Tuakau Stormwater Management Plan

Prepared for Waikato District Council
Prepared by Beca Limited

21 August 2019

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Contents

Appendices

Revision History

Revision Nº	Prepared By	Description	Date
A	**Emily Darlison**	Draft for WDC review	21.08.2019

Document Acceptance

Action	Name	Signed	Date
Prepared by	**Emily Darlison**		21.08.2019
Reviewed by	**Iain Smith**		21.08.2019
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on behalf of	Beca Limited		

Executive Summary

The Tuakau Stormwater Management Plan (SMP) has been prepared to provide high level guidance for sustainably designing and managing the stormwater within and surrounding the Tuakau township.

Tuakau is a growing town in the Waikato District and this contributes to several current and future pressures on Tuakau's infrastructure, lifestyle and local environment. In particular, stormwater management is directly impacted by the change in land use that arises from increases in population. Urbanisation and development, particularly of greenfield areas, will lead to increased surface runoff and decreased infiltration causing:

- increased flood hazard (both depth/extent and velocity aspects)
- the capacity of existing stormwater systems (both man-made and natural) to be exceeded
- increased pollutants to be discharged into receiving watercourses
- increased stream erosion and scour at instream structures
- changes in the groundwater table.

This SMP has been prepared to:

- summarise the key information from a variety of sources relating to stormwater in Tuakau area
- identify management constraints and opportunities
- identify gaps in current knowledge and the implications of these
- provide high level guidance for design and management of stormwater in Tuakau for both developers and WDC.

Glossary of Terms

ARI: Average Recurrence Interval. The expected period between exceedances of a given rainfall event with a given duration. The probability of a particular rainfall exceedance occurring.

Attenuation: Storage and detention of excess stormwater to manage peak flows. .

Brownfield development: Refers to development that takes place on land that is already developed.

Catchment: A drainage area, or watershed based on the limits of topography and piped network, from which water is drained to a point of interest.

CMP: Catchment Management Plan. This is a tool for managing water resources and land use within a catchment scale.

CN: Curve number. This is an empirical parameter used in Soil Conservation Service (SCS) based hydrological methods to predict the direct runoff from a surface.

Detention: to hold stormwater temporarily. The water is detained e.g. attenuation ponds/wetlands/basins.

Erosion: The gradual degradation or removal of something i.e. soils, rock or stream bed materials

Extended Detention: Holding stormwater for a period of time with slow release normally with a designed structure. Manages, peak flows and peak volumes in order to mitigate stream scour.

Greenfield development: Refers to development that takes place on land that is currently undeveloped or rural in nature.

HIRDS: High Intensity Rainfall Design System (HIRDS) is a NIWA database system providing rainfall intensity/depth/frequency data.

Integrated Water Management: Managing stormwater for multiple outcomes and amenity beyond just stormwater issues.

Impervious and pervious: Refers to whether water can pass through a surface. Generally referenced in relation to rainfall and whether it passes into the ground (pervious) or is converted to runoff. Is a graduated scale.

Levels of Service: Minimum level of performance described by how much, of what nature and how frequently the service will be delivered.

Low impact design: Refer Water Sensitive Urban Design.

Permeability: Having pores or openings that permit liquids or gases to pass through. Soil permeability is a property that describes how well stormwater is transmitted through it.

Rain Gardens: A designed depressed area in the landscape or specific structures that includes layers of soils or media for the purpose of water quality treatment.

Receiving Environments: The natural environment (watercourse, lake, ground, groundwater table) to which stormwater is discharged.

Retention: to hold stormwater permanently. The water is retained e.g. rainwater reuse, harvesting.

Runoff: Rainfall that does not pass into the ground but instead remains or flows across the surface.

Safety in Design: Is the integration of hazard identification, risk assessment and control methods in the design process to avoid, eliminate or minimise risks throughout the life span of the item being designed.

Scour: A process of removal of sediments from a stream bed or channel. Generally, event driven but can be cumulative.

Soakage: Process of stormwater runoff infiltrating (or being disposed of) into the ground.

Soak Pits: devices for disposal of stormwater by soakage.

Swales: A shallow grassed or planted open channel with sloping sides used to convey stormwater and can be used to provide water quality treatment functions also.

Time of Concentration: The time taken for water from the furthest/most remote part of the catchment to reach the catchment outlet.

Tributaries: A stream that flows to a larger stream or other body of water

Watercourse Ecosystem Health: The ecological state of a watercourse relative to an idealised natural, undisturbed state.

Water Sensitive Urban Design: Land planning and engineering design that incorporates the urban water cycle to minimise environmental degradation and increase social benefits. Often referred to as Low Impact Design or water sensitive design.

1 Introduction

1.1 Background

Tuakau is located on the northern bank of the Waikato River, between Pukekohe and Pokeno, around 60 km south of Auckland, as shown in Figure 1. As the Tuakau Structure Plan (TSP) (WDC, 2014) notes, the town Tuakau is fast growing reaching 2021 growth projections by 2007 (WDC, 2014). Growth over the last 10 years has occurred mainly within existing residential and rural residential zoned land.

Additional long-term population pressure on Tuakau is expected because of proximity and accessibility to Auckland, and in the context of the increased greenfield development in Pukekohe and Pokeno. The fast-increasing population is one factor contributing to current and future pressures on Tuakau's infrastructure, lifestyle and local environment. Increased urbanisation and development, particularly greenfield, will lead to increased runoff and pressures on the stormwater system and watercourses as well as increased pollutant loads to the receiving environments. To avoid, remedy or mitigate those pressures the current infrastructure may need to be altered to maintain the minimum levels of service expected by the community and as set out in the District Plan and the Regional Infrastructure Technical Specification (RITS).

The Waikato District Council (WDC) has engaged in high level planning to better understand infrastructure needs and the design/compliance requirements to manage stormwater in and around Tuakau. This process has spanned many years involving several studies, some led by developers and some by WDC, with the most significant being the TSP (WDC, 2014).

Subsequent to the TSP the Waikato Regional Council (WRC) released its *Stormwater Runoff Modelling Guide (WRC, 2018)* and the *Waikato Stormwater Management Guide (WRC, 2018)* whereas previously runoff and treatment within the district referenced Auckland Council's TP108 and TP10.

This Stormwater Management Plan (SMP) draws together the findings and recommendations from these previous stormwater studies, additional modelling (carried out in 2018/19) and provides an overview for planning for the effective stormwater management under future growth conditions. It should be read in conjunction with a number of other reports that remain valid and these are outlined in Section 1.5 below.

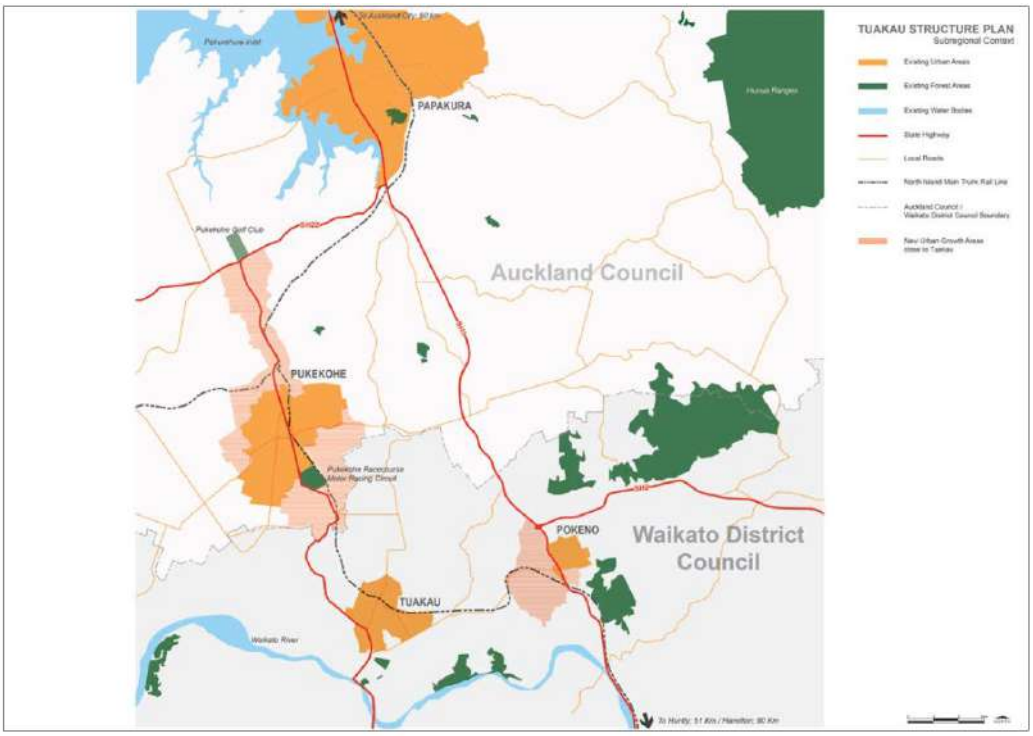

Figure 1 Tuakau regional context taken from the TSP(WDC, 2014).

1.2 Purpose

The purpose of this SMP is to bring together historic knowledge and use it to provide a framework for managing stormwater effects on the receiving environments in and around Tuakau township. It aims to promote the adoption of Integrated Water Management (IWM) and Low Impact Design (LID) for both brownfield and greenfield developments in order to:

- provide drainage
- manage flood hazard
- avoid watercourse scour and erosion
- improve the water quality of runoff discharged, and
- protect, enhance and restore watercourse ecosystem health.

This SMP is intended to be used by both developers and WDC and can be used to inform future resource consent applications. It lists the key stormwater management practices that developments will need to consider, assess and adopt unless it can be shown to WDC and WRC's satisfaction that they are not appropriate on a site specific basis.

This document is a live document that will be updated by WDC as more information becomes available or management practices change in the future. It will also assist in meeting the principles of water sensitive design described in the Waikato Stormwater Management Guidelines (WRC, 2018) and the RITS (LASS, 2018).

1.3 Scope

Past studies commissioned by WDC have covered various aspects of stormwater management and design for future developments and span the previous 10 years during which time design guidelines, practices and levels of service have changed. The scope of this SMP is to provide a reference point to these documents,

summarise the key points, determine which stormwater features and practices remain important and identify knowledge gaps, but not necessarily fill these gaps.

The underlying philosophy WDC seeks to achieve is to enhance and mimic natural drainage systems to protect and enhance ecosystem health, co-design with nature, take an integrated and regenerative approach to urban development, optimise environmental, social and cultural benefits and increase resilience to natural hazards and climate change (WSP Opus, 2018).

At this stage the SMP does not cover the below listed items, some of which are needed under WDC's stormwater resource consent (refer to Section 1.6.8). It is noted that a development proposal referring to this SMP may also need to address these as part of a normal resource consenting process of investigations, assessment, design and approvals (subject to the nature and scale of the development proposed).

- Activities and stormwater management in the upper, rural, catchment.
- Stakeholder engagement, beyond references within existing documents
- Social, cultural / mana whenua and heritage assessments beyond that already carried out for the Structure Plan
- Terrestrial vegetation survey and identification
- Groundwater and soakage - only a high-level hydrogeological commentary is included
- Contaminated land locations and assessments
- Updated percent impervious, as WDC building footprint information is not up to date
- Piped reticulation network capacity assessment
- Condition assessments and data accuracy/completeness
- Contaminant load modelling or water quality monitoring
- Ecological assessments beyond that already carried out for the Structure Plan
- Device failure blockage risk assessment
- Wastewater overflow initiatives
- Operation and maintenance procedures including spill response
- An updated schedule of prioritised initiatives.

It is noted that this SMP does not automatically grant statutory approval (resource consent, building consent, engineering approval) for developments proposed. The standard resource consenting and approval processes remain relevant, but developments that use this SMP can expect to have their stormwater management proposals more readily accepted by WDC than otherwise could be the case.

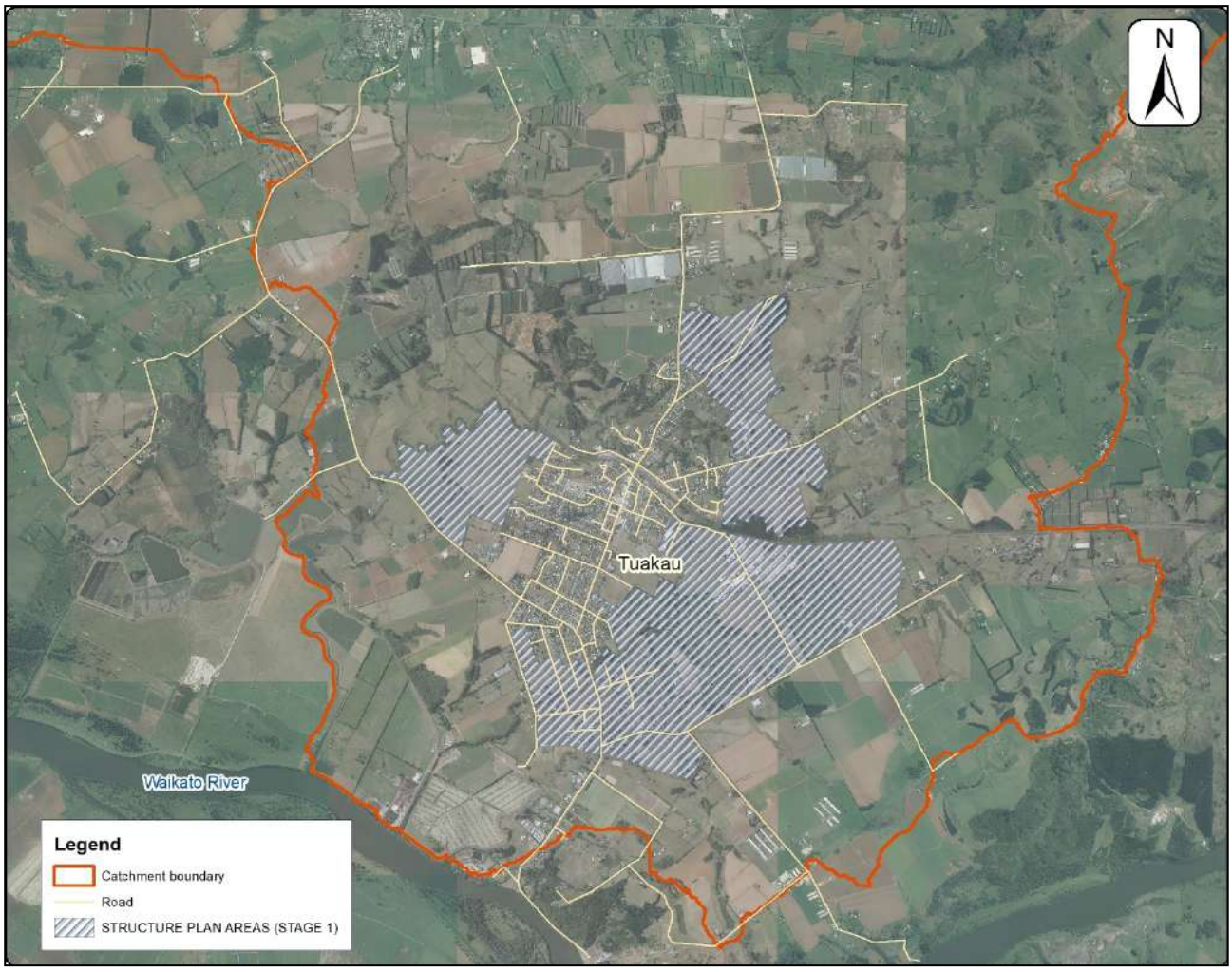

Figure 2 Tuakau town with the overall catchment boundary partially shown.

1.4 Integrated Water Management

Integrated water management (IWM) is a holistic approach to stormwater management, incorporating elements beyond drainage, flooding and water quality. IWM seeks to address such items as urban heating, public amenity, ecological benefits, financial efficiency, stormwater capture and re-use and cultural values. Some of these are in common with Water Sensitive Urban Design (WSUD) and LID however, IWM focuses more on wider scale multi-amenity uses of stormwater and stormwater infrastructure.

Recommendations in the Tuakau Structure Plan touch on elements of IWM through increasing connectivity, a focus on green spaces and requirements on water quality treatment. For IWM to work, it is important to engage in this process early, at the concept stage of a project, so that opportunities for development and infrastructure to include multiple environmental, cultural, social and financial benefits can be identified and actioned. There is great scope for innovative design and planning in towns with growth predictions as large as Tuakau's.

1.5 Relevant and Supporting Documentation

This report has compiled information from a number of sources and the key documents referenced are listed below:

- Proposed Waikato District Plan (Waikato District Council, 2018), Stage 2 currently in progress

- Regional Infrastructure Technical Specifications (LASS, 2018)
- Waikato Stormwater Management Guide (WRC, 2018)
- Tuakau Structure Plan Stage 1 Flood Hazard Modelling (Beca, 2018)
- Tuakau Structure Plan (Waikato District Council, 2014)
- Aquatic Ecological Assessment Update for the Tuakau Structure Plan Area (Brian T Coffey and Associates Ltd, 2014)
- Draft Catchment Management Plan Tuakau Structure Plan Area (Tonkin and Taylor, 2014)
- 50 Year Stormwater Strategy for the Waikato District (MWH, 2014)
- District Wide Stormwater Management Plan (Tonkin and Taylor, 2009)
- Tuakau Catchment Management Plan (Harrison Grierson, 2009)
- Tuakau Discharge to Water Resource Consent 105051 (WRC, 2008)
- Tuakau Stormwater Management Plan addendum (Harrison Grierson, 2008)
- Waikato Regional Plan (Waikato Regional Council, 2007)
- Operative Waikato District Plan, 2000.

1.6 Planning Context

There are several statutory documents, additional to those in the above list, that inform the context of this SMP, including:

- National Policy Statement for Freshwater Management (Ministry of Environment, 2014 amended 2017)
- National Policy Statement for Urban Development Capacity (Ministry of Environment and Ministry of Business, Innovation and Employment, 2016)
- Waikato Regional Policy Statement (WRPS, 2016)
- Waikato Regional Plan Change 1 (Healthy Rivers, 2016)
- Waikato Regional Plan (WRP, 2012), and
- Vision and Strategy for the Waikato River (Waikato River Authority, 2011).

These give direct requirements for protection, restoration and enhancement of watercourses and the use of IWM, LID and best practicable option management and design.

1.6.1 National Policy Statement for Freshwater Management

The relevant requirements of the National Policy Statement for Freshwater Management (NPS-FM) include:

- Considering and recognising Te Mana o te Wai in freshwater management
- Safeguarding fresh water's life-supporting capacity, ecosystem processes, and indigenous species
- Taking an integrated approach to managing land use and fresh water
- Safeguarding the health of people who come into contact with the water, and
- Protecting the significant values of wetlands and freshwater bodies.

1.6.2 National Policy Statement for Urban Development Capacity

The relevant requirements of the National Policy Statement for Urban Development Capacity (NPS-UD) include:

- Recognising the need to enable urban environments to develop and change and provide sufficient development capacity to meet the needs of people and communities and future generations in urban environments
- Providing effective and efficient urban environments that enable people and communities and future generations to provide for their social, economic, cultural and environmental wellbeing
- Local authorities shall ensure that at any one time there is sufficient development capacity available

- Short-term development capacity shall be appropriately zoned and serviced with development infrastructure, and
- Medium and long-term capacity shall be either serviced with development infrastructure or have development infrastructure identified in a long-term plan or infrastructure strategy.

1.6.3 Vision and Strategy for the Waikato River

The Vision and Strategy/Te Ture Whaimana o Te Awa o Waikato was adopted by the Government as part of Treaty Settlement legislation. It also gives effect to the NPS-FM and must be given particular regard by the Regional Council when assessing applications for activities relating to the Waikato River or Waipa River as well as activities in the respective catchments that affect the rivers. The sections of the Vision and Strategy relevant to the SMP are:

- The restoration and protection of the health and wellbeing of the Waikato River
- The restoration and protection of the relationship of Waikato -Tainui with the Waikato River, including their economic, social, cultural and spiritual relationships
- The integrated, holistic and coordinated approach to management of the natural, physical, cultural and historic resources of the Waikato River
- The recognition and avoidance of adverse cumulative effects, and potential cumulative effects, of activities both on the Waikato River and within its catchments on the health and wellbeing of the Waikato River
- The recognition that the Waikato River is degraded and should not be required to absorb further degradation as a result of human activities, and
- The restoration of water quality within the Waikato River so that it is safe for people to swim in and take food from over its entire length.

1.6.4 Waikato Regional Policy Statement and the Waikato Regional Plan

The requirements of the Waikato Regional Policy Statement (WRPS) and the Waikato Regional Plan (WRP) relevant to this SMP include:

- Restoring and protecting the health and wellbeing of the Waikato and Waipa Rivers.
- Addressing the effects of sedimentation and nutrients in estuaries that are not derived from natural processes
- Development consent decisions to be supported by information which identifies how stormwater will be managed having regard to a total catchment management approach and low impact design methods.
- Avoiding as far as practicable adverse effects on natural hydrological characteristics and processes, soil stability, water quality and aquatic ecosystems
- Adopting sustainable design technologies where appropriate
- Maintaining or enhancing water quality by reducing sediment that is derived from human based activities and by reducing microbial, nutrient and other identified contaminants
- Considering the alternatives to direct discharge to water including promotion of land-based mitigation of stormwater
- The requirement for territorial authorities to manage the effects of subdivision, use and development either by promoting best practice stormwater management for urban areas, including the need for stormwater catchment plans for greenfield development, and managing contaminant loadings (including sediment) entering stormwater networks, and
- Encouraging at-source management and treatment of stormwater discharges to reduce adverse water quality and water quantity effects of discharges on receiving waters. The associated explanation refers to statutory and non-statutory means to encourage stormwater management prior to its discharge to receiving waters.

Proposed Plan Change 1 – Waikato and Waipa River Catchments (Healthy Rivers) applies to the Waikato and Waipa River catchments and gives effect to the NPS-FM and the Vision and Strategy. The Plan Change 1 was notified on the 22 October 2016 with a purpose of reducing point source and non-point source of contaminant loadings (nitrogen, phosphorus, sediment and bacteria) entering watercourses (including groundwater) within the Waikato and Waipa River catchments.

The plan change sets out short-term and long-term numerical water quality targets for the Waikato and Waipa River catchments as well as rules related to farming activities and land use change.

1.6.5 Operative Waikato District Plan: Franklin Section

The Operative Waikato District Plan: Franklin Section became operative in 2000 and remains in force until the Proposed Waikato District Plan becomes operative. The Operative District Plan sets out strategic objectives related to growth and set out below:

- To provide for the majority of growth, within or as an extension to, existing and planned towns and villages in a structured manner that supports nodal growth
- To provide directed and managed residential opportunities associated with the villages in a manner that reduces pressure to develop rural land and supports existing and planned villages, and
- Towns and villages should generally be managed in a flexible way to provide for a wide range of activities.

It also includes specific policies regarding development:

- To manage the effects of the pattern of urban growth for Tuakau with respect to versatile land and to facilitate the effective use and servicing of land
- That WDC continues to investigate new (or upgraded) sewage treatment, stormwater treatment and control, and water supply systems taking into account tangata whenua perspectives, general environmental health concerns, and annual financial priorities
- Activities will be required to demonstrate that any risk of high or detrimental sediment loading arising from overland stormwater runoff is effectively managed at all stages of development or operation, and
- Any large areas (generally over one hectare) which are to be subdivided or developed, must at the time of rezoning or application for consent demonstrate that the natural character and functioning of any stream, water body or water course in, near, or immediately downstream from the site will be protected and enhanced.

1.6.6 Proposed Waikato District Plan

The Proposed Waikato District Plan (WDP) was notified in mid-2018. The further submission period closed on 16 July 2019, with hearings and decisions to follow. The Proposed WDP includes provisions intended to address the growth of Tuakau and provide flexibility for development by incorporating Stages 1 to 3 of the TSP.

The WDP sets up Tuakau as both a residential and industrial growth area and sets out specific objectives and policies including:

- Tuakau is developed to ensure:
  - Subdivision, land use and development in Tuakau's new residential and business areas occurs in a manner that promotes the development of a variety of housing densities, diversity of building styles and a high quality living environment
  - Existing intensive farming and industrial activities are protected from the effects of reverse sensitivity by considering the location of new residential development, and
  - Future neighbourhood centres, roads, parks, pedestrian, cycle and bridle networks are developed in accordance with the Tuakau Structure Plan.

- A wide range of housing options occurs in the Residential Zones of Huntly, Ngaruawahia, Pokeno, Raglan, Te Kauwhata and Tuakau
- Tuakau includes an industrial strategic growth node, and
- Buildings and access in Tuakau are located in a position to enable future subdivision and development when infrastructure and services become available and in a manner that provides for transition from large lots to smaller lots.

More generally, the Proposed WDP sets out objectives and policies related to infrastructure development including:

- Infrastructure is developed, operated and maintained to benefit the social, economic, cultural and environmental well-being of the district
- Infrastructure takes into account the qualities and characteristics of surrounding environments and community well-being
- Infrastructure services are developed to a standard that enables the service to be extended to future growth areas where appropriate
- Infrastructure is provided for, and integrated with, subdivision, use and development
- Adequate provision of infrastructure, including land transport networks, where land is subdivided or its use intensified
- Subdivision, use and development are provided with infrastructure and services to a level that is appropriate to its location and intended use including three waters (water, wastewater and stormwater supply)
- The hydrological characteristics of the natural drainage processes are retained, and
- Stormwater and drainage infrastructure for subdivision, land use and development:
  - Adopts, where appropriate, a best-practice low impact design approach to the management of stormwater
  - Manages stormwater in accordance with a drainage hierarchy, with a preference for on-site treatment;
  - Minimises impervious surfaces to reduce stormwater run-off
  - Retains pre-development hydrological conditions as far as practicable
  - Does not increase the flow of stormwater runoff onto adjoining properties or flood plains, or reduce storage capacity on-site
  - Provides a stormwater catchment management plan for future urban development, and
  - Promotes clean water reuse and groundwater recharge where practicable.

1.6.7 Tuakau Structure Plan

The TPS is a guide to the development of the town of Tuakau over the next 30 years to 2045. The plan was prepared by Waikato District Council working with local iwi, residents and key stakeholders.

Although the TPS will be largely superseded by the zoning set out in the Proposed WDP (i.e. will no longer be implemented through a series of staged plan changes) and the greater flexibility provided by the zoning, the Proposed WDP requires that the development of future neighbourhood centres, roads, parks, pedestrian, cycle and bridle networks in undertaken in accordance with the TSP.

This document also includes relevant technical reports on ecological stormwater amongst others.

1.6.8 Resource Consents

WDC has resource consent (105051) for discharge to the Tuakau Urban area for the following activity

> **Authorised Activity:** *Divert and discharge urban stormwater runoff and associated contaminants at multiple locations to land, the Whakapipi Stream, Tutaenui Stream and Kairoa Stream, and use discharge structures in the general vicinity of Tuakau Urban Area that is reticulated by the Tuakau municipal stormwater system*

The consent period expires on 14 November 2028 and covers an area that is referenced in the consent file as NZMS 260 R12: 830-364 and is shown in Appendix A.

This consent should be reviewed in the context of the zoning set out in the Proposed WDP and the development of new infrastructure that may be required to service that zoning.

It is expected that for all new developments (subject to the scale and nature of the proposed activity/design) will require individual resource consents to divert and/or discharge water (unless it can be shown to be a permitted activity).

Any new consents of which the assets will be transferred to WDC must consider the above consent conditions in addition to the conditions of a new consent(s). New consents for assets that will be vested to WDC, and therefore will become subject to the existing consent.

1.6.9 Permitted Activities

Some activities may be permitted by WRC and WDC under the relevant Regional/District Plans. The requirements of these Plans must be complied with for an activity to be considered to be permitted.

1.7 Stakeholder Engagement

The district wide SMP (Tonkin & Taylor, 2009) includes stakeholder engagement plans to set up Iwi feedback for the region. The report highlighted some key considerations brought to attention through Iwi engagement including:

- inclusion in decision making
- WRC to address stormwater discharge quality and mitigation of effects
- recognition of spiritual aspects of water management, and
- improvement of fish passage.

WDC has undertaken consultation and engagement to inform previous reports (including the TSP). Additionally, the Community Plan (Tuakau & Districts Community Committee, 2012) is referred to in previous documents and provides an overview of key community priorities for the region.

Depending on the nature of development and/or activity, key stakeholders will need to be identified and consulted. WDC/WRC will confirm effected parties as part of the standard resource consenting process.

2 Existing Environment

2.1 Receiving Environments

Surface water receiving environments are well documented in Tuakau however, information on aquifers and groundwater interactions (particularly with first and second order streams) is not well understood.

The key receiving environments are the:

- Kairoa Stream
- Whakapipi Stream
- Tutaenui Stream
- Waikato River
- various un-named tributaries (watercourses, farm drains etc) of the above watercourses, and
- groundwater table.

The watercourses and catchments in Tuakau are shown on the maps included Appendix B.

The Kairoa and Whakapipi Streams both drain to the Tutaenui Stream which, in turn, enters the Waikato River. The downstream boundary of the Tuakau catchment is the Waikato River which is tidally influenced (to a small degree) at these confluences. Over 60% of stream length in the Waikato region are first order streams, and it is important to have protection of these as a goal in any stormwater management proposal. Drainage features of the TSP area are further detailed in the 2014 Catchment Management Plan (Tonkin & Taylor, 2014).

The RITS and the *Waikato Stormwater Management Guideline* (WRC, 2018) outline requirements for discharge into various receiving environments including measures to address stream scour, water quality treatment and water quantity controls. Treatment is required for all receiving environments whilst water quantity control is required for streams, modified channels/rivers and where there is existing downstream flooding. Mitigation of stream and channel erosion/scour is needed in almost all instances so the incorporation of extended detention, scour counter measures and/or stream channel restoration will normally be standard design requirements. The *Waikato Stormwater Management Guideline* (WRC, 2018) reference several policies from the Resource Management Act (1991) that relate to discharge and receiving environments as well as recommending against piping of natural watercourses.

2.1.1 Catchments

The wider catchment area is characterised by gentle topography and is 6,322 ha in size, discharging around 30 km upstream of the mouth of the Waikato River. The furthest upstream point of the catchment extends to Pukekohe. Within the wider catchment there are four main watercourse that drain through Tuakau to the Waikato River, each with their own catchment areas:

- Whakapipi catchment – 1,416 ha
- Tutaenui catchment – 4,798 ha (including the Whakapipi as a sub-catchment)
- Kairoa catchment – 1,146 ha
- Whangarata catchment – 378 ha

The majority of the catchment is rural land, with Tuakau located in the south at the bottom of the catchment near the Waikato River. Some residential areas of Pukekohe located in the northern reaches.

2.1.2 WRC Scheme Drain

The lower reaches of the Tutaenui, Kairoa and Whangarata Streams (shown in Figure 3) form part of the Tuakau Swamp scheme drain which is administered and maintained by WRC for the purpose of pastural

drainage. Scheme drains generally have a 10 year ARI level of service that needs to be maintained. Developments that drain into these need to meet a set of WRC criteria as stipulated in Section 16 of WRC's *Waikato Stormwater Management Guideline* (WRC, 2018). This includes a 72 hour extended detention requirement and a requirement not to increase the total volume discharged to the drains. In an urban development context, this will drive the need for soakage disposal of stormwater. To understand the potential impact on the scheme drains and/or evidence no effect, an assessment of effects must therefore extend well beyond the immediate property boundary of any particular development site should that development drain into a scheme drain.

The Tuakau Swamp area also includes stopbanks and a pump station (shown in Figure 3) that while operated by WRC, are administratively separate to the drainage schemes. Impacts on the stopbank and pump level of service will also need to be addressed with WRC.

