the requirements for affordable housing in Rotokauri North).

- Identify potential constraints, demands for services and any infrastructure improvements necessary to accommodate growth, and to confirm that the available three waters infrastructure and infrastructure capacity can appropriately service the potential urban growth, development, and land use intensification within the catchment.

- Provide clear direction for the adoption of appropriate water-sensitive techniques to achieve water conservation, and minimise water demand, wastewater generation and stormwater runoff.

2.0 STRATEGIC CONTEXT

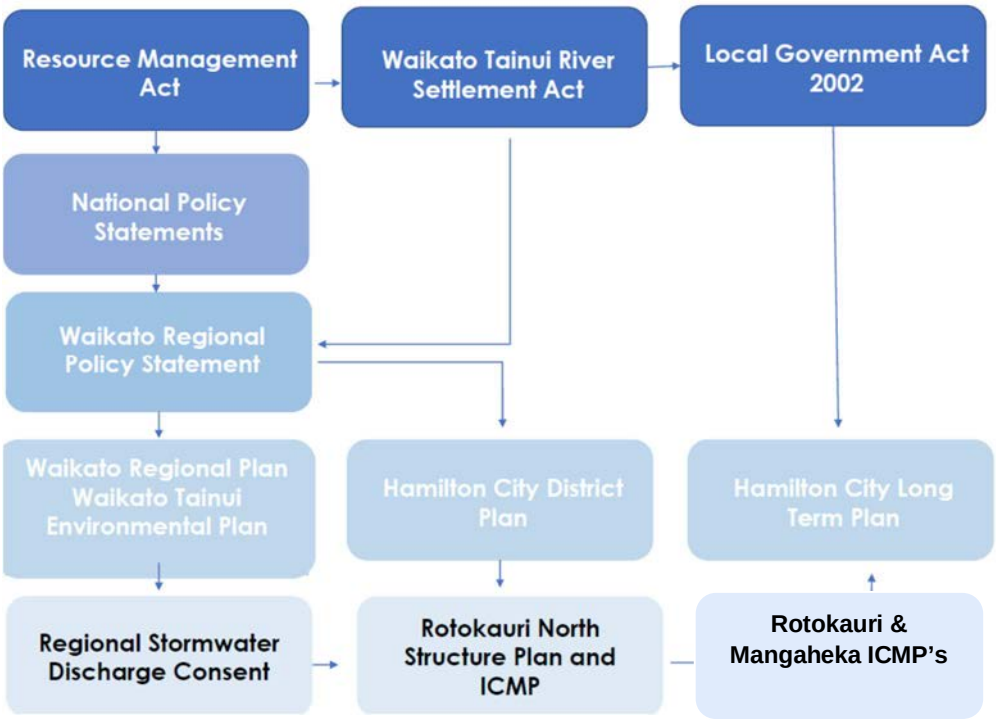
Development within the catchment is influenced by central and regional government policies, plans and resource consents, HCC policies and plans, and Waikato District Council ("WDC") policies and plans. Most policies and rules ultimately flow from the Waikato Regional Policy Statement ("RPS") which is given effect through planning documents such as District Plans and Regional Plans. The RPS also reflects iwi aspirations for the region and National Policy Statements.

The ICMP relies on current best practice stormwater management in the context of the existing strategic and legislative framework. Any changes to these external drivers must be considered during future reviews of the ICMP and Waikato Local Area Shared Services ("WLASS") Regional Infrastructure Technical Specifications ("RITS") to maintain alignment of objectives.

The key planning documents relevant to catchment management planning in the Waikato Region are discussed in this section. Their hierarchy is demonstrated in Figure 1. This sub-catchment falls within an area that has been anticipated for Hamilton's future urban growth.

This ICMP and its prescribed best practicable options ("BPOs") predominately focuses on mitigation of the adverse effects associated with the proposed land-use changes due to urban development. It includes best practicable options for water supply, wastewater and stormwater infrastructure, and management of receiving environments across the RNSP area.

Figure 1: Relationship of documents relevant to ICMP preparation



2.1 Legislation/Key Policy Documents

Development within Rotokauri North is influenced by central and regional government policies, plans and resource consents, HCC policies and plans (and in the lower catchment WDC policies and plans). Table 1 provides a list of the key source documents that provide policy direction and guidance for the management of three waters and have been taken into account in the preparation of this ICMP.

Table 1: Key Source Documents

Document	Outline/Summary
National Legislation:	
Resource Management Act 1991 ("RMA")	Specifically, Section 15 of the Act includes controls on the discharge of contaminants into the environment, including from stormwater, and states that no person may discharge any water into water or onto land unless the discharge is expressly allowed for in a national environmental standard, regional plan or resource consent.
Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010 ("Settlement Act")	A co-management agreement was signed between Waikato Raupatu River Trust (Waikato-Tainui) and WRC. The Act sets up Te Ture Whaimana o Te Awa, a Vision and Strategy relevant to all activities within its catchment with the purpose of "restoring and protecting the health and well-being of the Waikato River for future generations". The agreement clarifies a range of factors and acknowledges integrated catchment management requires coordination and collaboration between each Party's respective planning documents and implementation processes.
National Policy Statements:	
National Policy Statement for Freshwater Management 2020("NPS-FM")	The NPS-FM 2020 includes 15 policies, which direct Councils to limit and / or avoid further loss in the extent and values of freshwater systems, and prioritise the improvement of degraded systems while maintaining the health and well-being of all others. One of the key mechanisms for doing this is the setting of a series of "bottom lines" relating to a suite of parameters,
Regional Policy:	
Waikato Regional Policy Statement ("WRPS")	The WRPS provides an overview of the resource management issues of the region and the ways in which integrated management of the region's natural and physical resources will be achieved. It sets an overarching direction for the management and protection of Waikato's resources as well as objectives and policies for how these issues will be addressed.

Document	Outline/Summary
	The RPS recognises the Waikato River's Te Tura Whaimana o Te Awa as the primary document for management of the Waikato River and promotes catchment-based approaches to water quality and freshwater biodiversity. In 2016, the second generation of the WRPS became operative. It stipulates the importance of classifying waterways and assessing their ecological value to protect and restore the Waikato River and its tributaries. Any activities which could result in destabilisation of beds/banks of waterbodies, contaminant discharge, adverse effects on flora and fauna, loss of public access or adverse effect on any cultural association of Waikato-Tainui with the Waikato River must be controlled. The WRPS specifies the policy direction for the HCDP.
Waikato Regional Plan ("WRP")	The WRP contains issues, objectives, policies and rules, relating to the discharge of stormwater into water and the discharge of stormwater onto or into land. Water management is a key issue in the Waikato Region. The WRP includes requirements for efficient use of water, stormwater discharges and changes or disturbances to watercourses.
Sub Regional Three Waters Strategy	The vision of the strategy is to achieve the delivery of integrated, sustainable and well managed Three Waters services for the sub-region which ensures the cultural, social and economic needs of the community are met, and the quality of the Waikato River is improved.
Te Ture Whaimana o Te Awa o Waikato (Vision and Strategy for the Waikato River).	It is noted above that Te Ture Whaimana o Te Awa o Waikato (the Vision and Strategy for the Waikato River) has been included in full as part of the RPS. Te Ture Whaimana o Te Awa o Waikato sets out a vision whereby a healthy Waikato River sustains abundant life and prosperous communities who, in turn, are all responsible for restoring and protecting the health and wellbeing of the Waikato River, and all it embraces, for generations to come.
District Policy:	
Hamilton City District Plan	The HCDP became operative on 18 October 2017. It offers a framework for integrated resource management regarding the use, development or protection of land and associated natural and physical resources. The HCDP provisions include requirements for the preparation of integrated catchment management plans, sub-catchment integrated catchment management plans and water impact assessments.

Document	Outline/Summary
	There are also provisions which set standards such as water efficiency, surface permeability, and building coverage. Together with the RITS, the HCDP is a key tool for on-going management within the Rotokauri North sub-catchment.

In addition to the above, Table 2 provides a list of some of the key source/reference documents that have been reviewed during the development of this sub-catchment ICMP:

Table 2: Key Reference Documents

Document Title	Date/Version
Waikato River Authority Vision & Strategy	July 2011
National Policy Statement for Freshwater Management	August 2020
Sub-regional Three Waters Strategy	September 2012
Southern Growth Corridor Strategic Land-use and Infra SP	October 2015
HCC Long-term Infrastructure Strategy 2015-2045	2015
HCC Comprehensive Stormwater Discharge Consent (#105279)	June 2011
HCC Water Take Consent (#113941)	March 2009
HCC Wastewater Discharge Consent (#114674)	September 2007

2.2 Three Waters Master Planning, Integration and Hierarchy

The term "three waters" refers to the three key areas of strategic water management (including associated infrastructure) within the City – comprising water supply, wastewater and stormwater.

Three waters integration recognises that there is significant interaction between the three types of waters, surrounding natural water systems and land and that it is beneficial to consider their interconnectedness. To ensure protection of the environment and the ongoing availability of services to growth areas, they need to be managed in an integrated manner.

The HCDP adopts a best-practice hierarchy for three waters management based on principles for sustainable resource management, environmental protection and efficiency. In addition, the RITS and HCDP offer detailed information on the range of water sensitive techniques which are available for greenfield developments to minimise the impact of development.

The development and implementation of BPO's should have regard to and reflect the established hierarchy for the management of the three waters (as outlined in the RITS):

Minimise Demand (Water, wastewater) -> Reuse (stormwater) -> Treat & Dispose to Ground (stormwater) -> Treatment & Detention (stormwater) -> Reticulation (stormwater, wastewater)

The ideal stormwater management system for a developed site is one that replicates the undeveloped scenario. A range of water sensitive techniques are available to minimise the impact of development and enhance the environment.

2.3 Strategic Objectives

One of the purposes of ICMPs is for HCC to define and set objectives for its catchments.

Common strategic objectives have been set across all catchments within the HCC jurisdiction (refer to

Table 3 3). Strategic objectives for integrated catchment management planning have been developed by HCC to guide decision making.

Table 3: Strategic Objectives (applicable to all ICMP's)

Ref No	Strategic Objectives
SO1	Protect freshwater systems Maintain, protect and enhance freshwater ecosystems and natural drainage systems by safeguarding the life-supporting capacity, improving water quality where degraded and protecting significant values of wetlands and outstanding freshwater bodies.
SO2	Protect terrestrial systems Maintain, protect and enhance indigenous biodiversity values and functions for terrestrial ecosystems and protect significant habitat of indigenous fauna.
SO3	Kaitiakitanga Give effect to the relationship of tangata whenua as kaitiaki of receiving water bodies and including the relationship of Waikato-Tainui with the Waikato River.
SO4	Stormwater Management Stormwater management related to land use and development shall encourage and enable low impact design and incorporate best practicable mitigation measures to minimise actual and potential adverse effects on: • Receiving water bodies in terms of quantity and quality of stormwater discharges. • Locations and communities subject to flood hazards. • Natural groundwater levels. • Baseflows for freshwater systems.
SO5	Wastewater Management Wastewater management shall incorporate best practicable options and be managed so that: • Conveyed network volumes are minimised, (e.g. by demand management and management of stormwater infiltration) • Dry weather overflows are prevented, and wet weather overflows are minimised.

Ref No	Strategic Objectives
SO6	<u>Potable Water Management</u> Water supply is planned and provided for in a way that meets existing and future requirements to: • Provide firefighting water supply (flow and pressure) by conforming to the Code of Practice for Fire Fighting Water Supplies • Meet domestic, commercial and industrial water demand. • Ensure water consumption is managed to minimise peak and total demand.
SO7	<u>Three Waters Management</u> Three waters networks are planned, managed, and operated in an integrated manner to: • Meet existing and future development requirements whilst maintaining human and ecosystem health. • Meet design standards, consent conditions and regulatory levels of service. • Ensure assets, technology and resources have capacity, redundancy (n+1), knowledge and plans to prevent or cope with unplanned events. • Minimise the need for new infrastructure including by optimising the use of existing assets.

The following strategic objectives have been identified that are specific to this ICMP. As the area falls within both the Mangaheka and Rotokauri ICMPs the strategic objectives of both catchments are relevant and those below.

Table 4: Strategic Objectives applicable to this ICMP

Ref No	Strategic Objectives
Objectives across the whole ICMP area:	
CS1	<u>Alignment with the RNSP</u> Development and three waters infrastructure will be designed, constructed, operated, and maintained in general accordance with the overarching vision, objectives, policies, and guiding principles of the RNSP. In particular: • Manage stormwater in a manner that minimises the effects of development on downstream receiving waters. • Provide a 'green corridor' for stormwater drainage which connects the wider network of open spaces and natural features. • Ensure that new urban development is appropriately serviced. • Ensure that the LOS required for each sub-catchment is commensurate with that catchment and can be implemented in conjunction with the urbanisation of each sub-catchment.

Ref No	Strategic Objectives
CS2	<u>Flood protection and downstream LOS</u> The major stormwater drainage infrastructure will be designed, constructed, operated, and maintained to: • Meet cross jurisdictional flood protection LOS (HCC, WDC and WRC). • Align the sizing of flood storage and conveyance infrastructure requirements to that which is reasonably needed to service the development of the RNSP area (taking into account capital and ongoing operation and maintenance costs).
CS3	<u>Protecting water quality</u> Require the stormwater network to incorporate a treatment train approach which will be designed, constructed, operated, and maintained to improve water quality of onsite watercourses. This will: • Minimise temperature fluctuations in receiving waterbodies. • Maximise contaminant removal efficiencies at all times. • Be resilient to accidental or deliberate contaminant spills and discharges. • Meet or exceed the stormwater treatment requirements for the catchment, including a minimum of 75% total suspended solids removal, prior to discharge to the receiving environment.

2.4 Levels of Service

Levels of Service are documented in different levels of detail in various key documents. These currently include;

- Stormwater – management of 2, 10, and 100 year storm events (in accordance with land-use type);
- Wastewater - no additional overflows due to development (volume and frequency); and
- Water pressure – 20m of head at the boundary for residential pressure

Table 5 outlines documents to review for further levels of service and design standards information.

