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Waikato District Council

2021 Addendum to the 2010 Pōkeno Catchment Management Plan

25 June 2021

wsp

150 YEARS IN AOTEAROA

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Disclaimers

This report ('**Report**') has been prepared by WSP exclusively for Waikato District Council ('**Client**') in relation to an addendum to update the Pōkeno CMP ('**Purpose**'). The findings in this Report are based on and are subject to the assumptions specified in the Report, 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06) and 'Waikato District Council – Pōkeno Catchment Management Plan (2020 Update) – February 2020'. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose, or any use or reliance on the Report by any third party.

The modelling work undertaken does not include a detailed model of the existing urbanized catchment areas and their associated piped networks and overland flows. These internal subcatchments flows are calculated and inserted into the model as specific locations to provide a reasonable representation of the watercourses flooding. As such, the flood levels cannot be considered for detailed design or finished floor level determination within the urbanised subcatchments area as these areas may have other contributing (localised) factors that are not considered in the overall catchment flood risk assessment.

It is the requirement of any consent applicant to provide an assessment of the effects upstream and downstream of any proposed development. This addendum and associated modelling should be used as an initial indication of potential flood issues. The modelling results may also be used as inputs for a more detailed and localised flood model to suit individual development requirements.

Foreword

This addendum is to be read in conjunction with the 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)'.

Table 1-1 describes the four different actions used to update this addendum. Table 1-2 summarises the sections of this addendum in relation to the 2010 CMP and the action undertaken.

Table 1-1: Key for Table 1-2

Action	Description
New	Section is new to be read in conjunction with the 2010 CMP
Additional	Section is to be read in conjunction with the matching CMP section
Replaced	Section replaces the equivalent section of the 2010 CMP
Deleted	Section is no longer relevant and the equivalent section in the 2010 CMP should be disregarded

Table 1-2: 2021 Addendum summary table

Section	Action
1.1 – Background	Additional
1.2 – Purpose	Additional
2.0 – Strategic Planning Links	Additional
2.1 – Central and Regional Government Policies and Plans	No Changes
2.2 – Franklin District Council Policies and Plans	No Changes
2.3 - Proposed Pōkeno Structure Plan	Additional
3.0 – Catchment Description	Additional
3.1 – Catchment Overview	Replaced
3.2 – Subcatchments	Replaced
3.3 – Catchment Boundary Assumption	Deleted
3.4 – Previous Catchment Studies	No Changes
3.5 – Landscape	Additional
3.6 – Soils and Geology	Replaced
3.7 – Existing Land Use and Potential Contaminated Lands	No Changes
3.8 – Existing Stormwater Infrastructure	No Changes
3.9 – Climate Change	Additional
4.0 – Status of Receiving Environment	No Changes
5.0 – Stormwater Modelling	Replaced
5.1 – Hydrological Model	Replaced
5.2 – Selection of Hydrological Model Parameters	Replaced
5.3 – Data Sources	Replaced
5.4 – HEC-HMS Model Calibration	Replaced
5.5 – Hydraulic Model	Replaced
5.6 – Sectional of Hydraulic Model Parameters	Replaced
5.7 – TUFLOW Model Calibration	Replaced
5.8 – Model Scenarios	Replaced
5.9 – Option Evaluation	Replaced
5.10 – Modelling Nodes	Deleted
5.11 – Pre-Development Model	Replaced

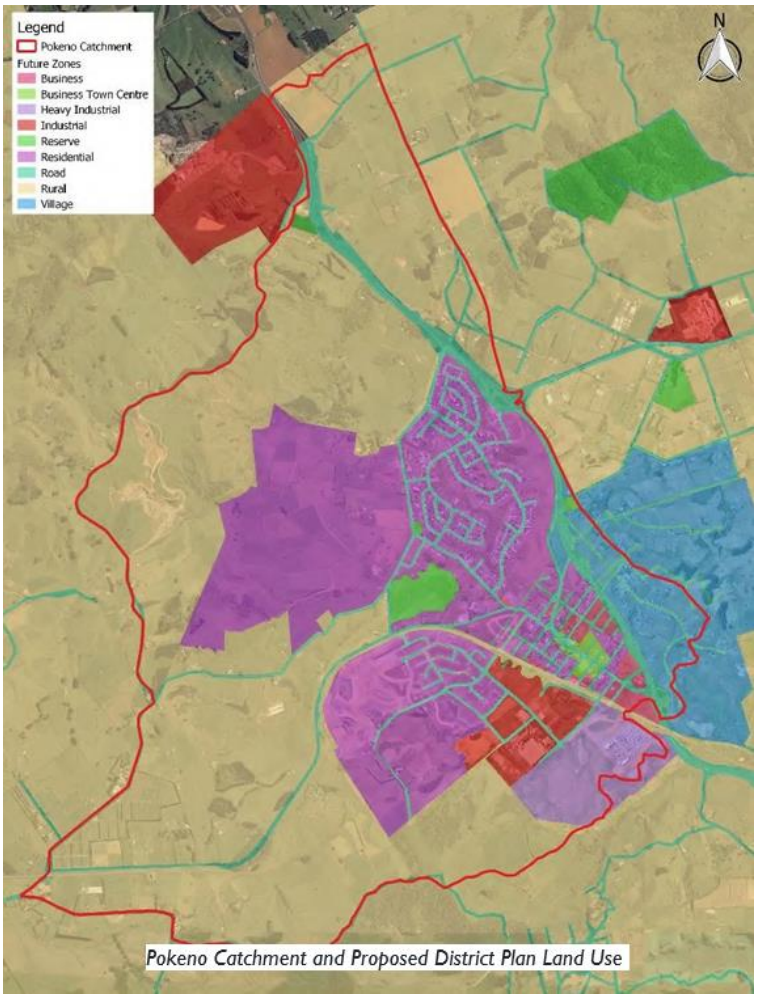
5.12 – Post-Development Model	Replaced
5.13 – Flood Plain Analysis and Flood Hazard Mapping	Additional
5.14 – Stream Erosion	Additional
5.15 – Results and Discussion	Replaced
6.0 – Environmental Effect of Development	Additional
6.1 – Environmental Implications	Additional
6.2 – Likely Effects on Terrestrial Ecology	No Changes
6.3 – Likely Effects on Aquatic Ecology	No Changes
6.4 – Likely Effects of Stormwater Structures	No Changes
6.5 – Piping of Perennial Streams	No Changes
7.0 – Consultations and Issues	No Changes
8.0 – Stormwater Management Outcomes	Additional
8.1 – Stormwater Management Philosophy	Additional
8.2 – Stormwater Quantity	Deleted
8.3 – Stormwater Water Quality	Additional
8.4 – Climate Change	Deleted
8.5 – Infrastructure Upgrade Works	Replaced
8.6 – Riparian Planting	Additional
9.0 - Recommendation	Replaced
9.1 – Flooding Considerations	Additional
9.2 – Ecological Considerations	Additional
9.3 – Erosion and Water Quality	Additional
9.4 – Climate Change	Replaced
9.5 – Land Development Rules	Replaced
9.6 – Operation, Maintenance and Monitoring Strategies	No Changes
9.7 – District Council Implementation Plan	No Changes
10.0 - Limitations	Additional

This addendum is focused on flood risk management, recognising a significantly improved tool (the Pōkeno Flood model) is available to support catchment management decisions.

Executive Summary

This addendum is an update of the hydraulic analysis portion of the Pōkeno Stormwater CMP prepared by Franklin District Council in 2010. This addendum has been prepared to support stormwater decision making in Pōkeno. WDC identified that stormwater flooding represents a key constraint to development within the Pōkeno Catchment. As such, the focus of this update has therefore been on flood risk management, recognising the significant step forward WDC have made in the development of hydraulic modelling for streams in the catchments. This provides:

1. A waterways assessment and Low Impact Design (LID) assessment.
2. Guidance measures to address development and reduce existing issues.



Pokeno Catchment and Proposed District Plan Land Use

The major outcome of the flood model was that there were significant increases (100mm to 400mm) in flood levels for the 1% AEP event between the pre-development flood model and the current development flood levels indicating a worsening of flooding due to development. This modelling indicated that stormwater flooding represented key constraint to development within the Pōkeno Catchment, thus a flood management plan for the whole catchment was needed.

The primary objective of this addendum is to provide evidence-based guidance on the necessary stormwater measures that need to be delivered by development, as well as associated off-site infrastructure improvements (e.g. downstream capacity improvements).

Stormwater Management in Pōkeno

There are existing stormwater management issues in Pōkeno – inundation of key transport infrastructure, stream erosion leading to sediment transport and loss of habitat, and the potential for low water quality. These issues will be exacerbated through development and climate change if not appropriately addressed. The change in approach in the Waikato from simply mitigating, to also enhancing ("net improvement") through best practicable options (BPO), has led to the following catchment management approach for Pōkeno:

1. To deliver environmental enhancement through growth by mitigating the effects of development.
2. Provide on-site attenuation to 70% of existing greenfield runoff rates to assist with flood management in Pōkeno.
3. Undertaking and allowing for:
    a. Upgrading of key transport infrastructure (bridges and culverts) crossing streams, in some cases including additional 'strategic' attenuation;
    b. Applying low impact design (LID) in the industrial area to deliver enhanced streams;
    c. Delivering stream enhancements as part of the Pōkeno Sports Park development;
    d. Filling in discrete sections of the floodplain in Pōkeno town to unlock development and deliver sustainable development.

It is important to note that stormwater treatment/detention facilities should be in place prior to upstream impervious services being constructed. Floodplain modifications in the industrial area need to start with removing restrictions prior to filling taking place.

Preliminary sequencing has been done but this will need to be considered further as will depend on development areas and staging. Development specific flowpath widths and device requirements will need to be reassessed at the time of subdivision. In most cases constructability constraints impose capacity limits on the size of measures, rather than seeking a specific level of service

1 Introduction

This section is to be read in conjunction with the 2010 CMP (Franklin District Council, 2010)

1.1 Background

The WDC vision for the Pōkeno catchment is:

"To achieve a sustainable community in the broadest sense. A sustainable community reflects managing and protecting natural and physical resources in a way that enables communities to develop economically, socially and culturally – while safeguarding the life supporting capacity of air, water, and ecosystems. A sustainable community must also consider not only the health and wellbeing of the community but also the needs of future generations"

The purpose of this addendum is to:

- Be used in conjunction with the 2010 CMP to update or supersede information;
- Give effect to the objectives and principals outlined in the 2010 CMP and 2020 CMP Update;
- Provide a clear implementation path to address stormwater issues;
- Investigate and describe the stormwater issues, constraints, hazards and opportunities to inform and set stormwater management practices needed within the Pōkeno Catchment;
- Set out concept designs for core stormwater infrastructure that will be end user, operated and controlled by WDC;
- Support stormwater resource consent applications (current and future);
- Provide a clear framework for ongoing stormwater management within catchments covered;
- Provide a clear understanding of flood risk and the impacts of recent development proposals including the Pōkeno Sports Park; and
- Implement a Maximum Probable Development flood model that can be utilised for development and remediation and provides a conservative flood boundary for future assessments.

In some cases, data from the 2010 Stormwater Catchment Plan has been repeated in this addendum to provide an easier to read document.

This addendum has been developed to support and manage growth in Pōkeno. This addendum section numbering aligns with the 2010 CMP for an easy to interpret document. Please refer to Table 1-2 for guidance.

1.2 Purpose

The addendum has been used to inform the Waikato District Council of the overall flood risk of Pōkeno's greater urban catchment area. This addendum assessed flood risks focussed on the main waterways through the urban area. This enabled a systematic solution to be outlined and implemented in the Long-Term Plan (LTP). This will enable further development without significantly increasing the flood risk to the greater urban catchment.

It is intended that the implementation of the CMP along with this addendum will result in a range of stormwater management activities being applied, including land use planning, development controls, stormwater asset and system design, construction guidance, operation and maintenance.

The list below highlights key stormwater management objectives sought for the Pōkeno Catchment:

- Provide value for money.
- Consider 'whole of life' of the assets and catchment.
- Provide stormwater systems that manage hazard and are safe to operate and maintain.
- Minimise the release of contaminants in waterways.
- Reduce scour and culvert washout from high energy flow.
- Reduce effect on the groundwater table and baseflows.
- Provide effective management of runoff volumes and flood levels in streams.
- Maintain or enhance ecological values.
- Stormwater is integrated into other land uses and values so that development can be maximised.
- Be inclusive of community and other stakeholders.

2 Strategic Planning Links

This section supersedes Section 2 of the 2010 CMP.

There are several statutory documents that have been used to inform this addendum. These are listed below with the relevant requirements from each document.

- National Policy Statement for Fresh Water Management 2017 [1]
  - Considering and recognising Te Mana o Te Wai in freshwater management
  - An integrated approach to managing land use and freshwater
  - Safeguarding freshwater's life supporting capacity, ecosystem and processes
  - Protecting significant freshwater values
- Waikato Regional Policy Statement 2016 and the Waikato Regional Plan 2012
  - Restoring the health and wellbeing of Waikato Rivers
  - Development consent conditions to manage stormwater using a whole of catchment approach and consider low impact design (LID)
  - Avoid as far as practicable adverse effects on natural hydrological characteristics and processes, soil stability, water quality and aquatic ecosystems
  - Adopting sustainable technologies
  - Maintaining or enhancing water quality by reducing sediment that derives from the manmade activities
  - Promotion of land-based stormwater mitigation
  - The requirements of territorial authorities to manage the effects of subdivision, use and development by promoting best practice stormwater development
  - Considering alternatives to direct discharge of stormwater
- Operative Waikato District Plan, 2017 (Waikato District Council, 2017)
  - The need for integrated design to make the most effective use of land resources

[1] It is acknowledged that the National Policy Statement for Freshwater Management is out of date, this will be updated when the report is next revised

- Use or development of land subject to significant natural hazard should be avoided. Where use cannot be avoided, mitigation of risks to health, safety and property should be undertaken
- Development or protection of land should not increase the adverse effects of natural hazards or compromise natural processes.
- Development should be designed and located to avoid or mitigate the predicted effects of global climate change on natural hazards, particularly increased flooding, erosion, and storms. Where there is incomplete information, a precautionary approach should be taken.
- Development should minimise impervious surfaces, provide adequate stormwater drainage, and mitigate the off-site effects of stormwater drained from the site.
- The density and type of development should not exceed the capacity of the area to absorb the adverse effects of the development on amenity, water quality, stormwater runoff, ecological values, health or safety.
- Changes to hydrology (including low and high flows, and groundwater levels), increased release of sediments and the discharge of contaminants shall be avoided.
- Riparian areas shall be retained and enhanced. The incorporation of an ecological corridor and reserves will result in them being enhanced as amenity features of high ecological value.
- Large-scale earthworks shall be avoided to ensure that the natural features of the area are retained, and hydrological characteristics are not substantially modified. Low impact stormwater management is to commence on site to ensure that natural water bodies are protected.

- Vision and Strategy for the Waikato River and Waikato Regional Plan Change I (Healthy Waters, 2018)

    - Restoration and protection of the health and wellbeing of the Waikato River.
    - Restoration and protection of the relationship of the Waikato-Tainui with the Waikato River, including the economic, social, cultural and spiritual relationships.
    - The integrated, holistic and coordinated approach to the management of the natural, physical, cultural and historic of the Waikato River.
    - The recondition and avoidance of cumulative effects within the Waikato River catchments.
    - The restoration of the water quality in the Waikato River so that it is safe for people to swim and take food from the river itself.

- Pōkeno Discharge Consent, 2008

    - Divert and discharge urban stormwater runoff and associated contaminants at multiple locations to land, the Tanitewhiora Stream, Helenslee Stream, and use discharge structures in the general vicinity of Pōkeno Urban Area that are reticulated by the Pōkeno municipal stormwater system.
    - Implementing Best Practicable Option's (BPO) to minimise actual or potential adverse effects on the receiving environment.
    - The need to remedy adverse scour and erosion effects.
    - Reasonably minimise potential adverse flooding effects to land and property.
    - No more than minor adverse effects on aquatic ecosystems.
    - Monitoring and reporting programme that considers visual signs of contaminants, scour and erosion effects, flooding, fish barriers, condition, cleaning and illegal wastewater/trade waste connections.
    - Identifying the existing flooding situation (baseline) and potential changes as a result of growth forms a key part of this updated CMP. At present only past

assessment undertaken from 2008 are available to determine the baseline condition of water quality and erosion within the catchment. No data collection is available since this time to understand how the receiving environment has changed and to inform a reporting programme.
- Stormwater Management Plans and CMPs are identified in the WDC Consent Evaluation Report as the key tools to both support new comprehensive stormwater discharge consents and co-ordinate catchment-specific requirements associated with a consent.

- Future Stormwater Consenting Framework (based on HCC new comprehensive consents 2018)

WDC will need to apply for a new comprehensive stormwater discharge consent by 2028. Waikato Regional Council have been advised the 2012 Hamilton Urban Area (application no. 105279) discharge consent provides an indication of the requirements that Pōkeno may expect moving forward. This advice may change as further consents in the region are issued.

- CMPs (i.e. this document and future updates) are a prerequisite to new diversion and discharge activities in the catchment.
- Some conditions remain similar to the existing Pōkeno consent (108592) such as the need to address adverse scour, erosion and sedimentation, flooding, effects to aquatic ecosystems, fish passage, illicit connections, etc.
- Refinements or nuances in condition wording and measure can be expected, however the intent is expected to remain similar.
- The promotion of LID measures will be required.
- Establishment of a Stormwater Steering Group involve iwi representatives.

2.1 Central and Regional Government Policies and Plans

The documents listed in Section 2.0 have been used to update this addendum. Please refer to Section 2.1 of 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' for guidance on documentation used to inform the 2010 CMP.

2.2 Franklin District Council Policies and Plans

The documents listed in Section 2.0 have been used to update this addendum. Please refer to Section 2.2 of 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' for guidance on documentation used to inform the 2010 CMP.

2.3 Proposed Pōkeno Structure Plan

2.3.1 Background and Key Socio-Economic Objectives

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 2.3.1 for guidance.

2.3.2 Structure Plan Layout

This section supersedes Section 2.3.2 of the 2010 CMP.

The development area is considered as 9 future land use zones. The future zones are:

- Business;
- Business Town Centre;
- Heavy Industrial;
- Industrial;

- Reserve;
- Residential;
- Road;
- Rural; and
- Village

These future zoned (as identified in the proposed district plan) and potential entire developable catchment is shown in Figure 2-1.

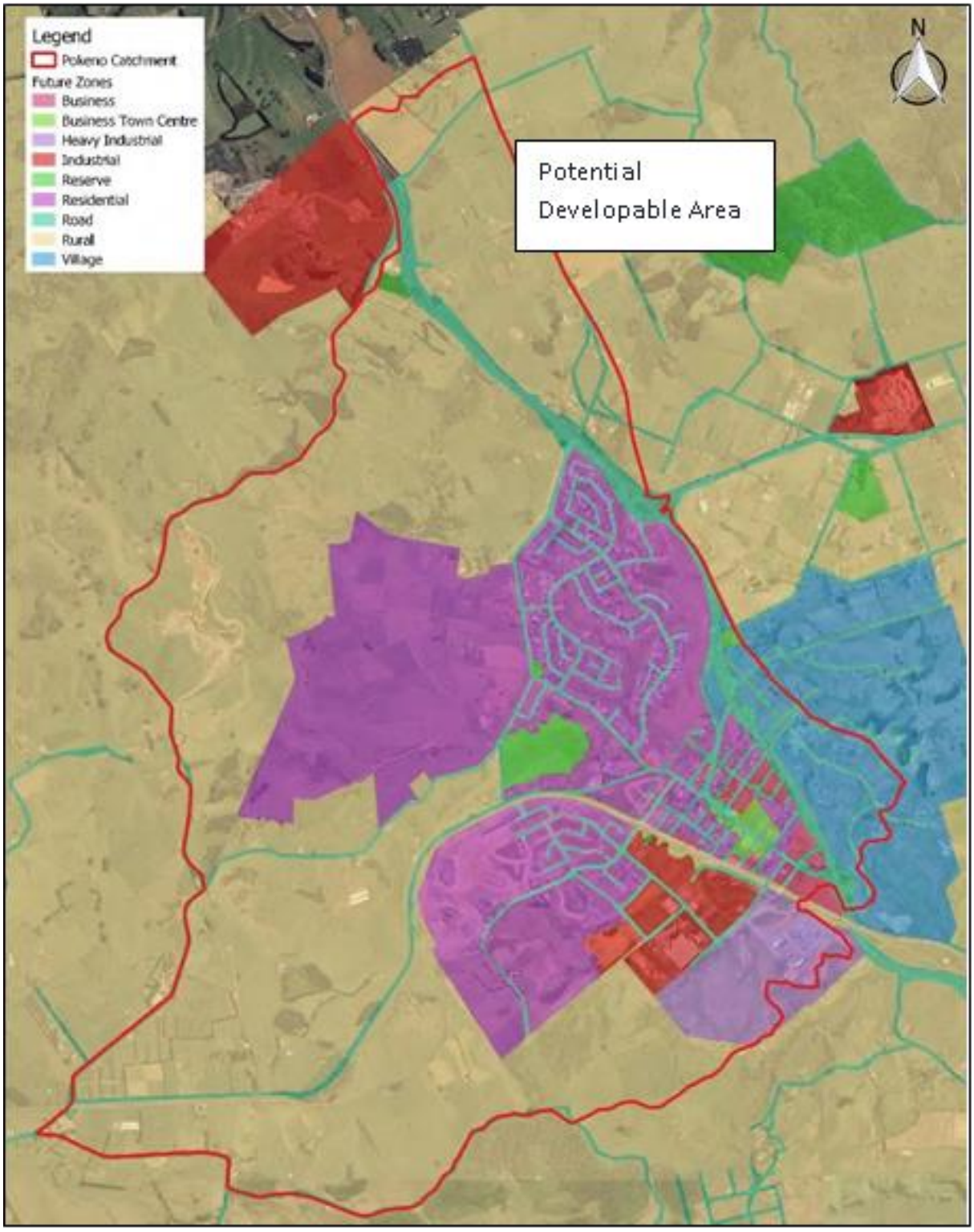


Figure 2-1: Existing future development zones and potential growth areas

2.3.3 Proposed Land Use Changes

This section supersedes Section 2.3.3 of the 2010 CMP.

