Oira Catchment

Watercourse Assessment Report

(Draft)

June 2017 Technical Report [20xx/xxx]

Auckland Council
Technical Report [20xx/xxx]
ISSN 2230-4525 (Print)
ISSN 2230-4533 (Online)

ISBN xxx (Print)
ISBN xxx (PDF)

This report has been peer reviewed by the Peer Review Panel using the Panel's terms of reference
Submitted for review on xxx Review completed on xxx Reviewed by xx reviewers
[Optional Reviewed by: Name xxxxx | Position: xxxxx]
Approved for Auckland Council publication by: Name: xxx Position: xxx
Date: xxx

Recommended citation:
Kane-Sanderson, P., Spyksma, A., Bennett, K., Lindgreen, M., Pertziger, F., Bennett, J., Secretin, C. (2017) Oira Catchment Watercourse Assessment Report. 4Sight Consulting and AECOM New Zealand Ltd for Auckland Council.
Auckland Council [technical report, TR20xx/xxx]

Oira Catchment
Watercourse Assessment Report

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Executive Summary

Presented below is the Watercourse Assessment Report (WAR) for the Oira Creek. Watercourse Assessments are designed to provide meaningful baseline information on the existing ecological condition and state of stormwater infrastructure within a waterway. Information collected should be able inform effective management of:

- Stream ecological health,
- Stormwater infrastructure; and
- Stormwater conveyance.

4Sight Consulting Limited, on behalf of Auckland Council, carried out an extensive survey of the Oira Creek watercourse between November 2016 and April 2017. The survey was conducted in accordance with the Watercourse Assessment Methodology: Infrastructure and Ecology (Version 2.0). Additionally, Stream Ecological Valuations (SEVs) were carried out at five representative sites within the catchment in May 2017.

The Oira Creek watercourse is a soft-bottomed stream network which predominantly drains through the rural, agricultural landscape from the northern fringes of Pukekohe in the south to the Drury Creek arm of the Pahurehure Inlet (Manukau Harbour) in the north. It is comprised of 61 km of watercourse, of which 81% was classified as permenant or intermittent stream. Two areas within the catchment are zoned for future urban growth; the fringes of Pukekohe and the eastern side of the lower catchment. Consequently, the Oira Creek catchment is likely to experience a rapid change in land-use within the next 30 years.

Stream characteristics during the survey were reflective of the current agricultural nature of the catchment with a limited intactness of the riparian vegetation and low stream shading, a lack of stream fencing, widespread signs of stock damage and stream bank erosion and multiple weed infestations. SEV scores were all below the Auckland Council mean reference score, with three sites below the Auckland Council minimum reference score.

Approximately 90% of the assets surveyed were privately owned. In general pipes and culverts were functional in terms of stormwater conveyance, but issues associated with fish passage and outfall erosion persisted throughout the catchment.

Five key management zones were identified within the catchment based on stream reaches with similar characteristics and facing similar land use pressures. As most of the land within the catchment is privately owned it is acknowledged that successfully managing the ecological and stormwater aspects of the Oira Creek will require co-operation from landowners. The management zones include:

- Areas zoned for future urban growth;
- Areas of significant ecological worth; and
- Highly degraded areas.

The combined coastal and future urban zone (Management Zone 1), surrounding and to the east of the Oira Creek stream mouth has the greatest potential for enhancement and includes three high priority Enhancement Opportunities. Some management goals could be fast-tracked to address existing issues within this area before land becomes rezoned for urban development. Therefore, future-proofing against issues that may be exacerbated by the effects of development. Taking advantage of developer-led stream management within Management Zone 1 and Management Zone 4 (Future Urban – Pukekohe) will help to achieve additional management goals, within these sections of the catchment.

Key objectives and goals identified across the five management zones include:

- Engage landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Encourage landowners to restore, enhance or protect riparian zones.
- Futureproof stream stormwater conveyance capacity by replacing undersized or poorly functioning engineering assets.
- Address inlet/outlet erosion issues, particularly within the future urban zones before land becomes developed.
- Create greater ecological linkages, particularly between Significant Ecological Areas, through the provision of riparian corridors and the removal of weed species.
- Improve fish passage where necessary though the provision of fish passage devices or removal/replacement of problematic engineering assets.
- Enhance potential inanga spawning habitats.
- Involve community groups in restoration projects.

Table 1: Summary of Oira Catchment.

Est. Length of Permanent and Intermittent Stream (m)	*78,800* (estimated from OLFP with catchments >2ha)					
Total Length of Surveyed Watercourse (m)	*61,557 (49,602 fully assessed)*					
Catchment Area (km^2)	*20.3*					
Catchment Imperviousness	*1.6%*					
Receiving Environment	*Pahurehure Inlet, Manukau Harbour*					
Dominant Substrate	*Silt/Sand*					
Vegetation	**0 – 10 %**	**10-30%**	**30-50%**	**50-70%**	**70-90%**	**>90%**
Average Overhead Cover (% of total stream length)	***14.7***	***15.9***	***25.4***	***22.5***	***17.4***	***4.1***
Wetlands	**Natural**			**Artificial**		
Number of Wetlands	*72*			*107*		
Erosion	**Excellent**		**Good**	**Fair**		**Poor**
Overall Stability Index (% of total stream length)	***2.2*** *Scores ≤13*		***32.2*** *Scores 14- 23*	***56.8*** *Scores 24 -32*		***8.8*** *Scores ≥33*
	Percentage of reaches with >60% erosion scarring			**Total No. Erosion hotspots**		
	2.7			*54*		
Engineered Assets	**Total No.**		**Poor-Very Poor Condition**	**Incorrect in GIS**		**Accessible Unsafe Drops >1.5m**
Inlet and Outlet Structures	*593*		*25*	*0*		*0*
Pipes and Culverts	*311*		*46*	*1*		-
Bank and Channel Lining (total length (m))	*349*		*29*	*na*		*0*
Fish	**No. of species observed**		**Percentage of fish points with suitable habitat**		**Percentage of reaches with suitable habitat**	
	8		*91% (instream or bank)*		*53% (instream or bank)*	
Potential Barriers to Fish Passage	**Swimmers**		**Climbers**		**Anguilliforms**	
Natural Structures	*22*		*9*		*3*	
Inlets and Outlet Structures	*25*		*19*		*9*	
Pipes and Culverts	*112*		*105*		*72*	

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1.0 Introduction

1.1 Scope

4Sight Consulting Limited (4Sight) were commissioned by the Auckland Council Stormwater Unit to undertake a Watercourse Assessment and associated Watercourse Assessment Report (WAR), including associated maps and completed geodatabase for the Oira Catchment.

The scope of this project included:

- All work to be undertaken in accordance with the Watercourse Assessment Methodology: Infrastructure and Ecology Document (Version 2.0).
- The length of stream identified within the scoping map (PIN_2897 Watercourse Assessment: Oira Catchment) must be surveyed. Additional stream length can be noted.
- Stormwater assets associated with the stream length to be assessed, are to be evaluated as per the Watercourse Assessment Methodology: Infrastructure and Ecology Document (Version 2.0), even if they are not shown on the Auckland Council GIS layers or the scoping map.
- The location of the five SEVs will be selected in consultation with Auckland Council and follow Appendix B Ancillary in the Watercourse Assessment Methodology (Protocols – Stream Ecological Valuation (SEV) protocols for guidance in selecting SEV site locations). As outlined in the Watercourse Assessment Methodology a number of additional variables are to be assessed at SEV sites.
- Before the survey is to commence on any stream, provide, in an excel spread sheet, a list of addresses of properties that will need to be accessed. Council will send out a form letter to those residents advising them that Council has commissioned 4Sight to undertake the stream survey and provide contact details of Council's Representatives and the consultant at 4Sight for any enquiries.

Additional scope included:

- The length of stream identified within the scoping map (PIN_2897 Watercourse Assessment: Oira Catchment) that must be surveyed (approximately 52 km), did not fully cover the catchment and align to maps provided by GIS. Therefore, additional stream length included in the GIS maps (approximately 26.8 km) was also surveyed.

Sections that were not undertaken as part of the agreed scope:

- This included areas of stream/catchment that could not be accessed due to no landowner's permission (four instances), unable to access due to gates/fences (two instances and unsafe access due to thick vegetation (one instance). In these areas,

the field team estimated the ecological data for the reach of stream and made a comment in the notes section about the estimation.

The deliverables were:

- Watercourse Assessment Report,
- Geodatabase,
- Map Series.

The purpose of the work being undertaken is to:

- Provide baseline information on the existing condition of waterways, including both built assets and natural features.
- Provide essential information to many internal Council departments (Stormwater, Environmental Services, RIMU, Parks) and to local boards and community groups.
- Contribute to management of built assets within the waterways, management of the waterways, and provide baseline surveys and identification of enhancement opportunities.
- Enable the Stormwater Unit to facilitate asset management and carry out project planning.

Table 2: Watercourse Assessment scope matrix.

Watercourse Management Plan Component Protocol	Urban Environment	Rural Environment
Pre-survey Desktop Assessment		
Literature Review	Yes	Yes
Field Stream Assessment		
Reach Assessment (Ecoline)	Yes	Yes
Natural Structures	Yes	Yes
Fish Survey	Yes	Yes
Stream Mouths	Yes	Yes
Inanga Spawning	Yes	Yes
Wetlands	Yes	Yes
Asset Inspection (Inlets / Outlets)	Yes	Yes
Asset Inspection (Culverts / Pipes)	Yes	Yes
Bank and Channel Lining	Yes	Yes
Erosion Hotspots	Yes	Yes
Enhancement Opportunities	Yes	Yes
Miscellaneous Points	Yes	Yes
Post-survey Desktop Assessment		
Management Zones	Yes	Yes
Stream Ecological Valuations (SEVS)		
SEV's	Yes	Yes
Electrofishing	Yes	Yes
Clarity Measurements	Yes	Yes
Sediment Chemistry and *E. Coli*	Yes	Yes

1.2 How to use this document

1.2.1 Overview

The Watercourse Assessment Report document summarises comprehensive data collected during the field watercourse assessment, as well as, additional Stream Ecological Valuations (SEV's) conducted at representative reaches throughout the survey area. The document relies on tables and maps to provide concise information to guide selection of management actions.

This document consists of a literature review (Section 2.0), summary of the watercourse assessment findings (Section 3.0), SEV results (Section 4.0), and watercourse management (Section 5.0) including Management Zones, Enhancement Opportunities and Maintenance Activities. These sections are supported by a map series provided in the appendices, which should be referred to whilst reading the body of the Watercourse Assessment Report. The geodatabase provided should be used for further analysis and interrogation.

Refer to the Watercourse Assessment Methodology: Infrastructure and Ecology (Version 2.0) document (Lowe *et al.* 2016) for information regarding survey methodologies and data collected during the field survey as well as information on the background and objectives of the Watercourse Assessment process and relevant policies and plans. Figure 1 provides a guide to the Watercourse Assessment structure.

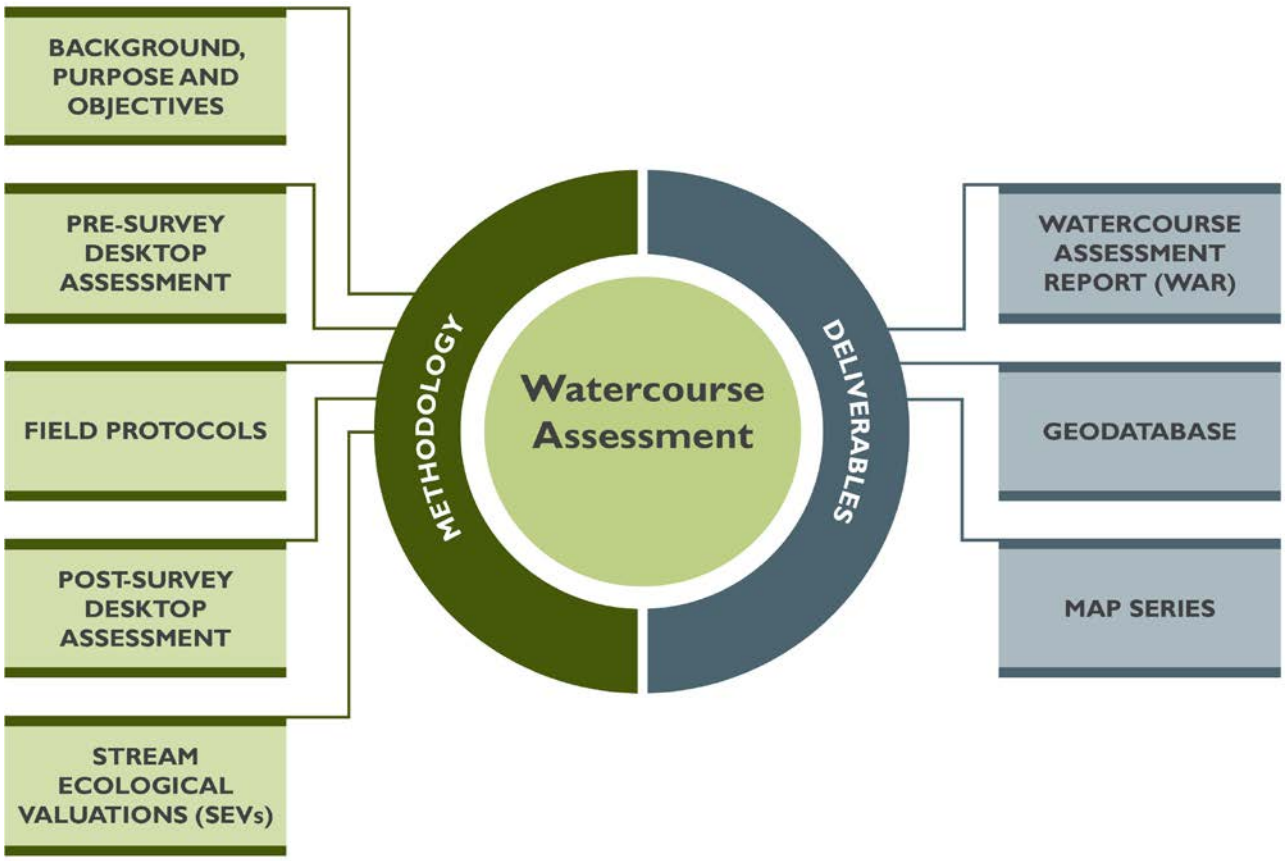


Figure 1: Watercourse Assessment structure.

1.2.2 Limitations

1.2.3 Identified Options

Auckland Council is not obligated to undertake any works identified as enhancement or management options in a WAR, nor is Auckland Council bound by preliminary prioritisation of projects undertaken as part of this methodology. Recommendations made will be considered within the context of Auckland Councils obligations, constraints, drivers, project identification, and catchment prioritisation undertaken or identified by Auckland Council.

1.2.4 Stream Classification

The Watercourse Assessment provides an unofficial field estimate of stream classification only and this classification is not specifically intended for Resource Consent purposes. Although specific and detailed assessment is required prior to consent approval for any works within a subject reach, the details contained in this document can be used to guide associated investigations for a resource consent application. Failure to identify a stream reach during this Watercourse Assessment process does not suggest that a stream does not exist or that any such stream is ephemeral.

1.2.5 Temporal limitations

Watercourse Assessment undertaken as per this methodology must be considered within the seasonal context. Variables such as water depth and velocity are dependent on the level of base flow, and stormwater influx prior to the assessment. Time since last rainfall event is recorded which can guide interpretation. Factors that are more variable over diurnal time scales such as temperature are not recorded as part of this assessment as time series data is required for meaningful results.

1.2.6 Rapid Assessment

It is acknowledged that the Watercourse Assessment Methodology is a ‘rapid’ assessment of engineering assets, as well as, biological and geomorphological stream state for informing effective management of, stream ecological health; stormwater infrastructure and stormwater conveyance. Therefore, this methodology may lack some parameters of more specific assessments (some of which have informed the development of this methodology).

2.0 Literature Review

2.1 Catchment Overview

The Oira Creek is a watercourse network (total catchment area = 20.3 km^2) situated within Auckland's Franklin District. Its headwaters arise from the north-eastern fringes of Pukekohe and drain predominantly rural land (58.2%, plus most of the land currently classified for new growth). Future urban growth areas have been earmarked for two sections within the Oira catchment; land located to the south of the catchment to expand the Pukekohe township, and to the east of its confluence with Drury Creek (25.3% of the catchment; Auckland Unitary Plan – Operative in Part (AUP(OP)), 2016). This is to help accommodate Auckland's growing population, and is one of many catchments likely to see significant changes in land use in the future.

Auckland's population is anticipated to grow by up to one million people by 2040 (Auckland Plan, 2012). It is anticipated that 400,000 new dwellings will be required to meet this growth figure and key strategic documents (Auckland Plan, 2012; AUP(OP), 2016) have identified rural land on the city fringes, along with the transition of smaller outlying communities into larger satellite hubs, as a way of partially supplying the accommodation required by Auckland. The 1,016 ha Drury West greenfield, which includes land within the Oira Creek catchment, is projected to contain up to 11,000 more dwellings by 2040 (AUP(OP), 2016). Pukekohe has been identified as a priority satellite town, with the 2040 population projected to reach 50,000, more than doubling its existing population (Franklin Local Board, 2014). This urban expansion will inevitably lead to changes in catchment land use which will consequently impact the functionality of the Oira Creek.

The Franklin Local Board recognises that there is likely to be rapid future growth within the area. The current Franklin Local Board Plan 2014 – 2017, identifies five key outcomes designed to provide a framework to guide decision-making and actions within the area as well as representing the community's interests in regional strategies and plans. These outcomes include; a cherished natural environment with healthy, well looked after forests, open spaces and waterways, and well-planned growth that protects agricultural production, minimises urban sprawl and provides timely and appropriate infrastructure.

Refer to Maps 1 and 2 in Appendix A Maps and Table 3 below.

Table 3: Catchment Overview.

Attribute					
Catchment Area (km^2)	20.3				
Geology	Basaltic rock and alluvium				
% Imperviousness	*1.6*				
	Public Open Space	**Rural**	**Residential**	**Business**	**New Growth**
Land use (% catchment)	*2.1*	*58.2*	*10.7*	*0.5*	*25.3*
Receiving Environment	Pahurehure Inlet, Manukau Harbour				

2.2 Catchment Development History

Historically the Oira Creek catchment was dominated by broadleaf podocarp forest, kahikatea (*Dacrycarpus dacrydiodes*) swamp forests and wetland systems (Lindsay *et al,* 2009, Singer *et al*. 2017). The soils within the catchment are largely of volcanic origin (Viljevac *et al.*, 2002), providing excellent growing conditions which ultimately resulted in the area being classified as high-quality land for agriculture (Land Use Capability Class 2 and 3; Curran-Cournane *et al.,* 2014). Consequently, large scale deforestation/draining of the Oira Creek catchment occurred over the past two centuries to support intensive agricultural practises. Presently, land use within the catchment is dominated by large tracts of grazed pasture, supporting dairy, dry stock and horses, as well as short-rotation cropland and the associated infrastructure (Kelly, 2008; Parshotam *et al.,* 2008). Small patches of remnant podocarp forest (dominated by puriri, *Vitex lucens*, and taraire, *Belischmiedia taraire*), kahikatea swamp forest and wetland still exist, particularly towards the southern reaches of the catchment, however these are highly fragmented (Singer *et al.* 2017).

Projected population growth and urban expansion within the Franklin District will likely result in the conversion of parcels of land within the Oira Creek catchment from agricultural to urban. Increased urbanisation has the potential to put additional strain on existing conveyance systems and may lead to an increased risk of flooding in flood sensitive areas. Much of the land along the margins of the Oira Creek that will flood during a 1% Annual Exceedance Probability (AEP) rainfall event is currently uninhabited, however there are some residential properties, particularly along Woodlyn Drive where potentially habitable buildings are within the 1% AEP flood zone (Paice, 2015). Additional conveyance strain may increase the risk to these properties and expand the amount of area currently within the 1% AEP zone. Since the initial preparation of a Catchment Management Plan (CMP) for North Pukekohe in 2002, Auckland Council has progressively upgraded culvert capacity in problematic areas (Franklin District Council, 2009). It is unclear whether any culverts within the Oira Creek catchment have been upgraded.

As part of the AUP(OP) small areas within the Oira Creek catchment are now designated as Stormwater Management Areas – Flow 1, therefore the development or redevelopment of impervious surfaces has specific requirements concerning the retention of stormwater (Auckland Council, 2013). The water sensitive design approach to stormwater management encouraged by the AUP(OP) through numerous policies and objectives, provides the opportunity to integrate multiple values into conveyance management systems, including biodiversity and community values. As the future urban growth areas on the northern fringes of Pukekohe and the eastern side of the lower Oira Creek (Drury West greenfield) are within the Rural Urban Boundary, similar development initiated stormwater controls can be expected within the Oira Catchment.

2.3 Prior Watercourse Assessment

The majority of the Oira Creek catchment is rural private land and therefore very little information regarding this watercourse has been collected. This is reflected in Andrew Stewart Limited (2012) who reviewed the state of freshwater environments within Auckland Council's 'Southern Sector'. The review summarised existing freshwater environmental data collected from each of the 44 catchments within the 'Southern Sector' and only referenced a single study, Phillips *et al*. (2006), that contained information pertaining to the Oira Creek.

Phillips *et al.* (2006) reported on the stream management component of an Integrated Catchment Management Plan developed for the former Papakura District Council. As part of this report a single site within the Oira Creek (6451386.2 N 2680887.8 E, where the main channel intersects with SH22) was examined for metal and bacterial contaminants, biotic intactness and overall stream function. Results from the study can be summarised as follows:

- Contaminant tests showed that copper and zinc levels within the water and sediment were below ANZECC guidelines.
- *E. coli* counts were 2.2 times higher than the National Guideline values of 550 E. *coli* /100 mL.
- Inanga (*Galaxias maculatus*) was the only fish species recorded during electrofishing and resulted in an Index of Biotic Integrity score of 16, or 'very poor', indicating the fish community was depleted in comparison to the species that could reasonably be expected at that elevation and distance inland.
- Of the 10 macroinvertebrate taxa collected only 2 were from the EPT group of taxa that are typically sensitive to increases in pollution or habitat changes.
- An Invertebrate Community Loss Index (ICLI) was calculated based on the observed community composition compared to what would be expected in an undisturbed system. For the Oira Creek the ICLI was scored as 'poor'.

- The stream ecological valuation (SEV) score was 0.57. The stream at the location surveyed scored moderately well for hydraulic and biogeochemical functioning, with very good flood plain connectivity and decontamination of pollutants. However functional scores suffered in terms of habitat provisioning and biodiversity intactness with limited spawning habitat for bullies (*Gobiomorphus* sp.), little woody debris or hydrological habitat variation, a poor riparian zone and compromised fish and invertebrate communities.

Phillips *et al*. (2006) concluded that the Oira Creek had high levels of *E. coli* contamination, likely due to livestock effluent inputs upstream, and that bacterial contamination was a major concern within the entire study area. The report concluded that Oira Creek had marginal ecological values, particularly in terms of providing suitable habitat for aquatic biota, and this was a result of the limited presence of riparian vegetation.

2.4 Significant and Existing Ecological Values

The Oira Creek flows into the Pahurehure Inlet of the Manukau Harbour, via Drury Creek. This is a low energy receiving environment dominated by soft, fine sediments and expansive mangrove forests (Kelly, 2008). Much of the Oira Creek tidal inlet is classified as a marine significant ecological area (SEA; SEA_M2_29a), comprising a variety of intertidal habitats, including characteristic transitional zones from mangroves to saltmarsh to freshwater and terrestrial vegetation. The Oira Creek also provides important habitat for wading birds (SEA_M2_29w1-2), including pied stilt (*Himantopus himantopus leucocephalus*).

Only a small amount of native forest and swampland that once dominated this area remains within the Oira catchment, with the land now predominantly characterised by pasture or cropland for agriculture purposes. The scarcity of these original land covers is reflected by the small number of terrestrial SEAs identified by the AUP(OP) within the Oira Creek catchment (Table 4; n = 13). For the most part, these SEAs are small and stand as isolated patches of remnant habitat within an agricultural landscape. No terrestrial SEAs are present north of State Highway 22.

The West Ramarama section of Outstanding Natural Landscape Area 59 (West Ramarama and Bombay) sits partially within the Oira Creek catchment and can be found slightly east of the Burtt and Tuhimata Roads intersection. This landscape is described as an "*attractive sequence of remnant forest and stream corridors contrasting with the surrounding pasture and market gardens, that reinforces the rolling to incised nature of the local rural landscape*".

Table 4: Significant ecological areas near streams within the Oira Creek Catchment.

Significant Ecological Area	Closest Ecoline	Representativeness	Threat Status / Rarity	Diversity	Stepping Stone / Migration Pathway / Buffer	Uniqueness or Distinctiveness
SEA_M2_29w1-2	Stream mouth					
SEA_M2_29a	Stream mouth					
SEA_T_4484	4_014_A	✓	✓	✓		
SEA_T_95	1_139_B	✓	✓	✓		
SEA_T_5352	4_015_C	✓	✓			
SEA_T_5353	1_151_B	✓	✓			
SEA_T_5351	4_020_B	✓	✓			
SEA_T_94	1_158_B	✓	✓			
SEA_T_4381	3_023_A	✓	✓			
SEA_T_93	3_023_C	✓	✓	✓	✓	
SEA_T_4380	1_160_A	✓	✓			
SEA_T_4375	3_029_B		✓		✓	✓
SEA_T_91	2_078_E	✓	✓			
SEA_T_4374	1_187_D				✓	
SEA_T_5278	1_196_A	✓	✓			

The catchment partially sits atop the Pukekohe Section of the Kaawa Aquifer and is classified as a High-Use Aquifer Management Area. Aquifers are an important contributor to the base flow of many streams, particularly in the southern parts of Auckland and provide important inputs into the overall quality and diversity of surface waterbodies (AUP(OP), 2016). High-Use Aquifers are those that are highly allocated, provide water to users, contribute to stream base flows, or will become highly allocated, putting pressure on the resource, particularly in potential growth areas (AUP(OP), 2016). Aquifer recharge is reliant on rainwater infiltration and an increase in impervious surfaces, due to urban development may result in increased surface water runoff, and reduced infiltration that would ultimately

contribute to aquifer recharge. The Oira Creek is considered to be sensitive to changes in the amount of imperviousness within the catchment and an increase in imperviousness is likely to have a significant negative effect on the groundwater contribution to base flows within the creek (Pattle Delamore Partners Ltd, 2012).

2.5 Cultural and Heritage Values

Several iwi identify with the land and waters surrounding the Oira Creek and its tributaries, including; Ngāti Tamaoho, Ngāti Te Ata, Ngāti Pou and Te Ākitai Waiohua (Flavell, 2010; Rutherford and Flavell, 2011; Heritage Consultancy Services, 2013; Te Ākitai Waiohua, 2015). The Manukau Harbour is considered a taonga and is considered a pateka kai (food bowl). The protection and enhancement of environmental linkages associated with the Manukau Harbour is regarded as a fundamental issue for iwi (Waitangi Tribunal, 1985). As such the tributaries feeding into the Manukau have cultural significance, both for food harvesting and ceremonial purposes.

Several archaeological sites are recorded on the Auckland Council GIS system within close proximity to the Oira Creek watercourse. The most significant is an historic, fortified Ngāti Tamaoho pa named Te Maunu-a-Tu, which once sat atop the Paerata Bluff. Several shell midden sites also exist around the mouth of the Oira Creek, suggesting the area was used, at least seasonally, for collecting resources.

The Burtt's Farm homestead ("Glenconnel"), built in 1859 (Cowen, 1955), is located near the historic Te Maunu-a-Tu pa site. This represents the only identifiable colonial or early European building with heritage values within the Oira Creek Catchment.

2.6 Community Involvement

The Franklin District Local Board recognises that the waterways within the region have significant importance to mana whenua and local residents, and are a resource to be utilised, used and enjoyed. The Local Board is committed to improving water quality within the region, and in general improving the overall state of its watercourses (Franklin Local Board, 2014). As part of its Cherished Natural Environment Outcome the Local Board is keen to support community initiatives such as plantings to enhance rivers, streams and coastlines (Franklin Local Board, 2014). Despite this, the rural nature of the Oira Creek Catchment and lack of public access to the waterway has, to date, resulted in very little opportunity for community involvement. Future development of the areas designated Urban or Future Urban may increase the opportunity for restoration and improved amenity values for local communities.

The Local Board is also part of the Manukau Harbour Forum, a collective of the nine local boards that border the Manukau Harbour. Strategic objectives for the Manukau Harbour Forum include raising the profile of the Manukau Harbour and its importance as a cultural, environmental and economic treasure. They also advocate for integrated management of

the Manukau Harbour to be incorporated into all planning frameworks and new Manukau Harbour projects.

3.0 Summary of Findings

3.1 Ecoline

The Oira Creek watercourse assessment was carried out between November 2016 and April 2017. Rainfall during the summer period (December to February) was lower than average (NIWA, 2017) and stream physical attributes were generally reflective of dry summer survey conditions. March and April had multiple, large rainfall events which resulted in surveys conducted one or two days after a significant rainfall event on numerous occasions. This was taken into consideration when assessing stream classification (permanent/ intermittent/ ephemeral).

As per the survey protocol, full ecoline assessments were only carried out for stream reaches classified as permanent or intermittent. The below summary of findings is therefore based on the total length of surveyed permanent and intermittent stream, not the total length of stream surveyed.

3.1.1 Physical Attributes

The Oira Creek, and its tributaries formed a predominantly soft-bottomed (sand and silt) watercourse, which drained through highly-modified agricultural land in Southern Auckland. Physical stream attributes were reflective of this fact (Table 5). Approximately 70% of the watercourse was bounded, at least on one side, by agricultural land with the majority of this land supporting livestock. Roughly one quarter of the surveyed watercourse (23%) had some form of channel modification, likely designed to improve conveyance and/or protect valuable land from flooding.

A lack of fencing throughout the catchment allowed stock access to 26,488 m, or 54% of the watercourse on at least one side. Moderate to severe stock damage was observed along 76% of these unfenced lengths of stream. Bank angles were moderately steep, averaging 39°, and 95% of all banks showed some degree of erosion scarring. Banks with less than 20% erosion scarring were the most frequently observed (65%), compared to 35% (34,682 m) which showed greater than 20% erosion scarring. The effects of stock access on the watercourse are further highlighted, as 22,963 m (66%) of the 34,682 m of bank which contained greater than 20% erosion scarring occurred along reaches with direct stock access.

The majority of banks assessed had an overall Pfankcuk bank stability score of ‘fair’ (Table 6) which would indicate the potential for ongoing erosion and slumping issues. In general reaches scored well in the mass wasting and debris jams categories but poorly on banks gradient and bank vegetation.

Active sediment deposition was low, averaging 10%, throughout the catchment. This was likely a reflection of the dry sampling conditions through December to February, where active erosion was likely to have been low. Interestingly 13 of the 20 ecolines (65%), where active sediment deposition was observed to be 50% or greater were surveyed in March and April following the multiple intensive rainfall events through those months.

