Appendix E: Te Kowhai CMP Assessment

REPORT

Waikato District Council

Appendix **E**
Catchment Management Plan
Te Kowhai Structure Plan Area

Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

REPORT

Waikato District Council

Appendix **E**
Catchment Management Plan
Te Kowhai Structure Plan Area

Report prepared for:

Waikato District Council

Report prepared by:

Tonkin & Taylor Ltd

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1 Catchment description

1.1 Location

The Te Kowhai Structure Plan Area (SPA) surrounds the central Waikato township of Te Kowhai, located approximately 12 km northwest of Hamilton City and 8 km south of Ngaruawahia. The location of the Te Kowhai SPA is presented in Figure 1. The SPA (red outline) covers approximately 90 ha. The SPA is surrounded by rural land, and is located at the upper reach of an unnamed tributary discharging to the Waipa River.

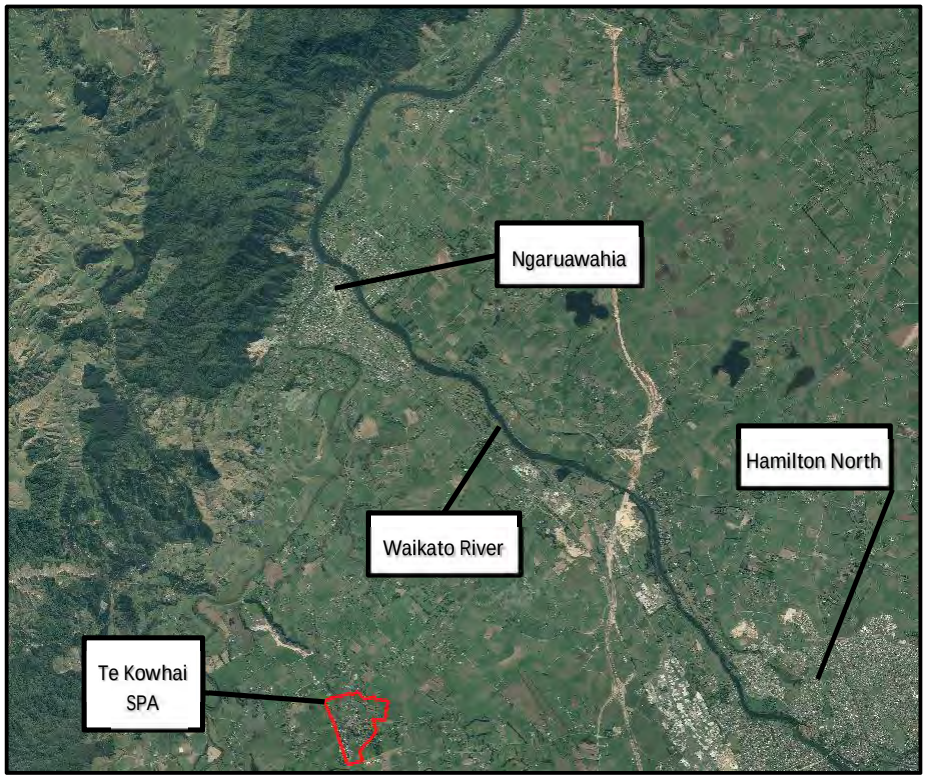


Figure 1. Te Kowhai SPA (Image sourced from WDC, 2014)

1.2 Topography

The topography of the Te Kowhai SPA is mainly flat, with a deep gully an an unnamed watercourse running through the centre of the SPA.

1.3 Geology and hydrogeology

The published geology of the area shows that the majority of the Te Kowhai structure plan area is underlain alluvial and colluvial deposits of the Piako Subgroup of the Tauranga Group (Edbrooke S. , 2005) as shown in the geological map below. The Te Kowhai Township is underlain by the Hinuera Formation which comprises cross-bedded pumice sand, silt and gravel with interbedded peat.

