Paerata-Pukekohe Future Urban Zone Structure Plan

Stormwater Management Plan

Preliminary Report - Catchment Characteristics and Constraints

Paerata-Pukekohe Structure Plan Future Urban Zone

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Preliminary Report - Catchment Characteristics and Constraints

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Date: 9 August 2017
Reference: 3-awc16.00
Status: Draft 2

Contents

1 Stormwater Concept Plan

Water is an important resource for all Aucklanders and the Auckland Unitary Plan Operative in Part (AUP OiP) is significant in managing the interaction and impacts between water and land activities. The policies, objectives and rules in the AUP OiP reflect the National Policy Statement for Freshwater Management (NPSFM) objectives. A range of policies and rules support these region wide objectives and address specific aspects of water and stormwater management. **The overall approach is to integrate stormwater into the environment** and this approach draws heavily on Water Sensitive Design.

The Auckland Plan vision is to become '*the world's most liveable city*'. The appropriate management of stormwater and freshwater is integral to the Auckland Plan vision to become '*the world's most liveable city*'. The Auckland Unitary Plan seeks to improve the integrated management of water and land use and in doing so promotes the use of Water Sensitive Design. The concept "Water Sensitivity" is a shift in the focus of stormwater management from removing or disposing of stormwater as fast as possible via built infrastructure, to recognising the value of stormwater, its close interrelationship with natural freshwater systems, and how it can enhance the liveability of our cities and communities.

There is greater opportunity in greenfield development to integrate and manage stormwater as part of the environment as a whole. Notably, designing the site as a whole, considering the placement of infrastructure, maintaining predevelopment hydrology, minimise the generation and discharge of contaminants, and using natural hydrological features as part of stormwater management.

The Paerata Pukekohe Structure Plan area covers approximately 1200 hectares around Pukekohe zoned for Future Urban in the Auckland Unitary Plan (Operative in Part). The Future Urban Zone sits across three stormwater catchments in south Auckland – the Whangapouri Creek Catchment, Pukekohe South-Tuatenui Catchment and the Oira Catchment. There are a number of existing stormwater constraints to development across the Future Urban Zone, however many of these can **not only be mitigated, but improved upon, by delivering 'water sensitive' development that is fully integrated with the other urban design guidelines of the Auckland Design Manual**.

This preliminary Stormwater Management Plan (SMP) provides guidance on how water sensitive design can be applied to development. The Future Urban Zone has been divided into a number of development subcatchments based on catchment boundaries, natural flowpaths, future urban zone boundaries and discharge locations. As further detail on the Structure Plan emerges, corresponding refinement and detail will be added to the SMP on how stormwater should be managed across these development subcatchments. This is expected to include:

- Application of **hydrological mitigation** will be a requirement of the Paerata Pukekohe Structure Plan in order to maintain, and enhance, the value of the stream corridors within and downstream of the Future Urban Zone. Hydrological mitigation can be achieved through a variety of measures, such as rain water storage tanks, rain gardens, and infiltration trenches.

- Parts of the area are underlain by volcanic soil. Although there are expected to be a range of infiltration capacities, **stormwater disposal via soakage and infiltration** is an opportunity to minimise the impact on stream baseflow and aquifers, however this is subject to further investigation. Maintaining the discharge of clean base flows into the aquifer is important for its long-term sustainability.

- The generally poor ecology, erosion and water quality across the three catchments due to heavy modification through farming means development represents an opportunity to improve the stream corridors. Development should provide a **10m riparian margin either side of intermittent streams and a 20m riparian margin either side of permanent streams to protect and enhance watercourses**.

- Further, priority should be given to **retaining and enhancing permanent and intermittent streams for primary and secondary stormwater conveyance**.

- There is a high value and sensitive downstream receiving environment in the Manukau Harbour. Providing **stormwater treatment to all roads** in the Future Urban Zone will assist in protecting, and enhancing, the downstream receiving environment.

- Construction represents the period when the most significant impact of the downstream receiving environment can occur, due to erosion and sedimentation from disturbed land. Provision of exemplar erosion and sediment control measures during construction will further mitigate downstream impacts.

There are significant areas of floodplain within Future Urban Zone in both the Whangapouri and Pukekohe South-Tuatenui catchments. **Sustainable and resilient development should avoid the floodplain, flood prone areas and manage overland flowpaths** in accordance with the Unitary Plan (OiP), however there is the opportunity to reduce floodplain extents in the Future Urban Zone through engineered interventions. There is potentially significant cost associated with delivering these engineered interventions to the floodplain, which will be subject to economic feasibility and funding agreement before being taken forward. It will also be necessary to provide flood attenuation in parts of the Future Urban Zone upstream of Pukekohe and Buckland to avoid increasing flood risk to the existing community.

2 Introduction

2.1 Integrated Stormwater Management – the Auckland Context

Water is an important resource for all Aucklanders and the Auckland Unitary Plan Operative in Part (AUP OiP) is significant in managing the interaction and impacts between water and land activities. The policies, objectives and rules in the AUP OiP reflect the National Policy Statement for Freshwater Management (NPSFM) objectives. Key objectives in B7.3 and B7.4 of the AUPOP for freshwater systems are summarised as:

- Safeguard the life-supporting capacity, ecosystem processes and indigenous species of freshwater and coastal environments.
- Improve the integrated management of fresh water and the use and development of land, including interactions between fresh water, land and coastal systems.
- Maintain the quality of freshwater and coastal water where it is excellent or good and progressively improved over time where it is degraded.
- Minimise, or if existing, progressively reduce, the adverse effects of point and non-point discharges, in particular stormwater runoff and wastewater discharges, on coastal waters, freshwater and geothermal water.
- The adverse effects from changes in or intensification of land use on coastal water and freshwater quality are avoided, remedied or mitigated.
- Mana Whenua values, mātauranga and tikanga associated with coastal water, freshwater and geothermal water are recognised and provided for, including their traditional and cultural uses and values.

A range of policies and rules support these region wide objectives and address specific aspects of water and stormwater management. The overall approach is to integrate stormwater into the environment and this approach draws heavily on Water Sensitive Design.

The Auckland Plan vision is to become '*the world's most liveable city*' and sets Auckland's direction for the next 30 years. The appropriate management of stormwater and freshwater is integral to a liveable city. The issues Auckland faces in stormwater can be grouped into three core categories which reflect the management of stormwater as an integral aspect of a liveable city:

1. **Safe Communities** – Risk to our communities including people, property and infrastructure is managed and reduced.
2. **Supporting Growth** – Growth through water sensitive development and provision of quality stormwater infrastructure is enabled.
3. **Healthy and Connected Waterways** – Stream, groundwater and coastal water values are maintained and enhanced and communities are connected with them.

To be a liveable city and address these issues Auckland needs to achieve a Water Sensitive Community.

2.2 Water Sensitive Design

The concept "Water Sensitivity" is a shift in the focus of stormwater management from removing or disposing of stormwater as fast as possible via built infrastructure, to recognising the value of stormwater, its close interrelationship with natural freshwater systems, and how it can enhance the liveability of our cities and communities. More guidance on this approach can be found in E1 of the AUP OiP and Water Sensitive Design – Guidance Document 04 (Auckland Council, 2015-1).

A water sensitive community will (Auckland Council, 2015-1):

1. Value our natural heritage
2. Sustainably manage natural resources
3. Treasure our coastline, harbours, islands and marine areas
4. Realise quality, compact urban environments
5. Demand good design in all development
6. Optimise, integrate and align network provision and planning
7. Protect, enable, align, integrate and provide social and community infrastructure for present and future generations.

The move to a water sensitive community is a significant change in approach and will take time. Built stormwater infrastructure has always been a primary component of stormwater management. Its on-going efficient and effective operation and renewal is fundamental to sustainable solutions, however built and natural assets need to be managed in an integrated way.

2.3 Development Context

There is greater opportunity in greenfield development to integrate and manage stormwater as part of the environment as a whole. Policies in E1.3.8 and E1.3.10 give guidance on how this is achieved, particularly:

- Designing the site as a whole, considering the placement of infrastructure including roads and reserves and the nature and sensitivity of the receiving environment.
- Maintaining predevelopment hydrology as much as possible to support stream health and groundwater recharge.
- Minimise the generation and discharge of contaminants and treat at source as much as possible.

- Providing for the management of gross pollutants, like litter, if they are likely to be an issue.

- Use natural hydrological features as part of stormwater management.

The Paerata Pukekohe Structure Plan area covers approximately 1200 hectares around Pukekohe zoned for Future Urban in the Auckland Unitary Plan (Operative in Part) (Figure 2.1). The Pukekohe Area Plan (Auckland Council ,2014) identifies growth in the Future Urban Zone as a key outcome. The Area Plan also identifies a series of environmental, heritage, open space and character outcomes that provide context to developing a Stormwater Management Plan for the Future Urban Zone, notably:

- ***Outcome 3.2: Maintain and improve Pukekohe's environmental quality and special ecological areas. Including a focus on the Tuatenui and Whangapouri streams.***

  and

- ***Outcome 3.5: A connected network of high quality open spaces and recreation areas within Pukekohe's new growth areas that connects to and builds upon Pukekohe's existing open space network.***

2.4 Purpose of this Stormwater Management Plan

The Paerata-Pukekohe Structure Plan area sits across three stormwater catchments in south Auckland – The Whangapouri Creek Catchment, Pukekohe South-Tuatenui Catchment and the Oira Catchment (Figure 3.2).

The purpose of this stormwater management plan is to:

- Identify water sensitive design measures to demonstrate how stormwater management in the Auckland Unitary Plan (Operative in Part) can be met.
- Promote water sensitive design principles during development for the creation of water sensitive communities.
- Support the Structure Planning process by providing a robust analysis of stormwater issues and management measures across the three catchments, based on current, best available information.
- Inform development of stormwater management obligations (i.e. minimum requirements).
- Inform the community of how stormwater management will be changing in the future.

This preliminary report provides an initial high level review of water sensitive design and stormwater management requirements. As the Structure Plan emerges, this will be refined and further detail added, as appropriate.

2.5 Scope of this Stormwater Management Plan

This Stormwater Management captures the current knowledge, thinking and best practice at this time. As improved understanding emerges, and the community, Iwi and other key stakeholders are consulted, it is expected the Stormwater Management Plan will be updated to reflect this.