Table 5: Summary of physical variables across the extent of watercourse surveyed. Note Adjacent Land Use is assessed separately for the TRB and TLB therefore the total length will be double the surveyed area. Summary statistics, from reach length onwards, are based off the surveyed permanent and intermittent reaches only.

Attribute							
Total Length of Surveyed Watercourse (m)	*61,557 (49,602 fully assessed)*						
No. Reaches	*725*						
	Permanent		**Intermittent**		**Ephemeral**		
Class (% of total stream length) (length of stream (m))	*48* *29,387*		*33* *20,215*		*19* *11,955*		
Summary of Permanent and Intermittent Reaches							
	Mean		**Min**		**Max**		
Reach Length (m)	*85*		*4*		*492*		
Average Width (m)	*1*		*0*		*5*		
Depth (m)	*0.22*		*0*		*1.5*		
Bank Angle (degrees)	*39*		*2*		*90*		
Bank Height (m)	*1.2*		*0.05*		*12*		
Sediment Deposition (% accumulation)	*10*		*0*		*100*		
	Bush	**Park**	**Agricultural**	**Residential**	**Light Industry**	**Industrial**	**Impervious Surface**
Adjacent Land Use (% of total stream length) (length of stream (m))	*24.0* *23,772*	*0* *0*	*69.8* *69,219*	*5.0* *4,960*	*0.6* *564*	*0.2* *192*	*0.5* *497*
	Artificial	**Bedrock**	**Boulder**	**Cobble**	**Gravel**	**Silt/Sand**	
Dominant Substrate (% of total stream length) (length of stream (m))	*0* *0*	*0.8* *402*	*0* *0*	*0.5* *231*	*0* *0*	*98.7* *48,969*	
	Widened	**Straightened**	**Deepened**	**Lined**			
Channel Modification (% of total stream length) (length of stream (m))	*17.1* *8,490*	*20.6* *10,227*	*15.1* *7,515*	*1.2* *594*			
	0%	**≤20%**	**20-40%**	**40-60%**	**≥60%**		
Erosion Scarring (% of total stream length) (length of stream (m))	*5.1* *5,073*	*59.9* *5,9448*	*22.5* *22,353*	*9.7* *9,657*	*2.7* *2,672*		
	None	**Minor**	**Moderate**	**Severe**	**NA**		
Stock Damage (% of total stream length) (length of stream (m))	*0.9* *427*	*11.9* *5,885*	*18.7* *9,296*	*21.9* *10,880*	*46.6* *23,115*		

Table 6: Summary of Pfankuch bank stability assessment of the total length of watercourse (m).

	Excellent	Good	Fair	Poor
Land Slope (m)	*11,888*	*7,363*	*13,363*	*16,987*
Mass Wasting (m)	*8,487*	*29,669*	*8,808*	*2,638*
Debris Jam (m)	*10,044*	*26,807*	*10,198*	*2,553*
Bank Vegetation (m)	*4,743*	*10,832*	*11,618*	*22,409*
Overall Stability Index (% of total stream length) (length of stream (m))	*2.2* *1,094* *Scores ≤13*	*32.2* *15,953* *Scores 14- 23*	*56.8* *28,188* *Scores 24 -32*	*8.8* *43,67* *Scores ≥33*

3.1.2 Water Quality Attributes

Four ecolines were observed to contain sewage fungus (Table 7). One of these ecolines was alongside an active green house that had multiple small drainage pipes discharging into the stream. Some streams were also observed to have bacteria sheens associated with effluent (likely livestock effluent), and in multiple areas the banks and stream channel had a strong effluent odour.

Roughly one in five ecolines surveyed had anoxic conditions, denoted by dark, bubbling sediment (Table 7). Of the 131 observations of anaerobic conditions, 96 or 73% occurred along sections of stream which had stock access from one or both sides. Sludge worm (*Tubifex tubifex*), a pollution tolerant species able to live in anoxic sediments was observed on two separate occasions.

Iron oxidising bacteria, forming fluffy orange growths or 'flocs' in slow-moving or still sections of stream were commonly observed and represented most of the 'other' attribute in Table 7. These bacteria obtain their energy by oxidising iron so are commonly found in iron-rich bodies of water (Landcare Research, 2017b). This can occur naturally where the watercourse interacts with iron-rich soils and seepages or where iron leeches into the water via an external source. On many occasions, the source could be traced to a specific location where rubble or rubbish, containing rusting iron products (often corrugated iron) was located near the watercourse.

One-off water clarity measurements were made on the 18th and 19th May 2017 during the Stream Ecological Valuation assessments (Section 4). Water clarity varied between 0.27 m and 0.48 m, which is considered between very turbid and extremely turbid (Biggs *et al.* 2002). Elevated stream turbidity is a likely indicator of a high suspended sediment load. High suspended sediment loads can impact instream plant communities by reducing light levels (Ryan 1997), altering native fish behaviour and/or having a lethal effect if prolonged exposure occurs (Kelly, 2010), which is detrimental to most stream life (Biggs *et al.* 2002).

Table 7: Summary of watercourse contamination.

Attribute	Number of observations		
Sewage Fungus	4		
Petroleum/Hydrocarbons	0		
Anaerobic Conditions	131		
Other	115		
	Mean	**Min**	**Max**
Clarity (m)*	*0.40*	*0.27*	*0.48*

*From SEV results only.

3.1.3 Biological Attributes

3.1.3.1 Vegetation

There was a limited intactness of the riparian margins along the Oira Creek and pasture was the most commonly observed streamside vegetation (Table 8). This is typical of a modified agricultural catchment where large scale land clearance has occurred to support livestock grazing. The lack of fencing and subsequent stock damage along many of the stream banks has further reduced the integrity of the riparian zone. Native riparian vegetation has particularly suffered as a consequence of land use changes, and presently very little of the observed canopy, understory or ground cover could be described as dominated (>70% population composition) by native species.

Where riparian vegetation did exist, it generally formed a thin (<5 m wide) buffer zone against the stream edge and lacked a canopy, providing little overhead shading (Table 8). For reaches where canopy trees were present and/or formed the dominant vegetation type, they were often exotic monocultures of pine (*Pinus* radiata), poplar (*Populus sp.*) or willow (*Salix sp.*). Understory vegetation comprised mostly of exotic or mixed vegetation containing some combination of Chinese privet (*Ligustrum sinense*), woolly nightshade (*Solanum mauritianum*), gorse (*Ulex europaeus*), red matipo (*Myrsine australis*) and tree ferns (*Cyathea sp.* and *Dicksonia sp.*).

Table 8: Summary of riparian vegetation across the extent of watercourse surveyed. Note that Average Riparian Width, Vegetation Height Categories, and Dominant Vegetation Type are assessed for each bank separately so the sum total length will be twice the total length of surveyed watercourse.

Attribute						
Length of Surveyed Permanent and Intermittent Watercourse (m)	*49,602*					
No. reaches (Ecolines)	*583*					
	Mean		**Min**		**Max**	
Percentage of intact vegetation within reach.	***40***		***0***		***100***	
	≤10 %	***≤30%***	***≤50%***	***≤70%***	***≤90%***	***>90%***
Average Overhead Cover (% of total stream length) (length of stream (m))	***30.8*** *15,295*	***14.4*** *7,150*	***18.9*** *9,390*	***16.7*** *8,284*	***15.1*** *7,473*	***4.1*** *2,009*
	0m	**≤5m**	**≤10m**	**≤15m**	**≤20m**	**>20m**
Average Riparian Width (% of total stream length) (length of stream (m))	***37.1*** *36,840*	***33.8*** *33,538*	***16.1*** *16,019*	***6.4*** *6,370*	***4.2*** *4,139*	***2.3*** *2,299*
	None	**Exotic**	**Mixed**	**Native**		
Canopy (% of total stream length) (length of stream (m))	***54.8*** *54,355*	***30.1*** *29,829*	***4.6*** *4,540*	***10.6*** *10,480*		
Understorey (% of total stream length) (length of stream (m))	***46.9*** *46,482*	***17.6*** *17,465*	***23.9*** *23,673*	***11.7*** *11,584*		
Groundcover (% of total stream length) (length of stream (m))	***2.9*** *2,887*	***80.9*** *80,264*	***13.4*** *13,316*	***2.8*** *2,737*		
	Grassed	**Planted**	**Low Growing**	**Scrub**	**Regenerating**	**Mature**
Dominant Vegetation Type (% of total stream length) (length of stream (m))	***38.6*** *38,258*	***8.6*** *8,497*	***10.7*** *10,595*	***11.2*** *11,143*	***5.7*** *5,642*	***25.3*** *25,069*

Runoff and nutrient loading, in conjunction with a lack of stream shading can result in a waterway containing excessive macrophyte and periphyton growth. Both submerged and emergent macrophytes were commonly observed in the Oira Creek (Table 9). In more than 37% of the ecolines surveyed emergent macrophyte cover was more than 20%.

Macrophytes have the potential to choke waterways and impede water movement, which can cause flooding issues during rainfall events (James, 2013). Periphyton was less commonly observed than macrophytes, however this may have been due to the lack of suitable stable substrate to maintain periphyton growth. Where periphyton was observed it typically comprised of small patches of green diatomaceous or filamentous algae growing

on the muddy substrate. Such growths can be easily disturbed or scoured during elevated stream flows.

Of concern to the watercourse was the widespread occurrence of *Glyceria maxima*, which is listed as a surveillance – whole region species under the Auckland Regional Pest Management Strategy (Auckland Regional Council, 2007). *Glyceria*, or sweet reed grass, a species of wetland grass native to Europe and temperate Asia, has become a serious aquatic weed in New Zealand, Australia and North America (Loo *et al*. 2009). This is an extremely fast-growing grass that can colonise an area, quickly out-compete the existing vegetation and subsequently form a dense monoculture (Saintly and Jacobs, 1994; Loo *et al.* 2009). *Glyceria* is a major source of cyanide poisoning in livestock (Saintly and Jacobs, 1994) and is considered as an autogenic ecosystem engineer (Clark *et al.* 2004). Dense stands are effective at impeding water flows and trapping sediment, which can eventually lead to the conversion of fast flowing aerobic streams to partially anaerobic swampy environments (Saintly and Jacobs, 1994; Clark *et al.* 2004). The worst occurrence of *Glyceria* was within Enhancement Opportunity 3, where dense stands of *Glyceria* had developed and created wetland conditions throughout the stream reaches, upstream from a perched culvert (Refer to Section 5.2.3 for further details).

Table 9: Summary of instream vegetation across the extent of watercourse surveyed.

	≤20%	**20-50%**	**>50%**
Submerged Macrophyte Cover (% of total stream length) (length of stream (m))	***55.2*** *27,389*	***14.6*** *7,230*	***2.2*** *1,093*
Emergent Macrophyte Cover (% of total stream length) (length of stream (m))	***44.6*** *22,098*	***22.5*** *11,148*	***15.1*** *7,487*
Periphyton Cover (% of total stream length) (length of stream (m))	***21.1*** *10,478*	***2.4*** *1,183*	***0.8*** *374*

3.1.3.2 Habitat

The soft-sediment nature of the Oira Creek watercourse has resulted in the catchment containing low in-stream habitat diversity and a limited amount of stable bank undercutting (Table 10). Runs were the dominant habitat type with the mean proportion of an ecoline characterised as 83% run. Runs were periodically dispersed by pools, which were the only other habitat type with a mean proportion of stream length above 10%. Riffles, rapids and cascades were rarely observed. Some backwaters were present in the wetland sections of streams where oxbow lakes had formed as meanders became cut off from the main stream, however these were by in large stagnant, shallow bodies of water.

Considering there is general lack of stable undercutting, cobbles, boulders, woody debris or riparian vegetation throughout the catchment, macrophytes are likely to be providing the most important form of three-dimensional habitat to organisms living within the water column. Dense macrophyte roots were considered when assessing the potential for fish spawning habitat and partially accounted for the high proportion of ecolines containing in-stream spawning habitat. While these root mats can provide good spawning habitat, excessive macrophyte growth and decay can also negatively impact fish by lowering in stream oxygen levels (Caraco and Cole, 2002).

Many of New Zealand's native galaxiids have terrestrial egg development and lay their eggs in areas of riparian vegetation that are temporarily inundated by tidal or freshwater flows. (Hickford and Schiel, 2014). Of the surveyed watercourse, 24% had suitable bankside conditions for fish spawning (Table 10). Suitable bankside vegetation mostly comprised of dense, ungrazed pastural grasses as opposed to native vegetation. Two stream mouths with suitable bankside spawning habitat have been identified as Enhancement Opportunities (Refer to sections 5.3.5 and 5.3.6 for more details).

Table 10: Summary of watercourse habitat diversity. Note that for bank undercutting the categories are defined by a percentage of the total reach length with undercutting present i.e. if there are 500 m of reach with 'Good' undercutting then <50% of this total length is undercut. Refer to the methodology document for further details.

Attribute	**Mean**	**Min**	**Max**
Number of Habitat Types within reach	*2*	*1*	*5*
	In stream	**Bank**	**In stream & Bank**
Percentage of Reaches with Fish Spawning Habitat present	***29.1***	***9.1***	***15.1***

	None	**Some**	**Moderate**	**Good**	**Extensive**
Stable Bank Undercutting (% of total stream length) (length of stream (m))	***60.1*** *29,808*	***20.5*** *10,174*	***16.2*** *8,060*	***2.8*** *1,408*	***0.3*** *152*

3.2 Natural Structures

Natural structures were relatively rare through the Oira Creek Catchment with only 22 identified through the 61 km of surveyed stream (Table 11). Waterfalls flowing over bedrock were the most frequently observed natural structure. All natural structures were on private land and were difficult to access due to their remoteness and/or the surrounding watercourse being fenced off. No structure was therefore considered to pose a public safety risk.

Waterfalls and cascades have the potential to cause issues for upstream fish passage due to drop height, water depth, water velocity and turbulence. All 22 natural structures had

some form of fish barrier present which is likely creating an issue for fish dispersal throughout the catchment. Further details of this are described in Section 3.3 of this report.

Table 11: Natural structure safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m'.

Attribute				
Total number of natural structures		*22*		
		Access		
Not safe		Easy	Moderate	Difficult
Land Ownership	Public	*0*	*0*	*0*
	Private	*0*	*0*	*4*
Not safe, Drop >1.5m		Easy	Moderate	Difficult
Land Ownership	Public	*0*	*0*	*0*
	Private	*0*	*0*	*5*

3.3 Fish Survey

During the watercourse assessment, a total of 3136 fish were observed (Figure 2). Banded kokopu (*Galaxias fasciatus*), inanga (*G. maculatus*), shortfin eel (*Anguilla australis*) and *Gambusia* (formerly mosquitofish, *Gambusia affinis*) were all positively identified. Unidentified bully, galaxiid and eel species, along with fish where no identification to genus level was possible, were also observed. The majority of observations (81%) were *Gambusia*, an exotic species classified as an 'unwanted organism' by the Biosecurity Act (1993). *Gambusia* are highly competitive, can tolerate a wide range of environmental conditions and can produce 3-4 broods per year, all of which create the potential for this species to impact our native fish species (Baker *et al.* 2004). Loose schools of a few hundred *Gambusia* were often observed in the shallow, unshaded margins of a stream or darting in and out of clumps of macrophytes. While they were observed throughout the catchment the frequency of observations notably increased south of Tuhimata Road (closer to Pukekohe).

Inanga were the most commonly observed native fish species (11% of total observations). Multiple schools were observed in the lower catchment, and particularly through many of the stream mouths. Of concern was the fact that *Gambusia* were also observed in several of the stream mouths. Experiments conducted by NIWA examining the effect of *Gambusia* on inanga at different temperatures, showed that in water temperatures above 15°C *Gambusia* were highly aggressive towards inanga and could cause considerable damage, via nipping to the caudal fin and peduncle (Baker *et al*. 2004). Both juvenile and adult inanga were susceptible to attack and more than 50% of inanga in each of the trials at water temperatures of 15°C or above died because of the damage sustained by *Gambusia* attacks (Baker *et al*. 2004).

Banded kokopu and shortfin eel were infrequently observed through the catchment. Banded kokopu were generally observed in well shaded sections of stream. Individuals would often dart away to some form of shelter as approached, but reappear after a minute or so if

observers remained relatively still. All shortfin eel observations were of exposed individuals lying stationary on the stream bed. A search of the New Zealand Freshwater Fish Database (NZFFDB) revealed only a single previous entry for the Oira Creek. This was in 1977, when Bioresearches recorded banded kokopu and unidentified eels. Numerical abundances were not available, however banded kokopu were occasionally observed (≥ 3 individuals) while eels were considered as common (> 10 individuals).

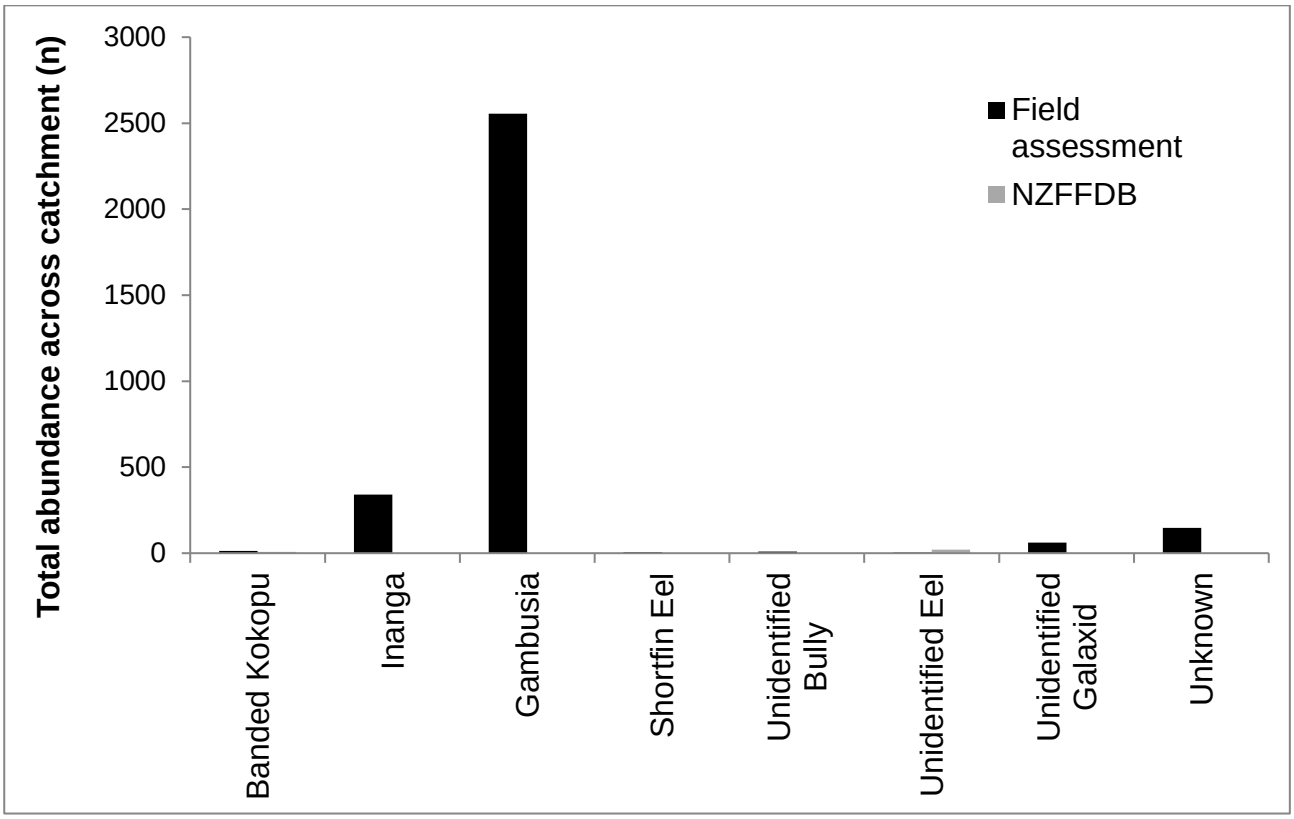


Figure 2: Fish species identified during the field survey and historically within the catchment from the New Zealand Freshwater Fish Database (NZFFDB). Where numerical abundances were not available in the NZFFDB the following abundance categories where used: Rare = ≤2, Occasional = ≥3, Common = >10, Abundant = >30. Midpoint values for each category were used in Figure 2.

Several fish passage barriers existed throughout the catchment (Table 12), which potentially limited the extent of watercourse that was inhabited by native fish. Culverts created the most significant issues, with 37% of all culverts surveyed (112 of 305 culverts) creating a barrier to at least one form of fish type (swimmer, climber or anguilliform). Of these 112 culverts, 64% comprised fish passage barriers for all three fish types. Culverts that were perched above the watercourse and/or experienced low flow impedances not characteristic of the surrounding reaches were the most commonly identified issues. No culverts were observed that contained devices intended to assist fish passage. There were relatively few fish passage issues associated with inlets and outlets. Fish passage issues were mostly associated with poorly constructed structures or damaged dissipating structures with inadequate flow depths, or a limited connection to the culvert. The majority of inlets and

outlets (72%) had no associated structure or only had an above culvert headwall, therefore were not assessed for fish passage issues.

Twenty-two natural structures were observed throughout the watercourse and all presented issues for fish passage. Natural waterfalls and cascades often had high velocity, high turbulence and a steep gradient, presenting a significant challenge for swimmers. Despite this there were generally enough wetted margins and/or sufficient resting areas for climbers and anguilliforms to be able to successfully navigate the barriers. Waterfalls in the lower catchment (upstream from ecolines 5_016_A and 3_001_B) could potentially be impacting the ability for swimmers (particularly inanga) penetrating further upstream. Only a single confirmed school of inanga was observed south (upstream) of these waterfalls.

Table 12: Fish passage and habitat features within the catchment.

Fish Barriers	Natural Structures	Engineering Assets (inlets and outlets)	Engineering Assets (culverts and pipes)
Fish Passage devices present	*na*	*1*	*0*
Barrier to Swimmers	*22*	*29*	*112*
Barrier to Climbers	*9*	*22*	*105*
Barrier to Anguilliforms	*3*	*11*	*72*

3.4 Stream Mouths

The Oira Creek drains into the Drury Creek arm of the Pahurehure Inlet, Manukau Harbour via a major tidal inlet. Several smaller stream channels within the lower catchment also drained independently into this inlet creating several separate smaller stream mouths. The tidal inlet servicing the Oira Creek exhibited a low energy environment, which contained well-established mangrove forests. It formed part of the Drury Creek SEA (M2_29a) which has been identified as significant due to the varied range of intertidal habitats and saline vegetation. The area is also considered as a suitable roosting site for pied stilts (AUP(OP), 2016).

The lower boundary of the Oira Creek stream mouth was characterised by a transition from mangrove forest to salt marsh, which in places was backed by freshwater wetland. Towards the upper boundary, bankside vegetation transitioned from saline tolerant to terrestrial. A distinct tidal line, below which no plants were growing, remained for the 300 metres preceding the upper boundary. Through this area crab holes were still sporadically observed. Vegetation in the smaller stream mouths varied between meadows of bachelors button (*Cotula coronopifolia*) and other ground covering species to transitional saltmarsh communities dominated by oioi (*Apodasmia similis*) and saltmarsh ribbonwood (*Plagianthus divaricatus*).

3.5 Inanga Spawning

Three areas of potential inanga spawning habitat were identified, totalling 469 metres (Table 13). All three areas were within small tributaries along the eastern side of the Oira Creek tidal inlet, as opposed to the main stream. Schools of inanga were observed within all three of these reaches.

The stream sections identified as having potential inanga spawning habitat were all well shaded, had low gradient banks, were likely to be inundated by tidal and rainfall events and were excluded from stock access. Ground cover at two sites (ecolines 2_003_A and 2_005_A and) were dominated by native sedges, while the third site (ecoline 1_020_A) had a much higher incidence of weedy species, and an overall less dense ground cover. Culverts creating fish passage issues were present at the upstream end of all three sites.

Two of the sites (ecolines 1_020_A and 2_005_A) had potential for enhancement. This is in large part due to the disconnect between the spawning habitats and upstream reaches caused by perched culverts. Remediation/removal of these culverts along with additional planting along the banks and the removal of debris creating natural stream impediments would be beneficial to these areas. More details on these sites as enhancement opportunities can be found in Section 5.2.5 and 5.2.6 of this report.

Table 13: Total length of potential inanga spawning habitat (m).

Inanga Spawning	Sedge/Rush	Pasture	Park	Other
No potential for enhancement (or already enhanced and protected)	*152*	*0*	*0*	*0*
Potential for Enhancement	*107*	*0*	*0*	*210*

3.6 Wetlands

A total of 175 wetlands were recorded throughout the catchment. Seventy-two (41%) were natural and 103 (59%) were artificial (Figure 3).

Palustrine wetlands were the most commonly observed natural type and often contained a mixture of sedges/rushes and pastural weeds. Ephemeral palustrine wetlands were frequently observed at the head of sub-catchments, particularly where steep hills gave way to a relatively flat, low gradient section of land. Most palustrine wetlands were not fenced and consequently, were impacted by stock damage. Larger riverine wetlands were found along the edges of major stream channels on ten occasions. Vegetation was more varied through these wetlands and often contained raupo (*Typha orientalis*), flax (*Phormium sp.*), cabbage trees (*Cordyline australis*), tree ferns, sedges (*Carex sp.*) and large exotics such as willow (*Salix sp.*). The largest area classified as a wetland was a natural riverine wetland

in the upper (southern) catchment. This comprised of a 40,574 m^2 area containing remnant stands of kahikatea (*Dacrycarpus dacrydioides*) swamp forest. Linking several of these remnant kahikatea stands and removing the weed species growing along the margins has been identified as an Enhancement Opportunity (see section 5.2.7 for more details).

Ponds designed to provide aesthetic value or service farm needs were the most commonly observed artificial wetland type. Aesthetic ponds were often located on lifestyle blocks, within close proximity to dwellings and had banks containing maintained mixed vegetation plantings. Many of the farm ponds were more remote and a number were poorly maintained, with no planted vegetation. Several maimai (duck shooting huts) were observed on these artificial ponds.

Perched culverts were present on many of these artificial wetlands. This potentially causes significant fish passage issues throughout the catchment as well as creating general stream conveyance problems. An area of concern is Enhancement Opportunity 3 (EO3) where culvert damming, because of a series of farm ponds and perched culverts, has led to a widespread *Glyceria* infestation. This has resulted in the conversion of multiple stream reaches into a *Glyceria* dominated wetland (See section 5.2.3 for more details).

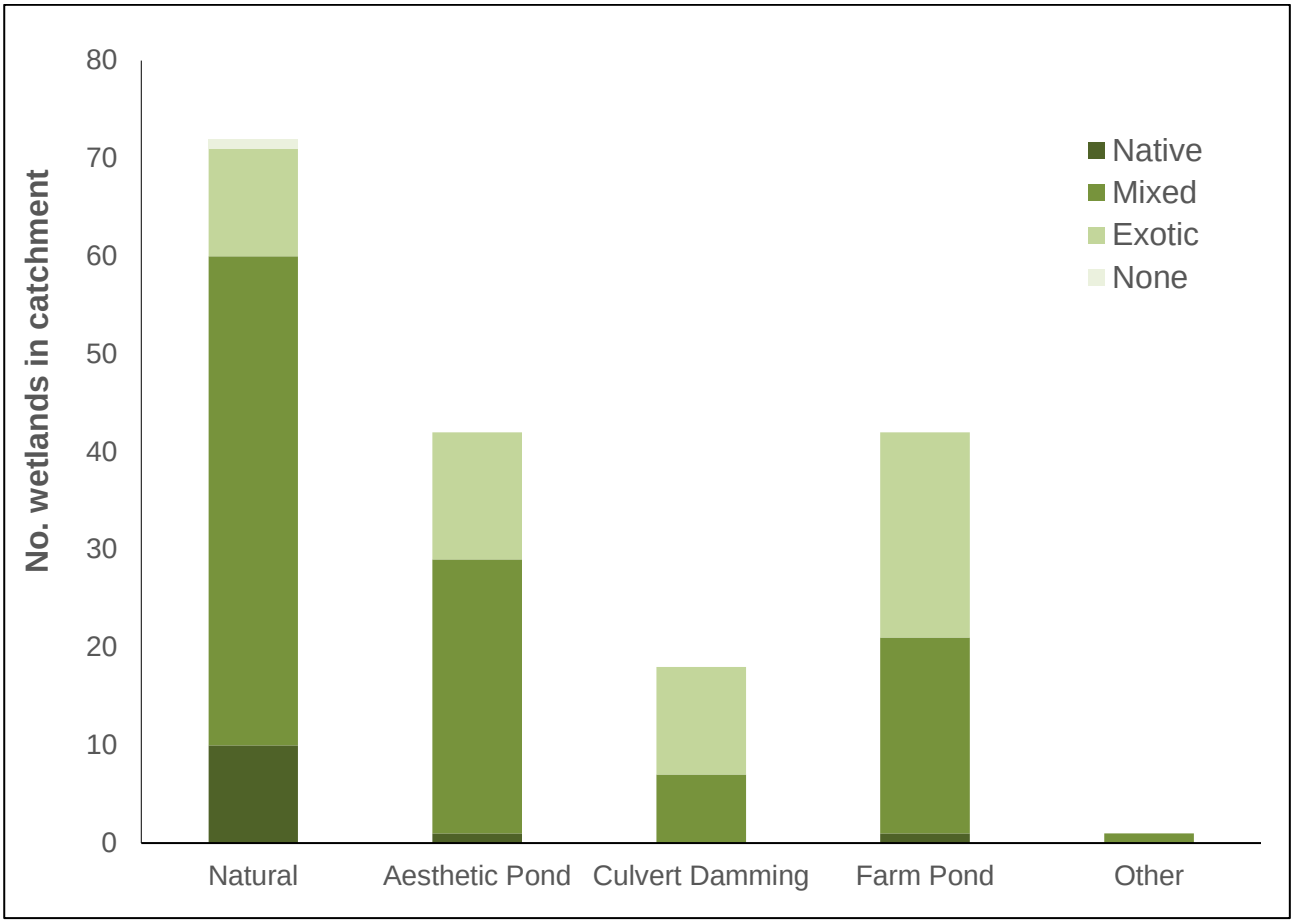


Figure 3: Summary of wetlands in the catchment area.

3.7 Engineering Assets (inlets, outlets)

Most of the assets found within the Oira catchment were private rural assets located on private land, with only very few reported in the Auckland Council GIS. The assets identified mostly consisted of private rural outlets discharging into waterbodies, and culverts to convey flow alongside or underneath public and private roadways.

This section provides description of inlets and outlets (defined as 'assets' in section 3.7) assessed at Oira Creek catchment (refer to section 3.8 for details about other engineering assets including culverts and pipes). A summary of those inlets and outlets is provided in Table 14.