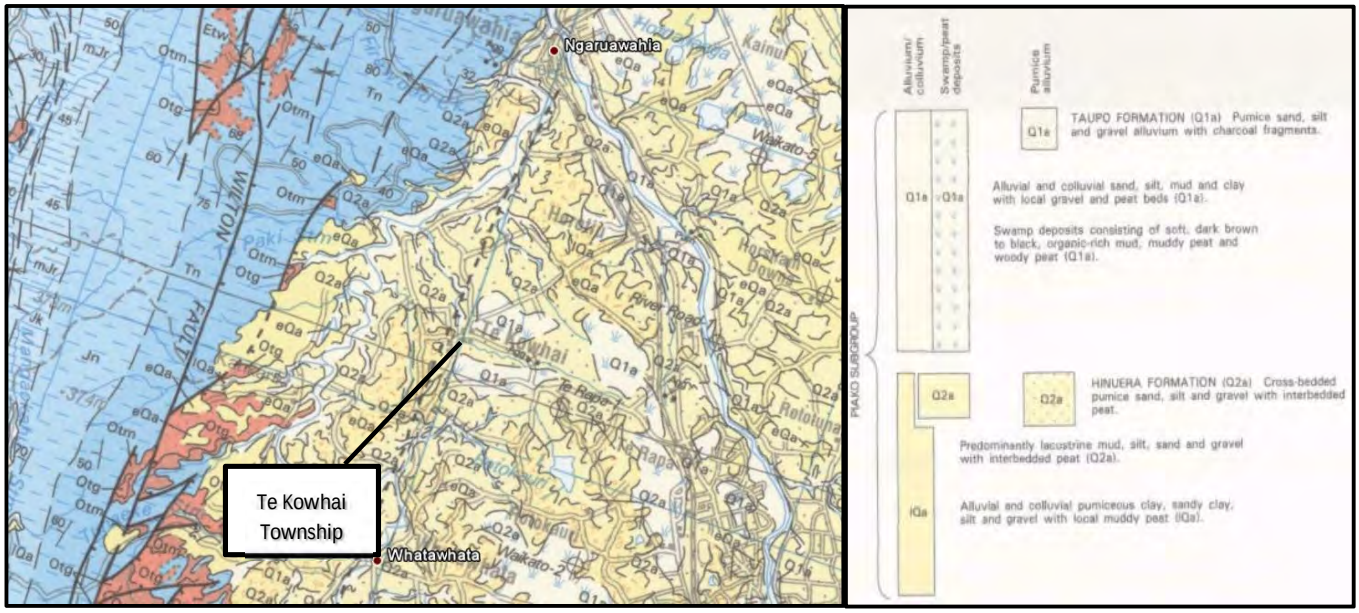


Figure 2. Geological map of Te Kowhai structure plan area

The hydrogeology of the Tauranga Group is characterised by a series of shallow unconfined and deeper semi-confined aquifers, which are variable in their horizontal and vertical distributions, and show varying degrees of connectivity with one another.

Groundwater is recharged from rainfall infiltration (and on the western side of the SPA some recharge from the Hakarimata Range) and a significant proportion of groundwater discharges to streams through the incised gullies. Marshall and Petch (1985) estimated that up to 85% of mean annual stream flow is sustained by groundwater discharges.

1.4 Watercourses

The nearest major watercourse to Te Kowhai is the Waipa River, located approximately 2.5 km west of the town centre. There is a significant unnamed tributary which flows through the Te Kowhai SPA and discharges to the Waipa River in the north. The northern and southern parts of the SPA drain to other unnamed tributaries of the Waipa River.

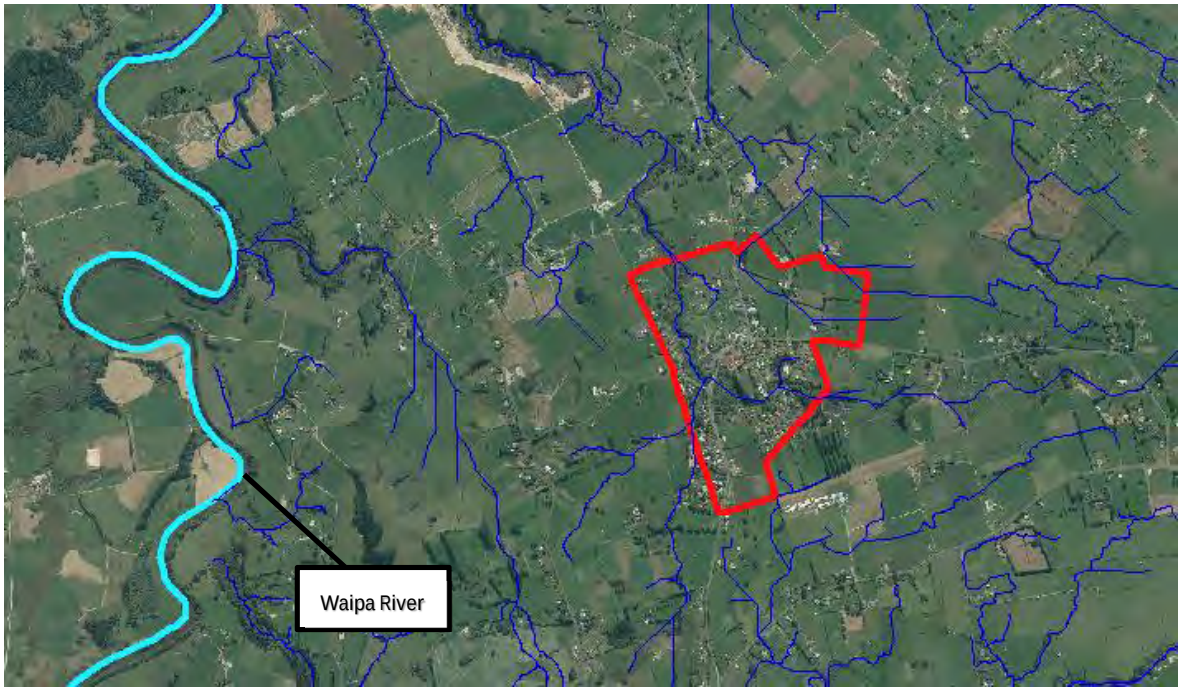


Figure 3. Main water courses (light blue) and tributaries (dark blue) around the SPA (red).

1.5 Receiving environments

The identified surface water receiving environments within or adjacent to the Te Kowhai SPA include:

- Waipa River.
- Unnamed tributaries of the Waipa River.