The proposed development area is expected to convert rural land to predominantly urban residential use with some green space/reserve areas as well as some industrial and heavy industrial zones. The entire upstream catchment for Pōkeno (currently zoned rural) is expected to be developed with an average impervious land cover of 65%.

It is noted that some floodplain infill and flattening of upper catchments will occur. These aspects have not been included in any modelling (apart from changes in time of concentration) due to uncertainty. Future land use changes that have been planned for by this CMP are represented in Figure 2-2.

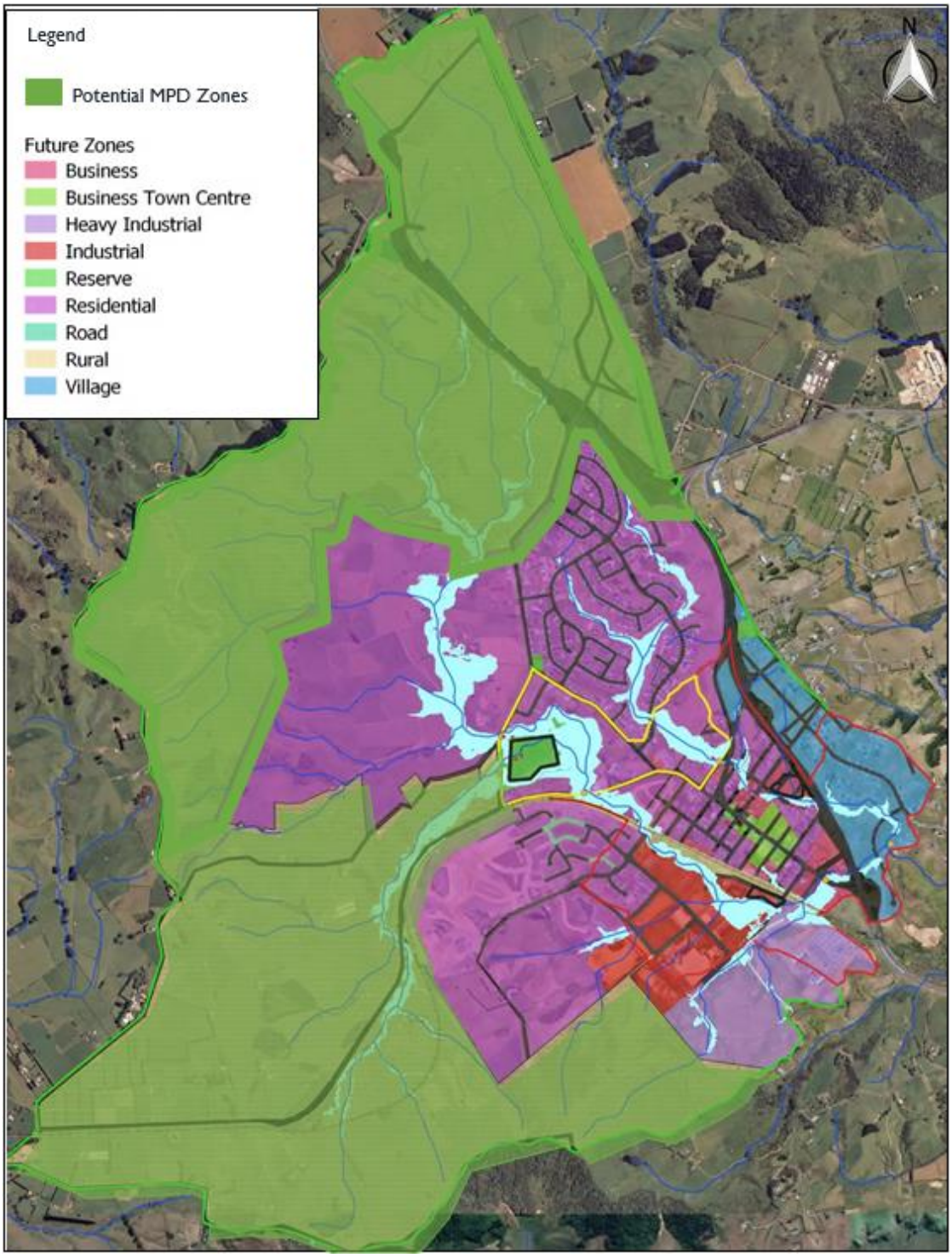


Figure 2-2: Future proposed zones and future MPD area

Draft Waikato 2070 population figures and the MPD scenario has indicated that the following (Table 2-1) development and land use changes are likely occur within the Pōkeno Catchment.

Table 2-1: Land use changes that are likely to occur within the Pōkeno Catchment

Location	1-3 years	3-10 years	10-30 years	>30 years (MPD)
Munro Block Residential	N/A	East Munro Block	Middle Munro Block	Remaining Munro Block
Hitchen Block Residential	Hitchen West Block	N/A	N/A	Remaining Hitchen Block Catchments
Pōkeno Road (West) Residential	N/A	N/A	N/A	Pōkeno Road
Pōkeno East Commercial	N/A	N/A	Pōkeno Commercial (Out of Catchment)	N/A
Pōkeno East Residential	N/A	N/A	Pōkeno Commercial (Out of Catchment)	Pōkeno Infill
Pōkeno Town Centre Infill Development	N/A	Town Centre	N/A	Remaining Town Centre Infill
Hillpark Drive Townhouse Residential	Hillpark Drive			

Should flood mitigation works not occur in the catchment, flooding will increase as demonstrated in Figure 5-4. Detailed outputs are provided in Appendix A.

2.3.4 Proposed Staging of Land Development

This section supersedes Section 2.3.4 of the 2010 CMP.

Table 2-2 identifies the broad sequencing of the preferred land development options in the catchment. Once there is a clearer picture of where and when development might occur in the catchment this sequencing can be refined and updated in conjunction with development plans. Further investigation of erosion and water quality may introduce additional works or alter the priority.

Table 2-2: Sequencing of preferred option measures

Order	Intervention	Comment
1	Great South Road bridge improvements	No constraints to it being done first. Required prior to Pōkeno Road bridge improvements to cater for additional flows.
2	Ford Street	Required prior to development in Pōkeno town so effects of floodplain filling downstream is minimised.
3	Pōkeno Sports Park	No constraints to it being done first. Stream improvement works required prior to upstream development due to likely residual erosion effects. Flood effects demonstrated as less than minor (refer Pōkeno Sports Park Location Flood Risk Assessment report).

4	Munro Road Improvements	Can be undertaken independently of downstream works as it incorporates strategic attenuation. Required prior to development on the upstream tributary of the Tanitewhiora Stream. Some development may be possible prior to the works; however, this will depend on the scale and location of development.
5	Huia Road Improvements	Can be undertaken independently of downstream works as it incorporates strategic attenuation. Required prior to development on the upstream tributary of the Tanitewhiora Stream. Some development may be possible prior to the works; however, this will depend on the scale and location of development.
6	Pōkeno Road Bridge improvements	Cannot be done until Great South Road bridge downstream is upgraded. Huia Road and Munro Road improvements should be done prior to Pōkeno Road bridge as these two measures include strategic catchment attenuation that assist in mitigating increased capacity of Pōkeno Road bridge improvements. It may be possible to do this upgrade before Munro Road and/or Huia Road, subject to further assessment of effects.
7	Floodplain optimisation in Pōkeno Town	Could be brought forward ahead of Ford Street, however, would require a review of effects and would likely mean additional land raising required in the floodplain.
8	Floodplain optimisation in industrial area	Land raising potentially required as part of site redevelopment. Timing of this site work would be dependent on the location and scale of upstream development.
9	Enhanced streams through industrial area	Could be done independent of other catchment works, however if delivered would likely require some co-ordination across multiple sites.

As stated in the 2010 CMP, stormwater mitigation should be in place prior to the effects being generated. This means that:

- Stormwater treatment/detention facilities should be in place prior to upstream impervious services being constructed.
- Floodplain modifications in the industrial area need to start with removing restrictions prior to filling taking place.

3 Catchment Description

3.1 Catchment Overview

This section supersedes Section 3.1 of the 2010 CMP.

The Pōkeno township is located approximately 50 km south of Auckland and the catchment area covers 19km^2. The catchment is largely comprised of rural farmland used for cropping and grazing. The catchment has been identified as a Growth Management Area and has the potential to cater for an additional 2000 households in addition to the 2200 zoned for the Pōkeno Structure Plan. In addition to the current plans, the CMP allows for future development of the entire Pōkeno

catchment should such scenarios arrive. The existing Pōkeno Township lies entirely within the lower portion of the catchment. A series of ridgeline roads form the catchment boundary. Razorbank Road to the northeast, Ridge Road to the north and west, Ewing Road and Potter Road to the south and Fraser Road to the east. The catchment is bisected east west by the Waikato Expressway and north south by the North Island Main Truck Railway (NIMTR), both of these routes have impacted on the natural topography of the catchment.

As stated in the 2010 CMP, the catchment termination point for this analysis is where the Helenslee stream meets with the Tanitewhiora Stream. Both streams have waterfalls approximately 4m in height which effectively means the streams are hydraulically separate from the backwater effects of flooding in the Mangatāwhiri swamp/wetland and Waikato River further downstream.

3.2 Subcatchments

This section supersedes Section 3.2 of the 2010 CMP.

The Pōkeno subcatchments were revised as part of the WSP 2018 Model Updates. This was done to ensure that catchments were delineated to all key hydraulic structures (i.e. roads and railway crossings) to be able to reliably assess the effects on flood risk due to development within Pōkeno township.

The Pōkeno catchment has been broken down into 46 subcatchments as shown in Figure 3-1.

3.3 Catchment Boundary Assumption

Section 3.3 from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' is no longer relevant due to the updated modelling work.

3.4 Previous Catchment Studies

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 3.4 for guidance.

3.5 Landscape

3.5.1 Topography

This section supersedes Section 3.5.1 of the 2010 CMP.

The catchment is characterised by a steep rural upper catchment to the north and west, divided by several minor tributaries. The Pōkeno township is located within the flatter base of the catchment area, mainly along the ridge between two waterways. The primary waterways are the Tanitewhiora Stream (the catchment west of Helenslee Road and Great South Road) and the Helenslee Stream (the catchment east of Helenslee Road and Great South Road) which move in a southerly direction towards the Waikato River. A waterfall at Pōkeno East forms a natural hydraulic boundary to the catchment. The Waikato Expressway and the North Island Main Trunk Railway (NOMTR) are major transport routes that have altered the existing topography of the catchment through cut and fill, disrupting floodplain function and overland flow. The key features are shown in Figure 3-2 and Figure 3-3.

Ground levels within the catchment range from a reduced level (RL) of 227m at the highest point of the catchment to RL 3m at the chosen termination point of the study area.

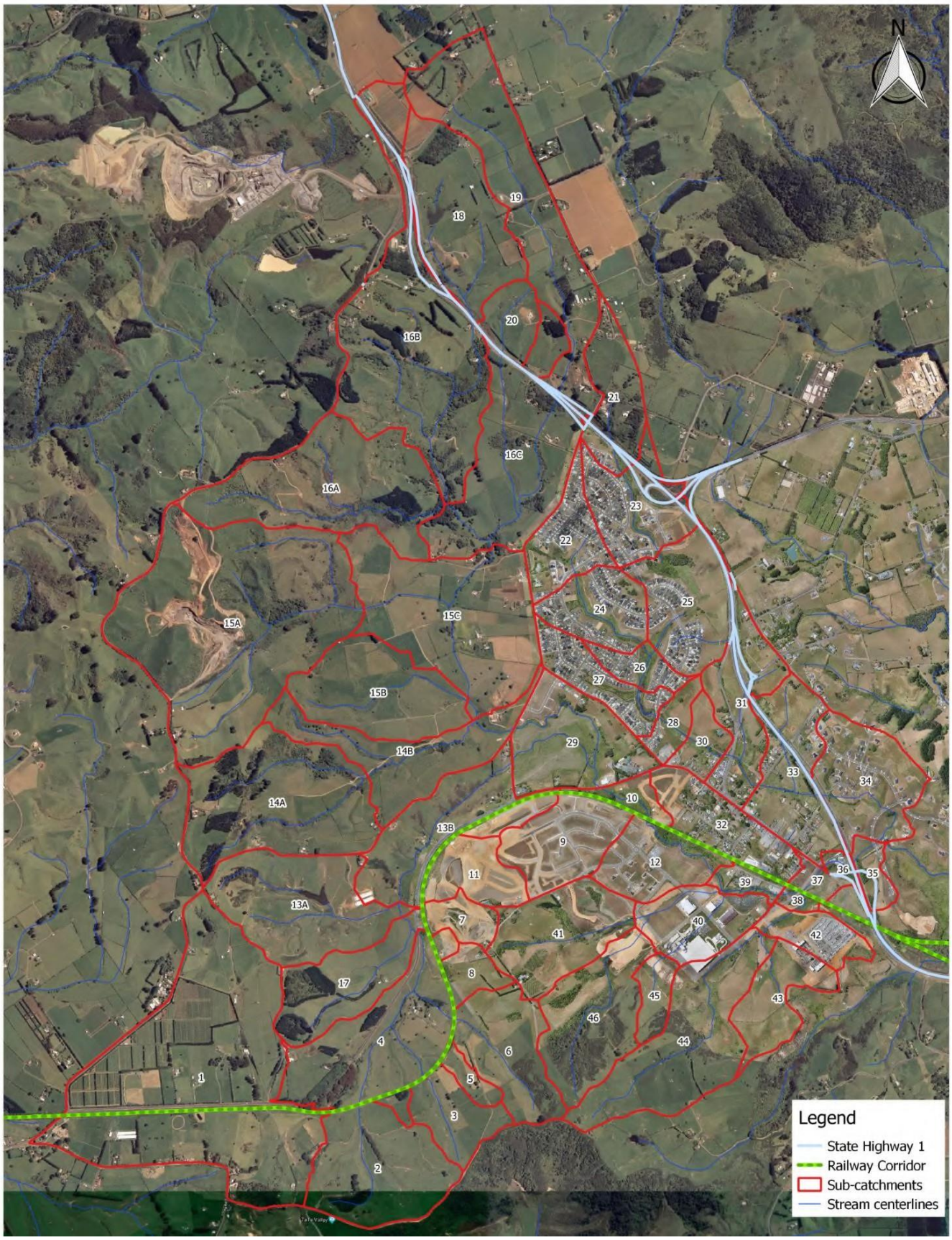


Figure 3-1: Subcatchment Delineation (Waikato District Council, 2020)

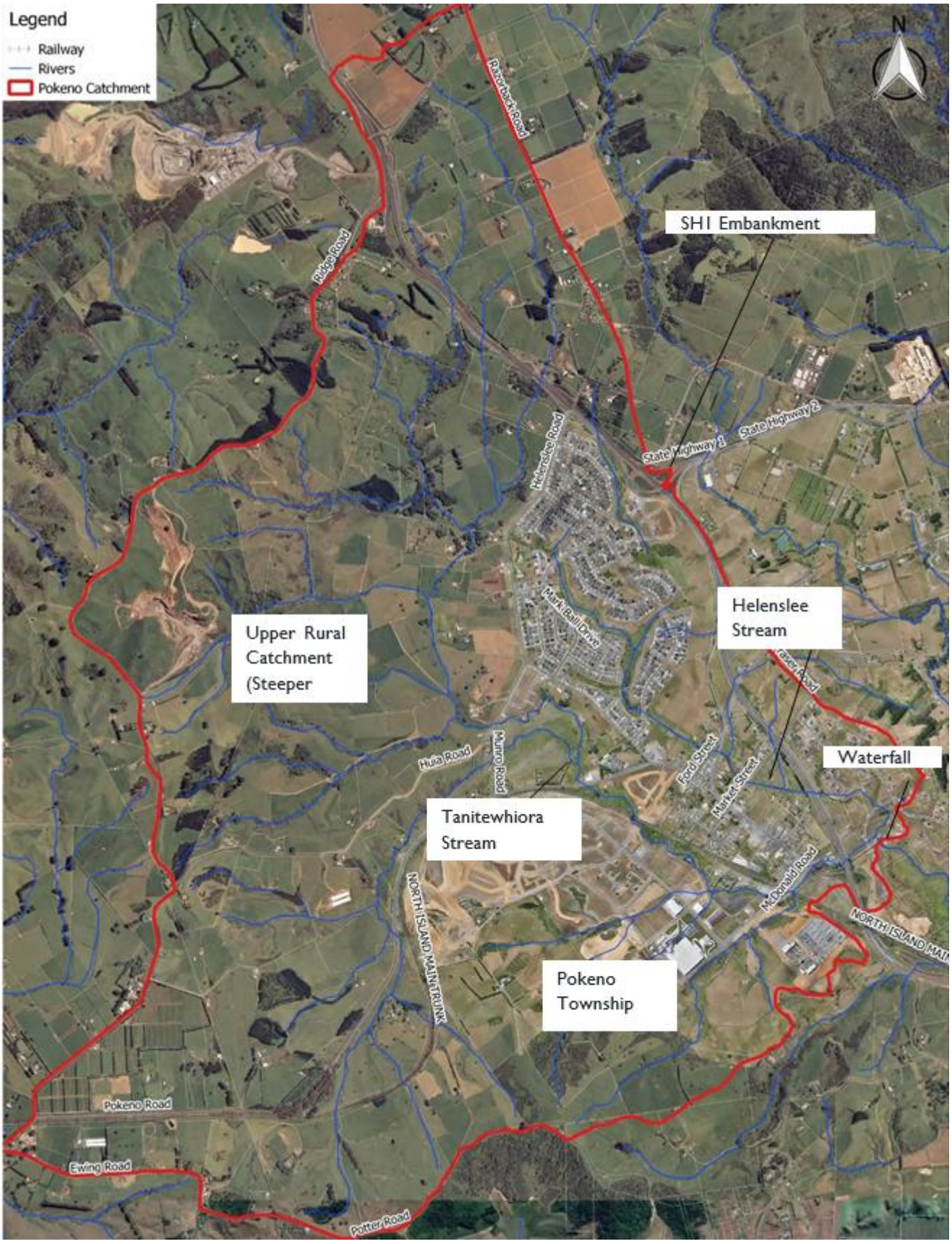


Figure 3-2: Existing Topography and Key Features (Waikato District Council, 2020)

Figure 3-3: Land use and current locations of fill (Waikato District Council, 2020)

3.5.2 Vegetation

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 3.5.2 for guidance.

3.5.3 Streams

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 3.5.3 for guidance.

3.5.4 Climate and Rainfall

This section supersedes Section 3.5.4 of the 2010 CMP.

The Waikato Stormwater Runoff Modelling Guideline (WSRMG) TR20-06 temporal pattern (Waikato District Council, 2018) has been adopted for modelling purposes. Further detail on rainfall and climate can be found in Section 5.2.1 and Section 5.2.3 respectively.

3.6 Soils and Geology

This section supersedes Section 3.6 of the 2010 CMP.

As shown in Figure 3-4, the Pōkeno catchment consists of three main soils classes:

1. South Auckland volcanic field – basalt lava, scoria, ash, lapilli and lithic tuff.
2. Taupo Pumice Alluvium – alluvium/colluvium.
3. Mercer Sandstone – sandstones and mudstones.

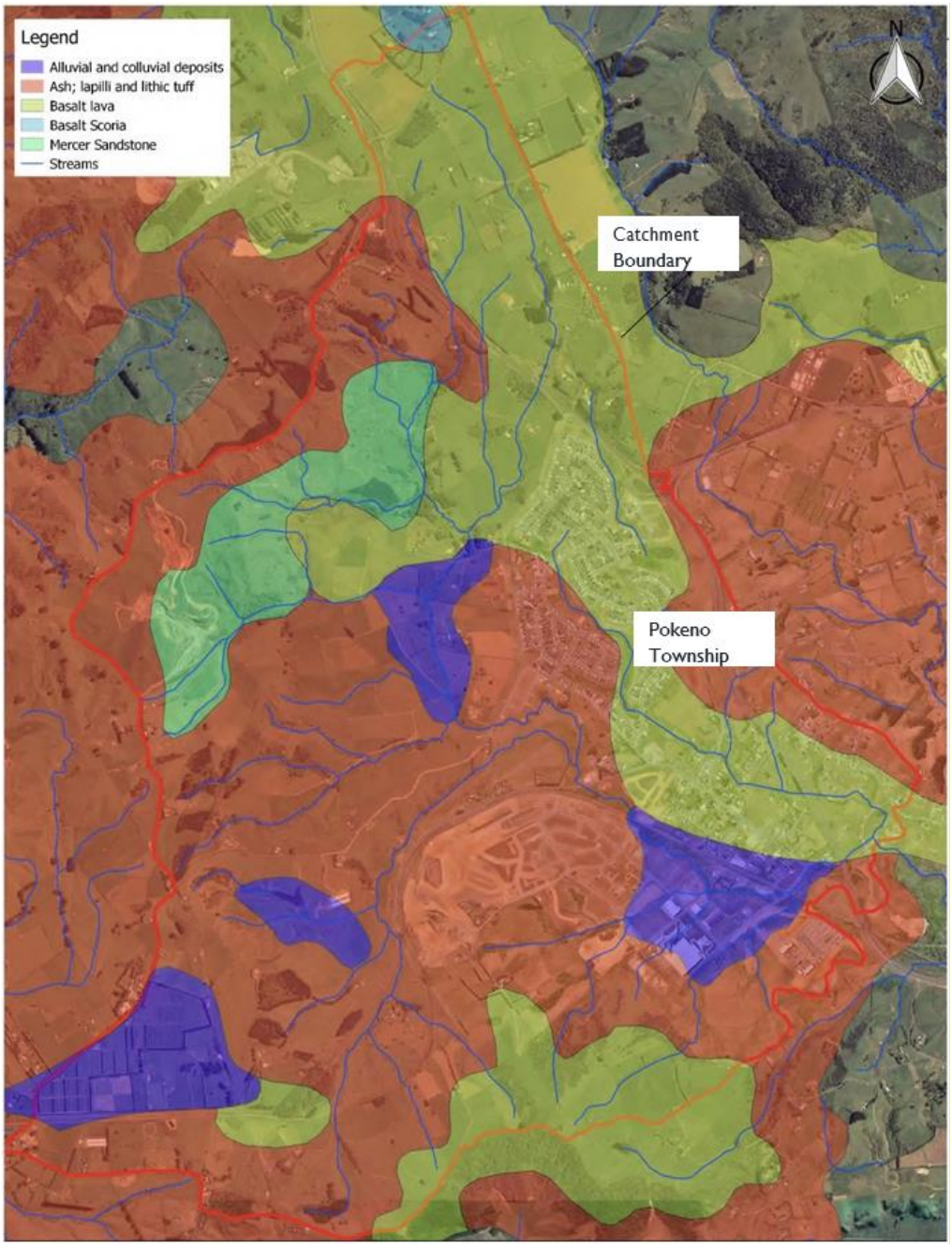


Figure 3-4: Pōkeno Geology and Soils (Waikato District Council, 2020)

3.7 Existing Land Use and Potential Contaminated Lands

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 3.7 for guidance.