Only three inlets and three outlets were owned by Auckland Council and located on Auckland Council land within Oira Catchment. All Auckland Council inlets/outlets were standard inlets/outlets with concrete headwall and wingwall with apron dissipating structure, and were correctly identified in Auckland Council GIS.

Table 14: Summary of Oira Creek outlets and inlets assessed over the watercourse extent.

	Assets Surveyed	**Assets Correct in GIS**	**Assets Incorrect in GIS**	**Assets Not in GIS**
Number of assets (inlets/outlets)	*593*	*6*	*0*	*587*

Condition Assessment	**Very Good**	**Good**	**Average**	**Poor**	**Very Poor**
Condition of structure	*2*	82	78	25	0

	None	**Slight**	**Moderate**	**Severe**
Extent of erosion associated with structures	*69*	*400*	*101*	*23*

	Replacement	**Structural**	**Patching**	**Debris Removal**	**Vegetation Clearance**	**Erosion Protection**
Maintenance required	*4*	*24*	*5*	*18*	*24*	*34*

The overall condition of assets was assessed using specified WAR methodology whereby each asset is assigned a condition rating along a spectrum from 'very poor' to 'very good'. This rating system could not be applied to inlet or outlet points that did not have headwall, wingwall or apron structures, and subsequently 68% of assets within the catchment could not be rated. The remaining 32% of assets are defined as 'rateable' throughout the report.

Most assets in the catchment were either in 'average' condition or in 'good' condition, representing 86% of rateable inlets/outlets (refer **Error! Reference source not found.**), and

27% of all inlets/outlets. Twenty-five inlets/outlets were considered in 'poor condition', representing 13% of rateable assets, and 4% of all assets. Two assets were in 'very good' condition and none were identified as being in 'very poor' condition.

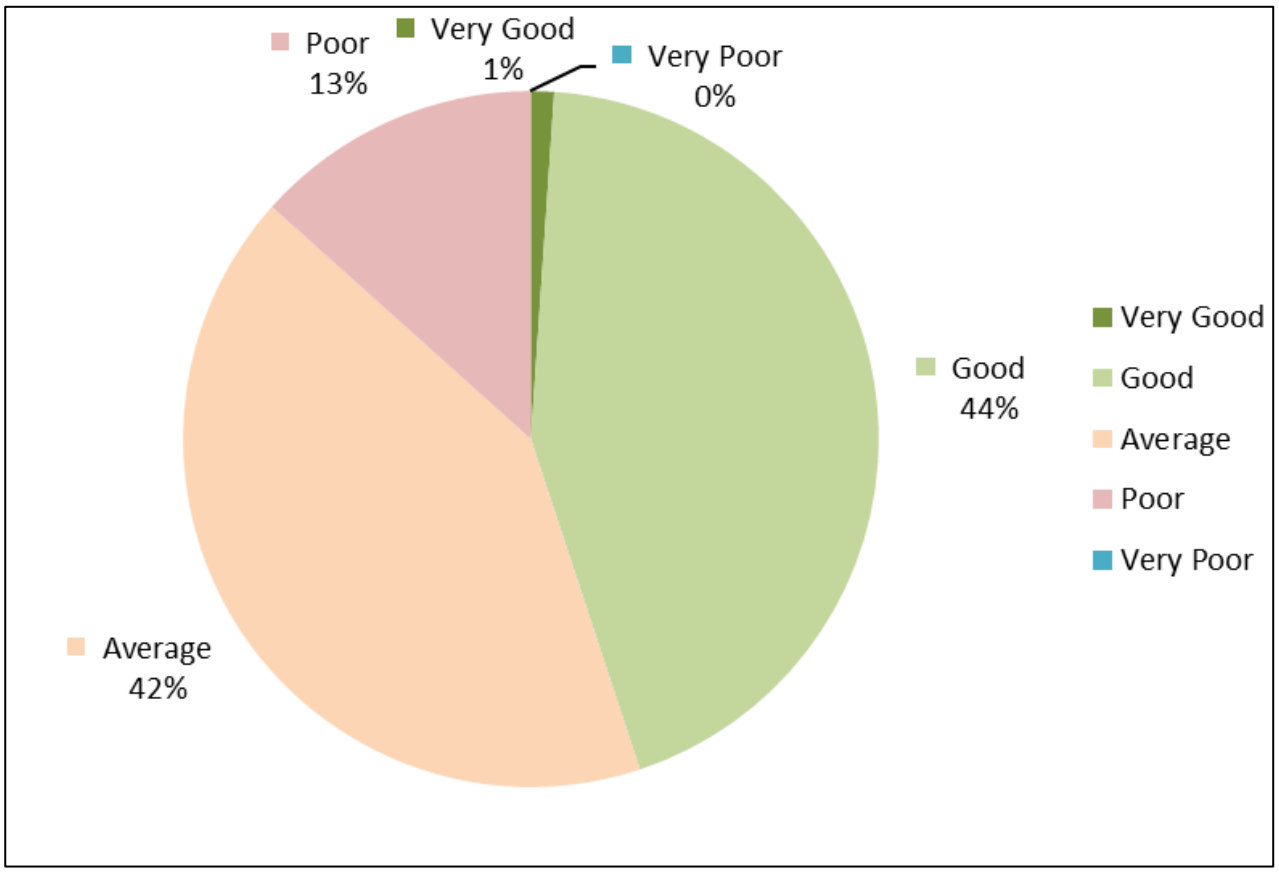


Figure 4: Oira Creek Outlets and Inlets Structures Condition Rating (of rateable inlets/outlets).

The condition of an asset and the type of maintenance required can have implications for stormwater conveyance and flood risk. These issues can be of concern in rural areas where banks are eroded and structures on private land are not operational due to structural issue or vegetation blockage/debris.

It has been identified in previous sections that some residential properties exist (particularly along Woodlyn Drive) where potentially habitable buildings are within the 1% AEP flood zone (Paice, 2015). Asset condition that affects conveyance through the catchment may exacerbate this issue. Auckland Council has progressively upgraded culvert capacity in Franklin District's problematic areas since 2009, however it is unclear whether any culverts within the Oira Creek catchment have been upgraded, since the preparation of the CMP for North Pukekohe in 2002.

The 2016-2017 watercourse assessment has indicated that twelve inlets/outlets (including two owned by Auckland Council) in the Oira Creek catchment (i.e. 6% of the total rateable inlets/outlets) were located within flood risk areas, thus these assets are generally not likely to pose a significant effect on stormwater flow conveyance and flooding.

Evidence of localised flooding issues was identified at several locations, which could potentially be due to the pipe/culvert being under capacity. It is recommended that a review of the capacity of the stormwater network is undertaken where flood risk has been identified in this investigation that may pose a risk to existing or future habitable floors.

Overall, approximately 58% of rateable inlets and outlets (representing 18% of total inlets/outlets) in the catchment required some form of maintenance. Assets which had a condition rating of ‘average’, to ‘poor’ typically required structural repair, replacement or patching. Generally, assets with a rating of ‘average’ required erosion protection and assets with a rating of ‘good’ required no maintenance; however, 42 inlets/outlets were noted as requiring routine maintenance by means of vegetation clearance or debris clearance. This is the responsibility of the asset owner.

Erosion protection was the most common form of maintenance required (18%), followed by structural repair (13%) and vegetation clearance (13%). Debris removal represented 9% of the rateable assets (i.e. 18 assets). A total of 33 inlets and outlets were identified as requiring engineering works through patching (five assets, i.e. 3%), replacement (four assets) and 24 assets required structural attention. Auckland Council owned inlets and outlets were in good condition, except for one outlet which was in ‘poor’ condition and required structural repairs. All Auckland Council (six) inlets/outlets rated as ‘good’ condition required vegetation clearance. It is recommended this is prioritised when implementing maintenance strategies.

The percentages of assets assessed at Oira Creek catchment requiring attention from each maintenance category are summarised in Figure 5.

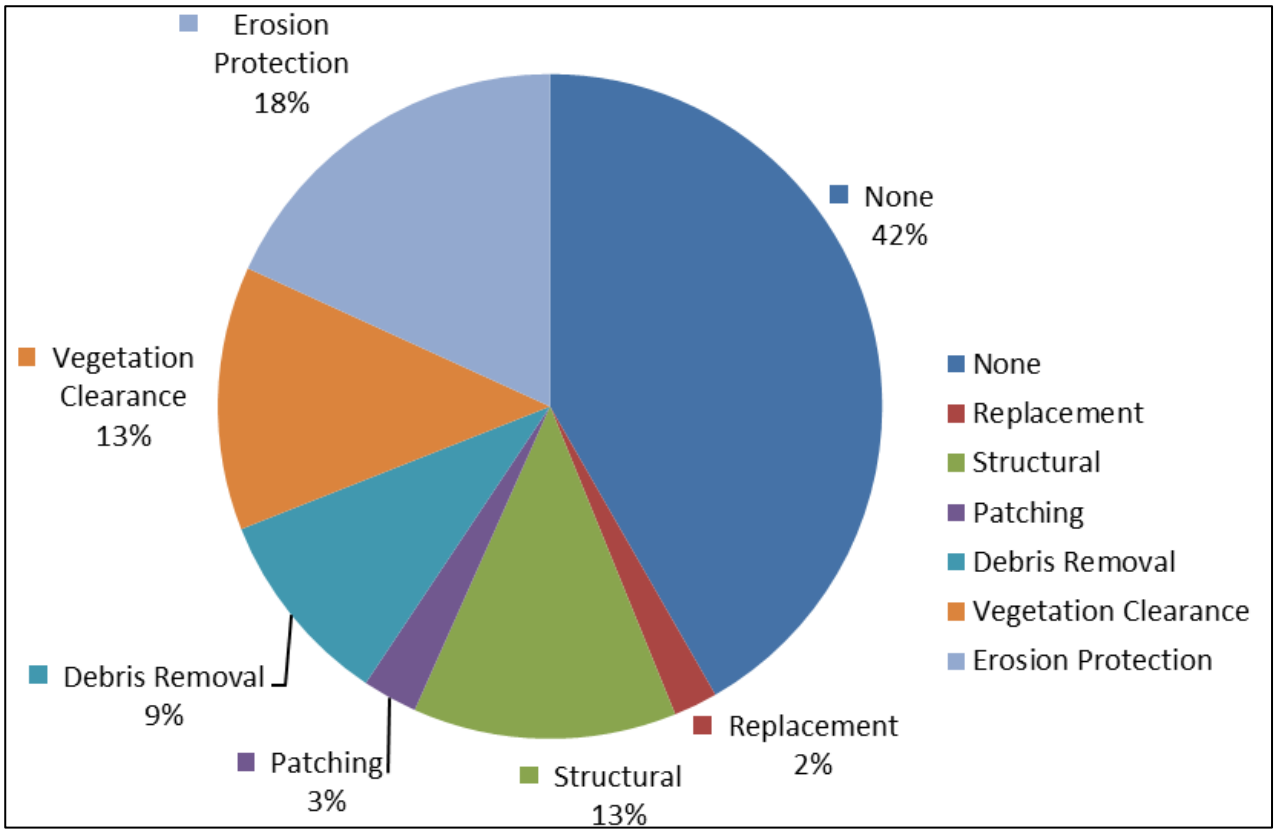


Figure 5: Oira Creek Outlets and Inlets Structures Maintenance Required Proportion (of rateable inlets/outlets).

A number of miscellaneous items were found throughout the catchment (refer to Section 3.11). A few observations were assessed as having a potentially significant effect on stormwater conveyance throughout the catchment, these included four pipes (debris jam and structural issues), two bridges, seven debris jams located generally within the stream itself, nine locations with piles of rubbish in ore adjacent to the stream and several man-made fords. Detail of miscellaneous items is provided in section 3.11.

Table 12 in section 3.3 identified fish passage impedance due to presence of stormwater assets and natural structures. Overall, 86 complete fish barriers (including three caused by natural structures, 11 by inlets/outlets and 72 caused by culverts/pipes) and 163 partial or temporary fish passage barriers to swimmers/climbers were observed within the catchment area. Several fish passage barriers existed throughout the catchment which potentially limited the extent of watercourse that was inhabited by native fish; however only a few fish passage issues were associated with ‘rateable’ inlets and outlets (i.e. with an asset or structure) in Oira Creek.

Fish passage issues were mainly associated with poorly constructed unrated structures or damaged dissipating structures with inadequate flow depths or a limited connection to the culvert. As stated above, a total of 11 complete barriers to fish were identified at rateable inlets and outlets in the Oira Creek catchment, these included 29 barriers to swimmers and 22 barriers to climbers. Overall these represented about 5% of the total number of inlets and

outlets identified in the catchment. Culverts and pipes, have a greater potential to significantly impact fish passage than inlets and outlets and this is discussed further in section 3.8. It is noted however that four assets (two inlets and two outlets) owned by Auckland Council were identified with upstream habitat present including two which presented a temporary barrier to fish passage (swimmers). These two assets (inlet SWP8368 and outlet SWP8365) were located on the true right bank (TRB) and with evidence of low flow impedance. It is recommended that these are carefully considered when prioritising maintenance activities.

Each asset was assessed for the overall risk they pose to public safety, considering the location, access and presence of fencing. 148 assets were noted as 'appears safe' and pose no threat to public safety.

There were 24 assets in the catchment identified as 'unsafe' (Table 15). The majority (22) were privately owned assets located on private land, in areas with difficult access. The two remaining were located on Council land, one being in an area with difficult access (Asset I.D: UNK134) and one with moderately difficult access (Asset I.D: UNK366).

The Not Safe rating, a drop of less than 1.5 metres, was given to 20 assets and can be attributed to potential hazards such as an unprotected drop of between 1 m and 1.5 m, or deteriorating fencing. Four additional assets were rated as Not Safe – Drop >1.5 m due to a drop exceeding 1.5 m. In addition, none of these 'unsafe assets - drop lower than 1.5 m' were on public land outside Council ownership. The ownership and access status of such assets are summarised in Table 15.

All Auckland Council owned inlets and outlets appeared safe and easily accessible.

Table 15: Oira Creek engineering structure safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m'.

Safety Rating		**Access**		
Not safe		**Easy**	**Moderate**	**Difficult**
Land Ownership	Public	*0*	*0*	*0*
	Council	*0*	*0*	*1*
	Private	*0*	*0*	*19*
	Unsure	*0*	*0*	*0*
Not safe, Drop >1.5m		**Easy**	**Moderate**	**Difficult**
Land Ownership	Public	*0*	*0*	*0*
	Council	*0*	*1*	*0*
	Private	*0*	*0*	*3*
	Unsure	*0*	*0*	*0*

3.8 Engineering Assets (culverts, pipes)

A total of 305 culverts and stormwater pipes (defined as 'assets' in Section 3.8) were assessed in the Oira Creek catchment. Most of those assets were not identified in the Auckland Council GIS, with one being incorrect. Similarly, to the inlets and outlets described in section 3.7, the culverts and pipes identified in the Oira Creek catchment were located within rural surroundings. The assets mostly consisted of private rural outlets discharging into waterbodies, and culverts to convey flow alongside or underneath public and private roadways.

A summary of culvert and pipes information including condition rating and maintenance requirement is provided in Table 16.

Of the nine pipes and culverts owned by Auckland Council (on Auckland Council land), the following were noted when undertaking the 2016-2017 Oira Watercourse Assessment:

- Six pipes and culverts identified in Auckland Council GIS were not located; and
- Three culverts were identified and assessed (no pipes were recorded).

One pipe located on private land was identified as unknown asset ownership and was incorrect in Auckland Council GIS.

Table 16: Summary of Oira Creek Engineering Culverts and Pipes.

	Assets Surveyed	**Assets Correct in GIS**	**Assets Incorrect in GIS**	**Assets Not in GIS**
Number of Assets (pipes/culverts)	*305*	*3*	*1*	*301*

Condition Assessment	**Very Good**	**Good**	**Average**	**Poor**	**Very Poor**
Condition of assets	*4*	*61*	*82*	*40*	*6*

	Replacement	**Structural**	**Patching**	**Debris Removal**	**Vegetation Clearance**	**Erosion Protection**
Maintenance required	*21*	*14*	*6*	*36*	*28*	*48*

The condition rating system described in section 3.7 has been applied to culverts and pipes. Due to the nature of the catchment, 'rateable assets' in the Oira Creek catchment identified in this section 3.8 were subject to the following criteria:

- All public pipes and culverts; and
- Private Rural pipes and culverts that are subject to moderate/severe erosion; or
- Private Rural pipes and culverts intersecting key infrastructure (roads and rail); or
- Private Rural pipes and culverts presenting a complete fish barrier where upstream habitat exists.

Subsequently 37% of assets assessed within the catchment were not rated. The remaining 63% of assets are defined as ‘rateable’ throughout the section.

The majority of assets in the catchment were either in ‘average’ condition or in ‘good’ condition, representing 74% rateable assets (refer Figure 6), and 47% of all assets. Forty assets were considered in ‘poor condition’, representing 21% of rateable assets, and 13% of all assets. Four assets were in ‘very good’ condition and six were in ‘very poor’ condition. Figure 6 provides a summary of condition rating for all culverts and pipes assessed in the Oira Creek catchment. Condition of pipes and culverts is consistent with condition of inlets and outlets assessed (refer Figure 4 in section 3.7).

Two Auckland Council culverts were assessed as being in ‘good’ condition and one culvert in ‘very good’ condition. The pipe with unknown ownership was assessed as being in ‘good’ condition.

Overall, approximately 50% of all culverts and pipes (representing 79% of rateable assets) in the catchment required some form of maintenance. Assets which had a condition rating of ‘average’, to ‘poor’ typically required structural repair, replacement or patching. Generally, assets with a rating of ‘Average’ required erosion protection and assets with a rating of ‘good’ required no maintenance; however, 64 pipes/culverts were noted as requiring routine maintenance by means of vegetation clearance or debris clearance. Vegetation clearance was required at two Auckland Council owned culverts. Erosion protection was required at the unknown owned pipe.

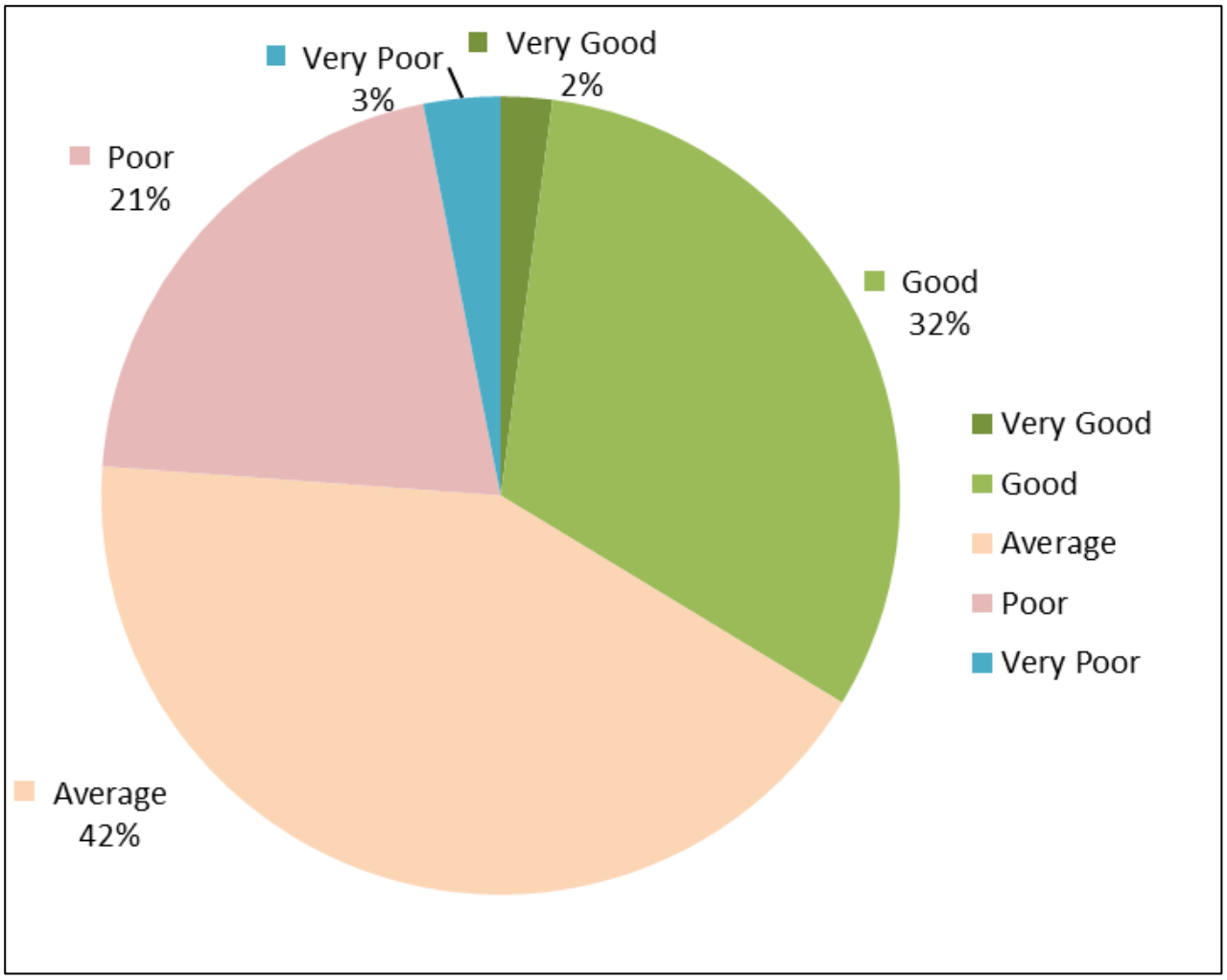


Figure 6: Oira Creek Culverts and Pipes Condition Rating (of rateable culverts/pipes).

Erosion protection was the most common form of maintenance required (25%), followed by debris removal (19%) and vegetation clearance (14%). Proposed maintenance, engineering repairs and replacement works at culverts and pipes included a total of 41 culverts and pipes:

- replacement (21 assets);
- structural works (14); and
- patching (six).

It is recommended these are the focus of any maintenance activities and should be communicated to the asset owner.

The percentages of culverts and pipes assessed in the Oira Creek catchment requiring attention from each maintenance category are summarised in Figure 7.

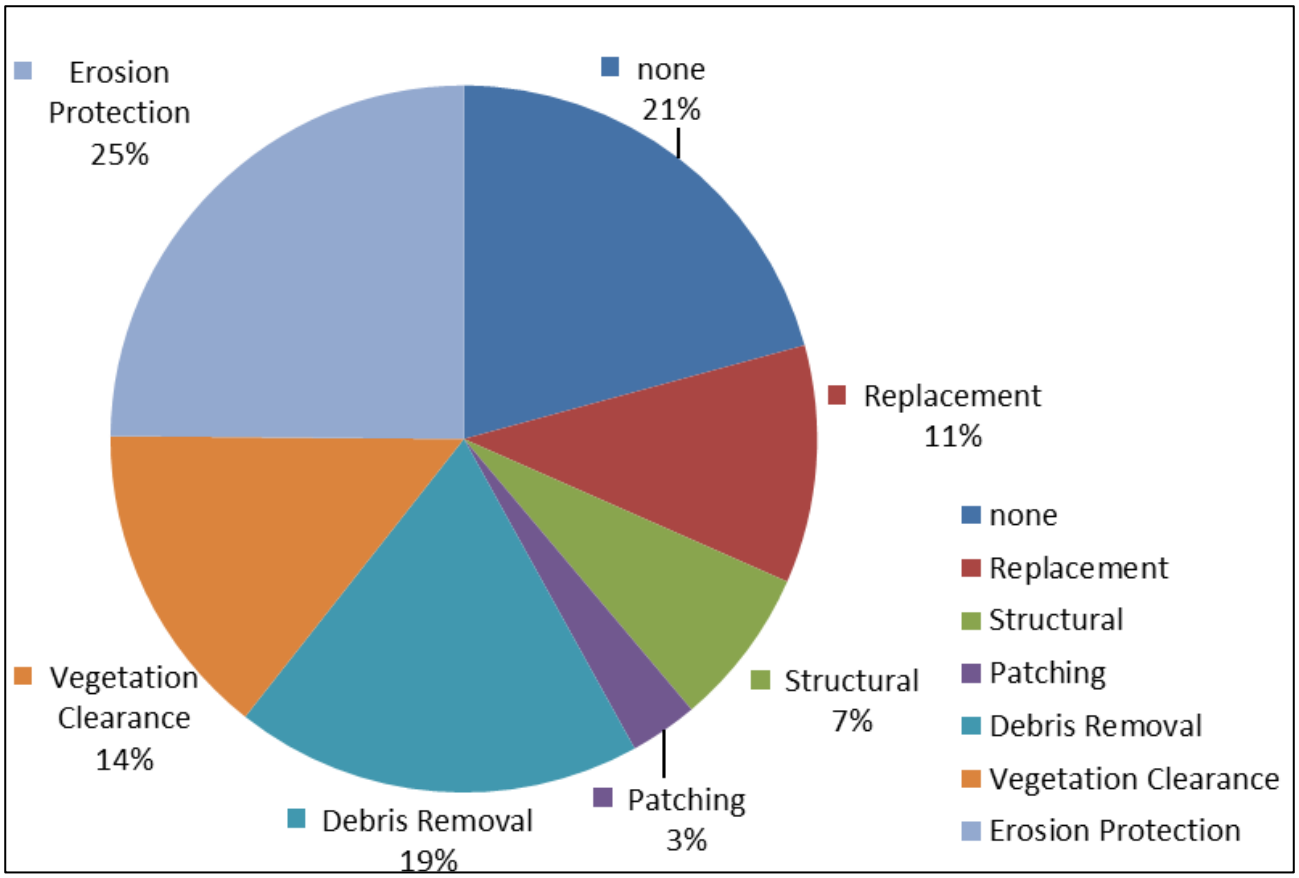


Figure 7: Oira Creek Culverts and Pipes Maintenance Required Proportion (of rateable culverts/pipes).

The 2016-2017 watercourse assessment has indicated that 30 culverts/pipes (including one Auckland Council owned culvert) were located within flood risk areas in the Oira Creek catchment (i.e. 10% of the total number of culverts/pipes and 15% of the assets assessed for flood risk) were located within flood risk areas. Thus, these issues are generally not likely to pose a significant effect on stormwater flow. As previously mentioned in section 3.7, opportunities exist for a review of the capacity of the stormwater network where potential flood risk has been identified by this assessment, in areas where further development is anticipated. This is further discussed in section 5.2.

Table 12 in section 3.3 (and detailed in section 3.7) identified 112 fish barriers. Of those, 72 complete fish barriers were caused by culverts and pipes in the Oira Creek catchment. Complete barriers were largely associated with dissipating structures with culverts elevated above the channel affecting fish passage. Swimming species, such as inanga and common bullies, were the most affected by engineering assets; followed by climbing species (i.e. kokopu and redfin bullies) which were affected by 105 assets. A total of 72 complete fish barriers were recorded at culverts and pipes causing barriers to all species including anguilliforms (eels). Opportunities exist in the catchment to improve fish passage. This is further discussed in section 5.2 and improvements could be made through the engineering maintenance works required for 79% of the rateable pipes and culverts (50% of all pipes and culverts) throughout the catchment.

Two Auckland Council owned culverts were identified as having upstream network habitat however neither of these assets presented a barrier to fish passage. Only one culvert (SWM8789) had evidence of low flow impedance at the inlet (as previously mentioned in section 3.7).

3.9 Bank and Channel Lining

Stream bank and channel lining are typically carried out to help manage erosion under high velocity stream flow conditions, often near existing structures which need to be protected. Extensive lining, however, can exacerbate downstream flooding by enabling higher flood peaks and leading to more frequent flood events. Stream reaches within the Oira Creek catchment with bank or channel linings were assessed based on condition and impact on stormwater flows.

The majority of surveyed streams within the Oira Creek Catchment possessed natural banks and channel bases, and were lacking in artificial channel and bank linings.

A total length of 348.5 metres of stream (less than 1% of total stream surveyed) had some form of lining (Table 17). This was predominantly bank lining with a small number of the bank lined sections of stream also containing channel lining. Linings were mostly in acceptable condition with only 29 metres in ‘poor condition’ and no linings assessed as being in ‘very poor’ condition (Table 17). No sections of lining presented a risk to public safety (Table 18).

Of the assessed lining, 98% had no significant impact on storm water flows. The only lining that had a critical impact on storm water flows was a length of 7 metres, upstream from ecoline 1_082_A. Here in-situ cast concrete lined the channel and bank for several metres downstream from a privately-owned culvert outlet servicing an online pond. At the downstream end of the lining significant erosion issues occurred, which caused the lining and the surrounding banks to be undercut. This erosion continued through a highly-incised channel for an additional 30 to 40 metres downstream and there was a considerable chance of ongoing erosion issues. Some attention could be given to remediating this area, enabling further armouring of the downstream area. Whilst impacts on stormwater flow are not considered significant, opportunities exist to remove bank or channel linings to create more naturalised stream reaches and increase amenity values using riparian planting (refer to Section 5.2).

Table 17: Summary of bank lining assessed over the surveyed extent. Note that the condition assessment is based on the overall condition of the lining, where both banks or channels are lined these are not assessed separately.

Physical Factors					
Total Length of Surveyed Watercourse (m)			*61,557 (49,602 fully assessed)*		
No. Reaches			*725*		
Total Length of Bank Lining (m)*			*348.5*		
Total Length of Channel Lining (m)*			*49.3*		
	Mean		**Min**		**Max**
Bank Height (m)	*0.46*		*0.15*		*1.1*
Length of bank lining (m)	*16.7*		*1.3*		*60*
Length of channel lining (m)	*8.2*		*1.3*		*17*
Condition Assessment	**Very Good**	**Good**	**Average**	**Poor**	**Very Poor**
Condition of bank lining (% of total bank lining length) (length of lining (m))	***0.0*** *0*	***52.3*** *182.3*	***41.4*** *144.2*	***6.3*** *22*	***0.0*** *0*
Condition of channel lining (% of total channel lining length) (length of lining (m))	***0.0*** *0*	***16.8*** *8.3*	***69.0*** *34*	***14.2*** *7*	***0.0*** *0*
	Not Significant		**Significant**		**Critical**
Impact on Stormwater Flows (% of total bank and channel lining) (length of lining (m))	***98.0*** *341.5*		***0*** *0*		***2.0*** *7*

*As channel lining did not occur separately from bank lining, i.e. channel lining was only found in stream sections also containing bank lining the total length of stream lining has been taken as the total length of bank lining. Separate condition assessments were not carried out where bank and channel lining where both were found.

Table 18: Bank lining safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m'.