An unknown proportion of surface water within the SPA discharges to groundwater via natural and engineered ground soakage.

1.6 Existing WRC resource consents

1.6.1 General

WRC's online database has been used to broadly identify the types of resource consents held within the SPA and these are summarised in Table 1 below.

Table 1. WRC Resource Consents

Resource Consent Type	Number	Growth Sector
Discharge - Air	0	-
Discharge - Land	3	-
Discharge - Water	0	-
Land Use – Bore/Well	1	-
Land Use – Other	0	-
Water Take - Ground	1	-
Water Take - Surface	0	-
Water Take - Other	0	-

1.6.2 Comprehensive stormwater discharge consent

Waikato District Council holds Resource Consent No. 105656, being a Comprehensive Stormwater Discharge Consent (CSDC) associated with urban Te Kowhai.

Relevant extracts from the resource consent are reproduced below:

Consent Type: Discharge permit

Consent Subtype: Discharge to land and water

Activity authorised: To divert and discharge urban stormwater and associated contaminants at multiple locations to land and the Waipa River, and use discharge structures, within the [Te Kowhai] urban area.

Consent duration: Granted for a period expiring on 22 September 2028

It is noted that the extent of the above consent (reticulated urban area of Te Kowhai) is significantly smaller than the extent of the SPA.

2 Land use in Te Kowhai

2.1 Current land use

Land within the SPA is dominated by urban and rural areas, with commercial industrial areas and council reserves also occupying a small portion of the SPA. Horotiu Road (State Highway 39) and Te Kowhai Road are notable arterial routes that run through the SPA.

2.2 Future land use

Future growth within the SPA has been provided by WDC and is shown in Figure 4 below. The figure shows that the future land use is anticipated to be residential only.

For reporting purposes, the growth areas defined by WDC have been categorised into "Growth Sectors" G and H. These are also presented in Figure 4.

Figure 4. Te Kowhai growth plan provided by WDC and Growth Sectors used for reporting.

3 Ecological review

This section presents the results of our review and assessment of the ecological status of stream resources in the Te Kowhai SPA. The assessment is based on a review of existing ecological information with a brief site visit to publicly accessible parts of the SPA.

3.1 SPA overview

3.2 Assessment methods

There has been no ecological assessments of Te Kowhai and its surrounds provided by Waikato District Council. Our assessment has reviewed the information available within national and regional ecological databases.

In addition, a site walk over of streams at publicly accessible locations was conducted by a T&T ecologist on 9 April 2014 to confirm levels of development, observe in stream structures, assess fish passage conditions and visually assess habitat condition. The sites assessed during the field assessment are shown on Figure 272 in Appendix EA.

3.3 Summary of existing ecological information

3.3.1 Operative District Plan

The Operative Waikato District Plan and associated maps were reviewed for any ecological features of note. The Te Kowhai SPA is included on Planning Map 20 and 26. There was no ecological features of note within the Te Kowhai SPA.

3.3.2 Waikato Regional Plan maps

Waikato Regional Plan (WRP) water management and stock exclusion maps were reviewed to check for any specific values that apply to SPA streams. All permanent watercourses within the area are classified as Waikato Surface Water (Map S14) and will be subject to the relevant standards in Section 3.2 of the WRP in regard to discharges of contaminants.

3.4 T&T's 2014 field assessment

A site inspection of publicly accessible locations on the unnamed tributaries within the SPA was conducted on 9 April, 2014. Locations inspected are shown on Figure 272 in Appendix EA.

Observations from site inspections concluded that the unnamed tributary to the Waipa River that flows north through Te Kowhai, was characterised by slow flow flowing open channel with excessive macrophyte growth. The likely factors contributing to excessive macrophyte growth are the lack of significant areas of riparian vegetation providing shade to the stream channel and the presence of nutrients in the stream. In-stream habitat at the sites inspected was generally limited to slow moving runs and pools with undercut banks, root mats and overhanging vegetation present at some locations. Within the soft bottom sections there was a lack of large woody debris providing hard substrate habitat for macroinvertebrate species. No barriers to fish passage were identified within the Te Kowhai SPA. Stream Bank vegetation had been recently sprayed.

The National Freshwater Fish Database has a record of the At Risk, black mudfish (*Neochanna diversus*) within the SPA, in the wetland area upstream from the Horotiu Rd culvert (Goodman et al., 2014). Crack willow (*Salix fragilis*) is the dominant vegetation within this area with small strands of kahikatea (Dacrycarpus dacrydioides) and Cabbage tree (*Cordyline australis*) also present.

4 Ecological assessment

4.1 Introduction

This section provides an assessment of the potential effects of development of the Te Kowhai SPA on surface water resources. The assessment has considered the general issues outlined within Section 2 of the main report. This section provides an assessment of the significance of these issues for each of the growth area identified by WDC.

4.2 Assessment of effects

This section provides an assessment of the potential effects of development of the Te Kowhai SPA on surface water resources. The assessment has considered the general issues outlined within Section 2 of the main report. This section provides an assessment of the significance of these for each of the growth areas identified by WDC.

The main ecological issues associated with future urban development in the SPA are described in Section 2 of the main report. The significance of proposed development to a range of issues for each growth area is presented in Table 2.