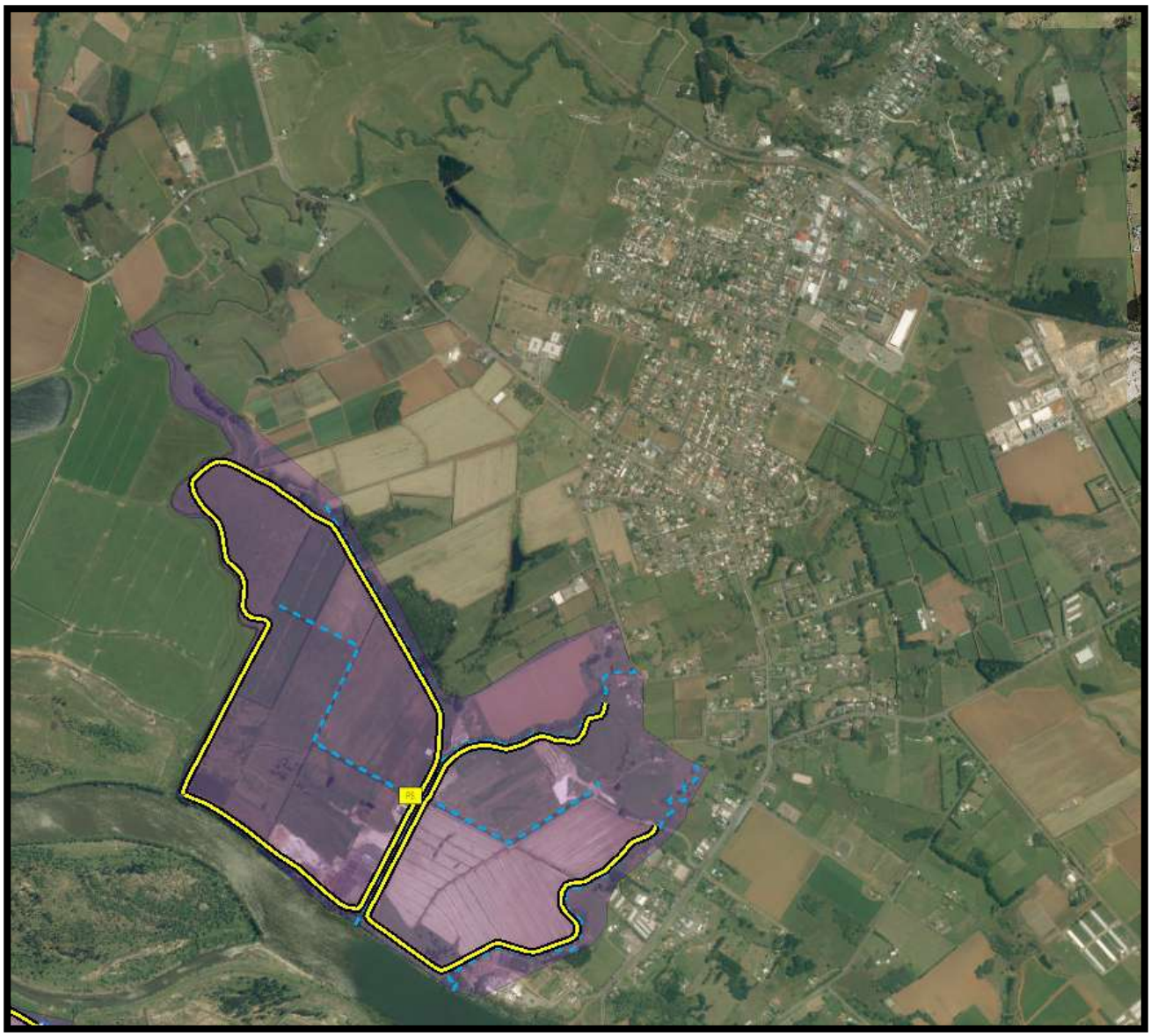

Figure 3 WRC's Tuakau Swamp Drainage Scheme also showing stopbanks and pump station.

2.1.3 Key In-stream Structures

There are several major waterway structures throughout Tuakau township including railway and road bridges and culverts. Major road crossings occur at:

- Buckland Rd on Tutaenui Stream
- Whangarata Rd on Whangarata and Kairoa Streams
- Harrisville Rd on Whakapipi Stream

These are shown on the information included in Appendix B (location map, photos and a table outlining parameters).

2.1.4 Aquatic Habitats

Ecological stream assessments have been carried out at various stages in the past, the latest as part of the TSP (Coffey B.T, 2008). This gave a thorough understanding of the state of the environment and watercourses, at the time, and identified key ecological areas. In summary of the survey:

- covered 6 subject matters: habitat, periphyton, macrophytes, macroinvertebrates, fish and water quality.
- there were generally poor to suboptimal habitat assessment scores in the Kairoa, Whakapipi and Tutaenui streams.
- the study confirmed results of an earlier 2008 study that covered the same area and also extended out to incorporate the Whakapipi and Kairoa streams.

Further details can be found in the report or in an overview of this and several other reports that was completed as part of the Tuakau CMP (Tonkin & Taylor, 2014). Furthermore, several other documents touch on ecological issues or concerns in the Tuakau region. The Tuakau Catchment Management Plan by Harrison Grierson (Harrison Grierson, 2009) recommends that watercourses are retained in their natural state and not piped, despite being of poor/degraded quality. However, subsequent to this, regional policy has developed to emphasise restoration and enhancement of watercourses (as noted in Section 1 above).

The CMP (Tonkin & Taylor, 2014) includes a high level ecological commentary which is summary below, it noted that:

- the health of streams in the catchment are considered to be generally degraded but there is significant potential for stream value enhancement
- there is a lack of significant riparian vegetation providing shading and the presence of nutrients (agricultural and horticultural side effects) is likely to have increased macrophyte and periphyton growth within the streams
- there is a lack of woody debris in streams. There are some regions with pools, slow moving runs, undercut banks, root mats and overhanging vegetation but these were at limited locations
- there are barriers to upstream fish passage were identified on Tutaenui, Whakapipi and Kairoa streams. These are most likely to impact non-climbing fish species. Some of these are natural (waterfalls) resulting from the interaction of streams with the underlying volcanic geology, and
- that public access is limited and it is therefore difficult to measure different ecological parameters.

WRC's online resource; Land, Air, Water Aotearoa (WRC, 2019), gives water quality information for numerous stations within the Waikato Region, one of which is located on the Whakapipi Stream near Tuakau. This can be used for high level updates on stream quality relative to other measured sites.

Depending on the nature of the development proposed (extent and type of activity), ecological assessments may be required as part of the resource consent application. This should be discussed and agreed with WRC and WDC in advance of preparing a submission / resource consent application.

2.2 Hydrogeology

2.2.1 Geology

The majority of Tuakau is underlain by basaltic lava flows, scoria and air fall deposits. Alluvial deposits along the Waikato River to the south of the catchment form part of the Puketoka Formation. These are comprised of pumiceous mud, sand and gravel with muddy peat and lignite; rhyolite pumice, including nonwelded ignimbrite, tephra and alluvial pumice deposits and massive micaceous sand. The underlying volcanic geology interacts with the watercourses through groundwater recharge and extrusions creating waterfalls where exposed.

Further detail on the geology of the area and its suitability for different purposes is discussed in geotechnical technical report prepared for the TSP (AECOM, 2014).

2.2.2 Hydrogeological Conditions

A desktop review of available information for the catchment considered the following information, which is also graphically shown in :

- published geological maps (Edbrooke, 2001)
- the Beca site investigation database, and
- the New Zealand Geotechnical Database (NZGD).

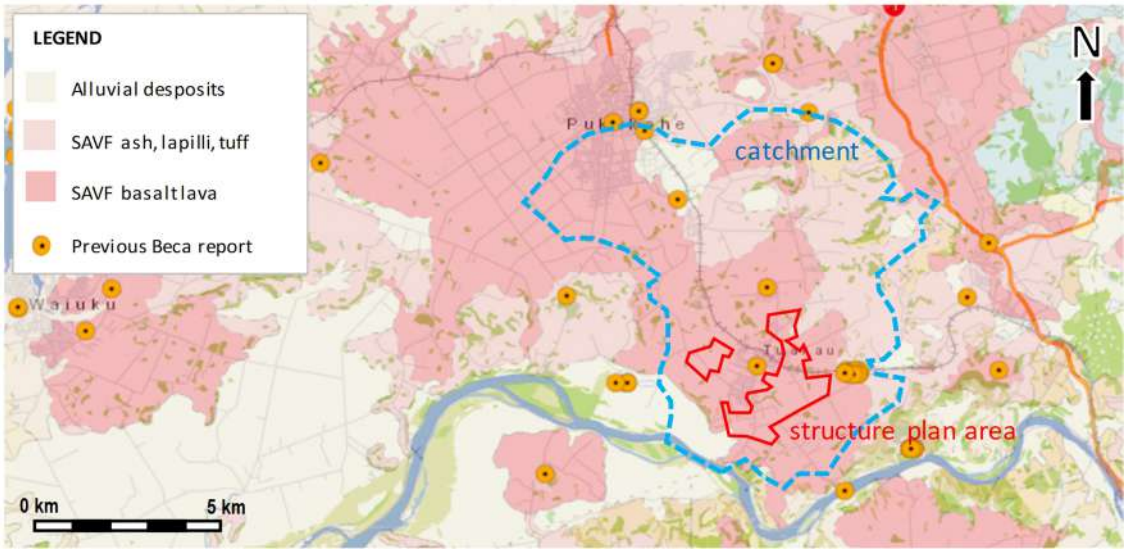

Figure 4 Geological map of the area (Edbrooke, 2001).

The review indicates that the shallow hydrogeology will be controlled by the presence of South Auckland Volcanic Field basaltic lava flows, ash and tuff.

Extensive basalt lava flows are mapped thoughout Tuakau, in some places these may outcrop at the surface, whilst in other areas, available bore logs indicate there may be 10 m to 20 m of residually weathered basalt, ash or tuff above shallow, perched watertables. The watertables are likely to be supported by the overlying soils and in the absence of any specific site data should be assumed as occurring within the upper few metres of the soil profile.

The hydraulic properties of the basalt lava flows will vary, depending on the nature and interconnection of fracturing and permeability, and could range over many orders of magnitude, though are generally expected to be high. Deeper groundwater levels of 10 m below ground level (bgl) to 20 m bgl are reported from limited groundwater well data in this area. Groundwater bores in the basalt are prominent in the wider Pukekohe

area for irrigation purposes. WRC's website shows the locations of stormwater bores around Tuakau, refer Figure 5.

The shallow basalt aquifer is likely to be unconfined and groundwater levels generally reflect the topography with an overall flow direction towards the Waikato River. There is a direct connection to watercourses, with shallow groundwater providing an important source of baseflow to streams (particularly in drier periods).

Low permeability alluvium is mapped at the surface in lower lying areas and is encountered at depth elsewhere, where it separates the volcanic aquifer from the underlying Kaawa Formation (also an important water supply aquifer in this region). The alluvium forms a leaky aquitard between the two aquifers, and in the wider and upper parts of the catchment downward vertical leakage from the basalt is considered an important source of recharge to the Kaawa Formation.

The township of Tuakau is however, located at lower topographic levels in the catchment and considered to be within a groundwater discharge zone (Hadfield, 2001), i.e. there is an upward vertical groundwater gradient and the presence of springs in some areas.

The volcanic and Kaawa aquifer in this area are generally at, or close to, reported allocable limits for water supply and surface watercourses are generally understood to be fully (or over) allocated, requiring careful and integrated management of the interaction between shallow groundwater and surface water.

The basalt is an important shallow aquifer that is widely used for groundwater supply. Any future development will need to consider if an increase in impervious cover could result in reduced rainfall recharge to the aquifer, and a subsequent change in groundwater level or quality that could impact existing groundwater takes. Similarly, soakage disposal to groundwater needs careful assessment.

The shallow basalt aquifer is an important source of baseflow to streams, particularly in drier periods where it may provide the only sustained source of flows. Again, future developments will also need to consider the potential effects (quality and quantity) on aquifers from reduced rainfall recharge, which could in turn result in a reduction in stream baseflows and associated impacts on dependent ecosystems and/or existing surface water takes.

Given the above, discharge of stormwater to the ground in some areas could be helpful for maintaining the shallow groundwater system and stream basflows. However, the hydraulic properties of the volcanic aquifers will vary laterally and in profile, such that site specific investigations will be required to determine if the local conditions (groundwater levels, gradients and infiltration rates etc) are favourable for soakage.

Soakage maybe viable where permeable basalt is near surface and the groundwater level is sufficiently deep. Where there is thick layer of residually weathered soils near surface soakage is likely to be less viable. In either case, the potential for mounding (rise in groundwater level) to occur would need to be considered, to determine if there were any associated adverse effects e.g. a rise in groundwater level that could result in surface flooding, alter flow paths sufficient to change the groundwater quality, impact structures or buried services, impact vegetation or create boggy surfaces on adjacent land.

The locations of groundwater bores (shown in Figure 5) will also need to be considered when proposing soakage disposal, in particular if these are being used for water supply. Referral to WRC must be undertaken in the first instance, and expert hydrogeological advice sought and used.

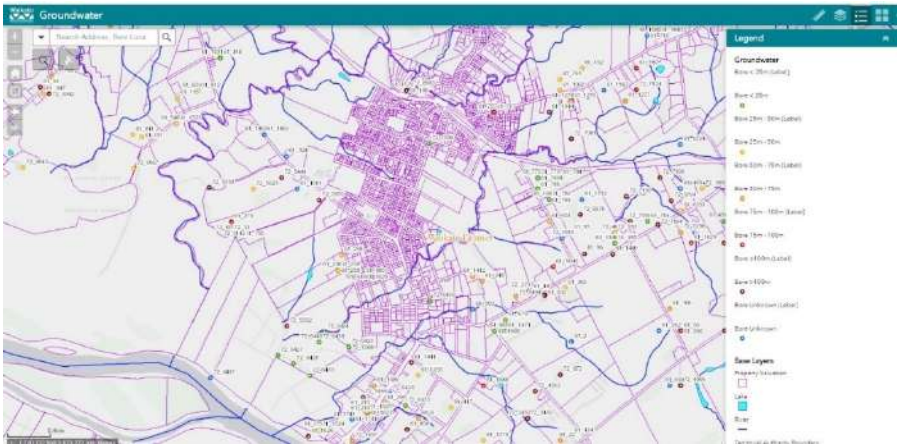

Figure 5 Screen shot of WRC's webviewer showing locations of groundwater bores.

2.3 Current Land Use and Development

Tuakau region is dominated by horticultural and agricultural land use with residential and commercial areas occupying a significant portion of the town. Light and heavy industrial areas are also present and the North Island Main Truck Line Railway line runs through town.

The land use incorporated in the Beca 2018 hydraulic modelling (discussed in subsequent sections) was based on aerial photographs of current zoning as development had not reached the full extent as yet. It is important to gather an understanding of existing infrastructure, particularly the stormwater network, in order to understand critical features and the impacts of additions to this network. Land use maps are shown in Appendix C.

2.3.1 Existing Drainage Network

Information on the current drainage network including stormwater and wastewater systems is available through WDC, although there are information gaps in both the urban and rural networks. Figure 6 shows a map of the available municipal drainage network (from WDC's GIS).

Figure 6 Tuakau existing stormwater system (includes some streams) as provided by WDC GIS data.

2.4 Existing Flood Hazard

Flood hazard modelling has been completed as part of the most recent Tuakau flood modelling (Beca, 2018/9) and at risk properties and manholes were identified through a District Wide model (WSP Opus, 2018) and the rapid flood model (Tonkin & Taylor, 2014). These different models are discussed in more detail under Section 6.3.

Hazard mapping that currently exists is limited by the scope and detail of these models. Flood extent and hazard mapping for Tuakau from the various models are included in Appendix D.

2.5 Documentation / Data Gaps

The SMP recognises that there are currently documentation and data gaps which when filled would inform different aspects of effective stormwater management and planning. Many of these gaps have been highlighted in previous reports and the significant ones are summarised below. It is not in the scope of the SMP to progress these further than identifying gaps and noting these may need to be addressed by an individual development/developer in the future.

The gaps identified through the reporting process are:

- Groundwater regime – including aquifers, levels, seasonal variations and soakage rates/potential and interactions with surface water

- Baseflow information for watercourses
- Detailed/recent water quality information for watercourses including contaminant loads
- Geotechnical interactions such as liquification and settlement risks
- Contaminated land locations and types of contaminant
- Condition of existing stormwater infrastructure (reticulated system, culverts, bridges etc)
- Information on minor culverts including KiwiRail culverts beyond the current Beca 2018 model extents. The main crossings have been surveyed as part of Beca's 2018 modelling
- Existing floor levels to determine flood vulnerability
- New development plans beyond the structure plan of Pukekohe
- Overland flows through town and updated overland flow modelling
- Significant vegetation and ecological sites
- Reticulation network capacity, and
- Iwi values.

3 Catchment Constraints and Opportunities

The TSP, informed through the Vision of the Community document, outlines some constraints and opportunities within the catchment. These cover a wide range of issues including tourism, lifestyle, development and public services and are important considerations for planning and development of Tuakau as the population and service need grows.

When considering these relative to stormwater, the CMP (Tonkin & Taylor, 2014) and recent flood modelling give insight to areas in which flooding constrains development and land use change, and those areas in which there is opportunity for urban growth with the provision for stormwater management.

The CMP (Tonkin & Taylor, 2014) identified some constraints on development opportunities created by flooding (from both overland flow paths and from streams) but found there are significant areas of open space that are largely free from flooding. The Beca 2018 modelling found significantly less land is subject to flood hazard than shown in the Tonkin & Taylor modelling.

Outside significant flood hazard areas and proposed industrial land use areas it is considered that there is generally low to medium flood constraint to growth within the town and planned development areas. This is based on an assumption that good practice measures will be employed to manage stormwater and other environmental and social aspects, in particular effects on watercourses and flood hazard. An opportunity arises from development, as increased growth leads to increased rates income to Council, which can be used to achieve more hazard, drainage and ecological goals (such as stream restoration).

There is a lot of opportunity for applying LID, alternative and holistic designs, especially considering the need for open spaces and that the community vision document highlights lifestyle values.

Figure 7 shows indicative locations of some of the catchment opportunities and constraints that have been highlighted by stakeholders and are recorded in previous documents and listed below.

Opportunities:

1. Increasing development can lead to greater resources and opportunity for activities such as watercourse restoration.
2. The railway runs through town.
3. There is a desire by the community to move sale yards from town centre could open opportunity to improve stormwater treatment of yard runoff.
4. Floodplain footprints are relatively constrained by topography (other than adjacent to the Waikato River) meaning that flows are mostly constrained to the channel or relatively small areas of localised floodplain.
5. The town centre layout is easy to develop and to restore/reintroduce wetland habitat features.
6. Improvements can be made to enhance aquatic values with provision and/or restoration of fish passage within the watercourses.
7. There is no need to provide 100 year ARI attenuation on some watercourses.

Constraints:

1. Flooding from the Waikato River is extensive and is of high hazard.
2. There is a disconnection between town and river.
3. There are erodible, degraded watercourses.
4. The Alexandra Redoubt Bush is an important natural feature and is a constraint to growth.
5. The WRC scheme drains and stopbanks will place discharge (peak flow and volume) limits on development discharges.

6. There are some flood prone areas, including areas of high hazard, associated with watercourses and overland flow paths.
7. WDC's infrastructure is aging and designed to outdated standards (i.e. pre 2018 pipes have a 2 year ARI capacity where current standard is 10 year ARI).
8. The stream water quality is poor and needs to be improved (Coffey B.T, 2008).
9. Private ownership (and unclear ownership) of watercourses is lead to poor or no maintenance.
10. There are several critical culvert locations, including at railway crossings, that have limited capacity (and are generally poorly maintained).
11. Flooding impacts a number of properties and development needs to be carried out in such a way that avoids flood hazard worsening.
12. There is a need to convey upstream flood flows/drainage over/around developing land without detrimental impacts on both upstream and downstream land.
13. There is a lack of hydrogeological (groundwater) information and understanding so the potential for impacts to occur on land, the groundwater table and the environment is significant.

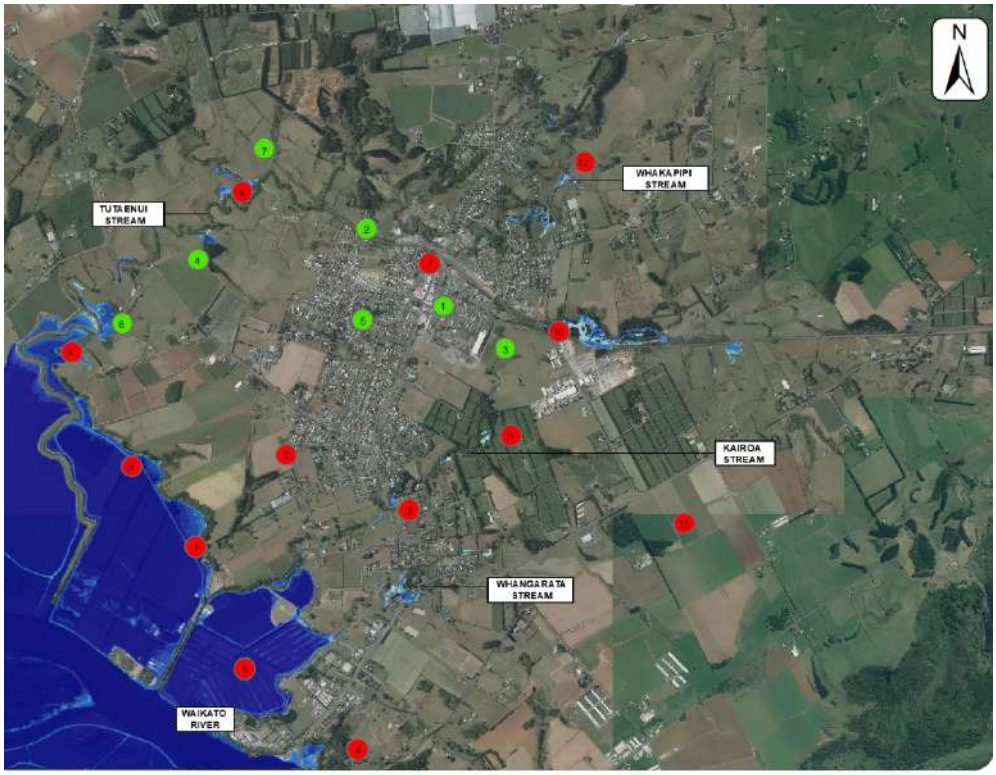

Figure 7 Indicative opportunities and constraints map.

4 Future Development and Proposed Land Use

Land use change and development in Tuakau is being driven by population growth and is exacerbated by growth in the surrounding region and Tuakau's proximity to Auckland.

WDC will employ staged development in Tuakau to ensure new developments are aligned and grow with infrastructure services such as the stormwater system. There are three proposed development stages set out by the TSP that will supply 10 years of development each. These are focused on residential development with provision for development of associated and neighbourhood level facilities, reserves and retail.

Development plans, as they are submitted, will provide more specific information on changes to land use, topography, impervious area and drainage infrastructure. The CMP (Tonkin & Taylor, 2014) notes that future development extends beyond the town and development area boundary given by WDC. Implications of this must be assessed when planning for growth.

New urban areas introduce new contaminants relative to natural or rural areas. Increased development, especially with the introduction of more industrial land use, can lead to a significant increase in contaminants discharged to the receiving environment. Contaminant types commonly found in stormwater can be further read about in the *Waikato Stormwater Management Guideline* (WRC, 2018). These guidelines emphasise the importance of capture and storage systems of at least first flush events. Specific treatment practices need to be tailored to the activity proposed i.e. industrial sites will have a different approach to residential sites.

Three types of development occur in Tuakau, greenfield, brownfield and infill. Of these, greenfield has potential for the greatest hydrological impact on stormwater systems and receiving environments due to the significant changes in land use type. Brownfields development typically include areas with a high proportion of impervious area already, whilst infill, densification of development, can have moderate change, depending on the existing proportion of on-lot pervious area that may be impacted (MWH, 2014). It is also noted that industrial developments may have much more of an impact on water quality than greenfield residential development.

Management and planning strategies often focus on brownfield and greenfield development but it is important to include emphasis on infill development also. This should include understanding flood hazard and avoid development in high hazard areas or overland flow paths, whilst mitigating in moderate to low hazard areas. Additionally, it is much more difficult to retrofit infrastructure in these areas, meaning infill is more limited in its ability to manage stormwater impacts, which generally require land to be set aside for this purpose.

Changes to land use can also have significant impacts on the stream morphology, with one study referenced in the *Waikato Stormwater Management Guidelines* (WRC, 2018) that predicts a threefold increase in stream channel cross section when a catchment goes from pastoral to urban land use. Potential impacts of this type of change must be addressed when considering a development.

Future green spaces are a key part of planning for Tuakau in the TSP (WDC, 2014), building on an existing network. These comprise a mix of land uses from buffer spaces to ecological corridors and parks and assist in increasing pervious area, increasing public amenity, as well as protecting ecological value and sensitive areas.

4.1.1 Growth of Pukekohe

Pukekohe, located in the north of the catchment, is also developing and will impact watercourses within the Tutaenui catchment, potentially contributing to downstream impacts in Tuakau. Being in the Auckland region,

growth in Pukekohe is outside WDC's jurisdiction and control, yet will impact stormwater and flood conditions around Tuakau and thus needs to be acknowledged and considered as part of a maximum probable development (MPD) catchment scenario. Beca's 2018 modelling includes this growth in the unmitigated MPD scenario.

4.2 Developer Requirements for Stormwater Design and Disposal

A hierarchy of stormwater management required for water quality treatment is outlined in RITS section 4.2.3.1. This covers retention of rainwater for reuse, soakage, treatment and detention prior to discharge to either a watercourse or piped stormwater system. Soakage has been identified as a current information gap so predictable impacts of this solution will remain as good as the available information. Site specific assessments of soakage should be undertaken to determine the feasibility of infiltration disposal of stormwater.

RITS Levels of Service list the requirements for flood management and downstream impacts, as well as for water quality and maintenance of stormwater systems that are applicable to both public and private systems. Stormwater discharge allowances are also governed by resource consent conditions, issued by WRC.

The *Waikato Stormwater Management Guideline* (WRC, 2018) outlines significant requirements for stormwater management within the Waikato region, including suggestions and direction for developers relating to LID and acceptable practices that form Best Practicable Options (BPO).

Detention of stormwater prior to release to Council stormwater systems is required to manage peak flows and volumes in the stormwater network which will likely increase with further development. However, detention may only be required for 2 and 10 year ARI events. Attenuation to 80% of the pre-development peak flows in 100 year ARI events may not be required in some locations, as discussed in following sections. Generally, attenuation of the 100 year ARI event is only needed in the upper half of a catchment.

Developers must carry out Safety in Design assessments and document this as part of their submission to WDC. This is required to meet the obligations of the Health & Safety in the Workplace Act, 2015.

In summary, the following will be required, as set out in WDC and WRC guidelines:

- Inclusion of climate change increases
- Soakage disposal (or evidenced why not appropriate)
- Drainage network capacity to RITS standards (where connecting into existing drainage with lesser capacity then either the upstream controls are needed to avoid overloading the drainage or the downstream network is to be upgraded)
- 10 year ARI discharge control to WRC requirements where upstream of a WRC Scheme Drain
- 100 year ARI peak flow attenuation where discharging into Kairoa and Whagarata Streams
- Provision for secondary flow paths
- Fish passage for instream structures
- Erosion and scour control measures (extended detention and scour at structures) and stream restoration
- Water quality treatment
- Protection, enhancement and restoration of aquatic habitats
- Off-setting of environmental effects (as required by WRC)
- Culvert debris blockage countermeasures (should a risk assessment determine these are needed)
- Safe and maintainable infrastructure (documented by a Safety in Design assessment and with operation and maintenance plans)
- Multi amenity features for stormwater infrastructure
- Sensitivity testing subject to the nature and location of proposed development and/or activity.

4.3 Urban Design Principles

The TSP outlines broad urban design and planning principles with further detail outlined in the Tuakau Urban Design Guide (an appendix to the TSP) (WDC, 2014). The guide emphasises the importance of design in infill, brownfields and greenfield development to creating effective public spaces and tying urban areas in with green spaces and the environment. There are several references which impact stormwater management in developments, however the design guide mainly looks more holistically at interactions between people, environment and urban development. The guidelines include an assessment covering natural character, including emphasis on natural drainage patterns, topography and vegetation as specified in the RITS and particularly WRC's stormwater management guidelines, the WRPS and the WRP. Natural watercourses are expected not just to be retained but restored and enhanced. There are also several references to the inclusion of sustainable drainage strategies which are defined as including the following:

- minimising impermeable surfaces;
- soak pits within residential areas and adjacent to streets;
- provide for swales, rain gardens and retention ponds;
- provide for local retention ponds and soakage areas in close vicinity of compact residential sites.

The Urban Design Guide is limited by its high level nature however, it provides inclusion of non-traditional drainage solutions within the wider picture of urban design, forming a starting point for future sustainable development. Other urban design guidelines such as Auckland Council's TP124 may also be used as appropriate.

5 Design Hydrology

5.1 Rainfall

5.1.1 Existing Climate Rainfall

The High Intensity Rainfall Design System (HIRDS) version 4 shall be used to determine current rainfall depths in accordance to most up to date guidance by National Institute of Water and Atmospheric Research (NIWA).

5.1.2 Climate Change Rainfall

The Waikato Regional Policy statement requires climate change to a minimum increase of 2.1˚C by 2090 to be considered.

HIRDS V4 is currently inconsistent with recent (2018) Ministry for the Environment (MfE) climate change advice with respect to national and regional temperature increase predictions. Therefore, HIRDS V4 needs to be used with caution. At the time of writing this report the RITS requirements for climate change rainfall were being reviewed to clarify this issue. Generally, Representative Concentration Pathway (RCP) 6.0 should be used for design and RCP 8.5 used as a sensitivity test.

Sensitivity testing shall be completed for areas that are upstream of critical infrastructure or for other features that are sensitive to flooding. The scope and need for sensitivity testing shall be discussed and agreed with WDC and WRC prior to finalising development proposals.

5.1.3 Hydrological Method

The following hydrological methods should be used:

- Rational method:
  This should be used for catchments under 8 ha as per RITS. There are several conditions in which the Rational Method is not appropriate for use:
  - if detention and/or attenuation is proposed
  - if the time of concentration exceeds 30 minutes and a high degree of reliability is needed
  - for historic flood comparison, and
  - if there is significant storage in the catchment.

- Waikato Runoff Modelling Guide (WRC, 2018):
  WRC's Curve Number based methodology. Note this method requires shallow infiltration testing to inform the selection of the soil classification.

Note that Auckland Council's TP108 is no longer an acceptable methodology for new developments.

6 Flood Management

6.1 Modelling

WDC had investigated the Tuakau township and catchment over the last 13 years, commissioning several flood models that focus on different scales and outcomes. The future application of these models is therefore limited and understanding the inputs and scope of potential outputs is critical to applying these models and interpreting their results. A brief outline of the most recent hydrological and hydraulic models covering Tuakau township is provided below, with further detail relating to the hydrological and hydraulic modelling discussed in the sections following.

The studies to date are as follows:

- **Tuakau Flood Modelling** (Beca, 2018 and 2019): Floodplain level modelling of the watercourses and catchments for existing and developed conditions in both current and future climates. Modelling included mitigation scenarios and sensitivity testing for HIRDS V3 (2018) and V4 (2019) rainfall. The model tested cumulative effects of the TSP development on receiving streams and associated floodplains for the 10 year and 100 year ARI events. This model was peer reviewed.
- **District Wide Model** (WSP Opus, 2018): Overland flow path modelling of the 100 year ARI event across large parts of the district covering multiple towns including Tuakau. Modelling completed for existing and developed conditions at a low resolution. This model was built to highlight potential flood risk zones and flow paths for future more detailed modelling.
- **Rapid Hazard Flood Mapping** (Tonkin & Taylor, 2014): Rapid flood and overland flow path modelling of the 100 year ARI event of Tuakau township under existing development conditions only to support the TSP. This modelling has higher resolution than the District Wide model but with more conservative initial conditions.
- **Whangarata Business Development Area Modelling** (GHD, 2006): Only relevant for site specific modelling. Note that this model may not be available for use.
- **Waikato River 1D flood model** (WRC, 2009): 1D cross section modelling of the Waikato River and flood plain for 2 to 100 year ARI events (without climate change increases applied).

None of the models completed to date include detailed modelling of the piped network in the town, nor test the changes in ground surface that come with development.

6.2 Hydrological Modelling

Hydrology has been modelled in three studies, each then followed with associated hydraulic modelling and each focusing on different outcomes.

- Beca 2018 used HIRDS V3 and WDC's modelling guidelines (WDC, 2016). In 2019 this was sensitivity tested with the new HIRDS V4 for existing and RCP 6.0 climate change. The 2018 hydrological and hydraulic model was calibrated against flow gauge records.
- WSP Opus 2018 district wide flood modelling was based on a report "Design Rainfall in Waikato District" (WSP Opus, 2017) which used empirical rainfall data because comparative estimates had concluded HIRDS V3 was too conservative. High altitude and low altitude data sets were used to account for difference in precipitation due to altitude. No climate change increases were included and the rainfall used has not yet been compared to HIRDS V4 rainfall. The modelling also uses a different rainfall design hyetograph (the PMP temporal distribution) to that set out in WDC and WRC's modelling guides. Therefore, direct comparison of results needs to be approached with additional caution.