Table 5: LOS and Design Standards

Document Title	Date/Version
HCDP	October 2017
WLASS RITS	May 2018
HCC Three Water Management Practice Notes	September 2016
HCC 2015-2025 10 Year Plan	June 2015
WRC 2015-2025 Long Term Plan	June 2015
HCC Bylaws (including Water bylaw and Stormwater bylaw)	
HCC Water Master Plan	June 2015
HCC Wastewater Master Plan	June 2015

3.0 SUB CATCHMENT / SITE DESCRIPTION AND CONTEXT

3.1 The Site

The site is located at the northwest extent of Hamilton City and consists of a total area of approximately 203 hectares as shown in Figure 2 below. It is bounded by the Te Kowhai Road (SH39) to the north, greenfield lands to the east and south and Exelby Road to the west and south. Burbush Road runs north to south through the eastern portion of the site.

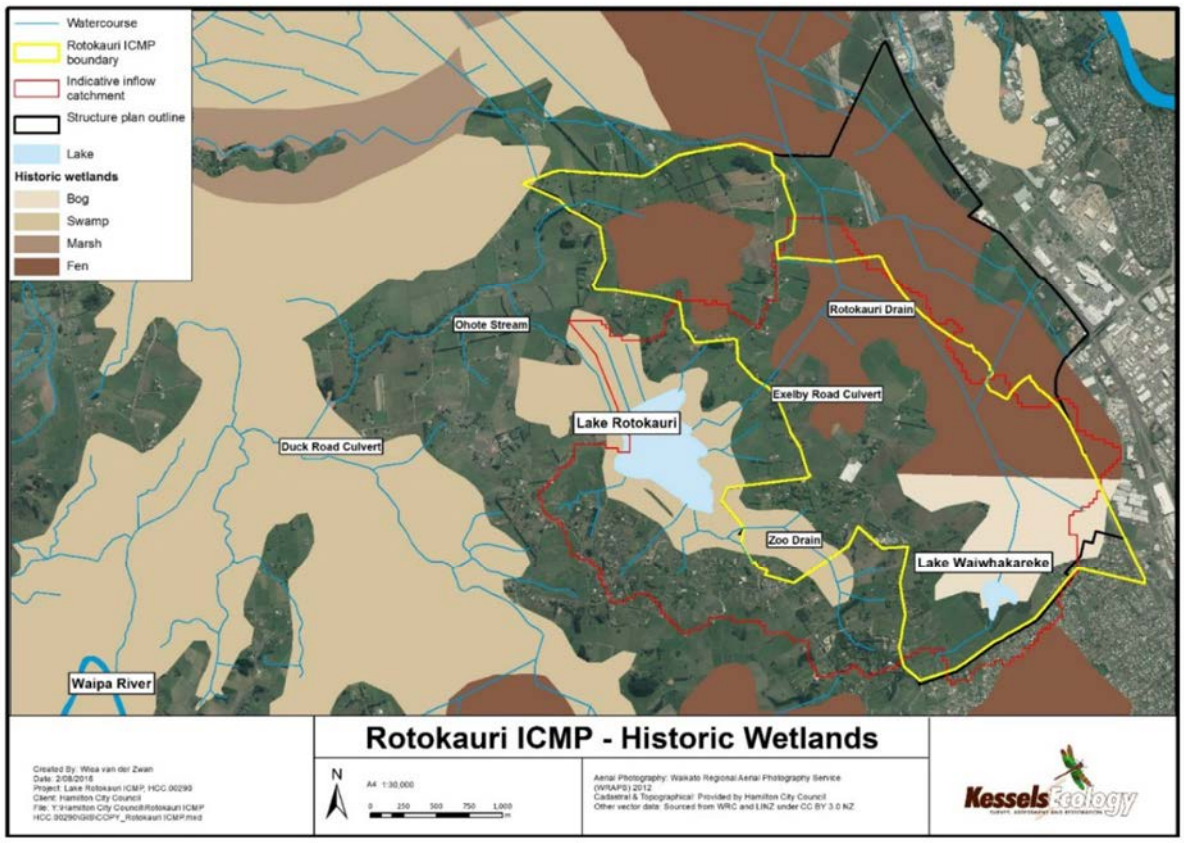
Figure 2 :ICMP area

3.2 Historic and Current Land Uses

Historically the site was partially covered by a wetland (fen) which, as identified in the archaeology section below, was drained to make way for agricultural land practises in the early 1900's. Figure 3 below is included in the Rotokauri ICMP (as Figure 2-2) and identifies the location of the fen / wetland.

The current land use is for agriculture, with some lifestyle dwellings. Historic uses of the site are associated with farming for livestock and dairying.

Figure 3: Historical fen / wetland



Vegetation on the site is mainly grazed pasture grasses and exotic tree species used for hedging and shelterbelts. Some native trees are present on the site but are generally located in amenity gardens surrounding dwellings. There is a significant existing stand of kahikatea in the north-eastern corner of the site, which is identified by the HCDP as an SNA.

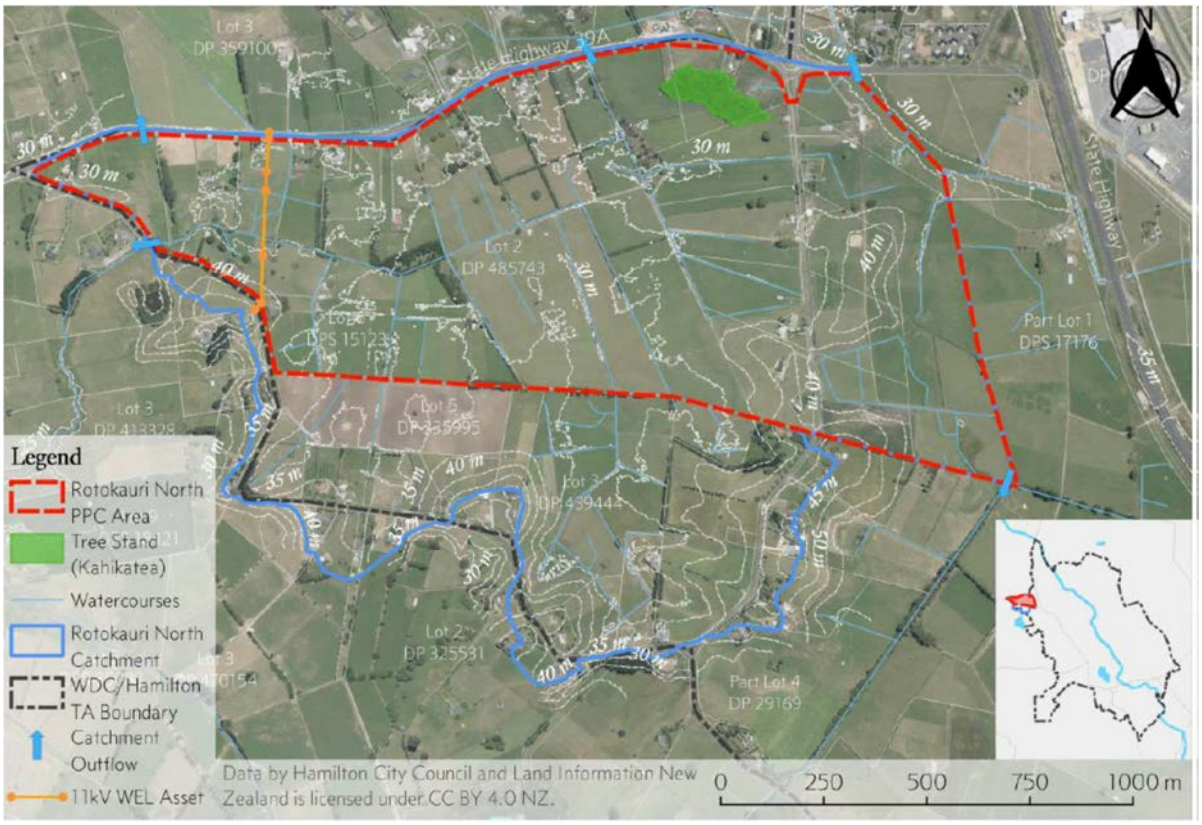
Proportionally across Rotokauri North, the land uses are as follows:

- 97.4% of land classified as exotic grassland,
- 1.6% classified as exotic forest, and
- the remaining 1.0% classified as indigenous forest as per the Land Cover Database (version 4.1).

3.3 Topography and Catchment boundaries

As identified in Figure 4 below, the majority of Rotokauri North is relatively flat, and generally at an elevation of 28-30m RL. There are some terraces along the southern and eastern edges of the development area which are up to 40m RL.

Figure 4: Topography map



The Rotokauri North area is within the catchments of the Ohote, Te Otamanui, Mangaheka and Rotokauri South stream networks.

The majority of the stormwater catchment discharge is via the Ohote catchment, which runs predominantly east-west through Rotokauri North and comprises approximately 138.8 hectares of land. The Ohote catchment ultimately discharges to the Waipa River approximately 6 kilometres downstream. The catchment drains through a culvert located at Exelby Road, which is also the eastern catchment boundary.

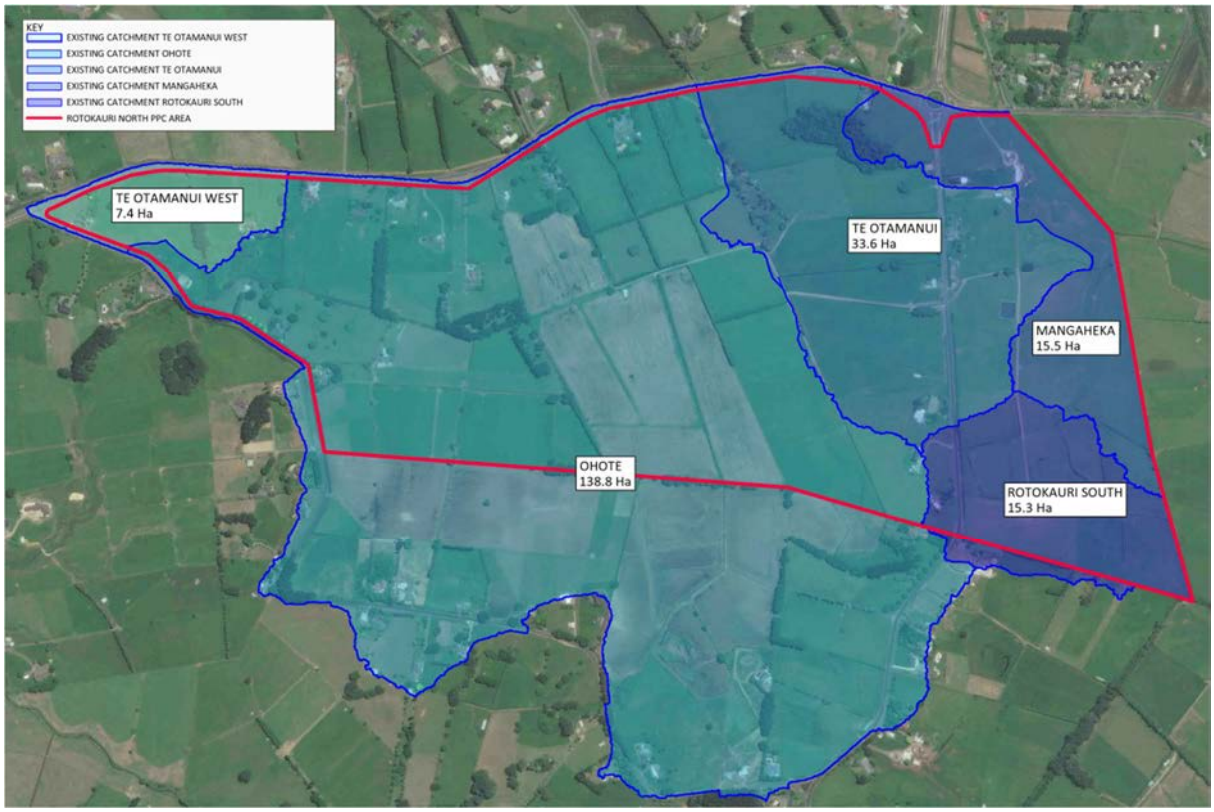
Te Otamanui catchment falls south of Te Kowhai Road within the HCC territorial boundary, with the northern portion of the catchment (outside of Rotokarui North area) within the WDC territorial boundary. Land within this catchment comprises approximately 41.0 hectares. Two culverts under Te Kowhai Road (SH39) convey flow from the south to north. One culvert services the western area (7.4 Ha) and the other the eastern area (33.6 Ha). Te Otamanui catchment discharges in a northwesterly direction to the Waipa River approximately 8 kilometres downstream.

The Mangaheka catchment flows from south to north, with the portion falling within Rotokauri North being 15.5 hectares located the upper portion of the catchment. The catchment eventually discharges to the Waipa River approximately 2.5 kilometres south of Ngaruawahia. This catchment has an approved Mangaheka Integrated Catchment Management Plan.

The portion of Rotokauri North within the upper reach of the Rotokauri South catchment comprises approximately 15.3 hectares. The catchment flows in a southwesterly direction to Rotokauri Lake approximately 1.5 kilometres away. The Rotokauri South catchment also has an approved Rotokauri Integrated Catchment Management Plan.

The majority of the land is currently used for farming, with minimal impervious areas.

Figure 5: Existing Catchments



3.4 Overland flowpaths and flooding

Figure 6 shows the main network of overland flow paths within the site. Classification of the modified and artificial watercourses is in accordance with Tonkin & Taylor stream classification report (2018). Figure 7 shows the existing flood extent and indicates that part of the site is subject to flooding.