Table 2. Significance of potential adverse effects from proposed development

Growth Sector / Issue	G - Residential	H - Residential
Stormwater		
Contaminants[1]	Low	Low
Increase in peak flows leading to stream bed/bank erosion	Low to Medium	Low
Hydrological		
Reductions in base flow[2]	Low to Medium	Low
Reduction in flow variability leading to reduced habitat quality	Low to Medium	Low
Habitat		
Culverting or infilling of perennial streams reducing habitat	Low	Low
Protection of riparian margins[3]	Low	Low
Barriers to fish movement	Low	Low
Overall potential adverse effect on surface water	Low	Low

5 Flood modelling and assessment

5.1 Introduction

A Rapid Flood Hazard Assessment (RFHA) has been undertaken. The purpose of a RFHA is to determine the areas which would be inundated if no pipe network is available. An RFHA is a valuable tool to provide an indication of where flooding hazards may occur and where future modelling efforts should be concentrated. An RFHA provides a conservative estimate of flooding as it assumes that the reticulated network (pipes, culverts and catchpits) are blocked. It defines the level of worst risk of property flooding issues within the catchment (Auckland Council, 2011)

The RFHA methodology adopted is generally in accordance with Auckland Council's Stormwater Flood Modelling Specification (SFMS) Version 4, November 2011.

5.2 Methodology

5.2.1 Model bathymetry

5.2.1.1 Digital elevation model (DEM)

A digital elevation model (DEM) for Te Kowhai was developed by T&T based on LiDAR data.

LiDAR was provided by WDC and WRC.

The WDC Waikato LiDAR data was collected between 22nd of November 2007 to 5th of February 2008 . Vertical accuracy for all point and grid data is within 0.15m RMS at 68% confidence relative to Moturiki 1953 and NZVD2009 datum. Horizontal accuracy is within 0.45 metre RMS (at 68% confidence). Accuracy estimates for terrain modelling refer to the terrain definition on clear ground. Ground definition in vegetated terrain may contain localised areas with systematic errors or outliers which fall outside of this accuracy estimate

A DEM with a grid size of 5m x 5m was generated for the Rapid Flood Hazard Assessment.

5.2.2 Catchment boundary

The initial catchment boundary was adopted based on REC (NIWA, 2004) database 1st Order catchments.

A 2m x 2m DEM was used to create ponding and overland flow paths for catchment delineation only. This 2m x 2m DEM was used to account for the farm drains within the catchment. For the rest of model, a DEM of 5m x 5m was used.

We have used a GIS tool to infill and map all topographic depressions based on the LiDAR survey provided. The mapped depressions represent all areas where stormwater could *potentially* pond. A key issue here is that the mapping does not allow for culverts or other sub-surface drainage features which could convey stormwater and reduce or eliminate ponding. Overall the largest ponding areas are generally associated with road and rail embankments and bridges.

The catchment boundary was then modified to encompass areas where overland flow paths were observed outside the REC catchment extent. The modified catchment boundary (indicative only) is shown in Figure 5 below.

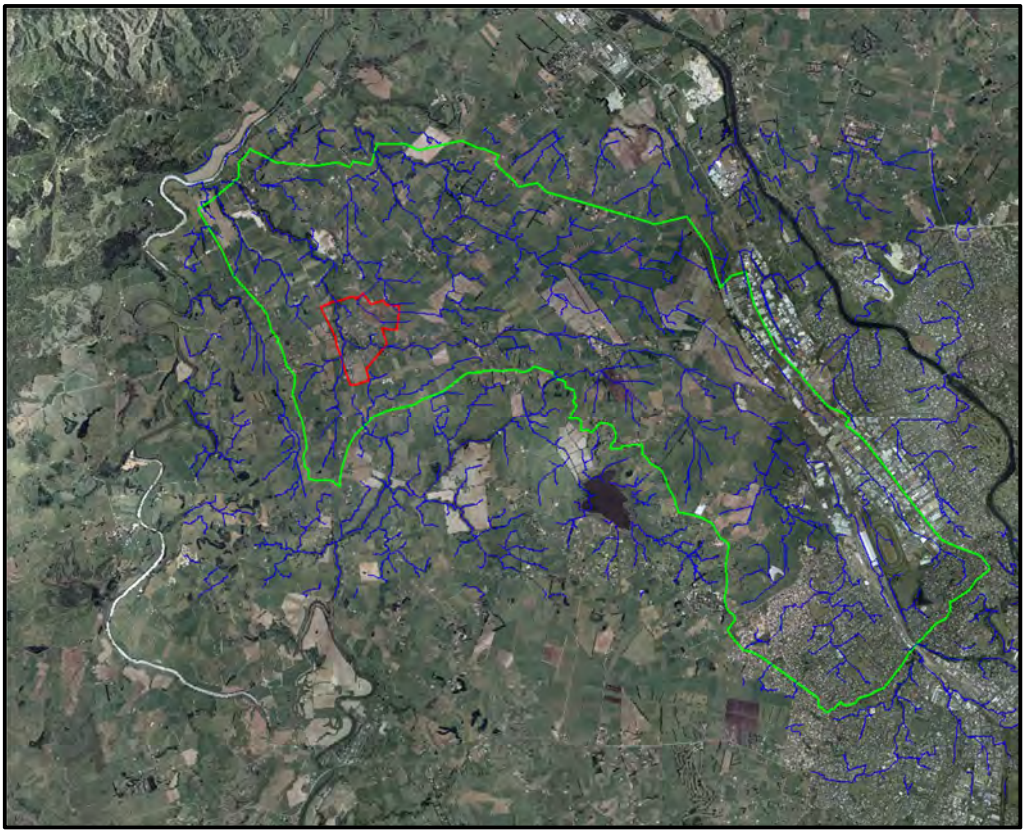


Figure 5. Indicative catchment boundary

The extent of the hydrological model is larger than the catchment boundary.