- Tonkin & Taylor 2014 Rapid Flood Hazard Mapping used HIRDS V3 and TP108 climate adjusted rainfall depth and applied a 3˚C temperature increase for climate change according to unpublished WRC guidance at the time.
- Harrison Grierson 2006 used TP108. The existing rainfall depth was then increased by 28% to account for climate change.

None of the models have used WRC's *Runoff Modelling Guideline* (WRC, 2018) for hydrology.

Beca's 2018 model prepared hydrographs for the 10 year and 100 year ARI flood events were calculated using HEC-HMS, for which further detail, including the sub-catchment area and peak flows, can be found in the model report (Beca, 2018) and the subsequent HIRDS V4 model update report (Beca, 2019). The total catchment was divided into 91 sub-catchments to define the hydrology and are shown in Appendix B. These sub-catchments were delineated taking into account land uses, tributaries, topography and structures. Several of the sub-catchments are quite large, exceeding the 3 ha limit stated in WDC's modelling guideline but have been retained as they reflect the true upstream catchments of these rivers. The catchment delineation process is further outlined in the model report (Beca, 2018). Hydrographs were calculated for each of these sub-catchments.

The Beca 2018 modelling was calibrated (albeit on a limited basis) using historic rainfall data from the Pukekohe EWS rainfall gauge. This was then used to model flow in Tutaenui Stream and compare flow, level and volume results against the Buckland Road flow gauge data. The results compared well in terms of volume balance, peak flow and flood levels.

6.3 Flood Modelling

Current flood mapping comes from hydraulic modelling completed through the above mentioned studies which remain relevant although they focus on different outcomes and have differing levels of detail/resolution. Caution is recommended with using any flood model for a different purpose than what it was originally commissioned for without modifying the model to suit.

6.3.1 Tuakau Flood Modelling (Beca, 2018)

The Beca 2018 flood modelling was carried out in DHI MIKE Flood software and is a coupled 1D/2D model based on LiDAR, surveyed stream sections and surveyed watercourse structures. The model uses sub-catchment hydrology applied at appropriate points along the stream network. It does not include the piped reticulation within the town itself and, because of the model structure, it does not identify overland flow paths (other than stream break outs) within the sub-catchments themselves.

The modelling also reviewed the impact of climate change on the Waikato River levels (including tidal and sea level rise influences) that form the downstream boundary conditions. This model is considered to be the most accurate model for stream flow and flooding. The modelling tested development to stage 1 of the TSP with and without mitigation (in this context only 100 year ARI attenuation to 80% of pre-development peak flows) and also a maximum probable development scenario.

The 10 year and 100 year ARI existing, developed (mitigated and unmitigated) and maximum probable development conditions for current and future climates scenarios were modelled.

The 10 year ARI flood event depths for existing development and maximum probable development conditions were prepared for purposes of understanding sub-catchment runoff quantities, tailwater conditions for future reticulation design and to form a basis for 10 year ARI restrictions relating to WRC scheme drains. 100 year ARI flows are mostly contained within the channel banks with some spill into adjacent floodplains.

Flood levels in the 100 year ARI event are at bank tops throughout much of the model, with over bank flooding in some locations. Flooding from the Waikato River dominates the low lying land adjacent to the river.

The flood extents associated with the streams were found to be much less than the more conservative rapid flood or district wide models. Care needs to be taken when developing alongside watercourses, particularly near breakout areas, to check flood levels in stream relative to the proposed development. Existing flood extents and hazard maps listed below, are included in Appendix D:

- Existing development 100 year ARI flood extents
- Existing development 100 year ARI flood hazard, and
- Existing development 100 year ARI flood extents (HIRDS V3 & V4 comparison).

Future flood extents and hazard maps listed below are included in Appendix E:

- Post development (unmitigated) 100 year ARI flood extents
- Post development (mitigated) 100 year ARI flood extents
- Maximum probable development 100 year ARI flood extents, and
- Maximum probable development 100 year ARI flood hazard.

6.3.2 District Wide Model (WSP Opus, 2018)

The district wide model was built using TuFLOW modelling software. It is a 2D model with a large grid resolution and was built to establish flow and inundation patterns in floodplains, coastal waters, estuaries, rivers and urban areas. Modelling was completed at a district scale for existing development and climatic conditions, with Figure 8 showing the Tuakau township area. The below map is also included in Appendix D. Direct rain-on-grid modelling was used in order to map overland flow paths through the district. The model did not include any watercourse structures and major culverts/bridges were cut out of the model ground surface to allow flow connectivity. Downstream tailwater levels used normal river levels rather than flood conditions. At risk properties, sewer manholes and inundated roads were identified to inform and prioritise areas that require more detailed modelling. The final stage 3 report on further more detailed modelling is not yet available.

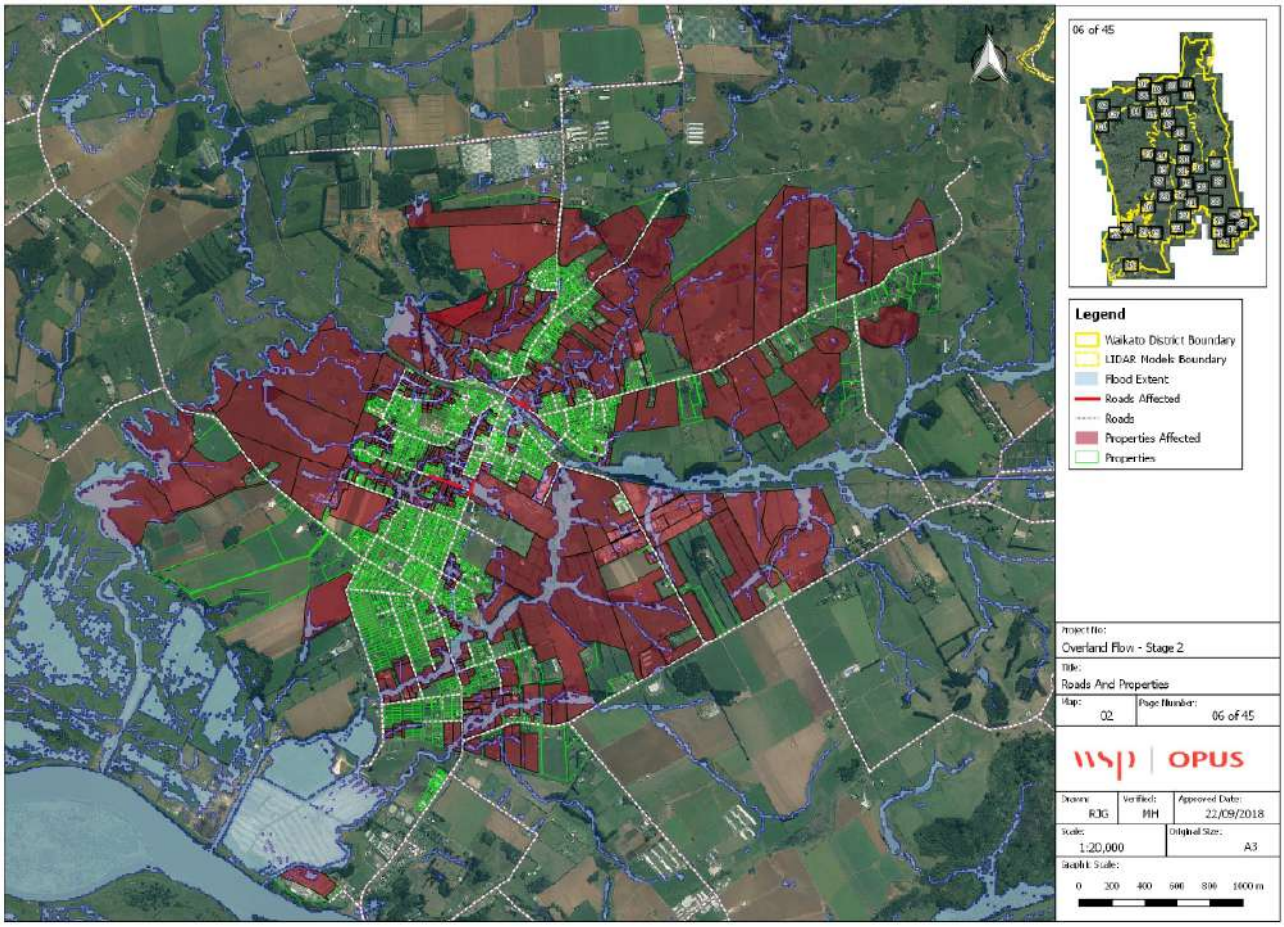

Figure 8 At risk property identification and flood mapping with a District Wide Model – Tuakau map (WSP Opus, 2018).

6.3.3 Tuakau Rapid Flood Hazard Assessment (Tonkin & Taylor, 2014)

This was completed prior to and at a higher resolution than the District Wide modelling. It was intended to be a tool that provides an indication of where flood hazard might occur and where future modelling efforts should be concentrated to support the TSP process. The model is very conservative but does provide better resolution than the District Wide model. It was aimed at determining the areas which would be inundated in a 100 year ARI flood (ignoring the pipe network and was built on the assumption that the reticulated system is blocked). Road and rail culverts and bridges were cut out of the model surface to provide flow connectivity. Initial conditions were included and based on all potential ponding depressions being pre-filled, and a constant tailwater of 3.8 m RL. The model incorporated solely existing development conditions, but with climate change applied. The Tonkin and Taylor flood maps are included in Appendix D.

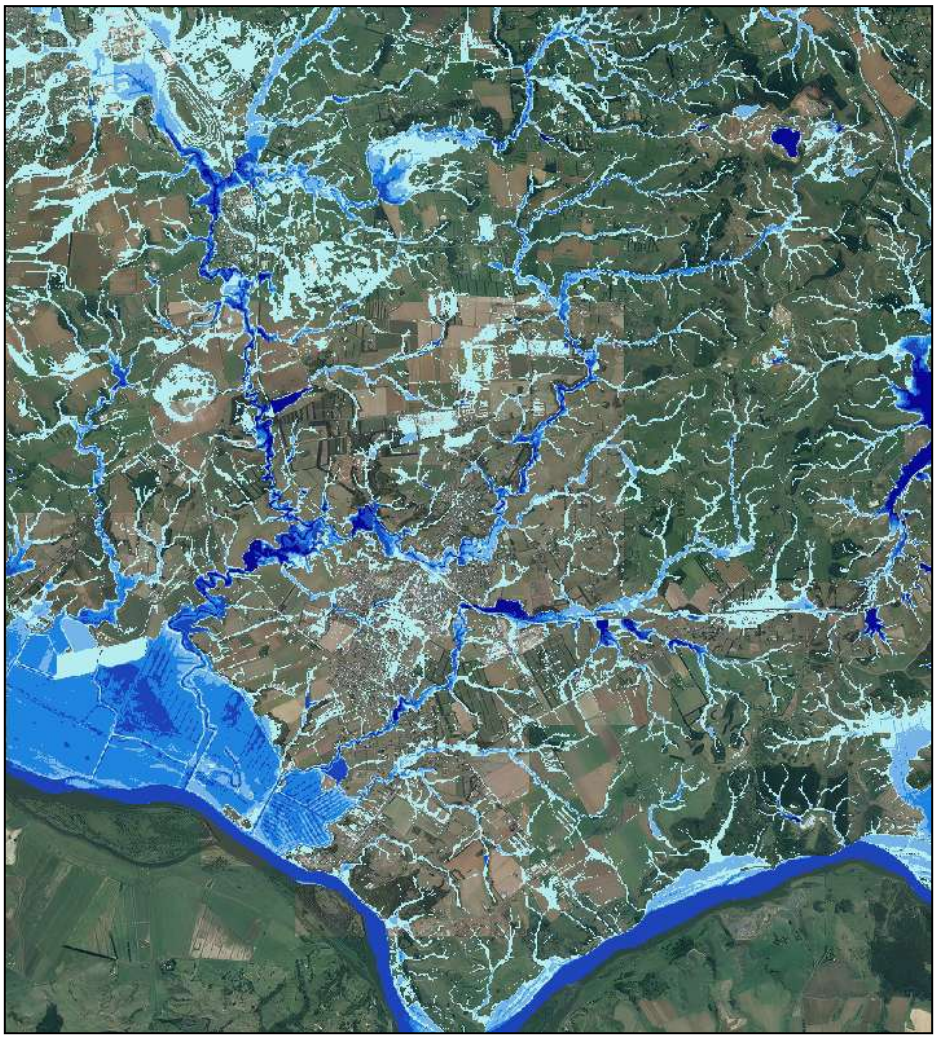

Figure 9 100 year ARI with climate change, rain-on-grid modelling (with first 50mm removed from the results).

6.3.4 Other Models

Tuakau Catchment Management Plan (Harrison and Grierson, 2009)

Modelling produced specifically for the Tuakau Township and included modelling of the urban stormwater network and identified several flood risk properties and hydraulic restrictions in main channels. Catchment area included Tuakau and upstream catchments of Whakapipi and Kairoa. Future residential areas are assumed to be 70% impervious (fully developed). Given the age of this model it needs to be treated with caution, with the hydrology most likely out of date.

Whangarata Business Development Area Modelling (GHD, 2006)

This model focused solely on the Whangarata business development area which covers an area of approximately 110 ha and 18 parcels of land and would only hold relevance for site specific information. Similarly to above, the age of this model requires caution in the use and application.

Waikato River 1D Flood Model (WRC, 2009)

Modelled 1D cross sections of the Waikato River and have been used in various models including the Rapid Flood model (Tonkin & Taylor, 2014) and the Tuakau flood model (Beca, 2018). This model does not include climate change increases.

7 Stormwater System Design

National and Regional policy (discussed in Section 1.6) require actions to protect people and environment from potentially damaging activities and land use changes. In some cases, enhancement of water quality and environmental conditions are required. One approach to meeting multiple outcomes for stormwater management is through LID, and on a broader scale, IWM as discussed in Section 1.4.

The Building Act 2004 specifies primary drainage must convey 10 year ARI events and that habitable buildings shall be designed such that a 50 year ARI event shall not enter. It is noted that the District Plan and the RITS are more stringent.

The RITS is a tool to be used for design, construction, testing and signing off developments covering many infrastructure areas, including stormwater. The stormwater section sets out requirements for design and construction for piped systems and stormwater treatment and detention devices. There is reference to the inclusion of LID, but no detailed specifications are explored. The RITS also specifies a disposal hierarchy to manage downstream impacts of stormwater runoff from land subject to development according to the following:

- retention of rainwater/stormwater for reuse on site
- soakage techniques
- treatment and detention and gradual release to a watercourse, and
- treatment and detention and gradual release to a piped stormwater system.

The *Waikato Stormwater Management Guide* (WRC, 2018) offers one guideline for LID, and although there are others available (such as Auckland Council's TP124), the WRC guide takes precedence in the Waikato.

In all cases designs need to be in accordance with the Regional Plan and the District Plan, comply with resource consent conditions and meet the Building Act.

7.1 Flooding

7.1.1 Flood Hazard

Development within high hazard areas and significant overland flow paths should be avoided. Development within medium to low hazard areas could proceed with appropriate design and mitigation.

The Beca 2018 modelling also identified flood sensitive zones associated with stream flooding. These areas are shown on map 1030 included in Appendix F. This identifies the area that is less than 500 mm clear of the 100 year ARI flood levels. Development within these areas is not recommended without careful consideration of the nature of the development and the activity proposed.

7.1.2 100 Year ARI Attenuation

The Beca 2018 modelling found that attenuating the 100 year ARI post-development discharges to 80% of the pre-development peak flow (as per the RITS) will result in some flood levels either staying the same or increasing slightly (<30 mm), depending on location. This is because attenuation in the lower half of a catchment can delay the peak discharge so that it more closely coincides with peak flow conditions coming down from upstream (and therefore flood levels can go up). In these instances, it is advisable to get the post-development flows away before the upstream peak arrives. In Tuakau, this effect is relatively small and as these peaks are still relatively far apart and do not directly coincide, so the increase in flood levels are relatively minor. This effect is shown on the difference maps included in Appendix G. In these difference maps, climate change to 2090 was also added to the existing development scenario in order to examine the effects of attenuation distinct from the effects of climate change on the otherwise unchanged, upstream

catchment. It was found that given the overwhelming size of the catchments upstream of Tuakau, that climate change alone unchanged, rural parts of the catchment dominates flood increases. To be clear, drainage design and flood hazard management of new developments must account for climate change increases in flows, volumes and flood levels. It is only that attenuation of 100 year ARI discharges that is not required and then only in selected locations.

Attenuation for the 100 year ARI storm is therefore not recommended for discharges to the Tutaenui/Whakapipi Stream and the Whangarata Stream downstream of George Street / River Road. Discharges to the Kairoa Stream (upstream of George St / River Road) and to the Whangarata streams do benefit from 100 year ARI attenuation and so attenuation will be required.

7.1.3 Requirements for Flood Assessments

Flood assessments must be carried out by competent persons with experience in flood and stormwater assessments and design. The following needs to be considered as part of a flood assessment (subject to scale of the development being proposed):

- identify any changes to sub-catchment boundaries and land use
- identify changes in discharge locations
- consider the downstream impacts from changes to runoff (peak flow and volume),
- consider changes form improved drainage efficiency,
- show impacts of land shaping and filling on overland flow paths and flood storage.
- confirm the need for attenuation. The 2 or 10 year ARI event, this maybe required where discharging into piped infrastructure downstream designed to a pre-RITS level of service. In some cases, attenuation will be required to mitigate downstream flood impacts
- use flood modelling (clarified further below) depending on the scale and nature of the proposed development/activity/works.
- clearly demonstrate and document (on section drawings) how freeboard is achieved
- Include a risk assessment approach to flood hazard management. NZS9401:2008 Managing Flood Risk – A Process Standard may be an appropriate reference depending on the scale and nature of the development.
- Include a sensitivity approach for climate change and also for other variable factors such as stream/floodplain roughness/tailwater conditions.
- Include a sensitivity approach for over-design events and implications of different levels of maintenance, in particular where flood protection structures are involved. The over-design event scenario shall be agreed with WDC and WRC.
- Include a blockage assessment based on a risk approach and apply appropriate mitigation measures.

It is recommended that the most recent flood models be used for assessing impacts of new development. This may involve using the models themselves (with appropriate version control) or using information from the models as inputs or boundary conditions for separate model used to evidence performance. Modelling will be required where attenuation, interaction with downstream controls, significant floodplain filling, stream/flow path diversion or complex hydraulic analysis underlies the design performance. This must be carried out by an experienced and competent stormwater/modelling practitioner. The requirement for modelling is at WDC's and WRC's discretion.

In the case of assessments/works within, and adjacent to, watercourse channels, relating to flooding from the streams and for assessing in-stream structures (culverts, bridges etc), then the Beca 1D/2D MIKE model is recommended for use.

Where investigations and analysis requires an understanding of overland flows paths, or high-level vulnerability identification, the recommended models are the WSP Opus District Wide model and the Tonkin

& Taylor Rapid model results which should be reviewed together. It is noted that to date, no model includes a comprehensive and up to date piped reticulation network within the township.

The Tonkin and Taylor rapid hazard model is limited to supporting the TSP where it was used to identify flood risk to growth zones. No development changes where included in this model, using only existing development conditions in a 100 year ARI event that included climate change impacts. While this model could be used, it is very conservative and would need significant updates to be used for testing development designs. Similarly, the District Wide model has relatively large grid spacings and so lower resolution depending on the scale of project being considered.

To date no one model contains all features that will be needed to assess and review stormwater and flood management issues that may be relevant to future development proposals.

7.2 Low Impact Design

Low Impact Design (LID) is based on the premise that environmental values can be less adversely impacted as new areas are developed if basic principles are followed. It is based on avoiding or minimising the generation of additional runoff. LID is known under many names, including Water Sensitive Urban Design (WSUD) and Low Impact Urban Design (LIUD) though LID is common throughout New Zealand guidelines and policy. The *Waikato Stormwater Management Guideline* (WRC, 2018) outline five key principles behind LID and outline LID design considerations, suggestions and costing. The five principles are to:

- achieve multiple objectives
- integrate stormwater design early in the process
- avoid rather than mitigate
- manage stormwater at source, and
- rely on natural soil and plant processes.

LID approaches are broader in scope than traditional stormwater drainage design, requiring thought and planning at a high level in the concept stage. It includes looking at development planning in an area through to the design within a development.

The Tuakau CMP (Harrison Grierson, 2009) explores some of these design elements within a development to address stormwater treatment and flood mitigation. Some of these include riparian planting and rainwater tanks on private property, amongst hard engineering options such proprietary treatment devices. Several of these themes remain valid and have been carried forward into this SMP.

The RITS also requires using LID in stormwater systems and that these should replicate the pre-development hydrological regime as far as practical. Several other references to LID are made throughout RITS, with guidance on meeting RITS requirements on flood risk mitigation due to land use changes referencing the Auckland Council's Technical Publication 124 (TP124) on Low Impact Design.

WRC has addressed water quality through a LID toolbox approach that gives options and ranks these to give an overall score. The toolbox aims to include stormwater management as a consideration from the outset of the design process, including the features at the site layout level rather than engineering it in after as an end of pipe feature. A matrix points system is used as part of the toolbox to aid the provision of development and resource consents and to promote spreading various measures throughout the development. This gives flexibility in approach whilst the scoring system provides a minimum score to be achieved, against which the varied systems and techniques are measured.

Importantly, the toolbox does not replace the need to consider other values such as social, environmental, cultural and economic issues as inputs to decision making. The key to effective LID design is early discussions and planning with experienced designers, WDC and WRC at the concept stage.

7.3 Soakage Requirements

Site specific investigation and assessment will be required to undertake soakage disposal, or to discount it as not being appropriate due to poor ground conditions or adverse groundwater table effects. Unless soakage can be readily discounted (to the approval of WDC and WRC) then disposal of stormwater by soakage up to a 10 year ARI storm is preferred. Soakage beyond a 10 year ARI event is unlikely to be feasible given the scale of the works needed and the size of such an extreme storm, generally involving widespread inundation and saturation of the ground.

Assessments shall include site permeability testing and classification of the underlying geology, effects on nearby features, topography, depth and clearance to the groundwater table and consideration of how the groundwater table may vary. A review of any long term groundwater monitoring data is also recommended, but as this is not comprehensive, consideration of the implications of this knowledge gap must be included.

A soakage design must include a risk based assessment when selecting a factor of safety, such as the approach set out in CIRIA,1996, is recommended which may result in a more stringent requirement than that in the RITS. A commitment to preventative inspections and ongoing maintenance is also essential. Soakage designs are likely to require assessments and design beyond Verification Method E1/VM1 (which has several limitations outlined in the document itself).

Current guidelines and requirements that refer to soakage are as follows:

- RITS
- Waikato Stormwater Management Guidelines
- Ministry of Business, Innovation and Employments Verification Method E1/VM1 (VM1), Section 9 - Disposal to Soak Pit, and
- Auckland Council's TR2013/040.

Soakage systems may require pre-treatment to protect against sediment clogging. A risk approach should be used as per Auckland Council's TR2013/040. Further commentary and advice on soakage issues can be found in Water NZ Conference papers such as Smith & France, 2018, Purton et al, 2012 and Brough, 2008; amongst others.

7.4 Water Quality

Design for water quality shall be in accordance with the RITS and Waikato Stormwater Management Guideline (WRC, 2018). Treatment is generally required for all land developments. Note that there is overlap and some inconsistency between the guides, which should be clarified as part of the design process. An exception may arise on low contaminant individual lots/activities where there is an approved, appropriately sized centralised downstream treatment device provided and the release is agreed to by WRC.

WDC should be consulted on the type and location of water quality devices that are to be vested to them. Specific resource consent conditions may require ongoing water quality monitoring to monitor performance of the device and a plan that outlines safe and ongoing Operation and Maintenance should be developed and submitted to WDC.

Generally, a best practicable option (BPO) approach shall be taken with the type of treatment selected based on the nature of the receiving environment and the expected pollutants involved with the development and/or activity. It is noted that "wet ponds" are no longer considered to be a BPO measure by both WDC and WRC with wetlands preferred.

Where proprietary through flow treatment devices are proposed, then a water quality storm of 10 mm/hr maybe used with the rational method hydrology based on Auckland Council's GD01.

7.5 Stream Scour

Stormwater management must consider the potential for watercourse erosion and scour from flow related changes. Design of scour protection should be in accordance with the RITS and *Waikato Stormwater Management Guideline* (WRC, 2018). Extended detention is required when discharging to any natural watercourse or modified channel that could erode. This can be offset, to a point, or supplemented by use of soakage or retention/reuse to a level equivalent to the prescribed extended detention. Stream scour mitigation may also include downstream planting and stream works.

7.6 Watercourse and Wetland Enhancement and Restoration

The Te Ture Whaimana o Te Awa o Waikato – the Vision and Strategy for the Waikato River includes objectives related to the restoration of the health and wellbeing of the Waikato River, including its tributaries. This is supported through the management recommendations in the *Waikato Stormwater Guideline* (WRC, 2018).

Developments need to maintain, protect and enhance existing watercourses. Piping existing watercourses (other than road culverts – see below) is to be avoided. Where stream restoration includes riparian planting or in stream habitat features that change the stream roughness or gradient then the stream cross-section shall be modified (such as with flood berms and/or multi-stage channel sections) to compensate for the decrease in capacity. Care needs to be taken in the design so that any widening of the watercourse does not cause a detrimental impact on the aquatic habitat and stream erosion risk.

Factsheets are also available from WRC that outline planting choice and processes and steps for obtaining resource consent.

Specific ecological and landscape expertise is required to inform the design of watercourse/wetland restoration within the Tuakau township or catchment.

7.7 Culverts and Bridges

Design of culverts and other waterway structures shall carried out in accordance with the RITS and *Waikato Stormwater Guideline* (WRC, 2018). It is noted the WRC also has level of service standards for culverts under the WRP.

Requirements for bridges are outlined in the following documents and are applicable to all bridges and culverts classified as “major”. A Major culvert is specified as one with a total waterway area greater than 3.4m^2 .

- RITS
- Bridge Manual (NZTA, 2013)
- TR2006/25R (Speirs D. Ryan G, 2006)
- Chapter 4.2.9 and chapter 4.2.8 of the Waikato Regional Plan (WRC, 2018)

Debris risk assessments shall be carried out on all structures in accordance with Australian Rainfall and Runoff’s (AR&R) method outlined in Book 6 (Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, 2019) and must also meet conditions outlined in RITS and the WRP.

All culverts and bridges on watercourses shall include fish passage design unless specific ecological assessment demonstrates otherwise and as confirmed by WRC.

7.8 Dams

Stormwater management devices that impound water can create dams and, depending on the scale of the impounded water, may require specific risk assessment, design features and operational (inspection etc)

requirements. This is particularly the case if the retained volume and height creates a “large dam” under the Building Act and the WRP. In these instances specific qualified dam engineering expertise shall be used in the assessment and design of such structures. A large dam is currently defined by the Building Act as over 4m high and being over 20,000 m^3 volume. Note this is potential volume to the crest, not the volume in a certain ARI event.

7.9 Safety in Design

Safety in Design is the integration of hazard identification, risk assessment and control methods in the design process to avoid, eliminate or minimise risks throughout the life span of the item/asset being designed.

All developments and proposed designs shall include a Safety in Design assessment to address and document risks, requirements and responsibilities through the whole lifecycle of the asset as per the Health and Safety at Work Act 2015. This assessment shall be updated as the design progresses through the various approvals, design and construction stages of a project and as the risks/issues develop.

7.10 Implementation

Developments should include staging plans and outline operation and maintenance requirements in submissions to WDC. Reference to WRC requirements and guidelines, as well as RITS should be prepared for the specific design or activity proposed.

7.11 Operation and Maintenance

Successful stormwater operation activities rely on regular inspection and maintenance appropriate to the type and nature of the device. A fundamental for maintenance activities is having safe access. Therefore, operation and maintenance activities must be considered as part of a Safety in Design review and arrangements incorporated in a design at an early stage. It is common for maintenance requirements to increase the footprint of a device.

Maintenance activities for assets to be vested with WDC need to linked back to, and integrated with, WDC’s standard operating procedures and practices. WDC shall be consulted on matters relating to operation and maintenance. Operation and Maintenance plans shall be prepared as part of standard resource consent and hand over documentation.

8 Summary

This SMP should be used as a framework by WDC and developers alike to manage stormwater. It sets out stormwater issues a development will need to address. The key recommendations are:

- Developments should be planned and designed on the basis of Integrated Water Management using Low Impact Design.
- Development and stormwater management must be planned, designed and operated in accordance with a variety of statutory requirements to avoid, mitigate or remedy environmental effects. These focus on considering the receiving environment and the nature of the development / activity proposed.
- Planning and design of assets to be vested to WDC need to meet the requirements of WDC's existing stormwater resource consent as well as other specific consents that may need to be obtained.
- Key stakeholders need to be identified and consulted. These will be subject to the scale and nature of the development and activity proposed. WDC and WRC must be consulted as part of planning a development and to assist in identifying key stakeholders for consultation.
- The existing watercourses in Tuakau are generally degraded, have poor water quality and are sensitive to erosion and scour. However, there is significant potential for stream restoration activities to be undertaken as part of WDC/WRC/community initiatives or as part of private land development.
- Impacts on WRC's Tuakau Swamp scheme drain, stopbanks and pump station need to be considered as part of planning and design of a development.
- Little is known about the hydrogeology around Tuakau and the potential for soakage disposal of stormwater. This will need to addressed as part planning and design for any development.
- Rainfall data shall be obtained from HIRDS V4. Hydrology is to be based on the Rational Method for areas <8ha and where volumetric/storage/attenuation issues are not involved, and on WRC's Runoff Modelling Guide (WRC, 2018) for areas >8ha or where volumetric/storage/attenuation issues are involved.
- Flood models are available from WDC to inform planning and design of developments and modifications to stormwater infrastructure. However, they are limited and need careful interpretation and use from experienced practitioners. The Beca 2018 model provides information on flows, flood levels and flood hazard associated with the watercourses. It also can provide information on catchment runoff (peak flow and volume), key existing in-stream structures (sizes, levels etc) and attenuation performance (where required). The 100 year ARI and 10 year ARI events have been modelled.
- The Opus 2018 District Wide model and the Tonkin and Taylor Rapid model can both provide information on overland flow routes though it is noted that the former is a coarse model and the latter conservative so therefore both are limited.
- Depending on the scale, nature and location of a development, it may need to be modelled to provide evidence of appropriate stormwater management and demonstrate acceptable effects. The requirement for modelling shall be discussed and agreed with WDC and WRC early in the development process.
- Development should be avoided in areas of high hazard or within significant overland flow path areas. Areas of medium or low hazard can be addressed with mitigation measures.
- Stormwater design shall be in accordance with the RITS and the *Waikato Stormwater Management Guideline* (WRC, 2018). Other design guides and standards will also need to be used depending on the nature of the asset being designed, and
- Safety in Design reviews, and operation and maintenance assessments and plans shall be included in any development or stormwater design.

9 References

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Waikato LASS, 2018, *Regional Infrastructure Technical Specification*

Waikato Regional Council (WRC), 2018a, *Waikato Stormwater Management Guideline*, TR201801

Waikato Regional Council (WRC), 2018b, *Waikato Stormwater Runoff Modelling Guideline*, TR201802

Waikato Regional Council, LAWA; Whakapipi Stream at SH22 Br, accessed 17/06/2019, Web link

WSP Opus, 2018, *Stormwater Management Plan Template,* Waikato District Council

A

Appendix A – Resource Consent

Resource Consent Certificate

Resource Consent: 105051

File Number: 60 56 25B

Pursuant to the Resource Management Act 1991, the Waikato Regional Council hereby grants consent to:

Franklin District Council
Private Bag 5
Pukekohe 1800

(hereinafter referred to as the Consent Holder)

Consent Type: Discharge permit

Consent Subtype: Discharge to water

Activity authorised: Divert and discharge urban stormwater runoff and associated contaminants at multiple locations to land, the Whakapipi Stream, Tutaenui Stream and Kairoa Stream, and use discharge structures in the general vicinity of Tuakau Urban Area that is reticulated by the Tuakau municipal stormwater system.

Location: Tuakau Urban Area

Map Reference: NZMS 260 R12: 830-364

Consent duration: Granted for a period expiring on 14 November 2028

Subject to the conditions overleaf:

CONDITIONS

Conditions:

General administration

1) This consent is subject to the General Conditions listed in Schedule A.