The scope of this preliminary document covers:

1. An appraisal of the current understanding of stormwater issues in the catchment, including opportunities and constraints to delivering stormwater solutions (Section 3);
2. An assessment of potential solutions to address existing flooding issues (Section 4);
3. Stormwater management requirements for development (Section 5);

As the details of the Structure Plan emerge, including through public consultation, this Stormwater Management Plan will be updated, added to and refined to provide additional information on stormwater management requirements.

3 Stormwater Characteristic and Constraints

Stormwater characteristics and constraints are described through this section, supported by mapping. Key stormwater management messages to inform the Structure Plan are **highlighted** through this section, and summarised in Section 1. Appendix A includes mapping at a finer scale for reference.

3.1 Land Use

The Paerata-Pukekohe Future Urban area surrounds the existing Pukekohe urban area. The *Paerata-Pukekohe Future Urban Zone Landscape and Visual Assessment* (Opus, 2017) identifies:

> *Immediately surrounded the study area and Pukekohe urban area are a mix of rural land uses comprising dairy farming, short term cropping and lifestyle blocks including equine activities. The land use has transformed over recent years from large beef and sheep and dairy farms to include finer scaled lifestyle blocks and increasingly, further subdivision to pockets of residential living.*
>
> *Within the study area, the land use is comprised of a mix of horticultural and agricultural uses which take advantage of the good, mainly volcanic soils, and climate.*

Based on Auckland Council's land use cover GIS dataset, existing land cover is predominantly pasture as described in Table 3.1. Figure 3.1 shows the overall permeable and impermeable land cover across the local area.

Table 3-1: Future Urban Zone Existing Land Use

Land Use	Area (ha)
High Producing Exotic Grassland	1115
Built-up Area	7.7
Indigenous Forest	22.5
Lake and Pond	0.5
Other Exotic Forest	0.4
Pine Forest - Closed Canopy	9.1
Short-rotation Cropland	103.5
Urban Parkland/ Open Space	3.4
TOTAL	**1262**

Source: Auckland Council Geospatial, 2017

N

WHANGAMAIRE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOUR CREEK

STREAM

MAUKU STREAM

Legend

- Contaminated Sites (Auckland Council owned)
- Existing Impervious Surfaces
- Pervious Surface
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

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Paerata and Pukehohe Future Urban Zone Stormwater Management Plan

Figure 3.1 Land Use

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3.2 Topography and (sub)catchments

The topography of the Future Urban Zone is shown on Figure 3.2. The topography is divided into the Whangapouri Creek catchment, Tuatenui catchment and Oira catchment.

The Landscape and Visual Assessment (Opus, 2015) identifies:

> *The landform of the study area and surrounds is diverse in character and comprises a mix of steep hills and valleys, rolling mid-slopes and undulating to flat lowlands.*
>
> *Pukekohe Hill to the south forms the most prominent and recognisable landform feature in the Pukekohe area. The top of the hill is 222 m above sea level.*
>
> *To the eastern side of the railway line, the landform comprises very steep to steep gully terrain that falls in a northern direction following the Oira and Whanagapouri Creek systems. The landform is dissected by volcanic tuff ridges and basins which are concentrated around the upper reaches of the Whanagapouri Creek and further north to the eastern side of Paerata.*
>
> *On the western side of Pukekohe urban centre, the landform is comprised of flat to rolling terrain between Pukekoke Hill and the southern side of Helvetia. The Helvetia tuff is the most distinctive landform feature in this area.*
>
> *To the north of Helvetia and west of Paerata, the landform is dominated by the Whangapouri Creek system. The western edge of the northern Paerata FUZ area is defined by a steep escarpment dropping to a broad gully floor and creates a distinctive boundary between the FUZ and the rural landscape beyond. Part of the ridge on the eastern side of the gully rises to a highly visible knoll.*

3.3 Geology and Soils

Auckland Council's soils map for the area is shown on Figure 3.3. The Future Urban Zone is primarily underlain by Pukekohe Volcanic Soils, primarily made up of pumice deposits and alluvium (tuff), however some of which includes basalt.

TR040: Stormwater Disposal via Soakage in the Auckland Region (Auckland Council, 2013), identifies the basalt areas around Pukekohe as "possible" locations for stormwater disposal via soakage. The uncertainty arises from the high variability in quality of borehole logs available.

Table 3.2 summarises the outcome of this regional dataset.

Table 3-2: Stormwater Disposal via Soakage in the Future Urban Zone

Future Urban Zone	Sub area	Soakage Potential
East of Pukekohe	Overall	Low.
	Headwater of the Oira catchment	Possible good.
South of Pukekohe	West of Buckland	Possible (inferred soakage)

Future Urban Zone	Sub area	Soakage Potential
	East of the Buckland	Low
West of Pukekohe		Possible good soakage covering part of the area
North of Pukekohe and Paerata		Generally low. Some possible medium soakage in pockets east of the railway.

In addition to infiltration capacity, soakage locations will need to consider land stability and sensitivity of the underlying aquifer (refer Section 3.7.3). Further information on the geology and soils of the Future Urban Zone can be found in the geotechnical report supporting the Structure Plan.

Data on soil soakage and infiltration in the Future Urban Zone will be important in informing stormwater management in the Future Urban Zone.

N

WHANGAMAIRE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

MAUKU STREAM

Legend

- Subcatchment Discharge Locations
- Intermittent/Permanent Streams
- Intermittent Streams
- Permanent Streams
- 20m Contours
- Future Urban Subcatchments
- Existing Urban Zone
- Stormwater Catchments

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

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Figure 3.2 Topography and (sub)catchments

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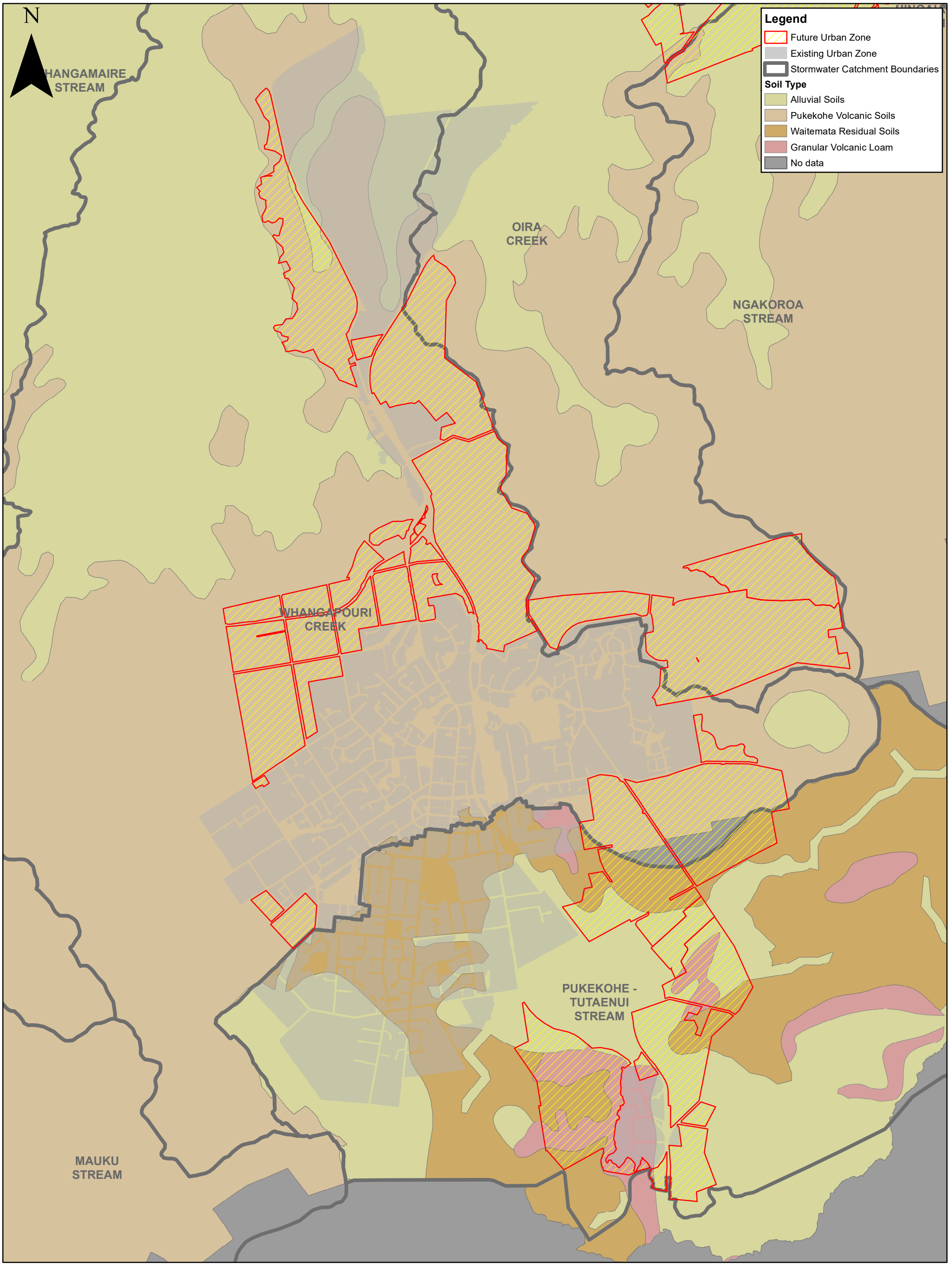

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Figure 3.3: Geology and Soils

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3.4 Existing Hydrological and Stormwater Network

The Future Urban Zone sits across three catchments:

1. Whangapouri Creek catchment, discharging into the Pahurehure Inlet of the Manukau Harbour;
2. Oira catchment, also discharging into the Pahurehure Inlet of the Manukau Harbour; and
3. Pukekohe-Tuatenui catchment, discharging into the Waikato River.

Key catchment features and stream classification is shown on Figure 3.4.

3.4.1 Whangapouri Creek Catchment

Key features of the Whangapouri Creek catchment are:

- Two tributaries to the east and west of Pukekohe, joining in the centre of the town. The eastern tributary begins in the Pukekohe East Explosion Crater. The western tributary at Pukekohe Hill.
- 53km^2, one of the larger in the Auckland Region, with a rural upper catchment (but which is proposed for growth), urban middle (Pukekohe) and rural downstream.
- A waterfall on the main stream at Paerata that acts as a hydraulic boundary between the upper and lower catchment.
- Heavily modified watercourses – both within Pukekohe, but also modified in rural areas – with little riparian cover, suffering from erosion (refer Section 3.5.2) and low water quality (3.5.3).
- A number of bridges and culverts along the stream that influence flooding, as well as the railway corridor embankment blocking overland flow (refer Section 3.6).