Figure 6: Existing overland flows

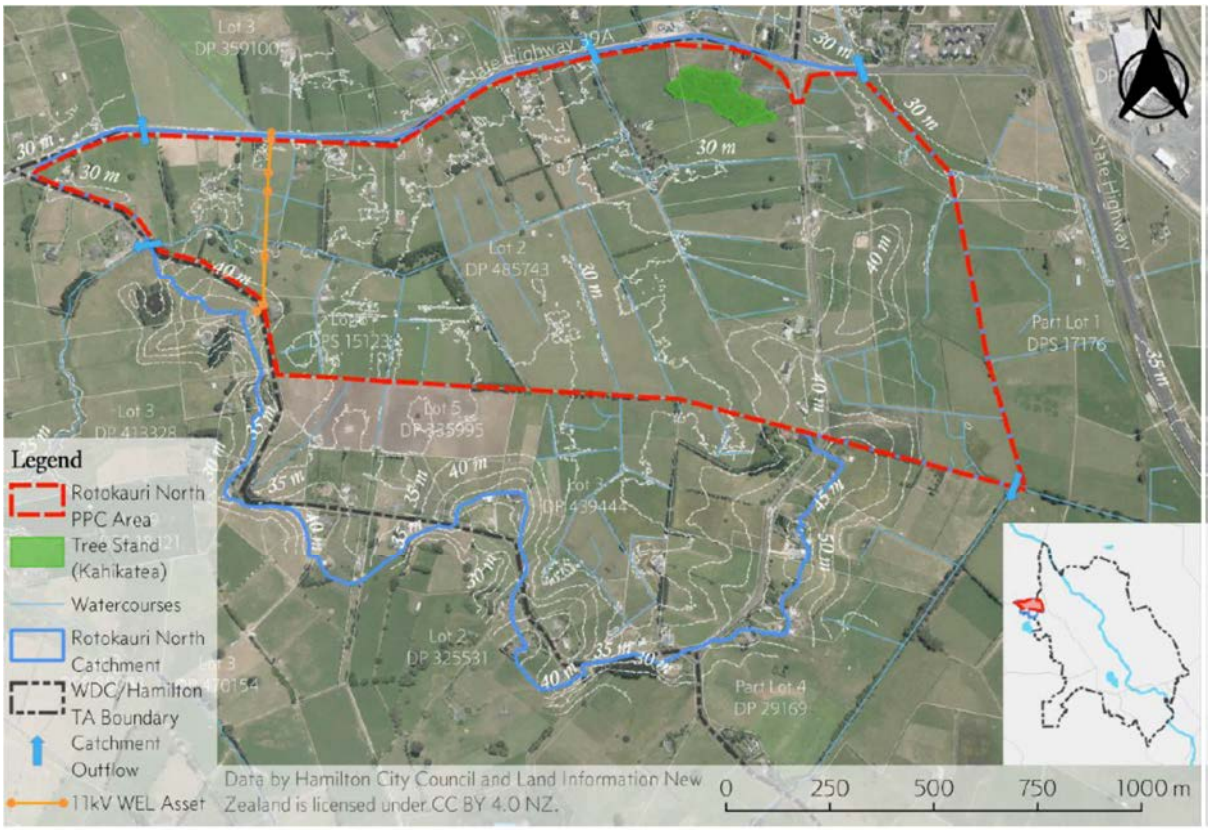
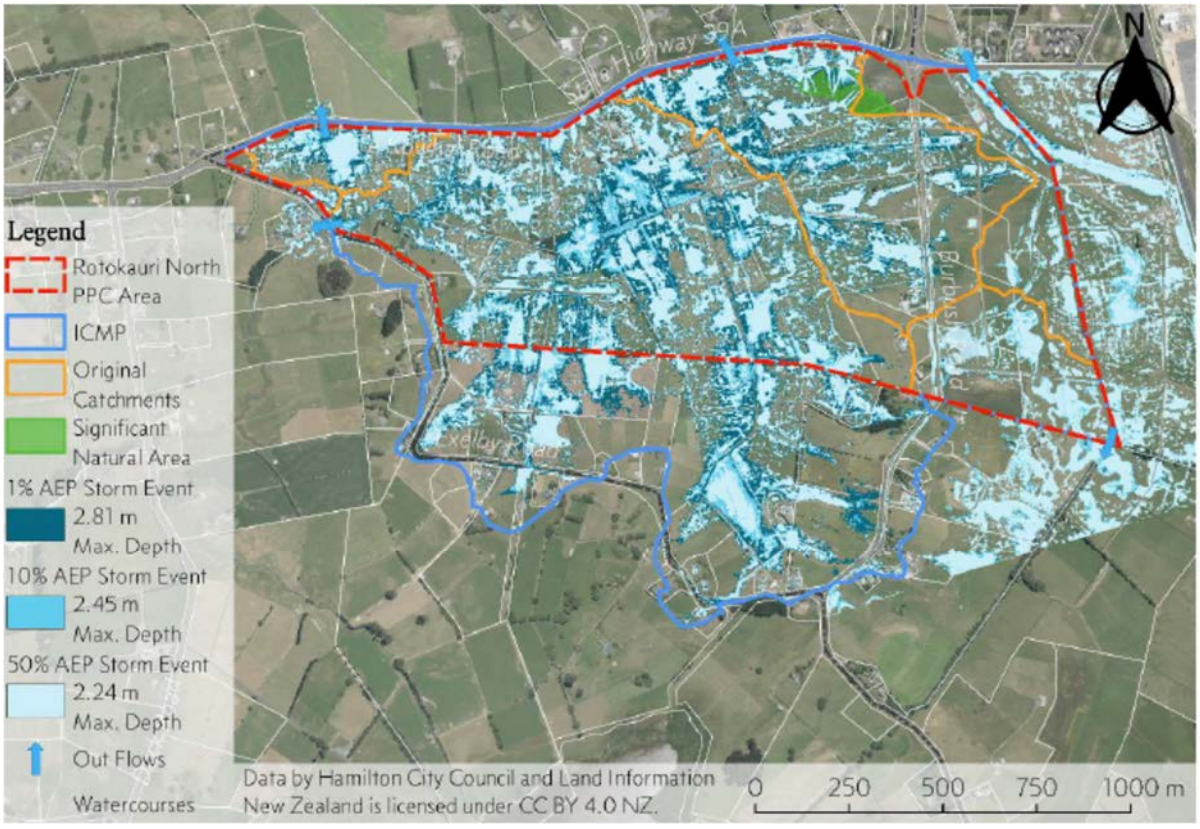


Figure 7: Flooding



3.5 Geology

The site is located approximately centrally within the broader Hamilton Basin which is characterized by low rolling hills (Hamilton Hills) and plains with low terraces and gullies draining into the Waikato and Waipa Rivers (Hamilton Lowlands) as described below (HDGeo, 2018):

- The Hamilton Hills are linear, sinuous hills and ridges that are remnant of an older erosion surface. They consist of alluvial material and non-welded ignimbrites (Walton Subgroup) and are typically overlain by a number of metres of airfall volcanic ash (Kauroa Ash and Hamilton Ash).

- The Hamilton Lowlands are a broad, low angle alluvial fan created by the Waikato River in the Late Quaternary. The fan materials are derived from rhyolitic eruptions in the central North Island and generally consist of late Pleistocene primary and secondary volcaniclastic sediments with a wide variety of grain sizes (Piako Subgroup and Hinuera Formation). Deposition of the fan materials ceased when the Waikato River entrenched into its current course approximately 17 ka and thin airfall tephra layers accumulated on the fan surface (Hinuera Surface).

The New Zealand Geological map (QMap) for the Waikato Region shows that local soils within Rotokauri North consist of the Walton Subgroup, the Hinuera Formation, and Piako Subgroup materials. The Walton Subgroup falls predominantly along the ridges west, south, and east of the Rotokauri North area and are described as Early Pleistocene to Middle Pleistocene alluvium dominated by primary and re-worked non-welded ignimbrite. The main basin within the Rotokauri North area consists of the Hinuera Formation and Piako Subgroup. The Hinuera Formation makes up the majority of the low- lying areas of the site, with small areas in the south and southeast of the site described as the Piako Subgroup. The Hinuera Formation is described as Late Pleistocene cross-bedded pumice sand, silt and gravel with interbedded peat. The Piako Subgroup is described as Late Pleistocene locally derived mud, silt, gravel and peat.

Site conditions encountered by HD Geo were typically consistent with the mapped geology.

The low-lying portions of the site contain sand and silty soils with a high groundwater table, which can be susceptible to liquefaction under earthquake-induced cyclic loading. Liquefaction of this magnitude is not uncommon in the Waikato, but it does have the potential to affect options for stormwater management. Specifically, chosen options must consider the potential for “lateral spreading”. Lateral spreading is a phenomenon were liquefied material allows the soil above to move horizontally towards a free face, such as a stream bank. HD Geo have indicated that the site currently has an isolated lateral spreading risk adjacent to the Mangaheka stream near Te Kowhai Road in the north-eastern corner of the site. As noted by HDGeo (2018) specific assessment of lateral spreading hazards will be required during detailed design. Potential mitigation options include:

- Dewatering of the adjacent ground so that liquefaction is unable to occur;

- Adoption of slope stabilisation methodologies;

- Buttress swale edges;

- Adoption of foundation designs that are tolerant to lateral spreading.

In response to Council's peer review of the HD Geo work a further response dated February 2019 also identifies mitigation utilised in the recently developed parts of Hamilton that also have a liquefaction hazard, which would be suitable for Rotokauri North. These include:

- Shallow ground improvement (to separate structures from liquefiable layers);
- Reinforced raft foundations (varying from simple ribraft to reinforced, resilient raft foundation piles to non-liquefying layers);
- De-watering to reduce the hazard (usually locally to a lateral spreading hazard);
- Setbacks or barrier piles in some locations where lateral spreading was considered to be a risk.

3.6 Soils

Landcare Research identifies the soils to be a mix of Land Use Capabilities (ranging from 1 in the flats adjacent to Te Kowhai Road to 4 towards the southern extent of the catchment).

Landcare Research identifies the site as having well-drained soils (along the ridges) and very poorly drained soils within the main basin (see Figure 8). The soil moisture regime ranges from moderate (along the ridges) to very high in the main basin (see Figure 9).

Figure 8: Soil Drainage

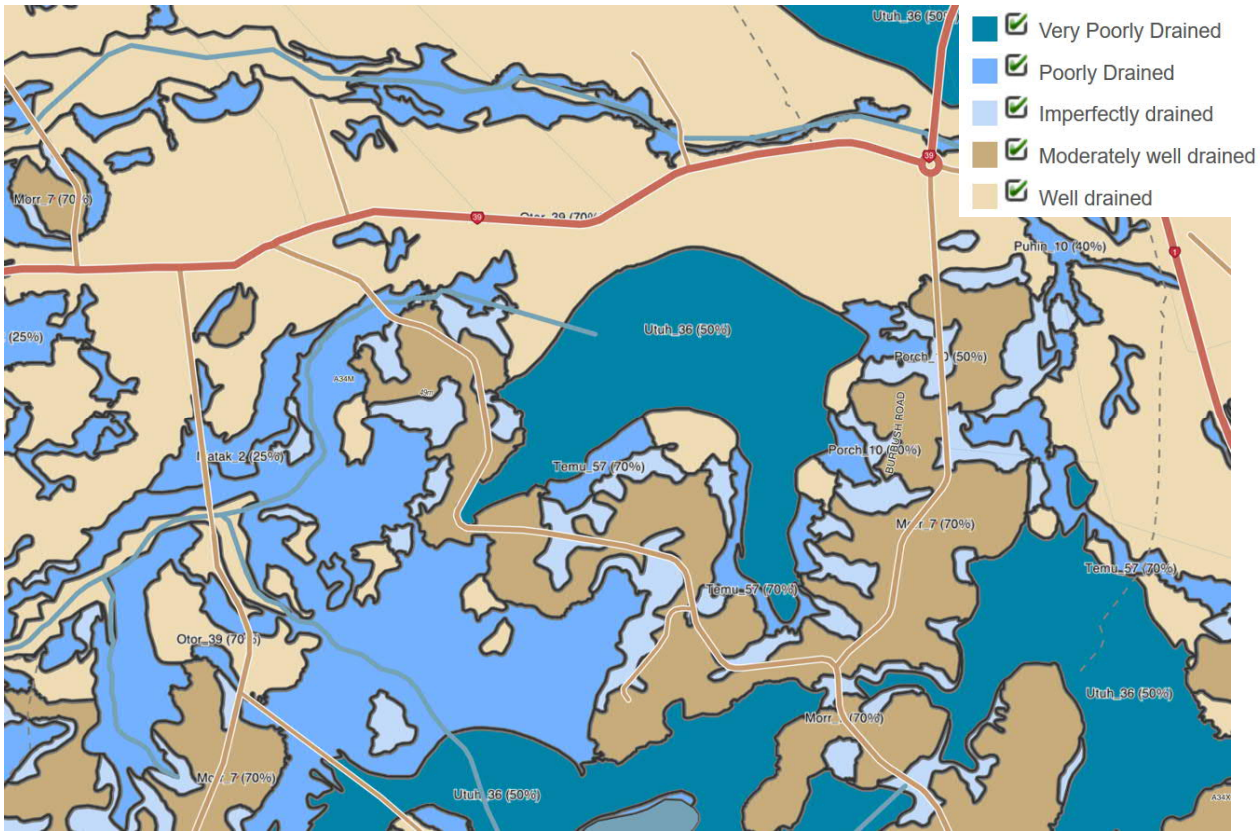
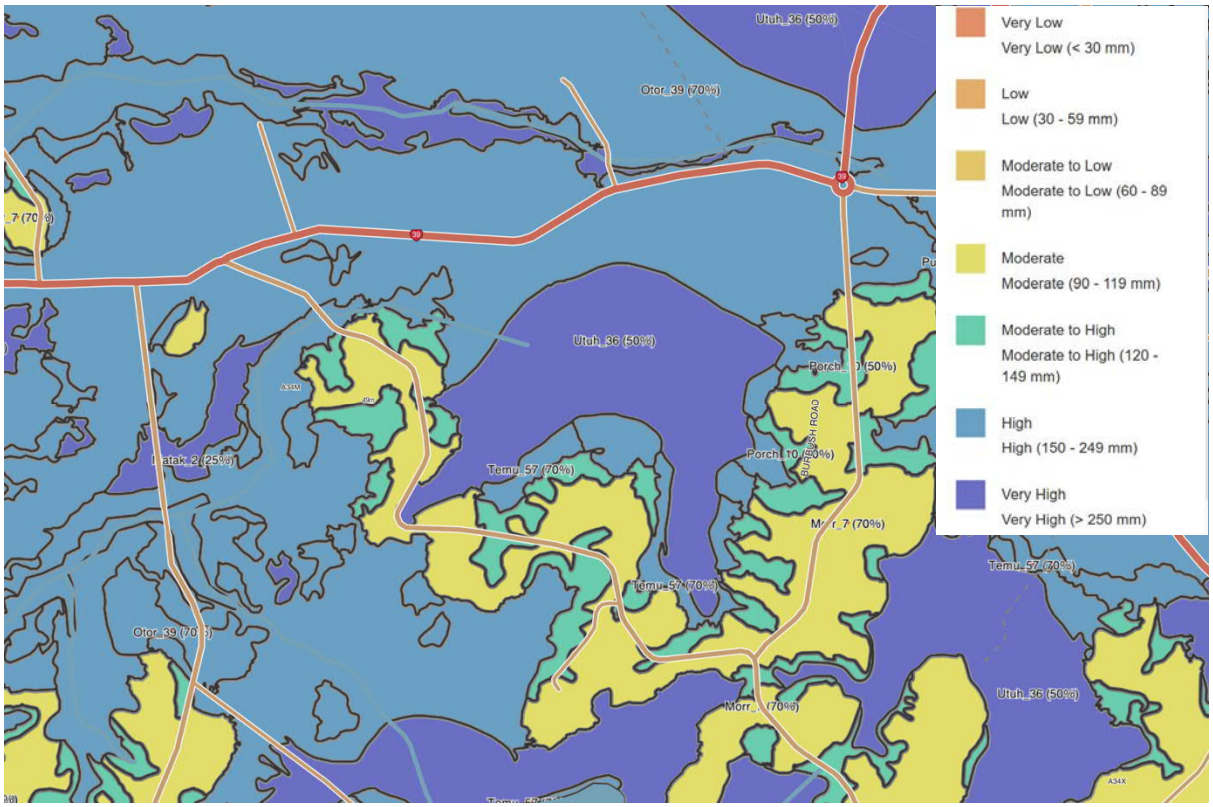