5.2.3 Initial conditions

The initial conditions for the RFHA model were developed based on ponding areas in the DEM. The ponding areas were identified from all depressions in the DEM which were filled to create the initial condition (water depth) i.e. all topographic depressions including those created by road embankments etc were filled with water prior to rainfall being applied.

5.2.4 Boundary conditions

The 24 hour rainfall depth for a 1% AEP design storm was obtained using NIWA's HIRDSv3 online rainfall inventory based on the approximate centroid of the catchment. To incorporate climate change, the rainfall depth was then increased by applying a 3 degree Celsius temperature increase within the HIRDSv3 inventory. An increase of 3 degree Celsius has been adopted in accordance with unpublished guidance from WRC. The climate change adjusted 24 hour rainfall depth used was 180mm.

The rainfall distribution was developed using the embedded storm hyetograph method, which was developed using the Intensity-Duration-Frequency (IDF) curve from HIRDSv3 up to 24 hours. The embedded storm hyetograph method is sometimes known as the Chicago method and is based on the work of (Keifer, (1957). For the purposes of this study the time of peak rainfall to rainfall duration ratio was assumed to be 0.5.

5.3 Information provided by WDC

5.3.1.1 Waterway and reticulated assets

WDC did not provide any information on any bridges or significant culverts within the catchment.

Some stormwater reticulation data was provided but in general layout information only was provided and infrastructure elements such as pipe sizes, lengths, and invert levels were generally not provided. It is also noted that road culverts were generally not shown on the stormwater asset layer provided and we understand that culvert information may be available on WDC's RAMM database but these were not available at the time of this assessment.

5.3.1.2 Buildings

WDC provided building footprints within the Waikato but no information on any floor levels.

5.3.2 Drainage operational issues

No drainage issues or flood reports were noted or provided by WDC.

5.3.3 Waipa River flooding, 2009.

T&T has liaised with WRC to obtain flood model data for the Waipa Rivers.

WRC have a Waipa River 1D flood model (MIKE 11) using the 1% AEP (with no climate change) event. The interpolated 2D extent of 1% AEP flooding was undertaken by WRC by interpolating the 2009 MIKE 11 1D models on to a LiDAR derived topography using WaterRide Software.

The interpolated 1% AEP river flood extents (with no allowance for climate change) are presented in Figures 262 in Appendix EA.

5.3.4 Model & parameters

TuFLOW (flood and coastal simulation software) was used to undertake the RFHA.

TuFLOW is a powerful computational engine that provides one-dimensional (1D) and two-dimensional (2D) solutions of the free-surface flow equations to simulate flood propagation.

Key model parameters were as follows:

- The grid size used was 5m x 5m.
- A time step of 0.2 sec was set however TuFLOW uses as adaptive time step function to adopt the best time step during the simulation run.
- Eddy viscosity was calculated based on 0.02 $dx^2/dt = 0.4$.
- A constant Manning's roughness coefficient of 0.050 was used except for buildings and roads. Buildings were represented by high roughness (Manning's n= 0.300) with roads represented by low roughness (Manning's n= 0.014).
- No structures (culverts and bridges) were represented in this model.
- No hydrological losses were applied in this model.

5.4 Results and discussions

5.4.1 Model review

The model and results have been reviewed by a Senior Modeller. Mass balance checks were carried out. The mass balance continuity error is approximately -3.7% which is considered acceptable for flood modelling purposes.