3.4.2 Pukekohe Tuatenui Catchment

Key features of the Pukekohe Tuatenui catchment are:

- 27km^2, beginning at Pukekohe Hill in the west and a large urban area in the upper catchment (Pukekohe), eventually discharging into the Waikato River.
- Generally steep, incised channels for much of the catchment that have been modified, with little riparian cover and suffering from erosion (assumed, subject to completion of Watercourse Assessment).
- The railway corridor embankment blocking overland flow, resulting in an increased flood extent in the flatter downstream area (refer Section 3.6).

3.4.3 Oira Catchment

Key features of the Oira catchment are:

- 20km^2, predominantly rural, however with some development and public stormwater network along the southern boundary. Future urban zones are identified at the head waters (the Paerata Pukekohe Future Urban Zone) and at the downstream end.

- There are Significant Ecological Areas (SEAs) designated within the Future Urban Zone.
- Generally steep, incised channels for much of the catchment that have been modified, with little riparian cover and suffering from erosion (refer Section 3.5.2) and low water quality (Section 3.5.3).
- The railway corridor embankment blocking overland flow, resulting in an increased flood extent in the flatter downstream area (refer Section 3.6).

N

WHANGAMAIRE STREAM

NGAKORAU STREAM

KIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE TUTAENUI STREAM

MAUKU STREAM

Legend

- Culverts/Bridges
- Ponds
- Stormwater Network
- Intermittent/Permanent Streams
- Intermittent Streams
- Permanent Streams
- Railway
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

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Figure 3.4: Existing Hydrological and Stormwater Network

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3.5 Ecology, Erosion and Water Quality

There are a number of streams within and downstream of the Future Urban Zone area. These are critical assets for both the transportation and storage of stormwater, as well as providing ecological, cultural (the mauri of water) and amenity value within the catchments. Increased stormwater runoff generated by development can adversely affect streams through impacting ecology, contamination of water and soils and erosion.

The National Policy Statement for Freshwater Management, the New Zealand Coastal Policy Statement and the Auckland Unitary Plan emphasise the importance of managing and improving the condition of Auckland's streams. Auckland Council's three strategic objectives for the management of freshwater (E1.2 of the Auckland Unitary Plan (Operative in Part) are:

- Freshwater and sediment quality is maintained where it is excellent or good and progressively improved over time in degraded areas.
- The mauri of freshwater is maintained or progressively improved over time enable traditional and cultural use of this resource by mana whenua.
- Stormwater and wastewater networks are managed to protect public health and safety and to prevent or minimise adverse effects of contaminants on freshwater and coastal water quality.

These objectives recognise that stormwater is an integral part of the hydrological cycle and that the quality of stormwater impacts on the mauri of water in the receiving environments.

Draft Watercourse Assessments have been completed for the Whangapouri Creek (Turner et al, 2015) and Oira catchments (Kane-Sanderson et al, 2017) to assist in the management of streams. These included comprehensive stream surveys, including physical attributes, water quality, habitat/ vegetation, structures, and fish. To date a Watercourse Assessment has not been completed for the Pukekohe-Tuatenui catchment, and this represents a gap in understanding. It is expected similar responses as described in Table 3.3 will also apply to Pukekohe-Tuatenui, however these cannot be mapped until the Watercourse Assessment is complete

3.5.1 Ecology

The Watercourse Assessment for both the Whangapouri Creek and Oira Stream indicate:

- Sparse and fragmented areas of native vegetation due to clearing for farming, however there are small patches of Significant Ecological Area (SEA).
- Instream habitat is relatively limited with very low levels of potential native fish spawning habitat and fish barriers throughout the catchments.
- Fish surveys were dominated by exotic fish.
- Nearly half the Whangapouri Creek stream length has less than 10% overhead vegetation cover (Turner et al, 2015).

3.5.2 Erosion

Erosion hotspots are prevalent in both the Whangapouri and Oira streams. These contribute to sedimentation within the watercourses and receiving environment, and poor quality habitat. A number of existing assets require further erosion protection.

3.5.3 Water Quality

Low water clarity results indicate uncontrolled sediment inputs into the Whangapouri Creek (Turner et al, 2015). No significant point source pollutants or contaminant discharge were recorded during the Watercourse Assessments, however sewage fungus, anoxic conditions (often at stock access locations) and iron oxidising bacteria were measured, often near rusting rubbish.

3.5.4 Watercourse Management

The recommended management responses in the Watercourse Assessments that relate to streams within, or influenced by, the Future Urban Zone are described in Table 3.3 and Figure 3.5. The highest priority for management responses is given to streams within growth/development areas.

Table 3-3: Watercourse Management Responses

Catchment	Watercourse Management Issues	Local Features in Future Urban Zone	Recommended Management Responses
Whangapouri	Heavily modified due to agricultural land use Poor riparian vegetation Sedimentation Loss of instream and riparian habitat	Permanent and intermittent streams Minor in-stream cascades and wetlands Erosion hotspots Engineering assets – culverts, bridges, etc	Incorporate water sensitive design Capture, retain and treat stormwater. Establish native riparian planting for cover, bank stability and protecting receiving environments Community education and engagement. Stabilise localised erosion hotspots Energy dissipation and soil stabilisation at outlet structures Incorporate/retrofit fish passage
Oira	Heavily modified due to agricultural land use Moderate to severe stock damage to streams and potential for ongoing erosion.	Permanent and intermittent streams Erosion hotspots Engineering assets – culverts, bridges, etc	Maintenance/improvement of private and public culverts, outlets and erosion hotspots within the Future Urban Zone. Repair or install fencing around damaged watercourses. Improve fish passage. Create ecological linkages between SEAs.

Catchment	Watercourse Management Issues	Local Features in Future Urban Zone	Recommended Management Responses
	Loss of instream and riparian habitat and significant weed species		Use development to enhance the existing condition of existing watercourses.
Pukekohe-Tuatenui	Watercourse Assessment is to be completed by end of 2017. Issues and outcomes are expected to be similar to the Oira and Whangapouri catchments.		

In addition to Water Sensitive Design, the Unitary Plan uses Stormwater Management Area – Flow (SMAF) areas where stream environmental protection and water conveyance is managed through hydrological mitigation (at source retention and detention) as part of development. None of the Future Urban Zones are classified as SMAF zones in the Auckland Unitary Plan (Operative in Part), however all development in the Structure Plan area must match pre-development hydrology in terms of flows, levels, volumes and frequency of runoff. SMAF 1 may be an appropriate mechanism to achieve this, however, subject to soil characteristics, additional mechanisms may be required that exceed SMAF 1. Additional assessment work will be required to assess this as the Structure Plan progresses.

Based on the outcome of the Watercourse Assessments, application of the hydrological mitigation will be a requirement of the Paerata Pukekohe Structure Plan in order to maintain, and enhance, the value of the stream corridors within and downstream of the Future Urban Zone.

Notably the Whangapouri and Pukekohe-Tuatenui catchments are classified as SMAF Zone 1 in the technical analysis (TR2013/035) that supported SMAF classification in the Proposed Auckland Unitary Plan (Auckland Council, 2013). The Oira catchment was not classified as a SMAF Area, however at the time of writing TR2013/035, the catchment was outside the Rural Urban Boundary, but assessed as meeting SMAF1 criteria. It is therefore appropriate that any development within the Oira catchment also apply the SMAF1 hydrological mitigation.

3.5.5 Stream Corridors

The Auckland Unitary Plan seeks a high level of protection for permanent and intermittent streams in the region. Currently 73% of the Whangapouri Creek and 71% of the Oira Stream has less than a 5m wide riparian margin.

Permanent and intermittent streams have been mapped for the Whangapouri Creek and Oira catchment (Figure 3.5), however have not been mapped for the Pukekohe South-Tuatenui catchment. Permanent/intermittent streams have been indicatively shown for the Pukekohe South-Tuatenui catchment as overland flowpaths with a catchment area greater than 3ha.

Protecting and enhancing permanent and intermittent streams will form a key feature of a water sensitive design approach, as described in Section 5.

Development should provide a 10m riparian margin either side of intermittent streams and a 20m riparian margin either side of permanent streams to protect and enhance watercourses.

N

Legend

- Erosion Hotspots
- Fish Survey
- Significant Ecological Areas
- Railway
- Intermittent Streams
- Permanent Streams
- Intermittent/Permanent Streams
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

NGAKAROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE TUTAENUI STREAM

MAUKU STREAM

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Figure 3.5: Ecology, Erosion and Water Quality

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3.6 Flooding

3.6.1 Floodplain

In Auckland the floodplain is defined as a 1% annual exceedance probability (AEP) event, including allowance for climate change and maximum probable development (MPD).

Development should be located outside of the floodplain and particularly the highest flood risk or flood prone areas -even with the introduction of infrastructure to reduce the extent of the floodplain there will remain a residual risk of infrastructure failure (e.g. culvert blockage) leading to flooding of low-lying properties.

Sustainable and resilient development should avoid the floodplain, in accordance with the Unitary Plan (OiP).

Figure 3.6 shows the floodplain within the Future Urban Zone. Further information on flood risk management is set out in Section 4.

Computational hydraulic modelling has been undertaken to determine the floodplain for each of the three catchments, as described in Table 3.3.

Table 3-4: Floodplain Data and Limitations

Catchment	Hydraulic Modelling Technique	Key Limitations	Outcome
Whangapouri	Detailed model	The floodplain is currently draft and requires processing prior to publication.	Little impact as upstream areas are alternatively mapped as overland flowpaths.
Pukekohe-Tuatenui	Detailed model		
Oira	Rain-on-grid	Assumes all rain that falls on the ground turns into runoff	Precautionary floodplain. Actual floodplain may be smaller. Updated floodplain expected to be available end of 2017.

Note: The floodplain in Auckland is considered to begin when flow reach 2m³/s. Flows less than 2m³/s are usually represented as overland flowpaths.

3.6.1.1 Whangapouri Floodplain

Upstream (South) of Pukekohe

The floodplain in Future Urban areas upstream of Pukekohe is generally limited to incised watercourse channels and the immediately adjacent floodplain. The floodplain as a development constraint will generally overlap with the requirement for protecting permanent and intermittent streams. Hydraulic modelling has demonstrated that growth can exacerbate flooding to properties in Pukekohe.

It will be necessary to provide flood attenuation upstream of Pukekohe to development to avoid increasing flooding to habitable floors.