Figure 9: Soil Moisture



3.7 Hydrogeology

There are three significant surface water bodies within three kilometres of the Site:

- Lake Rotokauri, located approximately 1.3 km to the south from the southwestern-most extent of the Site;
- Horseshoe Lake, located approximately 2.5 km to the south/southeast from the south-eastern-most extent of the Site; and
- The Waikato River, located approximately 2.5 km from the eastern-most extent of the Site.

Surface water flows are expected to generally follow local topography, toward the east, north and west along drainage trenches through the site. The southeastern corner of the site drains towards Lake Rotokauri through a network of a stream tributaries feeding into Lake Rotokauri, and then into the Waipa River. The bulk of the catchment flows westwards along a network of farm drains into the Ohote stream and then into the Waipa River. The headwaters of Te Otamanui stream fall within the central northern portion of the site. And the Mangaheka stream flows along the eastern boundary of the site. Both Te Otamanui and Mangaheka catchments flow northwards out to the Rotokauri North site and then westwards to the Waipa River. However, groundwater is likely to be largely constrained from following the same routes by the hills to the east, west and south, and is likely to travel northeast towards the Waikato River Beca (2018).

A groundwater investigation was conducted at the site by HD Geo (2018), but monitoring of groundwater is ongoing. It revealed groundwater at a depth of approximately 0.1 to 2.5m (below ground surface) in the low-lying areas and approximately 6m in the elevated areas.

3.8 Contaminated Land

An assessment and site inspection were undertaken to identify potentially contaminated sites by HD Geo (2018). The findings are summarised in the Preliminary Site Investigation ("PSI") included in the PPC supporting documentation.

Hazardous Activities and Industries List ("HAIL") sites are identified as sites where any potentially hazardous activities listed on the HAIL have occurred (or is currently occurring) as a result of past or current land use. The area is considered a HAIL site due to the potential sources of contamination identified in the PSI from rural activities.

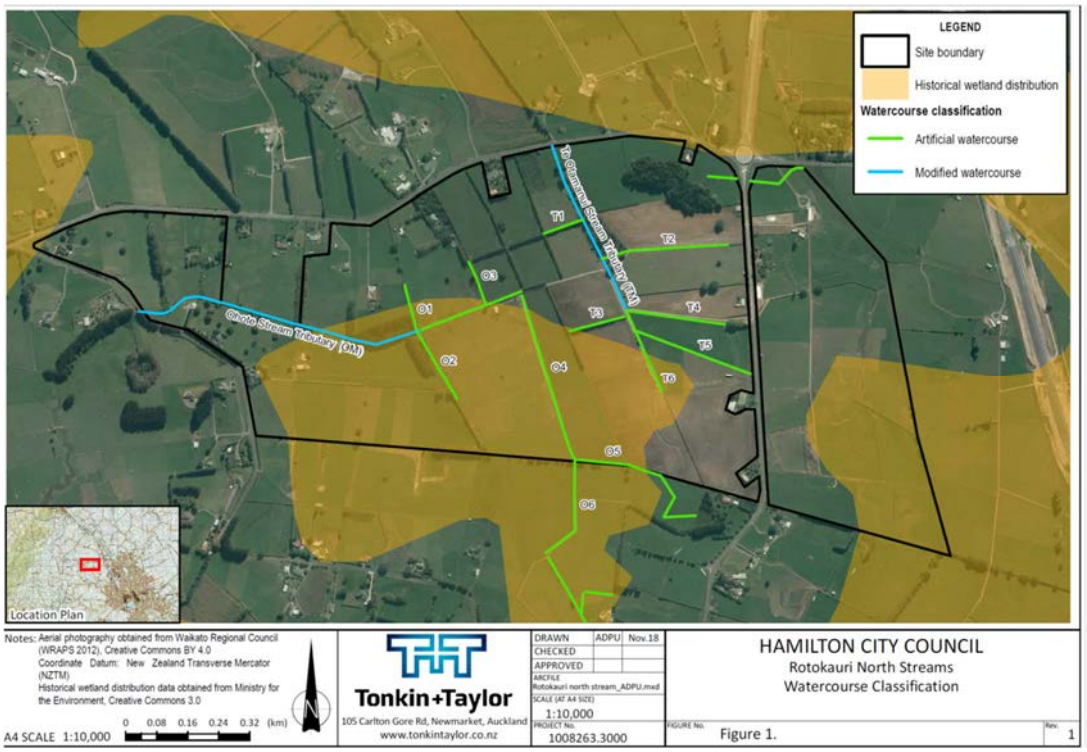
The PSI recommends that prior to the development of the site (i.e. earthworks or subdivision) where potentially contaminating land uses and/or activities have taken place, a Detailed Site Investigation ("DSI") is recommended. The DSI would confirm if the identified land uses and/or activities have affected the site soils and will confirm the consenting requirements for those areas of the site in respect to remediation.

3.9 Freshwater Environment

3.9.1 Stream Locations/Classifications

Tonkin & Taylor undertook an assessment to identify and classify (in accordance with WRP definitions) the watercourses located within the site. The majority of the watercourses present within the site are consistent with the WRP definition for an "artificial watercourse", and all watercourses have been mapped as per Figure 10 below.

Figure 10: Watercourse Classification

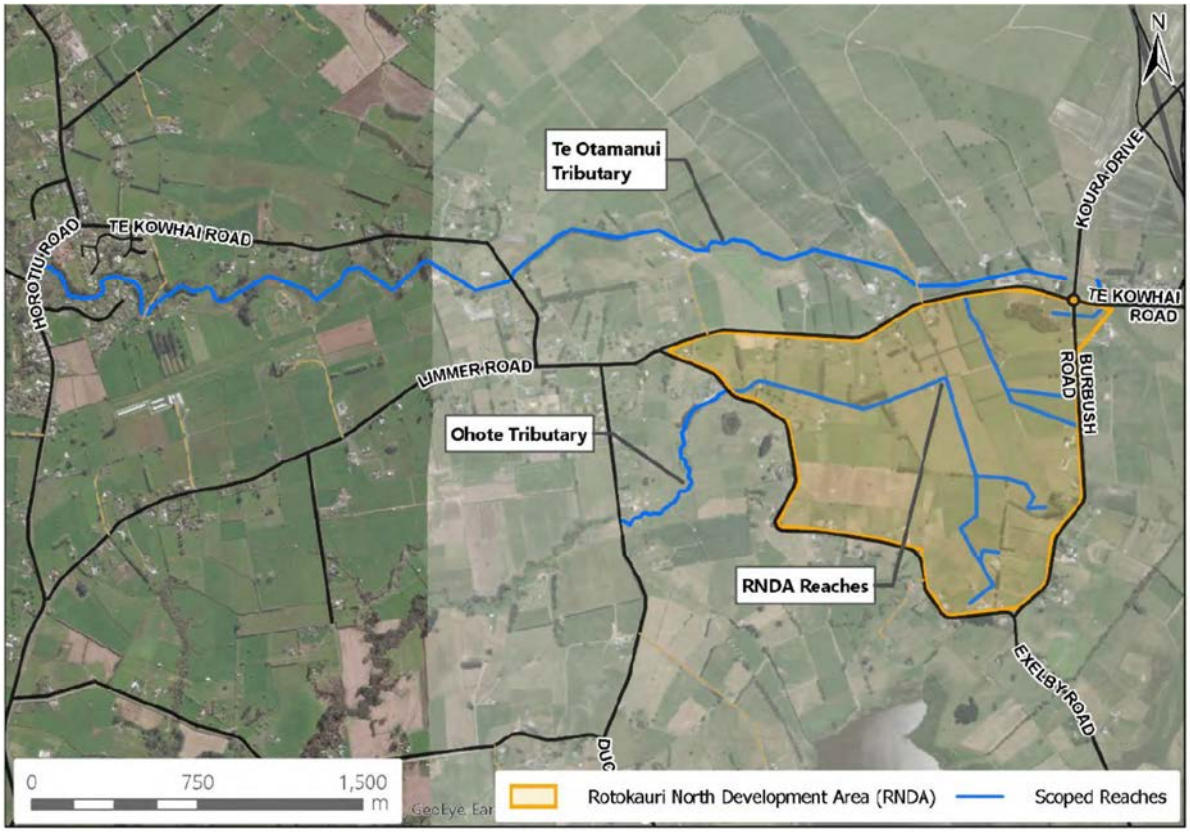


Mapping for wetlands meeting the NPS-FM 2020 is underway and can be confirmed at further design/subdivision stage.

3.9.2 Ohote and Te Otamanui Catchments

Morphum was engaged to undertake a watercourse ecology assessment of the Rotokauri North sub-catchment and its receiving environments of Te Otamanui Tributary and Ohote Stream, as shown in Figure 11.

Figure 11: Wider Tributaries



The watercourses in the sub-catchment and the receiving environments are soft-bottom streams and silt/sand are the dominant benthic substrate types. The flat topography of the area is reflected by the slow-flowing streams in the catchment.

The majority of the watercourses are located within agricultural pastoral land, with small areas of rural residential land use. These "agricultural streams" were found to have little to no native woody riparian vegetation and direct stock access to the stream channel is common with damage from stock, such as pugging of banks, evident along many reaches.

Generally, the watercourses show evidence of channel modification such as straightening, widening and deepening. Adjacent land use is dominated by agricultural, pastoral activities. Sparse vegetation consisting of gorse, barberry and poplar dominated these reaches. In the downstream reaches of Te Otamanui, mixed vegetation provides moderate shading to the stream channel.

Erosion scarring of stream banks is largely attributed to anthropogenic activities such as 'drain cleaning', stock damage and a lack of riparian vegetation. Bank benching, bank instability and fine sediment deposition can be largely attributed to stock damage rather than erosion

from high stormwater flows. In the downstream reaches of Te Otamanui, there is some evidence of fluvia erosion caused by larger flows through a constricted channel.

No "highly unstable" banks were identified. However, nine reaches (downstream of Rotokauri North in Te Otamanui catchment) in total were found to be "unstable". Erosion hotspots were also identified downstream of Rotokauri North.

Water Quality

Water quality results indicate poor water quality, with five measured parameters – including nitrogen and phosphorus exceeding the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (referred to hereafter by its industry reference as "ANZECC") trigger values. Sediment quality was indicative of agricultural land use, with high concentrations of arsenic at one site, but relatively low concentrations of heavy metals such as zinc and lead across the sampled sites. Specifically, the Morphum reporting found:

> Five parameters exceeded the ANZECC trigger values set for lowland rivers and streams (protection of 95% of species) and the 'satisfactory' levels set by Waikato Regional Council for river water quality in the region (WRC, 2012).
>
> Turbidity exceeded the guideline values at all five sites, and by a magnitude of five at TEOT2 (25 NTU). Turbidity indicates water clarity and studies have shown turbidity levels above 5 NTU have adverse effects on underwater light – and thus on plant and invertebrate production (Davies-Colley, 1991). Loss in water clarity also adversely impacts migration of common native freshwater fish species (Boubee et al., 1997). High sediment loads from the surrounding land use is contributing to high turbidity in the sub-catchment.
>
> Total nitrogen concentrations also exceeded the guideline values at all five sites. The highest concentrations were recorded in RNDA1 (4 g/m3) and TEOT1 (4.3 g/m3). Similarly, Total Kieldahl Nitrogen, which indicates the concentrations of biologically available nitrogen, exceeded guideline values at these two sites. The nitrogen concentrations results fall within the 'C' attribute state of the NPS-FM indicating an adverse effect on some sensitive species. These sites are downstream of cattle farms and stock access to the stream was recorded upstream of both these sites.
>
> Total phosphorus concentrations were also high in RNDA (0.18 g/m3), TEOT1(0.03 g/m3) and TEOT2 0.07 g/m3). Additionally, the site OHOTE, situated in the downstream reaches of the Ohote Stream (OHO_TRIB_1) also exceeded WRC guideline concentrations. Overall, the high concentrations of nutrients (N and P) are reflective of intensive agricultural land use in the sub-catchment."