Specification of documentation that municipal stormwater diversion and discharge activities are to be in accordance with

2) All municipal stormwater diversion and discharge activities that are authorised by this consent shall be designed, operated and maintained in general accordance with the application for this consent, the General Conditions in Schedule A of this consent, and as identified in the resource consent conditions below.

Identification of authorised stormwater diversion and discharge activities

3) Except as provided for by Condition 4 of the General Conditions listed in Schedule A of this consent, all municipal stormwater diversion and discharge activities that are authorised by this consent relate to the Franklin District Council municipal stormwater system as constructed at the commencement of this consent, and as generally shown on the Franklin District Council Tuakau Catchment Map dated 17 January 2008, or any subsequent catchment map approved by the Waikato Regional Council acting in a technical certification capacity. Any new municipal stormwater diversion and discharge activities that become authorised after the granting of this consent shall be shown on an updated version of the Tuakau Catchment Map, and this shall be provided to the Waikato Regional Council in accordance with Condition 5 of this consent.

Monitoring Programme

4) The consent holder shall retain suitably qualified and experienced persons to prepare a monitoring programme. The objectives of the monitoring programme are to:

- Investigate the actual and potential adverse effects of the municipal stormwater system's diversion and discharge activities on the receiving environment;

- Provide information that will be used to determine stormwater management initiatives that, through implementation, will avoid, remedy or mitigate actual or potential adverse effects on the receiving environment;

- Determine compliance with the conditions of this consent.

As a minimum, the monitoring programme shall include:

a) Monitoring for visual signs of contaminants in stormwater (conspicuous oil or grease films, scums or foams, floatable suspended materials, conspicuous change in colour or visual clarity).

b) Monitoring to identify adverse scour and erosion effects caused by municipal stormwater diversion and discharge activities.

c) Monitoring to identify adverse flooding effects to land and property caused by municipal stormwater diversion and discharge activities.

d) Monitoring to identify municipal stormwater diversion and discharge structures that are impeding the upstream and downstream movement of fish.

e) Monitoring to ensure that all municipal stormwater system management devices are maintained in good working order, and stormwater quality treatment devices achieving optimal contaminant removal efficiency at all times.

f) Monitoring to determine efficient street and catchpit cleaning operations and frequencies.

g) Monitoring to identify informal wastewater system connections to the municipal stormwater system, and to gauge wastewater pump station overflow frequencies.

h) Monitoring to determine municipal stormwater system collection points that are at risk from non-routine contaminant discharges.

The monitoring programme shall be to a standard acceptable to the Waikato Regional Council acting in a technical certification capacity, and shall be forwarded to the Waikato Regional Council by 30 April 2009 for approval. The consent holder shall review the monitoring programme on a triennial basis, and shall forward any suggested alterations to the monitoring programme to the Waikato Regional Council for approval. The Waikato Regional Council will review and may alter the monitoring programme (in scale and/or method and/or location) after having had regard to the consistency and significance of the monitoring data collected, and/or any other information relating to the activities authorised by this consent. This may result in discontinuing or altering various aspects of the monitoring programme to initiate stormwater flow monitoring, stormwater quality sampling, sediment quality sampling and/or biological sampling of stormwater receiving waters, as considered appropriate.

Note: *Waikato Regional Council staff will consult with Franklin District Council staff prior to requiring any significant alterations to the monitoring programme.*

Reporting

5) The consent holder shall provide to the Waikato Regional Council a written management report by 30 April 2010 and annually thereafter for each year that this consent is current, unless otherwise advised by the Waikato Regional Council acting in a technical certification capacity. As a minimum this report shall include the following:

a) A detailed summary of the Stormwater Management Plan initiatives undertaken during the year, along with the results of these initiatives. Also a detailed summery of the Stormwater Management Plan initiatives that are proposed for the coming year, along with any proposed amendments to the plan if/where considered appropriate by the consent holder.

b) Results of the monitoring required by Condition 4 of this consent, along with a critical analysis of the data, a detailed summary of the findings, a comparison of the findings to relevant literature and guideline documents, identification of any emerging trends and specific reference to the requirements of Conditions 22 - 26 (water quality conditions) of this consent. Suggested modifications to the monitoring requirements of Condition 4 should also be provided, if/where considered appropriate by the consent holder.

c) A detailed summary of the level of compliance achieved with all conditions of this consent, including any reasons for non-compliance or difficulties in achieving compliance.

d) Details of all non-routine contaminant discharge incidents that have been responded to, and a summery of the outcomes of these incidents. Also identification of any changes in incident response protocols, or any management decisions that have been implemented to reduce the occurrence and/or potential effects of these types of incidents.

e) A detailed summary of significant complaints received in regard to the activities authorised by this consent. A summary of how these complaints have been responded to should also be provided.

f) An updated Tuakau Catchment Map showing all new municipal stormwater diversion and discharge activities authorised by this consent.

g) Details of any other matters relevant to this consent and/or that the consent holder wishes to report.

Note: *for the purposes of (5)(b), relevant literature and guideline documents are considered to be historical data, the guidelines set out in the NIWA 'Urban Runoff Data Book' (1993), and the Guideline Trigger Levels in the Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality (2000), or any other technical publication approved in advance by the Waikato Regional Council acting in a technical certification capacity.*

In terms of S116 of the Resource Management Act 1991, this consent commences on 27th November 2008

Dated at Hamilton this ***3rd*** *day of* ***December 2008***

For and on behalf of the
Waikato Regional Council

.....

Advice Notes

1) *This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.*

2) *The reasonable costs incurred by the Waikato Regional Council arising from supervision and monitoring of this consent will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consent.*

3) *For new municipal stormwater diversion and discharge activities to be authorised by this consent, where these result from the upgrading of the existing municipal stormwater system, or development that occurs after the granting of this consent, either:*

    i) Condition 4 of the General Conditions in Schedule A of this consent is to be satisfied, as confirmed in writing by the Waikato Regional Council pursuant to Condition 4; or

    ii) Where the new diversion and discharge activities do not satisfy Condition 4 of the General Conditions in Schedule A, a change to the conditions of this consent has been granted by the Waikato Regional Council expressly authorising and allowing for the new diversion and discharge activities.

4) *This consent does not authorise any stormwater diversion or discharge activities derived from privately owned stormwater systems, nor any other stormwater diversion or discharge activities that do not result from the operation of the Franklin District Council's municipal stormwater systems.*

5) *This consent does not authorise any works in a watercourse, or any other activity for which further consents may be required under Sections 13, 14 and 15 of the RMA, or the provisions of the Waikato Regional Plan.*

6) *The consent holder is responsible for compliance with the conditions of this consent, except where statutory defences as stated in Section 341 of the RMA apply.*

7) *Note that pursuant to s332 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.*

Schedule A – General Conditions of Comprehensive Stormwater Discharge Consents

The grant of Resource Consents 105051, 105052 and 108592 is subject to the following general conditions which are applicable to all consents:

Definitions:

Act:	Resource Management Act 1991
BPO:	Best Practicable Option (refer to RMA, Part 1 – Interpretation and application)
Contaminant:	(Refer to RMA, Part 1 – Interpretation and application)
Ephemeral watercourse:	A watercourse where the bed is more likely than not to dry up each year
Formal wastewater connections:	Municipal wastewater system connections to municipal stormwater systems that are designed to prevent wastewater surcharging and contaminating public and private property
Gross pollutants:	Litter items such as plastic bottles, bags, takeaway wrappers and leaves
Hazardous substance:	(Refer to RMA, Part 1 – Interpretation and application)
High Risk Facility Site:	Commercial and industrial sites as listed in Section 3.5.12 of the Waikato Regional Plan
Informal wastewater connections:	Wastewater system connections to municipal stormwater systems that should otherwise be connected to municipal wastewater systems, and are unknown and not approved by the Franklin District Council
Low Impact Urban Design:	LIUD comprises design and development practices that utilise natural systems and low-impact technologies. Key elements include working with natural site features, avoiding or minimising impervious surfaces, minimising earthworks in construction, and utilising vegetation to assist in trapping sediment and pollutants
Municipal stormwater system:	The Franklin District Council stormwater system
Non-routine contaminant discharge:	An accidental spillage or deliberate contaminant discharge of which the consent holder has limited ability to control
Routine contaminant discharge:	Contaminants that routinely discharge to municipal stormwater systems during rain events
Urban development areas:	Areas where urban development is undertaken. Such areas will generally be either ‘brownfield site’ areas (i.e. within existing urban areas), or ‘greenfield site’ areas (i.e. within new urban areas).
WRC:	Waikato Regional Council

105051

General Conditions

Design, Maintenance & physical integrity of the municipal stormwater system

1) The consent holder shall be responsible for the design, maintenance and physical integrity of the municipal stormwater system, and shall operate and maintain the municipal stormwater system to avoid, remedy or mitigate adverse effects on the environment.

Changes in municipal stormwater diversion and discharge activities

2) The consent holder shall not undertake any changes to the municipal stormwater system which would increase the scale and/or intensity of actual or potential adverse effects of municipal stormwater diversion and discharge activities on the receiving environment.

Best Practicable Options

3) The consent holder shall seek to implement Best Practicable Options to minimise actual and potential adverse effects of municipal stormwater diversion and discharge activities on the environment.

New municipal stormwater diversion and discharge activities

4) All new municipal stormwater diversion and discharge activities commenced after the granting of this consent shall be authorised by this consent when the consent holder is notified in writing by the Waikato Regional Council to this effect. Such notification shall be provided on receipt of information showing to the satisfaction of the Waikato Regional Council acting in a technical certification capacity, that:
   a) the new diversion or discharge is consistent with the conditions of this consent; and
   b) for new diversion or discharge activities in developed urban catchments – the new diversion or discharge does not increase peak discharge rates to, or flow volumes in, receiving waters above those that would occur at the time of granting this consent, unless it is demonstrated that there shall be no additional adverse effects on the environment or downstream properties as a result of such increase; or
   c) for new diversion or discharge activities in undeveloped catchments - the new diversion or discharge is consistent with a Catchment Management Plan, prepared in accordance with Condition 29 of this consent, and approved by the Waikato Regional Council acting in a technical certification capacity prior to any new diversion or discharge activities occurring within the catchment.

Stormwater Quantity & Receiving Environment

Scour and erosion of land and the beds of receiving water bodies

5) The consent holder shall be responsible for any scour or erosion control works that become necessary to maintain the physical integrity and stability of land and the beds of receiving water bodies, where such effects are caused by the municipal stormwater diversion and discharge activities authorised by this consent.

Remedying adverse scour and erosion effects

6) The consent holder shall remedy adverse scour and erosion effects to land and the beds of receiving water bodies, where such effects are caused by the municipal stormwater diversion and discharge activities authorised by this consent.

Adverse flooding effects

7) The consent holder shall ensure that the municipal stormwater system is operated and maintained in such a way as to reasonably minimise the potential for adverse flooding effects to land and property that may otherwise result from municipal stormwater diversion and discharge activities

Note: *Municipal stormwater diversion and discharge activities in conjunction with urban land-use can adversely affect flood potential by either limiting the rate at which stormwater drains from a catchment, or by increasing the rate and volume of discharge to downstream catchments. Whilst such effects are the subject of this consent, it is also recognised that 'levels of service' for catchment flooding are established by the consent holder through separate statutory procedures and consultation with its community. These 'levels of service' are not the subject of this consent.*

Adverse effects on private land and drainage systems

8) The consent holder shall be responsible for avoiding, remedying and mitigating any adverse flooding, scour, erosion or sedimentation effects on private land and drainage systems where these effects are caused by the municipal stormwater diversion and discharge activities authorised by this consent. To this end the consent holder shall keep a record of complaints associated with municipal stormwater diversion and discharges to private land and drainage systems, and the actions taken by the consent holder in response to these complaints.

Adverse effects on aquatic ecosystems

9) As far as practicable, the consent holder shall manage the municipal stormwater system such that stormwater diversion and discharge activities do not result in more than minor adverse effects on aquatic ecosystems.

Fish passage

10) As far as practicable, and with the exception of ephemeral watercourses, all structures that have been placed in natural and modified watercourses to enable municipal stormwater diversion and discharge activities shall allow for the safe upstream and downstream movement of fish. When acting on this condition, all stormwater system modifications and fish passage devices shall be designed and constructed to the satisfaction of the Waikato Regional Council acting in a technical certification capacity.

Note: *When acting on this condition the consent holder shall also consult with the Department of Conservation, in accordance with Part VI of the Freshwater Fisheries Regulations 1983.*

Stormwater Quality & Receiving Environment

Franklin District Council asset management activities

11) All Franklin District Council asset management activities, including those relating to:
    a) municipal stormwater system activities;
    b) municipal water and wastewater systems activities;
    c) municipal roading and footpath activities;
    d) municipal parks and gardens activities;
    e) municipal refuse collection activities; and
    f) municipal building maintenance activities - shall be undertaken and managed to minimise contaminants discharging to/from the municipal stormwater system to the receiving environment.

Street and catchpit cleaning operations

12) The consent holder shall carry out regular street and catchpit cleaning operations to minimise the volume of stormwater contaminants entering the municipal stormwater system and discharging to the receiving environment. When determining appropriate street sweeping frequencies, the consent holder shall take account of the land use characteristics within respective stormwater sub-catchments, the intensity of the various land use activities taking place, and any means other than street sweeping operations that are currently being used to control and/or treat contaminated stormwater.

Municipal stormwater system catchpits

13) All stormwater catchpit devices that are associated with the municipal stormwater system shall be capable of capturing and retaining the majority of gross pollutants. New and/or replacement stormwater catchpits shall be further capable of capturing the majority of floatable contaminants, such as oil and grease, when constructed.

Note: *For catchpits that are not capable of capturing and retaining the majority of gross pollutants, the consent holder shall investigate and employ other means to minimise the discharge of gross pollutants from the municipal stormwater system.*

Stormwater quality treatment devices

14) All stormwater quality treatment devices that form part of the municipal stormwater system shall be operated and maintained to provide best practicable stormwater contaminant removal efficiency at all times.

Informal wastewater system connections to the municipal stormwater system

15) The consent holder shall undertake monitoring and remediation programmes that identify and discontinue informal wastewater system connections to the municipal stormwater system.

Formal wastewater system connections to the municipal stormwater system

16) Where formal wastewater system connections to the municipal stormwater system make up part of the municipal wastewater system design and operation, the consent holder shall undertake to minimise as far as practicable, the discharge of wastewater system contaminants to the municipal stormwater system.

Wastewater discharges to the municipal stormwater system

17) Events resulting in significant discharges of wastewater to the municipal stormwater system shall be reported to the Waikato Regional Council as soon as practicable after the consent holder becomes aware of such a discharge.

Routine contaminant discharges to the municipal stormwater system

18) The consent holder shall undertake investigations to identify and address routine contaminant discharges to the municipal stormwater system from known contaminated land, and commercial and industrial sites. In circumstances where site owners/operators are routinely discharging contaminants to the municipal stormwater system, or contaminants to land that could routinely discharge to the municipal stormwater system during rain events, the consent holder shall liaise with site owners/operators to determine appropriate stormwater management measures that will be implemented to avoid, or if avoidance is impractical, to remedy or mitigate these contaminant discharges.

Non-routine contaminant discharges to/from the municipal stormwater system

19) On becoming aware of a non-routine contaminant discharge to/from the municipal stormwater system, the consent holder shall make all reasonable attempts to stop the discharge and prevent further contaminant discharges from occurring. The consent holder shall seek to identify the source of the discharge and inform the Waikato Regional Council of the discharge incident as soon as practicable. At the written request of the Waikato Regional Council, the consent holder shall provide the Waikato Regional Council with information that it holds on its response to the discharge incident, and any other relevant information that may support subsequent enforcement action taken by the Waikato Regional Council against the discharger. For the purposes of this consent, a non-routine contaminant discharge to the municipal stormwater system is considered to be either an accidental spillage or a deliberate contaminant discharge, of which the consent holder has limited ability to control.

Note: *Requirements of the Fire Service Act and other legislative requirements may override the requirements of this condition.*

Non-routine contaminants discharged from the municipal stormwater system that result in adverse effects on the receiving environment

20) In circumstances where non-routine contaminants are discharged from the municipal stormwater system and result in actual adverse effects on the receiving environment, the consent holder shall provide practical assistance to the Waikato Regional Council, and any other emergency response agency that becomes involved, to remedy or mitigate against further actual or potential adverse effects on the receiving environment.

Connections to the municipal stormwater system

21) When permitting new or replacement connections to the municipal stormwater system the consent holder shall ensure that all such connections incorporate appropriate stormwater quality treatment devices that are capable of:

a) minimising all contaminants such that the conditions of this consent are complied with; and
b) preventing accidental releases of hazardous substances to the stormwater system; or
c) reducing all such hazardous substances prior to discharge to receiving waters to concentrations that will not result in contamination of either water or sediments to such a degree that is likely to result in adverse effects on aquatic life, or on the suitability of water for human consumption after treatment.

Floatable contaminants

22) As far as practicable, the consent holder shall manage the municipal stormwater system to minimise the discharge of any substance that is likely to cause the production of conspicuous oil, or grease films, scums or foams, or floatable suspended materials in receiving waters after reasonable mixing.

Suspended solids

23) As far as practicable, the consent holder shall manage the municipal stormwater system to minimise the discharge of suspended solids and any other substances that are likely to cause the following effects in receiving waters after reasonable mixing:
a) conspicuous changes in colour or visual clarity;
b) increases in suspended solids concentrations by more than 10 percent;
c) 100 grams per cubic metre suspended solids concentrations or greater.

Hazardous substances

24) As far as practicable, the consent holder shall manage the municipal stormwater system to minimise the discharge of concentrations of hazardous substances that are likely to adversely affect aquatic life, or the suitability of water for human consumption after treatment. Where a question arises as to whether the concentration of any particular hazardous substance is causing these effects, it shall be determined through the application of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000), or any other technical publication approved in advance by the Waikato Regional Council acting in a technical certification capacity.

Note: *When applying the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, the 'trigger values' within the 95% level of protection range of these guidelines shall apply.*

Micro-organisms

25) As far as practicable, the consent holder shall manage the municipal stormwater system to minimise the discharge of concentrations of micro-organisms to receiving waters that are likely to adversely affect human health. Where a question arises as to whether the concentration of micro-organisms is adversely affecting human health, it shall be determined through the application of the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003), or any other technical publication approved in advance by the Waikato Regional Council acting in a technical certification capacity.

Adverse effects on aquatic ecosystems

26) As far as practicable, the consent holder shall manage the municipal stormwater system to minimise discharges that are likely to adversely affect aquatic ecosystems and cause the following effects in receiving waters after reasonable mixing:

a) dissolved oxygen levels to fall below 80% of saturation;
b) pH to fall below 6 or exceed 9;
c) suspended sediments to smother benthic organisms;
d) undesirable biological growths to be visible to the naked eye as plumose growths or mats;
e) water temperature to change by more than 3^{o}C or exceed 25^{o}C;
f) turbidity levels to exceed 25 NTU between the months of August and December;
g) ammoniacal nitrogen concentrations to exceed 0.88 grams of nitrogen per cubic metre; and
h) other contaminant concentrations to exceed those of the corresponding 'trigger values' within the 95% level of protection range of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

Note: *Conditions 22 - 26 describe receiving water effects that this consent is attempting to avoid, remedy or mitigate through improvements in the management and operation of municipal stormwater systems. Compliance with these conditions will therefore be determined through the establishment and implementation of appropriate stormwater management initiatives. These initiatives will aim to minimise (as far as practicable) municipal stormwater diversion and discharge activities that would otherwise cause these effects in receiving waters.*

Stormwater Quality Improvement Programme

27) The consent holder shall prepare and implement a Stormwater Quality Improvement Programme, designed to improve the quality of municipal stormwater discharges and to generally assist the consent holder in meeting the requirements of the stormwater quality conditions of this consent. The Stormwater Quality Improvement Programme shall form part of the Stormwater Management Plan required by Condition 34 of this consent, and shall be implemented through this plan.

Stormwater Information Programme

28) The consent holder shall prepare and implement a Stormwater Information Programme, designed to increase the general publics understanding of stormwater management and the ways in which the public can minimise the contamination of stormwater and the impedance of stormwater flows. The Stormwater Information Programme shall form part of the Stormwater Management Plan required by Condition 34 of this consent, and shall be implemented as part of this plan.

Urban Growth and Development

Catchment Management Plans

29) In accordance with Condition 4(c) of this consent, Catchment Management Plans that are prepared to enable new municipal stormwater diversion and discharge activities in undeveloped catchments shall be approved by the Waikato Regional Council prior to the undertaking of these activities. To this end, Catchment Management Plans shall be prepared in consultation with the Waikato Regional Council and other key stakeholders and, as a minimum, Catchment Management Plans shall detail the following information:

a) Catchment maps / drawings of the catchment, delineating the catchment boundary, catchment topography, receiving environment and existing land uses within the catchment;
b) Social, economic, ecological, amenity and cultural objectives being sought for the catchment;
c) Identification of the key stakeholders within the catchment, and details of the consultation initiatives undertaken with key stakeholders;
d) Classification of the receiving waters within the catchment in accordance with the Waikato Regional Plan;
e) An assessment of the current status of the catchment and receiving environment, and the provision of detailed baseline information of the geological, hydrological, ecological and

existing infrastructural characteristics of the catchment, including any existing resource use authorisations within the catchment;

f) Identification of potential urban growth, development and land use intensification within the catchment;
g) An assessment of the potential effects of stormwater diversion and discharge activities on the catchment and receiving environment, including but not limited to effects on:
    i) Sites of cultural and/or historical significance;
    ii) Public health,
    iii) Flooding hazards,
    iv) Receiving water hydrology, including base flows in rivers and streams and long-term aquifer levels,
    v) Receiving water sediment and water quality,
    vi) Receiving water habitat, ecology and ecosystem health,
    vii) The natural and amenity values of receiving waters,
    viii) Receiving water riparian vegetation,
    ix) The extent and quality of open stream channels,
    x) Fish passage for indigenous and trout fisheries,
    xi) Erosion and sedimentation of receiving waters,
    xii) The discharge and accumulation of litter;
    xiii) Existing infrastructure,
    xiv) Existing authorised resource use activities;
h) The cumulative effects of stormwater diversion and discharge activities within the catchment, the range of general management options available and the Best Practicable Option to prevent and minimise the adverse effects of stormwater diversion and discharge activities, and to mitigate or offset any significant unavoidable adverse effects;
i) The effectiveness of District Plan provisions to implement the management approach adopted by the CMP and, where necessary, the changes or variations to relevant District Plan provisions likely to assist in achieving the objectives of the CMP;
j) Education initiatives to support the catchment management objectives;
k) The methods by which all stormwater diversion and discharge activities will be managed;
l) A description of all infrastructure works scheduled by Franklin District Council which may significantly affect stormwater management within the catchment.

Note: *It is recognised that Catchment Management Plans may also include information that provide for the integration of other municipal water services (water and wastewater services). Such information and the integration of these services, is generally encouraged, particularly where it results in environmentally sustainable catchment management.*

Environment Waikato guidelines for sustainable subdivision development

30) For all new stormwater diversion and discharge activities in urban development areas, the consent holder shall proactively encourage consideration of the Waikato Regional Council publication 'Sustainable Subdivision Development – An Environment Waikato Perspective' (WRC, 2006), or any other technical publication approved in advance by the Waikato Regional Council acting in a technical certification capacity.

Low Impact Urban Design principles and stormwater management devices

31) In addition to the requirements of Conditions 29 and 30 of this consent, the consent holder shall proactively encourage the implementation of Low Impact Urban Design principles and/or construction of stormwater management devices in urban development areas, to avoid and/or mitigate any potential adverse effects of new stormwater diversion and discharge activities, and to ensure that the condition requirements of this consent are met.

Register of stormwater management devices

32) As private developers progressively construct stormwater management devices that become part of the municipal stormwater system, the consent holder shall maintain a register of the stormwater management devices constructed, including their location, catchment area, operational procedures and maintenance requirements.

Stormwater management device maintenance

33) All stormwater management devices associated with the municipal stormwater system shall be maintained in good working order. The consent holder shall carry out all stormwater management device maintenance as necessary and, where practicable, within one week of receipt of notice in writing from the Waikato Regional Council to do so.

Stormwater Management Plan

34) The consent holder shall prepare a Stormwater Management Plan for the municipal stormwater system, and the stormwater diversion and discharge activities that are authorised by this consent. The Stormwater Management Plan shall be prepared in consultation with the Waikato Regional Council and other key stakeholders. The operational procedures and management initiatives that are detailed and implemented through the plan will largely assist the consent holder to achieve the condition requirements of this consent. The Stormwater Management Plan shall be submitted to the Waikato Regional Council for approval by 31 October 2009.

The Stormwater Management Plan shall record the way in which the municipal stormwater system is operated, and shall include methods to avoid, remedy and mitigate the adverse effects of stormwater diversion and discharge activities on the environment. The Stormwater Management Plan shall be reviewable on a triennial basis and, as a minimum, shall detail the following information:

a) The relationship and integration of the Stormwater Management Plan with other consent holder planning instruments and regulatory systems, including those that are utilised to assist the management of the municipal stormwater system;
b) A plan or drawing of the municipal stormwater system showing all key features, including administrative area, hydrological catchments, physical reticulation system, stormwater management devices and receiving waters;
c) A description of the municipal stormwater system, including infrastructure details, contributing catchments, existing land uses and receiving water descriptions (including locations, water quality, ecological and hydrological characteristics, and the existing uses and values of receiving waters);
d) A description of municipal stormwater system operation and maintenance procedures, including operation and maintenance procedures associated with all stormwater treatment devices;
e) Identification of High Risk Facility Sites and other potential sources of stormwater contaminants within reticulated catchments (including all potential sources of ‘routine’ and ‘non-routine’ contaminant discharges to the stormwater system);
f) Management initiatives and implementation methods to avoid, remedy or mitigate ‘routine contaminant’ discharges to the municipal stormwater system. This should include the preparation and implementation of a Stormwater Quality Improvement Programme as required by Condition 27 of this consent;
g) A Spill Response Plan, including detailed Standard Operating Procedures, for ‘non-routine contaminant’ spill incidents within reticulated catchments. The Spill Response Plan should also detail communication linkages with other key stakeholders and emergency response agencies who have administrative responsibilities associated with these types of incidents;
h) Management initiatives and implementation methods to minimise ‘formal’ discharges from the municipal wastewater system to the municipal stormwater system;
i) Management initiatives and implementation methods to identify and discontinue ‘informal’ wastewater system discharges to the municipal stormwater system;
j) Management initiatives and implementation methods to identify and remedy adverse scour and erosion effects to land and the beds of receiving water bodies;
k) Management initiatives and implementation methods to minimise adverse flooding effects to land and property;
l) Management initiatives and implementation methods to avoid, remedy or mitigate adverse effects on aquatic ecosystems;
m) Management initiatives and implementation methods to identify and remedy structures and stormwater management devices that are impeding the upstream and downstream movement of fish;

n) Management initiatives and implementation methods to encourage the implementation of Low Impact Urban Design principals and/or construction of stormwater management devices in urban development areas;
o) A register of all stormwater management devices associated with the municipal stormwater system, including their location, contributing catchment area, operational procedures and maintenance requirements;
p) Management initiatives and implementation methods to undertake community and stakeholder information programmes. This should include the preparation and implementation of a Stormwater Information Programme as required by Condition 28 of this consent;
q) Management initiatives and implementation methods to review, identify and implement Best Practicable Options;
r) A prioritised schedule for implementing the procedures, management initiatives, implementation methods and other requirements identified in consent conditions and the Stormwater Management Plan.

Administrative

Consent holder's representative

35) The consent holder shall appoint a representative who shall be the Waikato Regional Council's principal contact person in regard to matters relating to this consent. The consent holder shall forward contact details of its representative to the Waikato Regional Council. The consent holder shall inform the Waikato Regional Council in writing of any change in its representative as soon as practicable.

Review clause

36) The Waikato Regional Council may within three months of the 3rd, 6th, 10th and 15th anniversaries of the commencement of this consent, serve notice on the consent holder under section 128(1) of the Resource Management Act 1991, and commence a review of the conditions of this consent for any of the following purposes:

a) To review the effectiveness of the conditions of this consent in avoiding, remedying or mitigating any adverse effects on the environment from the exercise of this consent, and if necessary to remedy or mitigate such effects by way of further or amended conditions;

b) To require the consent holder to adopt the Best Practicable Option to prevent or minimise any adverse effects on the environment that result from the exercise of this consent;

c) To review the monitoring undertaken by the consent holder, and if necessary to amend and/or introduce new conditions to monitor any actual and potential effects on the environment that result from the exercise of this consent;

d) To take account of any changes to the Waikato Regional Council's Regional plans or policies.

Costs associated with any review of the conditions of this consent will be recovered from the consent holder in accordance with the provisions of section 36 of the Resource Management Act 1991.

Provision for change to consent

37) The consent holder may apply to change or cancel any condition of this consent (other than a condition as to the duration of this consent) under section 127 of the Resource Management Act at any time following the granting of this consent.

Administrative charges

38) The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act.

In reply please quote: 60 56 25B, 61 20 86A, 61 26 05A
Doc # 1403635
Enquiries to: Ruth Hutchinson

3 December 2008

Franklin District Council
Private Bag 5
Pukekohe 1800

Dear Sir/Madam

RESOURCE CONSENT NUMBER 105051,105052,108592

Please find enclosed the certificate detailing the terms and conditions of your resource consent recently granted by the Waikato Regional Council. Please keep this important document in a safe place for easy reference during the term of the consent.

Please note the following:

(i) Only the holder of the consent or their agent may exercise this consent, and then only for the purpose specifically authorised by the consent.
(ii) Those exercising the consent must comply with the conditions of the consent at all times.
(iii) The majority of consent holders will incur annual charges for holding consents, and may also incur costs associated with monitoring, inspecting and reporting on the exercise of this consent.
(iv) This consent will **expire** on the date specified on the certificate. If unexercised, the consent will **lapse** on the date specified in the consent, or if no date is specifed, within 5 years from the date of commencement, unless approval has been obtained from Environment Waikato to extend the lapse period.
(v) Should you no longer wish to perform the activities authorised by the consent, you may wish to apply to surrender the consent, giving reasons for the surrender. In addition should you sell the property or the operation to which this consent applies, you may wish to transfer the consent to the new owner. If you wish to undertake either of these actions, please forward the resource consent certificate to this office with advice of the action you require to be taken.

Should you have any further queries on these matters, or any other issues relating to the exercise of this resource consent, please do not hesitate to contact the Hamilton office toll-free on 0800 800 402 quoting the above reference.