Downstream (North) of Pukekohe
Large portions of the Future Urban Zone are at significant risk of flooding from the Whangapouri Creek, with large floodplains even in the 50% AEP (1 in 2 Year ARI) storm event. Without mitigation measures to reduce the risk, flooding presents a significant constraint to the extent and location of growth in these areas. The floodplain in the Future Urban Zone is influenced by structures on the watercourse – bridges, culverts, and railway embankments – exacerbating flooding of low lying areas.

The floodplain represents a significant constraint to the area available for development downstream of Pukekohe.

West of Pukekohe
The floodplain is large, however much of it is shallow sheet flow and the extent of flooding can potentially be reduced through controlled overland flow from the existing urban area through the growth area.

3.6.1.2 Pukekohe-Tuatenui Floodplain

The Future Urban Zone in the Pukekohe-Tuatenui catchment will potentially increase runoff into the Tuatenui Stream within the Waikato Region, and on to the Waikato River.

North of Buckland
The floodplain in the Future Urban Zone is influenced by structures on watercourses – bridges, culverts, and the railway embankment – exacerbating flooding of low lying areas.

East of Buckland
The floodplain is generally limited to low-lying areas that overlap with flood prone areas.

North and east of Buckland the floodplain represents a significant constraint to the area available for development.

West of Buckland
The floodplain is generally channelised. The floodplain as a development constraint will generally overlap with the requirement for protecting permanent and intermittent streams. Growth can exacerbate flooding to properties in and around Buckland.

It will be necessary to provide flood attenuation to development west of Buckland to avoid increasing flooding to habitable floors.

3.6.1.3 Oira Floodplain

The floodplain within the Future Urban Zone area is generally based on steep, incised channels with limited floodplain. The floodplain as a development constraint will generally overlap with the requirement for protecting permanent and intermittent streams. There are properties within the

floodplain further downstream, although the floodplain extent may reduce with further detailed modelling.

It will be necessary to provide flood attenuation to development in the Oira catchment to avoid increasing flooding to habitable floors.

3.6.2 Flood Prone Areas

Flood prone areas are topographical depressions that can fill rapidly during a storm event due to a lack of capacity or blockage. They can be natural low points, or man-made (e.g. due to embankments). Auckland Council have mapped flood prone areas using LiDAR data across the region (Figure 3.5). Where land is subject to both the floodplain and flood prone areas, floodplain rules apply.

For land outside the floodplain, but within the flood prone area, resilient development should avoid these areas. Where this is not practicable, design must consider how to manage this risk in accordance with the Building Code.

3.6.3 Overland Flowpaths

An overland flowpath is a low point in the terrain, excluding permanent or intermittent streams, where surface runoff flows. They have a contributing catchment of greater than 4000m^2. Auckland Council have mapped overland flowpaths using LiDAR data across the region (Figure 3.5).

There is little pipe infrastructure within the Future Urban Zone, therefore overland flowpaths currently act as the primary flow route for surface water upstream of intermittent streams.

Overland flowpaths require protection as part of development proposals in accordance with the Unitary Plan (OiP), Stormwater Code of Practice and Building Code.

N

WHANGAMAIRE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

MAUKU STREAM

Legend

- Overland Flowpaths
- Flood Prone Areas
- Floodplain (Draft)
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: Draft floodplain extents are subject to final review and editting prior to publishing.

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Figure 3.6: Flooding

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3.7 Receiving Environment

3.7.1 Manukau Harbour

The Future Urban Zones in the Whangapouri Creek and Oira catchments discharge into the local stream network, then into the Pahurehure Inlet on the Manukau Harbour. The Pahurehure Inlet is a low energy receiving environment (Kane-Sanderson et al, 2017), classified as a significant ecological area. High levels of sediment currently enter into the Manukau Harbour through the Pahurehure Inlet. The impact of sediment on the benthic ecology and water quality has been noted as a concern for Mana Whenua and Local Boards through the Manukau Harbour Forum. Stormwater Management Plans for future developments should include description of how the proposed management will address sediment control during both construction and operation.

More information on the ecological values of the receiving environments (e.g. inanga spawning habitat) can be found in the respective Watercourse Assessment reports. The local streams as a receiving environment is discussed in Section 3.5.

The status applied to the receiving environment emphasises the importance of how stormwater runoff from development areas is managed, including the potential for development to improve on the quality of existing discharge.

All roads in the Future Urban Zone are to include stormwater treatment to protect, and enhance, the downstream receiving environment.

Construction of development represents the period when the most significant impact of the downstream receiving environment can occur, due to erosion and sedimentation from disturbed land.

Auckland Council will seek exemplar erosion and sediment control measures, exceeding the minimum requirements in *GD05 Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*.

Further guidance will be provided as the SMP is developed.

3.7.2 Waikato River

Auckland Council hold a 2007 Stormwater Network Discharge Consent (Consent No 17624) that covers stormwater discharge from the Future Urban Zone in the Pukekohe South Tuatenui Catchment.

In the absence of a catchment wide stormwater management system, the consent requires development to:

- Treat stormwater discharge in accordance with TP10;
- Treat stormwater discharge from new industrial or trade processes;
- Minimise changes to the pre-development hydrological regime (i.e. attenuating stormwater flows)
- Consider low impact design (i.e. water sensitive design).

Stormwater management in the Auckland Region has progressed significantly since the granting of this consent. Complying with the above requirements can deliver much of the intent of the Unitary Plan, however it may be appropriate to consider revising these requirements in consultation with Environment Waikato.

3.7.3 Aquifer

The Whangapouri and Oira catchments sit on top of the Pukekohe Kaawa Aquifer, including most of the Future Urban Zone. The aquifer is classified as a High-Use Aquifer Management Area and a Quality Sensitive Aquifer in the Unitary Plan (see D1 and D2 in the Auckland Unitary Plan).

High Use Aquifers are sensitive to increasing imperviousness, which could have a negative effect on baseflow. Managing the aquifers to ensure adequate baseflow for the continued health of the aquifer and nearby streams is important.

Quality Sensitive Aquifers in volcanic areas such as Pukekohe are sensitive to contaminants from stormwater discharge and other land uses. The quality of these aquifers are also important for existing users. The Auckland Unitary Plan directs that the quality and quantity of water in Quality Sensitive Aquifers be protected from contamination. For this reason treatment of stormwater prior to discharge to ground is likely to be required in these areas.

Maintaining infiltration of clean surface water into the aquifer is important for its long-term sustainability and quality. This supports the need to infiltrate clean stormwater from the Future Urban Zone.

3.8 Knowledge gaps

The following data and information is required to further inform the production of the stormwater management plan:

1. Landuse and development type/layout (it is expected this will be refined through the Structure Plan process taking into account this preliminary stormwater management plan.
2. Improved soil information to inform the potential for soakage and/or infiltration of stormwater in different parts of the Future Urban Zone.
3. Information on potential contamination that might impact on stormwater management (e.g. soakage).
4. Watercourse Assessment for Pukekohe South Tuatenui catchment to confirm management responses for watercourses in this part of the Future Urban Zone and confirm the location and extent of permanent and intermittent streams.
5. Confirming appropriate stormwater management and flood risk management requirements for discharge into the Tuatenui Stream in the Waikato Region, including the need for peak flow attenuation.
6. Seek further water quality datasets (surface water and groundwater) from Auckland Council to confirm stormwater management approaches across the three catchments.

7. Finalise the Floodplain to inform development of Unitary Plan rules that apply within the Future Urban Zone.

At this stage these gaps do not represent significant risks to the development of the stormwater management plan to inform the Paerata Pukekohe Future Urban Zone Structure Plan.

N

PAHUREHURE INLET

Oira Creek Discharge Location

Whangapouri Creek Discharge Location

ORIA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

Pukekohe-Tutaenui Stream Discharge Location

WAIKATO REGION

Legend

- Discharge Location
- Intermittent Streams
- Permanent Streams
- Intermittent/Permanent Streams
- Railway
- Future Urban Zone
- Existing Urban Zone
- Quality-Sensitive Aquifer Management Area

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

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Figure 3.7: Receiving Environment

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4 Flood Risk Management

Flood risk can be managed through applying the hierarchy in Table 4.1.

Table 4-1: PPS 25 (UK) Flood Risk Management Hierarchy

Step	Approach	Description	Example
1	Avoid	Locate development in areas at least risk of flooding. **This process is enshrined within the Unitary Plan, and should be considered through the structure planning process for development and future urban areas.**	Set aside floodplains free from any development.
2	Substitute	Where development has to be located in the floodplain, located the least vulnerable land uses there.	Prioritise public open space, or similar, within the floodplain.
3	Control	Implement interventions to reduce the impact of flooding. Where the need for vulnerable land uses or critical infrastructure outweighs flooding, engineering interventions could be brought forward to reduce flood extents.	Culvert/bridge upgrades Channel widening Land raising
4	Mitigate	Implement interventions to reduce the residual risk of flooding	Property level flood protection or flood resilience measures.

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

The flood risk management hierarchy will be applied through the structure planning process for the Paerata-Pukekohe Future Urban Zone.

4.1 Controlling the Floodplain

Auckland Council Healthy Waters have undertaken studies to determine the scale and potential cost of interventions that could further **control** the floodplain. The objective was to understand the scale of works required to reduce the constraint the floodplain currently has on development yield in the Whangapouri and Pukekohe South-Tuatenui catchments (Opus, 2017; Tonkin & Taylor, 2017).

As the Future Urban Zone is located both upstream and downstream of Pukekohe, interventions in the Whangapouri catchment have been considered in tandem with interventions to address flooding issues in the existing Pukekohe urban area.

Potential interventions in the Whangapouri Catchment to control the floodplain in the Future Urban zone could include:

1. **SH22 Triple Barrel Culvert/Bridge Upgrade** – The existing triple barrel 2m diameter culvert beneath SH22 is predicted to be a significant constraint. Upgrading the culvert is predicted to result in a drop in water levels in the upstream channel. Replacing the culverts with

a bridge is the preferred option, if it can be taken forward collaboratively with NZTA as part of SH22 upgrade. If it cannot, then upgrading the culverts to triple 3.5m x 3.5m box culverts is an alternative option.

2. **Channel widening** – Channel widening through cut and fill can be used to limit the extent of the floodplain and improve developable area. Combined with the Paerata Road culvert upgrade, 1% AEP water levels are predicted to lower by 1m.