3.8 Existing Stormwater Infrastructure

This section supersedes Section 3.8 of the 2010 CMP.

The urban drainage network primarily serves the Pōkeno Township with an approximate 2-year ARI level of service. The urban drainage network has not been individually modelled; however, outlets are captured at the waterway boundaries.

Several local bridges and culverts cross the streams in the catchment. These act to restrict stormwater discharge in some events (i.e. provide informal attenuation). Some of these overtop in regular events (i.e. more frequently than 10% AEP). Most overtop during extreme storm events (e.g. 1% AEP event).

Pōkeno catchment does not form part of a rural drainage network but does feed into the Mangatāwhiri Scheme, suggesting that discharges must consider impacts to these areas.

The railway traversing the southern section of the catchment acts as a barrier to overland flow with several crossing points (bridges). This is a key transport corridor that is potentially at flood risk in some scenarios. The SH1 embankment acts as a barrier to overland flow, however large culverts provide significant capacity in all assessed events

3.9 Climate Change

This section supersedes Section 3.9 of the 2010 CMP.

Refer to Section 5.2.1 and 5.2.3 of this addendum for modelling climate change parameters.

4 Status of Receiving Environment

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 4 for guidance.

Refer to Section 5.14 for updated summary of stream erosion issues.

5 Stormwater Modelling

This section supersedes Section 5 of the 2010 CMP.

The 1D-2D model built for the 2018 Pōkeno flood risk study was adopted and used to update this addendum.

For the purposes of this addendum, both the existing and future scenario flood mapping focuses on the overland flow paths and the flood extents and reflects current approved development; future development, rainfall and climate predictions (existing and a 2.1˚C increase). The assessment does not consider flood risk from urban overland flow (specifically within the Pōkeno township) or the impacts of potential infill development (assumed to have mitigated flow).

The stormwater modelling was developed in two phases:

- Phase 1 – Updating and developing the existing Pōkeno Model to the existing situation.

- Phase 2 – Imposing land use changes on the existing model and developing stormwater management measures (primarily storage and culvert upgrades) to mitigate the effects of development.

These phases are further detailed in the following sections

5.1 Hydrological Model

This section supersedes Section 5.1 of the 2010 CMP.

WDC engaged WSP Opus to update the HEC-HMS hydrology model into a revised hydrology model. The catchment has been broken up into 46 sub-catchments and is presented in Figure 3-1. Some larger sub-catchments have been revised and split into smaller sub catchments as part of this study to help inform the location of potential future attenuation areas. The key updates to the model are detailed in Section 5.2.

5.2 Selection of Hydrological Model Parameters

This section supersedes Section 5.2 of the 2010 CMP.

5.2.1 Rainfall

The TR20-06 temporal pattern has been adopted.

Rainfall was obtained using HIRDS Version 3 for the catchment area. In accordance with the Hamilton Infrastructure Technical Specification (HITS) (Waikato Local Authority Shared Services, 2018) the recommended increase of 16.8% to the 1% AEP Rainfall has been adopted for climate change. The rainfall depths are shown in Table 5-1.

Table 5-1: HIRDS (V3) Design Rainfall Depths (mm)

ARI (years)	AEP	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
2	0.5	10.1	13.7	16.4	22.3	28.6	42.3	54.2	69.4	87.9	100.9
5	0.2	13.2	18	21.5	29.2	37.4	55.2	70.6	90.3	114.4	131.3
10	0.1	15.8	21.5	25.7	35	44.7	65.9	84.2	107.5	136.2	156.4
100	1	27.7	37.6	45.1	61.3	78.1	114.5	145.8	185.7	235.1	270
100+CC	1	32.4	43.9	52.7	71.6	91.2	133.7	170.3	216.9	274.6	315.4

5.2.2 Areal Reduction Factor

No areal reductions factors (ARFs) have been applied to the catchment design rainfall. This is due to the following reasons:

- The HIRD's data is produced as a point rainfall in a 10 km^2 grid. The Pōkeno catchment is only approximately 19 km^2 in total and therefore it is not considered that application of ARFs would cause a significant enough change in the rainfall intensity to be critical.
- The NZ guidance for ARFs is limited and therefore it would require additional work to determine the appropriate ARF values, beyond the present scope of this study, and with limited validity for the catchment size.
- Not using the ARF means that a more intense storm will be adopted. This will produce marginally more conservative flow results.

5.2.3 Climate Change [2]

Climate change allowances for rainfall are informed by the Regional Infrastructure Technical Specification (RITS) recommended climate change adjustment of 2.1°C to the 1% AEP rainfall. This is based on the Climate Change Effects and Impacts Assessment: A guidance manual for local government in New Zealand. The recommended increase of 16.8% to the 1% AEP rainfall has been adopted in accordance with HITS.

5.2.4 Curve Numbers

Curve numbers (CN) describe the soils infiltration potential. They represent a non-linear relationship between the rainfall and runoff. The CN values are related to the ground cover and underlying soil. CN values have been calculated based on the United States Soil Conservative Service (SCS) guidelines relating to land use and TR20-06. Geological maps were used to identify the different soil classifications in the region. The soil types and adopted CN values are presented in Table 5-2.

Table 5-2: Soil Types & CN Values

Soil Type	CN
Alluvial / Colluvial	61
Basal lava/ Ash, Lapilli & Lithic/scoria	39
Sandstone & Mudstone	74
Impervious	98

5.2.5 Initial Abstraction [3]

The initial abstraction can be considered as the amount of rainfall that soaks into the ground before surface runoff begins. In accordance with TP108 guidelines, a value of 0 mm has been used for all impervious areas and a value of 5 mm has been used for all pervious areas.

5.2.6 Channel Routing

Local subcatchment hydrographs have been applied directly into the hydraulic model to allow the hydraulic model to estimate lag/routing times between subcatchments. As a result, channel routing is considered to not be required within the hydrological model.

5.2.7 Percentage Impervious

The impervious coverage was updated for each modelled scenario (maximum probable development (MPD) and existing development (ED)). The percentage impervious values have been adopted in accordance with Hamilton Infrastructure Technical Specification (HITS) (Hamilton City Council, 2010) and WDC Modelling Guidelines (Waikato District Council, 2018). These values are shown in Table 5-3.

Table 5-3: Impervious Percentages

Land Use Type	Impervious Fraction (%)
Road / Rail	90
Industrial	90
Urban	65
Pasture / Bush	2

[2] It is acknowledged that the climate change approach is out of date, this will be updated when the report is next revised
[3] It is acknowledged that the initial abstraction approach is out of date, this will be updated when the report is next revised

5.3 Data Sources

This section supersedes Section 5.3 of the 2010 CMP.

Table 5-4 provides a summary of data available to inform the CMP, as well as data not currently available.

Table 5-4: Data available for modelling

Data Type and format	Data Name	Source	Date Provided	Comment
GIS Files	Building footprints	WDC	Sept 2018	
	Cadastral parcels			
	Land use planning zones			
	Reserve and recreational parcels			
	Stormwater pits and pipes			
Topographic	1m Digital Elevation Model (DEM)developed	WDC	July 2017	LiDAR survey data flown between Oct 2010 and June 2011
	0.5m and 1m DEM covering fromMunro Road south wards to SH1	WDC	Oct 2017	Unmanned aerial vehicle (UAV) Drone Photogrammetric Survey flown between 10th and 20th May 2015
	Proposed 1m contours of the development south of the railway line	Dines Group	Sept 2017	
	0.5m DEM covering from Munro Road south wards to SH1	WDC	Oct 2018	The LiDAR was assessed, and it has not been post-processed appropriately leading to a poor- quality dataset. This was particularly noticeable in vegetated areas around streams and ponds with some areas not capturing ground levels accurately. In comparison the 2015 LiDAR was a higher quality dataset.
	0.5m DEM Masahiko	Birch Surveyors	21 Jan 2019	
	0.5m DEM of Newland Development	Blue Wallace	1 Feb 2019	
	0.1 m DEM of Signature Resources development	Chester Engineers	11 Jan 2019	

	0.1 m DEM from Horizon resources			
	Hynds Factory	WDC	26 Nov 2018	Topography was assumed based on resource consenting pdf documents approved by WRC
	Synlait Factory			
	Archihomes development			
Aerial Imagery	2.5cm and 7.5cm orthophotography covering North wards from Helenslee road through to Pōkeno town and Hitchen development	WDC	Oct 2017	UAV Drone 2015
	2.5cm and 7.5cm orthophotography covering North wards from Helenslee road through to Pōkeno town and Hitchen development	WDC	Oct 2018	UAV Drone 2017
	2003/2004 aerial of catchment	LINZ		
	2012/2013 aerial of catchment in ruralarea	LINZ		
Data Currently Unavailable	Stream erosion assessment			
	Water quality data			
	Flow or level monitoring to validate hydraulic model			
	Iwi environmental plans or information on iwi customary protection rights			
	Stakeholder consultation outputs			
	Rail corridor culvert data	Kiwirail		5 Culverts downstream of the Hitchen developments were adopted from their reports – this data was extracted from the Hitchen development consent reports. The Hitchen culverts were critical to identify changes in flow due to the development

5.4 HEC-HMS Model Calibration

This section supersedes Section 5.4 of the 2010 CMP.

Validation of subcatchment flows and adopted model parameters has been undertaken in accordance with TR20-06 guidelines using the Graphical Method. The HEC-HMS results are typically within 15% of the graphical methods results, and therefore it is considered that the adopted model parameters are acceptable. Comparison of calculated values of 1% AEP event peak flow and rainfall runoff depth for some of the key catchments is provided in Table 5-5.

Table 5-5: Validation of subcatchment flows

Subcatchment	Area (km^2)	TR20-06 1% AEP Flow (m^3/s)	HEC-HMS 1% AEP Flow (m^3/s)	Difference (%)	TR20-06 Runoff Depth (m)	HEC-HMS Runoff Depth (m)	Difference (%)
1	1.24	7.4	6.8	8.4	81	78	3.6
6	0.27	1.8	1.6	8.6	60	59	1.7
15	2.10	20.1	18.6	7.3	98	96	2.0
16	1.91	20.1	18.6	7.4	102	100	1.5
24 (Existing)	0.19	2.7	2.4	12.5	97	96	0.8
24 (Developed)	0.19	4.1	3.4	16.5	133	132	0.7
44 (Existing)	0.45	5.0	4.6	7.9	97	96	1.4
44 (Developed)	0.45	5.1	4.7	8.6	99	98	1.3

5.5 Hydraulic Model

This section supersedes Section 5.5 of the 2010 CMP.

WDC engaged WSP Opus to update the existing steady state hydraulic model (HEC-RAS) into a 2D hydraulic model (TUFLOW). This allows for a more comprehensive assessment of cumulative effects of the existing and current/proposed developments on the main waterways through Pōkeno under current climate change predictions.

A survey of the existing culvert structures (excluding the railway culverts due to access issues) was undertaken within the Pōkeno catchment to ensure that the accurate infrastructure data was included in the TUFLOW hydraulic model.

The major outcome of the flood model was that there were significant increases (100mm to 400mm) in flood levels for the 1% AEP event between the pre-development flood model and the current development flood levels indicating a worsening of flooding due to development.

This flood risk modelling indicated that stormwater flooding represented key constraint to development within the Pōkeno Catchment, thus a flood management plan for the whole catchment was needed.

It should be noted that both the 2010 and 2018/2019 catchment models cover the impacts of the stream flood plain only and do not address localised flooding within the urban catchment and urban infrastructure (usually undertaken as catch pits and pipes in an Urban Stormwater Model).

This section summaries the key changes made to the Pōkeno hydraulic model:

1. The key update to the model was to include development recently completed (i.e. changes in landform and imperviousness) and future planned developments in the base model topography to enable the CMP model to accurately predict flooding constraints.
2. Some Kiwirail culvert parameters were updated based on information from the Civil Plan-Stormwater management report for Hitchen Block Wetlands E1 and E2. Assumptions have been made in model to allow water to pass through structure locations assumed to be in place for the rural sections. These seem an adequately precautionary approach at this stage and unlikely to significantly change the results through the main township. It is important to note that the model schematisation does not represent a floodplain within the Hitchen development, however this does not mean there is no flood risk.

5.6 Selection of Hydraulic Model Parameters

This section supersedes Section 5.6 of the 2010 CMP.

5.6.1 Topography

This section supersedes Section 5.6.1 of the 2010 CMP.

The hydraulic model has utilised LiDAR topography data to form a 2D grid to represent both the flood plain and the waterway channels. This LiDAR was the best available information to determine the impacts of the 1% AEP design storms without the need for further survey.

The existing case scenario utilises the topography obtained from LiDAR captured between 3 October 2010 and 30 June 2011. This data represents the catchment topography prior to development that has occurred rapidly since 2010-2012.

The developed case scenario utilises the same LiDAR as the existing case as well as a combination of UAV drone survey data captured between 11 May 2015 and 20 May 2015 and 1 m design contour data provided by Dines Group for the proposed earthworks of various development areas currently being constructed south of the railway line.

Various model cell sizes were investigated in order to determine the most appropriate model resolution that also achieved reasonable model simulation times. It was determined that a 4m cell size achieved an adequate representation of creek topography and manageable model simulation times.

5.6.2 Roughness Values

This section supersedes Section 5.6.2 of the 2010 CMP.

Hydraulic model roughness values were adopted based on WDC Stormwater Modelling Guidelines, industry best practice and previous modelling experience. Calibration of adopted roughness values could not be undertaken as there were no available recorded flows/levels for flood rainfall events or recorded flood debris marks to compare results to. Table 5-6 shows the adopted roughness values.

Table 5-6: Adopted hydraulic model roughness values

Land Use	Manning's n
Road / Rail	0.025
Bushland / Thick Vegetation	0.07
Urban / School / Cemetery Areas	0.15
Industry / Commercial Areas	0.2
Pasture / Open Space Areas	0.05
Waterways	0.15

5.6.3 Steady State Modelling

This section from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' is no longer relevant due to the updated model.

5.6.4 Model Boundary Conditions

This is an additional section not included in the 2010 CMP.

Boundary conditions used within the model consist of:

- Source area (SA) for catchment inflow hydrographs
- Model outflow boundary (normal depth)
- SX links for connecting 1D structures (pipes) with the 2D domain

The downstream model boundary has been extended a sufficient distance beyond the areas of interest to manage influence from boundary conditions.

5.7 TUFLOW Model Calibration

This section supersedes Section 5.7 of the 2010 CMP.

Model calibration could not be undertaken as there were no available recorded flows/levels for flood rainfall events or recorded flood debris marks to compare results to.

5.8 Model Scenarios

This section supersedes Section 5.8 of the 2010 CMP.

Three modelling scenarios were simulated (for both the hydrologic and hydraulic model). These were:

- Existing Scenario
- Future Scenario without mitigation
- Future Scenario with mitigation

These scenarios have been analysed in order to capture changes to flood risk within the Pōkeno catchment.

5.9 Option Evaluation

This section is to be read in conjunction with Section 5.9 of the 2010 CMP.

A number of scenarios have been explored these are related to the mitigation requirements outlined in Table 8-4 and include:

- Raising of Huia Road to 29m and maintain obvert of bridge to 28.54m

- Raising of Munro Road to 28m and upgrade existing 2m culvert to triple 2m box culverts
- Upgrade Pōkeno Road bridge from 14m to 36m
- Create enhanced watercourses that act as overland flow paths in industrial areas to convey excess flows from higher events and avoid flooding MacDonald Road and industrial area properties
- Upgrading Great South Road bridge and raising of low section leading to the bridge to avoid flows bypassing bridge
- Upgrade or raise Ford street and Great South road culverts

These mitigation scenarios are further outlined and detailed in Appendix B.

5.10 Modelling Nodes

This section from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' is no longer relevant due to the updated model.

5.11 Pre-Development Model

This section supersedes Section 5.11 of the 2010 CMP.

The pre-development model is based on pre 2010-2012 LiDAR before development began to occur rapidly in the Pōkeno catchment. The model parameters were chosen to reflect this land use as described in Section 5.5 and 5.6.

5.12 Post-Development Model

This section supersedes Section 5.12 of the 2010 CMP.

The post-development model is based on pre 2010-2012 LiDAR combined with UAV drone survey data captured between 11 May 2015 and 20 May 2015 and 1 m design contour data provided by Dines Group for the proposed earthworks of various development areas currently being constructed south of the railway line. The model parameters were chosen to reflect this change in land use as described in Section 5.5 and 5.6.

5.13 Flood Plain Analysis and Flood Hazard Mapping

As stated in the 2010 CMP to safeguard life and property, floodways to pass the 1% AEP flows should be reserved from development. Riparian margins, which are planned to be established for non-flood management reasons, are also to be reserved but the flood-conveyance and system capacity needs to be checked including fully vegetated riparian margins to ensure that total conveyance remains adequate.

Figure 5-3 shows the 50%, 10%, 1% and 1%+CC event existing flood extents.

5.13.1 Terminology

Section 5.13.1 from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' is no longer relevant due to the updated modelling work.

5.13.2 Stream Sections

Section 5.13.2 from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' is no longer relevant due to the updated modelling work.

5.13.3 School Block / Sports Park

Section 5.13.3 from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' is no longer relevant due to the updated modelling work.

5.13.4 Other Changes Modelled

Refer to Section 5.9 of this addendum for changes modelled.

5.14 Stream Erosion

This section should be read in conjunction with Section 5.14 of the 2010 CMP.

A catchment walkover (2018) identified significant stream erosion occurring through the catchment (Table 5-7).

Table 5-7: Erosion Issues in the Pōkeno Catchment

 Bank slumping on Tanitewhiora Stream in proposedsports park area	 Bank steepening downstream of Munro Road Bridge
 Temporary erosion control measures adjacent to Helenslee block, downstream of Munro Road	 Bank slumping on Tanitewhiora Stream
 Bank steepening and erosion adjacent to gabions at Market Street. Future gabion failure likely.	 Bank steepening and erosion at Ford Street

A preliminary assessment was completed to ascertain erosion impacts when the Pōkeno catchment is fully developed. This has used the 50% AEP (2-year ARI) storm event as a proxy for bank-full flows, although it is noted in many cases this flow exceeds the main channel capacity. It is important to note that this is a catchment scale model and is not currently suitable for

informing a detailed assessment of erosion effects. As such a more detailed model is recommended to be undertaken as part of future works.

Figure 5-1 shows the 50% AEP MPD flood velocities in the Pōkeno catchment has velocities greater than 1 m/s and in many locations greater than 1.5 m/s. The Waikato Stormwater Management Guidelines indicate flow velocity in much of the stream lengths would exceed the maximum permissible velocities for alluvial silt (0.61 m/s) through to stiff clay (1.14 m/s). Figure 5-2 presents the areas where velocities would be considered high.