One site (within Te Otamanui catchment) exceeded the ANZECC Interim Sediment Quality Guidelines (ISQG) high trigger values for arsenic.

Overall, the guidelines proposed in the NPS-FM, ANZECC and supporting WRC documents suggest that the watercourses in Rotokauri North and the receiving environments are degraded.

Aquatic Ecology

Surveys for black mudfish were conducted at 4 sites, while sediment and water quality were conducted at five sites within the study area. No black mudfish were recorded at the sample sites.

No natural in-stream fish barriers such as cascades, waterfalls or dams were found in the sub-catchment, however, farm culverts within Rotokauri North were identified as currently posing a barrier to fish passage.

3.9.3 Mangaheka Catchment

Boffa Miskell were engaged to undertake a watercourse ecology assessment of the receiving environments of Mangaheka Stream in conjunction with the preparation of an ICMP (prepared by Beca) for the Mangaheka Catchment. Although not specifically prepared for the PPC area, the comments made in the report relating to that part of the Mangaheka catchment falling in the PPC area are relevant and have been relied on for this assessment.

> "Downstream of the industrial area and Waikato Expressway, artificial farm drains flow north and northwest to Koura Drive, where they meet at the drain main stem. The drain then flows northwest through farmland before transitioning to a modified stream channel with perennial flow where natural topography forms a surface drainage channel. Outside the Hamilton City boundary, the catchment of the drains is almost entirely rural (dairy farming), comprising artificial farm drains, with very little riparian vegetation"

Over the majority of the Mangaheka catchment (including that part included in Rotokauri North) the reporting identifies that vegetation has been widely modified over time. Historic vegetation cover, including peat bog vegetation, has been replaced with exotic pasture grasses or crops and with exotic shrubs and trees established as shelterbelts. Indigenous plants are recorded as virtually non-existent throughout.

Aquatic Ecology / Water Quality

With respect to water quality the report generally identifies that in the upper catchment the watercourse type is an artificial watercourse (excavated drain) which generally provides poor habitat for fish and aquatic macroinvertebrates. Low or no flow, high temperatures, low dissolved oxygen, and very poor water clarity are likely to present fish passage barriers in this section of the catchment.

With respect to aquatic life the reporting generally finds that based on a fish survey (which was conducted in 2016) a total of four native species were identified, being: shortfin eel (Anguilla australis), longfin eel (Anguilla dieffenbachii), banded kokopu (Galaxias fasciatus), and black mudfish (Neochanna diversus); and one exotic species (mosquitofish). However, it was acknowledged that prior to development of the industrial land parcels in the upper catchment area in (in approximately 2011/12), three native species (mudfish (12 individuals), longfin eel (2 individuals) and shortfin eel (16 individuals)) were caught and translocated under permit from the upper catchment to the wetland area near Crawford Road in the lower part of the Mangaheka catchment.

3.9.4 Rotokauri South Catchment

There is no stream within this part of the PPC area.

3.9.5 Terrestrial Ecology

The site comprises mostly pasture and agricultural land. As previously outlined, there is a significant stand of kahikatea Trees adjacent to the intersection of Burbush Road and SH39 which is already protected under the HCDP provisions (and has a SNA overlay applied). All other vegetation is either associated with waterways (as accounted for in the assessment above), is of a shelterbelt/hedging variety, or associated with the garden areas of the dwellings.

As the area is already protected by the HCDP no further assessment of the values it holds have been undertaken nor are considered warranted.

Opportunities for the enhancement of terrestrial habitat are also proposed to be addressed through a specific assessment criterion for subdivision within the RNSP area.

3.10 Archaeology values

The area falls in drained swamp (fen) country. Archaeology reporting identified that in in 1919 the area was "drained swampy country" with "undulating country in grass" to the east, in the vicinity of Burbush Road. It is believed that due to the presence of the swamp and its subsequent draining there is no evidence of the land or buildings being used for European settlers until the 20th Century. No recorded European heritage features have been identified in the vicinity of the site.

The closest recorded archaeological site to the development area is S14/11, 700m southwest of Exelby Road. The site is recorded as being a pre-European Maori burial site.

Based on the archaeological survey of the site (CFH Heritage, 2018), there is no evidence of any pre-1900 archaeology or heritage, or any significant 20th century heritage.

3.11 Cultural values

The HCDP does not record any cultural or archaeological sites within Rotokauri North. The Burbush Road forest (SNA) is noted to be of high value. It has been acknowledged by the work undertaken for the Rotokauri ICMP and Structure Plan (Chapter 3 of the HCDP) that the wetland areas surrounding Lake Rotokauri may contained buried taonga.

Further background information on the cultural and archaeological significance of the catchment was provided in the cultural assessment undertaken by Nga Mana Toopu O Kirikiriroa (2001) in conjunction with the Rotokauri ICMP and Structure Plan. Cultural Impact Assessments and iwi engagement for this ICMP are ongoing. Bi-weekly meetings are being held with THaWK hapu to work through cultural values (general) and any specifics that may occur for the RNDA. A CIA has been provided with the PPC.

3.12 Existing Three Waters infrastructure

As the site functions similar to a rural environment, there is no current wastewater infrastructure (other than specific onsite devices associated with the rural lifestyle land uses). There is an existing 100mm diameter watermain on the north side of Te Kowhai Road extending to the western extent of Rotokauri North.

Existing key culverts for stormwater conveyance were also identified in the description of the catchments in section 3.3 above.

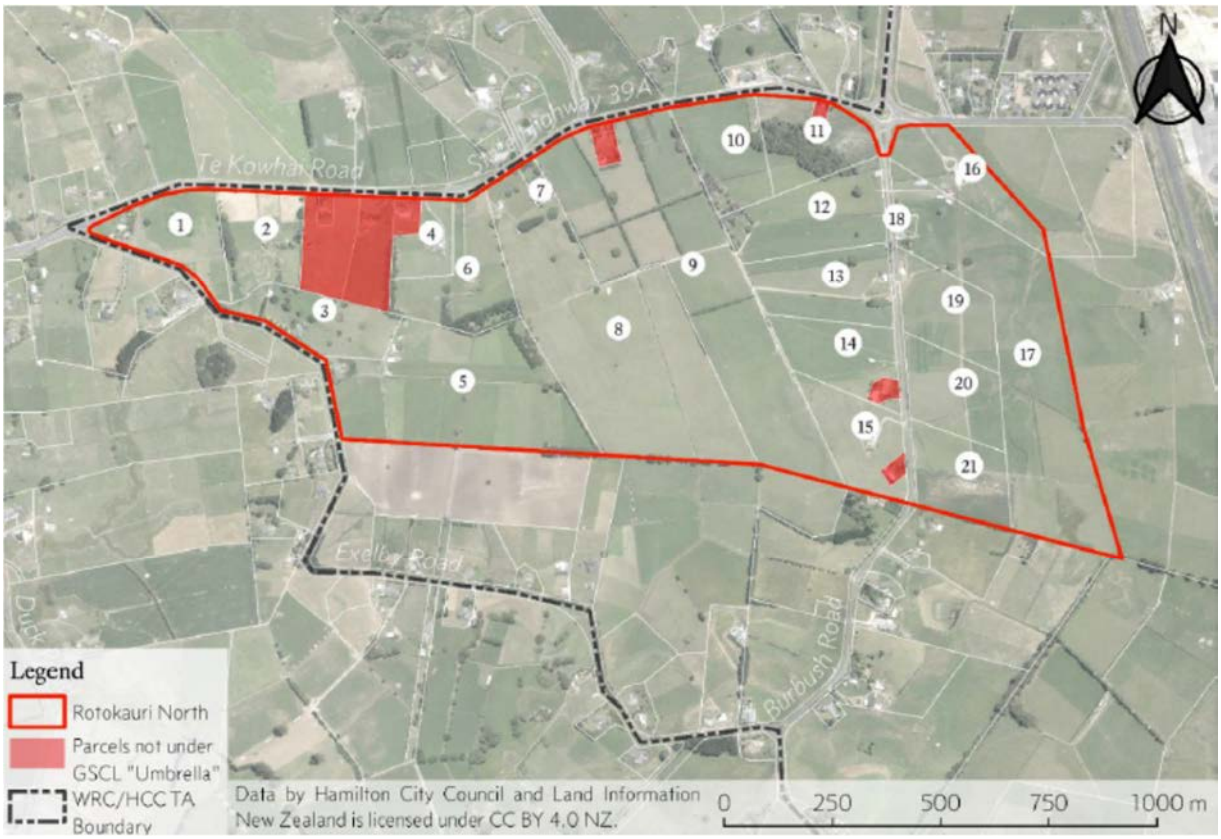
4.0 KEY STAKEHOLDERS IN THE CATCHMENT

Key stakeholders for this ICMP include;

- GSCL
- HCC
- WDC
- WRC
- Waikato-Tainui
- Te Haa o te whenua o Kirikiriroa ("THaWK")
- Landowners

The majority of the land is under the control of GSCL through purchase by investors or is contracted to purchase. Figure 12 identifies those properties in the sub-catchment not falling under the GSCL "umbrella".

Figure 12: Properties outside GSCL control



Efforts have been made to consult all owners of land within the sub-catchment boundary as they have been identified as key stakeholders in this ICMP alongside the consultation for the PPC. A Consultation summary has been provided as an Attachment to the PPC.

5.0 DEVELOPMENT CONCEPT

5.1 Overview of Proposed Development

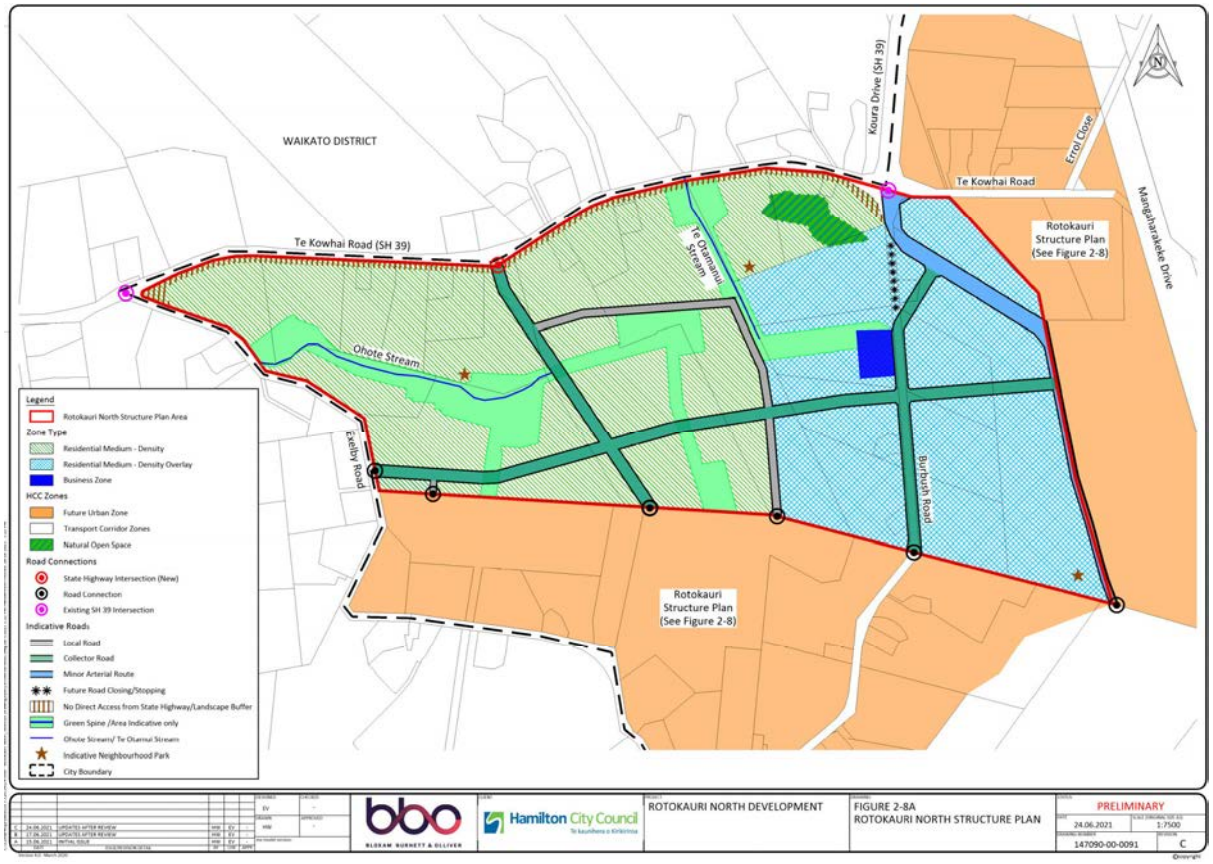
As outlined in detail in the PPC application and shown in Figure 13, the PPC seeks to rezone 140 hectares within the identified "sub-catchment" from Future Urban Zone to:

- Medium Density Residential (approximately 140 hectares); and
- Neighbourhood Centre (1.14 hectares).

The PPC and RNSP also identifies minimum vacant lot size (280m^2), medium density housing opportunities, duplex housing opportunities, increased height overlays, indicative open space locations for neighbourhood reserves, an indicative sports park, and a hierarchy of key roads in indicative alignments and locations, along with key connections to the surrounding network and sites.

Approximately 2,000 dwellings are anticipated to be developed within Rotokauri North. The remaining land within the ICMP will be retained as FUZ

Figure 13: Rotokauri North Structure Plan



5.2 Key Issues, Opportunities and Constraints

Taking into account any key site constraints identified above, Table 6 outlines any issues and constraints for the management of three waters and identifies any key opportunities that could be addressed (to assist in determining BPO's).