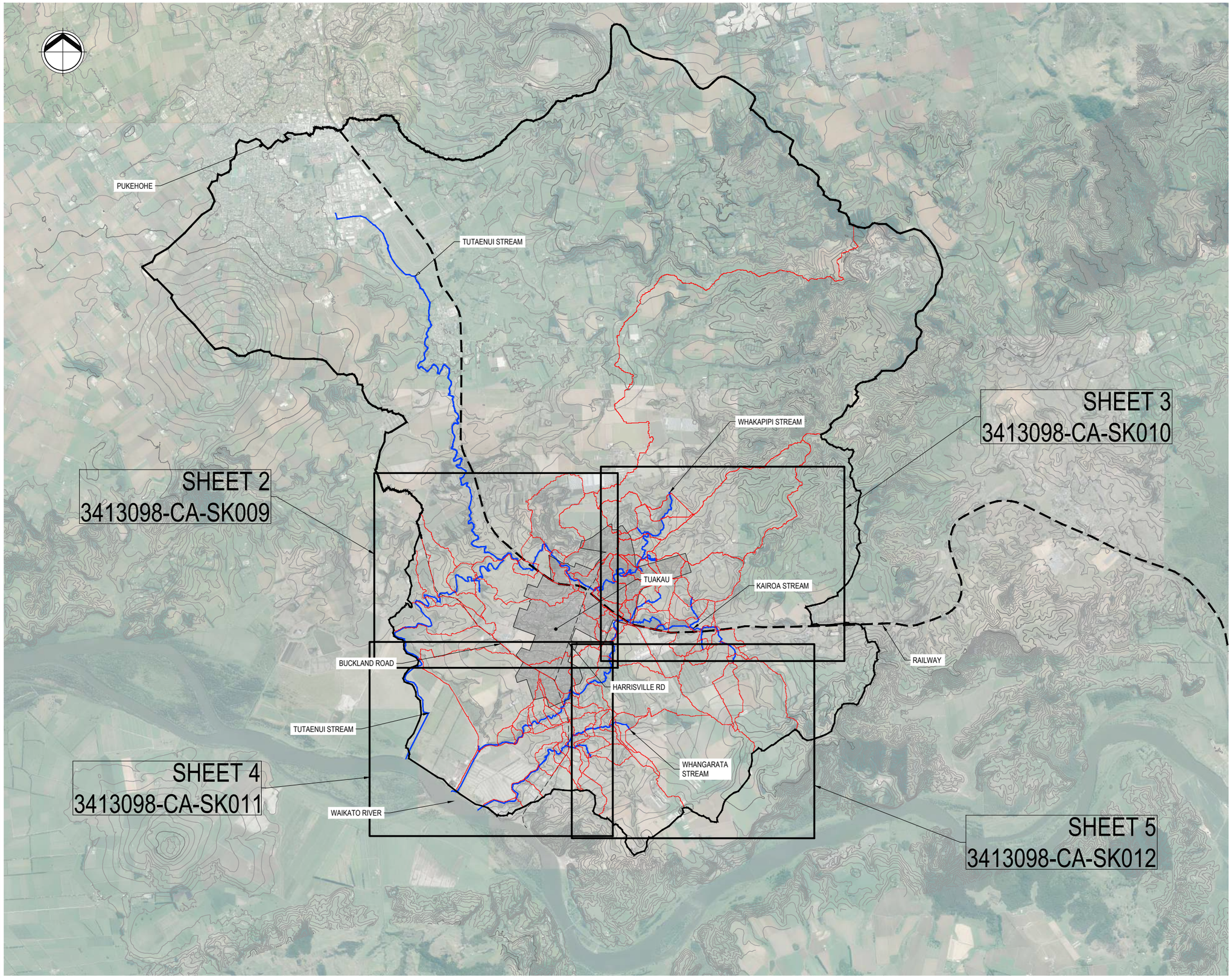
Yours faithfully

Ruth Hutchinson
Business Support – Resource Use

B

Appendix B – Catchment Maps and Watercourse Structures

Drawing Plotted: 22 Jan 2018 4:31 p.m.



LEGEND:

- CATCHMENT BOUNDARY
- SUBCATCHMENT BOUNDARY
- MAIN WATERCOURSES
- RAILWAY
- ROAD
- CONTOURS (MINOR)
- CONTOURS (MAJOR)

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2010

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	ADDED DRAWING REFERENCES	MS	IS		22.01.18
A	UNDER REVISION	SH	IS		05.04.17

Drawing Originator: Beca

Original Scale (A1) 1:25000	Design	MS	05.04.17	Approved For Construction*
	Drawn	MS	05.04.17	
Reduced Scale (A3) 1:50000	Dsg Verifier			
	Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: CATCHMENT BOUNDARIES
SHEET 1 OF 5

Discipline: CIVIL ENGINEERING

Drawing No.: 3413098-CA-SK001 Rev.: B

DO NOT SCALE

IF IN DOUBT ASK.

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Document No. 3413098-CA-SK001.DWG

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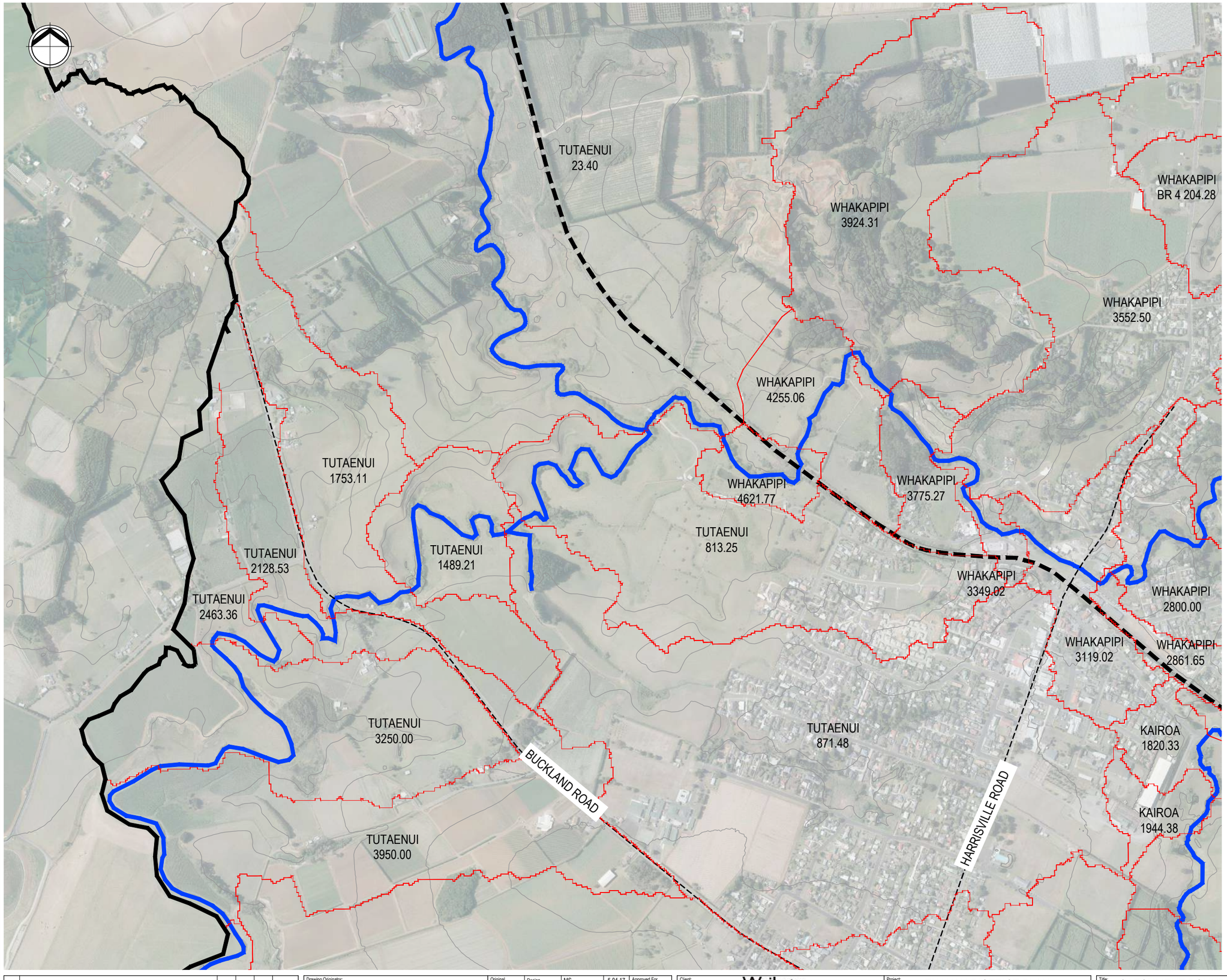

LEGEND:

- CATCHMENT BOUNDARY
- SUBCATCHMENT BOUNDARY
- MAIN WATERCOURSES
- RAILWAY
- ROAD
- CONTOURS (MINOR)
- CONTOURS (MAJOR)

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2010

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	MS	IS	IS	22.01.18

Drawing Originator: Beca

Original Scale (A1) 1:25000
Reduced Scale (A3) 1:50000

Design	MS	5.04.17	Approved For Construction*
Drawn	MS	5.04.17	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council, Te Kaunihera aa Takiwaa o Waikato

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: CATCHMENT BOUNDARIES
SHEET 2 OF 5

Discipline: CIVIL ENGINEERING

Drawing No. 3413098-CA-SK009

Rev. A

DO NOT SCALE

IF IN DOUBT ASK.

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Document No. 3413098-CA-SK009.DWG

www.beca.com

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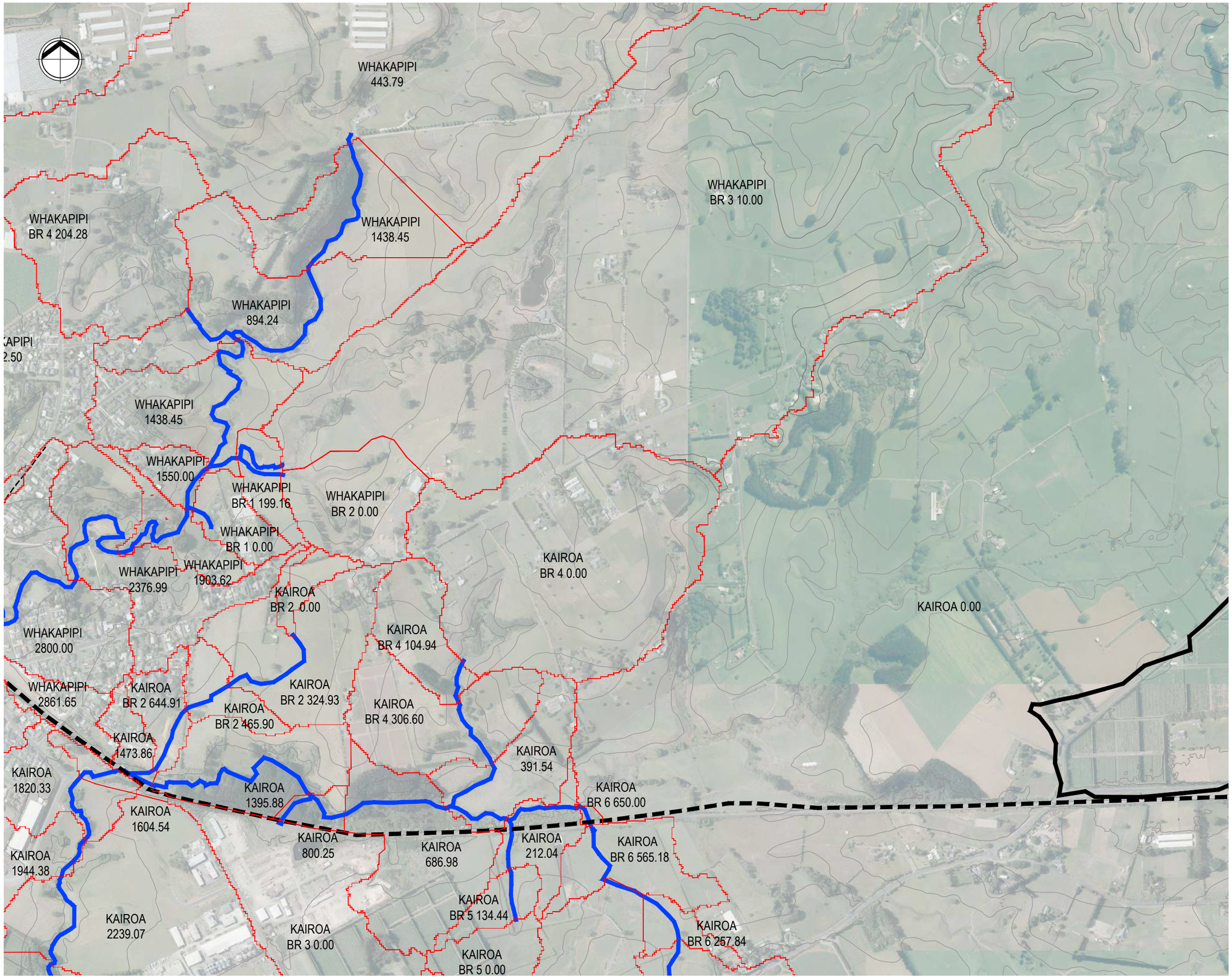

LEGEND:

- CATCHMENT BOUNDARY
- SUBCATCHMENT BOUNDARY
- MAIN WATERCOURSES
- RAILWAY
- ROAD
- CONTOURS (MINOR)
- CONTOURS (MAJOR)

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2010

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	MS	IS	IS	22.01.18

Drawing Originator: Beca

Original Scale (A1) 1:25000	Design	MS	5.04.17
Reduced Scale (A3) 1:50000	Drawn	MS	5.04.17
	Dsg Verifier		
	Dwg Check		

Approved For Construction* Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council — Te Kaunihera aa Takiwaa o Waikato

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: CATCHMENT BOUNDARIES
SHEET 3 OF 5

Discipline: CIVIL ENGINEERING

Drawing No. 3413098-CA-SK010 Rev. A

DO NOT SCALE

IF IN DOUBT ASK.

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Document No. 3413098-CA-SK010.DWG

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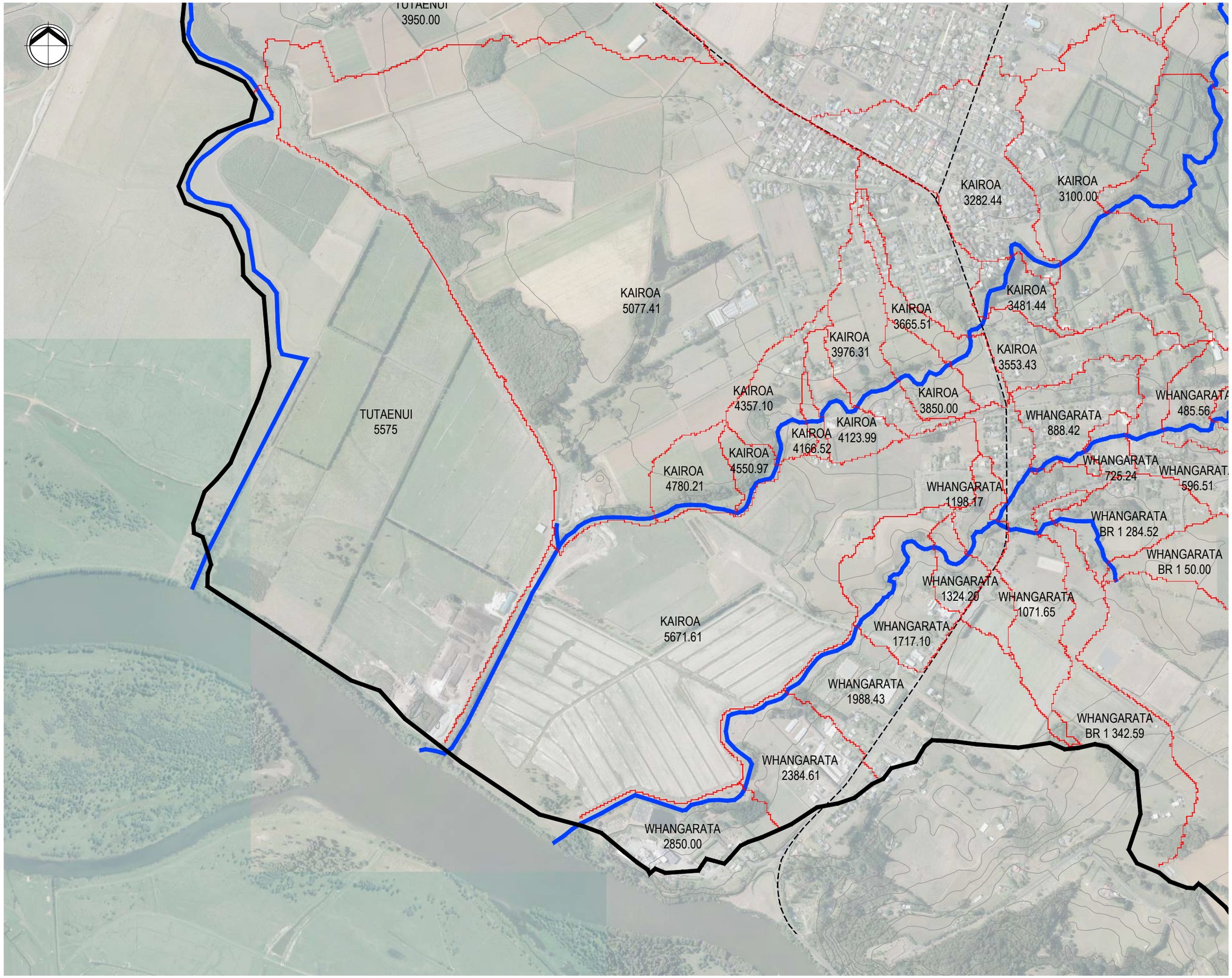

LEGEND:

- CATCHMENT BOUNDARY
- SUBCATCHMENT BOUNDARY
- MAIN WATERCOURSES
- RAILWAY
- ROAD
- CONTOURS (MINOR)
- CONTOURS (MAJOR)

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2010

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	MS	IS	IS	22.01.18

Drawing Originator: Beca

Original Scale (A1) 1:25000	Design	MS	5.04.17
Reduced Scale (A3) 1:50000	Drawn	MS	5.04.17
	Dsg Verifier		
	Dwg Check		

Approved For Construction* Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council — Te Kaunihera aa Takiwaa o Waikato

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: CATCHMENT BOUNDARIES
SHEET 4 OF 5

Discipline: CIVIL ENGINEERING

Drawing No. 3413098-CA-SK011 Rev. A

Document No. 3413098-CA-SK011.DWG

DO NOT SCALE

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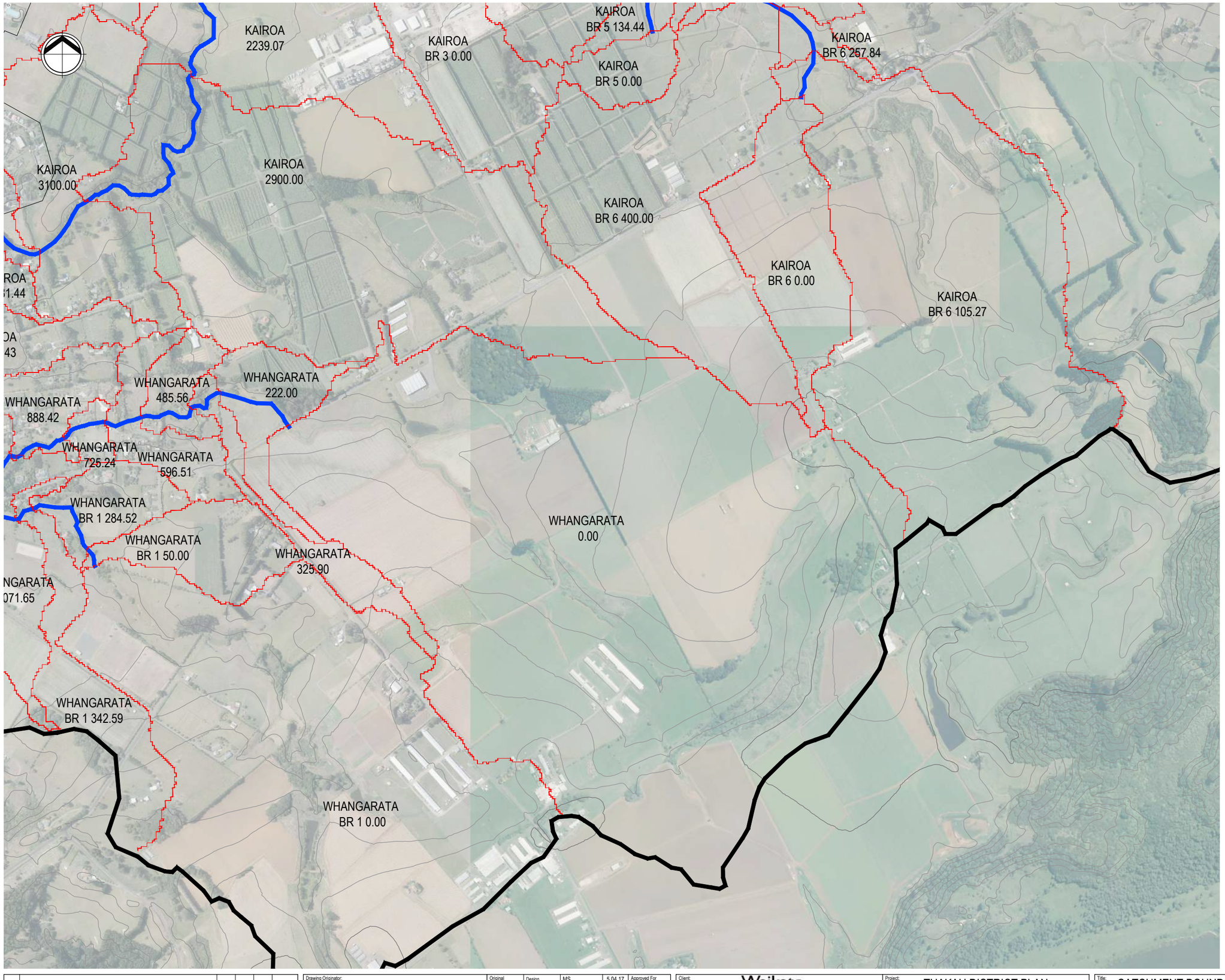
Drawing Plotted: 22 Jan 2018 5:36 p.m.



LEGEND:

- CATCHMENT BOUNDARY
- SUBCATCHMENT BOUNDARY
- MAIN WATERCOURSES
- RAILWAY
- ROAD
- CONTOURS (MINOR)
- CONTOURS (MAJOR)

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2010

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	MS	IS	IS	22.01.17

Drawing Originator: Beca

Original Scale (A1) 1:25000
Reduced Scale (A3) 1:50000

Design	MS	5.04.17	Approved For Construction*
Drawn	MS	5.04.17	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council — Te Kaunihera aa Takiwaa o Waikato

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: CATCHMENT BOUNDARIES
SHEET 5 OF 5

Discipline: CIVIL ENGINEERING

Drawing No.: 3413098-CA-SK012

Rev.: A

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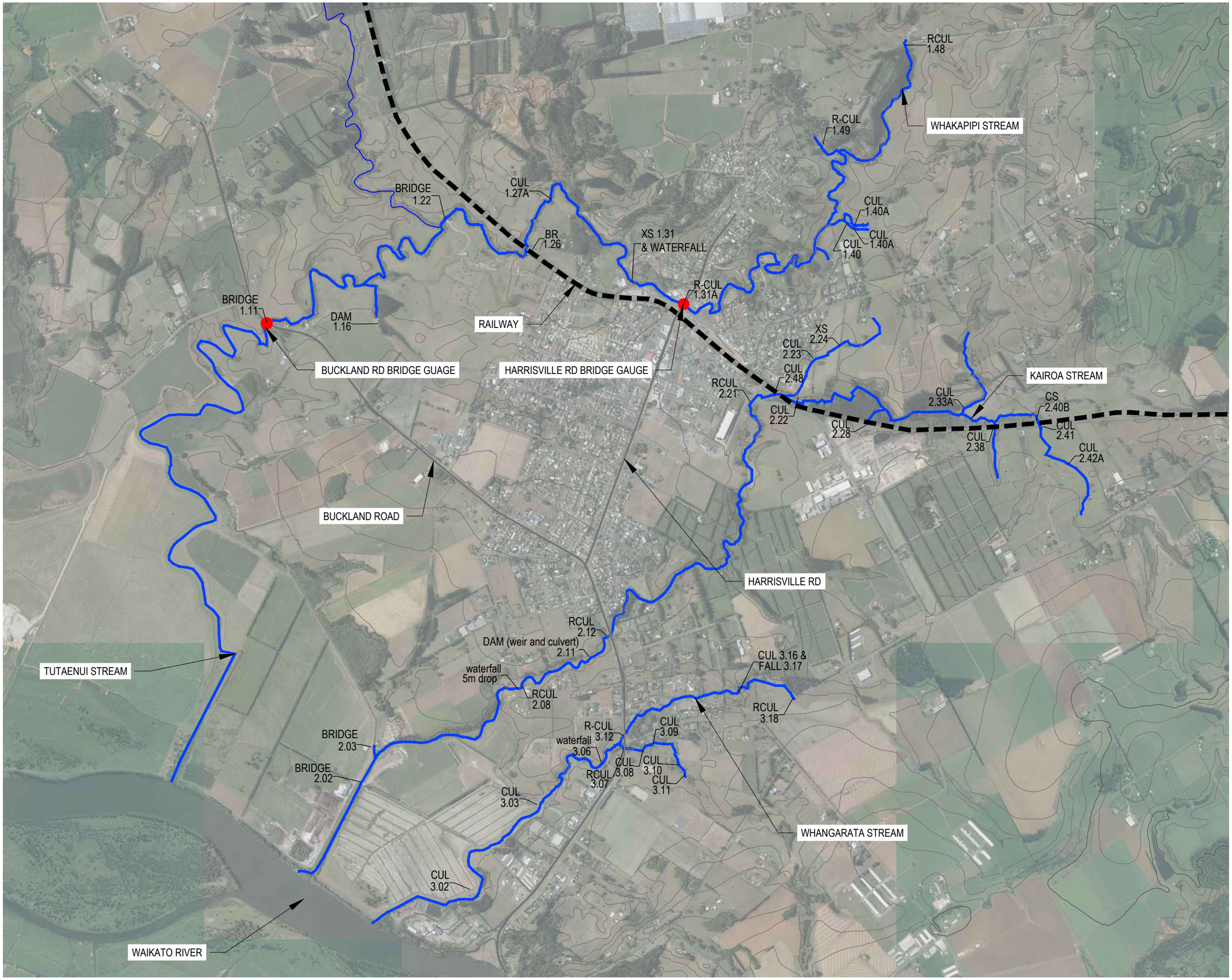
Document No. 3413098-CA-SK012.DWG

Drawing Plotted: 23 Jan 2018 10:46 a.m.



LEGEND:

- CATCHMENT BOUNDARY
- CONTOURS 10m
- STREAM
- RAILWAY
- ROAD
- FLOW GAUGE

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2015 (TBC)

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	FOR INFORMATION	MS	IS		22.01.18
A	UNDER REVISION	MS	IS		05.04.17

Drawing Originator: Beca

Original Scale (A1)	1:25000	Design	MS 05.04.17
Reduced Scale (A3)	1:50000	Drawn	MS 05.04.17
		Dsg Verifier	
		Dwg Check	

Approved For Construction* Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council

Project: TUAKAU DISTRICT PLAN FLOOD HAZARD MAPPING

Title: MODELLED STRUCTURES

Discipline: CIVIL ENGINEERING

Drawing No.: 3413098-CA-SK008

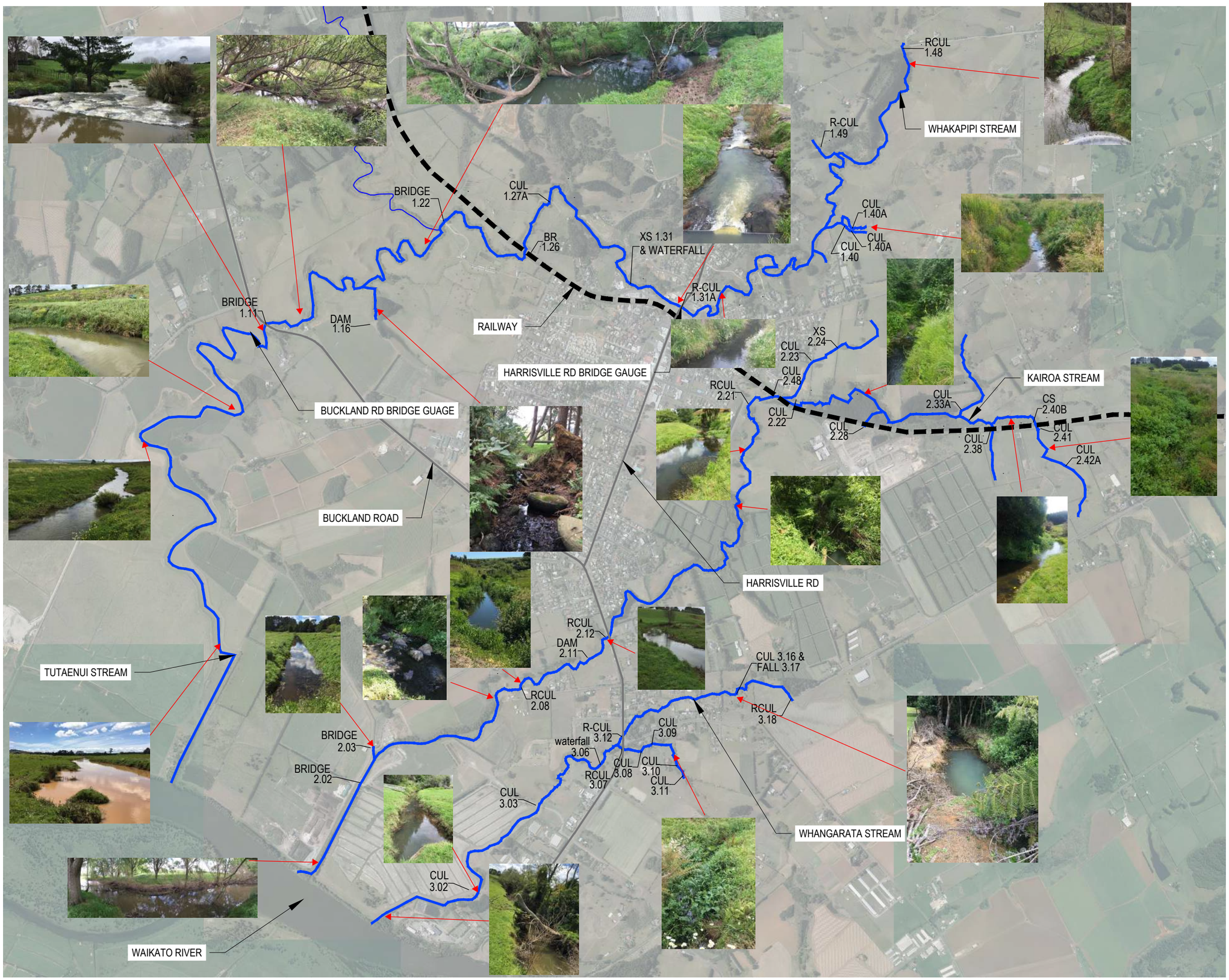
Rev.: B

DO NOT SCALE

IF IN DOUBT ASK.

www.beca.com

Document No. 3413098-CA-SK008.DWG

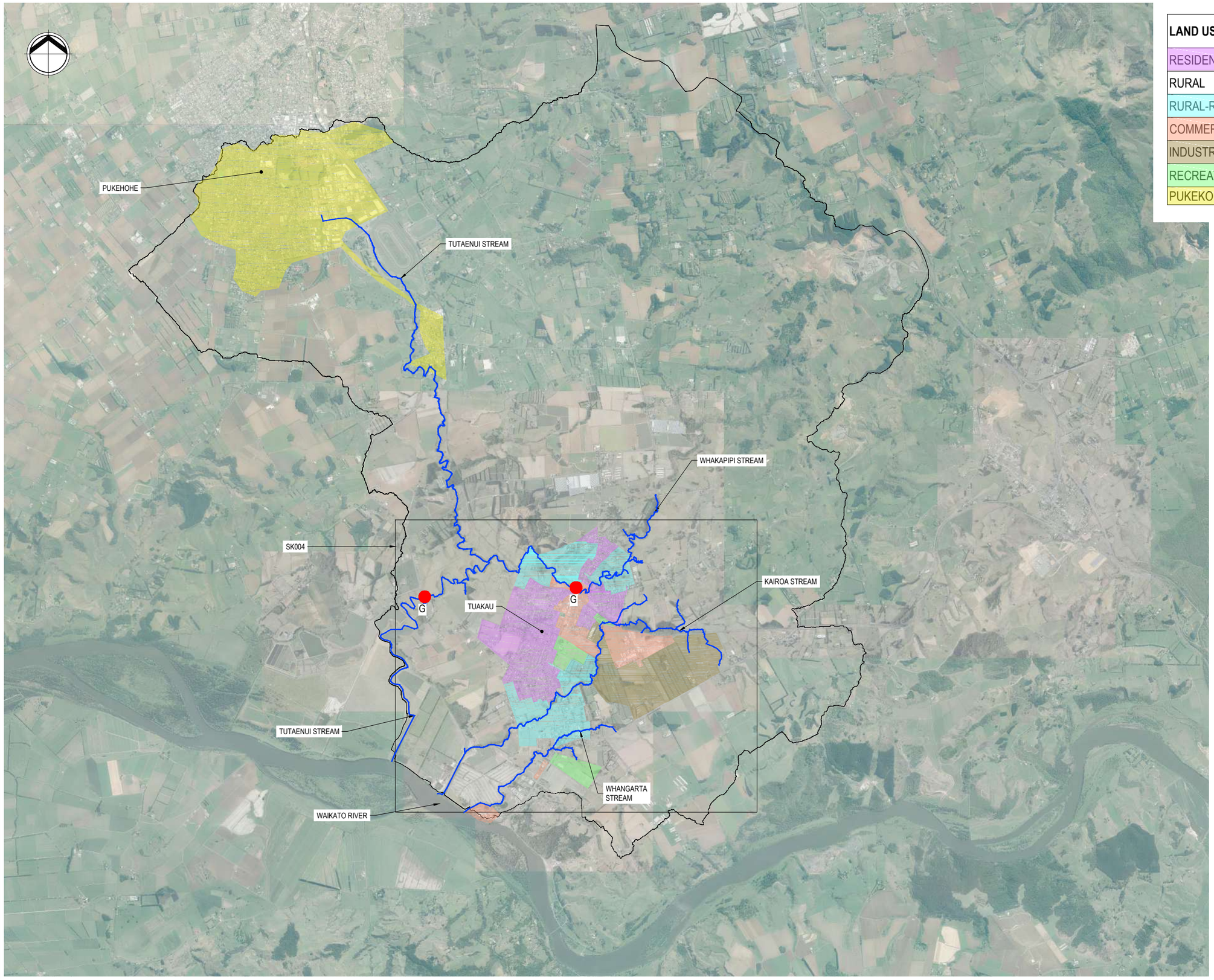

RCUL 1.48
WHAKAPIPI STREAM
R-CUL 1.49
BRIDGE 1.22
CUL 1.27A
BR 1.26
XS 1.31 & WATERFALL
R-CUL 1.31A
CUL 1.40A
CUL 1.40A
CUL 1.40
BRIDGE 1.11
DAM 1.16
RAILWAY
HARRISVILLE RD BRIDGE GAUGE
XS 2.24
CUL 2.23
CUL 2.48
RCUL 2.21
CUL 2.22
CUL 2.28
CUL 2.33A
KAIROA STREAM
CS 2.40B
CUL 2.41
CUL 2.38
CUL 2.42A
BUCKLAND RD BRIDGE GUAGE
BUCKLAND ROAD
HARRISVILLE RD
TUTAENUI STREAM
RCUL 2.12
DAM 2.11
RCUL 2.08
CUL 3.16 & FALL 3.17
RCUL 3.18
BRIDGE 2.03
BRIDGE 2.02
R-CUL 3.12
waterfall 3.06
RCUL 3.07
CUL 3.08
CUL 3.09
CUL 3.10
CUL 3.11
CUL 3.03
CUL 3.02
WHANGARATA STREAM
WAIKATO RIVER