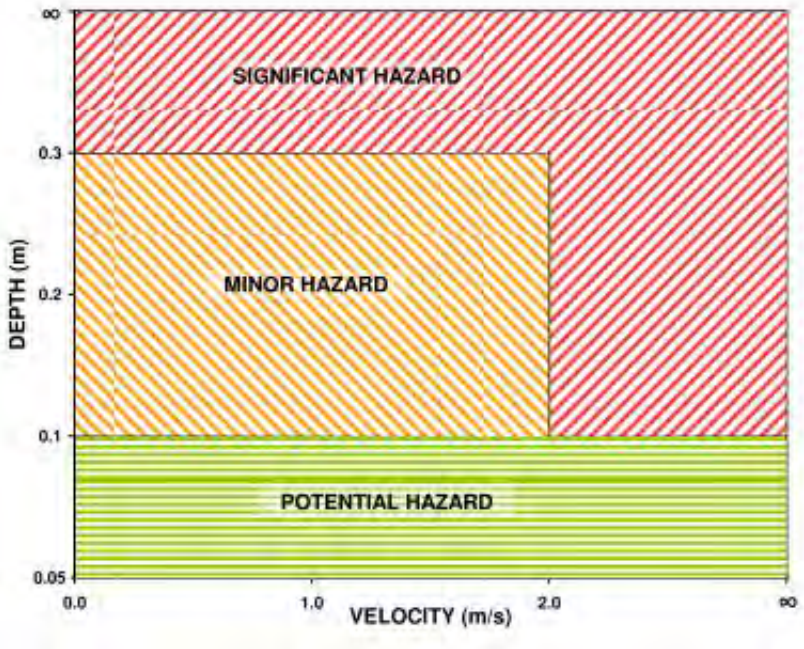
5.4.2 Post processing of model results

TuFLOW results files were processed, reviewed and plotted using WaterRide software.

Flood hazard has been categorised in accordance with the methodology set out in AC (SFMS), 2011. Table 7.5 and Figure 8 from the SFMS summarising the categorisation methodology has been reproduced below.

Table7.5 Flood Hazard Classification Category

Hazard Classification	Description	Depth – Velocity Criteria
1	Potential Hazard	0.05 m < Depth < 0.1 m
2	Minor Hazard	0.1 m ≤ Depth < 0.3 m and Velocity < 2.0 m/s
3	Significant Hazard	Depth ≥ 0.3 m and Depth ≥ 0.1 m & Velocity ≥ 2.0 m/s



Flood hazard plots using the 5m x 5m model grid results were generated from model results and are shown in Figure 262 in Appendix EA.

Building footprints supplied by WDC are shown on the Flood Maps presented in Appendix EA. Where a flood hazard layer encroaches on a building footprint we consider that the buildings are potentially flood prone, however building floor levels are unknown and therefore the number of buildings actually affected by flooding cannot be determined.

Additionally, we would expect modelled flood levels to be reduced after detailed flood modelling and therefore the number of flood prone buildings may be overestimated.

5.5 Reporting

For reporting purposes, each area of potential growth has been broken up into "Growth Sectors". Within the Te Kowhai SPA, there are two Growth Sectors – G and H. The locations of the Growth Sectors are shown in Figure 4 and Figure 262 in Appendix EA. Figure 4 shows that both Growth Sectors contain only proposed residential land.

Growth Sector G is the larger area, with an approximate area of 9.8 ha. The current land use in Growth Sector G appears to be primarily farmland.

Growth Sector H has an approximate area of 6.0 ha. The general land use of Growth Sector F also appears to be farmland.

5.6 Results

The results from the RFHA are presented in Figure 262 in Appendix EA. The RFHA entails a high level overview of the model provided in these figures and reviews the feasibility of the proposed residential area.

Flooding of each Growth Sector has been reviewed separately in the following sections. The areas within the SPA but outside of the proposed growth areas have not been considered as they are existing and not anticipated to change.

5.6.1.1 Growth Sector G

Generally, Growth Sector G has relatively extensive significant and minor flood hazard, covering approximately 50% of the area. Flood hazard is generally associated with of an overland flow path (ofpTKO100) running through the centre of Growth Sector G as well as another overland flow path just north of the SPA boundary.

During the site visit, a 600 mm diameter culvert (cTKO100) was observed under Te Kowhai Road, with an approximate location shown on Figure 262 in Appendix EA. No other culverts were noted under Te Kowhai Road. The RFHA model does not allow for culverts or road embankments, which may make the flooding upstream of culverts appear more significant or extensive than if culverts were included in the model.

Using the information provided by WDC regarding building footprints, it appears from the RFHA model that no existing building within the Growth Sector are affected by this flooding.

It is also important to note that if Growth Sector G is developed, the area will become more impermeable and result in greater runoff flows to the downstream culverts.

No assessment has been undertaken on whether or not the culverts downstream have sufficient capacity as there was no available information about the upstream or downstream invert levels of the pipes.

5.6.1.2 Growth Sector **H**

The RFHA model shows that there is extensive flooding within Growth Sector H. The area appears to currently be used as farmland, and there is a farm drain through the centre, running east to west, dividing the area in two. The farm drain appears to discharge via a culvert (cTKO101) under SH39 and to the unnamed watercourse which flows to the Waipa River.

The capacity of culvert cTKO101 has not been assessed due to insufficient information about the culvert size and the upstream and downstream invert levels.

If the area is to be developed, the area will become more impervious, and the culvert will have to be sized adequately to convey the increased flow rate. This should be investigated further if the area is developed.

The flooding shown in the RFHA and Figure 262 in Appendix EA shows that several existing buildings are affected by the estimated flooding.

5.6.1.3 Infrastructure

Table 3 below summarises the existing critical infrastructure within the Te Kowhai SPA which is considered a potential restriction on the flow of major overland flow paths, watercourses or streams. Refer to Figure 262 in Appendix EA which shows the locations of these restrictions. The flooding map was used to determine which infrastructure assets were considered 'restrictions'. WDC have provided stormwater asset details but unfortunately this did not include the culverts that have been identified as constrictions.