Not safe		**Access**		
		Easy	**Moderate**	**Difficult**
Land Ownership	Public	*0*	*0*	*0*
	Private	*0*	*0*	*0*
Not safe, Drop >1.5 m		**Easy**	**Moderate**	**Difficult**
Land Ownership	Public	*0*	*0*	*0*
	Private	*0*	*0*	*0*

3.10 Erosion Hotspots

Erosion hotspots are described in the WAR methodology as areas of the stream channel or bank greater than 2 metres in length where severe erosion has caused slumping, or exposed areas of soil that are greater than 5 m^2. Such areas must also show evidence of active erosion and pose a potential risk to stream health or safety to be considered a hotspot. Surveyed stream lengths were assessed for erosion hotspots according to these criteria and

areas located 10 metres immediately upstream of any erosion hotspots were assessed for bank and channel stability using the standard Pfankuch Bank Stability assessment method.

In total 54 erosion hotspots were recorded. These were all located on private land and the majority posed little or no risk to buildings or public safety. A single hotspot was judged to pose a moderate level of risk to an uninhabited farm shed, while five hotspots were judged to present a moderate risk to public safety.

The average hotspot length was 27 metres and had a surface area of 85 m² (Table 19). Erosion hotspots characteristically were found on steep, unvegetated slopes with evidence of mass wasting on the banks immediately upstream or downstream (Table 20). Consequently, they scored poorly in the Pfankuch bank stability assessment (Table 20) and are likely to suffer from ongoing erosion issues that are detrimental to the watercourse.

Table 19: Summary of erosion hotspots.

Attribute				
Total Length of Surveyed Watercourse (m)		*61,557 (49,602 fully assessed)*		
No. Reaches		*725*		
Total Length of Erosion Hotspots (m)		*1,465.5*		
Total Area of Erosion Hotspots (m²)		*4,602*		
Total Number of Erosion Hotspots		*54*		
	Mean	**Min**	**Max**	
Length (m)	*27*	*3*	*202*	
Bank Height (m)	*2.1*	*0*	*20*	
Area (m²)	*85*	*8*	*400*	
	Access			
	Easy	**Moderate**	**Difficult**	
Land Ownership	Public	*0*	*0*	*0*
	Private	*0*	*7*	*47*

Table 20: Summary of Pfankuch bank stability assessment of the 10 m upstream of erosion hotspots.

	Excellent	**Good**	**Fair**	**Poor**
Land Slope	*51*	*0*	*164*	*1,250*
Mass Wasting	*7*	*33*	*713*	*712*
Debris Jam	*363*	*584*	*347*	*172*
Bank Vegetation	*7*	*48*	*155*	*1,255*
Overall Stability Index	*0*	*0.5*	*26.1*	*73.5*
(% of total stream length)	*0*	*7*	*382*	*1077*
(length of stream (m))	*Scores ≤13*	*Scores 14- 23*	*Scores 24 -32*	*Scores ≥33*

3.11 Miscellaneous Points

3.11.1 Discharges

Four springs were observed along with a further two possible springs or groundwater seepages. A dead, decomposing cow was observed along the side of ecoline 4_020_A, while effluent scums were observed on the banks and near the farm identified as an enhancement opportunity (See Section 5.2.4 for more details).

3.11.2 Engineering Structures

Most miscellaneous points marked as engineering features were small (<225 mm diameter) pipes interacting with the waterway. Only four of these pipes were assessed as having a significant impact on storm water flows. One pipe was creating a debris jam, while the remaining three were structurally compromised, leading to more than minor flow and/or erosion issues. Nineteen debris jams were recorded throughout the watercourse, with seven large enough to have an impact on storm water flows, and likely to lead to flooding and erosion issues. Other engineering assets observed included weirs, cable bridges and pumps, none of which were likely to impact storm water flows.

3.11.3 Other

Bridges, either for stock access across the watercourse or recreational purposes were relatively common. Two bridges, both in poor condition, were likely to be impacting storm water flows and were also observed as having potential erosion issues. Rubbish piles or disused farm equipment was encountered throughout the catchment. Nine of these locations were large enough to be recorded as points of interest. Litter piles were often a source of iron floc in the water, as these piles contained sheets of corrugated iron or old machinery. One litter pile was close enough to the main Oira Creek for items to be picked up and transported downstream during periods of flood flow. Several man-made fords were identified, mostly to enable stock to cross streams. These were not likely to have any significant impact on storm water flows but may pose issues for fish passage.

4.0 SEV's and Additional Variables

4.1 In-Stream and Riparian Habitat

More detailed ecological sampling using the Stream Ecological Valuation (SEV) methodology was undertaken at five sites within the Oira Creek Catchment from 18-19 May 2017.

SEV locations were selected based on relevant criteria which included:

- Representative of the wider catchment – Considering major land use or catchment vegetation cover changes, major changes in stream geomorphology, or other significant differences in pressures affecting the watercourses within the region.
- High priority enhancement opportunity sites.
- Future development – Future urban and/or special housing areas designated under the Auckland Unitary Plan (Operative in Part), to improve understanding of watercourses within these areas to inform planning for future development.

The five sites selected for SEV's are described below:

SEV 1:

- Rural land use – representative of the wider catchment
- Stock access/damage – representative of the wider catchment
- Future Urban Area (Upper catchment - Pukekohe)

SEV 2:

- Rural land use – representative of the wider catchment
- Identified as a potential high priority enhancement opportunity
- One of the most degraded areas in the catchment

SEV 3:

- Rural land use – representative of the wider catchment
- Fenced and contains existing riparian cover (pines) with mixed native understory
- Potential habitat for native fish

SEV 4:

- Unfenced rural stream – representative of the wider catchment
- Enhancement opportunity, for landowner and nearby school
- Visible from and near to State Highway 22

SEV 5:

- Open stream on large lifestyle block with limited low growing riparian vegetation – representative of the wider catchment

- Future Urban Area (Lower catchment – Karaka)

Detailed instream assessments encompassed a SEV (Section 4.2), macroinvertebrate and fish community sampling (Section 4.3), as well as sediment chemistry (Section 4.4) and water quality/public health (Section 4.5).

For SEV site locations refer to Appendix A – Map 1. Representative photos of each SEV site surveyed in the Oira Creek Catchment are shown in Figure 8.

SEV Site 1

SEV Site 2

SEV Site 3


SEV Site 4


SEV Site 5

Figure 8: Representative photos of each SEV site surveyed in the Oira Creek Catchment.

4.2 Stream Ecological Valuation Assessment

The macroinvertebrate and fish community data was used in conjunction with transect and habitat data to calculate a SEV (SEV Spreadsheet Version 2.2) score using the methodology specified in the Auckland Council Technical Publication 2011/009 (Storey et al., 2011). A 100 metre reach was assessed at each of the five sites within the catchment. The overall SEV score consists of 14 functions, including hydraulic, biogeochemical, habitat and biodiversity functions, and provides a basis for comparison with other aquatic systems. Results of the function summaries are presented within Table 21.

Full detailed SEV scores are provided in Appendix B.

Table 21: Summary of mean SEV scores across sites.

Site Code	Hydraulic	Bio-geochemical	Habitat Provision	Biodiversity	Total SEV Score
SEV1	0.64	0.30	0.19	0.15	0.349
SEV2	0.67	0.23	0.17	0.17	0.334
SEV3	0.75	0.63	0.55	0.27	0.573
SEV4	0.66	0.29	0.31	0.28	0.397
SEV5	0.48	0.22	0.18	0.13	0.267

The SEV scores calculated for the sites ranged from 0.267 to 0.573, out of a possible total of 1.0. No site received an overall score within the 'high ecological value range' (above 0.8). The functional values of the streams were within the 'moderate' range (0.3 – 0.7) for Sites 1-4 and 'low' range (< 0.3) for Site 5.

The sites all scored highest for hydraulic functions. The 'moderate' scores were largely obtained because of the absence of artificial barriers to species migration within the survey reach, good instream flow rates, minimal channel modification (except at Site 5) and natural connectivity to groundwater.

Biogeochemical results were in the 'low' range for all sites, except Site 3. This was due to the increased stream shading at Site 3, which controlled water temperature and increased organic matter input, along with high dissolved oxygen levels and instream particle retention.

Habitat provision results were again in the 'low' range for all sites, except Site 3. Site 3 also showed better conditions when compared to the other SEV sites for fish spawning and aquatic fauna habitats.

The biodiversity values, which are derived from intactness of fish, invertebrates and vegetation communities were in the 'low' range for all the sampled sites.

The Auckland Council's State of Environment (SoE) Monitoring Programme monitors and undertakes SEV's at 30 rural sites (Holland and Hussain, 2016). The results for these rural sites are shown in Table 22.

Table 22: Auckland Council's SoE Monitoring Programme SEV results, for rural catchment land cover.

Rural	Hydraulic	Bio-geochemical	Habitat Provision	Biodiversity	SEV Score
Mean	0.73	0.60	0.60	0.55	0.63
Min	0.32	0.26	0.30	0.20	0.37
Max	0.99	0.97	0.89	0.86	0.91

The overall SEV scores for all sites in the Oira Catchment were below the Auckland Council's mean SEV score (0.63) and three sites (Site 1, 2, and 5) were below the minimum SEV score (0.37) for rural sites.

Hydraulic function was below the mean (0.73) at all sites except Site 3, where it was slightly above (0.75). All sites were well above minimum value of 0.32.

Biogeochemical function was again below the mean (0.60) at all sites except Site 3, where it was slightly above (0.63). Two sites (Site 2 and 5) had results which were below the minimum (0.26) for rural sites.

Habitat Provision and biodiversity functions were below the means (0.60 and 0.55) at all sites, with three sites (Site 1, 2 and 5) below the minimums (0.30 and 0.20) for rural sites.

These low results (especially at Sites 1, 2 and 5) are reflective of modification to the riparian vegetation through agricultural land use, limited instream habitats due to lack of shading cover, sediment inputs to the stream and low biodiversity.

A previous single SEV site in the Oira Creek Catchment was reported in Phillips et al. (2006) and was located where the main channel intersects with State Highway 22 (6451386.2 N 2680887.8 E). The SEV score was 0.57, which is similar to the highest SEV score at Site 3. The stream scored moderately well for hydraulic and biogeochemical functioning, with very good flood plain connectivity and decontamination of pollutants. However functional scores suffered in terms of habitat provisioning and biodiversity intactness with limited spawning habitat for bullies (*Gobiomorphus* sp.), little woody debris or hydrological habitat variation, a poor riparian zone, fish and invertebrate communities.

Phillips et al. (2006) concluded that the Oira Creek had marginal ecological values, particularly in terms of providing suitable habitat for aquatic biota, and this was a result of the limited presence of riparian vegetation. The results of the SEV assessments undertaken as a component of this assessment are consistent with those findings.

4.3 Biodiversity

The detailed assessments encompassed sampling various components of the aquatic life, including the fish community as well as macroinvertebrates (snails, insect larvae etc.), which are established indicators of habitat quality and are easily sampled.

Macroinvertebrate sampling was carried out in accordance with the Ministry for the Environment's "Protocols for Sampling Macroinvertebrates in Wadeable Streams" (Stark et al., 2001). Protocol C2: soft-bottomed, semi-quantitative was utilised at Sites 1, 2, 4 and 5. Protocol C1: hard-bottomed, semi-quantitative was utilised at Site 3. All samples were preserved in 70% isopropyl alcohol, returned to the laboratory and sorted by a specialist taxonomist using protocol 'P3: full count with sub-sampling option' (Stark et al., 2001).

Macroinvertebrates were identified to the lowest practicable taxonomic level and counted to enable biotic indices to be calculated.

A range of biotic indices were calculated, namely the number of taxa (taxa richness), the number of Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa recorded in a sample (EPT) and the Macroinvertebrate Community Index (MCI). EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment, but excludes *Oxyethira* and *Paroxyethira* as these taxa are not sensitive and can proliferate in degraded habitats.

To identify the range of fish species, on-site electric fishing was undertaken at the SEV sites. Single pass electric fishing was carried out at each site using an EFM 300 backpack electric fishing machine. This machine temporarily stuns fish, allowing them to be captured. All fish captured were identified, counted and their size estimated before being returned to their habitats. An Index of Biotic Integrity (IBI) was calculated for the site based on fish species present, altitude and distance inland (Joy & Henderson, 2004).

A full list of macroinvertebrate taxa and fish species identified is provided in Appendix B.

Table 23: Quality thresholds for interpretation of MCI (Stark *et al.* 2004).

Quality	Description	MCI score
Excellent	High quality, well shaded, clean water.	>120
Good	Mild pollution	100-120
Fair	Moderate pollution	80-100
Poor	Severe enrichment	<80

Table 24: Attributes and suggested integrity classes for the Index of Biotic Integrity: Fish

Total IBI score	Integrity class	Description
42 – 60	Very Good	Comparable to the best situations without human disturbance; all regionally expected species for the stream position are present.
36 – 41	Good	Species richness and habitat or migratory access reduced, site shows some signs of stress.
28 – 35	Fair	Some stressors present, biotic integrity impaired.
18 – 27	Poor	Species richness is drastically reduced biotic integrity harmed. Habitat and or access is impacted.
1 – 17	Very poor	Impacted or migratory access almost non-existent.
0	No native fish	Site is grossly impacted or access non-existent.

Macroinvertebrate Community Index (MCI) Scores

The number of invertebrate taxa recorded from the SEV sites ranged from 7-12, with most identified taxa tolerant of degraded instream conditions. No taxa from the typically sensitive EPT group of insects (mayflies, stoneflies and caddisflies) were recorded. However, at Sites 1, 2 and 4 the Axehead Caddis (Caddisfly *Oxyethira* sp.), which are most common in streams with abundant stream bed algae, most likely from nutrient enrichment, limited shade and a lack of recent high flow (algae scouring) events (Landcare Research, 2017a) was recorded.

A high diversity and abundance of EPT insects within a stream is typically indicative of good instream habitat quality. The MCI scores calculated for the five sites sampled were all less than 80, indicative of poor instream habitat and water quality with severe enrichment (Stark & Maxted, 2007).

The highest overall SEV score (Site 3) also had the highest MCI score (65.7). This site was hard bottomed, compact clay, however, no EPT taxa were observed.

Fish IBI Scores

IBI scores recorded for the five sites, reflected the overall SEV scores. The lowest SEV scores (Sites 1, 2 and 5) also had the lowest Fish IBI Scores, indicating 'very poor'. The higher SEV scores (Sites 3 and 4) had higher Fish IBI Scores, indicating 'fair'.

Electric fishing of the five SEV sites returned shortfin eels, along with unidentified and juvenile (elver) eels (*Anguilla* sp.), ranging in size from 80 mm to approximately 550 mm in length. Banded kokopu, ranging in size from 50 mm to approximately 100 mm in length, were found at Sites 3 and 4. The presence of this species is consequently reflected in the

higher Fish IBI Scores at these sites. The introduced *Gambusia,* which can be common in slow flowing or ponded watercourses with warm water temperatures and low shading cover, were found at Sites 1 and 2, reiterating the lower Fish IBI scores at these sites.

Shortfin eels and banded kokopu are listed as 'Not Threatened' in the Department of Conservation Threat Classification lists (Goodman et al, 2014). Shortfin eels are the most tolerant of New Zealand's native fish species with regard to high instream temperatures and low concentrations of dissolved oxygen, and are also exceptional climbers.

During the Watercourse Assessment, banded kokopu, inanga, shortfin eel and *Gambusia* were all positively identified. Therefore, inanga was the only species not captured at the SEV sites.

Inanga were the most commonly observed native fish species (11% of total observations), during the Watercourse Assessment, with multiple schools observed in the lower catchment, and particularly through many of the stream mouths. Inanga are classed as 'At Risk - Declining' in the Department of Conservation Threat Classification lists (Goodman et al, 2014).

Banded kokopu and shortfin eel were infrequently observed during the Watercourse Assessment. Banded kokopu were generally spotted in well shaded sections of stream. All shortfin eel observations were of exposed individuals lying stationary on the stream bed.

Table 25: Summary of biodiversity index values across sites.

Site Code	MCI-sb or hb	No. Taxa	EPT Taxa	Fish IBI Scores
SEV1	53.67-sb	12	0*	10
SEV2	60.83-sb	12	0*	10
SEV3	65.71-hb	7	0	30
SEV4	54.00-sb	11	0*	30
SEV5	58.00-sb	9	0	14

*Does not include Caddisfly *Oxyethira* spp.

4.4 Sediment Chemistry

All sites had sediment chemistry (heavy metals and PAH) below the ANZECC 2000 Guidelines ISQG low trigger values. All sites were on relatively open rural land away from residential and industrial areas and activities, which potentially lead to higher contaminant levels. Results indicated low risk for adverse biological effects as a result of these contaminants.

The receiving environment of the Oira Creek is the Manukau Harbour, via the Pahurehure Inlet. Manukau Harbour is the second largest estuary and natural harbour in New Zealand,

with an approximate area of 365 km^2 (Kelly, 2008). The estuary comprises numerous side branches and in conjunction with the Pahurehure Inlet, contains two other major inlets; Mangere Inlet and Waiuku River. Sediment contaminant concentrations vary significantly throughout the wider harbour body, reflecting development history and land use of the catchments drained by respective inlets. The marine surface sediments near the Mangere Inlet are recognised as some of the most contaminated in the country (Williamson et al., 1992), reflecting the area's history as a hub of urban and industrial development (Kelly, 2008).

Auckland Council tests for zinc, copper and lead every two to five years. Environmental Response Criteria (ERC) are used: green indicates low levels of contaminants, amber indicates some elevation and red indicates relatively high levels. Four sites were sampled in the nearby Drury Creek area and all had low levels of metals indicating ERC green (Mills, 2016).

A previous single SEV site in the Oira Creek Catchment was reported in Phillips et al. (2006) and was located where the main channel intersects with State Highway 22 (6451386.2 N 2680887.8 E). At this site, contaminant tests showed that copper and zinc levels within the water and sediment were below ANZECC guidelines.

Table 26: Heavy metal concentrations across sites.

Site	Heavy Metal Concentrations (mg/kg dry wt)		
	Zn	Cu	Pb
SEV1	49	14.3	22
SEV2	86	16.4	21
SEV3	61	7.0	13.5
SEV4	57	8.6	17.1
SEV5	91	27	32

Table 27: Summary of sediment contaminants.

	Zn	Cu	Pb	Total PAH
No. sites ANZECC >ISQG-Low	0	0	0	0
No. sites ANZECC >ISQG-High	0	0	0	0

4.5 Public Health

Results from the SEV sampling are shown in Table 28 below. These results are compared to the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' published by the Ministry for the Environment, 2003, and the 2014 National Policy

Statement for Freshwater Management (NPSFM) National Bottom Line for *E. coli* (Table 29).

The Freshwater Bathing Guidelines are based on an estimate that approximately 5% of *Campylobacter* infections could be attributable to freshwater contact recreation. This is also similar for exceedance of the NPSFM National Bottom Line for *E. coli* in which people are exposed to a high risk of infection (greater than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).

Four of the five sites (Sites 1, 3, 4, 5) returned microbiological indicator values which were below the Ministry for the Environment 'Acceptable/Green Mode' and the NPSFM *E. coli* Attribute State A with the single samples collected at these sites less than 260 *E. coli*/100 mL. This indicates that people are exposed to a low risk of infection (up to 1% risk) when undertaking activities likely to involve full immersion.

Site 2 was the only site above the 'Acceptable/Green Mode', with the sample exceeding the 'Action/Red Mode' by more than 2.5 times. Under the action mode, this area would be unsuitable for recreation. It was also above the NPSFM *E. coli* Attribute State D.

Site 2 was located amongst rural land use, and therefore representative of wider catchment. The site also had stock access and stream bed and bank damage was prevalent, and was visually identified as one of the most degraded reaches in the catchment. It is most likely that bacterial contamination can be attributed to runoff from agricultural practices and direct stock access to the stream within the site and further upstream.

A previous single SEV site in the Oira Creek Catchment was reported in Phillips et al. (2006) and was located where the main channel intersects with State Highway 22 (6451386.2 N 2680887.8 E). At this site, *E. coli* counts were 2.2 times higher than the National Guideline values of 550 E. *coli*/100 mL, which is similar to the results recorded for SEV Site 2. Phillips et al. (2006) concluded that the Oira Creek had high levels of E. *coli* contamination, likely due to livestock effluent inputs upstream, and that bacterial contamination was a major concern within the entire study area.

Table 28: Summary of E. *coli* results across sites, compared to the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (Ministry for the Environment, 2003).

						Surveillance, alert and action levels for freshwater		
SEV Site	1	2	3	4	5	Acceptable/ Green Mode	Alert/Amber Mode	Action/Red Mode
E. coli (E. coli/100mL)	82	1400	120	64	160	*≤260 E. coli/ 100mL*	*>260 E. coli/ 100mL*	*>550 E. coli/ 100mL*

Table 29: Summary of *E. coli* levels compared to the Attribute States of the 2014 National Policy Statement for Freshwater Management.

	A	B	C	D
No. sites in Microbial Assessment Categories (sample 95th percentile)	4	0	0	1

4.6 Summary

The SEV scores ranged from 0.267 to 0.573 and were within the 'moderate' range (0.3 – 0.7) for Sites 1-4 and 'low' range (< 0.3) for Site 5.

These low scores (especially at Sites 1, 2 and 5) are reflective of modification to the riparian vegetation through agricultural land use, limited instream habitats due to lack of shading cover, sediment inputs to the stream and low biodiversity.

The MCI scores calculated for the five sites were all less than 80, indicative of poor instream habitat and water quality with severe enrichment. The highest overall SEV score (Site 3) also had the highest MCI score (65.71). This site was hard bottomed however, no EPT taxa were observed.

Fish IBI scores reflected overall SEV scores. The lowest SEV scores (Sites 1, 2 and 5) also had the lowest Fish IBI Scores ('very poor'), reflective of the introduced *Gambusia*, which were found at Sites 1 and 2. The higher SEV scores (Sites 3 and 4) had higher Fish IBI Scores ('fair'), reflective of the banded kokopu found at these locations.

All sites had sediment chemistry (heavy metals and PAH) below the ANZECC 2000 Guidelines ISQG low trigger values. All sites were within relatively open rural land away from residential and industrial areas and activities, which potentially lead to higher contaminant levels.

Four of five sites sampled indicated good water quality in relation to pathogen indicators at the time of sampling. One site (Site 2) exceeding the 'Action/Red Mode' of the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas more than 2.5 times, along with the NPSFM National Bottom Line for E. *coli*, indicating that this area would be unsuitable for recreation.

Opportunities to improve stream habitats and associated SEV scores in the Oira Creek Catchment include reducing stock access by fencing off streams and undertaking riparian planting.

5.0 Watercourse Management

5.1 Management Zones

Five management zones have been identified within the Oira Creek Catchment (Table 30; Map 7, Appendix A). These management zones have been identified in acknowledging that much of the land within the catchment is currently privately owned and that any Council driven stream or asset management will likely require engagement with and co-operation from private landowners.

The management zones have been designed to reflect areas where:

- Land is zoned for future urban growth and an opportunity exists to fast-track management issues that may be exacerbated by the effects of land development;
- Significant degradation has occurred and restoration would address a number of significant management objectives;
- Scarce or high value habitats exist, but could be improved through greater management and the creation of ecological corridors; and
- General day to day ('status quo') management will continue to occur.

Table 30: Management Zone Summary.

Management Zone (MZ)	Location/Stream Reaches	Enhancement Opportunities
1 Coastal and Future Urban (North)	1_001 - 1_0020, 1_0025, 1_0028, 1_003, 1_0032 - 1_0040, 1_0042, 1_0048 - 1_0051, 1_0053, 1_0054, 1_0056 - 1_0058, 1_0066, 1_0069 - 1_0073, 2_001- 2_0011, 2_0018 - 2_0020, 2_0024 - 2_0026, 3_001, 5_0014 - 5_0031	EO_05 EO_06 EO_08 EO_09
2 Restoration/Highly Degraded Land	1_00159, 1_00164, 1_00171, 2_0063 - 2_0067, 3_0023 - 3_0027, 3_0037 - 3_0038	EO_04
3 Remnant Swamp Forest	1_00150 - 1_00158, 1_00174, 1_00179 - 1_00182, 2_0073 - 2_0074, 3_0028 - 3_0031, 4_0015 - 4_0020	EO_07
4 Future Urban (Pukekohe)	1_00178, 1_00183, 1_00187 - 1_00189, 1_00192 - 1_00193, 1_00195 - 1_00200, 2_0074, 2_0077 - 2_0082, 2_0084	
5 Rural Stream Management	1_0021 -1_0031, 1_0036, 1_0040 - 1_0099, 1_00100 - 1_00149, 1_00154 - 1_00156, 1_00160 - 1_00178, 1_00184 - 1_00194, 2_0012 2_0062, - 2_0083, 3_005 - 3_0036, 4_001 - 4_0019, 5_0031 - 5_0044	EO_01 EO_02 EO_03

5.1.1 Management Zone 1 – Coastal and Future Urban (North)

All streams within the lower catchment Future Urban Zone and/or interacting directly with the Oira Creek tidal inlet have been incorporated into Management Zone 1. This section of the catchment largely exists as farmland and large lifestyle blocks, but is likely to be developed into a more intensive urban area within the next 30 years. Land around streams 1_001 and 2_002 has been rezoned, while land within the Drury West Stage 1 area will be development ready by 2022 and land within the Drury West Stage 2 area is anticipated to be development ready between 2028 and 2032 (Auckland Council Planning Committee, 2017).

An opportunity exists to fast track management priorities within Management Zone 1 and address current management issues in conjunction with land rezoning and development. This would alleviate issues, particularly those concerning stormwater conveyance and erosion, that might become more pronounced as development occurs. Addressing these issues could also improve fish passage through the lower catchment. As most of this land is private it is acknowledged that addressing current issues will require the co-operation of existing property owners.

There are four identified Enhancement Opportunities within this Management Zone (Refer to section 5.2). Three of these; EO_05, EO_06 and EO_09 are the highest priority Enhancement Opportunities within the catchment. Addressing stormwater and asset issues within EO_05 and EO_06 prior to or in conjunction with upstream land development would be beneficial, while EO_09, which is already public land presents a good opportunity for public engagement and community involvement.

General Maintenance Issues with Management Zone 1:

- Two Council owned culverts (SWM8799 and SWM8789) required vegetation clearance.
- Six Council owned inlet/outlets with structure, required some form of maintenance, mostly vegetation clearance. One (SWP8369) was recorded to be in poor condition, requiring structural maintenance.
- Inspection of eight culverts identified as Council owned (or unknown) assets requiring maintenance, but that are not currently registered within the GIS system. If they are Council owned assets then incorporation into the GIS system and maintenance schedule is required.
- Twenty-five privately owned pipes/culverts required some form of maintenance, including vegetation removal, erosion protection and structural repairs. Seven private culverts were assessed as being in poor or very poor condition.

- Twelve privately owned inlet/outlets with structure required maintenance, including vegetation clearance, erosion protection and structural repairs. Additionally, sixteen inlets/outlets without structure had moderate or severe erosion issues.
- Eleven erosion hotspots were recorded, two of which posed a moderate safety risk to the public.
- Two debris jams, likely to have a significant impact on stormwater flows, were identified along with a stormwater pipe and bridge structure, creating the potential for significant debris jams.

Suggested goals and objectives for Management Zones 1:

- Engage landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Address inlet/outlet erosion issues before land becomes developed.
- Futureproof stormwater conveyance capacity by replacing undersized or poorly functioning engineering assets.
- Improve fish passage where necessary though the provision of fish passage devices or removal/replacement of problematic engineering assets.
- Involve community groups in the protection and enhancement of the public conservation land along the coastal margins of the catchment.
- Encourage landowners to restore, enhance or protect riparian zones.
- Improve access to public land around the coastal margin.
- Enhance potential inanga spawning habitats.
- Take advantage of greenfield development to leverage stream enhancement outcomes (improving ecological, amenity and stormwater functions).

5.1.2 Management Zone 2 – Restoration/Highly Degraded Land

Management and enhancement of the highly-degraded rural land within Management Zone 2 should be prioritised above the general maintenance goals of Management Zone 5 – Rural Stream Management. SEV2, which was undertaken within this zone, was one of the lowest scoring and was also the only site where *E. coli* levels were above Ministry for the Environment guideline levels. Management issues within this zone include a complete lack of stream fencing or planting, poorly functioning culverts and widespread erosion issues.

Management Zone 2 has been identified as an enhancement opportunity (Refer to Section 5.2.4 and Map 7, Appendix A). Encouraging and assisting with the fencing and planting of the watercourse within this zone would not only provide immediate benefits on a local scale

but help to create crucial ecological linkages between the remnant patches of indigenous forest to the north and south (parts of Management Zone 3).

General Maintenance Issues with Management Zone 2:

- A potential public health risk exists, with *E. coli* concentrations at SEV Site 4 exceeding the Ministry for the Environment Action/Red Mode guideline value by more than 2.5 times.
- Inspection of one culvert and four inlet/outlet points identified as Council owned (or unknown) assets required maintenance, but are not currently registered within the GIS system. If these are Council owned assets then incorporation into the GIS system and maintenance schedule is required.
- Seven privately owned culverts required some form of maintenance, including erosion protection, structural repairs or replacement. Five of these culverts were assessed as being in poor condition.
- Six privately owned inlet/outlets with structures required maintenance, including vegetation clearance, erosion protection and structural repairs. Five of these structures had moderate to severe erosion issues and four structures were assessed as being in poor condition. Additionally, eight inlets/outlets without structure had moderate erosion issues.
- Eleven erosion hotspots were recorded. None posed a risk to property or public safety.

Suggested goals and objectives for Management Zones 2:

- Educate landowners on their responsibilities and ways they can manage the watercourses running through their property.
- Engage landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Engage landowners to restore, enhance or protect riparian zones, particularly around erosion hotspots and significant ecological areas.
- Provide information on support programmes and appropriate restoration funding avenues.
- Create ecological riparian corridors linking degraded land to nearby SEAs.
- Address inlet/outlet erosion issues.
- Improve fish passage through the area.
- Daylight sections of stream that have been piped.

5.1.3 Management Zone 3 – Remnant Swamp Forest Land

A number of fragmented patches of remnant forest, mostly kahikatea swamp forest, exist in the mid/upper catchment. These are mostly classified as SEAs and should be considered as highly valuable ecological features due to the rarity of these indigenous habitats within the Auckland region and because they provide important ecological stepping stones or migratory pathways for native fauna. This was recognised during the watercourse survey and a substantial proportion of the southern section of Management Zone 3 is identified as an Enhancement Opportunity (refer to Section 5.2.7). Creating greater linkages between these SEAs, particularly through the establishment of riparian corridors and removal of competing weed species would help safeguard and increase the coverage of these important habitats.

While much of this zone is privately owned, and public access is limited, it is recommended that restoration efforts try to involve community groups and are made to improve public access where possible.

General Maintenance Issues with Management Zone 3:

- Inspection of two culverts identified as Council owned assets required maintenance, but are not currently registered within the GIS system. If these are Council owned assets then incorporation into the GIS system and maintenance schedule is required.
- Four privately owned culverts required some form of maintenance, including patching, erosion protection or replacement. Two of these culverts were assessed as being in poor condition.
- Three privately owned inlet/outlets with structure required maintenance, including erosion protection or structural repairs. One of these structures had moderate erosion issues and was assessed as being in poor condition.
- Two erosion hotspots were recorded. Neither posed a risk to property or public safety.