Branch	Chainage (m)	Culvert ID	Geometry Type	U.S. IL (m RL)	D.S. IL (m RL)	Length (m)	Manning's Number	Size Diameter (mm)	Weir level (m)	Waterway Area (m^2)
KAIROA	5210	BR-2.02	Cross Section DB	0.371	0.36	6.1	0.05		2.68	8.83
KAIROA	4118	R-CUL-2.08	Circular	11.93	11.85	4.1	0.015	2x600	12.87	0.56
KAIROA	3691.5	DAM-2.11	Circular	17.71	17.72	3.82	0.015	2x600	18.55	0.56
KAIROA	3520	George St (R-CUL-2.12)	Circular	17.68	17.68	10.6	0.015	4000	21.6	12.56
KAIROA	1630	Bollard Rd (R-CUL-2.21)	Circular	29.15	28.94	26.7	0.025	3600	33	10.17
KAIROA	1502	CUL-2.48	Circular	30.781	30.683	16.2	0.015	4000	35.89	12.56
KAIROA BR 1	16.1	BR-2.03	Circular	1.69	1.26	10.4	0.015	1050	4.5	0.86
KAIROA BR 2	316	XS-2.24	Circular	47.906	47.864	4	0.013	300	48.2	0.07
KAIROA BR 3	21.1	CUL-2.28	Circular	35.97	35.12	16.4	0.015	375	38.56	0.11
KAIROA BR 4	482	CUL-2.33A	Circular	36.75	36.77	5.8	0.015	1050	38.28	0.86
KAIROA BR5	251	CUL-2.38	Circular	38.08	38.08	18	0.015	925	42.37	0.67
KAIROA BR 6	588	CUL-2.41	Circular	39.44	39.28	20	0.015	1200	44.33	1.13
KAIROA BR 6	296	CUL-2.42A	Circular	40.51	40.41	3.2	0.015	900	42.54	0.63
KAIROA BR 6	621.5	CS-2.40B	Cross Section DB	39.021	39.019	2.5	0.015		42.24	3.94
TUTAENUI	1723	Black Bridge (BR 1.11)	Cross Section DB	8.365	7.9	8.4	0.05		11.37	23.52
WHAKAPIPI	4906	BR-1.22	Cross Section DB	10.528	10.25	3.6	0.05		15.57	18.94
WHAKAPIPI	4323	BR-1.26	Cross Section DB	18.623	18.5	5.8	0.05		29.33	75.75
WHAKAPIPI	4022	CUL-1.27A	Circular	19.3	19.03	6.4	0.015	2x1500	21.55	3.53
WHAKAPIPI	2934	R-CUL-1.31A	Cross Section DB	32.887	32.887	7.9	0.05		36.7	11.89
WHAKAPIPI	22	Barnaby Rd (R-CUL-1.48)	Circular	48.25	48.19	9.8	0.025	3300	52.3	3.53
WHAKAPIPI BR 2	72	CUL 1.40 A	Circular	40.58	40.45	5.5	0.015	950	41.51	0.7
WHAKAPIPI BR 2	127	CUL-1.40	Circular	39.49	39.61	12.4	0.015	1100	41.06	0.95
WHAKAPIPI BR 3	84	CUL-1.40A	Circular	41.05	40.89	6.14	0.015	450	41.6	0.15
WHAKAPIPI BR 4	260	R-CUL-1.49	Circular	44.85	44.6	16.2	0.015	300	48.18	0.07
WHANGARATA	2422	CUL-3.02	Circular	1	0.88	5.1	0.015	1650	2.77	2.13
WHANGARATA	1738	CUL-3.03 (1350mm)	Circular	2.34	2.47	7.7	0.015	1350	4.84	1.43
WHANGARATA	1738	CUL-3.03(1050mm)	Circular	2.34	2.71	7.7	0.015	1050	4.84	0.86
WHANGARATA	1017	R-CUL-3.12	Circular	19	18.53	31.5	0.015	2x900	20.48	1.27
WHANGARATA	358.5	CUL-3.16	Circular	25.65	25.86	3.7	0.015	1150	26.9	1.03
WHANGARATA	10	R-CUL-3.18	Irregular	33.89	33.85	14	0.015		37.06	1.68
WHANGARATA BR 1	435	R-CUL-3.7	Circular	18.83	18.08	28.1	0.015	300	21.67	0.07
WHANGARATA BR 1	350	CUL-3.08 (2x225 mm)	Circular	20.5	20.55	6.7	0.015	2x225	21.02	0.079
WHANGARATA BR 1	350	CUL-3.08 (525 mm)	Circular	19.36	19.35	6.7	0.015	525	21.02	0.21
WHANGARATA BR 1	279	CUL-3.09	Circular	20.05	19.71	7.8	0.015	900	21.54	0.63
WHANGARATA BR 1	74.5	CUL-3.10	Circular	21.97	22.09	5.2	0.015	700	22.8	0.38
WHANGARATA BR1	16.3	CUL-3.11	Circular	22.78	22.53	7.8	0.015	700	23.73	0.38

C

Appendix C – Land Use Maps

Drawing Plotted: 22 Jan 2018 4:37 p.m.



LAND USE	CN	IMPERVIOUS (%)
RESIDENTIAL	65.9	38
RURAL	46.7	0
RURAL-RESIDENTIAL	56.3	19
COMMERCIAL-BUSINESS	90.1	85
INDUSTRIAL	83.5	72
RECREATIONAL	56	0
PUKEKOHE RESIDENTIAL	65.9	38

LEGEND:

- CATCHMENT BOUNDARY
- STREAM
- FLOW GAUGE

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2015 (TBC)
2. EXISTING LAND USE ZONES PROVIDED BY WDC, 2016
3. FOR EXISTING DEVELOPMENT HYDROLOGY THE CN AND % IMPERVIOUS ASSUMES EXTENT DEVELOPMENT BASED ON AERIAL PHOTOS NOT LAND USE ZONING.
4. SOIL GROUP, CN AND % IMPERVIOUS HAVE BEEN SELECTED FROM TP108 AND THEN VALIDATED BY ANALYSIS OF THE GAUGE DATA FOR THE TUTAENUI STREAM AND CALIBRATED IN THE MODEL.

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	FOR INFORMATION	MS	IS	IS	22.01.18
A	UNDER REVISION	SH	IS	IS	5.04.17

Drawing Originator: Beca

Original Scale (A1) 1:25000
Reduced Scale (A3) 1:50000

Design	MS	5.04.17	Approved For Construction*
Drawn	SH	5.04.17	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council, Te Kaunihera o Tuakau o Waikato

Project: TUAKAU DISTRICT PLAN FLOOD HAZARD MAPPING

Title: EXISTING LAND USE MAP SHEET 1 0F 2

Discipline: CIVIL ENGINEERING

Drawing No. 3413098-CA-SK003 Rev. B

Document No. 3413098-CA-SK003.DWG

DO NOT SCALE

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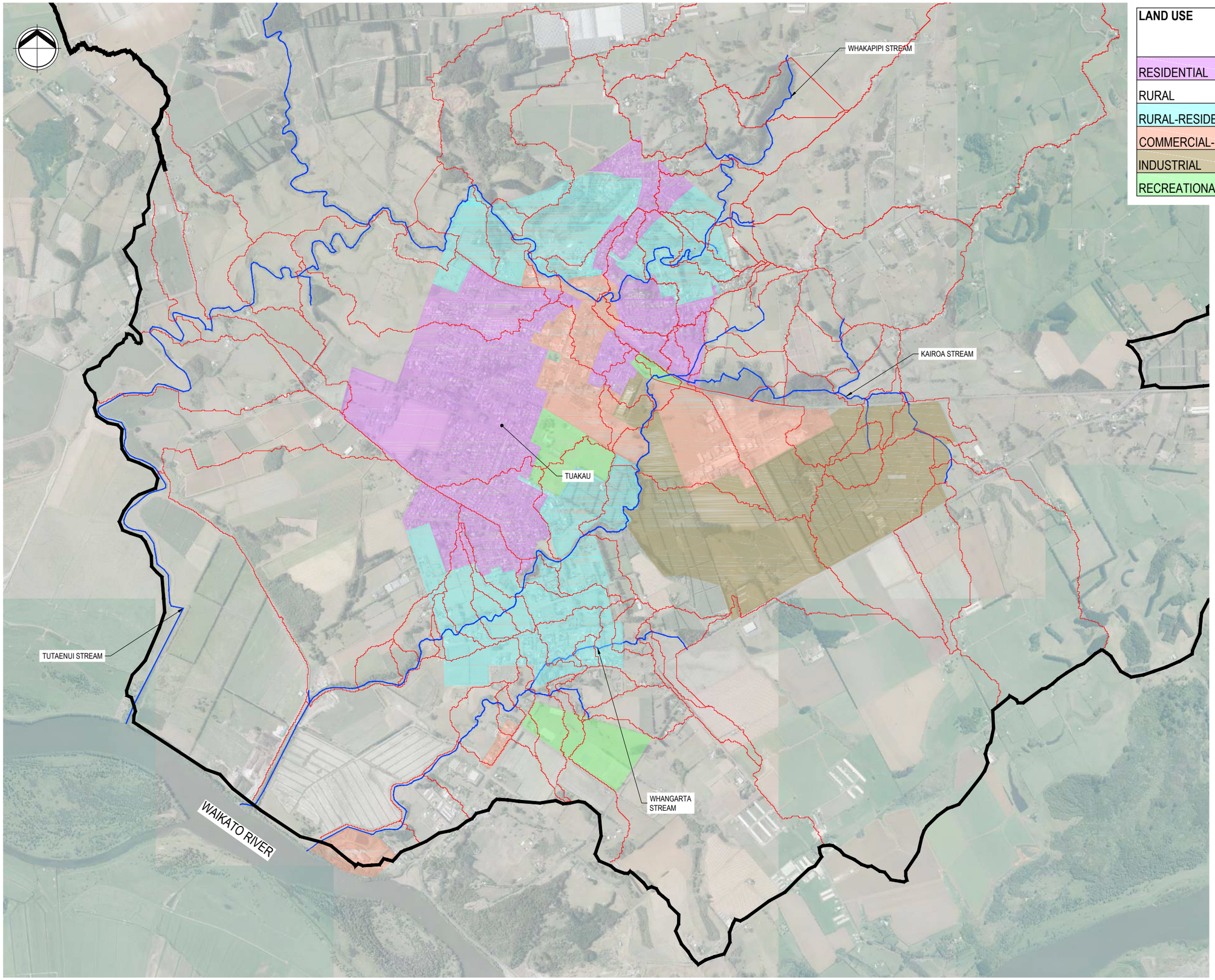
Drawing Plotted: 22 Jan 2018 5:55 p.m.



LAND USE	CN	IMPERVIOUS (%)
RESIDENTIAL	65.9	38
RURAL	46.7	0
RURAL-RESIDENTIAL	56.3	19
COMMERCIAL-BUSINESS	90.1	85
INDUSTRIAL	83.5	72
RECREATIONAL	56	0

LEGEND:

- SUBCATCHMENT BOUNDARY
- STREAM

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2015 (TBC)
2. EXISTING LAND USE ZONES PROVIDED BY WDC, 2016
3. FOR EXISTING DEVELOPMENT HYDROLOGY THE CN AND % IMPERVIOUS ASSUMES DEVELOPMENT BASED ON AERIAL PHOTOS NOT LAND USE ZONING.
4. SOIL GROUP, CN AND % IMPERVIOUS HAVE BEEN SELECTED FROM TP108 AND THEN VALIDATED BY ANALYSIS OF THE GAUGE DATA FOR THE TUTAENUI STREAM.
5. CALIBRATION OF THE MODEL AGAINST GAUGED INFORMATION HAS SHOWN THE SOILS TO BE IN BETWEEN SOIL GROUP A AND B.

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	FOR INFORMATION	MS	IS	IS	22.01.18
A	UNDER REVISION	SH	IS	IS	5.04.17

Drawing Originator: Beca

Original Scale (A1) 1:25000
Reduced Scale (A3) 1:50000

Design	MS	5.04.17	Approved For Construction*
Drawn	SH	5.04.17	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: EXISTING LAND USE MAP
SHEET 2 OF 2

Discipline: CIVIL ENGINEERING

Drawing No.: 3413098-CA-SK004

Rev.: B

DO NOT SCALE

IF IN DOUBT ASK.

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Document No. - 3413098-CA-SK004.DWG

Drawing Plotted: 23 Jan 2018 9:10 a.m.

LAND USE	CN	IMPERVIOUS (%)
RESIDENTIAL	65.9	38
RURAL	46.7	0
RURAL-RESIDENTIAL	56.3	19
COMMERCIAL-BUSINESS	90.1	85
INDUSTRIAL	83.5	72
RECREATIONAL	56	0

LEGEND:

- STRUCTURE PLAN STAGE ONE ZONING
- SUBCATCHMENT BOUNDARY
- STREAM

WAIKATO RIVER

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2015 (TBC)
2. LAND USE ZONES PROVIDED BY WDC, 2016
3. EXISTING AREAS OF TUAKAU REMAIN AT CURRENT DEVELOPMENT DENSITY/ % IMPERVIOUS TO ALLOW THE EFFECTS OF THE STRUCTURE PLAN TO BE SHOWN.
4. CALIBRATION OF THE MODEL AGAINST GAUGED INFORMATION HAS SHOWN THE SOILS TO BE IN BETWEEN SOIL GROUP A AND B.

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	FOR INFORMATION	MS	IS	IS	22.01.18
A	UNDER REVISION	SH	IS	IS	5.04.17

Drawing Originator: Beca

Original Scale (A1) 1:25000
Reduced Scale (A3) 1:50000

Design	MS	5.04.17	Approved For Construction*
Drawn	SH	5.04.17	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: STAGE ONE STRUCTURE PLAN LAND USE MAP

Discipline: CIVIL ENGINEERING

Drawing No. 3413098-CA-SK005 Rev. B

DO NOT SCALE

IF IN DOUBT ASK.

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Document No. 3413098-CA-SK005.DWG

Drawing Plotted: 23 Jan 2018 10:36 a.m.

LAND USE	CN	IMPERVIOUS (%)
RESIDENTIAL	82.4	70
RURAL	46.7	0
RURAL-RESIDENTIAL	56.3	19
COMMERCIAL-BUSINESS	92.6	90
INDUSTRIAL	90.1	90
RECREATIONAL	56	0
LIGHT INDUSTRIAL	83.5	72
PUKEKOHE EXISTING DEVELOPMENT	82.4	70
PUKEKOHE FUTURE DEVELOPMENT	82.4	70

PUKEHOHE

PUKEHOHE FUTURE DEVELOPMENT

TUTAENUI STREAM

WHAKAPIPI STREAM

SK007

TUAKAU

KAIROA STREAM

G

TUTAENUI STREAM

WHANGARTA STREAM

WAIKATO RIVER

LEGEND:

- PUKEKOHE URBAN AREA
- PUKEKOHE FUTURE DEVELOPMENT
- TUAKAU STRUCTURE PLAN STAGE ONE ZONING
- GUAGED CATCHMENT BOUNDARY
- CATCHMENT BOUNDARY
- STREAM
- FLOW GUAGE

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2015 (TBC)
2. LAND USE ZONES PROVIDED BY WDC, 2016
3. PUKEKOHE FUTURE DEVELOPMENT TAKEN FROM ACC's PUKEKOHE AREA PLAN, OCT 2014.
4. IT IS ASSUMED THAT EXISTING AREAS OF TUAKAU WILL INFILL DEVELOP TO THE EXTENT OF THE CURRENT DISTRICT PLAN AND TO THE MAXIMUM PERCENT IMPERVIOUS FOR EACH LAND USE ZONE
5. CALIBRATION OF THE MODEL AGAINST GAUGED INFORMATION HAS SHOWN THE SOILS TO BE IN BETWEEN SOIL GROUP A AND B.

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	FOR INFORMATION	MS	IS	IS	22.01.18
A	UNDER REVISION	SH	IS	IS	5.04.17

Drawing Originator: Beca

Original Scale (A1) 1:25000
Reduced Scale (A3) 1:50000

Design	MS	5.04.17	Approved For Construction*
Drawn	SH	5.04.17	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Waikato District Council, Te Kaunihera aa Takiwaa o Waikato

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: MAXIMUM PROBABLE DEVELOPMENT MAP SHEET 1 OF 2

Discipline: CIVIL ENGINEERING

Drawing No.: 3413098-CA-SK006 Rev.: B

DO NOT SCALE

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Document No. 3413098-CA-SK006.DWG

Drawing Plotted: 23 Jan 2018 10:41 a.m.

LAND USE	CN	IMPERVIOUS (%)
RESIDENTIAL	82.4	70
RURAL	46.7	0
RURAL-RESIDENTIAL	56.3	19
COMMERCIAL-BUSINESS	92.6	90
INDUSTRIAL	90.1	90
RECREATIONAL	56	0
LIGHT INDUSTRIAL	83.5	72
PUKEKOHE EXISTING DEVELOPMENT	82.4	70
PUKEKOHE FUTURE DEVELOPMENT	82.4	70

LEGEND:

- PUKEKOHE URBAN AREA
- PUKEKOHE FUTURE DEVELOPMENT
- TUAKAU STRUCTURE PLAN STAGE ONE ZONING
- GUAGED CATCHMENT BOUNDARY
- CATCHMENT BOUNDARY
- STREAM
- FLOW GUAGE

WAIKATO RIVER

NOTES:

1. AERIAL PHOTO PROVIDED BY WDC, 2015 (TBC)
2. LAND USE ZONES PROVIDED BY WDC, 2016
3. PUKEKOHE FUTURE DEVELOPMENT TAKEN FROM ACC's PUKEKOHE AREA PLAN, OCT 2014.
4. IT IS ASSUMED THAT EXISTING AREAS OF TUAKAU WILL INFILL DEVELOP TO THE EXTENT OF THE CURRENT DISTRICT PLAN AND TO THE MAXIMUM PERCENT IMPERVIOUS FOR EACH LAND USE ZONE
5. CALIBRATION OF THE MODEL AGAINST GAUGED INFORMATION HAS SHOWN THE SOILS TO BE IN BETWEEN SOIL GROUP A AND B.

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	FOR INFORMATION	MS	IS	IS	22.01.18
A	UNDER REVISION	SH	IS	IS	5.04.17

Drawing Originator: Beca

Original Scale (A1) 1:7500
Reduced Scale (A3) 1:15000

Design	MS	5.04.17	Approved For Construction* Date
Drawn	SH	5.04.17	
Dsg Verifier			
Dwg Check			

* Refer to Revision 1 for Original Signature

Client: Waikato District Council

Project: TUAKAU DISTRICT PLAN
FLOOD HAZARD MAPPING

Title: MAXIMUM PROBABLE DEVELOPMENT MAP SHEET 2 OF 2

Discipline: CIVIL ENGINEERING

Drawing No. 3413098-CA-SK007 Rev. B

Document No. 3413098-CA-SK007.DWG

DO NOT SCALE

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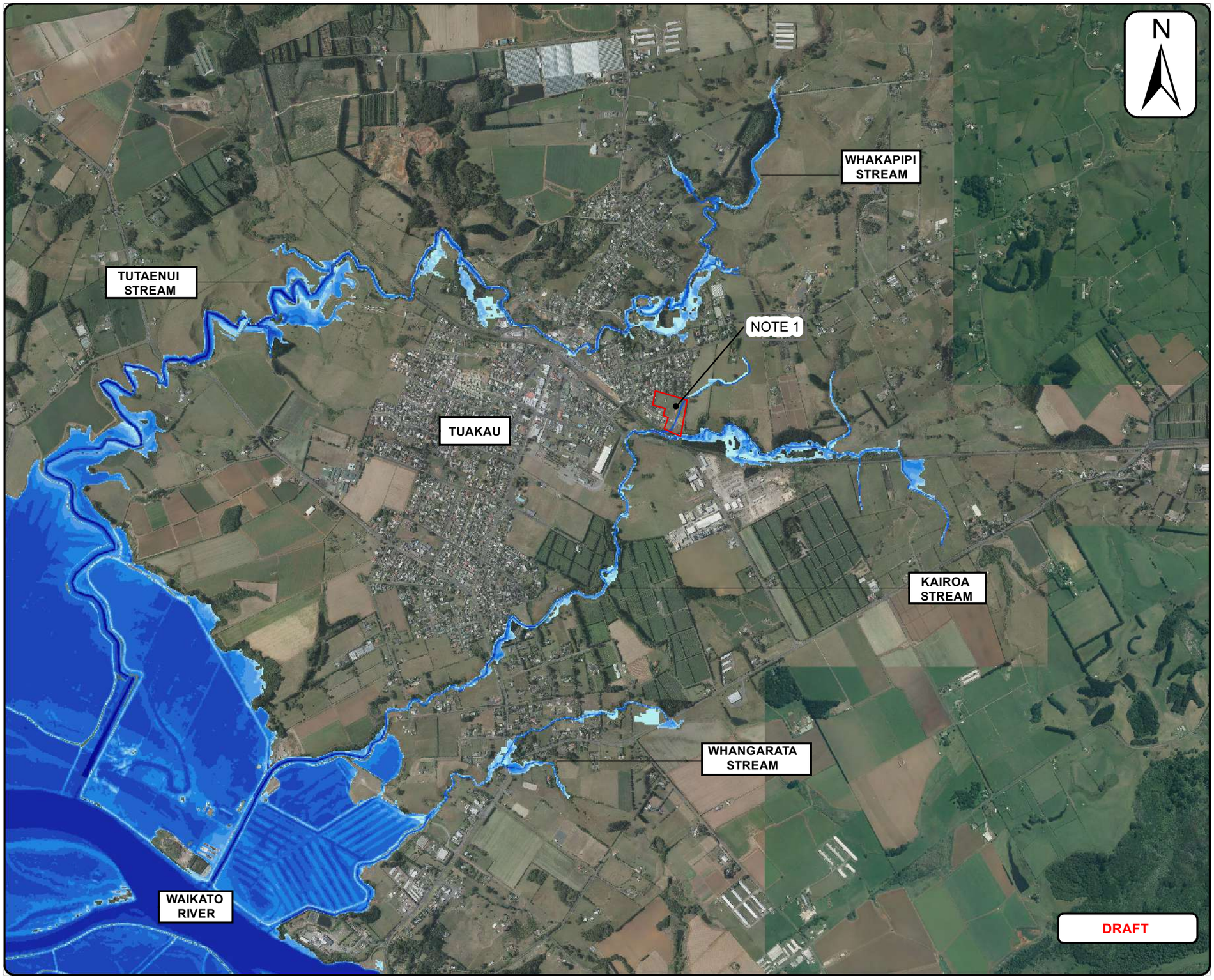
D

Appendix D – Existing Flooding



LEGEND

MAX DEPTH (m)

- 0 - 0.1
- 0.10- 0.3
- 0.3 - 0.5
- 0.5 - 1
- 10- 1.5
- 1.50 - 2
- 20 - 3
- 3 - 3.5
- 3.5 +

KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.

CLIENT: Waikato District Council – Te Kaunihera ā Takiwaa o Waikato

CONSULTANT: Beca

Map Use:
- ☒ S&P
- ☐ ICMP
- ☐ RFHA
- ☐ District Plan
- ☐ LIM
- ☐ Council GIS
- ☐ Floor Levels
- ☐ Other _____

Event:
- ☒ 100 -year ARI
- ☐ Observed event: _____
- Climate change ☐ Yes ☒ No to year_____

Development:
- ☒ ED: Exisiting Development
- ☐ PD: Post-Development
- ☐ MPD: Maximun Probable
- ☐ Other: _____

Modelling Approach:
- ☒ 1D
- ☒ 2D
- ☐ Rain-on- grid
- ☒ Open channels
- ☐ Piped networks
- ☒ Structures
- ☒ DEM/ overland flow
- ☒ Flow Gauge Calibrated

Map Parameter:
- ☒ Depth
- ☐ Water Surface
- ☐ Elevation
- ☐ Velocity
- ☐ Flood Hazard
- ☐ Difference
- _____

		NAME	SIGNED	DATE
COORDINATES	NZTM 2000			
DATUM	MOTURIKI 1953	DESIGNED	MRS	22.01.2018
SURVEY	2016	DES. REVIEW	ET	22.01.2018
AERIAL PHOTO	2012	DRAWN	MRS	22.01.2018
LIDAR	WRC, 2010	DRW. CHECK	IS	22.01.2018
CONSULTANT PROJECT REF.		3413098		
FILE LOCATION	P:\341\3413098\THY\Modelling\05 Models\03_Q100ED			

APPROVED

FOR INFORMATION	
DATE	SIGNED

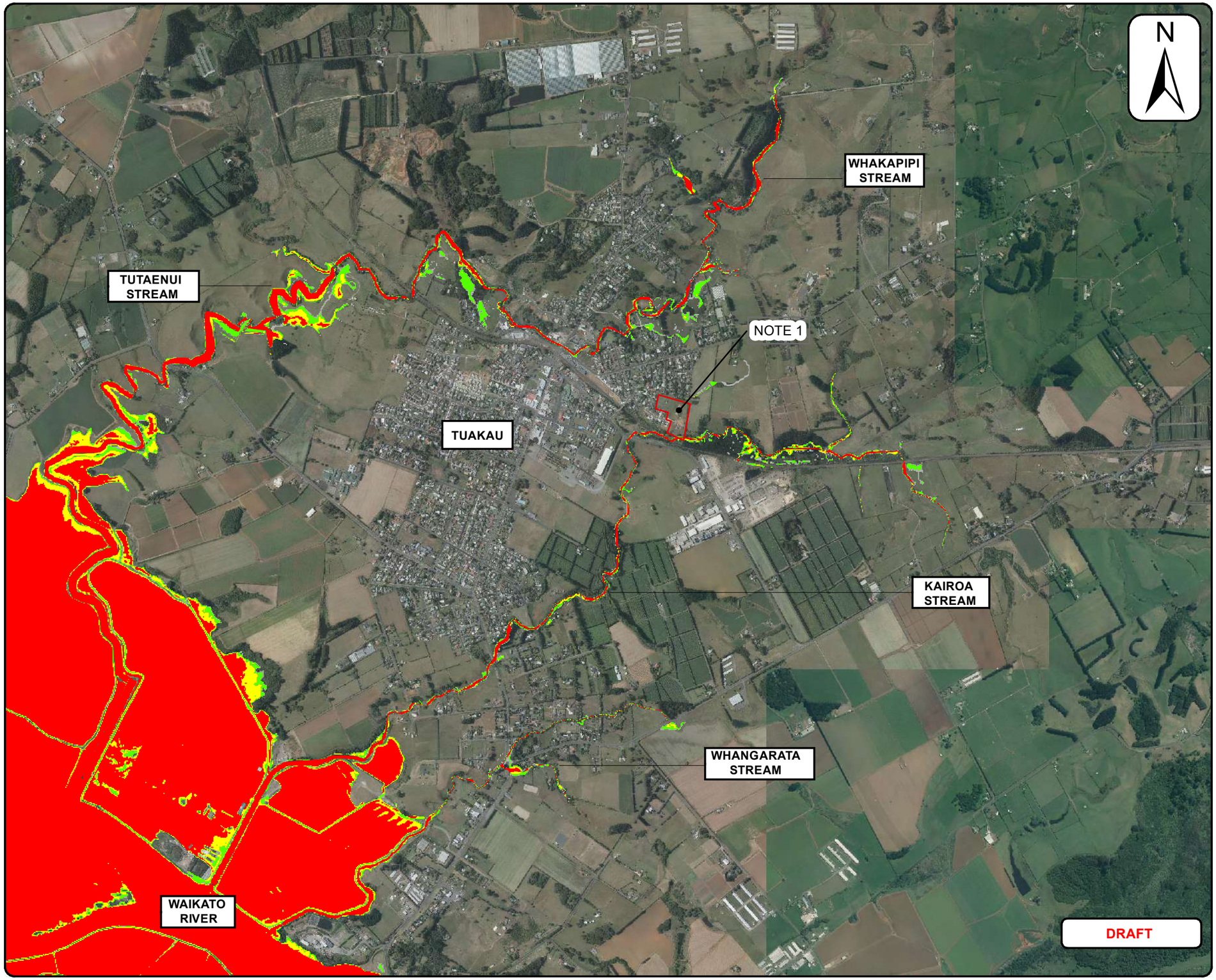
SCALE 1:20,000

PROJECT TITLE: **TUAKAU STRUCTURE PLAN (STAGE 1) FLOOD HAZARD MAPPING**

CONTRACT NUMBER: 16/073

DRAWING TITLE: **EXISTING DEVELOPMENT**
100 YR ARI FLOOD DEPTH

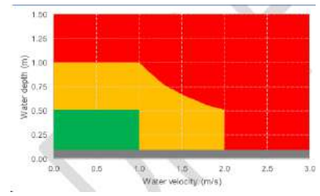
DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1001	A3	1 OF 1	C



LEGEND

Hazard_Min

- High
- Medium
- Low
- Insignificant



KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.