Table 3. Summary of critical infrastructure

Infrastructure ID	Length (m)	Diameter (mm)	IL's – US/DS	Capacity check required?	Other notes
cTKO100	No data	600	No data	Yes	RCRRJ
cTKO101	No data	No data	No data	Yes	

5.7 Summary of flooding issues

This section provides an assessment of the potential effects of flooding on the Te Kowhai SPA. The assessment includes an evaluation of potential ponding areas on future residential development, and on the capacity of infrastructure critical to managing flood hazard within the SPA.

A summary evaluation of the issues is presented in Table 4. For critical infrastructure, those structures that are unable to pass the 1% AEP peak flow (without heading up to above road crown level and/or causing upstream flooding) would likely pose a significant constraint to development.

In this table we have made the following assumptions on the constraint that potential ponding might pose to development in each growth sector:

- Low constraints to development has been categorised as growth sectors with large areas not affected by flooding, and overall not a great amount of mitigation required.
- Medium and high constraints to development would probably need to be managed through land use policies, and/or rules in the District Plan, or modifications to the Development Manual.

- For critical infrastructure, those structures that are unable to pass the 1% AEP peak flow (without heading up to above road crown level and/or causing upstream flooding) would likely pose a significant constraint to development.

Table 4. Summary of flooding issues

Flooding Assessment	Growth Sector G - Residential	Growth Sector H - Residential
Existing buildings affected by ponding?	No	Yes
Existing potentially critical infrastructure	cTKO100	cTKO101
Overall constraint[1]	High	High

1. Based on area affected by ponding and ability of the land use type to avoid or mitigate the adverse effects of flood hazards on the built environment.

5.8 Information gaps

Through our review of available information and our assessment of issues and constraints we have identified the following information gaps:

- Information about existing culvert levels, diameters, lengths and materials. This information would be useful in verifying the capacity of existing culverts that are of concern and is essential for more detailed modelling efforts.
- Existing building floor levels to clarify potential flood vulnerability.
- More detailed information on future growth areas including road layout and waterway crossings.

6 References

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7 Applicability

This report has been prepared for the benefit of Waikato District Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
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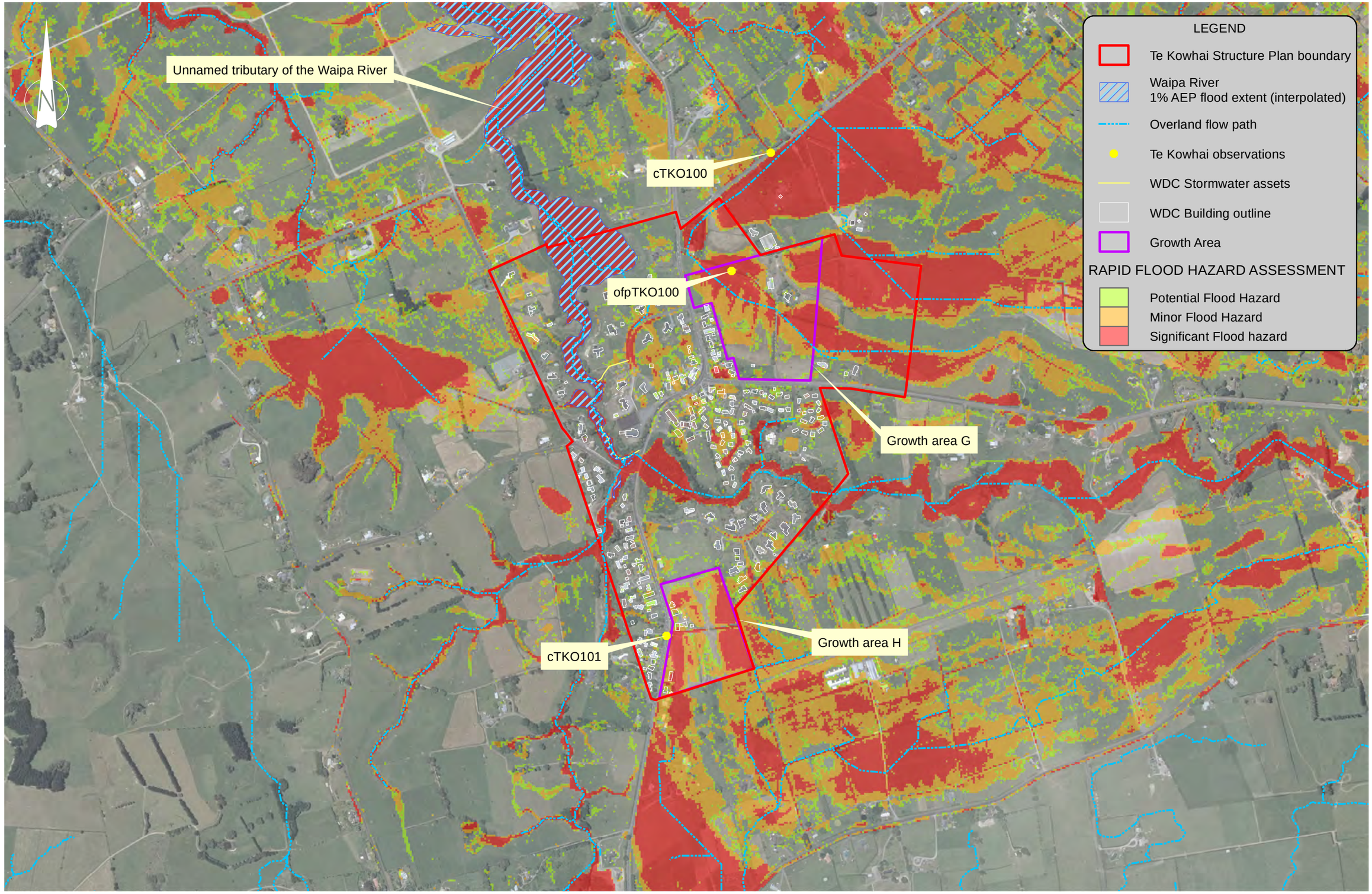
Appendix EA: Figures