Suggested goals and objectives for Management Zone 3:

- Educate landowners on the ecological values of remnant forests.
- Engage with and encourage landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Encourage landowners to restore, enhance or protect riparian zones.
- Create ecological corridors between existing patches of remnant forest.
- Facilitate community group involvement in enhancement opportunities on private land.
- Remove weed infestations, such as willow and *Glyceria*.

5.1.4 Management Zone 4 – Future Urban (Pukekohe)

Over the next 30 years the watercourses within Management Zone 4 are likely to experience large-scale changes in catchment land use due to the Pukekohe future urban zone. This zone is anticipated to be development ready between 2023 and 2027 (Auckland Council Planning Committee, 2017). It would be beneficial to fast-track some management goals to address issues before they become exacerbated by the effects of development. This will not only help to future-proof the stream, but may reduce costs in terms of the resources required to fix the immediate issue versus an intensified issue in the future. Some management goals and objectives will likely be achieved as a result of development. This will lead to the advantage of developer led enhancement and will be a practical and cost-effective solution for achieving lower priority management goals.

General Maintenance Issues with Management Zone 4:

- One Council owned asset (Asset I.D: 42815) was incorrectly recorded in the GIS system. This asset required erosion protection.
- Eleven privately owned culverts required some form of maintenance, including vegetation removal, erosion protection or structural repairs. A single culvert, requiring replacement, was assessed as being in poor condition.
- Six privately owned inlet/outlets with structures required maintenance, including erosion protection and debris removal. Four of these had moderate erosion issues and two were assessed as being in poor condition. Additionally, eight inlets/outlets without structures had moderate or severe erosion issues.
- Four erosion hotspots were recorded, two of which posed a moderate safety risk to the public.

Suggested goals and objectives for Management Zones 4:

- Engage landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Encourage land owners to restore, protect and enhance riparian vegetation.
- Address inlet/outlet erosion issues before land becomes developed.
- Futureproof stream stormwater conveyance capacity by replacing undersized or poorly functioning engineering assets.
- Improve fish passage where necessary though the provision of fish passage devices or removal/replacement of problematic engineering assets.
- Create ecological linkages between SEAs within future urban zone and the remnant swamp forest management zone.

- Take advantage of greenfield development to leverage stream enhancement outcomes (improving ecological, amenity and stormwater functions).

5.1.5 Management Zone 5 – Rural Stream Management

Management Zone 5, is the largest Management Zone within the catchment. This management zone considers the rural watercourses running through the Oira Creek catchment that are outside of future urban zones, are not classed as 'highly degraded' and do not run through areas of high ecological significance. Land within this zone is likely to remain as private, rural, agricultural land and represents the catchments 'status quo'. Management will require landowner co-operation which may present a challenge, particularly in terms of implementing any large-scale management goals.

Management objectives within this zone should focus on encouraging and assisting landowners to improve the state of the watercourse running through their property, particularly through fencing and riparian planting. Council driven assistance should be prioritised towards addressing engineering assets that were assessed as being poorly functional or had moderate to severe erosion issues. Fish passage improvements should be considered when carrying out maintenance works on engineering assets.

General Maintenance Issues with Management Zone 5:

- Inspection of eleven pipes/culverts and twelve inlet/outlet structures identified as Council owned (or unknown) assets requiring maintenance, but that are not currently registered within the GIS system. If they are Council owned then incorporation into the GIS system and maintenance schedule is required.
- Eighty privately owned pipes/culverts required some form of maintenance, including vegetation removal, erosion protection and structural repairs. Twenty-three private pipes/culverts were assessed as being in poor or very poor condition.
- Fifty-eight privately owned inlet/outlets with structure required maintenance, including vegetation clearance, erosion protection and structural repairs. Twenty-two of these had moderate or severe erosion issues, while fifteen were assessed as being in poor condition. Additionally, forty-five inlets/outlets without structure had moderate or severe erosion issues.
- Twenty-seven erosion hotspots were recorded, three of which posed a moderate risk safety.
- Five debris jams likely to have a significant impact on stormwater flows were identified. Three stormwater pipes, a bridge and a rubbish pile likely to be significantly impacting stormwater flows were also identified.

Suggested goals and objectives for Management Zones 5:

- Educate landowners on their responsibilities and ways they can manage the watercourses running through their property.
- Encourage and assist landowners with replacing or repairing culverts in poor or very poor condition and those with moderate to severe erosion issues.
- Improve fish passage through the catchment by installing fish passage devices through culverts.
- Engage landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Encourage landowners to restore, enhance or protect riparian zones, particularly around erosion hotspots and significant ecological areas.
- Provide information on support programmes and appropriate restoration funding avenues.
- Help to control or minimise aquatic weed infestations, such as *Glyceria maxima*.

5.2 Enhancement Opportunities

Nine Enhancement Opportunity (EO) sites have been selected, based on field observations and conversations with land owners. While it should be recognised that the entire catchment has the potential to be significantly enhanced the sites chosen represent areas where:

- Immediate gains could be made, particularly around ecological benefits;
- Landowner initiatives are already occurring;
- Public involvement could be incorporated;
- Future developers could lead enhancement; and
- Sites could be used as offset sites for mitigation.

Each site has been prioritised in terms of the overall value to amenity, ecology, and conveyance that enhancement would provide. While the perceived benefits of improving a site's conveyance capacity is a key component in determining an EO prioritisation score most land within the catchment, and consequently the storm water assets are privately owned. This makes it less feasible, from a council perspective, to drive enhancement of an area, particularly if improving conveyance measures is the focus of the EO. Therefore, sites that have received high prioritisation scores in Table 31 may not necessarily reflect sites where there is the most value for council to be involved. Details of the benefits to council for each EO are detailed in the sections below.

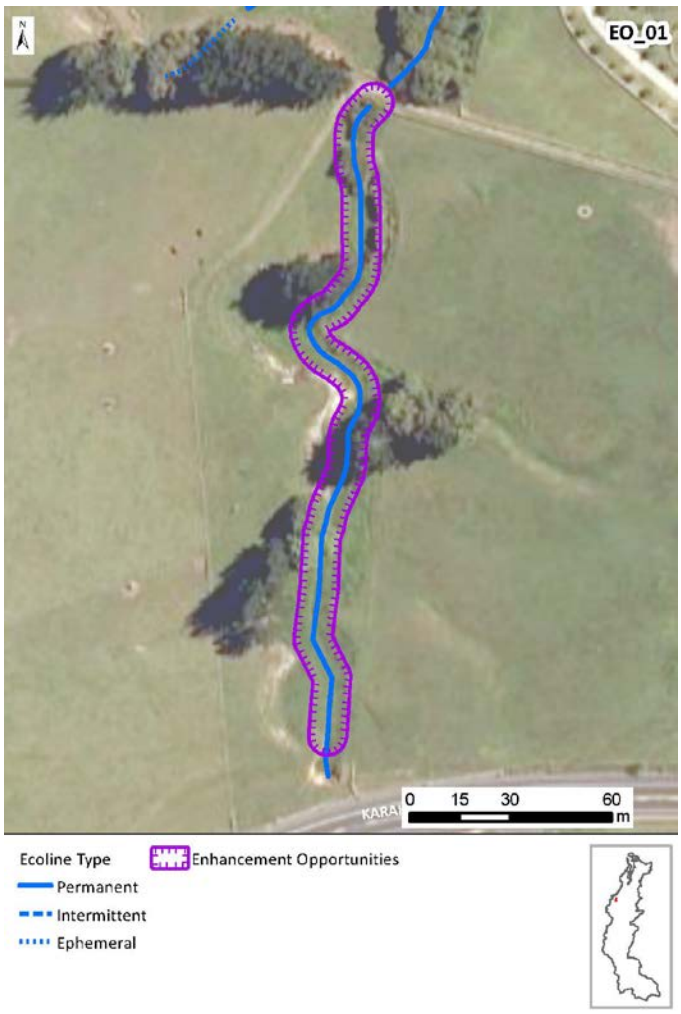
Table 31: Summary of prioritisation of enhancement opportunities.

Enhancement Opportunity	Management Zone	Description	Amenity	Ecology	Conveyance	Overall Score	Prioritisation Score
01	MZ5	Unfenced, unplanted section of stream visible from State Highway 22.	Moderate	Moderate	Low	8	4
02	MZ5	Stream section littered with rubbish.	Low	Moderate	Low	7	5
03	MZ5	Subcatchment with conveyance issues and *Glyceria* infestation.	Low	Moderate	High	9	3
04	MZ2	Highly degraded section of stream with conveyance, erosion and ecological issues.	Low	High	High	9	3
05	MZ1	Stream in future urban zone. Opportunity to improve conveyance and fish passage.	Moderate	High	High	11	1
06	MZ1	Stream in future urban zone. Opportunity to improve conveyance and fish passage.	Moderate	Moderate	High	10	2
07	MZ3	Expansive wetland network surrounded by stands of remnant kahikatea forest.	Moderate	High	Low	9	3
08	MZ1	Public land around Oira Creek Tidal Inlet. Partially within future urban zone.	High	High	None	9	3
09	MZ1	Stream sections that will potentially become esplanade reserves if development occurs.	High	High	Low	10	2

5.2.1 Enhancement Opportunity 1

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 01</td><td>Area (m^2)</td><td>2031</td><td rowspan="4">Enhancement</td><td>Fencing/Stock Exclusion</td><td rowspan="4">Stakeholders</td><td>Private Landowner(s)</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Weed Control and Planting</td><td>Local School</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Whangapouri Road – upstream from ecoline 3_008_B.</td><td>Outfall Erosion</td><td>AC ESU</td></tr>
<tr><td>Community Engagement</td><td>AC SW</td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Engagement with local community (E.g. schools).</td></tr>
<tr><td>Notes</td><td colspan="8">In its present state, the stream running through this enhancement opportunity is unfenced, unplanted and has been impacted by stock damage. Erosion issues are also present at the culverts leading into and out of the area.

The land owner expressed an interest in fencing and replanting the area and as this site has good public visibility from State Highway 22, an excellent opportunity exists to involve the community in any enhancement project, thus improving the amenity value of the site. This could be achieved by involving school children from the nearby Karaka School in replanting the stream margins with native vegetation.</td></tr>
</table>

Plan	
Photo	 Unfenced, unplanted section of stream  Stream visible from SH22

5.2.2 Enhancement Opportunity 2

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 02</td><td>Area (m^2)</td><td>3383</td><td rowspan="4">Enhancement</td><td>Erosion Protection</td><td rowspan="4">Stakeholders</td><td>Residents</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Naturalising (habitat enhancement)</td><td>AC ESU</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Woodlyn Drive. Upstream from ecoline 3_010_A</td><td>Weed Control and Planting</td><td>AC SW</td></tr>
<tr><td>Outfall Erosion</td><td></td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Potential offset site for stream works mitigation.</td></tr>
<tr><td>Notes</td><td colspan="8">A wide, low gradient flood plain exists around a poorly channelised stream. The flood plain is currently dominated by weed species and is littered with debris and rubbish. The stream has the potential to offer good bankside spawning habitat but needs to be replanted with native species. The habitat could be further enhanced by removing the debris and rubbish, which may also present a future conveyance issue if left.

At the upstream end of the site, improvements could be made to the artificial online pond. Some erosion issues, where trees have been felled are present, while the culvert that was in place appears to no longer function. The overflow channel may also be impacting fish passage upstream.</td></tr>
</table>

Plan	
Photo	 Rubbish around old pond outlet point  Weed infested low gradient banks

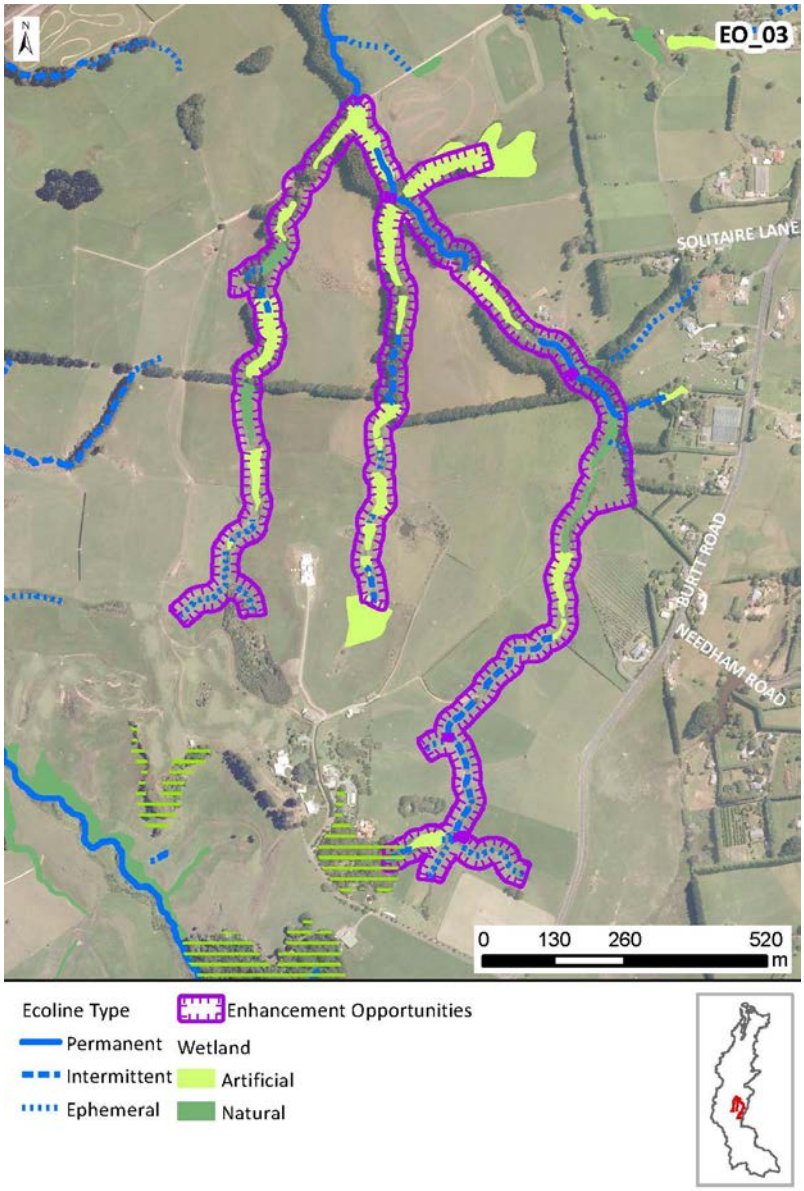
5.2.3 Enhancement Opportunity 3

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td colspan="3">EO 03 Area (m^2) 152964</td><td rowspan="4">Enhancement</td><td>Aquatic Weed Control</td><td rowspan="4">Stakeholders</td><td>Private Landowner(s)</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Fish Barrier</td><td>AC ESU</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Burtt Road and Solitaire Lane. Upstream from ecoline 3_014_A</td><td>Weed Control and Planting</td><td rowspan="2">AC SW</td></tr>
<tr><td>Conveyance Improvements</td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Potential offset site for mitigation.</td></tr>
<tr><td>Notes</td><td colspan="8">A series of farm ponds and perched culverts have likely created significant ecological and conveyance issues throughout this area. Poor drainage has resulted in a serious build-up of the noxious weed Glyceria. This ecologically damaging species, reduces the conveyance capacity of streams and rivers and poses a health risk to livestock (see section 3.1.3 for more details).

While removing Glyceria from all three stream channels would require extensive weed control, large-scale clearances are economically cheaper than small scale clearances, in terms of a reduction of infested area per unit invested (Loo et al. 2009). In the upper catchment (eastern fork) there are currently landowners who are controlling Glyceria via spraying, therefore it is likely that approaching landowners to help combat the problem would be positively received. Improving the riparian margins within the reaches would also help to reduce the risk of infestations returning.

Reconnecting the stream network through replacement of culverts that are perched above the water table would also provide benefits to the watercourse. A more consistent flow may help prevent Glyceria establishing across the channel, while the removal of significant fish barriers would improve the accessibility of upstream areas to native fish species.</td></tr>
</table>

Plan



Photo

Glyceria chocked watercourse

Stream section sprayed to control *Glyceria*

	 Perched culvert at downstream end of EO

5.2.4 Enhancement Opportunity 4

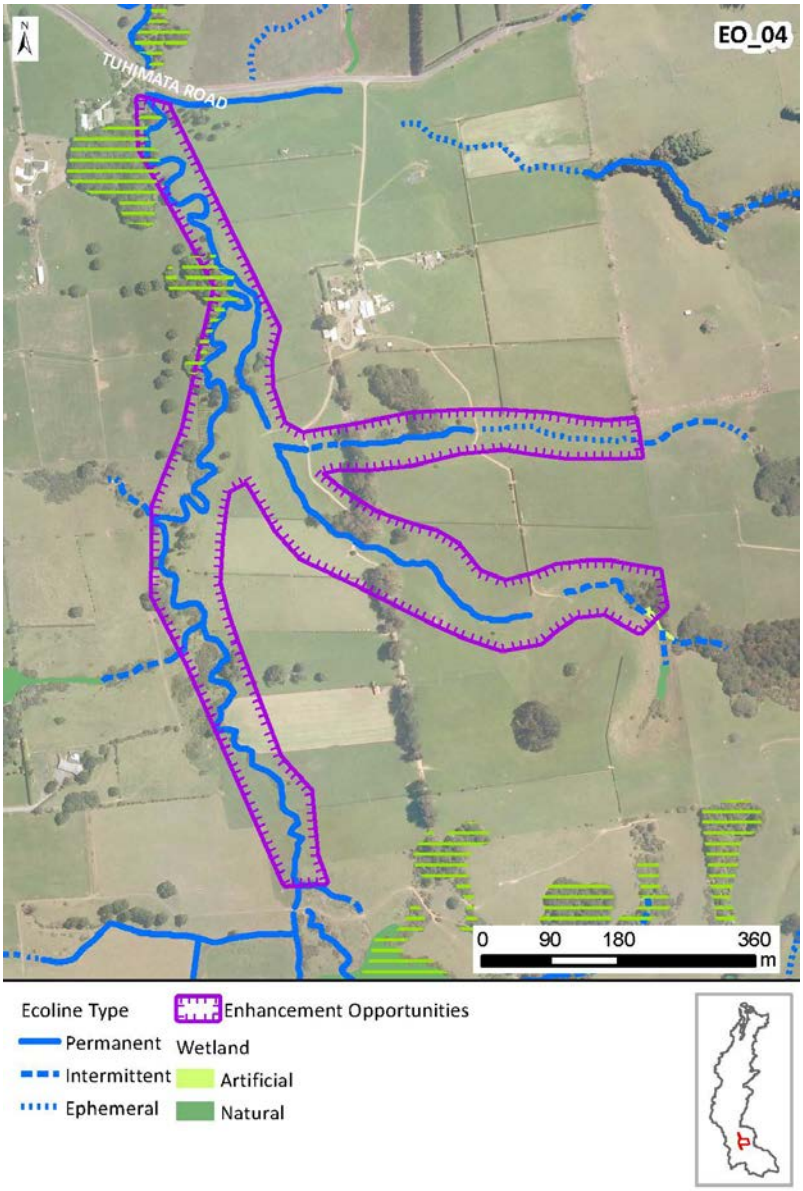
<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td colspan="3">EO 04 Area (m^2) 257042</td><td rowspan="4">Enhancement</td><td>Erosion Protection</td><td rowspan="4">Stakeholders</td><td>AC ESU</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Fencing/Stock Exclusion</td><td>Residents</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Tuhimata Road. Downstream from ecoline 3_023_A</td><td>Weed Control and Planting</td><td>AC SW</td></tr>
<tr><td>Fish Barrier</td><td>Community Groups</td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Potential offset site for stream works mitigation.

Ecological linkage corridor between upstream and downstream SEAs.</td></tr>
<tr><td>Notes</td><td colspan="8">The streams running through this section of the catchment were observed to be the most degraded during the watercourse survey. A lack of fencing, combined with severe stock damage has resulted in significant erosion issues throughout the area, with multiple erosion hot spots identified.

There is an overall absence of riparian vegetation and sections of the stream have been piped to increase the amount of space available for livestock grazing. Multiple perched culverts existed creating erosion issues and fish barriers are present. The incidence of mosquito fish presents further challenges to native fish.

This area needs significant attention and the watercourse would benefit immensely from fencing and stock exclusion. Naturalising, including riparian vegetation planting and the daylighting of piped sections of stream would improve the stream function and increase habitat for native fish, while erosion protection and the incorporation of fish passage devices into many of the culverts would help to alleviate fish passage issues and culvert erosion.

The proximity between this EO and EO_07 presents an opportunity to link the two areas forming a more continuous corridor of native riparian vegetation. A scenic reserve (SEA_T_5351) also exists directly downstream from this EO, providing further potential for ecological linkages.</td></tr>
</table>

Plan	
Photo	 Unfenced, stock impacted watercourse  Eroded bank and thick macrophyte growth

5.2.5 Enhancement Opportunity 5

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 05</td><td>Area (m^2)</td><td>4494</td><td rowspan="4">Enhancement</td><td>Fish Barrier</td><td rowspan="4">Stakeholders</td><td>AC SW</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Daylighting</td><td>AC ESU</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Oira Rd upstream from ecoline 2_005_A</td><td>Conveyance Improvements</td><td>Private Landowner(s)</td></tr>
<tr><td>Outfall Erosion</td><td></td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Developer funded.</td></tr>
<tr><td>Notes</td><td colspan="8">During the survey, inanga were observed within the stream mouth but were not able to access any upstream habitat due to the presence of fish barriers. An opportunity exists here to improve fish passage, daylight a section of piped stream (first culvert within the EO) and improve the inanga spawning habitat at the downstream end of the EO.

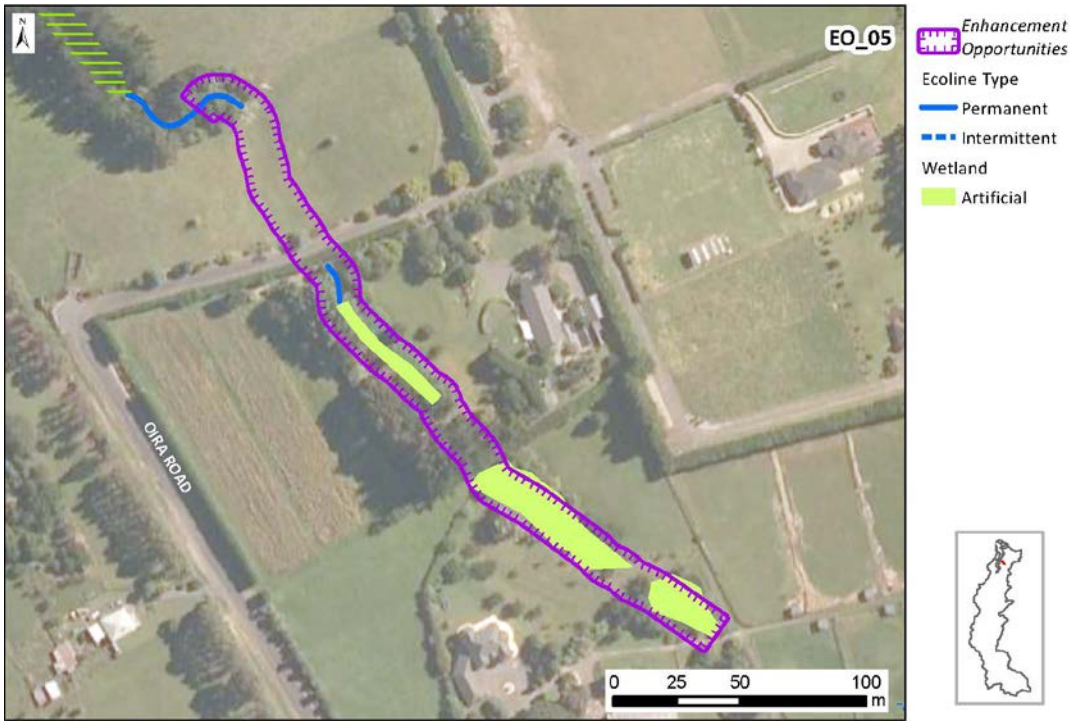
Local residents have noted that over the past few years stormwater flows have increased, leading to more flooding within their properties. This EO is within the Drury West Stage 1 future urban growth area (developed by 2022; Auckland Council Planning Committee, 2017), therefore is likely to experience further increase in storm water flows within the short-term future. Erosion issues around the existing culverts may be exacerbated by this so taking action to address these issue and future proof the culverts against increased flows is recommend.</td></tr>
<tr><td>Plan</td><td colspan="8"> 
</td></tr>
</table>

Photo	 Perched culvert  Downstream inanga spawning habitat

5.2.6 Enhancement Opportunity 6

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 06</td><td>Area (m^2)</td><td>4540</td><td rowspan="4">Enhancement</td><td>Fish Barrier</td><td rowspan="4">Stakeholders</td><td>AC SW</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Conveyance Improvements</td><td>AC ESU</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Oira Rd upstream from ecoline 1_020_A</td><td>Fencing/Stock Exclusion</td><td>Private Landowner(s)</td></tr>
<tr><td>Weed Control and Planting</td><td></td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Developer funded.</td></tr>
<tr><td>Notes</td><td colspan="8">Several culverts within this enhancement opportunity consist of three small (0.15 m diameter) PVC pipes as opposed to a single larger pipe. Many of these small pipes are broken, perched and have created erosion issues, particularly around the outlets. Fish passage was also restricted and during the field survey inanga were observed in a pool at the downstream end of the EO but could not proceed further upstream due to a perched culvert.

The watercourse within the EO is unfenced, lacks any riparian vegetation and is choked with macrophytes. Habitat enhancement, including weed removal, riparian plantings and adding additional rough elements would be beneficial to the stream, as would fencing.

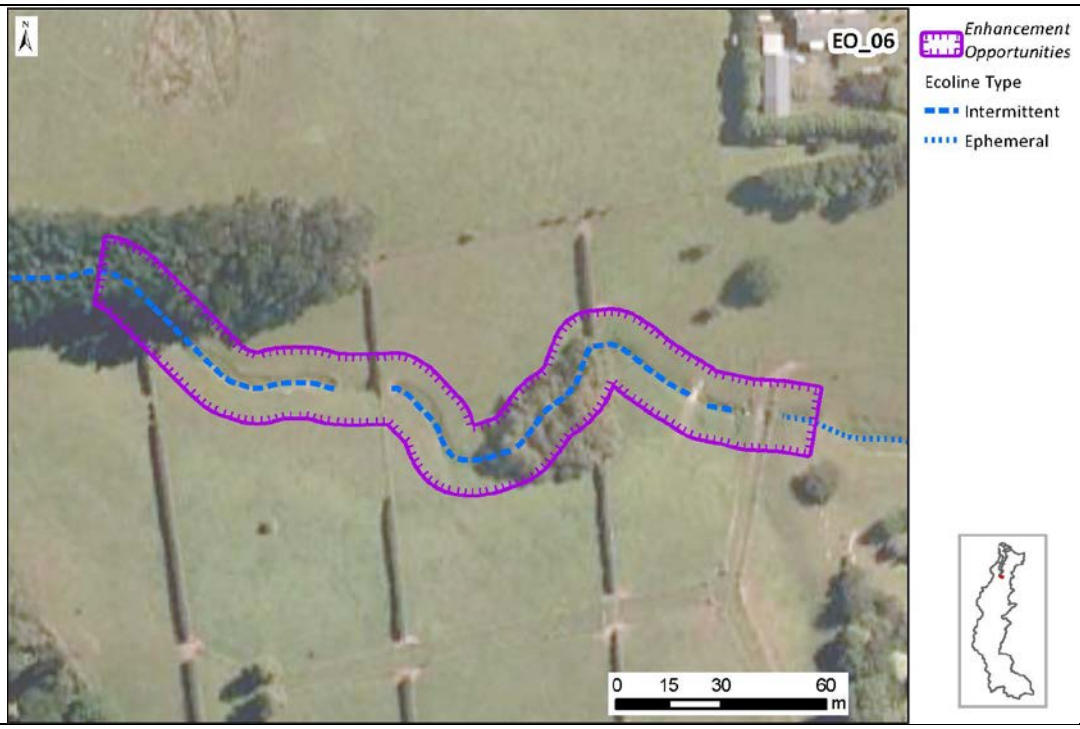
This EO is within the Drury West Stage 1 future urban growth area (developed by 2022; Auckland Council Planning Committee, 2017). As this is likely to increase storm water flows replacing the existing culverts with more appropriate ones that can cope with increased flows would help future proof the stream and hopefully alleviate future conveyance and erosion issues.</td></tr>
<tr><td>Plan</td><td colspan="8"> 
</td></tr>
</table>

Photo	 Undersized, perched culvert  Unfenced, macrophyte chocked watercourse

5.2.7 Enhancement Opportunity 7

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 07</td><td>Area (m^2)</td><td>135865</td><td rowspan="4">Enhancement</td><td>Amenity</td><td rowspan="4">Stakeholders</td><td>Community Groups</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Weed Control and Planting</td><td>Residents</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">North of Grace James Drive. Upstream from ecoline 3_028_A</td><td>Fencing/Stock Exclusion</td><td>AC ESU</td></tr>
<tr><td>Conveyance Improvements</td><td>AC SW</td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Wetland restoration, scarcity of habitat in Auckland.

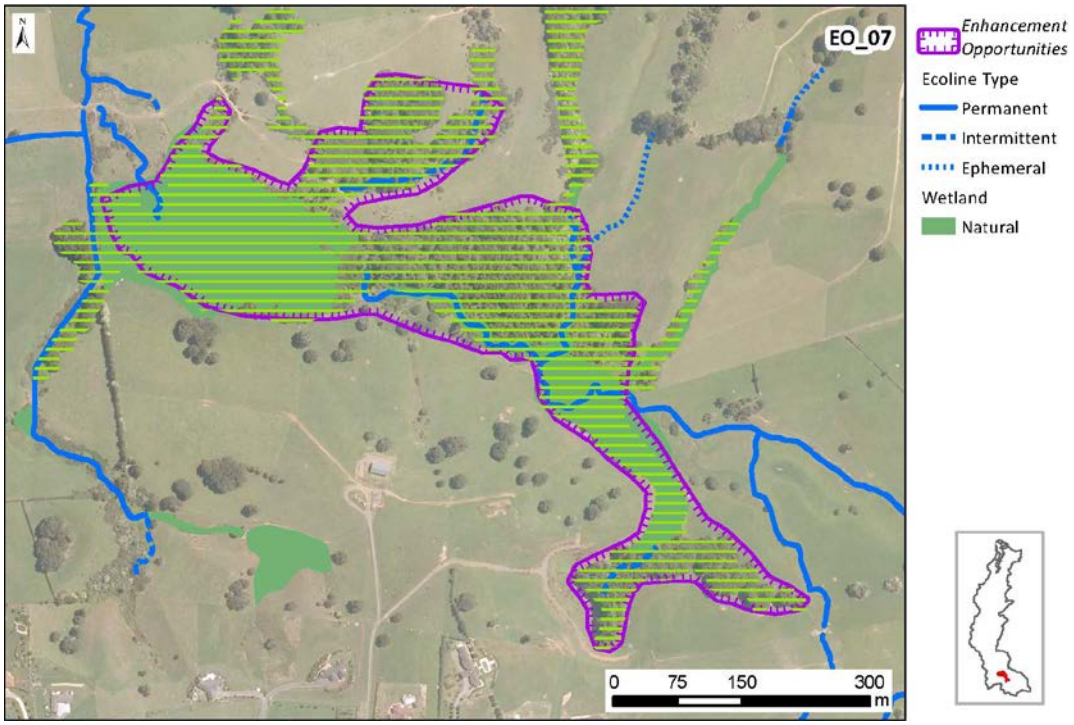
Potential offset site for mitigation.