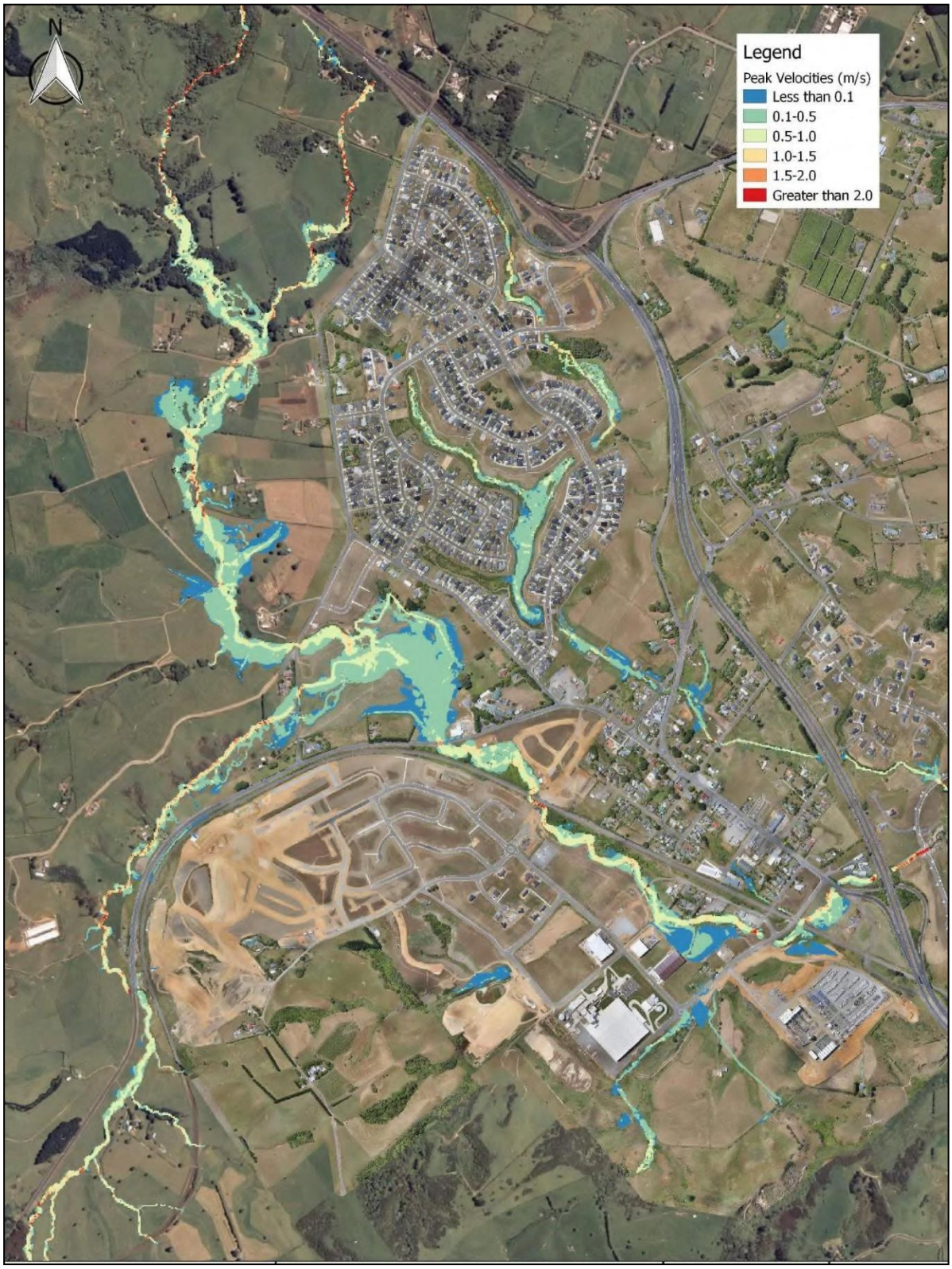


Figure 5-1: MPD 50% AEP velocities

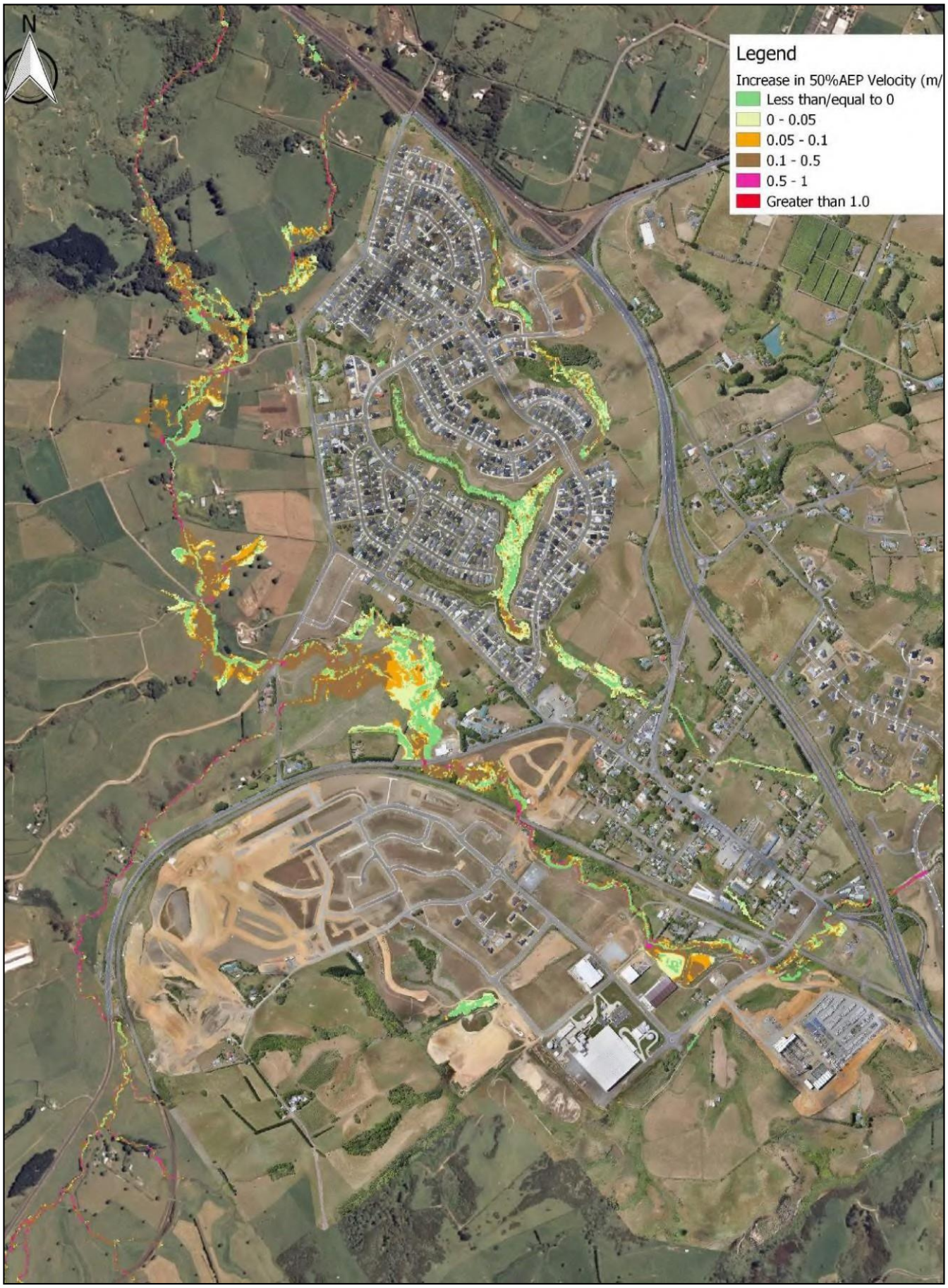


Figure 5-2 50% MPD velocities compared to ED velocities:

5.14.1 Stream Erosion Monitoring

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 5.14.1 for guidance.

5.15 Results and Discussion

This section supersedes Section 5.15 of the 2010 CMP.

The attached appendices and following figures summarise the results from the TUFLOW model for the existing and post-development scenario.

As stated in the 2010 CMP, the proposed zoning for the catchment allows for a mixture of development densities and the exact roading and reserve configuration is not finalised. Therefore, the floodplain widths and stormwater treatment attenuation devices have been conservatively sized. However, development specific flowpath widths and device requirements will need to be reassessed at the time of subdivision.

5.15.1 Existing Scenario Flood Impacts

Existing scenario flood modelling indicates in general that that:

1. Road crossings achieve varying levels of service (10% to 1% AEP immunity);
2. A small number of existing buildings may be at risk during the 1 % AEP storm event; and
3. Ponding occurs behind a number of road embankments.

Key existing flooding issues are highlighted in Figure 5-3 and referenced below (Table 5-8). Detailed flood maps are provided in Appendix A

Table 5-8: Description of issues highlighted in Figure 7

Figure 4 Key	Description of issues presented in Figure 4.
01	The Munro Road bridge (north of Huia Road) is predicted to have 10% AEP flood immunity. The 1% AEP event is predicted to overtop the road immediately south of the bridge location by up to 180mm and then traverse over the kerb and into the open space area as well as continuing south down Munro Road to the southern road culvert location.
02	The southern Munro Road crossing (south of Huia Road) is predicted to overtop in a 10% AEP event by up to approximately 125mm and by up to approximately 320mm in a 1% AEP event. Some ponding behind the road embankment occurs, extending approximately 100m upstream of the road.
03	Pōkeno Road is predicted to overtop by approximately 10mm in the 10% AEP event and 600mm in a 1% AEP event. Ponding is predicted to occur upstream of the bridge extending between up the two different flow paths.
04	Great South Road is predicted to have 10% AEP flood immunity. A small section of the SH1 off-ramp is predicted to be overtopped by about 20mm.
05	Ponding behind the Great South Road and railway embankments is predicted to occur due to the very flat hydraulic grade between structures. This indicates that the structure under Great South Road provides a hydraulic restriction through the bottom section of the Tanitewhiora Stream.
06	On the Helenslee stream, Ford Street is predicted to be flood immune in a 10% AEP. Flooding over the road is predicted in a 1% AEP event by up to approx. 500mm.

Other key items of note include:

1. Great South Road, Market Street and the State Highway are predicted to have greater than 1% AEP flood immunity.
2. Significant ponding occurs behind Ford Street, extending approx. 450m behind the embankment.
3. There are some properties at risk of flood impacts.
4. Results indicate that structures at Ford Street, Great South Road and Pōkeno Road Bridge are causing hydraulic restrictions that result in significant ponding behind their respective road embankments.

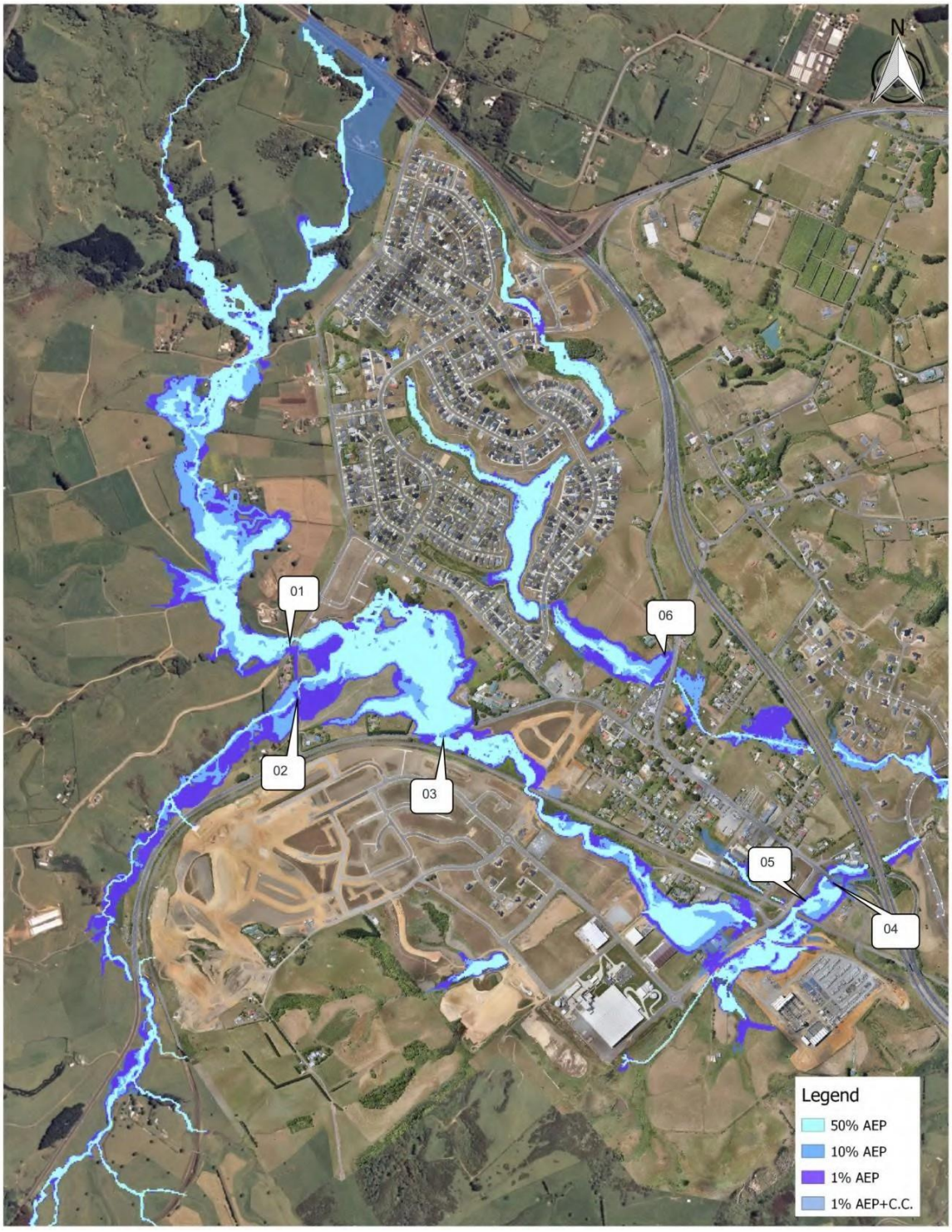


Figure 5-3: 50%, 10%,1% and 1%+CC event Existing Flood Extents

5.15.2 Flooding Issue Areas

Filling within the floodplain and various changes to the existing topography due to developments in the catchment are predicted to create the following changes to the existing flood behaviour in Tanitewhiora Stream:

- Upstream of Pōkeno Road the flood levels in a 1% AEP flood event are predicted to increase between 50mm and 100m in a 1% AEP event
- Between Pōkeno Road and McDonald Road the flood levels in a 1% AEP flood event are predicted to increase by up to approximately 250mm

The following changes are predicted in the Helenslee Stream:

- Significant changes to flood levels within the Helenslee development area are predicted due to modifications of the catchment that have included formalising pond systems, new road crossings and filling required to ensure flooding of the newly developed residential properties does not occur. No properties in the Helenslee development area are predicted to experience flooding from the stream in a 1% AEP event.
- Flood levels between Hillpark Drive and Ford Street are predicted to increase by up to approximately 100 mm in the 1% AEP event.
- Flood levels between Ford Street and Great South Road are predicted to increase by up to approximately 400 mm in the 1% AEP event
- Flood levels between Great South Road and Market Street are predicted to increase by between approximately 200 mm and 350 mm in the 1% AEP event
- Flood levels between Market Street and State Highway are predicted to increase by typically less than 100 mm in the 1% AEP event

Some reductions in flood levels were predicted in the following areas:

- Up to 500mm immediately upstream of the railway, extending for approximately 200m
- A 100m strip between Hitchen Road and McDonald Road (adjacent to the pond)

Predicted to now overtop Great South Road in a 1% AEP (by less than 100mm in depth).

The above flood level changes/impacts can be attributed to the following:

- Differences between survey datasets;
- Slight modifications to the floodplain storage areas (due to filling and stream earthworks/modifications)

No additional properties were predicted to experience flood impacts as a result of further development within the stream catchment. No houses were predicted to experience flooding in the 1% AEP event. Flood depths for this scenario are shown in Figure 5-4.

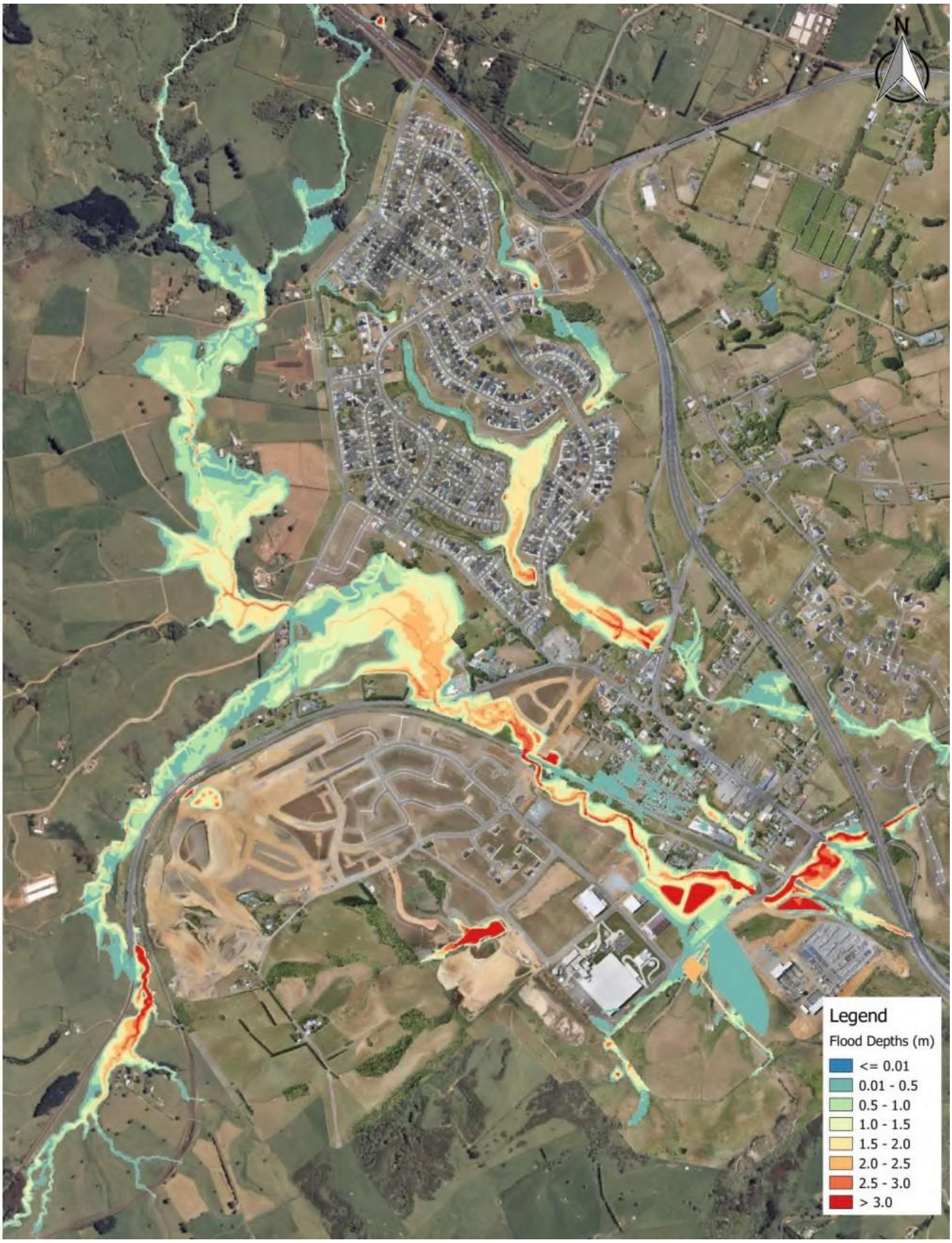


Figure 5-4: Flood impacts as a result of no mitigation and MPD

5.15.3 Flooding Interventions Approach

The options outlined in Section 5.9 were integrated into the flood model. Figure 5-5 and Figure 5-6 present the flood mapping results as a result of mitigation to the catchment (flood depth and afflux). Figure 5-5 in particular shows the level and extent differences between the mitigated

option and the ED scenario. Flood levels on the Tanitewhiora Stream within Pōkeno are generally less than ED levels with minor increases in some small sections. It is noted that where the flood levels increase, the channel is quite incised and therefore encroachment onto private property is limited.