3. **Culvert upgrades/additions beneath the railway** – The land east of the railway is low-lying. Flooding is dominated by the backwater effect from the Whangapouri Creek. Upgrading the SH22 culvert and widening the channel reduce water levels downstream sufficiently for culvert upgrades to be effective in further reducing the floodplain east of the railway. **There is no benefit in upgrading the culverts in isolation.**

4. **Filling of the floodplain east of railway** - Low-lying land can be filled to reduce floodplain and improve developable area, subject to some increased flood level downstream, or other interventions also being brought forward to mitigate increased risk.

Interventions that could reduce the extent of the floodplain in the Future Urban Zone in the Whangapouri catchment are further described in Table 4.2.

Potential interventions in the Pukekohe South-Tuatenui Catchment to control the floodplain in the Future Urban zone could include:

1. **Culvert/Bridge upgrade** – reducing the restriction caused by culverts on the stream downstream of Buckland Road by increasing channel capacity is expected to have the most benefit on upstream flood levels in the Future Urban Zone.

2. **Storage in Pukekohe** – Increasing the attenuation capacity at the existing Cloverlea Recreational Reserve will assist in reducing downstream flood levels in the Future Urban Zone. This would need to be undertaken in combination with downstream channel improvements.

3. **Conveyance to Storage near Future Urban Zone** – effectively relocate some of the floodplain from the Future Urban Zone to designated attenuation areas. This would also require conveyance channels within the Future Urban Zone.

Interventions in the Pukekohe South-Tuatenui catchment as subject to feasibility assessment.

There is potentially significant cost associated with delivering engineered interventions to the floodplain, which will be subject to economic feasibility and funding agreement before being taken forward.

Table 4-2: Whangapouri Catchment Growth Interventions to Control Flooding

Inter-vention	Description	Opportunities	Constraints	Comments
1B	Replace Paerata Road culverts with bridge	• Deculverting a section of river, improving habitat and fish passage. • Construct the bridge as part of highway improvements necessary to accommodate increased growth in the Future Urban area	• Likely full closure of SH22 required. • Very deep excavation required, with sheet pile trench support likely. • There is limited working room upstream and downstream. • Excavation would be required in watercourse adding diversion, erosion and consenting complexity. • Require collaborative working/cost sharing with NZTA. • Soil beneath the road likely to be fill of unknown content/quality • Significant Watercare watermain (900mm PE) crosses culvert. • Safety in Design issues: o Construction and operation of temporary works within the watercourse/floodplain o Potential to improve safe access for operations inspection and maintenance of culvert Very deep excavations close to SH22 during construction	Despite this option showing slightly worse performance to Option 1A, it is recommended as design optimisation is expected to show improved hydraulic performance as well as the opportunities for deculverting. This option should be the preferred option, if it can be taken forward collaboratively with NZTA as part of SH22 upgrade. If it cannot, then Option 1A is the fall back option.
2A	Stream upgrade to contain 100 year flow in stream, from SH22 to 71 Adams Drive.	• Place making - Creation of public open spaces, linking people with water, education, park/walkway/cycleway. • Environmental restoration: Incorporate erosion protection measures; creation of habitat, planting and water quality measures. • Address existing 'poor' stream bank stability rating in this stretch of the watercourse (refer Whangapouri	• Working across multiple private properties requiring land owner approval. • Consent for working in the watercourse. • Future consideration of the need to do channel widening beneath railway bridges (NB: widening at railway bridges and immediately next to SH22 were not modelled). • Removal of existing trees. • Temporary impact on access to private property. • Temporary bridges required to cross the watercourse for construction. • New bridges to cross water course for properties on eastern side (this may be covered as part of development proposals).	This work is obligatory under Environmental Court Consent Order 2010 (CMP 15 & 16). In isolation it has limited flood risk benefit, but in combination with Option 1A/B provides a significant benefit.

Inter-vention	Description	Opportunities	Constraints	Comments
		Catchment Watercourse Assessment, Version 2, May 2015). • Improve riparian overhead cover to the watercourse (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015)	• Potential erosion sediment control and temporary stream bypass. • Currently unknown geotechnical conditions and contamination.	
4A	Upgrade culvert under railway to pass more flow. Upgrade by keeping existing culvert (1.0m dia), and add extra barrel.	• Potential for improved fish passage • Upgrade culverts as part of additional railway track (if it occurs).	• Restricted access to downstream end beneath railway bridges. • Construction via trenchless only (pipe jacking) under live railway – contractor experience critical. • Soil beneath railway likely to be fill of unknown content/quality • Kiwirail approval for construction • Working under dripline of trees upstream end, possible tree removal. • Safety in Design issues: ○ Working in close proximity to live railway line.	This Intervention alone has minimal effects as the level on the main stream is similar to the tributary. Greater effects can be achieved if implemented after creating a head difference through Intervention 1 and/or Intervention 2.
5A	Upgrade channel to contain 100 year flow.	• Place making - Creation of public open spaces, linking people with water, education, park/walkway/cycleway. • Intervention can be delivered entirely as part of development. • Environmental restoration: Incorporate erosion protection measures; creation of habitat, planting and water quality measures, forming part of a stormwater management plan for future growth area.	• Very flat grade for channel – siltation and maintenance. • Require bridging or culverting over stream to access all development area. • Consent for working in the watercourse (to be confirmed).	Potential increased risk to a building.

Inter-vention	Description	Opportunities	Constraints	Comments
5B	Importing fill and land raising in floodplain	Improves development yield within a Future Urban area.	• Does not conform to intent of the Unitary Plan. • Loss of natural floodplain. • Currently unknown geotechnical conditions and contamination. • Potential increase in risk to third parties if not considered in combination with other measures	Potential increased risk to a building.
6A	Non-Return valve at existing culvert.		• NRV may restrict fish passage. • Restricted access to downstream end across stream requiring temporary access track and bridge • Kiwirail approval. • Additional maintenance required – both to check for blockage and ensure NRV is caught open.	Optimisation during the design phase may remove the need for this intervention. Interventions 1A/B, 2 and 6A are generally more resilient flood risk management solutions.
6C	Importing fill and land raising in floodplain	Improves development yield within a Future Urban area.	• Does not conform to intent of the Unitary Plan. • Loss of natural floodplain. • Currently unknown geotechnical conditions and contamination. • Potential increase in risk to third parties if not considered in combination with other measures	

4.2 Mitigating the Effects of Increased Runoff from the Future Urban Zone

The Future Urban Zone upstream of Pukekohe will require flood attenuation to mitigate the increase in flood risk to existing properties downstream. This has been assessed and tested in the Pukekohe North Options Assessment (Opus, 2017). Three wetland storage devices are likely to be needed (Table 4.3 and Figure 4.1). These have been identified conceptually only at this stage, and further design refinement is required as the structure plan is brought forward. Wetland attenuation is likely to also be required in parts of the Pukekohe South-Tuatenui catchment, however this is subject to further assessment.

N

Legend

- Floodplain (Draft)
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

Possible Engineering Interventions

- Culvert/Bridge upgrade
- Storage
- Land Raising
- Channel/Pipe Upgrade

NB: Draft floodplain extents are subject to final review and editting prior to publishing.

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

MAUKU STREAM

Intervention 1: Culvert Upgrade

Intervention 2: Channel Upgrade

Intervention 4A: Culvert Upgrade

Intervention 5A: Channel Upgrade

Intervention 5B: Land Raising

Intervention 6A: Culvert Upgrade

Intervention 6C: Land Raising

Intervention 9: Storage

Intervention 8A: Storage

Intervention 8B: Storage

Issue 3 Option 2A/2B:
Storage + Conveyance Channel and Pipe Upgrade

Issue 4 Option 2:
Storage + Conveyance Channel and Pipe Upgrade

Issue 1 Option 1: Storage

Issue 1 Option 4:
Culvert/Bridge Upgrade and Channel Improvements

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Figure 4.1: Possible Engineering Interventions

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Table 4-3: Flood Risk Management Interventions

Inter-vention	Description	Opportunities	Constraints
8A	Golding Road North Storage - New storage pond in north east growth area.	• Place making - Creation of public open spaces, linking people with water, education, park/walkway/cycleway. • Environmental restoration: Incorporate erosion protection measures; creation of habitat, planting and water quality measures. • Incorporate storage creation into road improvement. • Control peak flows and reduce erosion potential that has led to 'poor' stream bank stability rating downstream of the storage site (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015). • Improve riparian overhead cover to the watercourse (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015).	• Unknown geotechnical conditions. • Potential Council operation and maintenance obligations • Safety in Design issues: ○ Potential breach hazards.
8B	Golding Road South Storage - New storage pond in north east growth area. (CMP 09) Lauer appeal	• Place making - Creation of public open spaces, linking people with water, education, park/walkway/cycleway. • Environmental restoration: Incorporate erosion protection measures; creation of habitat, planting and water quality measures. • Control peak flows and reduce erosion potential that has led to 'poor' stream bank stability rating downstream of the storage site (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015). • Improve riparian overhead cover to the watercourse (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015).	• Unknown geotechnical conditions. • Potential Council operation and maintenance obligations • Safety in Design issues: ○ Potential breach hazards. • Working across multiple private properties requiring land owner approval

9	Pukekohe East Storage – new storage in north east growth area (CMP 07)	• Place making - Creation of public open spaces, linking people with water, education, park/walkway/cycleway.
		• Environmental restoration: Incorporate erosion protection measures; creation of habitat, planting and water quality measures.
		• Intervention can be delivered entirely as part of development.
		• Control peak flows and reduce erosion potential that has led to 'poor' stream bank stability rating downstream of the storage site (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015).
		• Improve riparian overhead cover to the watercourse (refer Whangapouri Catchment Watercourse Assessment, Version 2, May 2015).
			• Historic slips in the area.
			• Unknown geotechnical conditions.
			• Safety in Design issues:
			  ○ Potential breach hazards.
			  ○ Potential Council operation and maintenance obligations regarding certified large dams.
			• Limited storage created for works involved.
			• Working across multiple private properties requiring land owner approval.

5 Water Sensitive Design

5.1 Introduction

Water Sensitive Design is an inter-disciplinary design approach to urban planning and development which provides opportunities for integration of land use and freshwater management and aims to protect and enhance natural freshwater systems, by sustainably managing water sources and mimicking natural processes. (Auckland Council, 2015)

Auckland Council's Water Sensitive Design for Stormwater Guidance Document 2015/004 (GD04) sets out a process for delivering water sensitive design in the Auckland Region.