Opportunity for community engagement.</td></tr>
<tr><td>Notes</td><td colspan="8">In the upper catchment, several stands of remnant kahikatea swamp forest exist surrounding a large area of wetland. This area sits within SEA_T_4375. An opportunity exists here to provide linkages between the stands, creating an ecological corridor and facilitating the re-establishment of native vegetation within the catchment. This would be a large-scale project and presents a good opportunity for local resident and community group engagement.

The area is presently being encroached by weed species, with stands of grey willow (Salix cinerea), Glyceria meadows and pastural weeds common along the vegetated fringes. Removal of weed species combined with the replanting of natives would enhance the vegetation value within this significant ecological area. During the time of survey riparian planting along a wetland feeding into the enhancement opportunity (wetland 1_180_B_1) was being carried out. Linkage with this planting would further increase the total continuous area covered by native vegetation.

The catchment upstream of the wetland has land zoned for future urban growth. As this, and surrounding land, becomes developed there is likely to be an increase in storm water flows entering the Oira Creek. The existing wetland nature of the EO could potentially be improved and utilised as a natural buffer against an increase in storm water flows.</td></tr>
</table>

Plan



Photo

Remnant kahikatea swamp forest

Grey willow stands on swamp fringe

Replanting of nearby wetland

5.2.8 Enhancement Opportunity 8

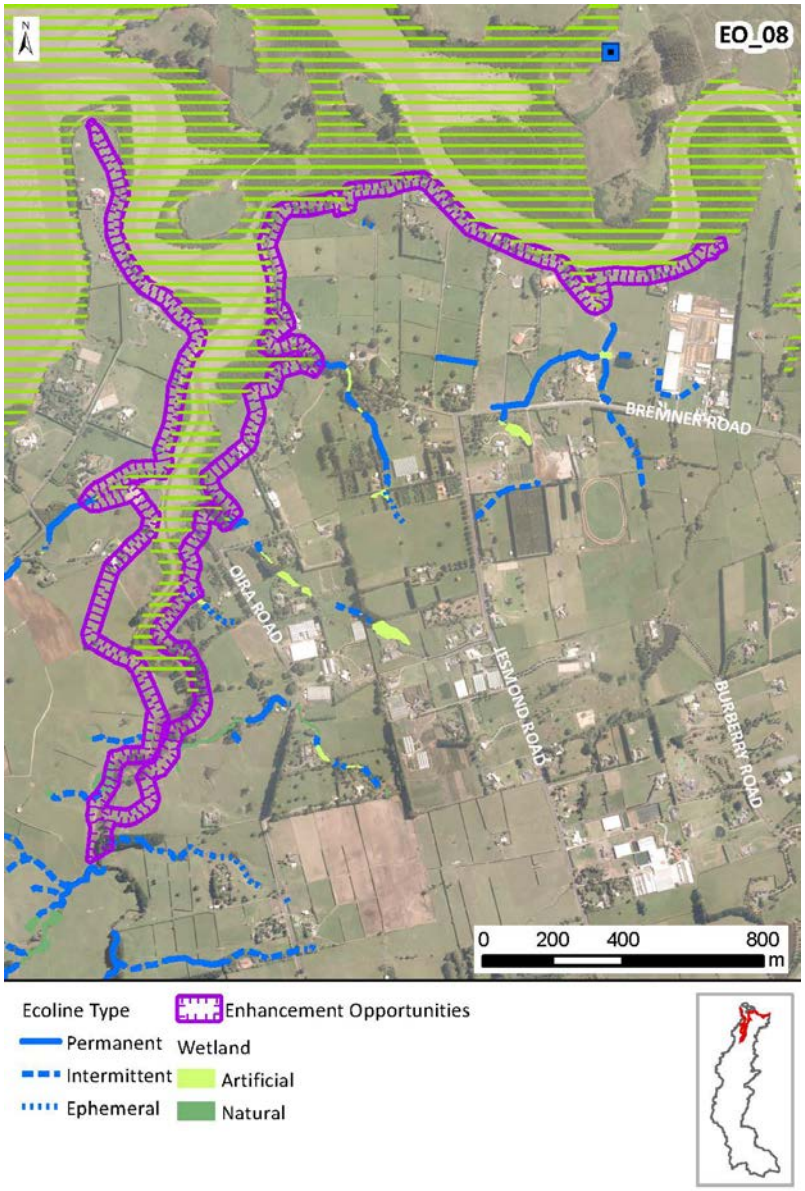
<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 08</td><td>Area (m^2)</td><td>180526</td><td rowspan="4">Enhancement</td><td>Amenity</td><td rowspan="4">Stakeholders</td><td>AC ESU</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Community Engagement</td><td>AC SW</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Oira Rd, Whangapouri Rd and Arana Drive. Land surround Oira Creek Tidal Inlet</td><td>Inanga Spawning</td><td>Residents</td></tr>
<tr><td>Weed Control and Planting</td><td>Community Groups</td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Developer funded.

Potential inanga spawning site.

Opportunity for community engagement.</td></tr>
<tr><td>Notes</td><td colspan="8">The coastal margin along both sides of the Oira Creek Tidal Inlet is zoned as open space – conservation as well as a coastal transition zone. The tidal inlet itself is also part of the Drury Creek Marine SEA. This strip of conservation land/esplanade reserve is not currently readily accessible to the public, however that is likely to change as development of the area occurs, particularly on the eastern side of the EO where land is zoned for future urban growth.

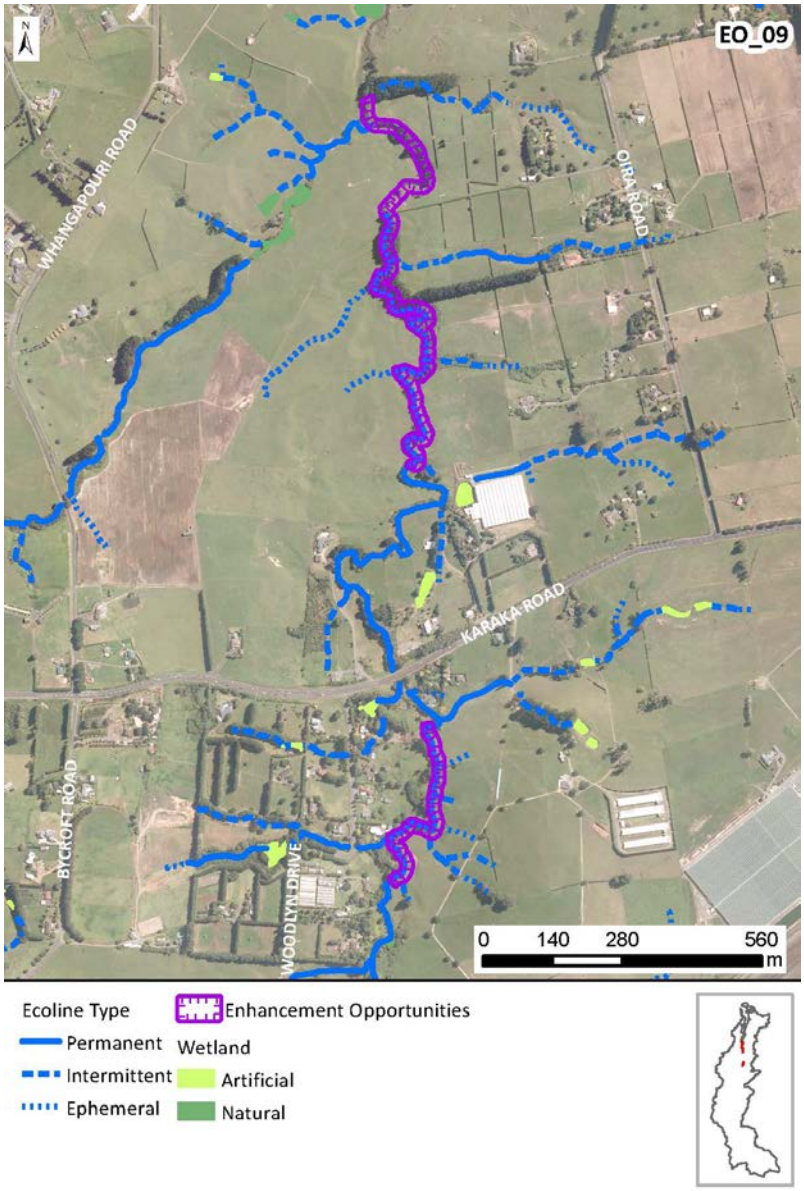
The area boasts a variety of different habitats, including saltmarsh and freshwater wetland. Improving public access would increase the amenity value of this area, allowing it to be observed and enjoyed by more than just the immediate landowners.

The value of conservation land has been compromised as is backed directly by unfenced farmland. Weed species were also common throughout native vegetation. Community involvement in restoring this area would help improve its ecological value as well as enhancing community pride in the local area. Improvements to low growing bank vegetation would also increase the potential inanga spawning habitat of the small stream mouths along this coastal edge within the Oira Creek Catchment.</td></tr>
</table>

Plan	
Photo	 Riparian margins along the upper Oira Creek Tidal Inlet

5.2.9 Enhancement Opportunity 9

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO 09</td><td>Area (m^2)</td><td>15684</td><td rowspan="4">Enhancement</td><td>Amenity</td><td rowspan="4">Stakeholders</td><td>AC ESU</td></tr>
<tr><td>Stream</td><td colspan="3">Oira Creek</td><td>Community Engagement</td><td>Community Groups</td></tr>
<tr><td rowspan="2">Location</td><td colspan="3" rowspan="2">Oira Rd and State Highway 22. Riparian Margin of Oira Creek</td><td>Weed Control and Planting</td><td>Residents</td></tr>
<tr><td>Fencing/Stock Exclusion</td><td></td></tr>
<tr><td>Benefits for Council</td><td colspan="8">Developer funded.
Opportunity for community engagement.</td></tr>
<tr><td>Notes</td><td colspan="8">Two sections of the Oira Creek, in the lower catchment, are bound on the eastern side by land zoned as future urban. It is likely that the stream width along these sections is sufficient to trigger the requirement for the creation of an esplanade reserve when development of properties bordering the stream occurs.
Any esplanade reserves would most likely become public/accessible land, increasing the amenity value of the stream. Developers also have a good opportunity to involve community groups with restoration projects, further boosting the amenity values. Riparian plants, removal of weed species and fencing (where stock may remain) would all be beneficial and help to improve the state of the stream.</td></tr>
</table>

Plan	
Photo	 Stream section with multiple weed species.

5.3 Auckland Council Maintenance Contract

Intergroup is responsible for implementing the 'southern area stormwater maintenance contract' for Auckland Council. This contract includes the Oira Creek catchment area. The contract works to be carried out under this contract include, but are not limited to the regular maintenance of the Auckland Council's Stormwater assets in the Southern Area. This includes maintenance of pipeline, open channel and watercourses, culverts, ponds, treatment devices, network and related works within urban areas, including isolated urban settlements. The contract includes regular inspections for both lined and unlined channels specifically scheduled within the contract. Vegetation control is to be undertaken as required. The purpose of vegetation control of watercourses is to maintain the low flow and ensure the stormwater capacity of the drainage system remains in an efficient state. It is also to ensure watercourses are acceptable from an aesthetic and environmental viewpoint. Tasks to be carried out include grass cutting, weeding, and spraying. All spraying is to be carried out by licensed applicators, which shall use the appropriate herbicide spray and additive agents to achieve a successful result. Particular care shall be taken to ensure that bank stabilisation is maintained by restricting spray only to the required areas.

The contractor shall complete an inspection and clearing of the features as detailed in the contract. Inlets and outlet locations are specifically listed in the contract within the Oira Creek catchment. The assets are listed as requiring either 2 weekly or 4 weekly inspections and clearing of obstructions. The inlet or outlet includes the adjacent area 2 m wide and 5 m long on either side along the direction of flow. Critical hotspots are also identified which include known areas of flooding, surcharging, and/or overflowing that are known to cause flooding in private property. These also need to be inspected prior to heavy rain at the request of the engineer to the contract. The contractor shall also conduct inspections of all stormwater inlet and outfall structures as part of the watercourse inspection. Each outfall shall be maintained to ensure that water flows freely from the outfall into and along the watercourse, or receiving environment, that it discharges to.

Ponds and wetlands listed in the contract, filters (sand and storm filters) and other mechanical devices such as litter traps are also listed for regular inspection.

Additional maintenance contracts such as those relating to parks and open spaces were not provided, and therefore are not discussed here.

6.0 Conclusions

The Oira Creek catchment encompasses 20.3 km^2 of land within the Franklin District, Auckland Region. This soft-bottomed watercourse runs north through predominantly rural, agricultural land from the fringes of Pukekohe to the Drury Creek arm of the Pahurehure Inlet. Land in the north and south of the catchment is zoned for future urban growth, therefore the Oira Creek is likely to experience a rapid change in land-use over the next 30 years.

In its present state, the Oira Creek can be considered a degraded environment with most of the issues identified throughout the watercourse assessment being ecological in nature. These included; a limited intactness of the riparian vegetation, a lack of stream fencing, significant stock damage issues, and widespread fish passage issues cause by natural and engineering structures. Degradation was further reflected in the SEV scores, which were below the Auckland Council mean SEV reference score for all five sites assessed. In general sites scored poorly for habitat provisioning and biodiversity.

There were relatively few issues identified with the Oira Creek's capability to convey stormwater flows, however stormwater infrastructure with moderate to severe outfall erosion were identified. These existing erosion issues are likely to worsen and the streams ability to contain stormwater flows may become compromised because of rapid changes in land-use within the catchments designated future urban growth zones.

Five Management Zones and nine Enhancement Opportunities have been identified through the catchment. Most of these fall within privately owned land and therefore achieving management goals will require significant co-operation from landowners. Management Zone 1 – Coastal and Future Urban, which also includes three high priority Enhancement Opportunities, has the most potential for achieving multiple management goals. The resolution of currently identified issues, particularly stormwater issues, could be fast tracked to future-proof against the inevitable development that will occur within this area over the next 30 years. Taking advantage of developer-led initiatives to improve the streams amenity, ecological and conveyance values will likely achieve additional management goals without requiring large-scale council investment.

Key management goals and objects identified across the five Management Zones include:

- Engagement with landowners to install or repair fencing around moderately or severely damaged watercourses, thus minimising further damage, erosion and pollution issues.
- Encourage landowners to restore, enhance or protect riparian zones.
- Futureproof stream stormwater conveyance capacity by replacing undersized or poorly functioning engineering assets.
- Address inlet/outlet erosion issues, particularly within the future urban zones before land becomes developed.

- Create greater ecological linkages, particularly between isolated Significant Ecological Areas, through the provision of riparian corridors and the removal of weed species.
- Improve fish passage where necessary though the provision of fish passage devices or removal/replacement of problematic engineering assets.
- Enhance potential inanga spawning habitats.
- Involve community groups in restoration projects.

7.0 References

ANZECC. (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Auckland Council. (2012). Auckland Plan.

Auckland Council. (2016). Auckland Unitary Plan – Operational in Part.

Auckland Council Planning Committee (2017). Planning Committee Open Agenda. *Minutes from the Auckland Council Planning Committee Open Agenda 7 March 2017*. Reception Lounge, Auckland Town Hall.

Auckland Regional Council (2007). Auckland Regional Pest Management Strategy 2007 – 2012.

Baker, C., Rowe, D., Smith, J. (2004). *Gambusia* – a biodiversity threat? *Water & Atmosphere*, 12, 24-25

Biggs, B.J.F., Kilroy, C., Mulcock, C.M., Scarsbrook, M.R., Ogilvie, S.C. (2002). New Zealand Stream Health Monitoring and Assessment Kit. Stream Monitoring Manual. Version 2K – A Tool for Kaitiaki. NIWA Technical Report 111-1. 190 p

Andrew Stewart Limited. (2012). State of the Freshwater Environment: Southern Sector - A Literature Review. Report prepared by Andrew Stewart Limited for Auckland Council.

Auckland Council. (2013). Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements. Prepared by Auckland Council. Auckland Council technical report, TR2013/035.

Clark, A., Lake, P.S., O'Dowd, D.J. (2004). Ecological impacts on aquatic macroinvertebrates following upland stream invasion by a ponded pasture grass (*Glyceria maxima*) in southern Australia. *Marine and Freshwater Research*, 55, 709-713.

Cowen, J. (1955). *The New Zealand Wars: A history of the Maori campaigns and the pioneering period: Volume 1 (1845-64)*. R. E. Owen, Wellington, New Zealand.

Caraco, N.F., Cole, J.J. (2002). Contrasting impacts of a native and alien macrophyte on dissolved oxygen in a large river. *Ecological Applications*, 12, 1496-1509.

Curran-Cournane, F., Vaughan, M., Memon, A., Fredrickson, C. (2014). Trade-offs between high class land and development: Recent and future pressures on Auckland's valuable soil resources. *Land Use Policy*, 39, 146 – 154.

Flavell, K, W, T. (2010). Ngati Te Ata working draft assessment report: proposed Kingseat Structure Plan. Prepared by Ngati Te Ata for Kingseat Village Incorporation

Franklin District Council (2009). Franklin District Council Community Plan 2009 – 2019. Volume 1. 118 p

Franklin Local Board (2014). Franklin Local Board Plan 2014 – 2017.

Goodman, J.M., Dunn, N.R., Ravenscroft, P.J., Allibone, R.M., Boubee, J.A.T., David, B.O., Griffiths, M., Ling, N., Hitchmough, R.A. and Rolfe, J.R. (2014) Conservation status of New Zealand freshwater fish, 2013. New Zealand Threat Classification Series 7. Department of Conservation, Wellington. 12 p.

Heritage Consultancy Services. (2013). RUB South Cultural heritage report. Prepared for Auckland Council.

Hickford, M.J., Schiel, D.R. (2014). Experimental rehabilitation of degraded spawning habitat of a diadromous fish, *Galaxias maculatus* (Jenyns, 1842) in rural and urban streams. *Restoration Ecology*, 22, 319-326.

Holland, K., Hussain, E. (2016). Stream Ecological Valuation (SEV) Training Workshop (Day 2), Auckland Council.

James, A. (2013). A review of the ecological effects of macrophyte management in soft-bottomed waterways. Prepared by EOS Ecology for Waikato Regional Council. Waikato Regional Council Technical Report 2013/03.

Joy, M. and Henderson, I. (2004). A fish index of biotic integrity (IBI) for the Auckland Region. Report and user guide for use with the Auckland_Fish_IBI software. Centre for Freshwater Ecosystem Modelling and Management for Auckland Regional Council, 6.

Kelly, S. (2008). Environmental condition and values of Manukau Harbour. Prepared by Coast and Catchment Ltd. for Auckland Regional Council. Auckland Regional Council Technical Report 2009/112.

Kelly, S (2010). Effects of stormwater on aquatic ecology in the Auckland region. Prepared by Coast and Catchment for Auckland Regional Council. Auckland Regional Council Document Type 2010/021.

Landcare Research. (2017a). *Axehead Caddis (Hydroptilidae: Oxyethira)*. Retrieved from landcareresearch.co.nz.

Landcare Research. (2017b). *Signs of iron leachates.* Retrieved from landcareresearch.co.nz.

Lindsay, H., Wild, C., and Byers, S. (2009). Auckland Protection Strategy. Report prepared by the Natural Heritage Fund for the Natural Heritage Fund Committee.

Loo, S.A., Mac Nally, R., O'Dowd, D.J., Lake, P.S. (2009). Secondary Invasions: Implications of riparian restoration for in-stream invasion by an aquatic grass. *Restoration Ecology*, 17, 378 – 385.

Lowe, M., Ingley, R and Young, D. (2016). Watercourse assessment methodology: infrastructure and ecology version 2.0. Prepared by Morphum Environmental for Auckland Council. Auckland Council technical report, TR2016/002.

Mills, G N (2016). Auckland marine sediment contaminant monitoring: data report for November 2015 sampling. Prepared by Diffuse Sources Ltd for Auckland Council. Auckland Council technical report, TR2016/020

Ministry for the Environment. (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Wellington, New Zealand.

Ministry for the Environment. (2014). National Policy Statement for Freshwater Management 2014. Wellington, New Zealand.

NIWA (2017). New Zealand Climate Summary: Summer 2016-17, NIWA National Climate Centre Seasonal Climate Summary.

Paice, D.S. (2015). Statement of Evidence – Topic 017 RUB Stormwater. Prepared for Wesley College Trust Board and Grafton Downs Limited.

Parshotam, A., Wadhwa, S., Semadeni-Davis, A. and Moores, J. (2008). South eastern Manukau Harbour contaminant study: Landuse analysis. NIWA Client Report HAM2008-162. Prepared by NIWA for Auckland Regional Council.

Pattle Delamore Partners Ltd. (2013). Karaka Rural Urban Boundary Waitemata Aquifer recharge assessment. Report prepared for the Auckland Council.

Phillips, N., Parkyn, S., Smith, B. (2006) Papakura ICMP – Stream Management Component. NIWA Client Report HAM2006 -102. Prepared by NIWA for Papakura District Council.

Rutherfurd, L., Flavell, K, W, T. (2011). Cultural assessment report: proposed Patumahoe Hill Structure Plan 24 and 36, Kingseat Rd Patumahoe. Prepared by the Ngati Tamaoho Trust and Te Iwi o Ngati Te Ata Waiohua for T.K. and B.W McMiken Limited.

Ryan, P.A. (1991). Environmental effects of sediment on New Zealand streams: A review. *New Zealand Journal of Marine and Freshwater Research*, 25, 207-221.

Saintly, G.R., Jacobs, S.W.L. (1994). *Water Plants in Australia*. Saintly and Associates, Sydney, Australia.

Singer, N., Osborne, B., Lovegrove, T., Jamieson, A., Boow, J., Sawyer, J., Hill, K., Webb, C. (2017). *Indigenous terrestrial and wetland ecosystems of Auckland.* Auckland Council, Auckland, New Zealand.

Stark, J.D., Boothroyd, I.K.G, Harding, J.S., Maxted, J.R. and Scarsbrook, M.R. (2001) Protocols for sampling macroinvertebrates in wadeable streams. New Zealand

Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Stark JD, Maxted JR (2004). Macroinvertebrate community indices for Auckland's softbottomed streams and applications to SOE reporting. Cawthron Report No. 970.

Stark, J.D. and Maxted, J.R. (2007) A user guide to the Macroinvertebrate Community Index. Prepared for the Ministry for the Environment. Cawthron Report no. 1166. 58p.

Storey, R.G., Neale, M.W., Rowe, D.K., Collier, K.J., Hatton, C., Joy, M.K., Maxted, J. R., Moore, S., Parkyn, S.M., Phillips, N. and Quinn, J.M. (2011) Stream Ecological Valuation (SEV): a method for assessing the ecological function of Auckland streams. Auckland Council Technical Report 2011/009.

Te Akitai Waiohua (2015). Cultural impact assessment: Old Mangere Bridge Replacement Project.

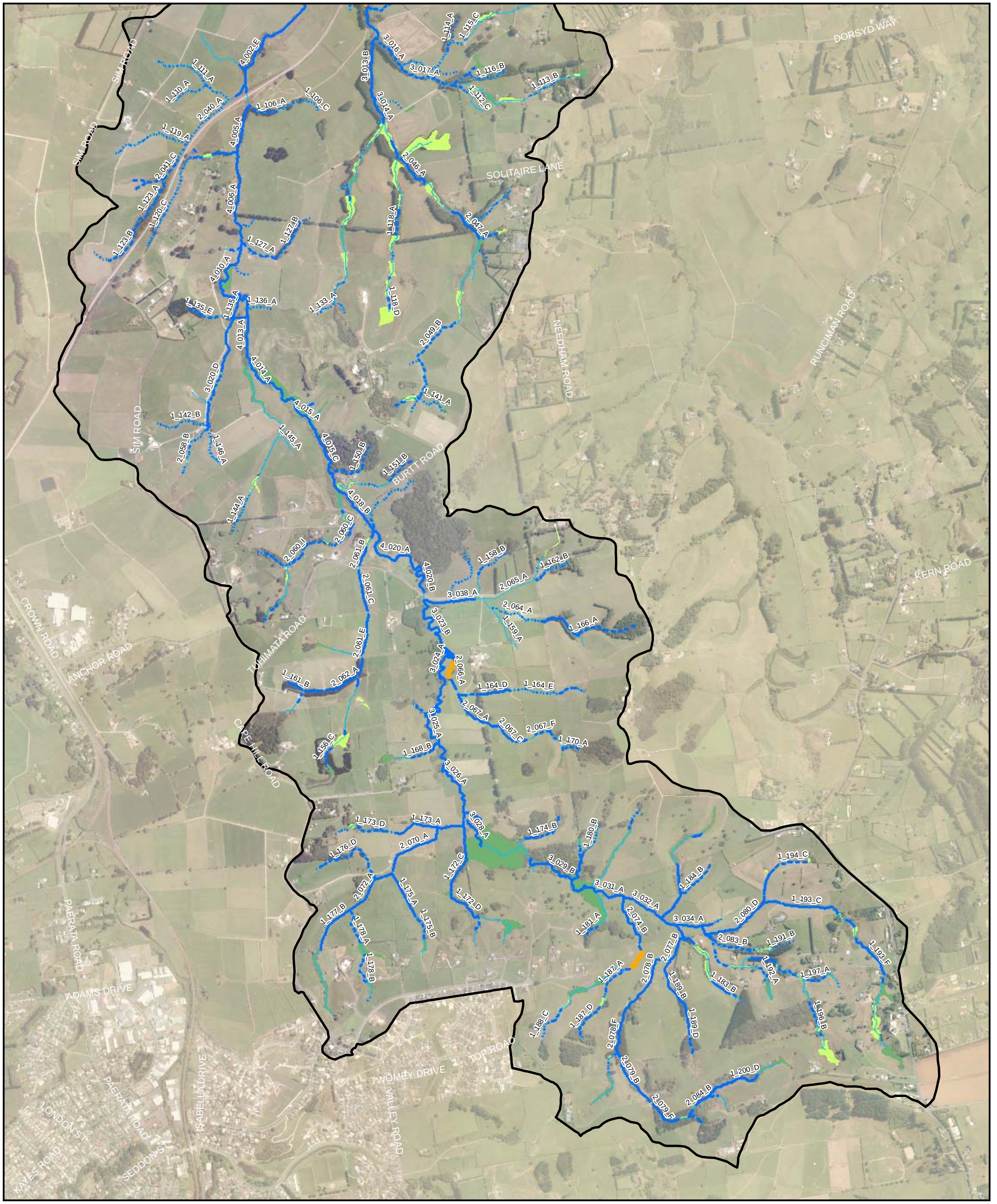
Vilijevac, Z., Murphy, G., Smaill, A., Crowcroft, G., and Bowden, D. (2002). South Auckland groundwater: Kaawa Aquifer recharge study and management of the volcanic and Kaawa aquifers. Prepared for Auckland Council. Auckland Council technical report, TR2002/133.

Waitangi Tribunal (1985). Report of the Waitangi Tribunal on the Manukau Claim (Wai-8). 2nd Edition, Wellington, New Zealand.

Williamson, R.B., Blom, A., Hume, T.M., Glasby, G.P. and Larcombe, M. (1992). Heavy metals in Manukau Harbour sediments. Water Quality Centre, Hamilton, New Zealand.