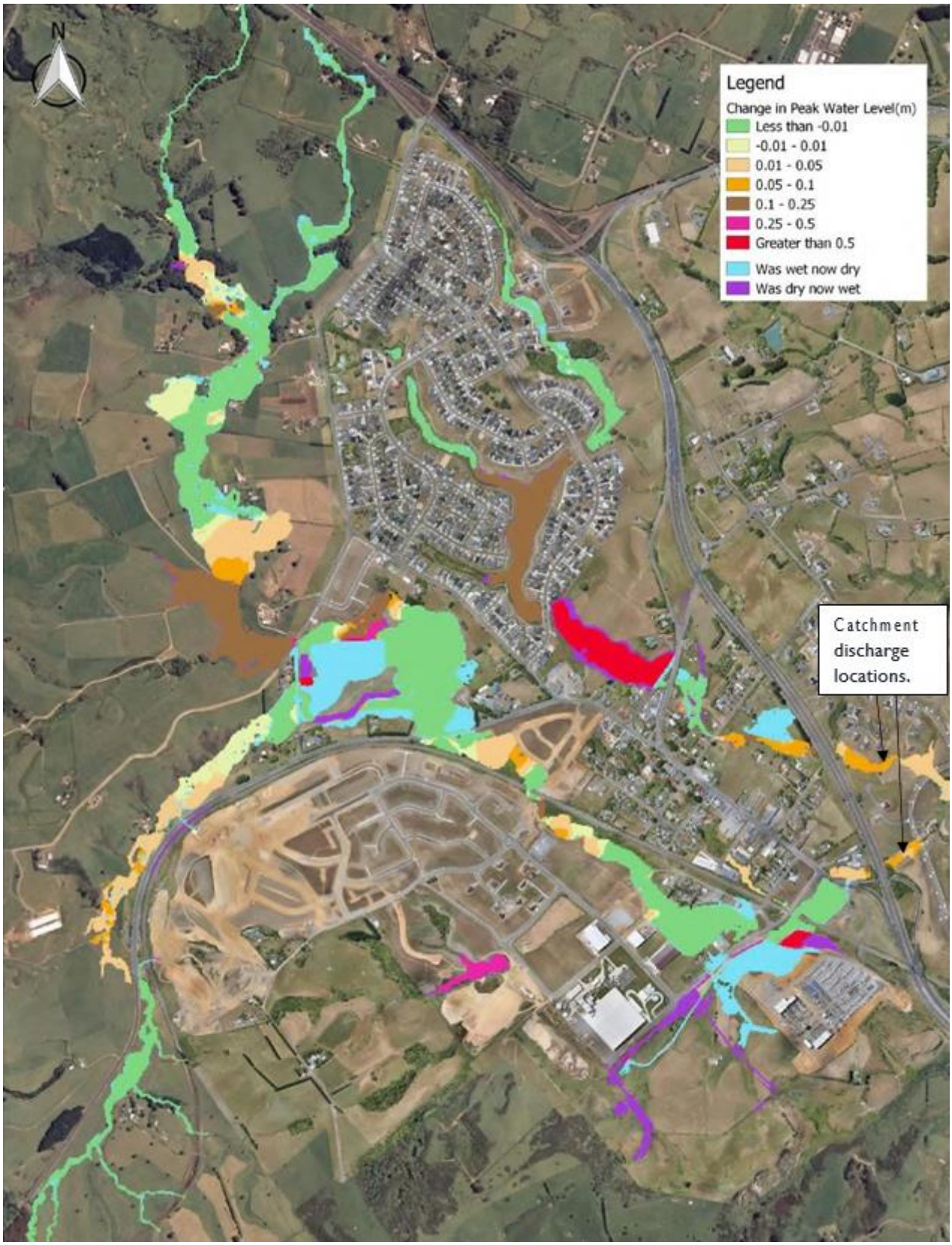


Figure 5-5: Mitigated MPD afflux results between existing development and proposed mitigated development (70% attenuation of 1% AEP design flows)

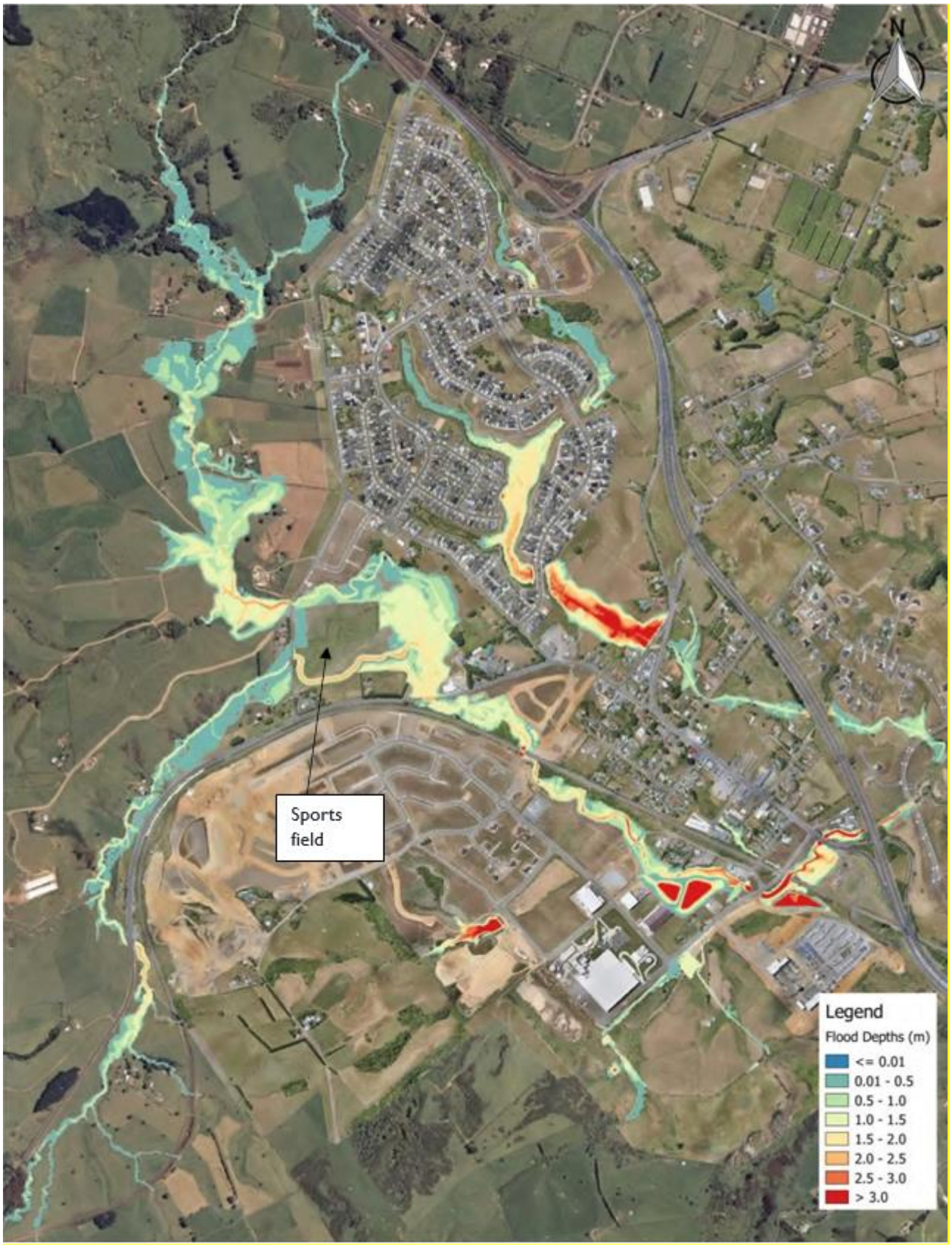


Figure 5-6: Flood depths as a result of mitigation (including attenuating 70% of greenfield runoff rate)

6 Environmental Effects of Development

6.1 Environmental Implications

This section should be read in conjunction with Section 6.1 of the 2010 CMP.

Post-colonial occupation in this catchment has primarily been dairy farming, crops and market gardens. Contaminated land may exist in the catchment associated with farming and ad-hoc commercial/industrial uses.

The change in land use from farming to urban can change the types of contaminants generated (e.g. moving from farm-associate runoff (e.g. faecal or fertilisers) to heavy metals. Suspended sediment can also increase if not managed appropriately.

The key receiving environments for this catchment consist of

- Tanitewhiora Stream and Helenslee Stream; and
- The Mangatāwhiri Drainage Scheme.

Existing ecological features identified as part of the 2010 CMP are summarised as follows:

- Most of the area consists of grazed pasture and small, modified remnants of native forest, scrub and wetland.
- Indices of macro invertebrate community structure indicate that the Tanitewhiora and Helenslee Stream within, upstream and downstream of the proposed development are generally moderately polluted and, insome cases, probably severely polluted.
- The mainstream of both the Tanitewhiora and Helenslee streams did have fisheries values to climbing native eel proportions and to resident landlocked common bully populations during the summer period.

6.2 Likely Effects on Terrestrial Ecology

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 6.2 for guidance.

6.3 Likely Effects on Aquatic Ecology

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 6.3 for guidance.

6.4 Likely Effects of Stormwater Structures

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 6.4 for guidance.

6.5 Piping of Perennial Streams

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 6.5 for guidance.

7 Consultation and Issues

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 7 for guidance.

8 Stormwater Management Outcomes

8.1 Stormwater Management Philosophy

This section should be read in conjunction with Section 8.1 of the 2010 CMP.

The CMP and this addendum have been undertaken to provide a framework of mitigation to be undertaken in the catchment to mitigate existing and future impacts identified. The CMP recommends that works shall be:

- Completed to mitigate changes introduced during development (filling, changes to the topography and increased impervious area)
- Residual ongoing issues are addressed through development and remediation.
- Shall not increase total discharge out of the catchment.

Implementation of these works will reduce and prevent worsening of flood levels from the existing development case (ED). A range of measures were assessed that could manage the flood risk. The measures were based on preliminary hydraulic analysis as well as consideration of growth and constructability. The measures have been reviewed through a high-level approach suitable for a CMP. Further scrutiny is required at the detailed design stage.

The benefit of the CMP and addendum approach is that each intervention has been considered on a catchment wide basis rather than in isolation. The benefit of an individual measure is maximised when undertaken in combination with other measures. The delivery of the flood management improvements requires completion of all the associated infrastructure and development control measures proposed.

The resilience of measures has been tested by assessing a likely maximum 'pass forward' flow from the upper catchment. This is to check how downstream measures perform in a 'worst case' scenario. Note, in most cases constructability constraints impose capacity limits on the size of measures, rather than seeking a specific level of service.

Flood risk can be managed through applying the hierarchy in Table 8-1

Table 8-1: PPS 25 (UK) Flood Risk Management Hierarchy

Step	Approach	Scope of this Study
1	Avoid	Apply to new development
2	Substitute	
3	Control	Apply to new development and existing development - consideredin this flood risk management study
4	Mitigate	

Source: Planning Policy Statement 25 Practice Guide, CLG, December 2009

It is important to note that approaches differ where flooding is mitigated as a part of (re)development, compared to mitigating risk to existing development. All these steps should be considered in managing flooding in the Pōkeno.

Potential stormwater management approaches in the Pōkeno catchment are outlined in Table 8-2.

Table 8-2: Potential Stormwater Management Approaches in the Pōkeno catchment

Development Status	Approach	Description	Applicability
New Development (including greenfield development)	Sequential Land Use Selection Process (Spatial Land Use Planning)	Keep development out of the floodplain as far as practicable. If this is not practicable, prioritise lower consequence land uses (e.g. public open space) over higher consequence land uses (e.g. housing)	This process should be considered through the planning process for development and future urban areas.
	'At Source'	Controlling water where it falls in the public domain.	The Waikato Regional Plan Policy 7 encourages at-source management of stormwater discharges in the public domain. This is highly applicable for future growth areas. 'At source' measures generally target frequent rainfall events and have less benefit in mitigating less frequent flood events. 'At source' measures while difficult to retrofit to address existing flooding issues should be adopted in large scale 'infill' development.
	LID	A design process considering urban design, landscape amenity, community alongside stormwater	This is the expected approach for redevelopment and future growth areas as described in the Waikato Stormwater Management Guideline. It is difficult to retrofit to address existing flooding issues and generally requires large scale redevelopment in brownfield land to be applicable.
	Land Raising	Importing or cut/fill to raise land above flood levels	In some locations where a sequential land use selection process means development must be located in the floodplain, flood protection can be achieved by raising land (i.e. avoiding flood risk). However, this potentially increases flood risk to others and requires mitigation.
Existing Development and New Development (if flood risk areas can't be avoided)	Storage	Attenuate stormwater above or below ground	There are significant rural catchment areas on both branches of the Tanitewhiora Stream upstream of Munro Road. Attenuation in the upper catchment is an appropriate solution for mitigating the effects of development in Pōkeno (refer Table D-1). This would generally be delivered as part of development master planning,

			however, could be 'communal' attenuation area for several developments if the benefit/opportunities are greater.
	Conveyance (Channel widening)	Increasing the channel width to increase capacity, convey more water, faster to downstream locations and lower flood levels	As engineering channels can have an impact on ecology and biodiversity if not undertaken in an appropriate manner, needs to be demonstrated that all other options have been exhausted. If widening is considered acceptable needs to be carefully designed to ensure ecological values are enhanced. Channel conveyance improvements following a LID approach can lead to enhancement of the environment. In the middle and downstream areas of the Pōkeno catchment improving the conveyance of runoff, particularly through the town will be more applicable to avoid accumulation of runoff peaks and particularly as the downstream waterfall provides a natural boundary for effects.
	Conveyance (flood defences)	Using structures to contain flood flows within the existing channel width to protect adjacent properties from flooding. Conveys more water, faster to downstream locations however can locally raise flood levels in the channel.	This is currently not applicable for Pōkeno based on the flooding mechanisms and therefore has not been considered further.
	Conveyance (Culvert)	On-line culvert upgrades to reduce bottlenecks in the stream corridor	Similar to channel improvements, this is an appropriate response to restrictions on the stream corridor that result in flooding.
	Conveyance (Pipe)	Upgrade pipe networks discharging to the stream corridor to reduce flood extents in depression areas or overland flow paths.	This is an appropriate response to lack of network capacity; however localised reticulation assessment does not form part of this scope.

	Flood resilience and resistance	Improve the resilience and recovery of people and infrastructure when flooding occurs	Where flooding cannot be controlled it is appropriate to consider measures to buildings to mitigate the effects of flooding. This is appropriate where measures to control flooding are not cost effective. This is not applicable based on the existing flood risk to Pōkeno and therefore has not been considered further.
	Land Purchase	Council purchase existing properties, or undeveloped land, at high risk of flooding, for use in flood protection or reducing existing flood risk	This option is considered where other options are not practicable or cost effective. It is generally only applicable where Council has some existing liability for flooding, or where the opportunity-costs of land purchase are justified by the quantity of land freed up for development. This option has not been considered to date based on flood mechanisms within Pōkeno.

8.2 Stormwater Quantity

Section 8.2 from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' has been superseded by the updated modelling work. Please refer to Section 5.15 and Section 8.5 of this addendum for information on the modelling results and proposed attenuation devices.

8.3 Stormwater Water Quality

This section is to be read in conjunction with the recommendations in Section 8.3 of the 2010 CMP which has been augmented to include attenuation sizing. Please refer to Section 8.5 of this addendum for information on the proposed attenuation devices.

8.4 Climate Change

Section 8.4 from 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' has been superseded by the updated modelling work. Please refer to Section 5.2.3 of this addendum for information on climate change.

8.5 Infrastructure Upgrade Works

This section supersedes Section 8.5 of the 2010 CMP.

Infrastructure upgrades and development controls are required to mitigate the effects of development in the Pōkeno Catchment. The stormwater management criteria proposed represents the best practicable option (BPO) and it aligns with the Waikato Stormwater Management Guideline requirement for "net improvement". This option also represents an opportunity to address existing flooding issues and has undergone a peer review. The proposed catchment mitigation is summarised in the following points.

- Onsite attenuation in the upper catchment:
    - Development attenuating to 70% of existing greenfield runoff rates for storm events 50% AEP to 1%AEP.
    - Upgrading the culvert beneath Munro Road and raising the road to improve the level of service and provide strategic attenuation.
    - Throttling the bridge at Huia Road and raising the road to improve the level of service and providestrategic attenuation
- Control flow in the middle catchment through a combination of strategic attenuation and capacityimprovements:
    - Throttling the culvert at Ford Street and raising the road to improve the level of service and providestrategic attenuation.
    - Creation of enhanced streams as floodway channels around Pōkeno Sport Park.
- Pass forward flow in the lower catchment (conveyance):
    - Upgrade to Pōkeno Road bridge to improve the level of service and increase capacity.
    - Upgrade to Great South Road Bridge to improve level of service and increase capacity.
    - Discrete land raising in the floodplain to manage flood risk.
    - Enhanced streams to provide a LID approach to conveyance.

Indicative attenuation volumes required for each is provided in Table 8-3. The location and catchment contributing to the attenuation is provided in Figure 8-2. Works proposed to be undertaken at road crossing/culverts are presented in Table 8-4. Culvert locations as presented in

Figure 8-3, with further detail provided in Appendix B. The (Franklin District Council, 2010) recommended stormwater management infrastructure has been undertaken at a conceptual level. It is expected that this concept would require refinement through the infrastructure design process to optimise performance, including consideration of a full range of storm events between 50% AEP and 1% AEP. Key recommendations are summarised in Figure 8-1

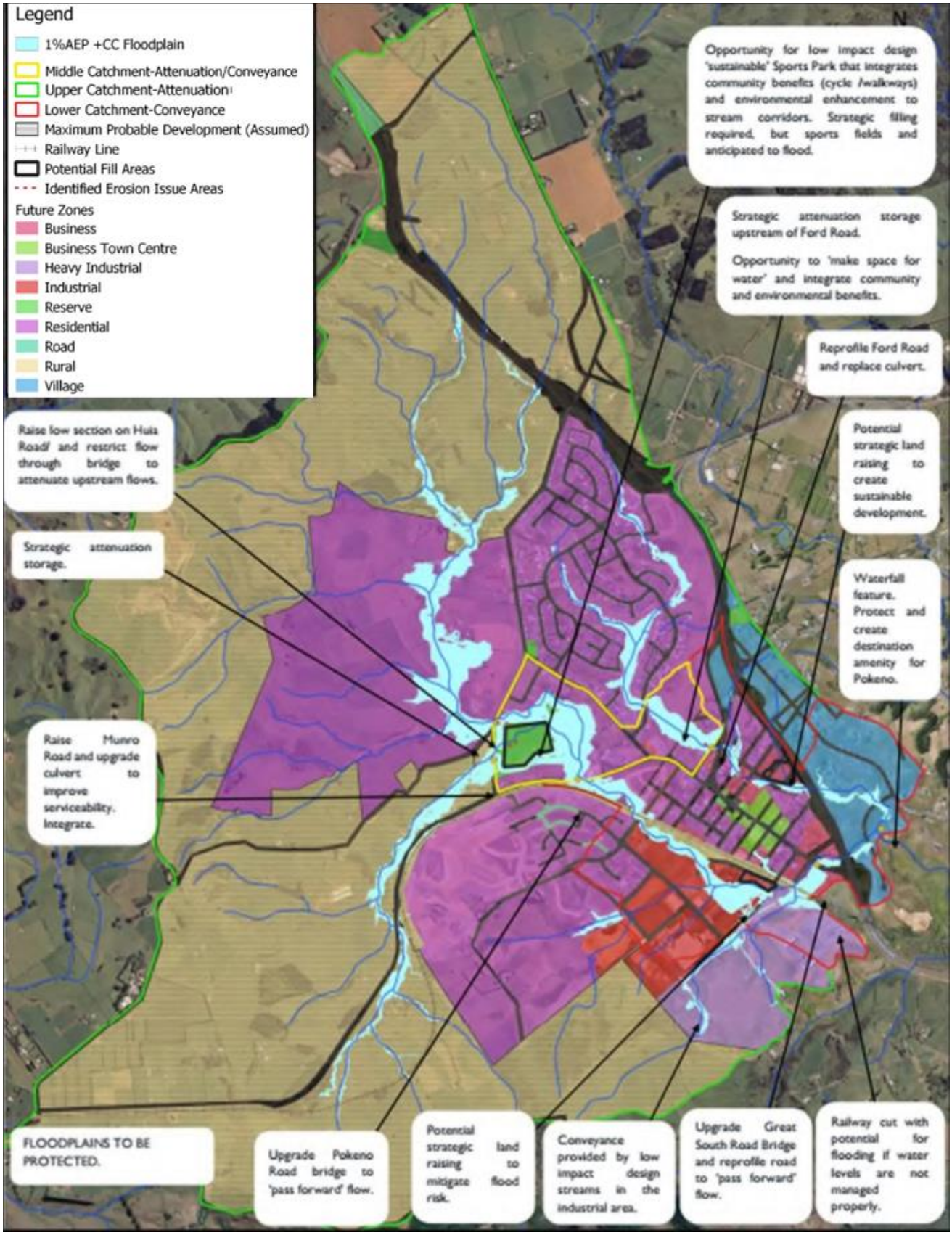


Figure 8-1: Pōkeno Preferred Flood Risk Management Approach

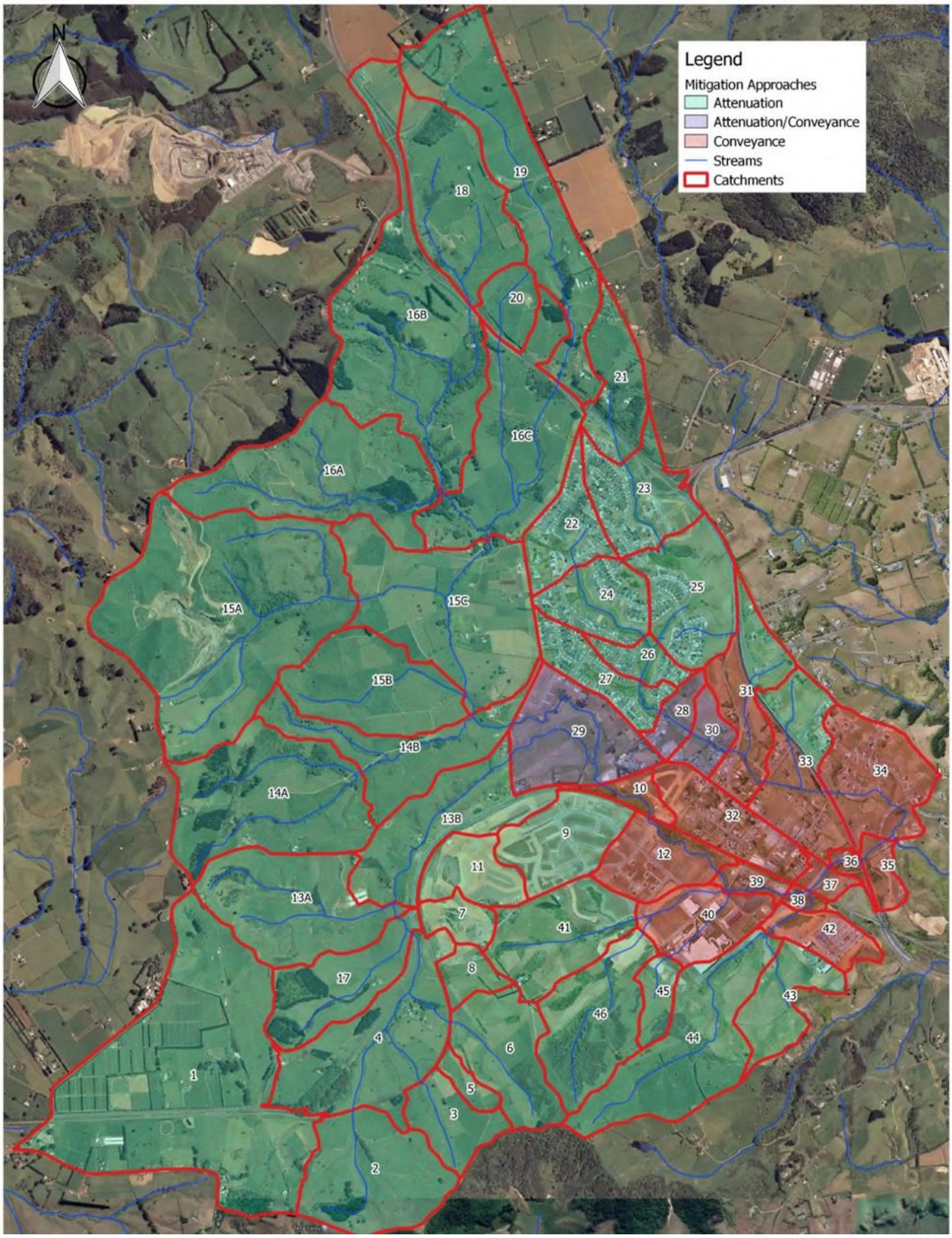


Figure 8-2: Catchments and proposed location of attenuation and conveyance

Table 8-3: Indicative attenuation volumes per sub-catchment

Subcatchment	1% AEP MPD (incl CC) to 70% existing greenfield runoff rates
1	68100
2	18800
3	6800
4	25000
5	2200
6	13300
7	3400
8	2800
9	11800
11	7200
13A	27400
13B	20900
14A	35400
14B	18400
15A	43400
15B	11800
15C	26600
16A	22900
16B	30900

Subcatchment	1% AEP MPD (incl CC) to 70% existing greenfield runoff rates
16C	21800
17	8900
18	11700
19	17200
20	2900
21	5900
22	3200
23	4000
25	6100
28	1500
29	4700
30	3200
31	5700
33	7300
41	10100
43	7000
44	17400
45	2200
46	13200
Total	551,100

Note: storage volumes are an approximate calculation-based on flow hydrographs for each sub catchment assessed. The actual storage required will depend on the final land use, site layout and attenuation device outlet design.