This SMP provides guidance on how water sensitive design can be applied to development brought forward in the Paerata-Pukekohe Future Urban Zone.

Figure 5-1: Water Sensitive Design and the Water Cycle (source: GD04)

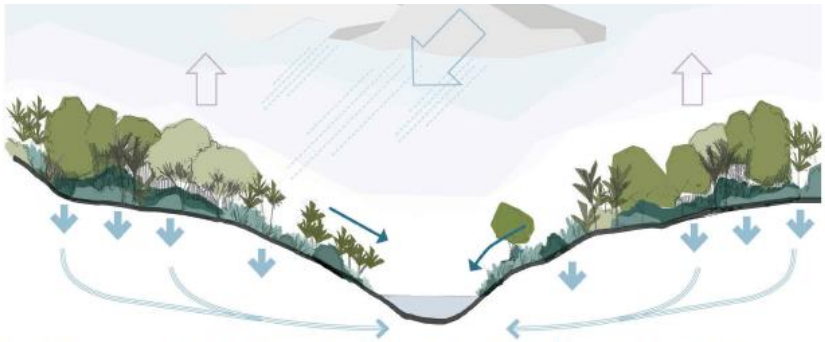

Figure 4: The water cycle interacts with plant and soil systems that capture, infiltrate and transpire rainwater and stormwater runoff.

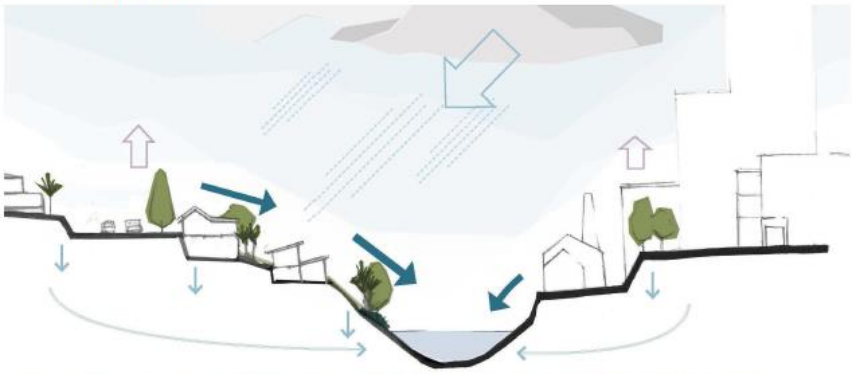

Figure 5: A developed catchment has increased overland and reticulated flows directed rapidly to receiving environments, bypassing natural systems and processes.

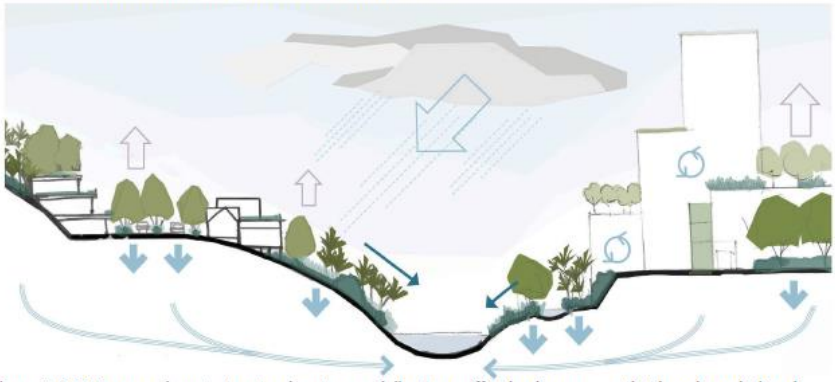

Figure 6: A WSD approach protects natural systems and directs runoff to landscape areas that have been designed to utilise natural processes to treat and retain runoff.

5.2 Applying Water Sensitive Design in the Future Urban Zone

Table 5.1 provides a 'toolbox' of options that can be applied by development to meet minimum stormwater management requirements. For primary and secondary conveyance, priority is given in Table 5.1 to the order in which options should be applied. For example, for secondary stormwater conveyance the preferred option is to retain and enhance permanent and intermittent streams. If there are practical reasons why this cannot be achieved, then swales and open channels can be considered. Finally if swales are not suitable, the road network can then be considered for secondary conveyance.

As the Structure Plan is developed further the appropriateness of particular devices or approaches can be further refined.

Guidance on applying water sensitive design at the development level can be found in the following documents.

1. GD04: Water Sensitive Design for Stormwater, March 2015
2. GD05: Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016.
3. SW CoP: Code of Practice for Land Development and Subdivision, Chapter 4 – Stormwater, November 2015
4. TP10: Technical Publication 10 – Stormwater Management devices design guideline manual, 2003 (Note this is in the process of being superceded by GD01).
5. TR035: Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements, August 2013

5.3 Development Subcatchments

The Future Urban Zone has been divided into development subcatchments (Figure 3.2) based on:

- Catchment boundaries and drainage flowpaths;
- Future Urban Zone and proposed land use; and
- Discharge location and receiving environment.

As the Structure Plan develops, particular interventions or stormwater management approaches outlined in Table 5.1 will be developed for each area based on the needs of development and impact on the downstream receiving environment. If necessary these areas may be further split or merged.

Table 5-1: Water Sensitive Design Toolbox

General			
• Minimise impervious surfaces and land disturbance • Apply exemplar erosion and sediment control measures to minimise the impact on the downstream receiving environment • Disconnection of impervious surfaces prior to discharge to the stormwater system • Maximise infiltration into Pukekohe volcanic soils – directly via pervious surfaces or using infiltration devices • Avoid soil compaction or undertaken cultivation to include organics and restore damage to maximise permeability • Re-vegetation/planting to reduce runoff and erosion and maximise biodiversity • Reduce contaminant sources by avoiding zinc/copper roof material			
Land Use	***Requirements***	***Options***	***Auckland Council Guidance Documents*** ***(refer Section 5.2)***
Residential	Hydrological Mitigation – Retention and Detention	• Above ground rainwater storage tanks • Rain gardens/planter boxes • Underground storage tanks, structural cells • Permeable pavement and porous concrete • Filter trenches/trench drains	TR035 GD04 TP10
	Primary Stormwater Conveyance	1. Soakholes (To be confirmed) 2. Retain and enhance permanent and intermittent streams 3. Swales 4. Pipe network	GD04 SW CoP TP10
	Secondary Stormwater Conveyance	1. Retain and enhance permanent and intermittent streams 2. Swales and open channels 3. Road corridors	GD04 SW CoP
All roads/ carparking and High Contaminant Generating Activities (HCGAs)	Hydrological Mitigation - Retention and Detention	• Rain gardens • Tree pits • Filter trenches/trench drains • Permeable pavement and porous concrete	TR035 GD04 TP10
	Stormwater Treatment	• Rain gardens • Tree pits • Filter strips/swales • Wetlands	TP10

	Primary Stormwater Conveyance	1. Soakholes (To be confirmed) 2. Retain and enhance permanent and intermittent streams 3. Swales 4. Pipe network	GD04 SW CoP TP10
	Secondary Stormwater Conveyance	1. Retain and enhance permanent and intermittent streams 2. Swales and open channels 3. Road corridors	GD04 SW CoP
Business	Hydrological Mitigation - Retention and Detention	• Above ground rainwater storage tanks • Rain gardens/planter boxes • Underground storage tanks, structural cells • Permeable pavement and porous concrete • Filter trenches/trench drains • Detention basins	TR035 GD04 TP10
	Stormwater Treatment (where required by the AUP)	• Rain gardens • Tree pits • Filter strips/swales • Proprietary treatment devices • Wetlands	TP10
	Primary Stormwater Conveyance	1. Soakholes (To be confirmed) 2. Retain and enhance permanent and intermittent streams 3. Swales 4. Pipe network	GD04 SW CoP TP10
	Secondary Stormwater Conveyance	5. Retain and enhance permanent and intermittent streams 6. Swales and open channels 7. Road corridors	GD04 SW CoP
Special Purpose	Hydrological Mitigation - Retention and Detention	To be confirmed	
	Primary Stormwater Conveyance		
	Secondary Stormwater Conveyance		

6 References

1. Auckland Council (2013) -1. TR2013/035 Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements.
2. Auckland Council (2013) -2. TR040: Stormwater Disposal via Soakage in the Auckland Region
3. Auckland Council (2014). Pukekohe Area Plan
4. Auckland Council (2015) -1. Water Sensitive Design for Stormwater. Guidance Document 2015/004.
5. Auckland Council (2015) -2. Code of Practice for Land Development and Subdivision Chapter 4 – Stormwater. Version 2.0.
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Appendix A: Catchment Characteristic and Constraints Mapping

WHANGAMAIKE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

Legend

- Contaminated Sites (Auckland Council owned)
- Existing Impervious Surfaces
- Pervious Surface
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchments

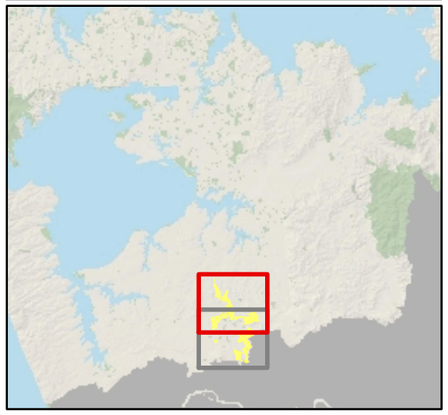

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Figure 3.1A Land Use

OIRA CREEK

NGAKOROA STREAM

WHANGAPOURI CREEK

WHANGAMAIRE STREAM

PUKEKOHE - TUTAENUI STREAM

MAUKU STREAM

Legend

- Contaminated Sites (Auckland Council owned)
- Existing Impervious Surfaces
- Pervious Surface
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchments

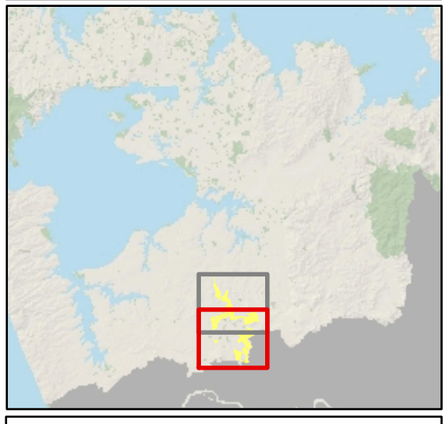

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Figure 3.1B Land Use

WHANGAMAIRE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

1 2 3 4 5 6 7 8 9 10 11 12 13 14 14 15 16 20

Legend

- Subcatchment Discharge Locations
- Intermittent/Permanent Streams
- Intermittent Streams
- Permanent Streams
- 20m Contours
- Future Urban Subcatchments
- Existing Urban Zone
- Stormwater Catchment Boundary