Appendix A Maps

Map 1: Overview Map



Auckland Council

OIRA CREEK CATCHMENT STREAM SURVEY

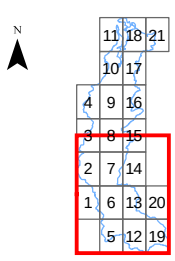
Stream Class

- Permanent
- Intermittent
- Ephemeral
- Overland Flow Path

Wetland

- Artificial
- Natural
- SEV Lines

0 0.125 0.25 0.5 km



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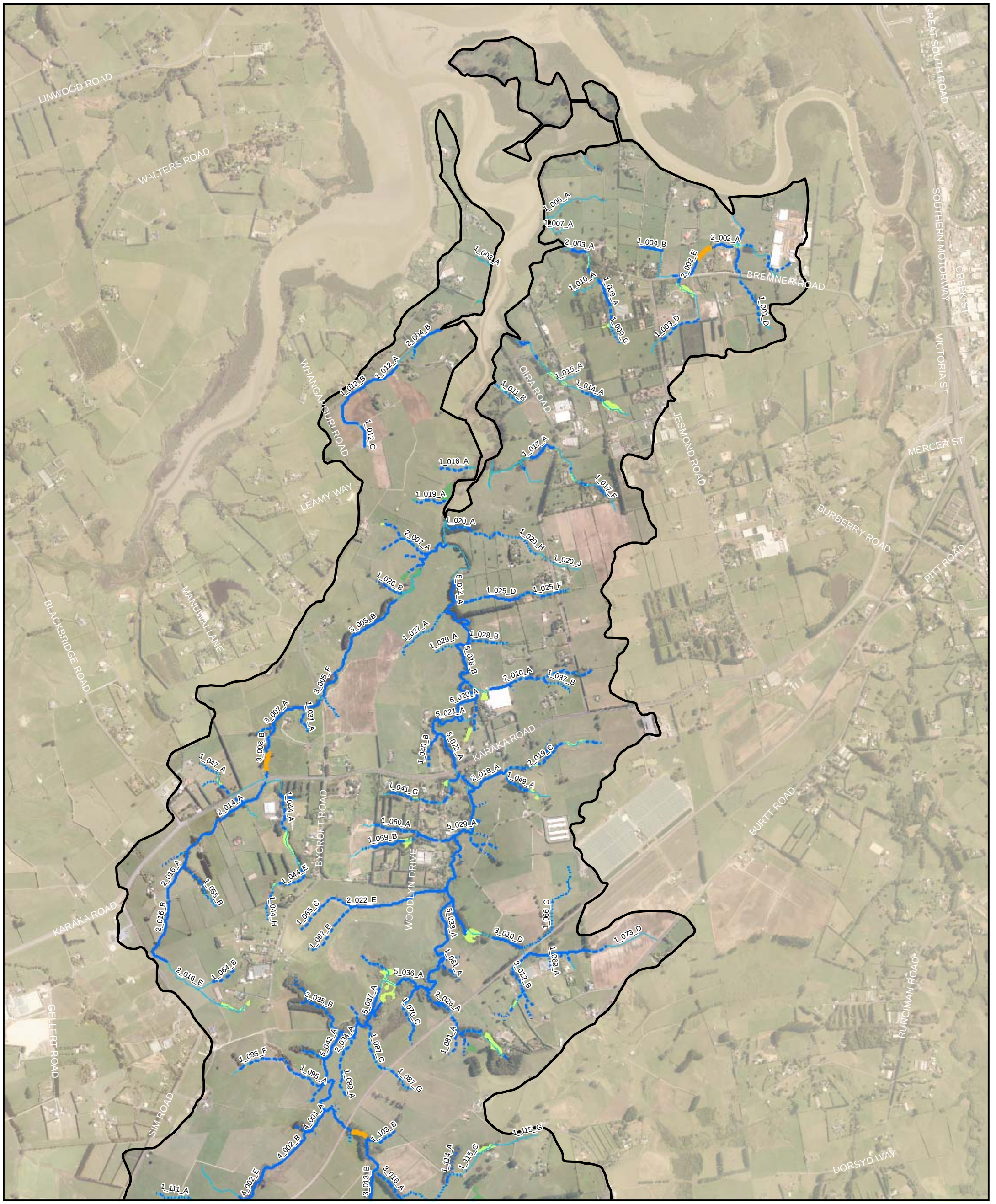
Map 1: Overview Map



Auckland Council

OIRA CREEK CATCHMENT STREAM SURVEY

Stream Class

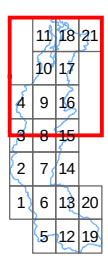
- Permanent
- Intermittent
- Ephemeral
- Overland Flow Path

Wetland

- Artificial
- Natural
- SEV Lines

0 0.125 0.25 0.5 km

N



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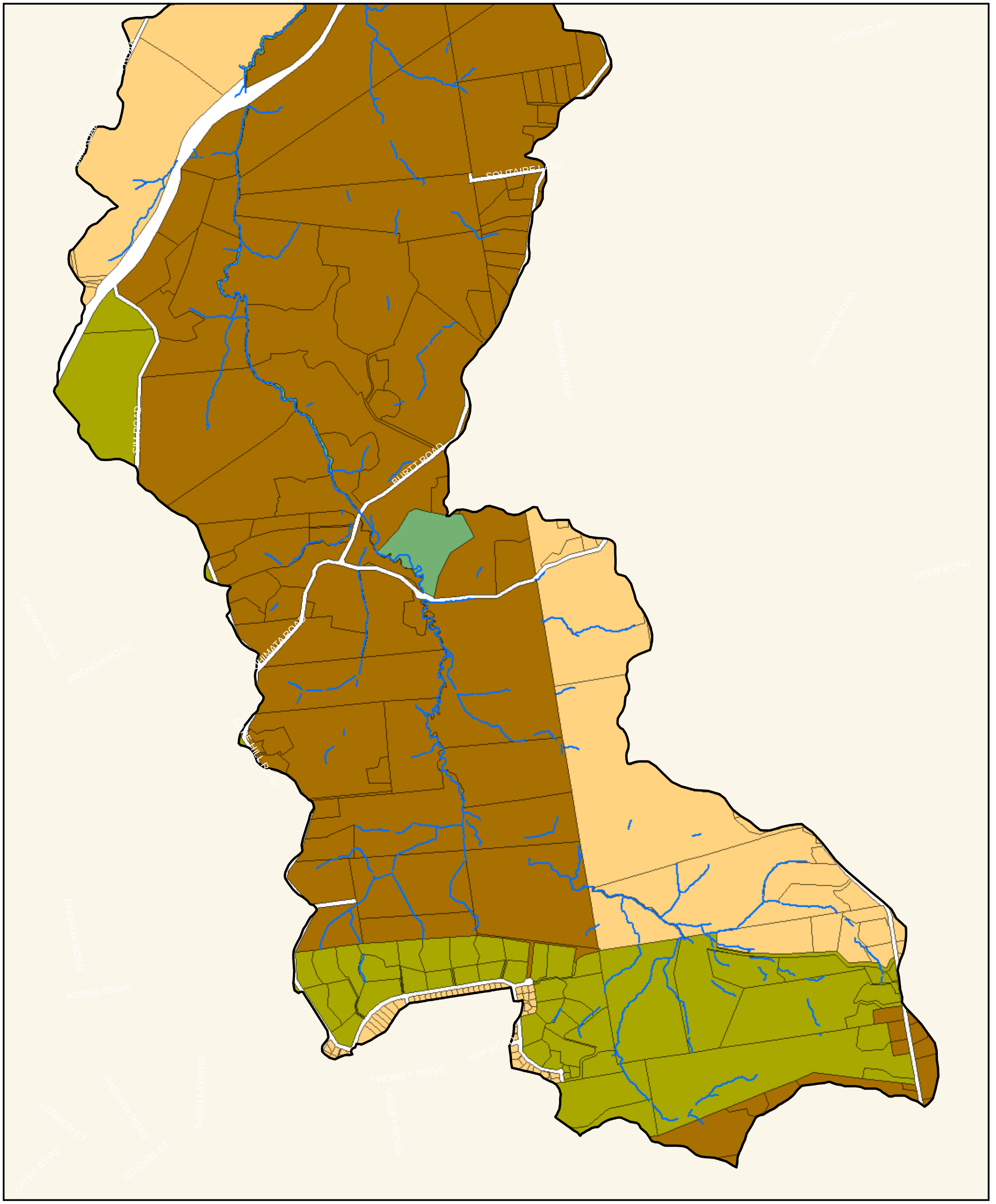
Map 2: Catchment Land Use



OIRA CREEK CATCHMENT STREAM SURVEY

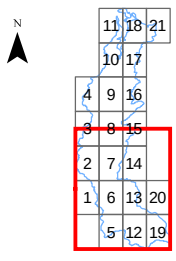
Eco Line

PAUP Base Zone

- Business
- Public Open Space
- Rural
- Residential
- New Growth

0 0.125 0.25 0.5 km

N



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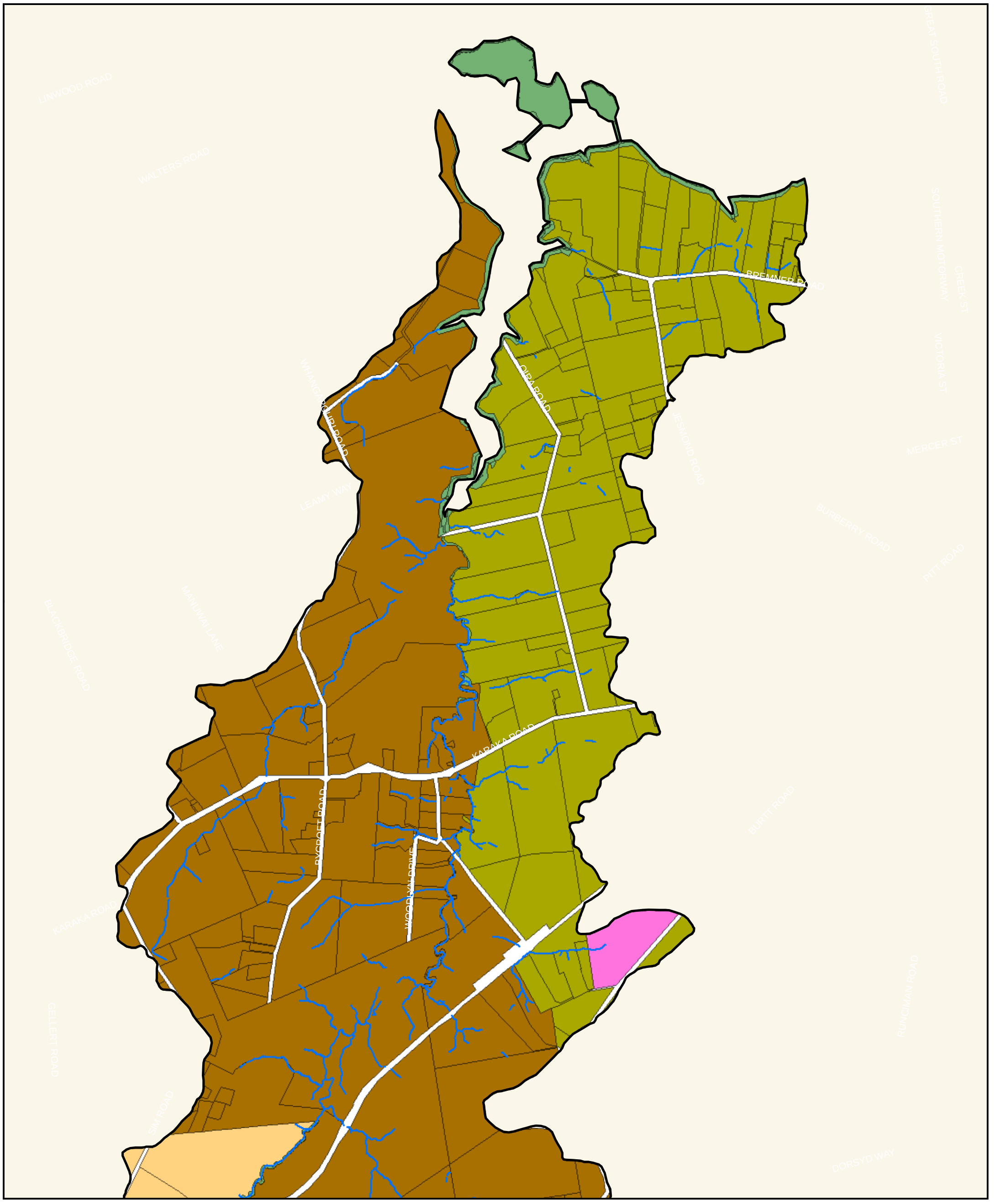
Document Path: C:\JOBS\OIRA\MAPS\MAP_02_LandUse.mxd

Map 2: Catchment Land Use



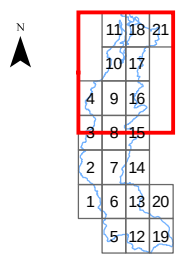
OIRA CREEK CATCHMENT STREAM SURVEY

Eco Line

PAUP Base Zone

- Business
- Public Open Space
- Rural
- Residential
- New Growth

0 0.125 0.25 0.5 km



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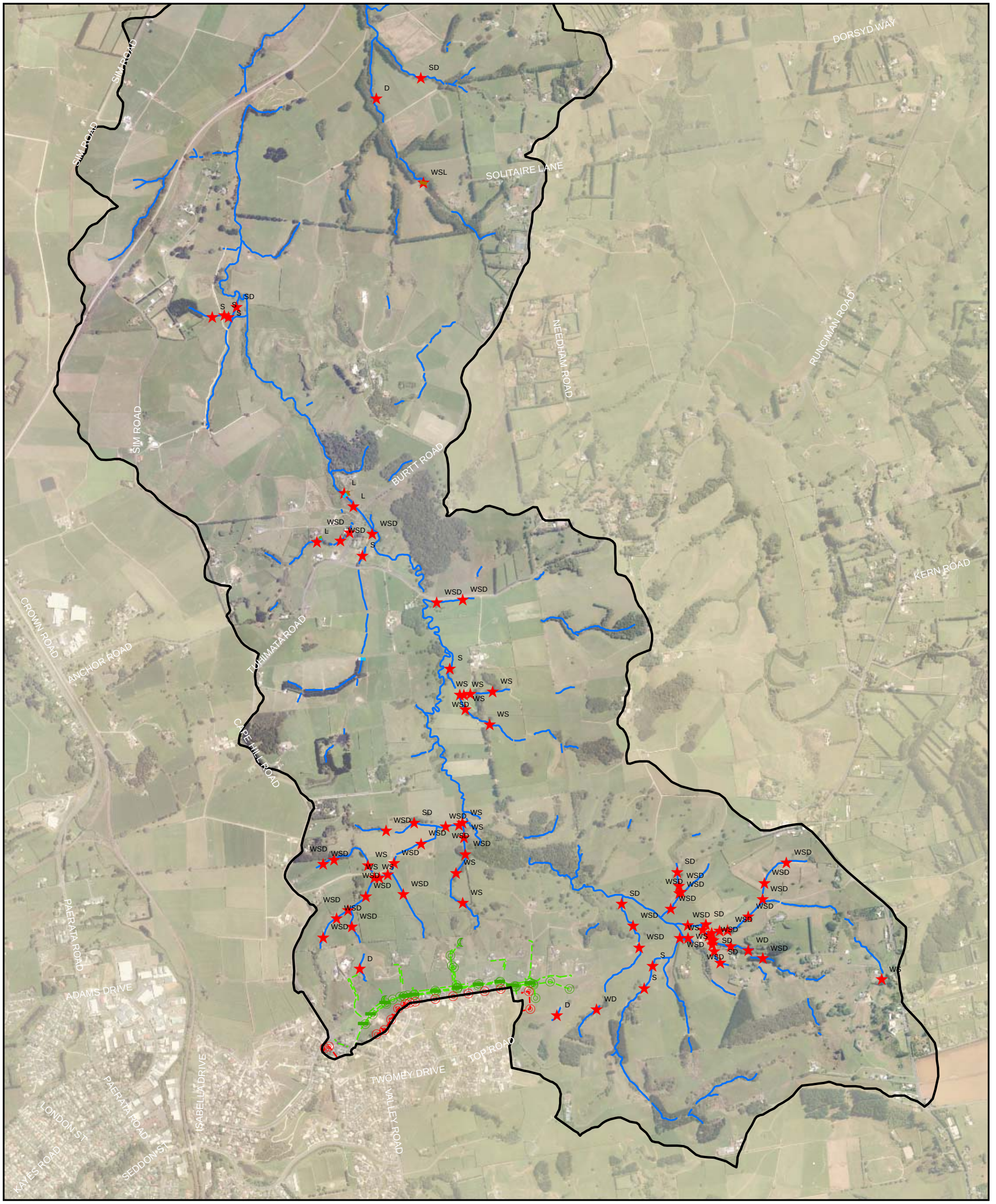
Map 3: Bank and Channel Modification Type & Extent (%)



OIRA CREEK CATCHMENT STREAM SURVEY

Bank Lining

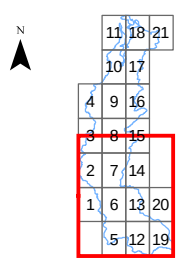
- Cast In Situ Concrete
- Masonry Block
- None
- Other
- Rock
- Timber

- Eco Line

Modification:
W - widened
S - straightened
D - deepened
L - lined

- Stormwater Drain
- Catchpit
- Inlet or outlet
- Manhole
- Wastewater Pipe
- Wastewater Manhole

0 0.125 0.25 0.5 km



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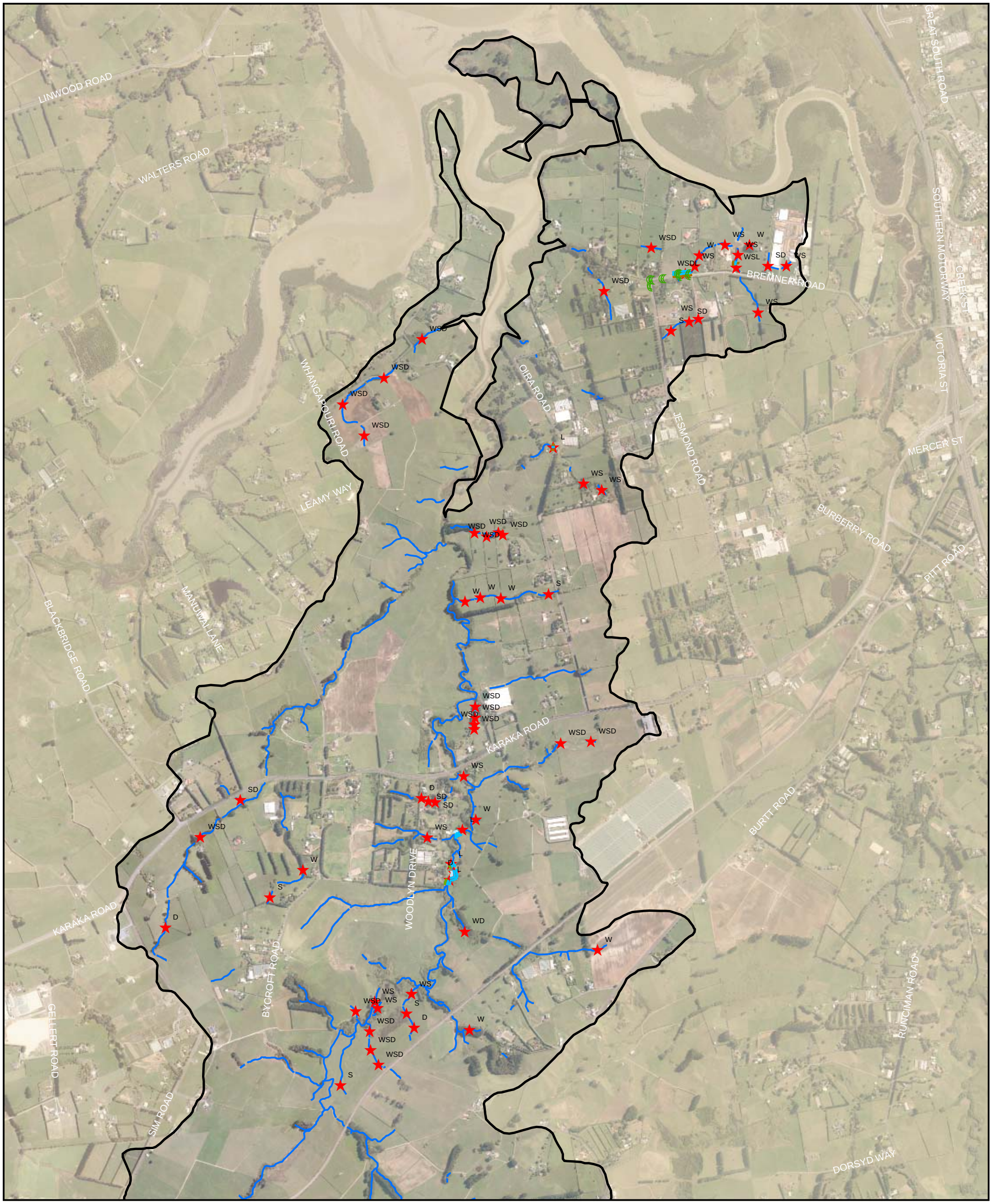
Map 3: Bank and Channel Modification Type & Extent (%)



OIRA CREEK CATCHMENT STREAM SURVEY

Bank Lining

- Cast In Situ Concrete
- Masonry Block
- None
- Other
- Rock
- Timber

Eco Line

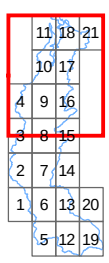
Modification:
W - widened
S - straightened
D - deepened
L - lined

Stormwater Drain

Inlet or outlet

0 0.125 0.25 0.5 km

N



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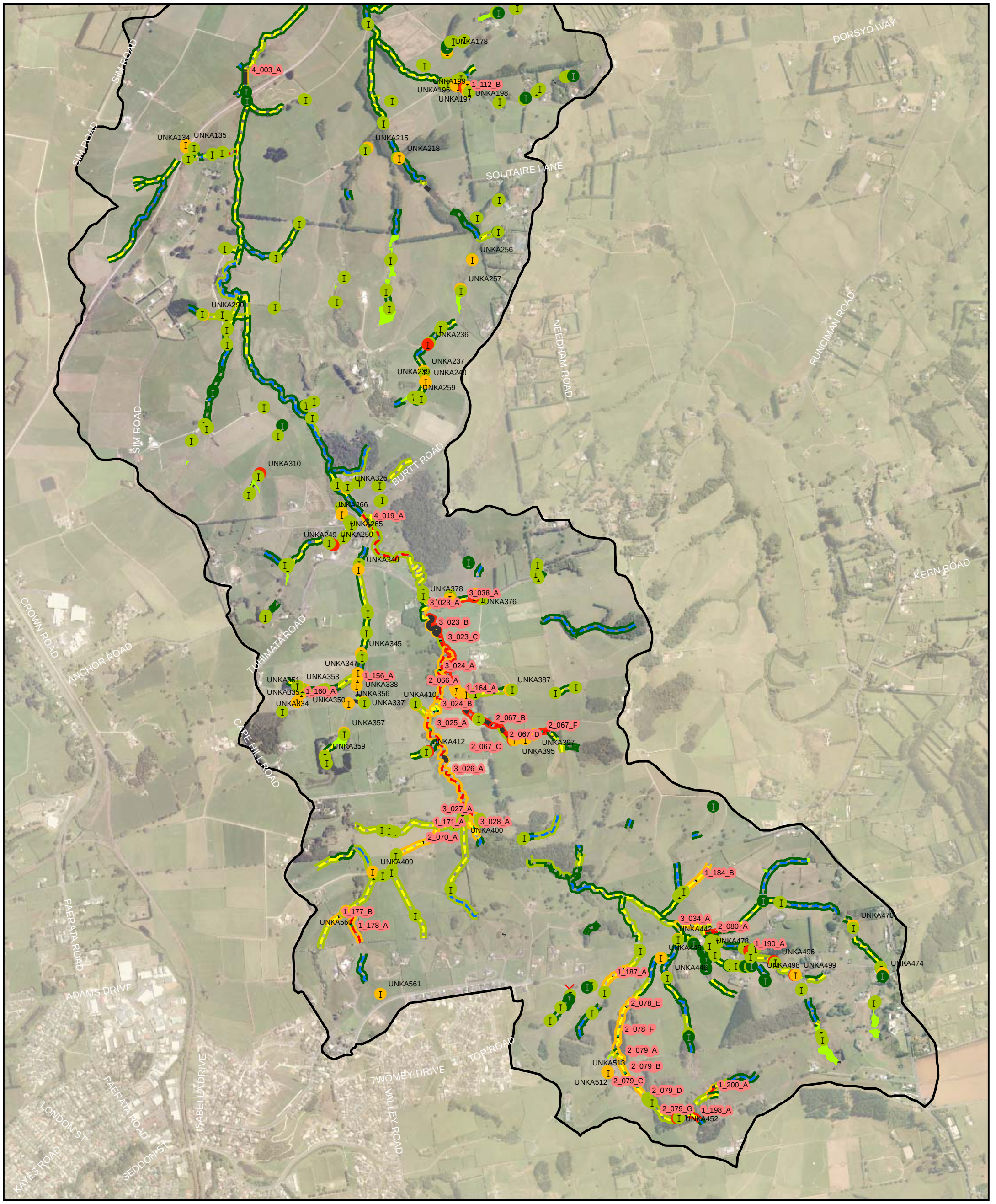
Document Path: C:\JOBS\OIRA\MAPS\MAP_03_Bank_Channel_Modification.mxd

Map 4: Engineering Asset Locations, Stream Bank & Outfall Erosion



OIRA CREEK CATCHMENT STREAM SURVEY

Erosion Scars

- 0-20%
- 21-40%
- 41-60%
- >60%
- Erosion Hotspot

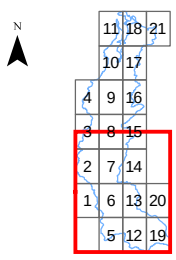
Bank Stability

- Excellent
- Good
- Fair
- Poor
- Wetland

Inlet/Outlet Erosion

- None
- Slight
- Moderate
- Severe
- Could not locate

0 0.125 0.25 0.5 km



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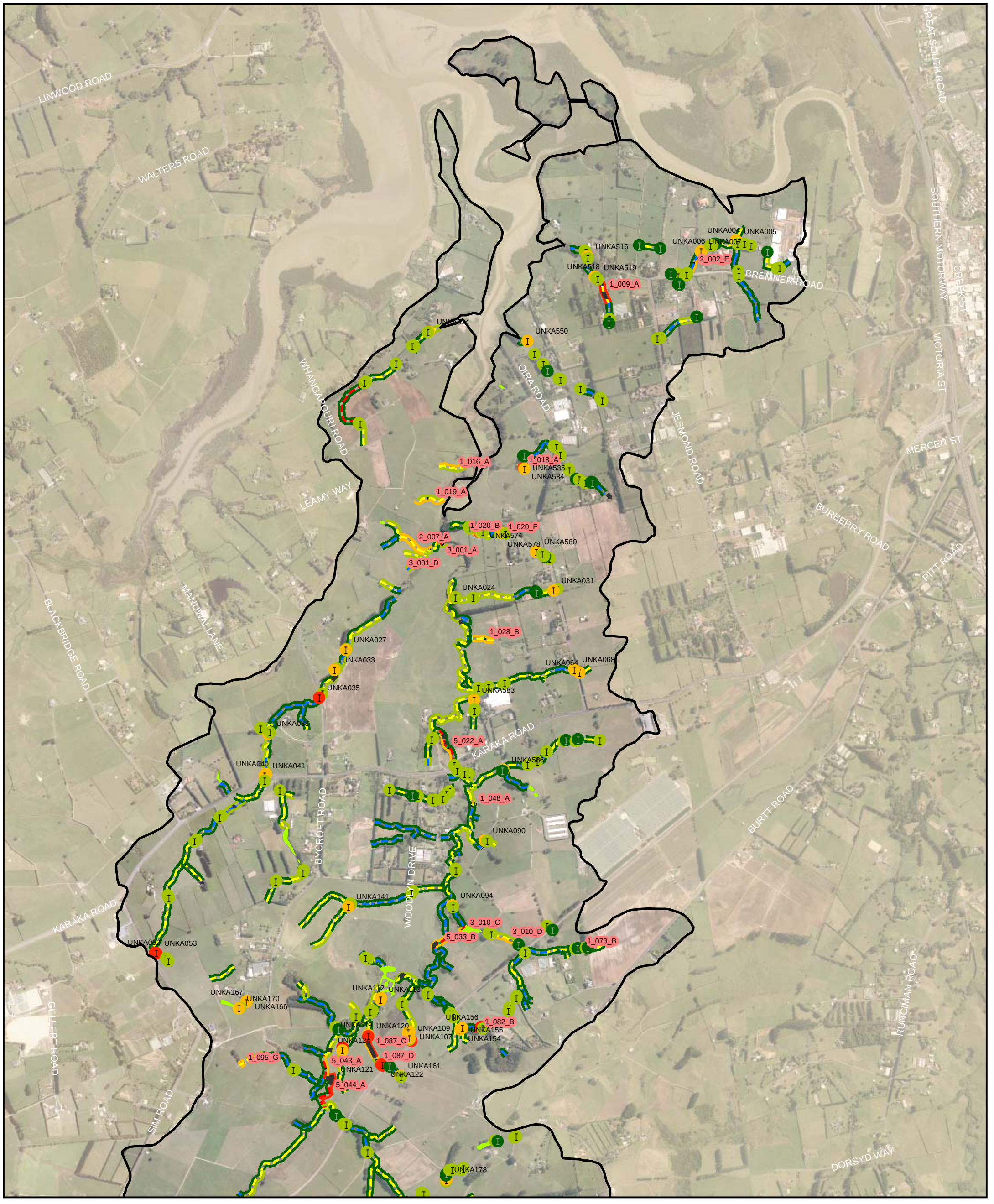
Map 4: Engineering Asset Locations, Stream Bank & Outfall Erosion



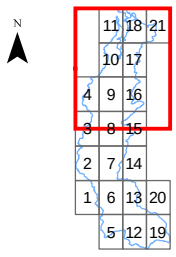
OIRA CREEK CATCHMENT STREAM SURVEY

Erosion Scars
- 0-20%
- 21-40%
- 41-60%
- >60%
- Erosion Hotspot

Bank Stability
- Excellent
- Good
- Fair
- Poor
- Wetland

Inlet/Outlet Erosion
- None
- Slight
- Moderate
- Severe

0 0.125 0.25 0.5 km



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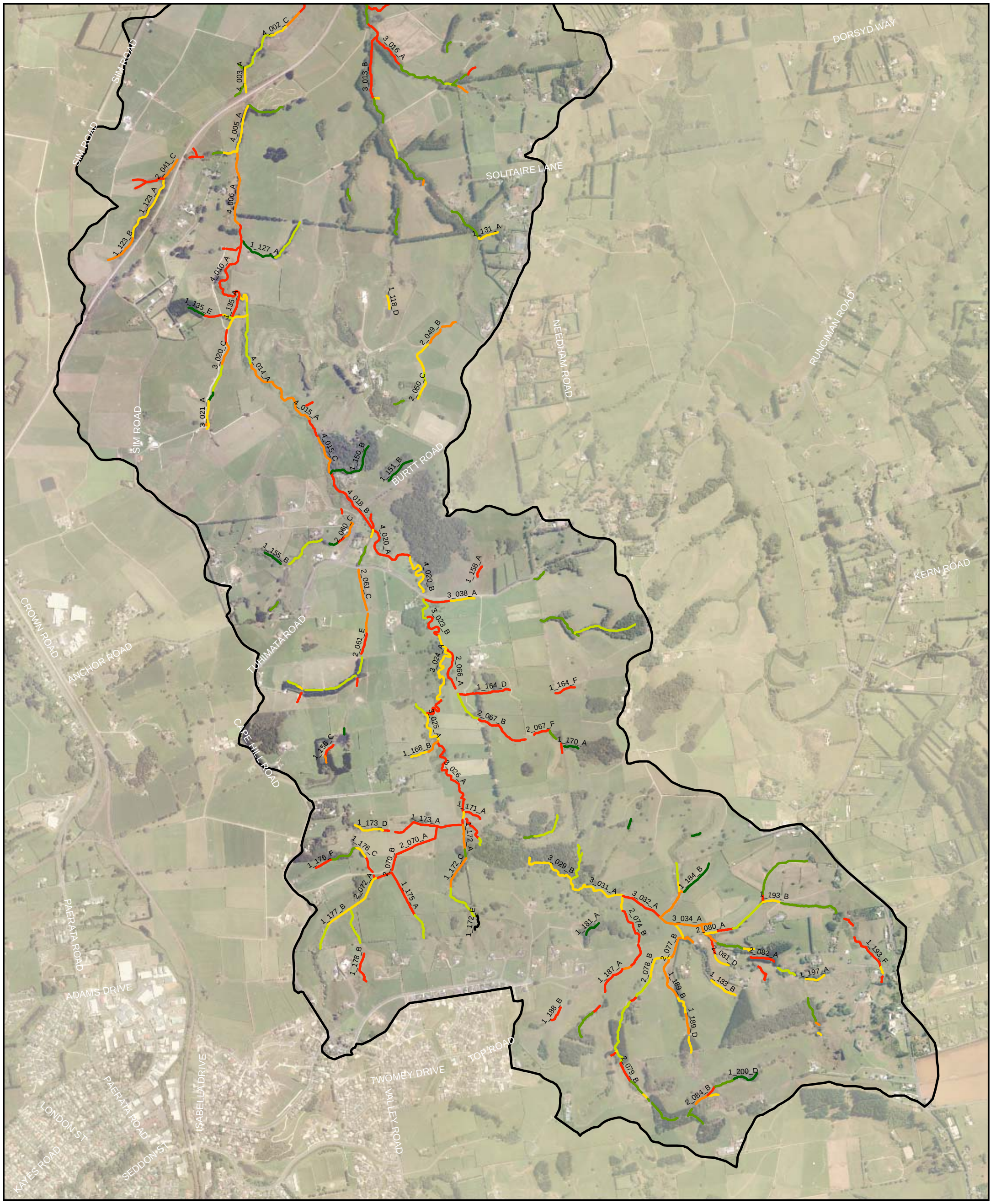
Map 5: Riparian Overhead Cover