CLIENT: Waikato District Council — Te Kaunihera ā Takiwā o Waikato

CONSULTANT: Beca

Map Use: ☒ S&P ☐ ICMP ☐ RFHA ☐ District Plan ☐ LIM ☐ Council GIS ☐ Floor Levels ☐ Other _____

Event: ☒ 100 -year ARI ☐ Observed event: _____ Climate change ☐ Yes ☒ No to year_____

Development: ☒ ED: Exisiting Development ☐ PD: Post-Development ☐ MPD: Maximun Probable ☐ Other: _____

Modelling Approach: ☒ 1D ☒ 2D ☐ Rain-on- grid ☒ Open channels ☐ Piped networks ☒ Structures ☒ DEM/ overland flow ☒ Flow Gauge Calibrated

Map Parameter: ☐ Depth ☐ Water Surface ☐ Elevation ☐ Velocity ☒ Flood Hazard ☐ Difference _____

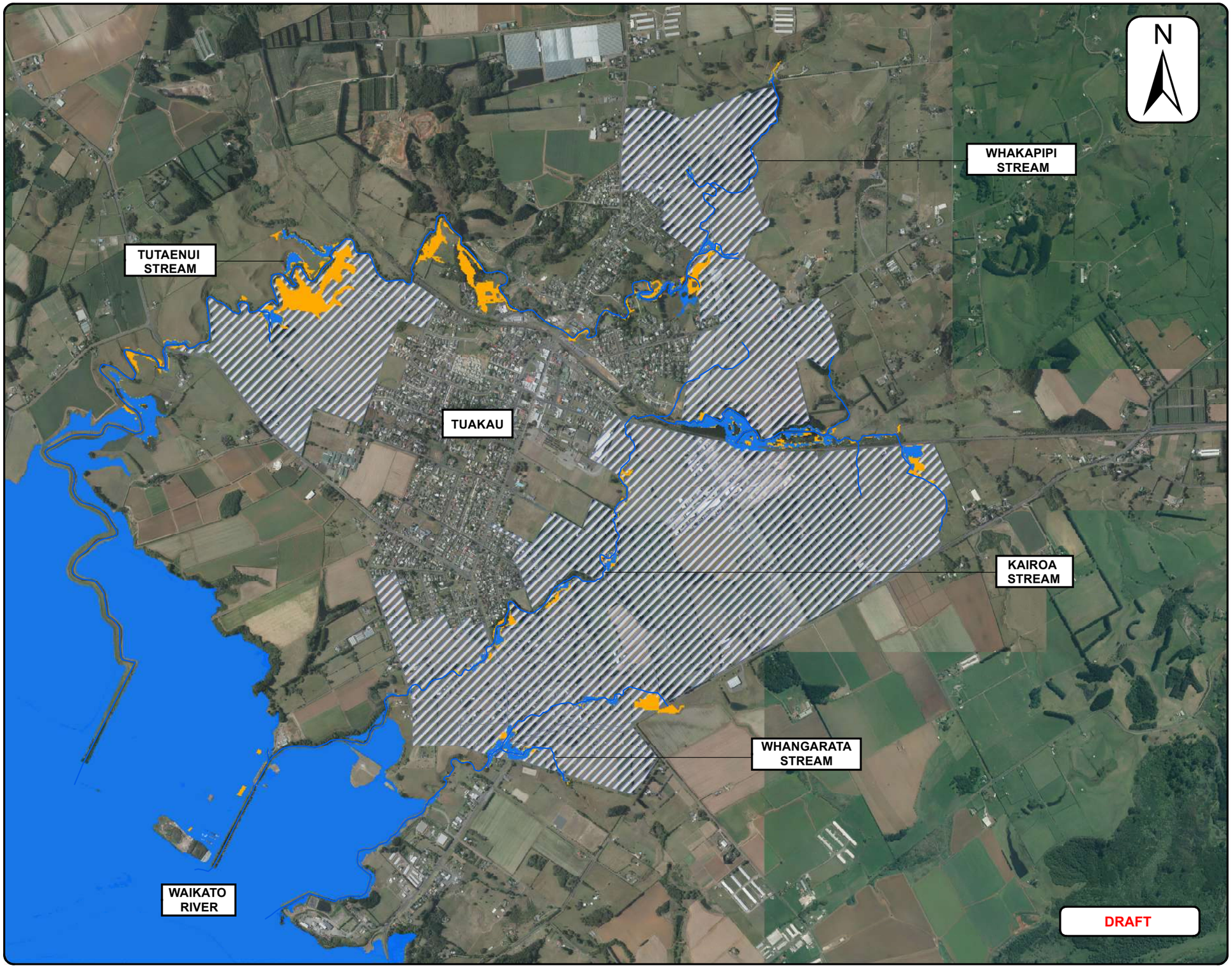
		NAME	SIGNED	DATE	APPROVED
COORDINATES NZTM 2000					
DATUM MOTURIKI 1953	DESIGNED	MRS		22.01.2018	FOR INFORMATION
SURVEY 2016	DES. REVIEW	ET		22.01.2018	DATE / SIGNED
AERIAL PHOTO 2012	DRAWN	MRS		22.01.2018	
LIDAR WRC, 2010	DRW. CHECK	IS		22.01.2018	
CONSULTANT PROJECT REF.	3413098				SCALE 1:20,000
FILE LOCATION	P:\341\3413098\THY\Modelling\05 Models\03_Q100ED				

PROJECT TITLE: **TUAKAU STRUCTURE PLAN (STAGE 1) FLOOD HAZARD MAPPING**

CONTRACT NUMBER: 16/073

DRAWING TITLE: **EXISTING DEVELOPMENT 100 YR ARI FLOOD HAZARD**

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1003	A3	1 OF 1	C



LEGEND

HIRDS V4
- 100 year Existing Development Extent

HIRDS V3
- 100 year Existing Development Extent
- Waterway
- STRUCTURE PLAN AREAS (STAGE 1)

NOTES

1. ONLY 2D RESULTS ARE SHOWN IN THIS MAP IN ORDER TO SHOW FLOOD EXTENT

CLIENT: Waikato District Council

CONSULTANT: Beca

Map Use:
- ☒ S&P
- ☐ ICMP
- ☐ RFHA
- ☐ District Plan
- ☐ LIM
- ☐ Council GIS
- ☐ Floor Levels
- ☐ Other _____

Event:
- ☒ 100 -year ARI
- ☐ *Observed event:* _____

Climate change ☒ Yes ☐ No
to 2100 RCP 6.0

Development:
- ☒ ED: Exisiting Development
- ☐ PD: Post-Development
- ☐ MPD: Maximun Probable
- ☐ Other: _____

Modelling Approach:
- ☒ 1D
- ☒ 2D
- ☐ Rain-on- grid
- ☒ Open channels
- ☐ Piped networks
- ☒ Structures
- ☒ DEM/ overland flow
- ☒ Flow Gauge Calibrated

Map Parameter:
- ☐ Depth
- ☐ Water Surface
- ☐ Elevation
- ☐ Velocity
- ☐ Flood Hazard
- ☒ Difference
_____

		NAME	SIGNED	DATE
COORDINATES NZTM 2000				
DATUM MOTURIKI 1953	DESIGNED	GJC		
SURVEY 2016	DES. REVIEW			
AERIAL PHOTO 2012	DRAWN	GJC		
LIDAR WRC, 2010	DRW. CHECK			
CONSULTANT PROJECT REF.	3413098			

FILE LOCATION
P:\341\3413098\THY\Modelling\05 Models\03_Q100ED

APPROVED
FOR INFORMATION

DATE	SIGNED

SCALE
1:20,000

PROJECT TITLE:
TUAKAU STRUCTURE PLAN
FLOOD HAZARD MAPPING

CONTRACT NUMBER: 16/073

DRAWING TITLE:
EXISTING DEVELOPMENT
HIRDS V3 AND V4 FLOOD EXTENT

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1000	A3	1 OF 1	A

Whakapipi Stream

Harrisville Road bridge

CTUA112

CTUA105

CTUA107

CTUA109

CTUA106

Kairoa Stream

Kairoa Stream

N

LEGEND

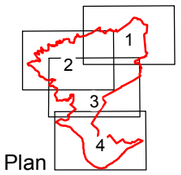
- Tuakau Structure Plan Boundary
- Critical culvert locations
- Existing pond locations
- Overland flow path/Unnamed tributary
- Significant waterways
- WDC Building outlines
- Waikato River 1% AEP flood extent (interpolated)
- WDC stormwater assets
- North Island Main Trunk Rail boundary
- North Island Main Trunk Railway
- Potential Flood Hazard
- Minor Flood Hazard
- Significant Flood Hazard

Notes: Aerial photograph supplied by Waikato District Council.

A3 SCALE 1:10,000

0 100 200 300 400 500 Meters

Location Plan



Tonkin & Taylor
Environmental and Engineering Consultants
Level 1, 9 CliftonRoad, Hamilton
www.tonkin.co.nz

DRAWN	DWM	Jul.14
CHECKED	BMD	7/14
APPROVED	PRC	7/14
ARCFILE	61814.000-F102_F105.mxd	
SCALE (AT A3 SIZE)	1:10,000	
PROJECT No.	61814.000	
FIGURE No.	Figure 102	Rev. 0

WAIKATO DISTRICT COUNCIL
CATCHMENT MANAGEMENT PLAN
TUAKAU STRUCTURE PLAN AREA
Flooding Map - Sheet 1 of 4

Path: P:\61814\61814.0000\WorkingMaterial\GIS\61814.000-F102_F105.mxd Date: 16/07/2014 Time: 9:15:49 a.m.

Whakapipi Stream

Tutaenui Stream

Harrisville Road bridge

Buckland Road bridge

CTUA104

CTUA112

CTUA113

CTUA103

CTUA108

CTUA109

CTUA105

CTUA107

Kairoa Stream

Tutaenui Stream

Kairoa Stream

CTUA110

N

LEGEND

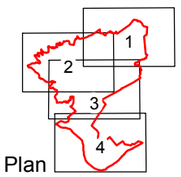
- Tuakau Structure Plan Boundary
- Critical culvert locations
- Existing pond locations
- Overland flow path/Unnamed tributary
- Significant waterways
- WDC Building outlines
- Waikato River 1% AEP flood extent (interpolated)
- WDC stormwater assets
- North Island Main Trunk Rail boundary
- North Island Main Trunk Railway
- Potential Flood Hazard
- Minor Flood Hazard
- Significant Flood Hazard

Notes: Aerial photograph supplied by Waikato District Council.

A3 SCALE 1:10,000

0 100 200 300 400 500 Meters

Location Plan



Tonkin & Taylor
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Level 1, 9 CliftonRoad, Hamilton
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DRAWN	DWM	Jul.14
CHECKED	BMD	7/14
APPROVED	PRC	7/14
ARCFILE	61814.000-F102_F105.mxd	
SCALE (AT A3 SIZE)	1:10,000	
PROJECT No.	61814.000	
FIGURE No.	Figure 103	Rev. 0

WAIKATO DISTRICT COUNCIL
CATCHMENT MANAGEMENT PLAN
TUAKAU STRUCTURE PLAN AREA
Flooding Map - Sheet 2 of 4

Path: P:\61814\61814.0000\WorkingMaterial\GIS\61814.000-F102_F105.mxd Date: 16/07/2014 Time: 9:15:52 a.m.

CTUA103
CTUA108
CTUA109
CTUA107
CTUA105
Kairoa Stream
CTUA106
Kairoa Stream
CTUA110
CTUA111
CTUA102
CTUA101

LEGEND

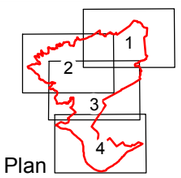
- Tuakau Structure Plan Boundary
- Critical culvert locations
- Existing pond locations
- Overland flow path/Unnamed tributary
- Significant waterways
- WDC Building outlines
- Waikato River 1% AEP flood extent (interpolated)
- WDC stormwater assets
- North Island Main Trunk Rail boundary
- North Island Main Trunk Railway
- Potential Flood Hazard
- Minor Flood Hazard
- Significant Flood Hazard

Notes: Aerial photograph supplied by Waikato District Council.

A3 SCALE 1:10,000

0 100 200 300 400 500 Meters

Location Plan



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DRAWN	DWM	Jul.14
CHECKED	BMD	7/14
APPROVED	IRR	7/14
ARCFILE	61814.000-F102_F105.mxd	
SCALE (AT A3 SIZE)	1:10,000	
PROJECT No.	61814.000	

WAIKATO DISTRICT COUNCIL
CATCHMENT MANAGEMENT PLAN
TUAKAU STRUCTURE PLAN AREA
Flooding Map - Sheet 3 of 4

FIGURE No. Figure 104

Rev. 0

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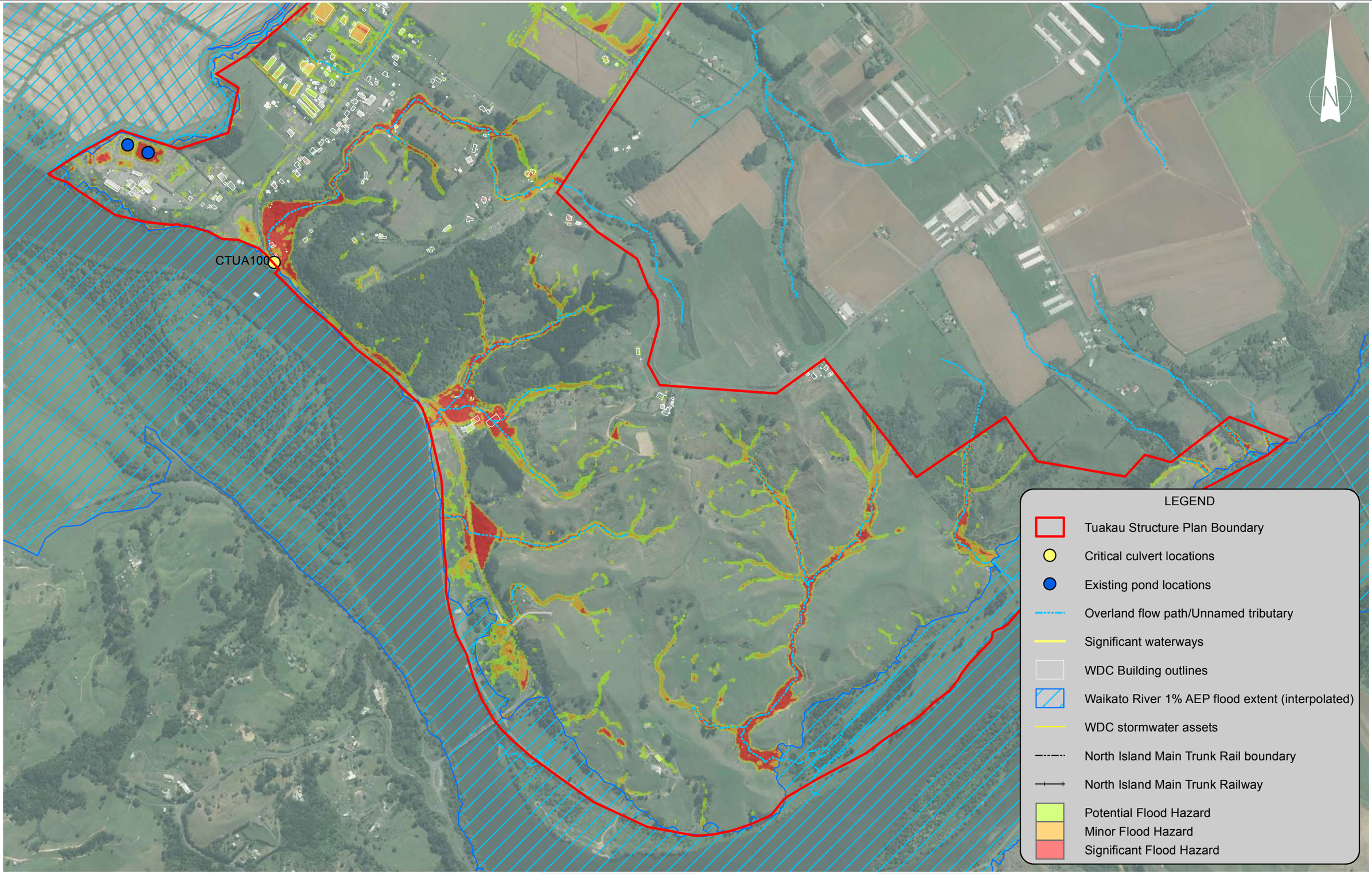
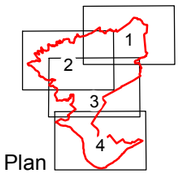


Notes: Aerial photograph supplied by Waikato District Council.

A3 SCALE 1:10,000

0 100 200 300 400 500 Meters

Location Plan



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Level 1, 9 CliftonRoad, Hamilton
www.tonkin.co.nz

DRAWN	DWM	Jul.14
CHECKED	BnD	7/14
APPROVED	RR	7/14
ARCFILE	61814.000-F102_F105.mxd	
SCALE (AT A3 SIZE)	1:10,000	
PROJECT No.	61814.000	

WAIKATO DISTRICT COUNCIL
CATCHMENT MANAGEMENT PLAN
TUAKAU STRUCTURE PLAN AREA
Flooding Map - Sheet 4 of 4

FIGURE No. Figure 105 Rev. 0

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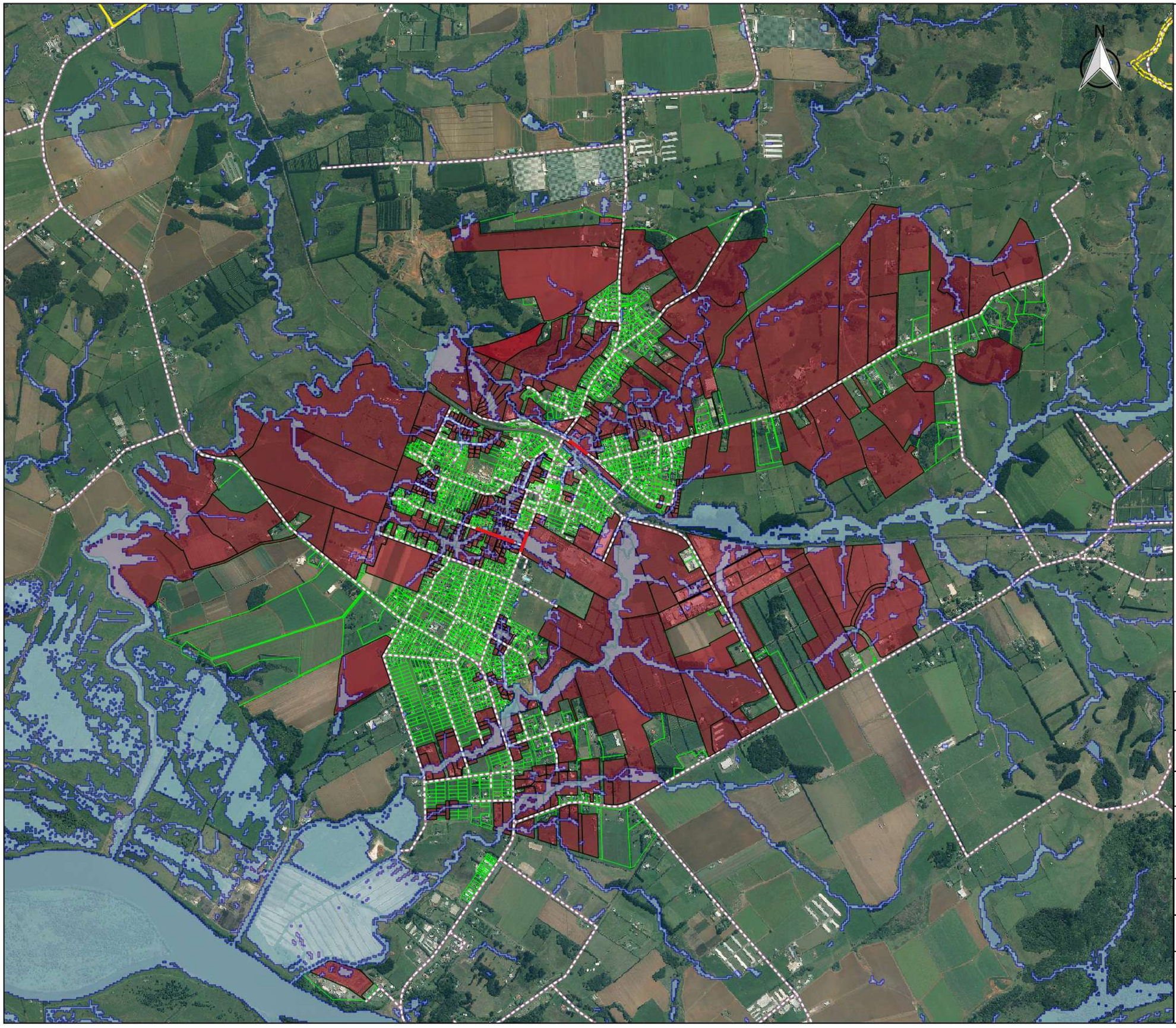
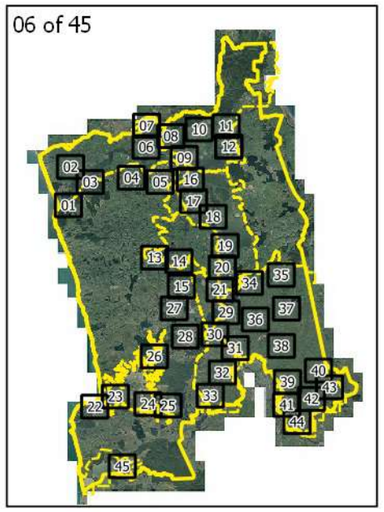




Legend

- Waikato District Boundary
- LIDAR Models Boundary
- Flood Extent
- Roads Affected
- Roads
- Properties Affected
- Properties

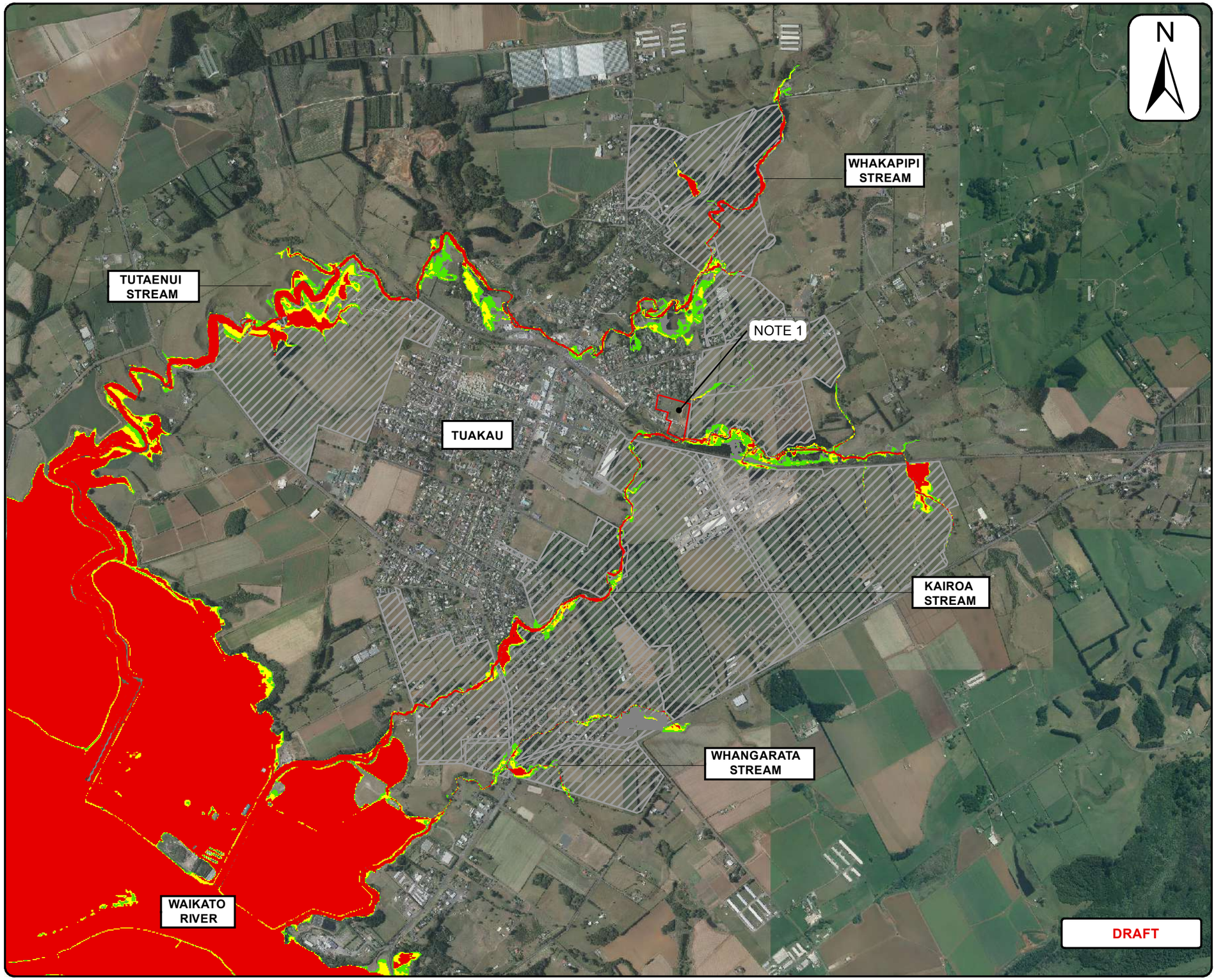
Project No:	Overland Flow - Stage 2
Title:	Roads And Properties
Map: 02	Page Number: 06 of 45
WSP | OPUS	
Drawn: RJG	Verified: MH / Approved Date: 22/09/2018
Scale: 1:20,000	Original Size: A3

Graphic Scale:

0 200 400 600 800 1000 m

E

Appendix E – Post Development Flooding Maps

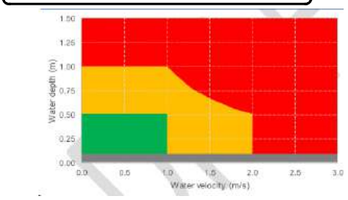


LEGEND

Structure Plan (Stage 1)

Tuakau Hazard

- High
- Medium
- Low
- Insignificant



KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.

CLIENT: Waikato District Council — Te Kaunihera ā Takiwā o Waikato

CONSULTANT: Beca

Map Use: ☒ S&P ☐ ICMP ☐ RFHA ☐ District Plan ☐ LIM ☐ Council GIS ☐ Floor Levels ☐ Other _____

Event: ☒ 100 -year ARI ☐ *Observed event:* _____ *Climate change* ☒ *Yes* ☐ *No* *to year* 2090

Development: ☐ ED: Exisiting Development ☒ PD: Post-Development ☐ MPD: Maximun Probable ☐ Other: _____

Modelling Approach: ☒ 1D ☒ 2D ☐ Rain-on- grid ☒ Open channels ☐ Piped networks ☒ Structures ☒ DEM/ overland flow ☒ Flow Gauge Calibrated

Map Parameter: ☐ Depth ☐ Water Surface ☐ Elevation ☐ Velocity ☒ Flood Hazard ☐ Difference _____

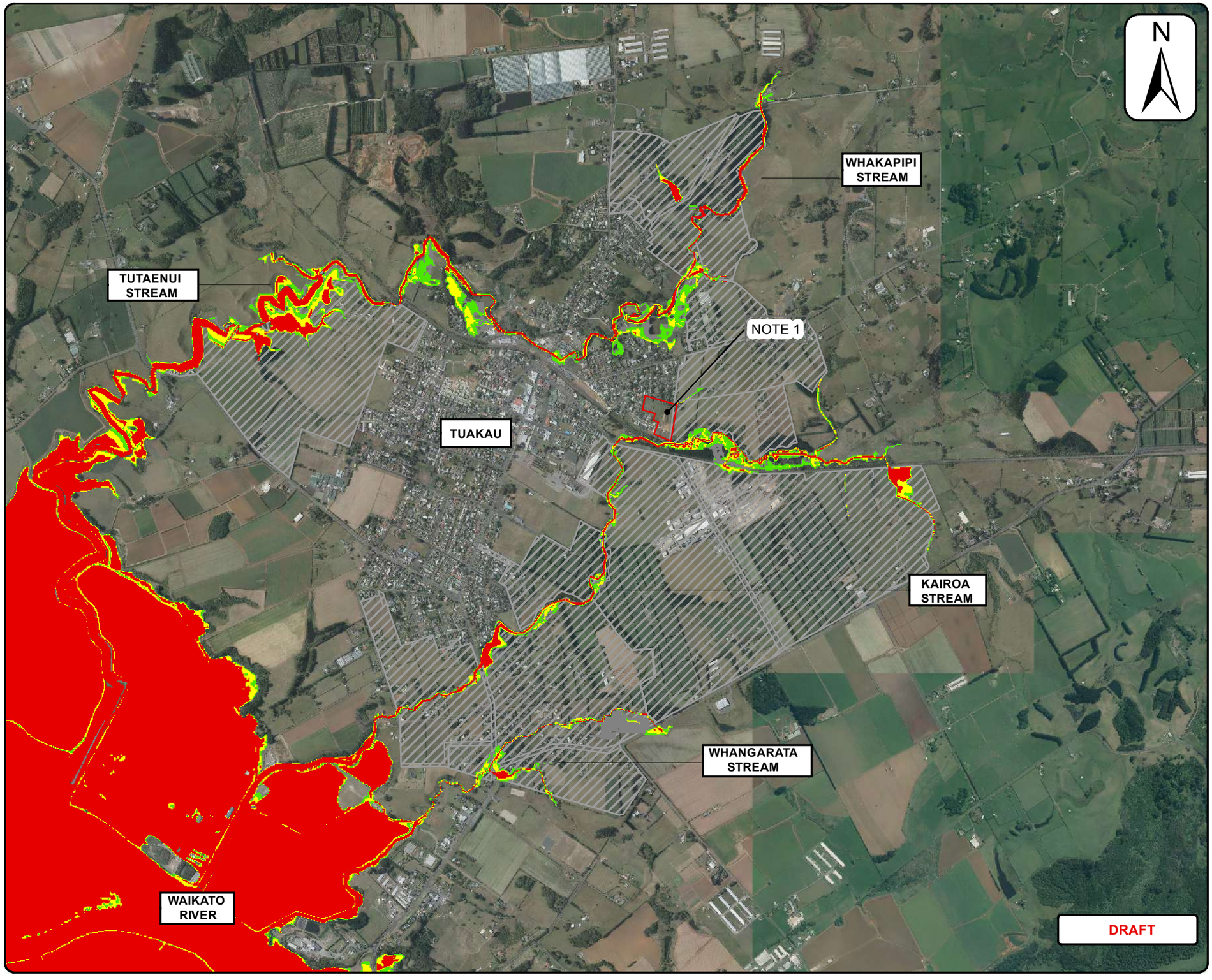
		NAME	SIGNED	DATE	APPROVED
COORDINATES NZTM 2000					FOR INFORMATION
DATUM MOTURIKI 1953	DESIGNED	MRS		22.01.2018	DATE / SIGNED
SURVEY 2016	DES. REVIEW	ET		22.01.2018	
AERIAL PHOTO 2012	DRAWN	MRS		22.01.2018	
LIDAR WRC, 2010	DRW. CHECK	IS		22.01.2018	
CONSULTANT PROJECT REF.	3413098				SCALE 1:20,000
FILE LOCATION	P:\341\3413098\THY\Modelling\05 Models\03_Q100ED				

PROJECT TITLE: **TUAKAU STRUCTURE PLAN (STAGE 1) FLOOD HAZARD MAPPING**

CONTRACT NUMBER: 16/073

DRAWING TITLE: **POST DEVELOPMENT (UNMITIGATED) 100 YR ARI FLOW HAZARD**

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1006	A3	1 OF 1	B

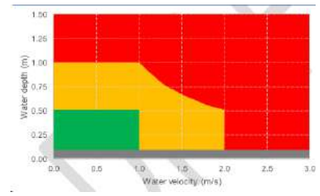


LEGEND

- Structure Plan (Stage 1)

Tuakau Hazard

- High
- Medium
- Low
- Insignificant



KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.
3. MITIGATION APPLIED ONLY IN SUBCATCHMENTS AFFECTED BY STRUCTURE PLAN (STAGE 1)
4. MITIGATION INCLUDES ONLY FLOW ATTENUATION. FURTHER INVESTIGATION AND DESIGN IS NEEDED TO TEST OTHER POTENTIAL STORMWATER EFFECTS SUCH AS FLOODPLAIN FILLING, DIVERSION OF FLOW PATHS, ETC.