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

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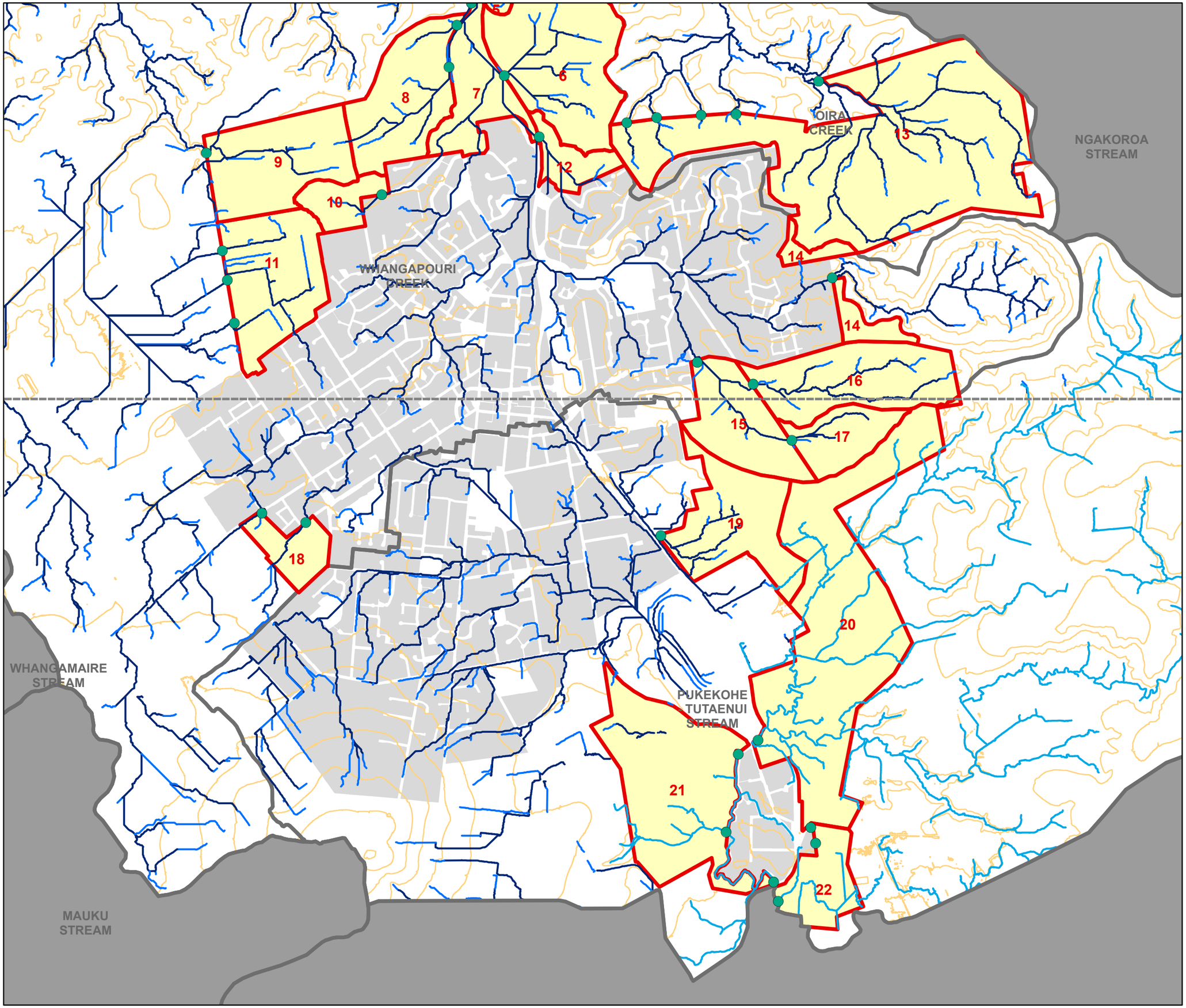
Figure 3.2A Topography and (sub)catchments



Legend

- Subcatchment Discharge Locations
- Intermittent/Permanent Streams
- Intermittent Streams
- Permanent Streams
- 20m Contours
- Future Urban Subcatchments
- Existing Urban Zone
- Stormwater Catchment Boundary

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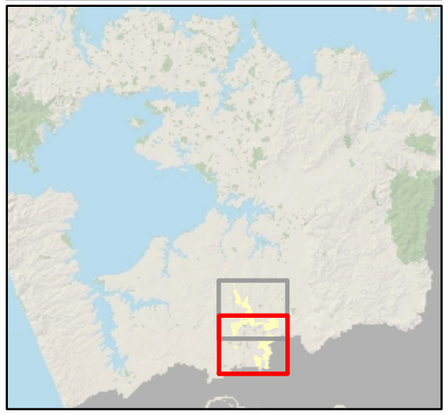

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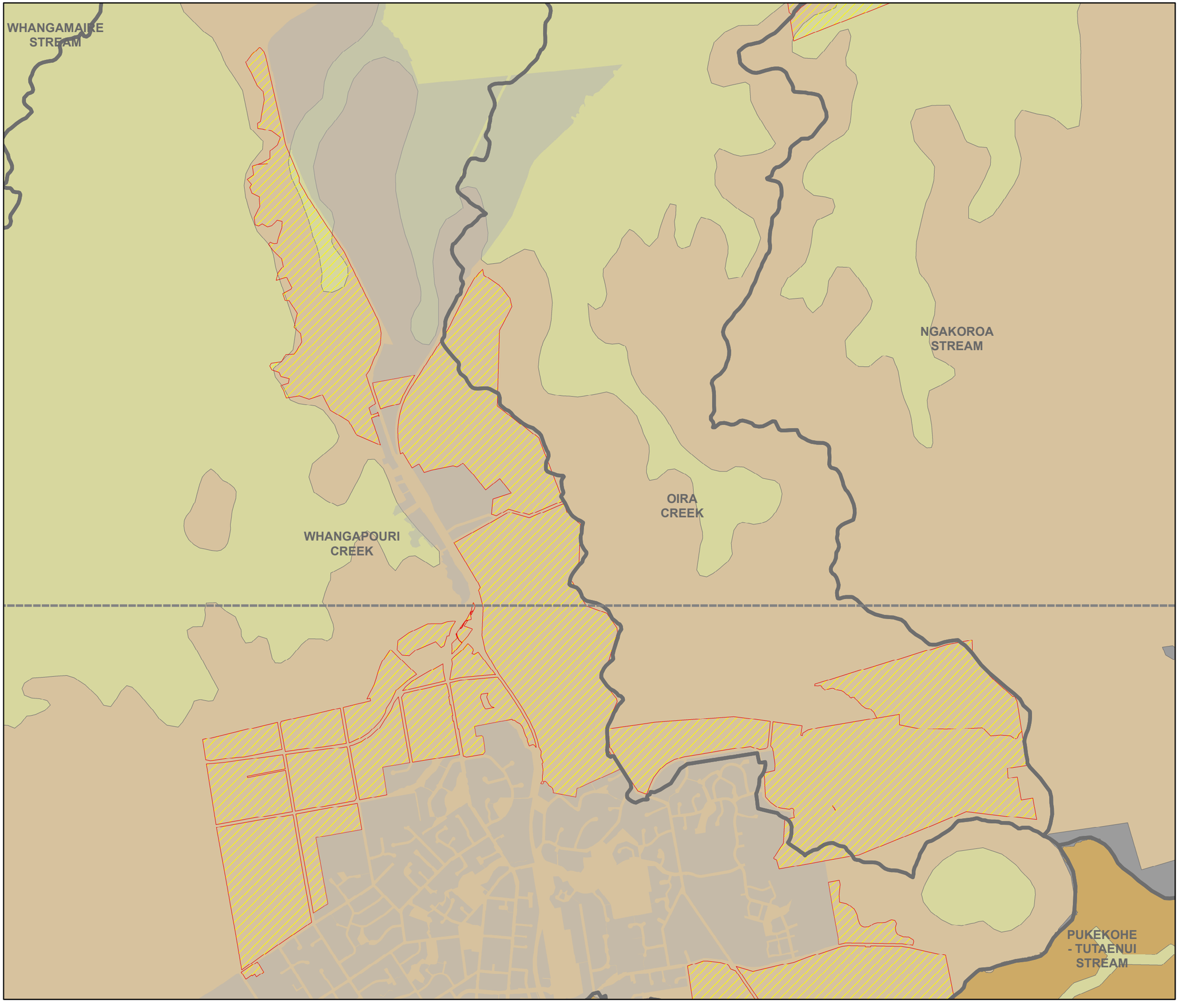
Figure 3.2B Topography and (sub)catchments



Legend

- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

Soil Type

- Alluvial Soils
- Pukekohe Volcanic Soils
- Waitemata Residual Soils
- Granular Volcanic Loam
- No data

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Figure 3.3A Geology and Soils

OIRA CREEK

NGAKOROA STREAM

WHANGAPOURI CREEK

WHANGAMAIRE STREAM

PUKEKOHE TUTAENUI STREAM

MAUKU STREAM

Legend

- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

Soil Type

- Alluvial Soils
- Pukekohe Volcanic Soils
- Waitemata Residual Soils
- Granular Volcanic Loam
- No data

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Figure 3.3B Geology and Soils

WHANGAMAIRE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

Legend

- Culverts/Bridges
- Ponds
- Stormwater Network
- Intermittent Streams
- Permanent Streams
- Intermittent/Permanent Streams
- Railway
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