Table 6: Issues, Opportunities and Options

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Topography	The majority of the site is flat. This creates potential issues for conveyance of stormwater and wastewater. If not designed carefully the gradients may not allow for piped network for stormwater conveyance and/or wastewater lines being installed at considerable depths.	For water: Minimal requirements for zone management across the site. For stormwater: • Potential to use engineered wetlands for treatment (wetlands work better on flat sites). • Potential to re-create streams (and major overland flows) to allow for conveyance.	Water	As per current Technical Specifications.
			Wastewater	• Utilise gradients carefully to manage flows
			Stormwater	• Engineered wetlands for treatment and detention. • Conveyance via existing stream network.
Soils/Permeability	Soil profile creates risk of liquefaction. Infiltration difficulties / low permeability with soils, which affects storage volumes for stormwater devices (and needs to be accounted for in design and sizing of devices, both on-lot and communal).		Water	
			Wastewater	'Leak tight' standard for any gravity system
			Stormwater	Stabilise areas prone to liquefaction No onsite soakage

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Groundwater	High groundwater table – potential for underground tanks and structures to rise (need to be weighted) and high potential for groundwater to enter stormwater devices and gravity wastewater network. Installation of gravity piped networks would require dewatering operations for trench excavations, increasing complexity of installation. Designers for stormwater devices to be wary that increasing excavation depth for devices will be counterproductive as it is likely that groundwater will enter device. Gravity wastewater network would expose risk of infiltration occurring over asset design life, leading to reduced future capacity, increased treatment costs at Pukete Wastewater Treatment Plant.	Utilise new above ground and green technologies for stormwater detention, etc. Utilise existing stream channels systems for stormwater conveyance.	Water Wastewater Stormwater	Groundwater monitoring for depth of groundwater table prior to design of wetlands, etc. Provide impermeable lining for stormwater devices as identified by monitoring. Limit underground devices OR provide additional weighting to reduce buoyancy (additional cost.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Significant Natural Area	Ensure all works are outside the SNA including devices and pipes for three waters.	Retain SNA (protected by a Zone in the HCDP).	Water	NA
			Wastewater	
			Stormwater	
Stream Network	Natural streams and farm drains (artificial watercourses) transverse the site. Stream channels are narrow with limited hydraulic capacity. Stability of existing farm drains uncertain due to liquefaction potential. Currently water quality is degraded. Depth of any proposed gravity wastewater networks affected by separation between watercourses and new assets. Gravity wastewater network will require emergency overflow structure(s) to manage abnormal flow conditions, specifically at pumping stations.	Retain permanent natural watercourse (identified as modified watercourses by Tonkin & Taylor, 2018). Potential for conveyance of stormwater – widen stream margins, which also reduces liquefaction potential. Margins of stream corridors could be enhanced with riparian planting and works undertaken to naturalise straightened portions of streams Existing performance of septic tanks and disposal fields for existing properties unknown. Removal of these has potential to improve stream water quality.	Water	
			Wastewater	Removal of poorly performing septic tanks and disposal fields. Careful design of gravity system
			Stormwater	Utilise re-created stream network for conveyance of stormwater runoff – widen margins to accommodate flood flows. Treatment prior to entering streams. Riparian planting of stream margins (above the permanently wet flow level). Where possible naturalise portions of streams and remove farm culverts across natural watercourses. Allowance for fish passage.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Overland Flowpaths ("OLFP")	Potential risk should be accounted for in the design of flow path corridors. Gravity wastewater network manholes within road reserve that would be within overland flowpath.	Enable flows to pass through the site unimpeded by preserving OLFP routes (i.e., entry and exit points, along with capacity through the RNSP design). Consider type of wastewater manhole and chamber lids within road reserve to reduce potential for inflow from overland flowpaths. Utilise 'leak tight' wastewater networks to reduce the number of chambers within overland flow paths.	Water	
			Wastewater	Utilise 'leak tight' wastewater network or low-pressure sewers.
			Stormwater	Utilise road network for overland flow, while maintaining a minimum one lane equivalent of unflooded road in the 100-year ARI event. Green corridor (stream and retention of major flowpaths channels) for flow conveyance.
Existing Culverts	• Some are undersized for flows (i.e., Exelby Road). • Some are restricting fish passage. • Onsite farm culverts.	Remove farm culverts. Provide fish passage in new devices and naturalised baseflow channel.	Water	
			Wastewater	
			Stormwater	Naturalise stream channels/remove farm drains/culverts, provide fish passage.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Multiple Stormwater Catchments	• Multiple catchments across the site.	During development, align catchments boundaries to road network (rather than retain in current locations).	Stormwater	Catchment boundaries modified at development stage to align with key roading network (utilising opportunities for conveyance associated with roads). .
Fragmented land ownership	• 15% of land subject to this ICMP falls in separate ownership. This creates issues for cost allocation associated with devices and conveyance networks, i.e., only one stormwater device at the bottom of the catchment creates a large land loss and cost obligation on one landowner. Coupled with the fact that 30% of the land is not subject of the private plan change (and will retain its FUZ zoning) this also creates issues for HCC in having to maintain overdesigned/larger devices than what is necessary to treat the zoned land until such time that the remaining land is developed.	Within the stormwater network identify areas that can manage their own stormwater.	Water Wastewater	Identification of key infrastructure items.
			Stormwater	Sub-catchments falling outside of zoned and/or GSCL ownership be required to provide for own detention and treatment – at the time of development of those land areas.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	• Similarly for the water and wastewater networks, the first landowner undertaking development will be required to install the trunk infrastructure to service the overall plan change development area. • Bulk watermains may have water age risks initially due to small stages. Performance of the water network dependent on HCC implementing upgrades as identified in the HCC Long Term Plan ("LTP"), with some upgrades to be constructed sooner than previously planned. • Initial trunk wastewater assets likely to be oversized, thereby having odour, septicity and corrosion risks. Long Term Plan upgrades at the WWTP may need to be brought forward to deal with increased flows.			

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Change in land use (from agricultural); AND Increase in impervious surfaces	• Concentration of flows and change in peak flows and volume for stormwater. • Increases in peak flow rates and volumes for all waters. • Increased temperature/heat. • Increased volume, velocity and heat of stormwater flows, can affect the physical shape and form of streams, cause scour and erosion within stream channels and at discharge points. • Increased water supply demand may require bringing forward network and treatment plant upgrades as per LTP. • Increased wastewater loading may require bringing forward network and treatment plant upgrades as per LTP.	Utilise water quality management and water sensitive design principles, including at source stormwater management, to mitigate increased flows and volumes from increased imperviousness. The range of lot sizes creates opportunities for on-site retention and detention solutions for individual lots (for impervious surfaces). Sizing of wastewater networks to optimised using 'smart' sewers allowing all units to be telemetry controlled.	Water	Toolbox range of water sensitive design options, including those enabling potable water substitution.
			Wastewater	
			Stormwater	Improve water quality through new on-lot and communal devices.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Lot Sizes – Less than 280m2 and affordable lots	• Site area constrains above ground reuse and/or detention tanks. • Usually higher impervious surfaces/greater building coverage. • Insufficient area for soakage (and high groundwater table). • Cost of detention tanks and dual plumbing in the provision of affordable housing opportunities where fixed price points for sale of house and land packages apply.	Utilise new technology for above ground devices. Potential for communal devices to provide centralised treatment and storage location. Communal location allows for stormwater harvesting for secondary uses, e.g., reserve/garden watering.	Water	Limited potential for reuse.
			Wastewater	
			Stormwater	Limited toolbox range of devices to use.
Lot sizes greater than 280m2		Potential for a lower impervious surface threshold (i.e. 70%) due to site size and backyard size. Greater flexibility in type of retention and detention devices that can be used onsite.	Water	Some reuse potential
			Wastewater	
			Stormwater	Increased number of devices available in toolbox range.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Roads	Key contaminants of concern from high use roads into stream environments are heavy metals, sediment. Potential for increase in water temperature. Need quality treatment close to source. Space constraints due to access ways and services (but reduced where rear lanes access ways are used). Risk to road pavement where subsoil drainage is not possible due to above ground stormwater conveyance and devices. Water and wastewater networks to be located within the road reserve.	Stormwater contaminants will need to be mitigated using devices compliant with TR 2013/035, Table 7 and designed according to the TP 10 water quality requirements. Pavement subsoil drainage to be integrated with stormwater conveyance system.	Water	Locate water supply network in berms as per current Technical Specifications.
			Wastewater	Locate wastewater networks in berms and carriageway as per current Technical Specifications.
			Stormwater	Potential for treatment train of devices (at source) to remove contaminants. Groundwater monitoring for depth prior to design of subsoil drains, etc.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Car Parking Area (Neighbourhood Centre areas).	Key contaminants of concern from high contaminant parking areas into stream environment are heavy metals (zinc/copper), sediment and increase in temperature. Need treatment close to source. Space constraints due to access ways and services. Risk to road pavement due to stormwater device having higher water level than adjacent subsoil drainage.	Stormwater contaminants will need to be mitigated using devices compliant with TR 2013/035, Table 7 and designed according to the TP 10 water quality requirements. Consider treatment devices at car parking area to complement architecture and landscaping design.	Water	
			Wastewater	
			Stormwater	Potential for treatment train of devices (at source) to remove contaminants. Groundwater monitoring for groundwater table depth prior to design of subsoil drains etc

5.3 Operational Objectives

Taking into account the above issues and opportunities, the following operational objectives (Table 7) have been derived to address the issues and to align with the strategic objectives outlined above.

Due to the overlap with the Mangaheka catchment (and similarity in many of the issues) the objectives below have been derived generally from the Mangaheka operational objectives. However minor difference have been identified with bold and italics for clarity.

Table 7: Operational Objectives

Operational Objective	Description
OO1	<u>Maintain or Enhance Mangaheka, Te Otamanui and Ohote Streams' Water Quality</u> (a) Contaminants derived from urban or road stormwater are managed through appropriately designed treatment devices, so that any increase in mass contaminant loads and concentrations in the receiving environment following development, are minimised as much as practicable. For general guidance purposes the following guidelines (or updates thereof) are referred: i. For in-stream water quality and comparison with baseline contaminant concentrations: ANZECC, 2000 – 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality'; ii. For in-stream sediment quality and comparison with baseline contaminant concentrations: ANZECC, 2000 –'Australian and New Zealand Guidelines for Fresh and Marine Water Quality / Interim Sediment Quality Guidelines ("ISQG")'<u>; and</u> ii. For treatment device design and performance efficiencies: WLASS RITS. (b) Primary stormwater treatment devices must achieve at least 75% sediment removal on an average long-term basis. (c) Devices servicing roading should be suitable for the removal of hydrocarbons and heavy metals. (d) To avoid increases in temperature in downstream receiving waterways, open water areas must be avoided in treatment devices and wetland vegetation cover must exceed 80% of the device surface area. (e) Where it is shown that a single device will not address receiving environment sensitivities, ~~that~~ <u>then</u> a treatment train approach should be adopted to minimise temperature effects and maximise contaminant removal.

Operational Objective	Description
	(f) Construction generated sediment shall be controlled to meet Waikato Regional Council standards and shall comply with relevant city bylaws and District Plan requirements This operational objective aligns with strategic catchment objective 6.
OO2	Minimise Erosion Effects to the Downstream Receiving Environment (a) The erosion and scour of the bed and banks of the Mangaheka, or Ohote or Te Otamanui streams and other catchment waterways is not increased following proposed development within Hamilton City Council boundary. Where it is identified that stormwater discharges will have an effect on aquatic habitat and water quality values, then additional mitigation measures will be required (e.g. on-lot treatment / detention). (b) Where stormwater discharge to the Mangaheka, Ohote or Te Otamanui streams needs to occur, extended detention shall be provided by the proposed stormwater management structures in accordance with RITS to control flow velocities and erosion. (c) Energy dissipation and erosion protection measures are provided at all discharge locations, and preference is given to green engineering solutions over hard engineering solutions based on rock and concrete. (d) Stream flooding in a land drainage area shall be managed to the extent that the ponding from a storm with a 10% probability of occurring in any one year (the 10% Annual Exceedance Probability (AEP) event or 10 year ARI storm) shall be removed within three days. This operational objective aligns with strategic catchment objective 4.
003	Utilise Water Sensitive Practices (a) ~~Where on-lot and soil conditions allow, stormwater shall be discharged directly to ground via soakage. This will minimise increases in discharge volume, help to recharge groundwater, maintain stream base flows, and mimic the natural water cycle~~. (b) The use of 'water sensitive practices' shall be incorporated into the stormwater management approach for the catchment. (c) Where it is shown that a single device will not address flood risk or receiving environment sensitivities a treatment train approach shall be adopted. (d) On lot devices for such as rain tanks for water re-use should be incorporated into residential development. This operational objective aligns with strategic catchment objectives 2 and 7
004	Promote Riparian Margin Enhancement and Re-Vegetation (a) Riparian planting shall be undertaken within the RNSP area to mitigate effects of urbanisation in potentially affected areas.

Operational Objective	Description
	(b) Stock fencing shall be erected along stream banks to reduce bank erosion as well as help reduce suspended solids and pathogens in the water column. (c) Works using natural solutions or green engineering which will enhance habitat and maintain natural stream processes in a soft sediment environment are preferred over hard engineering solutions using rock and concrete. This operational objective aligns with strategic catchment objectives 1, 2 and 5.
005	<u>Have Due Regard for Economic Affordability and Safety</u> (a) Proposed stormwater management systems are cost-efficient during long term operation and maintenance. (b) Stormwater and wastewater management systems are designed for public safety. (c) Where it is shown that a single device will not address flood risk or receiving environment sensitivities, that a treatment train approach, incorporating an approved at source device upstream of a centralised public device, shall be adopted. (d) Limitations for onsite mitigation associated with affordable housing are acknowledged. This operational objective aligns with strategic catchment objectives 1, and 4.
006	<u>Protect Cultural Values</u> (a) Riparian planting shall be encouraged by Hamilton City Council throughout the catchment in conjunction with developers, landowners, local iwi and other interested parties. Planting shall include an appropriate mix of native eco-sourced plant species. This operational objective aligns with strategic catchment objectives 1, 2, 3 and 5.
007	<u>Maintain or Improve Flood Protection Level of Service</u> (a) Where existing flooding is known, or potential flooding is predicted, peak flow management is generally required with reduction to 80% ~~70%~~ (70% for discharge into Mangaheka) of predevelopment flow for the 100 year ARI storm event. (b) Overland flow paths shall be provided for all stormwater discharges in accordance with Hamilton City Council standards. Wherever possible, the use of private property for overland flow paths shall be avoided. (c) Sufficient freeboard protection, in accordance with Hamilton City Council standards, shall be provided to building floor levels. This operational objective aligns with strategic catchment objectives 1 and 4.