CLIENT: Waikato District Council — Te Kaunihera o Tohiwaa o Waikato

CONSULTANT: Beca

Map Use: ☒ S&P ☐ ICMP ☐ RFHA ☐ District Plan ☐ LIM ☐ Council GIS ☐ Floor Levels ☐ Other _____

Event: ☒ 100 -year ARI ☐ Observed event: _____ Climate change ☒ Yes ☐ No to year 2090

Development: ☐ ED: Exisiting Development ☒ PD: Post-Development ☐ MPD: Maximun Probable ☐ Other: _____

Modelling Approach: ☒ 1D ☒ 2D ☐ Rain-on- grid ☒ Open channels ☐ Piped networks ☒ Structures ☒ DEM/ overland flow ☒ Flow Gauge Calibrated

Map Parameter: ☐ Depth ☐ Water Surface ☐ Elevation ☐ Velocity ☒ Flood Hazard ☐ Difference _____

			NAME	SIGNED	DATE
COORDINATES	NZTM 2000				
DATUM	MOTURIKI 1953	DESIGNED	MRS		22.01.2018
SURVEY	2016	DES. REVIEW	ET		22.01.2018
AERIAL PHOTO	2012	DRAWN	MRS		22.01.2018
LIDAR	WRC, 2010	DRW. CHECK	IS		22.01.2018
CONSULTANT PROJECT REF.		3413098			

FILE LOCATION: *P:\341\3413098\THY\Modelling\05 Models\03_Q100ED*

APPROVED — FOR INFORMATION — DATE — SIGNED

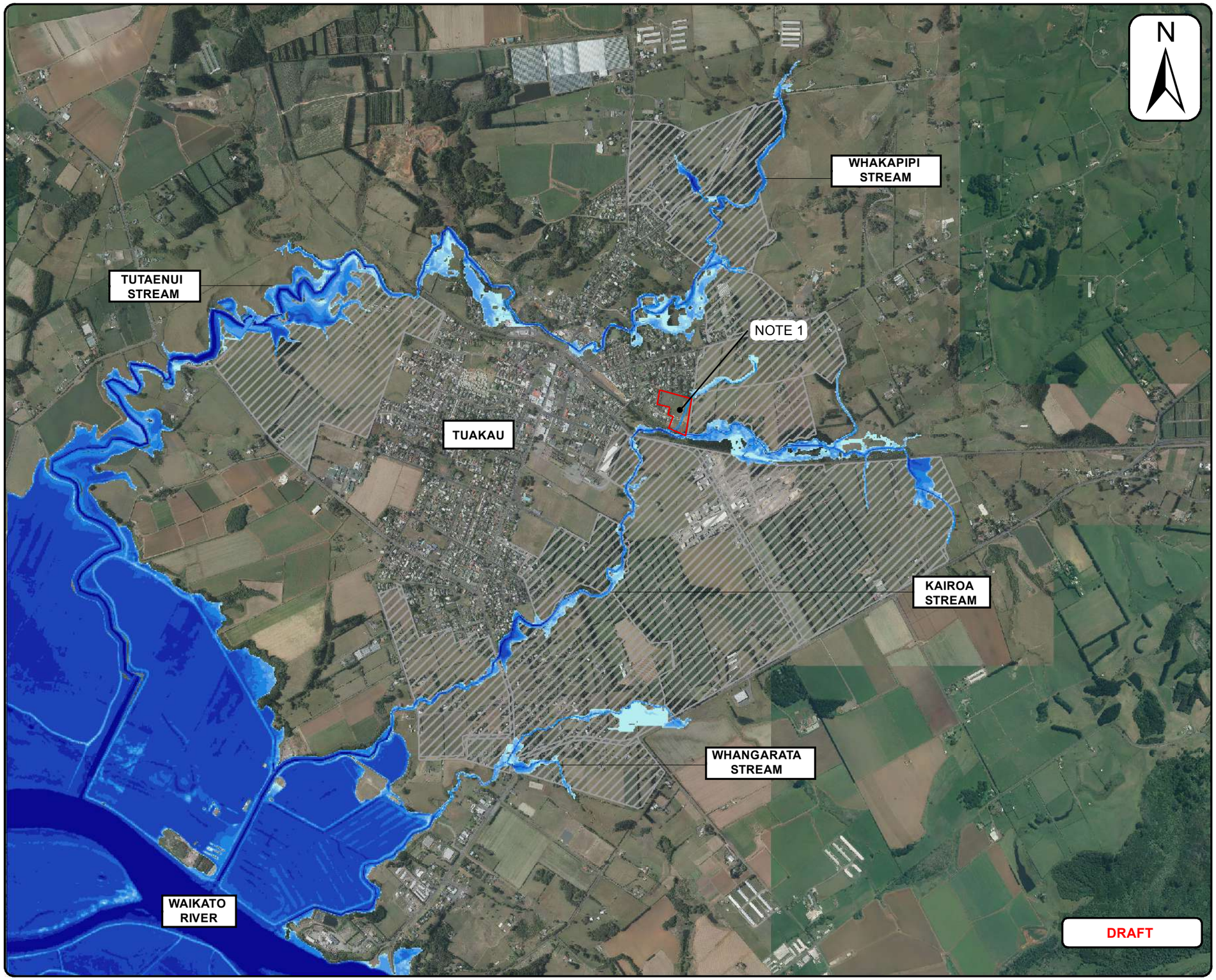
SCALE 1:20,000

PROJECT TITLE: **TUAKAU STRUCTURE PLAN (STAGE1) FLOOD HAZARD MAPPING**

CONTRACT NUMBER: 16/073

DRAWING TITLE: **POST DEVELOPMENT MITIGATED 100 YR ARI FLOW HAZARD**

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1009	A3	1 OF 1	A



LEGEND

STRUCTURE PLAN AREAS (STAGE 1)

DEPTH (m)

- 0 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1- 1.5
- 1.5 - 2
- 2 - 3
- 3 - 3.5
- 3.5 +

KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.
3. NOTE ONLY STAGE 1 STRUCTURE PLAN AREAS HAVE MITIGATION APLPLIED.

CLIENT: Waikato District Council — Te Kaunihera ā Takiwā o Waikato

CONSULTANT: Beca

Map Use:
- ☒ S&P
  - ☐ ICMP
  - ☐ RFHA
- ☐ District Plan
- ☐ LIM
- ☐ Council GIS
- ☐ Floor Levels
- ☐ Other _____

Event:
- ☒ 100 -year ARI
- ☐ Observed event: _____

Climate change ☒ Yes ☐ No *to year* 2090

Development:
- ☐ ED: Exisiting Development
- ☐ PD: Post-Development
- ☒ MPD: Maximun Probable
- ☐ Other: _____

Modelling Approach:
- ☒ 1D
- ☒ 2D
- ☐ Rain-on- grid
- ☒ Open channels
- ☐ Piped networks
- ☒ Structures
- ☒ DEM/ overland flow
- ☒ Flow Gauge Calibrated

Map Parameter:
- ☒ Depth
- ☐ Water Surface
- ☐ Elevation
- ☐ Velocity
- ☐ Flood Hazard
- ☐ Difference
- _____

		NAME	SIGNED	DATE
COORDINATES	NZTM 2000			
DATUM	MOTURIKI 1953	DESIGNED	MRS	22.01.2018
SURVEY	2016	DES. REVIEW	ET	22.01.2018
AERIAL PHOTO	2012	DRAWN	MRS	22.01.2018
LIDAR	WRC, 2010	DRW. CHECK	IS	22.01.2018
CONSULTANT PROJECT REF.		3413098		

FILE LOCATION: *P:\341\3413098\THY\Modelling\05 Models\04_Q100MDU*

APPROVED

FOR INFORMATION

DATE	SIGNED

SCALE 1:20,000

PROJECT TITLE:

TUAKAU STRUCTURE PLAN (STAGE1) FLOOD HAZARD MAPPING

CONTRACT NUMBER: 16/073

DRAWING TITLE:

MAXIMUM PROBABLE DEVELOPMENT
100 YR ARI FLOOD DEPTH

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
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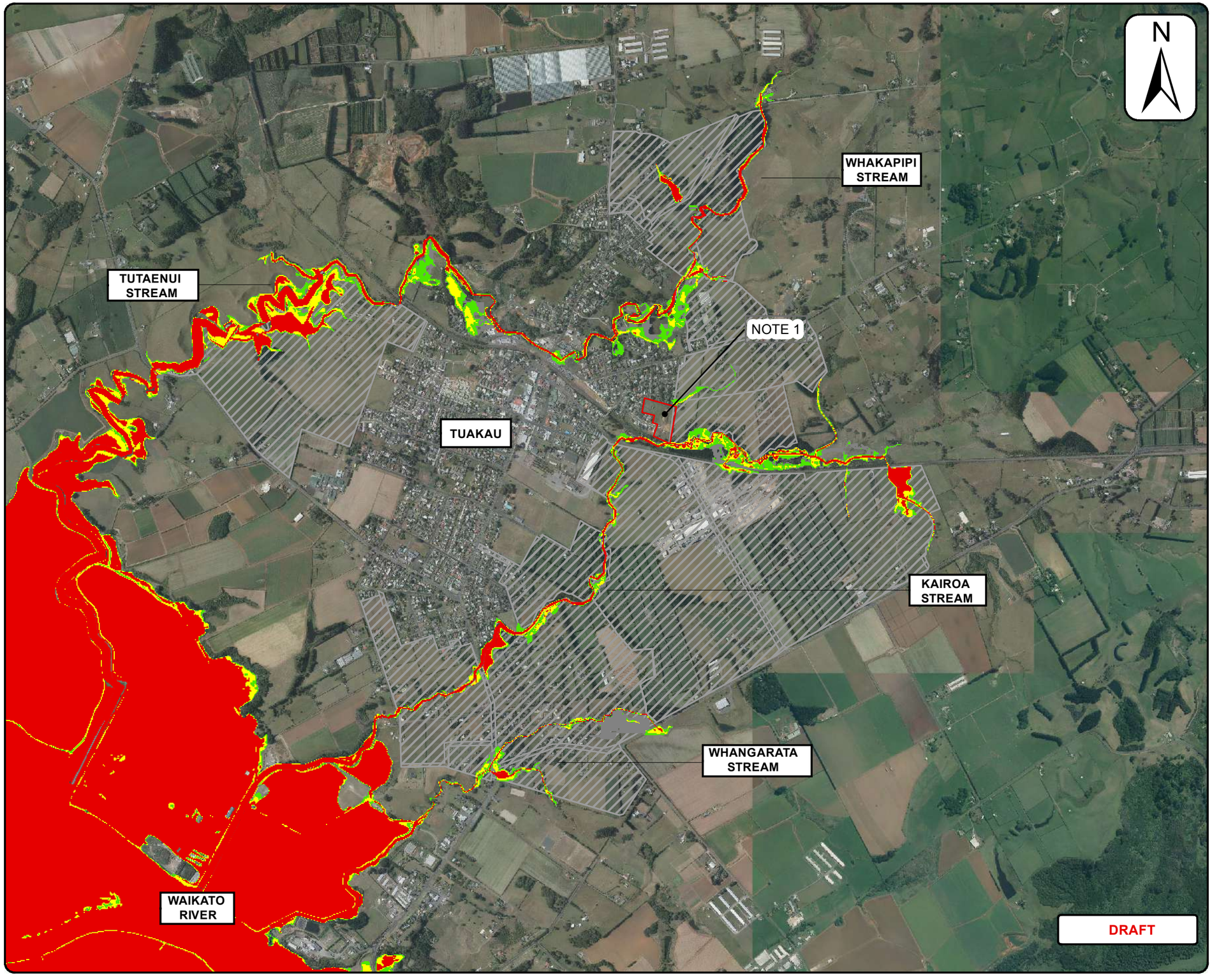
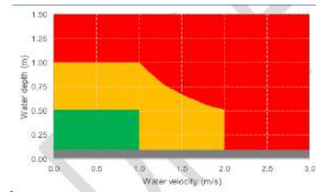


LEGEND

- Structure Plan (Stage 1)

Tuakau Hazard

- High
- Medium
- Low
- Insignificant



KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.
3. NOTE ONLY STAGE 1 STRUCTURE PLAN AREAS HAVE MITIGATION APLPLIED.

CLIENT: Waikato District Council — Te Kaunihera aa Takiwaa o Waikato

CONSULTANT: Beca

Map Use:
- ☒ S&P
- ☐ ICMP
- ☐ RFHA
- ☐ District Plan
- ☐ LIM
- ☐ Council GIS
- ☐ Floor Levels
- ☐ Other _____

Event:
- ☒ 100 -year ARI
- ☐ Observed event: _____

Climate change ☒ Yes ☐ No to year 2090

Development:
- ☐ ED: Exisiting Development
- ☒ PD: Post-Development
- ☐ MPD: Maximun Probable
- ☐ Other: _____

Modelling Approach:
- ☒ 1D
- ☒ 2D
- ☐ Rain-on- grid
- ☒ Open channels
- ☐ Piped networks
- ☒ Structures
- ☒ DEM/ overland flow
- ☒ Flow Gauge Calibrated

Map Parameter:
- ☐ Depth
- ☐ Water Surface
- ☐ Elevation
- ☐ Velocity
- ☒ Flood Hazard
- ☐ Difference

		NAME	SIGNED	DATE
COORDINATES NZTM 2000				
DATUM MOTURIKI 1953	DESIGNED	MRS		22.01.2018
SURVEY 2016	DES. REVIEW	ET		22.01.2018
AERIAL PHOTO 2012	DRAWN	MRS		22.01.2018
LIDAR WRC, 2010	DRW. CHECK	IS		22.01.2018
CONSULTANT PROJECT REF.	3413098			

FILE LOCATION: *P:\341\3413098\THY\Modelling\05 Models\03_Q100MDU*

APPROVED — FOR INFORMATION — DATE — SIGNED

SCALE 1:20,000

PROJECT TITLE: **TUAKAU STRUCTURE PLAN (STAGE1) FLOOD HAZARD MAPPING**

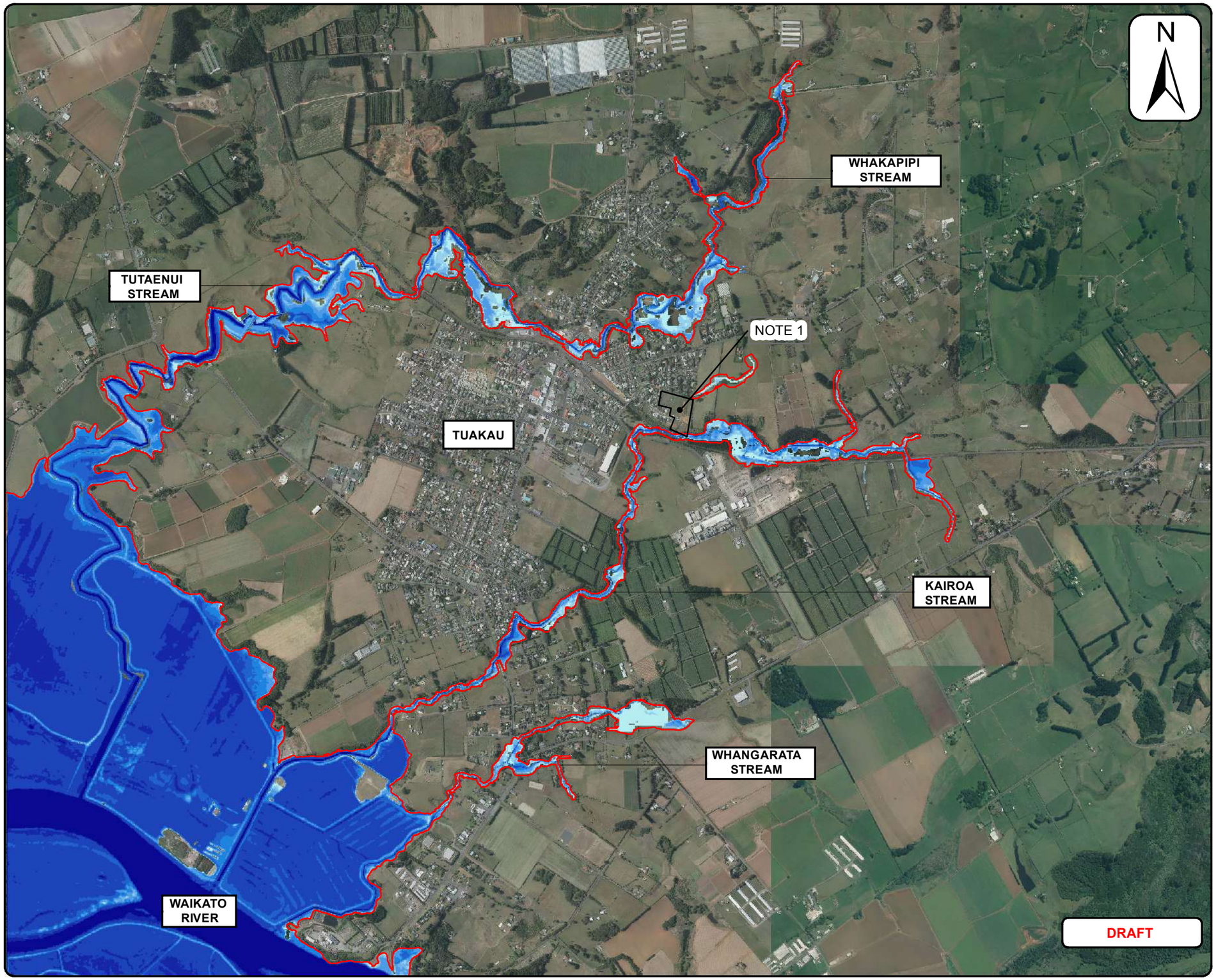
CONTRACT NUMBER: 16/073

DRAWING TITLE: **MAXIMUM PROBABLE DEVELOPMENT 100 YR ARI FLOW HAZARD**

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1012	A3	1 OF 1	A

F

Appendix F – Flood Sensitive and Difference Maps



LEGEND

- FLOOD SENSITIVE BOUNDARY

DEPTH (m)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1- 1.5
- 1.5 - 2
- 2 - 3
- 3 - 3.5
- 3.5 +

KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.
3. MITIGATION APPLIED ONLY IN SUBCATCHMENTS AFFECTED BY STRUCTURE PLAN (STAGE 1)
4. MITIGATION INCLUDES ONLY FLOW ATTENUATION. FURTHER INVESTIGATION AND DESIGN IS NEEDED TO TEST OTHER POTENTIAL STORMWATER EFFECTS SUCH AS FLOODPLAIN FILLING, DIVERSION OF FLOW PATHS, ETC.
5. FLOOD SENSITIVE EXTENT IS DEFINED BY THE LAND THAT HAS A SURFACE ELEVATION LESS THAN OR EQUAL TO 500 MM ABOVE THE 100 YR ARI FLOOD LEVEL.
6. THE 100 YR ARI EVENT IS TAKEN AS THE POST DEVELOPMENT MITIGATED SCENARIO.

CLIENT: Waikato District Council — Te Kaunihera ā Takiwā o Waikato

CONSULTANT: Beca

Map Use: ☒ S&P ☐ ICMP ☐ RFHA ☐ District Plan ☐ LIM ☐ Council GIS ☐ Floor Levels ☐ Other _____

Event: ☒ 100 -year ARI ☐ Observed event: _____ Climate change ☒ Yes ☐ No to year 2090

Development: ☐ ED: Exisiting Development ☒ PD: Post-Development ☐ MPD: Maximun Probable ☐ Other: _____

Modelling Approach: ☒ 1D ☒ 2D ☐ Rain-on- grid ☒ Open channels ☐ Piped networks ☒ Structures ☒ DEM/ overland flow ☒ Flow Gauge Calibrated

Map Parameter: ☒ Depth ☐ Water Surface ☐ Elevation ☐ Velocity ☐ Flood Hazard ☐ Difference _____

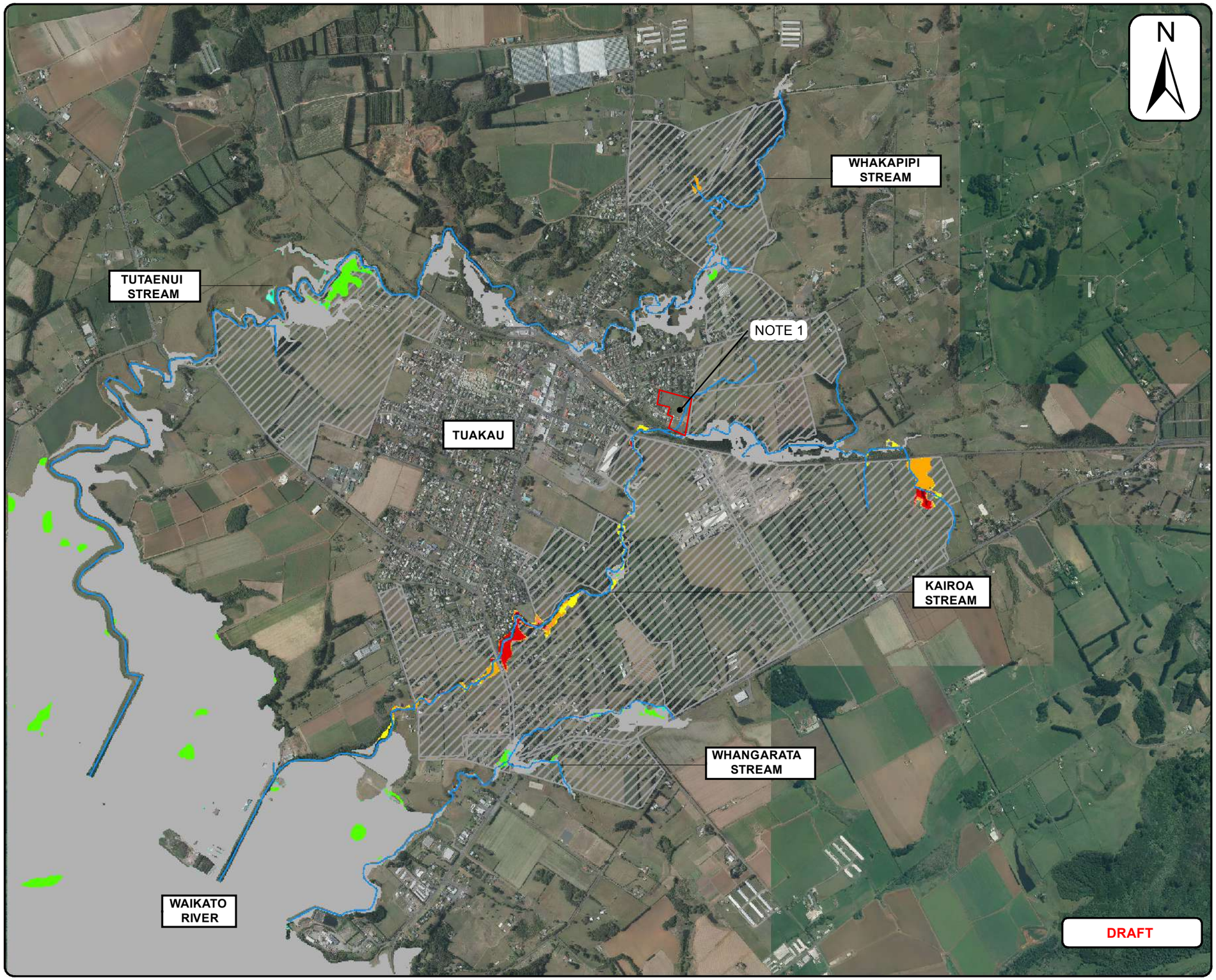
		NAME	SIGNED	DATE	APPROVED
COORDINATES NZTM 2000					FOR INFORMATION
DATUM MOTURIKI 1953	DESIGNED	MRS		22.01.2018	DATE / SIGNED
SURVEY 2016	DES. REVIEW	ET		22.01.2018	
AERIAL PHOTO 2012	DRAWN	MRS		22.01.2018	
LIDAR WRC, 2010	DRW. CHECK	IS		22.01.2018	
CONSULTANT PROJECT REF.	3413098				SCALE 1:20,000
FILE LOCATION	P:\341\3413098\THY\Hydrology\Maps ArcGIS\09 Flood Sensitive Area				

PROJECT TITLE: **TUAKAU STRUCTURE PLAN (STAGE 1) FLOOD HAZARD MAPPING**

CONTRACT NUMBER: 16/073

DRAWING TITLE: **FLOOD SENSITIVE AREA 100 YR ARI FLOOD DEPTH**

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1030	A3	1 OF 1	A



LEGEND

- STRUCTURE PLAN AREAS (STAGE 1)
- STREAMS

PDU/ED with Climate Change

DIF DEPTH (m)

- -0.15
- -0.15 - -0.05
- -0.05 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 +

KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
2. MODEL IS LIMITED TO STREAM SYSTEMS AND DOES NOT IDENTIFY LOCALISED FLOODING WITH TUAKAU TOWNSHIP.
3. DEPTH DIFFERENCE BETWEEN EXISTING DEVELOPMENT WITH CLIMATE CHANGE AND STRUCTURE PLAN DEVELOPMENT (UNMITIGATED) WITH CLIMATE CHANGE.
4. POSITIVE VALUES INDICATE AN INCREASE IN MAX FLOOD DEPTHS IN THE POST DEVELOPMENT (UNMITIGATED) MODEL COMPARED TO THE EXISTING DEVELOPMENT.

CLIENT: Waikato District Council — Te Kaunihera ā Takiwā o Waikato

CONSULTANT: Beca

Map Use: ☒ S&P ☐ ICMP ☐ RFHA ☐ District Plan ☐ LIM ☐ Council GIS ☐ Floor Levels ☐ Other

Event: ☒ 100 -year ARI ☐ Observed event: _____ Climate change ☒ Yes ☐ No to year 2090

Development: ☒ ED: Exisiting Development ☒ PD: Post-Development ☐ MPD: Maximun Probable ☐ Other: _____

Modelling Approach: ☒ 1D ☒ 2D ☐ Rain-on- grid ☒ Open channels ☐ Piped networks ☒ Structures ☒ DEM/ overland flow ☒ Flow Gauge Calibrated

Map Parameter: ☒ Depth ☐ Water Surface ☐ Elevation ☐ Velocity ☐ Flood Hazard ☒ Difference ED-PDU

			NAME	SIGNED	DATE
COORDINATES	NZTM 2000				
DATUM	MOTURIKI 1953	DESIGNED	MRS		22.01.2018
SURVEY	2016	DES. REVIEW	ET		22.01.2018
AERIAL PHOTO	2012	DRAWN	MRS		22.01.2018
LIDAR	WRC, 2010	DRW. CHECK	IS		22.01.2018
CONSULTANT PROJECT REF.		3413098			

FILE LOCATION: P:\341\3413098\THY\Modelling\05 Models\07_Difference Scenarios Maps

APPROVED — FOR INFORMATION — DATE — SIGNED

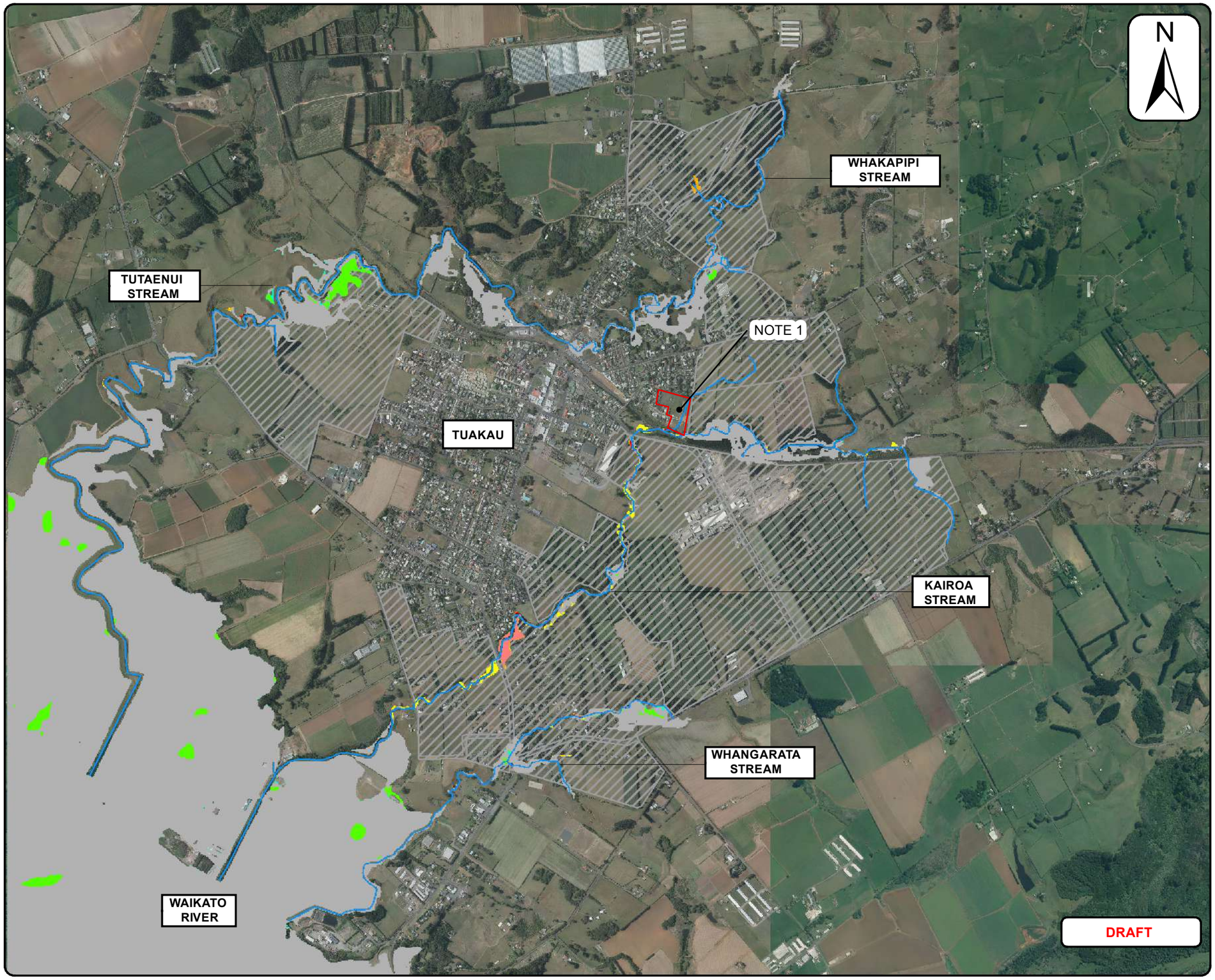
SCALE 1:20,000

PROJECT TITLE: TUAKAU STRUCTURE PLAN (STAGE1) FLOOD HAZARD MAPPING

CONTRACT NUMBER: 16/073

DRAWING TITLE: EXISTING /POST DEVELOPMENT (UNMITIGATED) 100 YR ARI FLOOD DEPTH (WITH CLIMATE CHANGE)

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1016	A3	1 OF 1	B



LEGEND

- STRUCTURE PLAN AREAS (STAGE 1)
- STREAMS

PDMC-ED with Climate Change

DIF DEPTH (m)

- -0.15
- -0.15 - -0.05
- -0.05 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 +

KEY PLAN

NOTES

1. THIS AREA HAS BEEN SUBDIVIDED SINCE THE AERIAL PHOTO WAS TAKEN. THIS DEVELOPMENT HAS BEEN ALLOWED FOR IN THE CATCHMENT HYDROLOGY.
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5. DEPTH DIFFERENCE BETWEEN EXISTING DEVELOPMENT WITH CLIMATE CHANGE AND STRUCTURE PLAN DEVELOPMENT (MITIGATED) WITH CLIMATE CHANGE.
6. POSITIVE VALUES INDICATE AN INCREASE IN MAX FLOOD DEPTHS IN THE POST DEVELOPMENT MODEL (MITIGATED) COMPARED TO THE EXISTING DEVELOPMENT.

CLIENT: Waikato District Council — Te Kaunihera o Tokiwa o Waikato

CONSULTANT: Beca

Map Use: ☒ S&P ☐ ICMP ☐ RFHA ☐ District Plan ☐ LIM ☐ Council GIS ☐ Floor Levels ☐ Other

Event: ☒ 100 -year ARI ☐ Observed event: _____ Climate change ☒ Yes ☐ No to year 2090

Development: ☒ ED: Exisiting Development ☒ PD: Post-Development ☐ MPD: Maximun Probable ☐ Other: _____

Modelling Approach: ☒ 1D ☒ 2D ☐ Rain-on- grid ☒ Open channels ☐ Piped networks ☒ Structures ☒ DEM/ overland flow ☒ Flow Gauge Calibrated

Map Parameter: ☒ Depth ☐ Water Surface ☐ Elevation ☐ Velocity ☐ Flood Hazard ☒ Difference ED-PDU

			NAME	SIGNED	DATE
COORDINATES	NZTM 2000				
DATUM	MOTURIKI 1953	DESIGNED	MRS		22.01.2018
SURVEY	2016	DES. REVIEW	ET		22.01.2018
AERIAL PHOTO	2012	DRAWN	MRS		22.01.2018
LIDAR	WRC, 2010	DRW. CHECK	IS		22.01.2018
CONSULTANT PROJECT REF.		3413098			

FILE LOCATION: P:\3413\3413098\THY\Modelling\05 Models\07_Difference Scenarios Maps

APPROVED — FOR INFORMATION — DATE — SIGNED

SCALE 1:20,000

PROJECT TITLE: TUAKAU STRUCTURE PLAN (STAGE1) FLOOD HAZARD MAPPING

CONTRACT NUMBER: 16/073

DRAWING TITLE: EXISTING /POST DEVELOPMENT (MITIGATED) 100 YR ARI FLOOD DEPTH (WITH CLIMATE CHANGE)

DRAWING NUMBER	ORIGINAL SHEET SIZE	SHEET	REVISION
3413098-300-1017	A3	1 OF 1	A