- **Figure 262 Flooding Maps**
- **Figure 272 Ecological Map**



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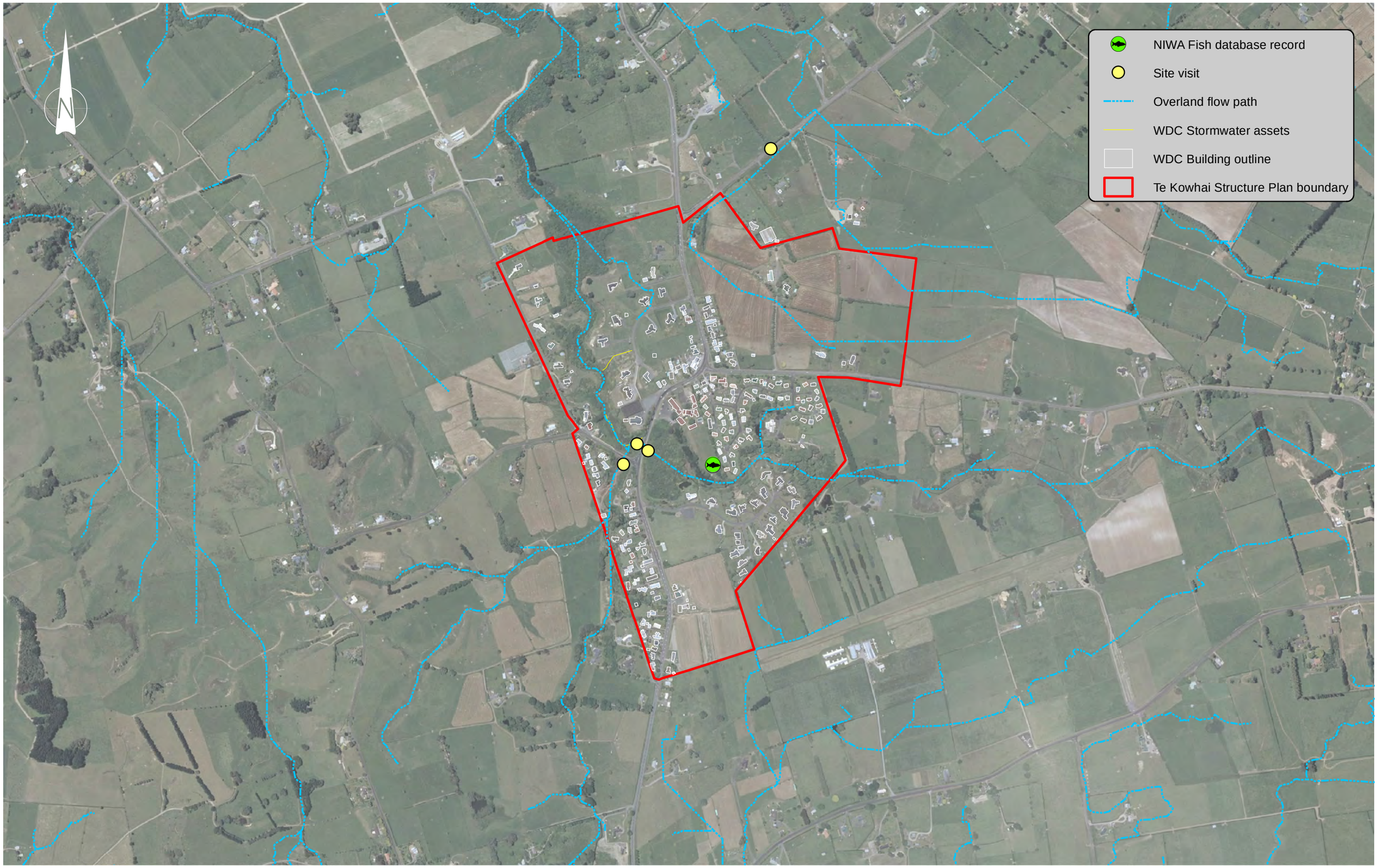
WAIKATO DISTRICT COUNCIL
CATCHMENT MANAGEMENT PLAN
TE KOWHAI STRUCTURE PLAN AREA
Flooding Plan

FIGURE No. Figure 262 Rev. 0



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WAIKATO DISTRICT COUNCIL
CATCHMENT MANAGEMENT PLAN
TE KOWHAI STRUCTURE PLAN AREA
Ecological Map

FIGURE No. Figure 272
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