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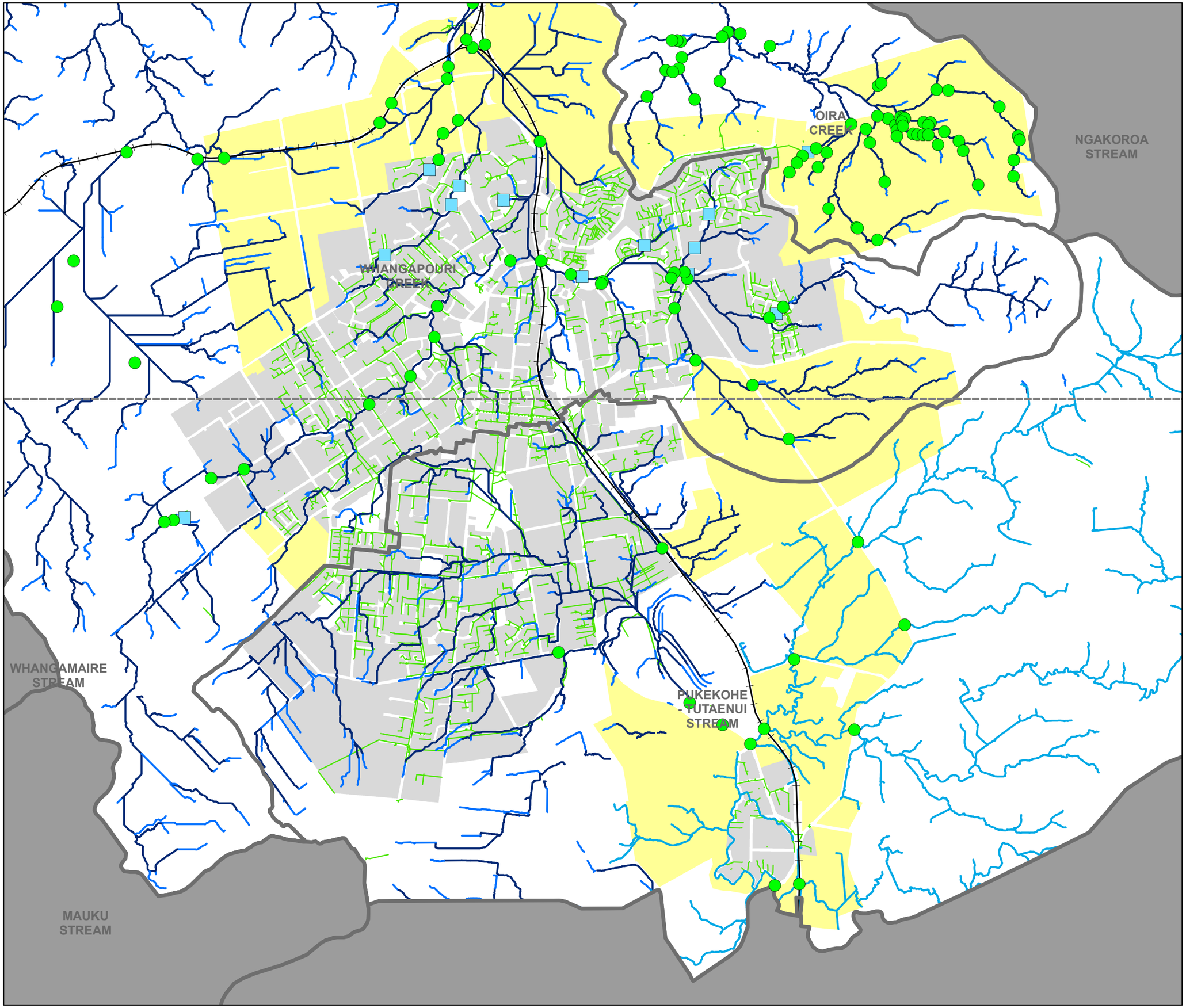
Figure 3.4A: Existing Hydrological and Stormwater Network



Legend

- Culverts/Bridges
- Ponds
- Stormwater Network
- Intermittent Streams
- Permanent Streams
- Intermittent/Permanent Streams
- Railway
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

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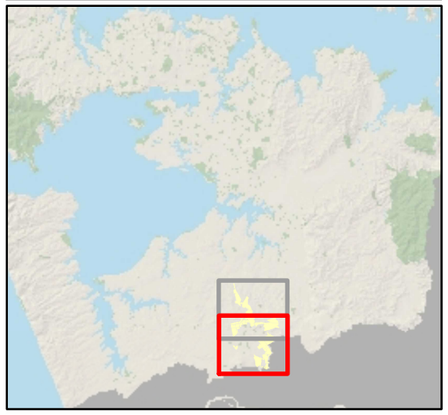

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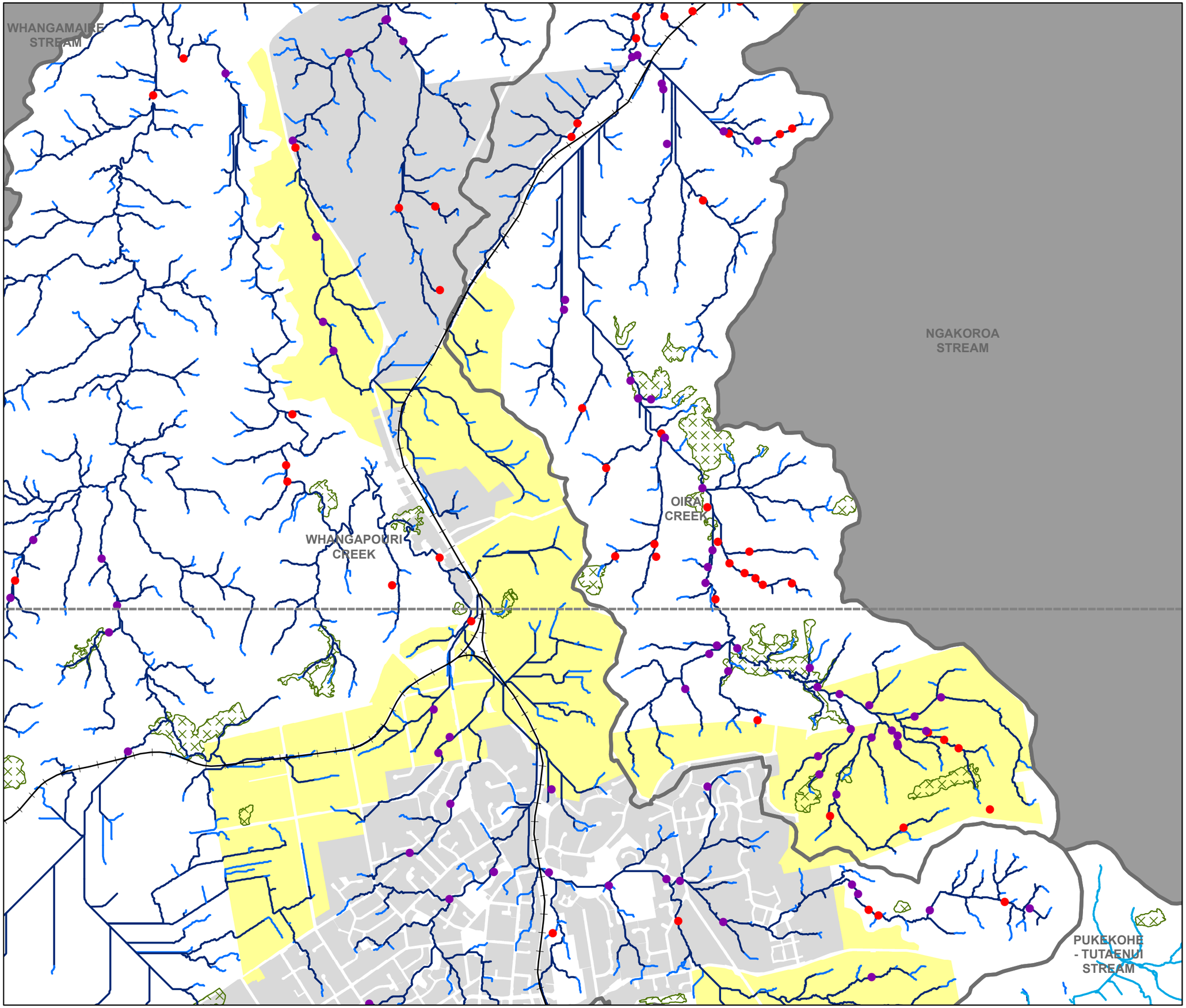
Figure 3.4B: Existing Hydrological and Stormwater Network



Legend

- Erosion Hotspots
- Fish Survey
- Significant Ecological Areas
- Railway
- Intermittent Streams
- Permanent Streams
- Intermittent/Permanent Streams
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: No Watercourse Assessment data currently available for Pukekohe South Tutaenui Stream Catchment. Permanent and Intermittent streams in the Pukekohe South Tutaenui Stream Catchment have not been mapped as part of a Watercourse Assessment. The extent of permanent/intermittent streams in this catchment is assumed to have a drainage catchment of >3ha.

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Figure 3.5A: Ecology, Erosion and Water Quality

WHANGAPOURI CREEK

OIRA CREEK

NGAKOROA STREAM

WHANGAMAIRE STREAM

PUKEKOHE - TUTAENUI STREAM

MAUKU STREAM

Legend

- Erosion Hotspots
- Fish Survey
- Significant Ecological Areas
- Railway
- Intermittent Streams
- Permanent Streams
- Intermittent/Permanent Streams
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

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Figure 3.5B: Ecology, Erosion and Water Quality

WHANGAMAIRE STREAM

NGAKOROA STREAM

OIRA CREEK

WHANGAPOURI CREEK

PUKEKOHE - TUTAENUI STREAM

Legend

- Overland Flowpaths
- Flood Prone Areas
- Floodplain (Draft)
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: Draft floodplain extents are subject to final review and editting prio to publishing.

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Future Urban Zone
Stormwater Management Plan

Figure 3.6A: Flooding

OIRA CREEK

NGAKOROA STREAM

WHANGAPOURI CREEK

WHANGAMAIRE STREAM

PUKEKOHE - TOTARA STREAM

MAUKU STREAM

Legend

- Overland Flowpaths
- Flood Prone Areas
- Floodplain (Draft)
- Future Urban Zone
- Existing Urban Zone
- Stormwater Catchment Boundaries

NB: Draft floodplain extents are subject to final review and editting prio to publishing.

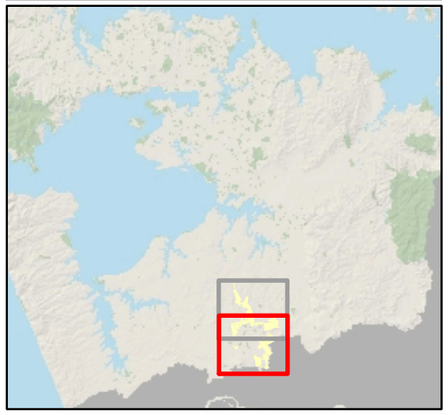

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Figure 3.6B: Flooding

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