Operational Objective	Description
008	Minimise water consumption and wastewater discharge (a) That rainwater re-use tanks are installed and plumbed into non-potable water systems on-lot where practicable. (b) That water efficient fittings are incorporated into dwellings and businesses and promote sustainable water use practices. (c) That the size of infrastructure is minimised by promoting sustainable water use. (d) That future infrastructure upgrades are avoided or minimised by identifying and managing inefficiencies such as leakage, inflow & infiltration and unauthorised use. This operational objective aligns with strategic catchment objective 7.
009	Integrated water management (a) Plan and implement three waters networks on a catchment wide basis to minimise the number of public stormwater treatment devices, wastewater pump stations and storage devices. (b) Where it is shown that a single device will not address receiving environment sensitivities, that a treatment train approach, incorporating an approved at source device upstream of a centralised public device, shall be adopted and include minimisation of temperature effects, metals, metalloids and PAHs. Construction generated sediment shall be controlled to Waikato Regional Council standards and relevant city bylaws. This operational objective aligns with strategic catchment objective 7.

6.0 THREE WATERS MANAGEMENT AND CAPACITY – WATER

For the water supply management of the sub-catchment ICMP, a concept level design has been carried out. A summary of the concept design is given below. Details can be found in Appendix J.

6.1 Existing Network

The Rotokauri ICMP describes the plans to incorporate the majority of the Rotokauri Structure Plan area into the Pukete Water Supply Zone. Once the Pukete zone is closed, the pressures throughout Rotokauri are expected to exceed 200kPa at all times.

6.2 Constraints and Design Parameters

The proposed water supply networks to service the Rotokauri North sub-catchment have been designed in compliance with RITS. The key water design parameters are shown in Table 8.

Table 8: Key Water Design Parameters

Design Parameter	Value
Domestic demand per person per day	260 litres
Peak flow rate factor	5
Minimum residual pressure	200 kPa
Minimum flow rate at point of supply	25 l/min

Key design assumptions and considerations were as follows:

- Tie into the existing water network at a minimum of two suitable locations.
- Existing upstream water supply network has sufficient capacity to service the area covered by the sub-catchment ICMP, based on implementing network upgrades as per the HCC Water Supply Master Plan.
- Design to include linked or looped mains to avoid dead end water mains.
- Design to meet the FW2 firefighting requirements at the street boundary for residential areas and FW3 requirements for other zones.

6.3 Required Water Upgrades and Water Supply Networks

Water supply for Rotokauri North is dependent on a new 450mm bulk main and a 250mm trunk main extension from the eastern side of the Waikato Expressway (SH1). The alignment of the new mains is proposed to follow the new minor east-west arterial that connects Arthur Porter Drive on the eastern side of the Waikato Expressway with the new north-south minor arterial on the western side of the Waikato Expressway.

The bulk main will be extended in a northerly direction along the north-south minor arterial until the junction with the major east-west road (identified as a Collector Road on the Structure Plan) within the Rotokauri North development. The bulk main will follow the major east-west road into the development.

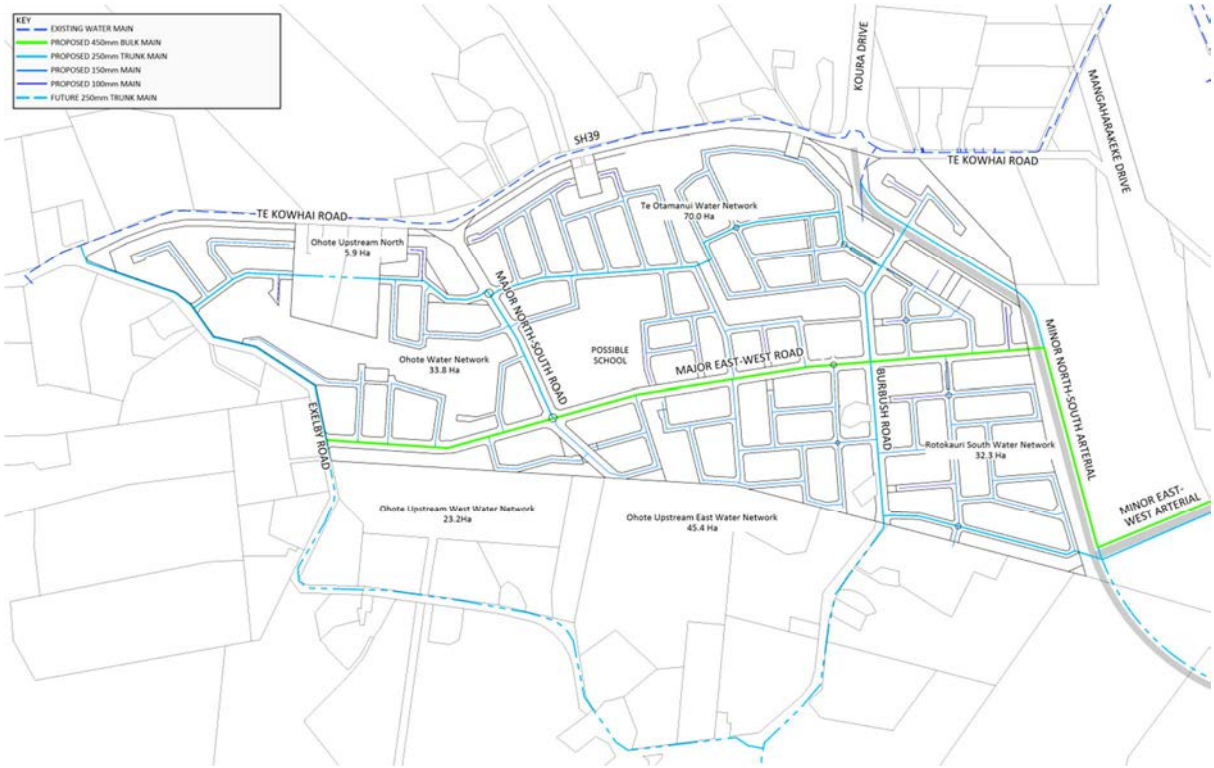
The 450mm bulk main is proposed to terminate at the intersection of the major east-west road with Exelby Road (Figure 14). At various locations along the major east-west road, the bulk main splits into multiple 250mm trunk lines. The 250mm trunk main, that comes into the development at the south-eastern corner of Rotokauri North, is proposed to be extended in an easterly direction to Burbush Road. Together these 250mm trunk mains will form the major water supply networks within the development.

Within the Rotokauri North development, there are proposed to be three main water networks (Figure 14):

- Rotokauri South Water Network has an area of 32.3 Ha and will require an estimated flow rate of 11.2 l/s
- Te Otamanui Water Network has an area of 70.0 Ha and will require an estimated flow rate of 20.5 l/s
- Ohote Water Network has an area of 33.8 Ha and will require an estimated flow rate of 12.2 l/s

During future developments, Ohote Upstream North will be incorporated into the Ohote Water Network. The Ohote Upstream West and Ohote Upstream East Water Networks will require the completion of the 250mm trunk main along Exelby and Burbush Roads which will enable the areas to be incorporated into the Ohote and Te Otamanui Water Networks respectively.

Figure 14: Indicative Water Network



7.0 THREE WATERS MANAGEMENT AND CAPACITY – WASTEWATER

For the wastewater management of the sub-catchment ICMP, a concept level design has been carried out. A summary of the concept design is given below. Details can be found in Appendix J.

7.1 Existing Network

The existing 1050mm Far Western Interceptor ("FWI") is located on the western side of the Waikato expressway, some 200m south of Te Kowhai Road (SH39).

7.2 Constraints and Design Parameters

The wastewater network has been designed in compliance with RITS. The key wastewater design parameters are shown in Table 9.

Table 9: Wastewater Design Parameters

Design Parameter	Value
Population Equivalent per Lot	2.7
Average daily flow per population equivalent per day	200 litres
Infiltration allowance per serviced hectare per day	2,250 litres
Surface water ingress per serviced hectares per day	16,500 litres

Key design assumptions and considerations were as follows:

- Use existing manholes, that connect to the HCC wastewater network, as the discharge point for all wastewater from the Rotokauri North ICMP.
- Existing downstream wastewater network has sufficient capacity to manage the flow generated in the Rotokauri North ICMP area.
- Use gravity only to convey wastewater from the eastern subcatchments to the wastewater discharge manhole.
- Use a maximum of two pumpstations to convey wastewater from the remaining parts of the Rotokauri North development to the wastewater discharge manhole.
- Incorporate options for the wastewater management of areas that align with the catchment boundaries, but fall outside of the Rotokauri North development.

7.3 Required Wastewater Infrastructure and Existing Infrastructure Upgrades

7.3.1 Wastewater Discharge Location

There are two potential connection points for the Rotokauri North Sub-catchment ICMP area to the existing HCC wastewater network. Both are 1050mm wastewater pipelines, ending at manholes on the east side of SH 1. Each of these connection points is intended to serve a specific wastewater sub-catchment.

The north connection point (WWK09003, on the west side of SH1 approximately 230m south of Te Kauwhai Road) is intended to serve the wastewater catchment that includes Rotokauri North and the south connection point (WWL09002 on the east side of SH1 in the future East-West Arterial corridor) is intended to serve the wastewater catchment south of the wastewater catchment that includes Rotokauri North. While the northern wastewater connection point is specifically identified in the Rotokauri ICMP as the appropriate location for the Rotokauri North Development to connect to the HCC wastewater network, there is no designation for crossing privately owned land and no process is currently underway to designate the required corridor. The locations of the wastewater connection points can be seen in Figure 15. Therefore, connection to the northern manhole will be deferred, until an appropriate corridor can be designated.

In order to allow the development of Rotokauri North to progress, it was agreed with HCC to temporarily utilise the southern wastewater connection point. This allows the use of a corridor established for the future Minor East-West Arterial. Utilising the southern wastewater connection point will not result in capacity issues, until the wastewater catchment south of Rotokauri North develops. Development of the wastewater catchment south of Rotokauri North would then drive the establishment of the corridor required for the northern wastewater connection point. Once the northern wastewater connection is established, approximately 25.4 Ha of the Rotokauri North Development will continue to discharge the southern wastewater connection point.

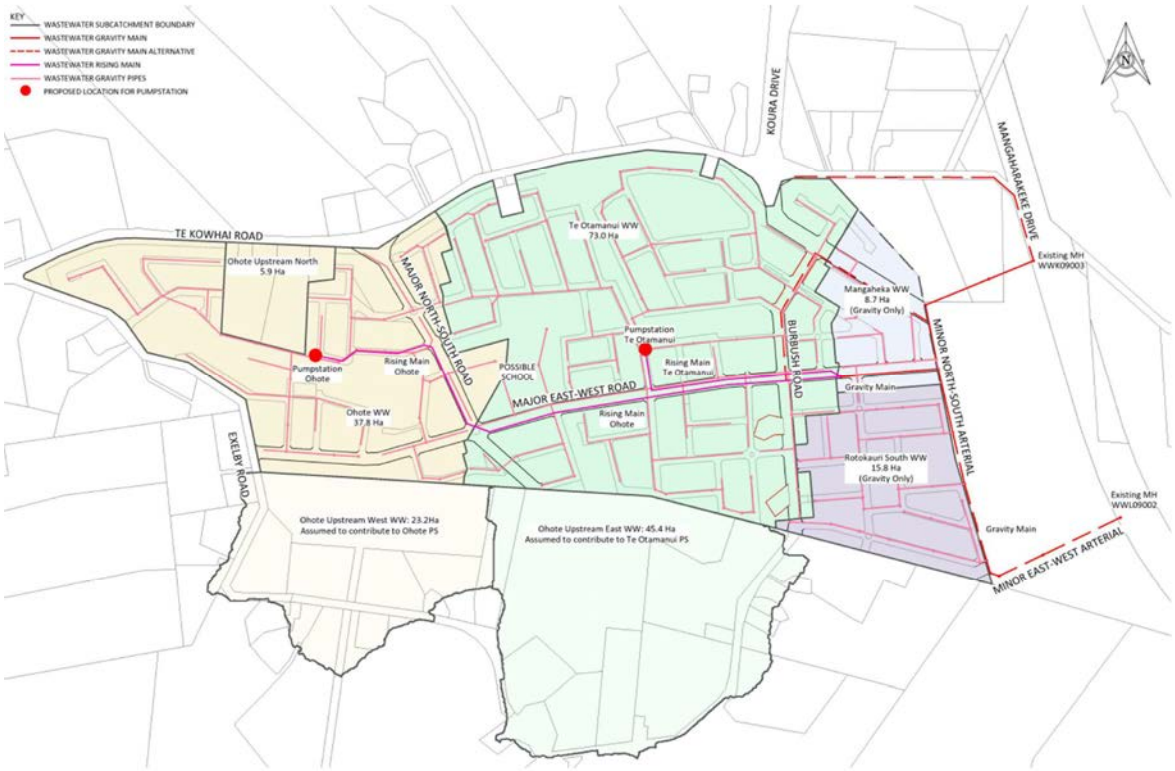
7.3.2 Wastewater Sub-Catchments

Based on the alignment of the wastewater main and the number of pumpstations, the Rotokauri North development was divided into four wastewater sub-catchments. These are Rotokauri South WW, Mangaheka WW, Te Otamanui WW and Ohote WW (Figure 15).