Table 8-4: Culvert and bridge level summary service

Culvert/ Bridge ID	Conceptual measures to Culvert/ Bridge	Compliance with NZTA Bridge Manual [1]	Compliance with WDC standard	Comments
Culverts				
Ford Street culvert	Increase road crest level to21.5m. Maintain existing culvert size.	No	Yes, 20mm freeboard	
106 Great South RoadCulvert	None	Yes	Yes, 2.16m freeboard	
Walter Rodgers Roadculvert	None	Yes	Yes, 2.20m freeboard	
State Highway 1A	None	Yes	N/A	
Munro Road Culvert	Triple 2m culverts, road raised to level 28m	No	Yes, 0.55m freeboard	Culvert surcharging by 0.77m and freeboardto road level of 0.55m. Road raising integrates additional flood storage behind road.
State Highway 1B	None	No	N/A	This culvert in the 1% AEP mitigated scenario is surcharging by 25mm. The freeboard to the road level is however greater than 1m. This is no change from theexisting situation (refer Table 1).
Market Road culvert	None	No	Yes, 1.56m freeboard	This culvert is still flowing nearly full in mitigated scenario the freeboard to the road level is however greater than 1.5m inall scenarios.
State Highway 1E	None	Yes	N/A	
State Highway 1D	None	Yes	N/A	
State Highway 1C	None	Yes	N/A	
Pōkeno Road	None	Yes	Yes, 0.93m freeboard	
Hillpark Drive 1	None	Yes	Yes, 1.45m freeboard	
Macdonald Road	None	Yes	Yes, 1.64m freeboard	
Hillpark Drive 2	None	Yes	Yes, 3.7m freeboard	
Mark Ball Drive	None	Yes	Yes, 1.69m freeboard	
East of Hill Park drive	None	No	Yes, 90mm freeboard	
Bridges				
Munro Road Bridge	Raise road to 29m bridge. bridge obvert unchanged	No	Yes, 0.97m freeboard	Freeboard to bridge obvert in MPDmitigated scenario is 0.53m
Pōkeno Road Bridge	Raised road to 27. Bridgeobvert changed to 26.5, bridge width 36	No	Yes, 0.61m freeboard	Freeboard to bridge obvert is 0.11m whichis less than requirement of 0.6m. Bridge obvert and road could be further raised toprovide improved level of service.

North Island MainTrunk line (NIMT) Bridge 1	None	Yes	Yes, 0.97m freeboard	
McDonald Road Boxculvert	None	No	Yes, 0.83m freeboard	
North Island MainTrunk line (NIMT) Bridge 2	None	No	Yes, 1.2m freeboard	
14 Great South Road	Raised right section of road to 19.5mRL and bridge obvert to 18.6mRL and widened to 20m	No	Yes, 0.83m freeboard	Bridge is surcharging by 6mm. this Bridge and road level to be further assessed in detail design.

Figure 8-3: Bridge and culvert locations

8.6 Riparian Planting

This section is to be read in conjunction with the recommendations in Section 8.6 of the 2010 CMP.

A minimum 10m riparian margin shall beprovided either side of first order streams and aminimum 20m riparian margin either side of second order streams. Guidance is available in the Auckland Regional Council Technical Publication TP148 *Riparian Management Guideline* (Becker et al., 2001).

9 Recommendations

This section supersedes Section 9 of the 2010 CMP.

The following recommendations represent the actions required to implement the preferred stormwater outcome for the Pōkeno Catchment. Key elements of these recommendations are summarised in Figure 8-1 and outlined in Table 9-1. These recommendations are focused on flood risk management, recognising a significantly improved tool (the Pōkeno Flood model) is available to support catchment management decisions.

Table 9-1: Summary of mitigation requirements

Area	Mitigation Requirement
Pōkeno Road / Munro Road	Opportunity for low impact design 'sustainable' sports park
Ford Street	Strategic attenuation storage upstream of Ford Street. Reprofile Ford Street and replace culvert.
Selby Street	Strategic land raising to create sustainable development
Pōkeno Waterfall	Protect and create destination amenity for Pōkeno
Huia Road	Raise low section of road and restrict flow through bridge to attenuate upstream flows. Strategic attenuation storage.
Munro Road	Raise Munro Road and upgrade culvert to improve serviceability.
Pōkeno Road	Upgrade Pōkeno Road bridge to 'pass forward' flow
McDonald Road	Strategic land raising to mitigate flood risk
McDonald Road / Synlait Milk	Conveyance provided by low impact design streams in the industrial area
Great South Road	Upgrade Great South Road Bridge and reprofile road to 'pass forward' flow
Railway near Great South Road	Railway cut with potential for flooding if water levels are not managed properly
All	Floodplains to be protected

Key points from this addendum include:

1. Integrating the proposed stormwater management upgrades outlined in this CMP with a well-planned water sensitive approach to development offers an opportunity to enhance the existing social, cultural and environmental outcomes in Pōkeno. The large-scale development across the catchment offers a unique opportunity to deliver substantial stormwater related benefits to the local community.

2. The purpose of this addendum is to bring together the latest data and knowledge for the Pōkeno catchment in one location and plan the long-term approach for stormwater. The

need now is driven by the significant development currently proposed, and likely expected in the future. It is critical that cumulative effects are well understood and opportunities for enhancement are integrated.

3. A number of stormwater attenuation ponds are recommended to mitigate the effects of development, within the structure plan area based on flood modelling (Figure 8-2 and Table 8-3)
4. Streams to be protected and riparian planting areas
5. Recommended system upgrades

Further specifications for stormwater management are given below.

9.1 Flooding Considerations

This section should be read in conjunction with Section 8.5 of this addendum and Section 9.1 of the 2010 CMP.

The safety of people and operation of infrastructure is affected by the lack of culvert/bridge capacity where roads cross waterways. Table 8-4 provides a summary of proposed works to be undertaken at road crossing / culverts.

Hydraulic modelling analysis predicts mitigation of upstream runoff to 80% existing greenfield rates still results in increased levels downstream that have an adverse flooding effect.

The proposed catchment mitigation is summarised in the following points. (and described in more detail in Section 8.5 of this addendum):

- Stormwater attenuation ponds be constructed as onsite attenuation in the upper catchment.
- Control flow in the middle catchment through a combination of strategic attenuation and capacity improvements.
- Pass forward flow in the lower catchment (conveyance)

Indicative attenuation volumes required for each is provided in Table 8-3. The location and catchment contributing to the attenuation is provided in Figure 8-2.

WDC should consider opportunities for integrating flood risk management measures with other strategic overlays, such as transport and parks that may reduce or share costs. Recommendations for reducing flood risk during development are outlined in Table 9-2.

Table 9-2: Flood Risk Development Requirements

Category	Issue	Development Requirement
Planning	Flood risk to new development	Apply sequential land use selection process (spatial land use planning) to keep development out of the floodplain as far as practicable. Modification of the floodplain is generally not encouraged, however where there is no other option, will need to be assessed on a case-by-case through hydraulic modelling. Developers shall: • Provide an options assessment that demonstrates sustainable development cannot be brought forward without encroachment on the floodplain.

		• Demonstrate there is a less than minor effect for the 50%, 20%, 10%, 5%, 2% and 1% AEP + climate change return period events. • Contribute to the proposed strategic attenuation proposed as part of road corridor improvements
	Historic responses to stormwater management do not work, having long term and cumulative effects.	Development must adopt an integrated stormwater management approach using LID. The requirements of the Waikato Regional Stormwater Guidelines Section 6 shall be adopted. Should a LID approach not be proposed, development must submit a detailed options assessment demonstrating a conventional approach is the BPO over a LID approach.
Flooding	Increased impervious surfaces associated with development increase flood risk to others downstream.	On-site attenuation is required in the upper catchment (within public realm) to 70% existing greenfield runoff rates for the 50%, 20%, 10%, 5%, 2% and 1% AEP + climate change return period events.
	Historically, some stormwater devices havebeen constructed that are not suitable for the current, or potential future, development.	Attenuation devices delivered by development shall be designed to enable asset owners to easily adapt the outlet control to optimise their performancein the future. If catchment gauge data becomes available this should be doneusing time-series.
	Existing transport infrastructure crossing the streams cannot cope with future flows and willnot achieve an acceptablelevel of transport service.	Developer consult with WDC. In the mid to lower part of the catchment transport infrastructure owners can reduce hydraulic constraints caused by existing transport infrastructure crossings over the streams. At strategic locations this will also include road raising to both improve the serviceability of the road and provide necessary additional storage. Development will need to contribute to the necessary upgrade to transport infrastructure to provide safe access and egress to new properties.

	There are existing flooding issues in thelower catchment that will be exacerbated and restrict development if action isn't taken.	If sufficient conveyance solutions cannot be provided within the 'conveyance' area of the catchment (Figured-), developers shall agree the BPO with WDC.
	This CMP is a high-level document data improvement, and innovation should be encouraged.	Alternative approaches to flood risk management can be considered, however are subject to a detailed assessment of effects, including assessmentof cumulative effects.
	Uncertainty in climate change effects leads to uncertainty in flood levels.	Development shall apply the freeboard requirements specified in the Districtor Regional Plan for the 1% AEP storm event (including latest, recommendedclimate change predictions).
	Network capacity is exceeded, or system performance can reduce (e.g. with blockage).	Development and infrastructure shall be designed for exceedance, inaccordance with the Waikato Regional Stormwater Guidelines and RITS.

9.2 Ecological Considerations

This section should be read in conjunction with Section 9.2 of the 2010 CMP.

The existing database for terrestrial flora and fauna, erosion, water quality and stream ecology are poor and requires resolution via a field survey. Location and protected status of waterway areas need to be identified so that their potential can be protected and explored.

Significant development has occurred within the catchment since this assessment was completed. In the absence of any further data it is assumed the overall assessment of "moderately to severely polluted" still applies to the streams. National and regional policy objectives and guidelines have also changed – particularly the requirement that stormwater management **enhances ecological values**, not just an effects-based mitigation. Filling in ephemeral or perennial streams, which may have been considered 'unavoidable' 10-15 years ago, is generally no longer acceptable today and isnot supported by WDC.

It should be noted that any area of native vegetation or waterway should be protected, and it is recommended that should development occur within the vicinity of a waterway, then survey and a management plan should be created.

Table 9-3 presents the stream protection requirements for developers.

Table 9-3: Stream Protection Requirements for Development

Category	Issue	Development Requirement
Stream corridors	First and second order streams are critical assets for managing downstream effects	Greenways (lineal parks) are to be incorporated to provide the framework to protect, conserve and link stream corridors as open spaces. These can provide important cycle and walkways, wildlife corridors and riverways linking natural, cultural and recreational areas. Greenways will need to be established early in the master planning process, in collaboration with landowners.
		Where Greenways are not practical or appropriate, create Riparian Buffer Zone through private land on allfirst and second order streams. These can have a significant effect on water quality in the receiving environment. A minimum 10m riparian margin shall beprovided either side of first order streams and aminimum 20m riparian margin either side of second order streams. Guidance is available in the Auckland Regional Council Technical Publication TP148 *RiparianManagement Guideline* (Becker et al., 2001).
	In combination with managing increased runoff, preparing the stream corridor to receive flows from an urbanised catchment is critical to protect against erosion and to attenuate stormwater runoff.	Depending on the size of the upstream catchment, enhancement planting is required around first and second order streams in headwater locations, or harder measures such as rock armouring or bank shallowing where highly erosive flows are anticipated.
		Development layout must maintain, as far as practicable, the natural drainage pattern of the site.

9.3 Erosion and Water Quality

This section should be read in conjunction with Section 9.3 of the 2010 CMP.

Regional policy and guidelines require that development generate a 'net improvement' in water quality and enhance ecological outcomes. As such a higher level of protection is required for first and second order streams in Pōkeno than has been previously expected. This is also required in the Waikato Urban Design Guidelines. This recognises the range of values that streams have including hydrological function, ecological values and amenity value for community.

Through the development of Pōkeno the existing stream corridors will be transformed from rural streams to functionalurban waterways. The urbanisation of the contributing catchments to these streams presents a unique opportunity to implement practices that will result in resilient and ecologically functional urban streams in the future. With a co- ordinated approach, these corridors could form the building blocks for green corridors (greenways) incorporating walking and cycling facilities and, where appropriate, provide a corridor for other utility provisions. In addition to providing habitat and biodiversity streams provide an important hydrologic function – detaining and attenuating flows and reducing flood risk compared to pipe systems.

Parts of the Helenslee Stream are currently classified as Significant Natural Areas in the Proposed District Plan. No watercourse assessment has been completed for the Pōkeno catchment. This data will be important in informing development of areas that require protection and enhancement.

Section 3.1.1 of the Waikato Regional Plan provides an overview of the regional issues that drive the need to focus on the quality of stormwater that discharges into the receiving environment. There is an expectation of **"net improvement"** in water quality across the Waikato Region (Section 3.1.2 of the Waikato Regional Plan (Waikato Regional Council, 2012)).

As mentioned in Section 5.14 a catchment walkover was undertaken in 2018 and areas with significant stream erosion occurring are shown in Table 5-7.

Significant development has occurred within the catchment since the 2010 CMP was completed. In the absence of any further data, it is assumed that the overall assessment of "moderately to severely polluted" still applies to the streams.

The streams within Pōkeno are already eroding, discharging sediment and damaging habitat. If unmitigated, development is expected to result in a significant increase in erosion. The Waikato Regional Guidelines require development mitigate this effect; however, erosion is expected to be ongoing.

It has been identified that stream erosion is occurring at present. Volume control and/or extended detention, as specified in the Waikato Regional Guidelines, will assist in mitigating some of these effects. However, in some locations stream bank erosion will continue without further intervention due to the longer duration and more frequent occurrence of erosive flows. Table 9-4 sets out development requirements necessary to manage erosion effects in the catchment.

Table 9-4: Erosion Requirements for Development

Category	Issue	Development Requirement
Erosion	Stream velocities are predicted to be greater than the likely maximum permissible velocities through the catchment.	Subject to site specific geotechnical testing, extended detention is required for all development, designed inaccordance with the Waikato Regional Stormwater Guidelines Section 7.2.7 (2).
		Retention should be provided in accordance with the Waikato Regional Stormwater Guidelines Section 7.2.7 (1). Wherever practicable this should be through adopting a LID approach and apply the LID scoring matrix.

		As the existing development (ED) scenario velocities exceed maximum permissible velocities in the Waikato Regional Stormwater Guidelines, a precautionary approach is required involving *multiplying the water quality volume by 1.2 to determine extended detention volume* (WRC, 7.2.7 (3)). If a catchment scale assessment of shear stress is undertaken, this requirement may be revised.

It is key to note that, if unmitigated, development is expected to result in a significant increase in erosion. The Waikato Regional Stormwater Guidelines require development deliver measures to mitigate these effects, however erosion is expected to be ongoing if these measures are delivered in isolation.

Development provides an opportunity to improve the water quality discharging into the sensitive receiving environment – faecal pathogens associated with farming may reduce, however there is a risk other pollutant may increase (e.g. sediment, heavy metals, PAHs, etc). Stormwater treatment is required in accordance with the Waikato Regional Plan and Waikato Regional Stormwater Guidelines to mitigate these increases. Water quality requirements for developmentare set out in Table 9-5.

Table 9-5: Water Quality Requirements for Developments

Category	Issue	Development Requirement
Water Quality	Development can generate contaminants that have an adverse effect on theenvironment.	Stormwater treatment is required in accordance withthe Waikato Regional Plan and Waikato Regional Stormwater Guidelines.

9.4 Climate Change

This section supersedes Section 9.4 of the 2010 CMP.

Potential climate change effects on peak flows is to be allowed for in the design of attenuation ponds. The design if therefore expected to allow for an increase of 16.8% to the 1% AEP rainfall (in accordance with HITS).

As recommended in the 2010 CMP, freeboard allowances to occupiable floor levels be set at 500mm above the calculated flood level (proposed development and mitigated flows) allowing for a 16.8% climate change increase on the rainfall depths for 1% AEP event.

9.5 Land Development Rules

This section supersedes Section 9.5 of the 2010 CMP.

Development shall proceed in accordance with the FDC subdivision provisions for stormwater volume control, stream setbacks and open drains. Local differences may occur only with the written permission of FDC.

Land development densities and coverage shall not generally exceed those detailed in Table 5-2 & Table 5-3 of this addendum. Where the stated assumptions are exceeded the effects of this area to be re-modelled to confirm that they can be incorporated into the CMP

For sites with high risk land use activities such as those referred to in EW's Regional Plan, Rule 3.5, additional source control measures for stormwater discharges appropriate for that activity shall be utilised.

Development of land upstream of the railway embankment has the potential to increase flows to the existing culverts. In these areas a detailed assessment of culvert capacity should be carried out, by the developer, to confirm what mitigation measures are required to ensure the long-term stability of the embankment and railway assets.

In the following areas the minimum occupiable floor level should be set 0.5m above the 1% AEP event + 16.8% climate change and allowing for 50% partial blockage of the downstream culverts:

- Upstream of Great South Road
- Between Great South Road and Market Street
- Between Market Street and State Highway 1
- Upstream of Hitchen Road

9.6 Operation, Maintenance, and Monitoring Strategies

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 9.6 for guidance.

9.7 District Council Implementation Plan

No amendments to this section please refer to 'Franklin District Council – Pōkeno Stormwater Catchment Management Plan – September 2010 (FDC Ref D450/06)' Section 9.7 for guidance.

10 Limitations

This addendum has been prepared by WSP. It has been prepared for the particular project described to the consultants and its extent is limited to the scope of work agreed between the clients and consultants. No responsibility is accepted by the consultants or their directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this addendum in any other context or for any other purposes. This report is for the use of Franklin District Council only and should not be used or relied upon by any other person or entity or for any other project.

11 References

Franklin District Council. (2010). *Pōkeno Stormwater Catchment Management Plan (FDC Ref D450/06).*

Hamilton City Council. (2010). *Hamilton Infrastructure Technical Specifications.*

Waikato District Council. (2017). *Waikato District Plan.*

Waikato District Council. (2018). *Waikato Stormwater Ruoff Modelling Guideline.*

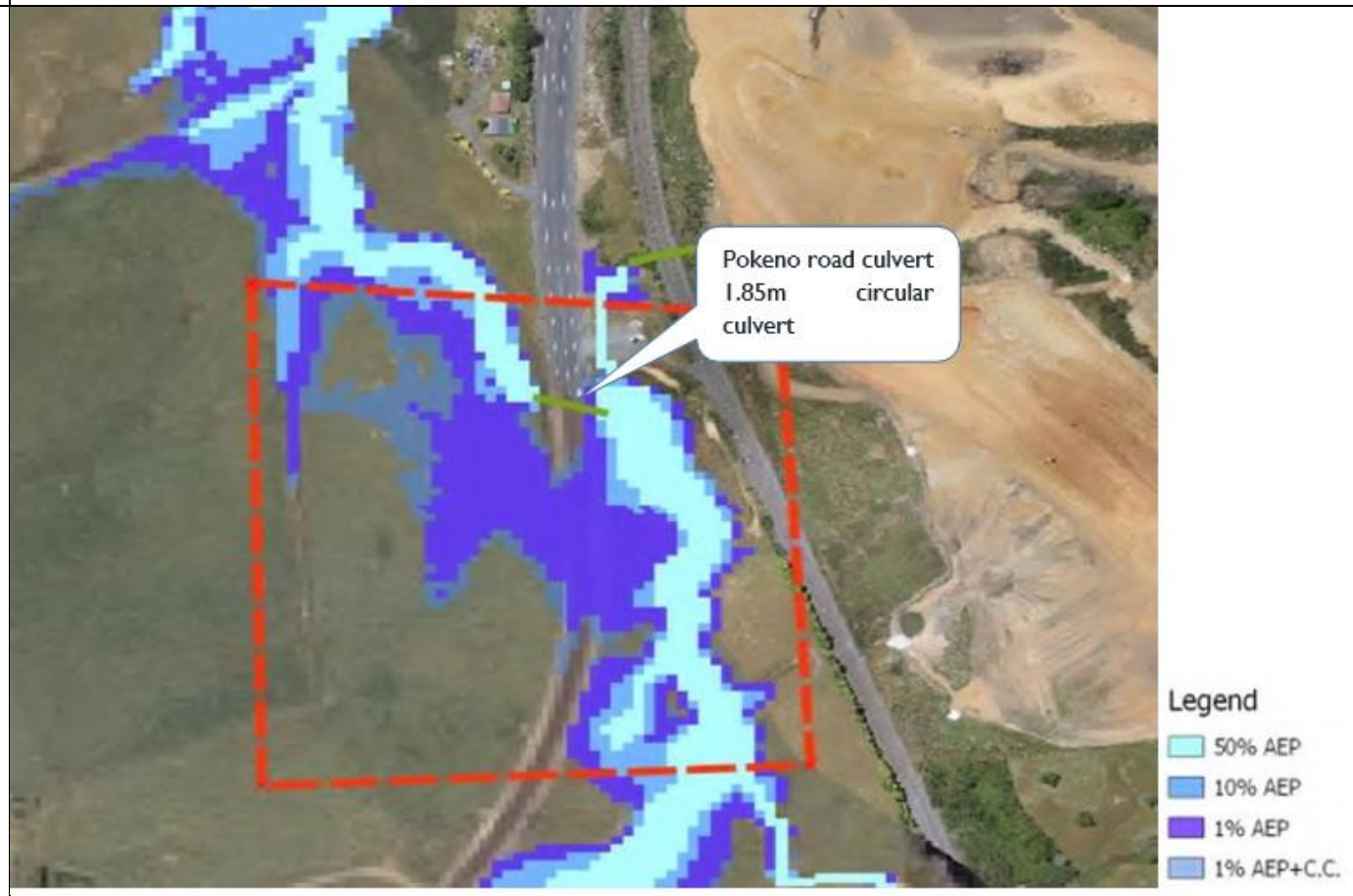
Waikato District Council. (2020). *Pōkeno Catchment Management Plan (2020 Update).*

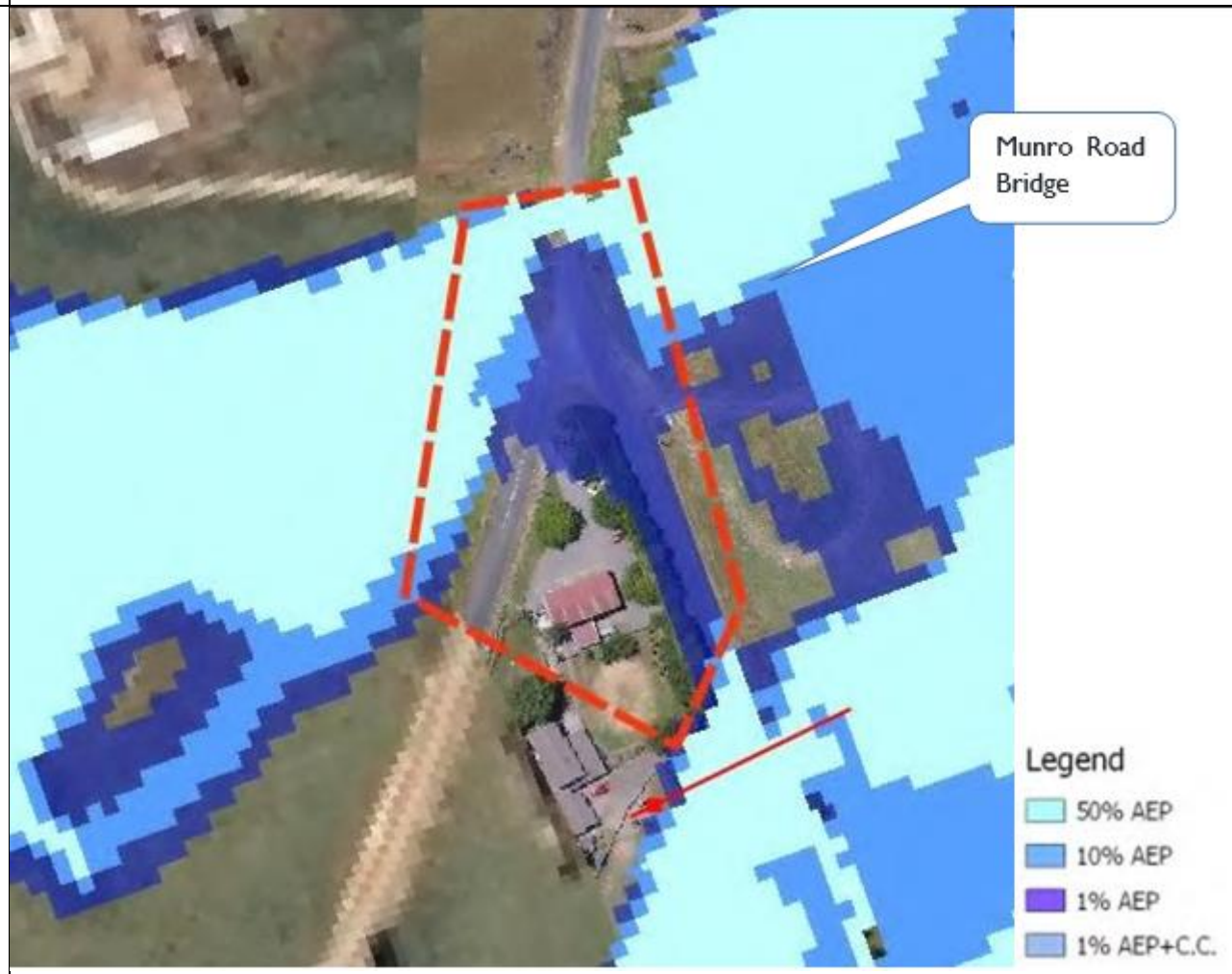
Waikato Local Authority Shared Services. (2018). *Regional Infrastructure Technical Specifications* .

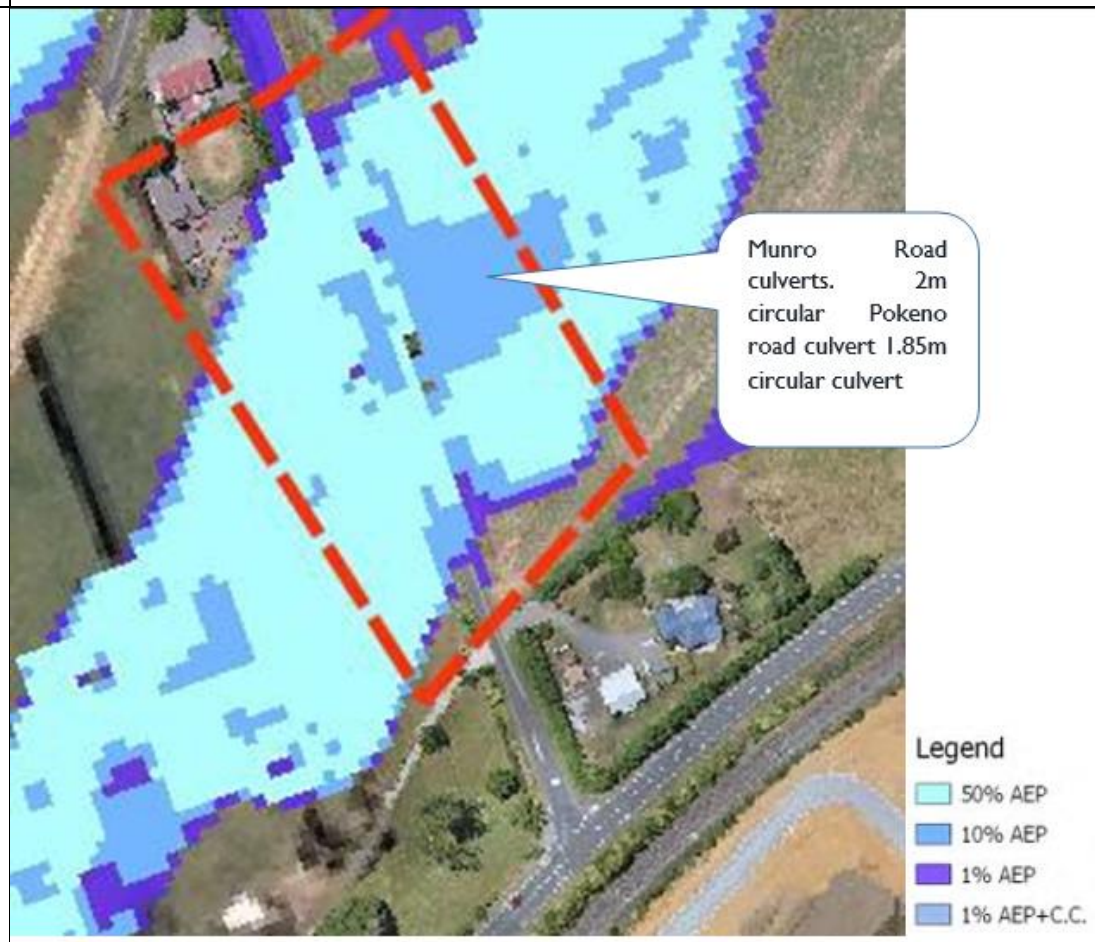
Waikato Regional Council. (2012). *Waikato Regional Plan.*

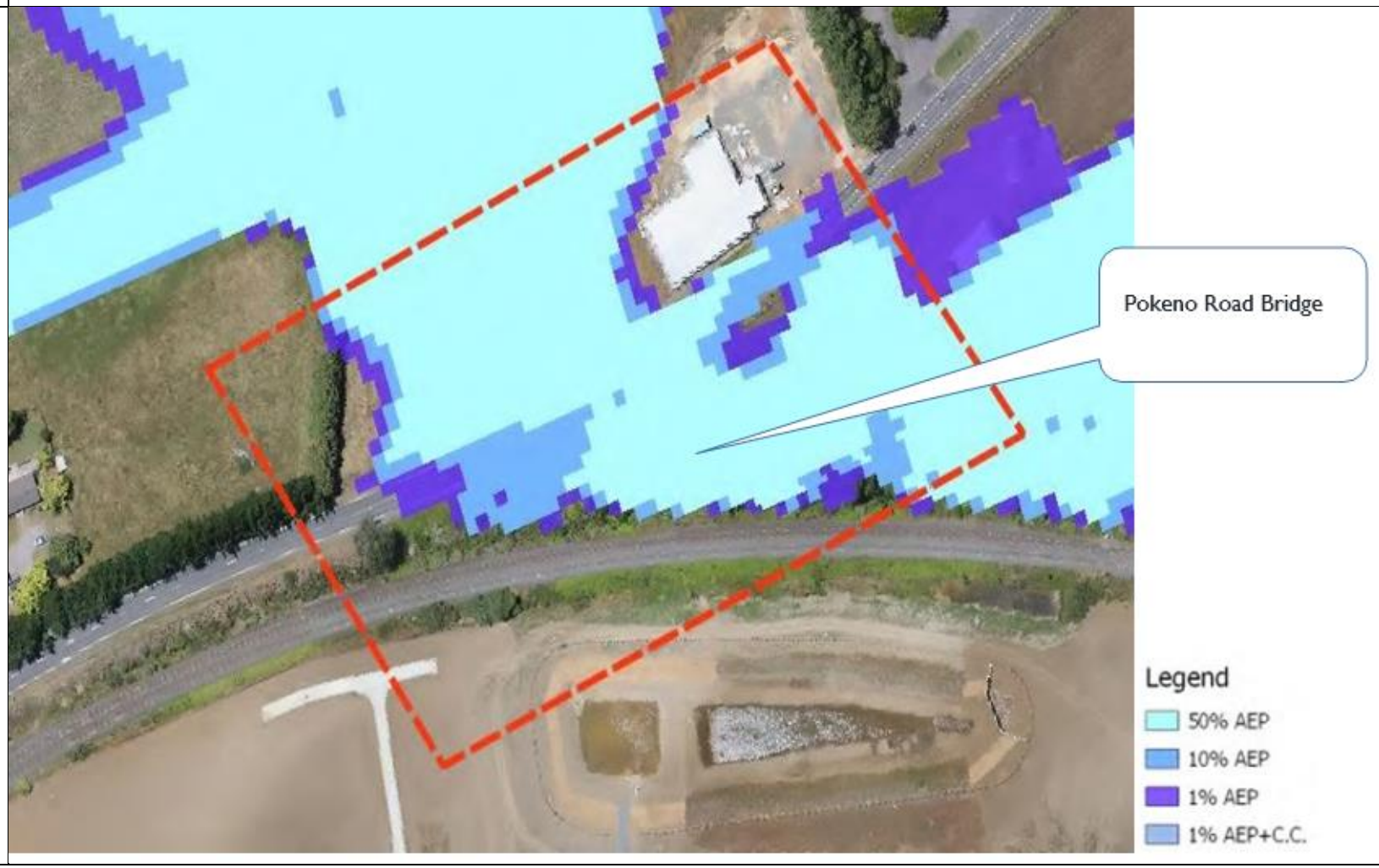
Appendix A
Flood Issue Areas

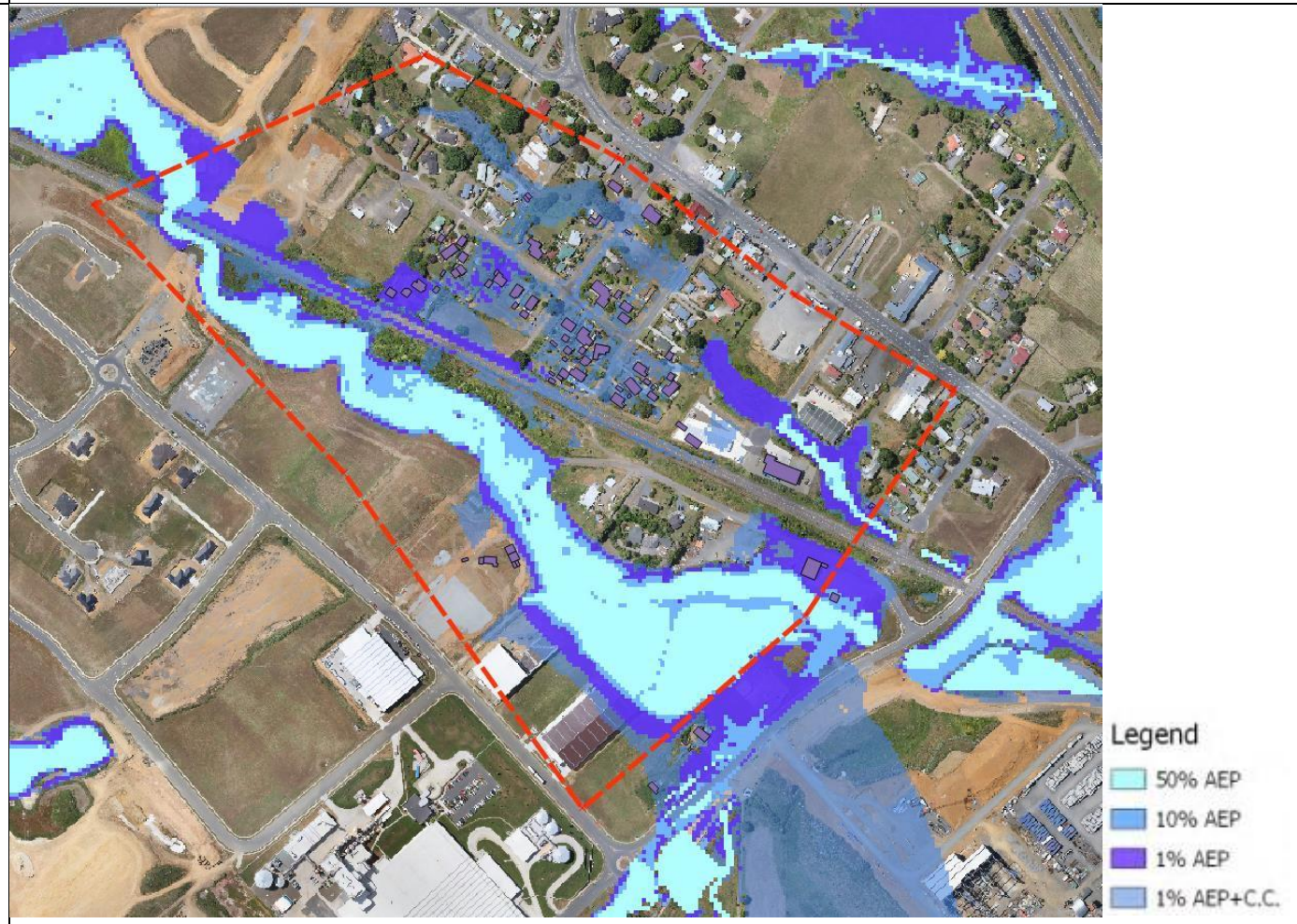
Flood Issue Areas

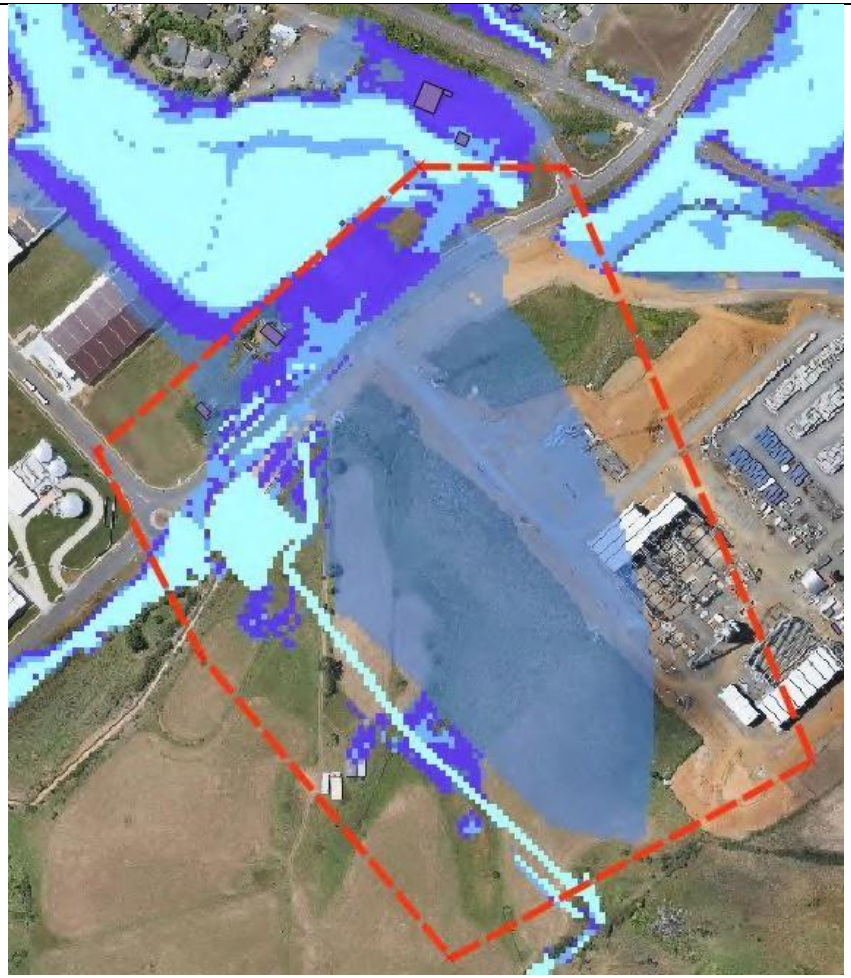
Area 01	Issues	Flooding over Pōkeno road in the 1%AEP and 1%AEP +CC event., Flood hazard category as outlined by Australian Emergency Management Institute in Level H1. which are relatively benign flows with no vulnerability
	Flooding Mechanism	Culvert has insufficient capacity to pass the 1%AEP storm event. Excess water overtopping the road.
	Map	

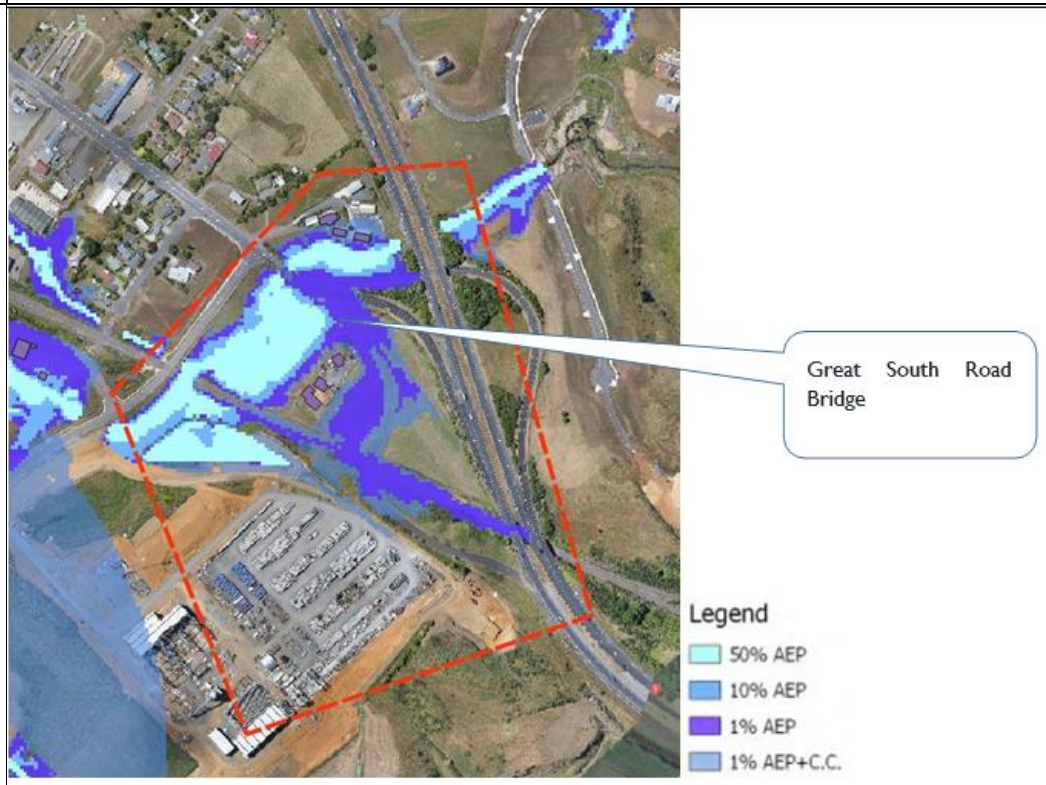
Area 02	Issues	Flooding over intersection of Huia and Munro Road in a greater that 10% AEP event. Potential access restricted to Pōkeno West development and main Pōkeno Road. House driveway flooded. Flood hazard category as outlined by Australian Emergency Management Institute in Level H5, deeming it unsafe for all people and vehicles.
	Flooding Mechanism	Low freeboard between existing bridge and Huia Road.
	Map	 Note: Flooding indicated over road corridor in map is representing water flowing under bridge