- Rotokauri South WW has an area of 15.8 Ha. Lots within the catchments drain under gravity directly into the gravity main.
- Mangaheka WW has an area of 8.7 Ha. Lots within the catchments drain under gravity directly into the gravity main.
- Te Otamanui WW has an area of 73.0 Ha. Invert level of the wastewater pipes at the pumpstation are at 26.1m R.L. which is about 5m below the finished surface level required for storm water management. The pumpstation is also assumed to be able to service 21 Ha of the Ohote Upstream East WW catchment. The combined peak wet weather flow is estimated to be 48 l/s. The pumpstation is connected via a 590 m long rising main with an internal diameter of 250mm to the upstream manhole of the gravity main.
- Ohote WW has an area of 37.8 Ha. Invert level of the wastewater pipes at the pumpstation are at 26.0m R.L. which is about 4.2m below the existing surface level. The pumpstation is also assumed to be able to service 7 Ha of the Ohote Upstream West WW catchment. The combined peak wet weather flow is estimated to be 28 l/s. The pumpstation is connected via a 1450 m long rising main with an internal diameter of 200mm to the upstream manhole of the gravity main.

To service those areas of Ohote Upstream East WW and Ohote Upstream West WW sub-catchments, that cannot drain to the Te Otamanui or Ohote pumpstations, will require at least one pumpstation. The combined peak wet weather flow is estimated to be 21 l/s. A connection point for the wastewater from this pumpstation will be provided at the boundary of the Rotokauri North development along the north-south road that also passes the Te Otamanui pumpstation.

Figure 15: Indicative Wastewater Network



8.0 THREE WATERS MANAGEMENT AND CAPACITY – STORMWATER

For the stormwater management of the sub-catchment ICMP, a concept level design has been carried out. A summary of the concept design is given below. Details can be found in Appendix K.

8.1 Objectives of the Stormwater Strategy

The objectives for the stormwater management within the catchment are documented in the Rotokauri and Mangaheka Integrated Catchment Management Plans. Relevant recommendations by the Rotokauri North Tangata Whenua Working Group are documented Cultural Impact Assessment.

8.2 Constraints and Design Parameters

Design parameters are documented in the Rotokauri and Mangaheka Integrated Catchment Management Plans (and thus need not be repeated here). The key design parameters are:

- Water quality treatment compliant with RITS (Waikato Local Authority Shared Services, 2018) and WRC TR2018/01 (Waikato Regional Council, 2018) including pre-treatment for High Contaminant Load surfaces in all Sub-catchments.
- Quantity control for the extended detention volume, the 2yr ARI 24 hr, the 10yr ARI 24 hr and 100yr ARI 24 hr storm events within the Rotokauri North Sub-catchment

In addition, the standards in Table 10 have been applied for piped infrastructure that applies directly to The Rotokauri North development.

Table 10: Drainage Design Criteria

Element	Design Event	Criteria
Piped drainage infrastructure	10yr ARI	HGL to be generally below pipe soffit level. In locations with high tailwater elevations, this may not be possible. In these cases, the HGL must not be higher than 1.0m below the finished carriageway level or, where pipe cover is 1.0m or less, ½ the distance between top of pipe and finished carriageway level with road subsoil drainage connections above the 10yr ARI HGL..
Cross culverts	20yr ARI	Culvert must convey the design event without the flow reaching the soffit or obvert.
Cross culverts	100yr ARI	Must convey flow in a manner that does not result in increased flooding outside of the Rotokauri North development area. Ponding behind the culvert embankment to be <1.0m above the soffit, or less if necessary, to prevent scour due to high water velocities around the culvert entrance and exit.

Rainfall re-use is proposed primarily for lots greater than 350m^2. The rain tanks can be integrated into the garage structure to hold a sufficient amount of water for toilet flushing as well as outdoor use or underground or above ground tanks may also be suitable.

Due to the high groundwater level throughout the Rotokauri North sub-catchment, using soakage to dispose of stormwater is not a viable option. Design of stormwater wetland for quality and floodplain volume for attenuation requirements have assumed that no soakage occurs.

8.3 Stormwater Catchments

The Rotokauri North area has been divided further into 18 major Sub-catchments. Wetlands have been adopted in all the catchments as the preferred major sub-catchment stormwater devices as wetlands generally provide the best mix of water quality, ecological, maintenance, land and amenity outcomes. Wetlands can also be designed to provide attenuation as well as treatment, with very little additional area required.

In addition, short swales have been implemented between the downstream ends of the stormwater reticulation networks and the inlet to the wetland and between the outlet of the wetland and the discharge location in the stream. The swales in combination with the wetland form a treatment train to meet the water quality requirements.

The major Sub-catchments, devices, and stormwater discharge locations are shown in Figure 16. Ten major sub-catchments drain into the Ohote stream. Five major sub-catchments drain into a tributary of the Te Otamanui tributary. The streams and its floodplains will be utilized for attenuation of the peak flows to meet the maximum discharge flow rate requirements. The streams will be designed to provide geomorphologically stable habitats. Depressed stream banks will be used to create areas of fringe wetlands, which will provide spawning habitats. Other portions of the floodplain will be riparian or open space for human habitat. The Ohote discharge location is underneath Exelby Road. The Te Otamanui discharge location is under SH39.

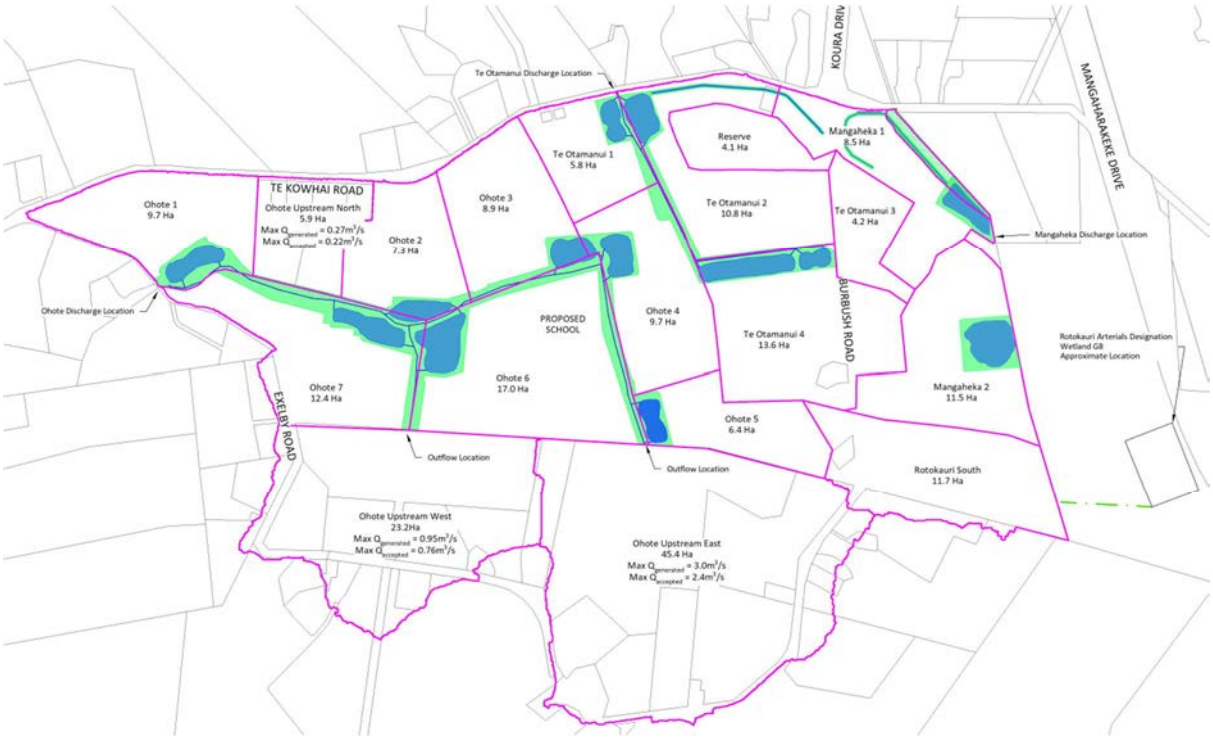
The two wetlands in the Mangaheka major sub-catchments will treat water quality and attenuate the peak flow rates to meet maximum discharge flow-rate requirements, before discharging directly into the Mangaheka stream. The Rotokauri South major sub-catchment falls within the catchment area of basin 3 as part of the Rotokauri Greenway. Hence treatment and attenuation of the stormwater will be carried out outside of the boundaries of the Rotokauri North sub-catchment ICMP.

Three of the major sub-catchments (Ohote Upstream North, Ohote Upstream West and Ohote Upstream East) are not part of the Rotokauri North development by Green Seed Consultants Ltd, but as these do drain into the Ohote, their contributions are taken into account as part of this sub-catchment ICMP. During future developments, these major sub-catchments will require their own treatment and attenuation devices.

Device locations are indicative only and during detailed design other factors may contribute to or require device locations to be modified from that shown in Figure 16[1].

[1] Such scenarios may include the presence of wetlands meeting the NPS-FM definition, and/or changes resulting from more detailed geotechnical investigations, or the final location of the designation for the Minor Arterial.

Figure 16: Indicative Stormwater Management System



8.4 Stormwater Design

Stormwater hydrology and hydraulics were modelled using EPA SWMM-5. Based on current rainfall patterns, soil infiltration characteristics and soil cover complexes, the pre-development flow rates out of the Rotokauri North sub-catchment were determined for the existing discharge locations. The results are presented in Table 11.

Table 11: Modelled existing peak flow rates at pre-development discharge locations

Discharge Location	2 yr ARI (m3/s)	10 yr ARI (m3/s)	100 yr ARI (m3/s)	80% of 100yr ARI (m3/s)
Exelby Road (Ohote)	0.81	1.87	2.72	2.17
SH 39 (Te Otamanui tributary)	0.31	0.65	1.28	1.04*
Mangaheka	0.46	0.85	1.51	1.06**
Rotokauri South	0.26	0.53	0.97	0.78

* The Te Otamanui tributary minor sub-catchments include the Reserve. Run-off from the Reserve needs to be conveyed through the stream, but does not require attenuation.
** For the 100-year event, the discharge into Mangaheka will be 70% of the modelled existing condition as per Mangaheka ICMP.

To model the proposed condition, rainfall patterns were updated to include climate change, and the soil infiltration characteristics and soil cover complexes were updated to take into account the change in land-use. The wetlands were designed to match the pre-development peak flow rates at the proposed discharge locations out of the Rotokauri North sub-catchment ICMP. The results are presented in Table 12. As the run-off from the Rotokauri South Major sub-catchment is treated outside of the Rotokauri North sub-catchment ICMP, no details are available at this moment.

The required attenuation volumes available in the Ohote and Te Otamanui tributary floodplains were confirmed in a 2D HEC-RAS model. The model results also showed that the internal velocities within the wetlands do not exceed 0.25 m/s, preventing the resuspension of sediments in the wetlands.

Table 12: Modelled proposed peak flow rates at proposed discharge locations

Discharge Location	2 yr ARI (m3/s)	10 yr ARI (m3/s)	100 yr ARI (m3/s)
Exelby Road (Ohote)	0.82	1.49	2.16
SH 39 (Te Otamanui tributary)	0.28	0.53	1.05
Mangaheka	0.26	0.47	0.82
Rotokauri South	NA	NA	NA

9.0 IMPLEMENTATION METHODS

In general, land falling within the Mangaheka and Rotokauri South catchments (identified above) should adhere to the implementation requirements of those relevant ICMPs.

However, there are some overarching recommendations of this ICMP that impose additional restrictions over and above the adopted ICMPs. These are clearly identified in the breakdown of recommendations and implementation guide (Table 13).

Where the recommendations of this ICMP exceed the requirements of the Mangaheka or Rotokauri South ICMPs, the higher requirements imposed under this ICMP shall apply. Similarly if the areas falling under the Mangaheka ICMP or Rotokauri South portion of the Rotokauri ICMP have a higher requirement, that higher requirement must be adhered to.

Table 13: Implementation/Means of Compliance

Lot/Area Type	Requirements		Recommended Devices Options
All Catchments			
Single dwelling, residential lots under 350m^2	Detention/Re-use	LID device to manage SW from impermeable surfaces on the site.	Tank for re-use(depending on space constraints) Bioretention devices
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials Runoff discharged through treatment wetlands
Affordable Lots/Houses	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials Runoff discharged through treatment wetlands
Single dwelling, residential lots 350m^2 and over	Detention	LID devices to manage SW from impermeable surfaces on the site. Detention device plumbed into the dwelling for non-potable uses Detention device sized to a minimum 5m^3 per site (which allows for reuse plus some detention in the device).	Tank (above or below ground Green Roof Bioretention devices
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials Runoff discharged through treatment wetlands

Lot/Area Type	Requirements		Recommended Devices Options
Multiple units/duplex product	Detention	LID devices to manage SW from impermeable surfaces on the site.	Tank (above or below ground Green Roof Bioretention devices Option to make devices communal
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials Runoff discharged through treatment wetlands
Commercial Activities + B6Z	Detention	Refer to HCC Three Waters Management Practice Note 06: Detention Tank (~26.5 litres per m^2 of roof)	Tanks (above or below ground)
	Treatment	75% TSS	Runoff to main swale / treatment is provided in communal wetland
Roads	Conveyance		Piped network
	Treatment		Treatment is provided in communal wetland
Communal Devices	Treatment	75% TSS and 95% total contaminant removal	Wetlands (offline)
	Detention		Wetlands (offline)
Green Corridors	Attenuation		Floodplain attenuation
		Environmental enhancement	Riparian Planting (streams, network and wetlands (natural and created)) Green outfalls
Rotokauri South Subcatchment	Treatment	Phosphorous removal of 70% or greater (of total phosphorous)	Treatment wetlands and source control through earthworks
	Attenuation	Interim storage of 1200m^3/Ha for any development ahead of Rotokauri South green corridor	Temporary attenuation facility

10.0 FURTHER WORK

Further work and actions includes:

- Regional Consenting for stormwater discharge.