Area 03	Issues	Flooding over Munro road even in the 50%AEP event. Access to Pōkeno Road restricted. Flood hazard category as outlined by Australian Emergency Management Institute is Level H3, deeming it unsafe for all vehicles., children and the elderly
	Flooding Mechanism	Undersized culvert and low section in road
	Map	

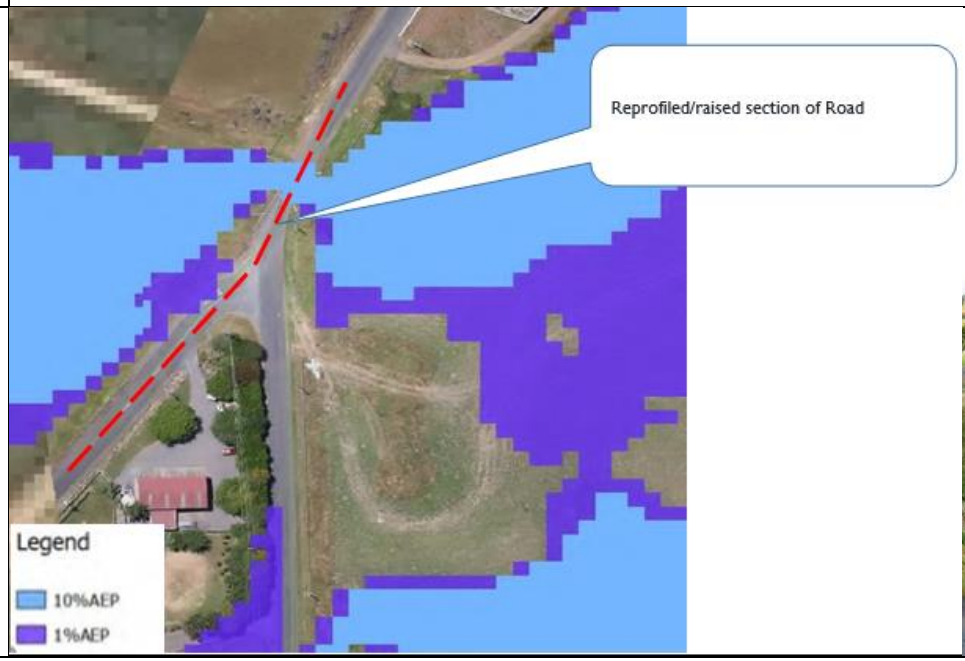
Area 04	Issues	Flooded Pōkeno Road. Main access to western section of Pōkeno and potentially new development areas Flood hazard category as outlined by Australian Emergency Management Institute is Level H5 for at least 50m section of the road, deeming it unsafe for all vehicles and people
	Flooding Mechanism	Pōkeno Road Bridge has insufficient capacity for upstream flow, resulting in overtopping.
	Map	

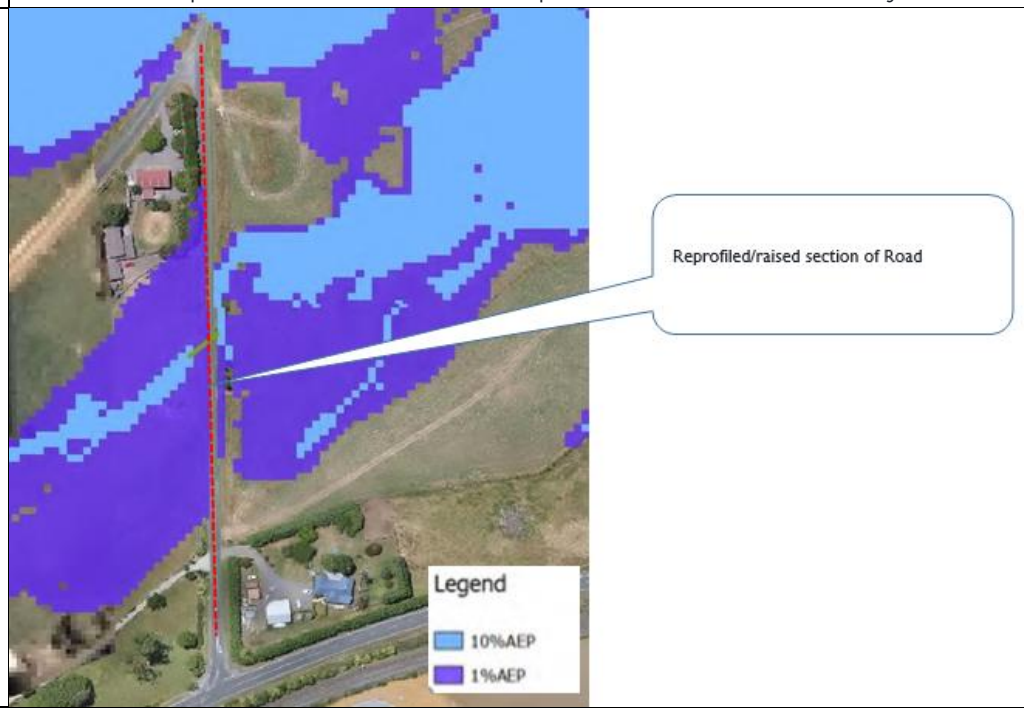
Area 05	Issues	Pōkeno Town Flooding – over 30 dwellings affected in a 1%+CC AEP event (floor levels not confirmed). Flood hazard category as outlined by Australian Emergency Management Institute is Level H1. which are relatively benign flows with no vulnerability
	Flooding Mechanism	Railway bridge capacity exceeded in a greater that 1% AEP event. Excess floodwater flows via overland flow paths through town.
	Map	

Area 06	Issues	Access to Synlait and HYNDS factory flooded. Properties around attenuation ponds flooded. Flood hazard category as outlined by Australian Emergency ManaInstitute is Level H1. which are relatively benign flows over the roads with no vulnerability
	Flooding Mechanism	Existing ponds do not have sufficient capacity for future development. Insufficient MacDonald's road culvert and HYNDS network capacity. The combine results in flooding of properties and over the road.
	Map	

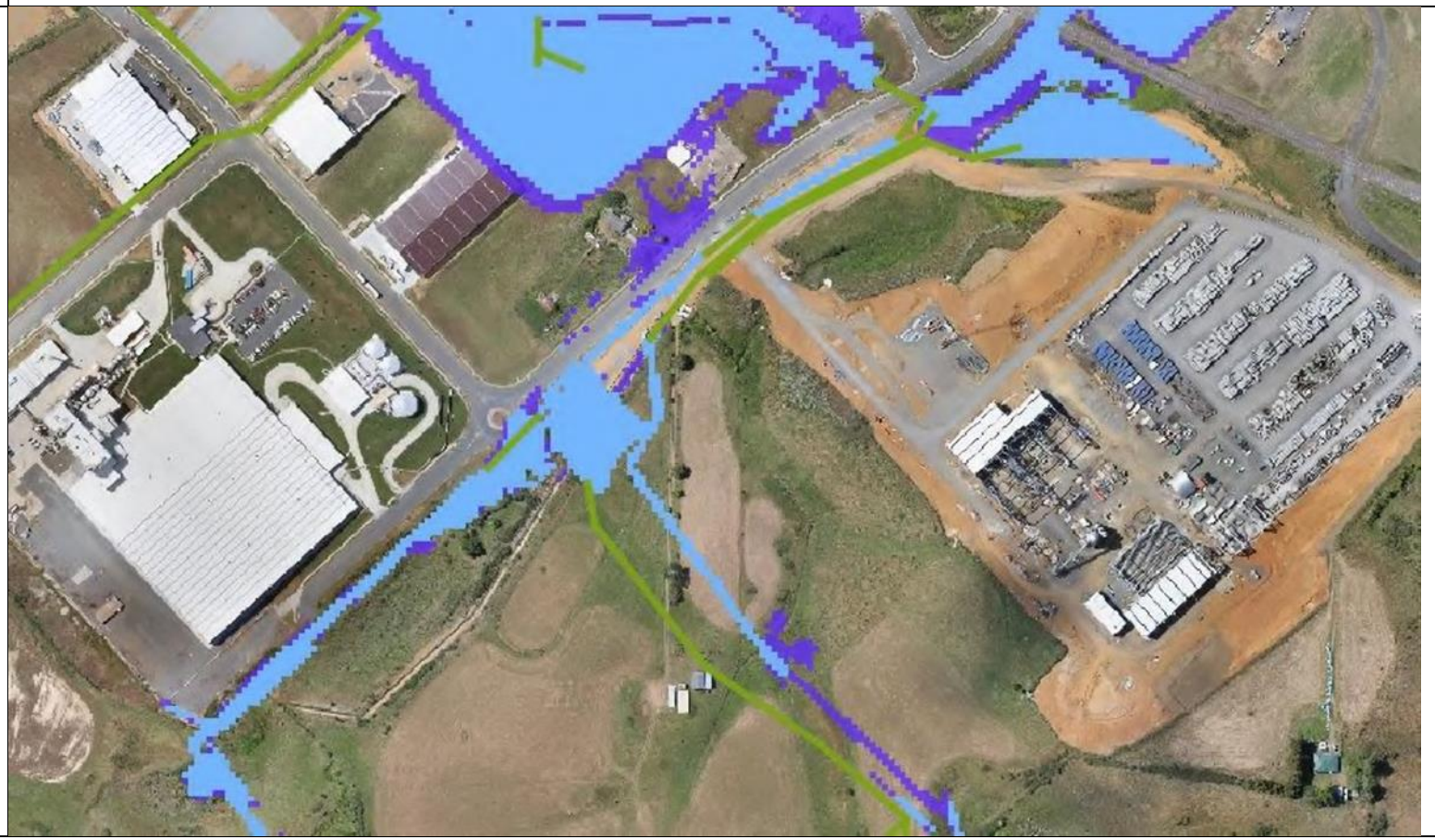
Area 07	Issues	Flooding of SH1 off ramp into Pōkeno Township. Flooding of railway line and some properties in 1% and 1%+CC AEP events. Flood hazard category as outlined by Australian Emergency Management Institute in Level H5, deeming it unsafe for all people and vehicles.
	Flooding Mechanism	Insufficient capacity bridge on Great South Road. Low section on SH1 off-ramp road
	Map	
Area 08	Issues	Flooding of Ford Street and properties on Lot IDP 207324, Lot 2DP 207324 and Lot 10 DP 41875. Flood hazard category as outlined by Australian Emergency Management Institute is Level H3 for Ford Road, deeming it unsafe for all vehicles, children and the elderly. The upstream areas are categorised H4 which is unsafe for all vehicles and people.
	Flooding Mechanism	Undersized culvert Ford street culvert and water ponding behind Ford street and Great South Road

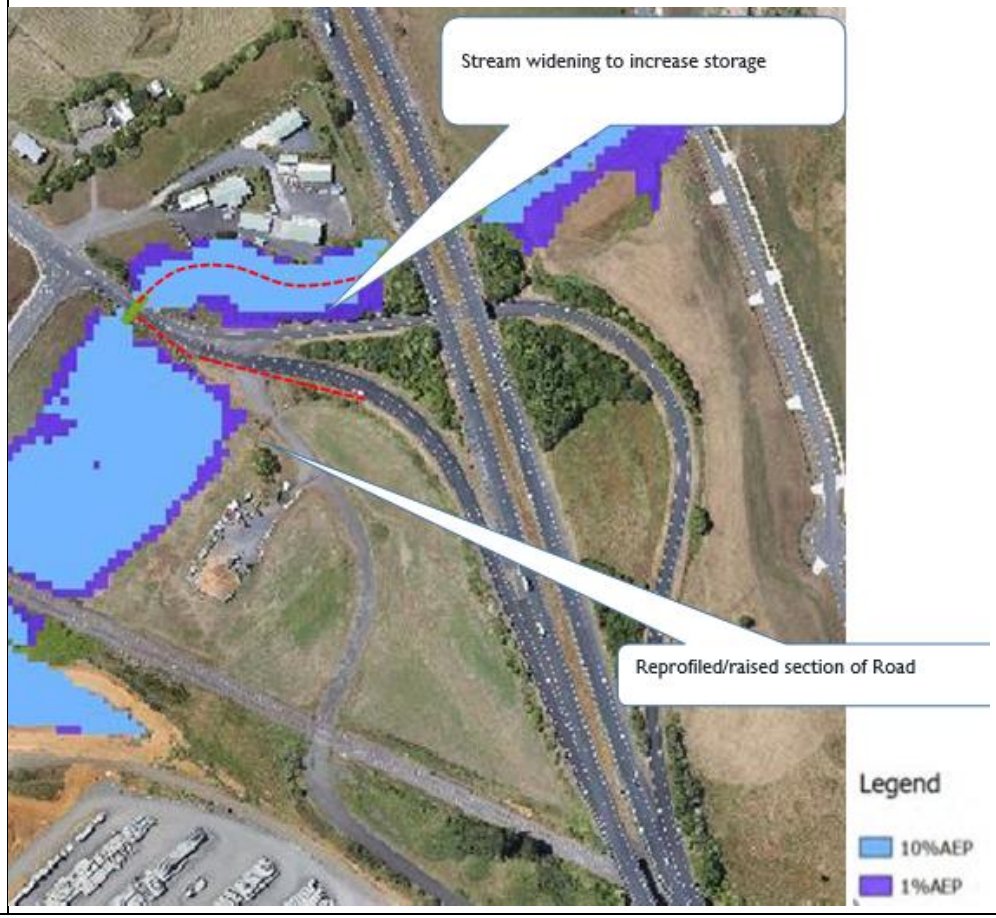
Appendix B
Flood Intervention Areas

Area 02	Measures tested	• Raising of Huia road to 29m and maintain obvert of bridge to 28.538. Estimated Cost: $1.4 million.
	Opportunities	• Reprofile/ Upgrade Huia road which improves the level of service to road users. • Upgrade Munro Road Bridge to dual lane to improve conveyance. • Incorporate storage into road improvement by storing of flood waters behind Huia Road to enable flood attenuation benefits.
	Constraints	• Potential for creation of dam by raising road. Will need to be assessed against Dam Regulations as part of design process. • Temporary impact on access to private property. • Potential erosion sediment control and temporary stream bypass.
	Map	 

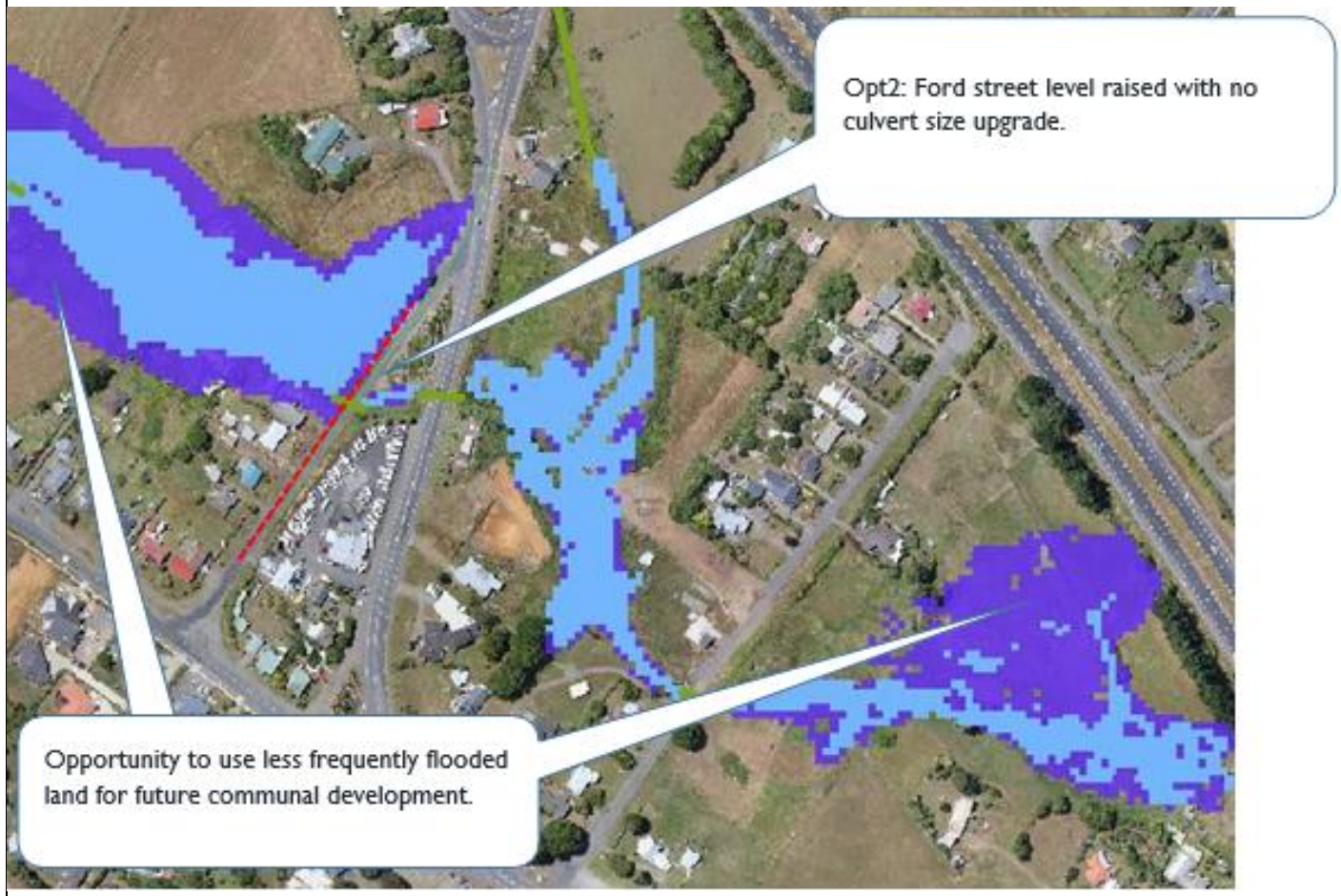
Area 03	Measures tested	Raising of Munro Road to about 28 RL and upgrade existing 2m culvert to triple 2m box culverts. A bridge could also be considered at this location during the design process. Estimated cost $2.1 million.
	Opportunities	• Reprofile/ Upgrade Munro Road which improves the level of service to road users. • Incorporate storage into road improvement by storing of flood waters behind Munro Road to enable flood attenuation benefits. • Integrate fish passage in new culvert.
	Constraints	• Proposed option non-compliant to NZTA standards. Culvert flow area greater than 0.34m2 and thus treated as a bridge. Currently surcharging in the 1%AEP event. with 0.74m freeboard to road surface. • To comply with the guideline the culverts may need to be upgraded to bridge configuration with approx. minimum bridge obvert of about 27.86RL. This upgrade would effectively reduce the storage benefit and • council would have to decide if the cost to upgrade to a bridge outweighs the storage benefit just upgrading the culverts. • Temporary impact on access to private property. • Open cut construction: disruption of Munro Road – likely to be down to one lane (stop go).
	Map	

Area 04	Measures tested	Upgrade Pōkeno Road bridge. Significant bridge widening from 14m width to 36m. Estimated cost $4.9 million.
	Opportunities	• Reprofile/ Upgrade Pōkeno road which improves the level of service to road users. • Potential for improved fish passage. • Environmental restoration: Incorporate erosion protection measures; removal of weed species, creation of habitat, planting and water quality measures.
	Constraints	• Modelled option non-compliant to NZTA standards only 0.2m freeboard to bridge obvert (0.6m required), however this is based on a 1% AEP event rather than 2% AEP event. • Excavation would be required in the watercourse adding diversion, erosion and consenting complexity. • Ensure a minimum freeboard to day care facilities and other developments. Current freeboard of 400mm is increased to 500mm. • Road closure likely during construction – alternative route available via Munro Road and Helenslee Road. • Soil beneath the road likely to be fill of unknown content/quality. • Potential erosion sediment control and temporary stream bypass during construction.
	Map	

Area 06	Measures tested	Create enhanced watercourses that act as overland flow paths in Industrial area to convey excess flows from higher events and avoid flooding Macdonald Road and industrial area properties.
	Opportunities	Enhanced water courses provide amenity and ecological benefits and reduced flooding on MacDonald Road.
	Constraints	Pipe drainage system has already been constructed past the HYNDS site, representing a lost opportunity for LID. The enhanced water course will need to interface with the existing HYNDs drainage design and be incorporated into the Synlait layout.
	Map	

Area 07	Measures tested	Upgrading Great South Road bridge and raising of low section leading to the bridge to avoid flows bypassing bridge. Estimated cost $2.7 million. Stream widening for storage capacity to offset minimal flooding on Great south road due to increased flow from bridge widening.
	Opportunities	• Reprofile/ Upgrade Great South Road which is key access route into Pōkeno township from the State Highway 1. • Stream enhancements as part of capacity improvements.
	Constraints	• Alternate route into Pōkeno Township to be considered during construction. • Require collaborative working with NZTA. • Consent for working in the watercourse. • The current freeboard to the bridge obvert is 0.19 m as compared to the 0.6m required by the guideline. The road level could be raiseda further 0.5m at least and the bridge obvert to approx. 19RL to comply to NZTA guidelines.
	Maps	

Area 08	Measures tested	Opt 1: Upgrade Ford street and Great South road culverts with to twin 1.6m circular culverts. **Opt 2**: Raise Ford street in lieu of upgrading culvert size (replace culvert like for like due to its current poor condition)- **Recommended. EstimatedCost $1.7 million.**
	Opportunities	• Incorporate storage creation into road improvement. By raising Ford Street this enables land between Ford Street and Hillpark Drive tobe used for storage. This will free up land downstream of Market Street culvert and close to the centre of town for development. • Flood section between the two streets may be used for future parking etc. • Replace ford street culvert which is not in good condition.
	Constraints	• Properties previously identified to be at risk of flooding are still flooded i.e. (Lot 1DP 207324, Lot 2DP 207324-) It is assumed that theseLot 10 DP 41875 • Increased flood extent limited to 3 identified properties and depth up to approx. 600mm in land immediately upstream of Ford Street.
	Maps	


Opt2: Ford street level raised with no culvert size upgrade.
Opportunity to use less frequently flooded land for future communal development.

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