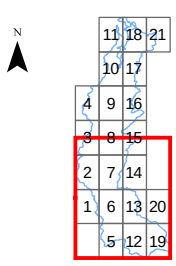


OIRA CREEK CATCHMENT STREAM SURVEY

Riparian Overhead Cover

- Did not access cover
- <10%
- 10-30%
- 30-50%
- 50-70%
- 70-90%
- >90%

0 0.125 0.25 0.5 km



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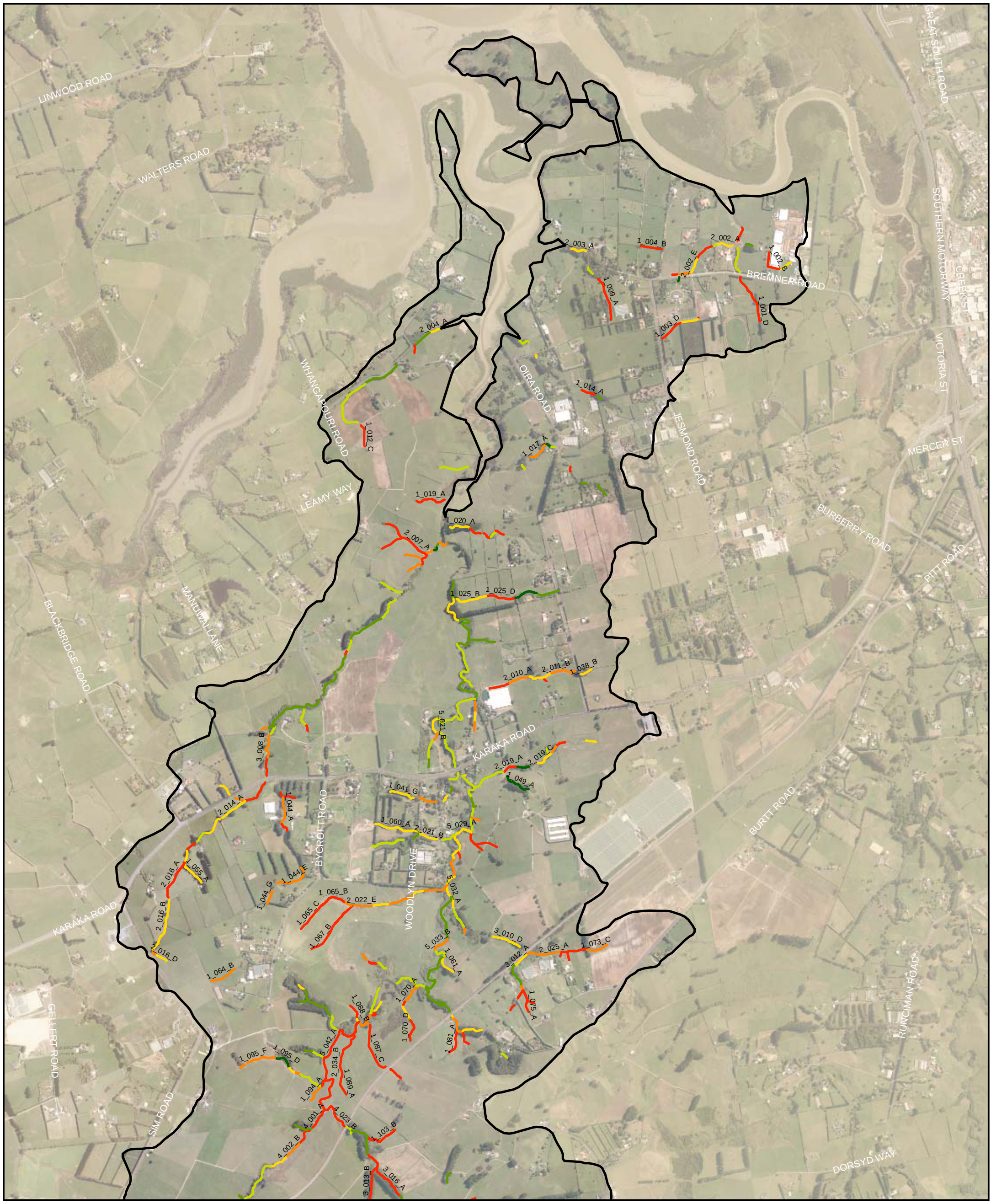
Document Path: C:\JOBS\OIRA\MAPS\MAP_05_Riparian.mxd

Map 5: Riparian Overhead Cover

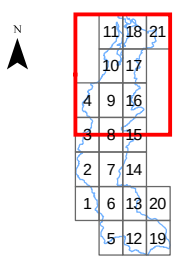


OIRA CREEK CATCHMENT STREAM SURVEY

Riparian Overhead Cover

- <10%
- 10-30%
- 30-50%
- 50-70%
- 70-90%
- >90%

0 0.125 0.25 0.5 km



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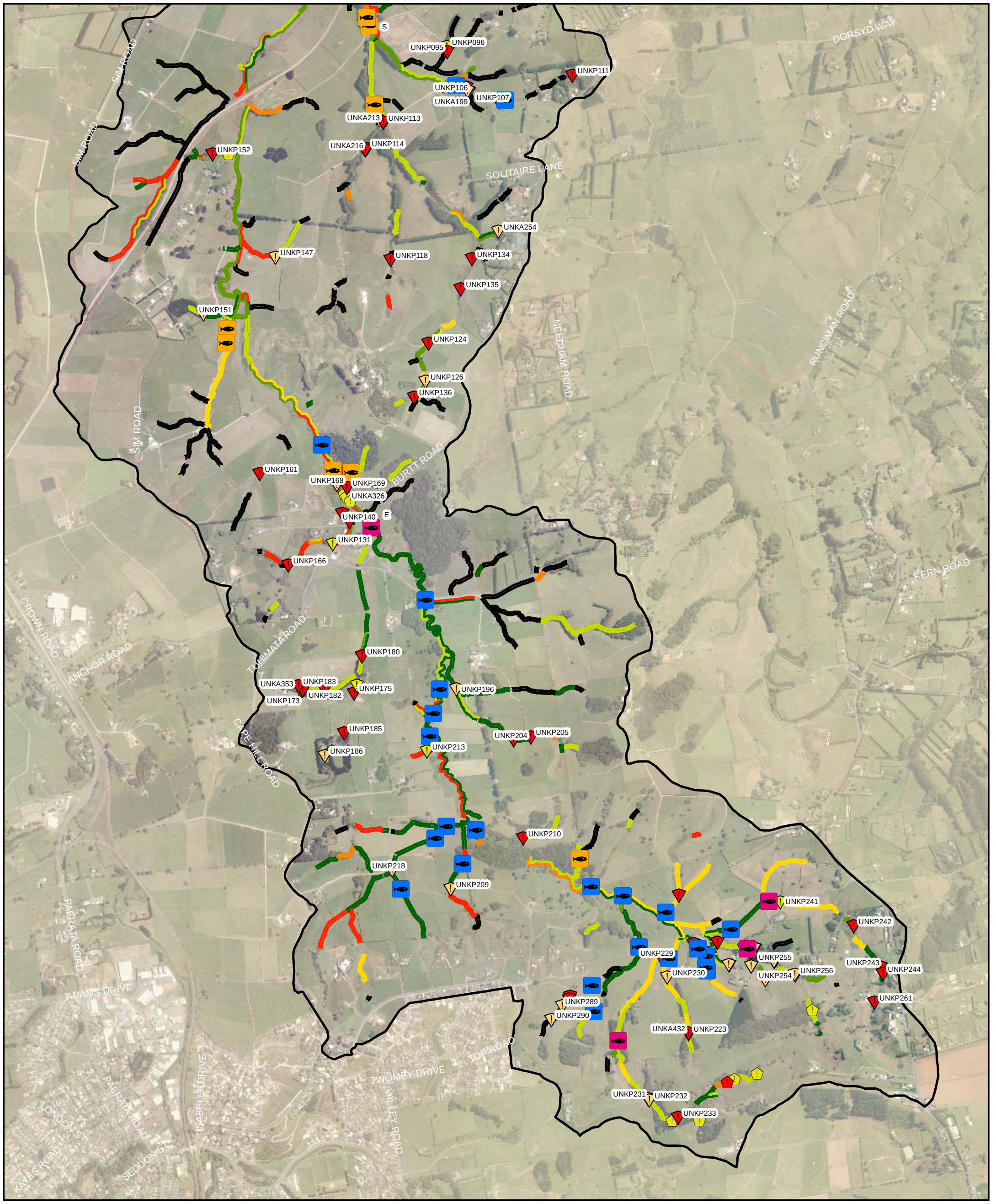
Document Path: C:\JOBS\OIRA\MAPS\MAP_05_Riparian.mxd

Map 6: Inanga Spawning, Fish Locations and Potential Barriers to Fish Passage



OIRA CREEK CATCHMENT STREAM SURVEY

Vegetation Development

- Not assessed
- Grasses
- Low growing
- Mature
- Planted
- Regenerating
- Scrub

Nat. Barrier to:

- Anguilliforms
- Climbers
- Swimmers

Eng. Barrier to:

- Anguilliforms
- Climbers
- Swimmers

0 0.125 0.25 0.5 km

Fish Survey

- Anguilliform (A)
- Climber (C)
- Swimmer (S)
- Exotic (E)

N

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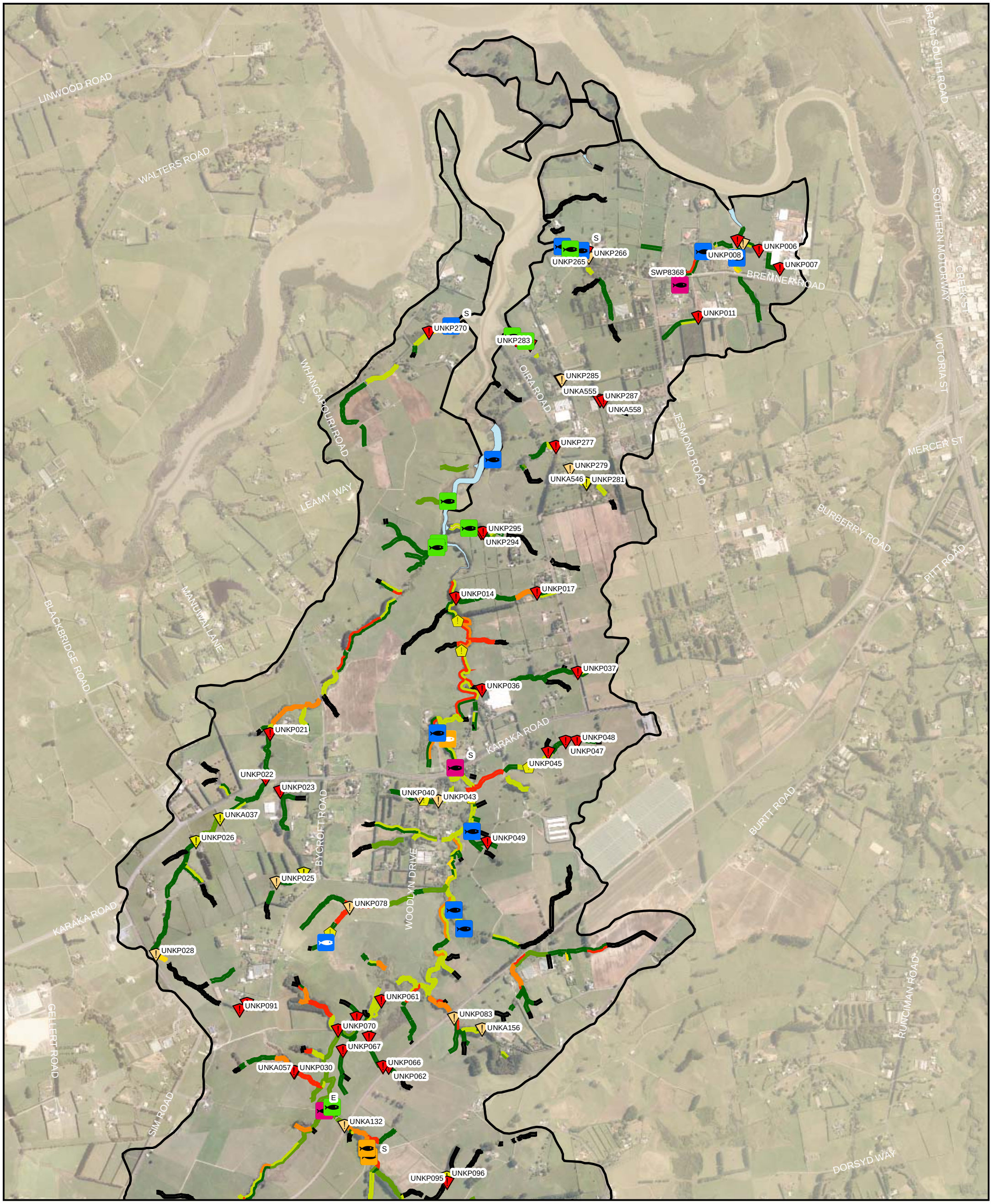
Document Path: C:\JOBS\OIRA\MAPS\MAP_06_Fish.mxd

Map 6: Inanga Spawning, Fish Locations and Potential Barriers to Fish Passage



OIRA CREEK CATCHMENT STREAM SURVEY

Vegetation Development

- Not assessed
- Grasses
- Low growing
- Mature
- Planted
- Regenerating
- Scrub

Nat. Barrier to:

- Anguilliforms
- Climbers
- Swimmers

Eng. Barrier to:

- Anguilliforms
- Climbers
- Swimmers

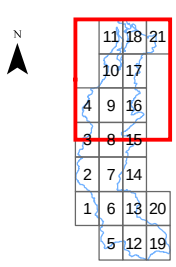
0 0.125 0.25 0.5 km

Fish Survey

- Anguilliform (A)
- Climber (C)
- Swimmer (S)
- Exotic (E)

NZDFFB

- Climber
- Exotic



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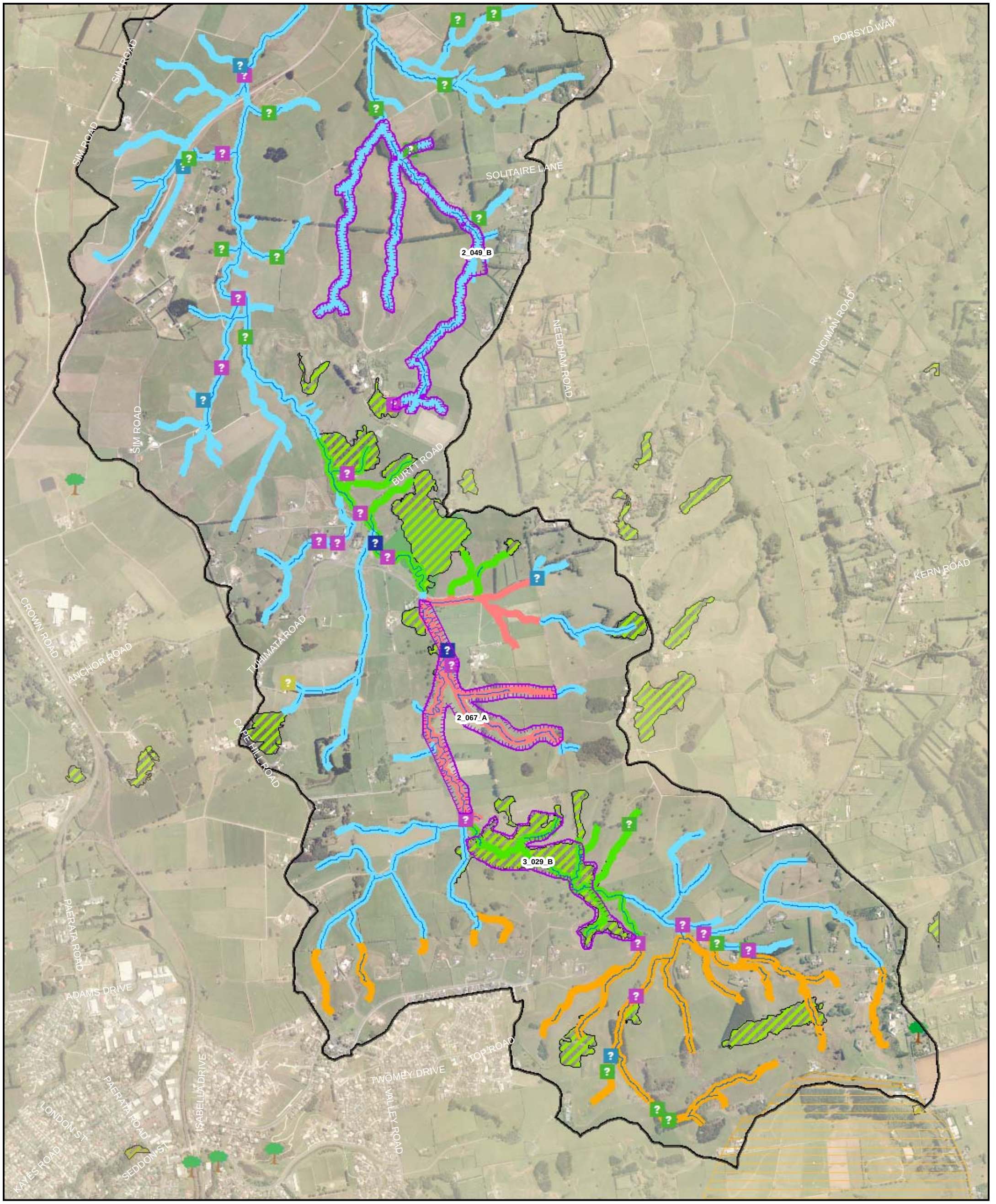
Document Path: C:\JOBS\OIRA\MAPS\MAP_06_Fish.mxd

Map 7: Management Zones and Enhancement Opportunities



OIRA CREEK CATCHMENT STREAM SURVEY

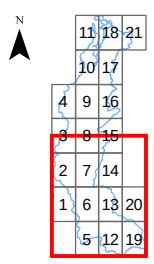
Auckland Council

Notable Trees
Historic Heritage
Outstanding Natural Features
Places Of Value To Mana Whenua
Historic Heritage Extent Of Place
Significant Ecological Areas
Public Open Space
Enhancement_Opportunities

Miscellaneous
- Bridge
- Debris Jam
- Land Slide/Slip
- Litter Dumping
- Pollution
- Spring

Management Zones
- MZ2
- MZ3
- MZ4
- MZ5

0 0.125 0.25 0.5 km



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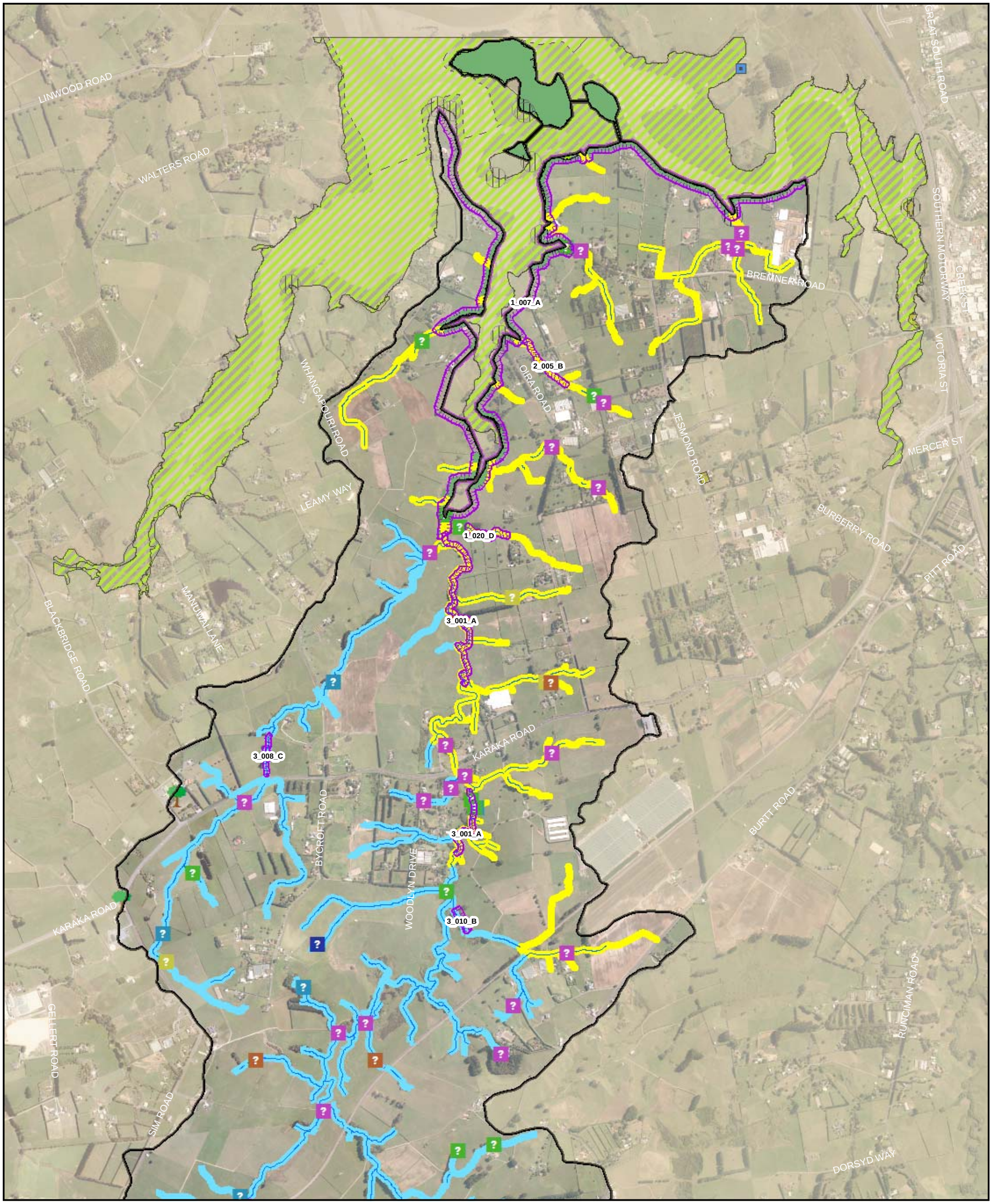
Map 7: Management Zones and Enhancement Opportunities



OIRA CREEK CATCHMENT STREAM SURVEY

Auckland Council

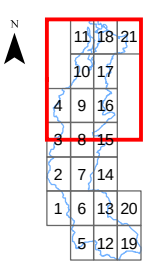
Notable Trees
Historic Heritage
Outstanding Natural Features
Places Of Value To Mana Whenua
Historic Heritage Extent Of Place
Significant Ecological Areas
Public Open Space
Enhancement_Opportunities

Miscellaneous
- Bridge
- Debris Jam
- Land Slide/Slip
- Litter Dumping
- Pollution
- Spring

Management Zones
- MZ1
- MZ5

0 0.125 0.25 0.5 km

N



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Appendix B SEV Results

Ecological Functions	SEV1	SEV2	SEV3	SEV4	SEV5
Hydraulic					
1. Natural flow regime	0.54	0.67	0.86	0.57	0.10
2. Floodplain effectiveness	0.21	0.27	0.33	0.24	0.23
3. Connectivity for migrations	1.00	1.00	1.00	1.00	1.00
4. Connectivity to groundwater	0.82	0.75	0.79	0.84	0.57
Hydraulic function mean score	*0.64*	*0.67*	*0.75*	*0.66*	*0.48*
Biogeochemical					
5. Water temperature control	0.20	0.06	0.30	0.26	0.22
6. Dissolved oxygen maintained	0.45	0.23	1.00	0.45	0.17
7. Organic matter input	0.00	0.10	0.80	0.10	0.01
8. Instream particle retention	0.26	0.40	0.60	0.28	0.20
9. Decontamination of pollutants	0.58	0.36	0.43	0.35	0.49
Biogeochemical function mean score	*0.30*	*0.23*	*0.63*	*0.29*	*0.22*
Habitat Provision					
10. Fish spawning habitat	0.05	0.05	0.50	0.18	0.05
11. Habitat for aquatic fauna	0.32	0.29	0.60	0.45	0.30
Habitat provision function mean score	*0.19*	*0.17*	*0.55*	*0.31*	*0.18*
Biodiversity					
12. Fish fauna intact	0.17	0.17	0.50	0.50	0.23
13. Invertebrate fauna intact	0.18	0.17	0.11	0.18	0.10
14. Riparian vegetation intact	0.10	0.16	0.20	0.16	0.07
Biodiversity function mean score	*0.15*	*0.17*	*0.27*	*0.28*	*0.13*
Overall mean value (SEV)	**0.35**	**0.33**	**0.57**	**0.40**	**0.27**

Taxa	MCI-sb or hb	SEV1	SEV2	SEV3	SEV4	SEV5
Caddisfly *Oxyethira*	1.2	36	1		104	
Damselfly *Xanthocnemis*	1.2	1	9		1	
Bug *Anisops*	2.2					1
Beetle Dytiscidae	0.4				1	
True Fly *Austrosimulium*	3.9	1				1
True Fly *Chironomus*	3.4		2	20	20	512
True Fly Muscidae	1.6		1			
True Fly Orthocladiinae	3.2	1	1		2	
True Fly Tanypodinae	6.5		1			
Collembola	5.3			1	1	
Crustacea Copepoda	2.4				2	1
Crustacea Ostracoda	1.9	112	180	2		20
Crustacea *Paracalliope*	5.5		20	36		
Crustacea *Paraleptamphopus*	5.5	2			16	1
MITES	5.2	2	28			
Mollusc Lymnaeidae	1.2	2				
Mollusc *Potamopyrgus*	2.1	80		1	2	
OLIGOCHAETES	3.8	136	228	84	200	200
LEECHES	1.2	12	48	20	32	44
NEMERTEANS	1.8	68	84			64

Scientific name	Common Name	SEV1	SEV2	SEV3	SEV4	SEV5
Anguilla australis	Shortfin eel	6	4	4	6	4
Anguilla sp.	Unidentified eel	15	4	2	7	2
Anguilla sp.	Elver	1	3		4	3
Galaxias fasciatus	Banded kokopu			1	2	
Gambusia affinis	Mosquitofish	33	4			

Appendix C Engineering Maintenance Works Summary – Inlets and Outlets

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
1_004_A	SWP8363	Standard Inlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Vegetation Clearance	Slight	Council	Appears Safe	None	Submerged apron. Macrophytes in stream could be cleared.
2_002_F	SWP8364	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Vegetation Clearance	Slight	Council	Appears Safe	None	Submerged apron. Macrophytes in stream could be cleared.
2_002_F	SWP8365	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Vegetation Clearance	Slight	Council	Appears Safe	Swimmer	Concrete and rock wall attached to the upstream side of outlet, approx. 1 m long. Macrophytes could be cleared.
2_002_F	SWP8367	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Vegetation Clearance	Slight	Council	Appears Safe	Does Not Apply	Macrophytes could be cleared.
1_003_A	SWP8368	Standard Inlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Vegetation Clearance	Slight	Council	Appears Safe	Swimmer	Dense macrophyte roots causing a 20 cm climb out of the bottom of pipe.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
2_002_F	SWP8369	Standard Inlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Structural	Slight	Council	Appears Safe	Does Not Apply	Apron requires attention.
2_002_B	UNK018	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Large outlet underneath stock access. Some vegetation around it but no major concern around erosion and upstream habitat connectivity. No dissipating structures.
3_005_D	UNK027	Standard Inlet (Headwall and Wingwalls)	Rock Mattress	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Inlet has moderate erosion. Rock walls are ok but bank has eroded beyond start of culvert and slumping above outlet caused by broken culvert combined with stock damage.
1_025_F	UNK030	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	None	Private	Appears Safe	None	In reasonably good condition.
2_014_B	UNK037	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Swimmer	Culvert inlet with timber headwall and rock wingwalls in good condition but debris blocking inlet could create flooding issues and in low

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										flow block fish from swimming out of culvert to upstream areas.
1_044_E	UNK045	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Inlet with loose masonry block headwall but no dissipating structure. Some blocks have fallen into the channel but nothing severe.
2_014_D	UNK049	Standard Inlet (Headwall and Wingwalls)	Gabion Baskets	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Inlet has gabion basket headwall but no dissipating structure. Good condition. Some debris build up but not a severe issue.
2_016_D	UNK054	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Slight	Private	Appears Safe	Does Not Apply	Outlet for plastic culvert. Slight erosion around the outlet. Timber headwall – potentially more retaining wall.
1_095_C	UNK057	Inlet point (no structure)	None	Not in GIS	Debris Removal	Slight	Private	Does Not Apply	Anguilliform	Loose rock dissipating structure. Lots of debris around inlet. Inlet structure is above current water channel. Water flowing up to bottom of dissipating structure suggests it's seeping through ground.
1_040_A	UNK058	Standard Outlet	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Outlet with concrete head wall structure. Lots of

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		(Headwall and Wingwalls)								vegetation around the outlet but doesn't present any immediate issue. No dissipating structure in front. No issues with fish passage.
1_040_B	UNK059	Standard Inlet (Headwall and Wingwalls)	Rock Mattress	Not in GIS	Patching	Slight	Private	Appears Safe	Does Not Apply	Inlet with rock headwall. Some rocks have slid down headwall and could be patched up. Slight erosion where rocks have moved. No dissipating structures.
2_008_C	UNK067	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Drop height recorded is climb height, as 1.25 m timber wall is completely crossing culvert inlet. 25 cm gap at top of wall for water to flow through. Sediment has built up on upstream side of wall so channel depth is only 0.03 m.
1_041_D	UNK073	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Not Safe	Does Not Apply	This inlet appears dangerous and needs protection i.e. scruffy dome cover installed immediately/urgently. This is a drowning hazard.
5_031_C	UNK093	Standard Inlet (Headwall	Timber	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet has a timber headwall but no dissipating structure. Some sediment and vegetation removal

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		and Wingwalls)								could be good but not necessary as this only drains a farmhill. Structure appears to be functioning fine.
3_010_A	UNK094	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Moderate	Private	Appears Safe	Does Not Apply	Outlet structure in poor condition, headwall made of mismatched log filled in behind with rocks to prevent erosion. Moderate erosion to the left.
1_066_B	UNK100	Standard Inlet (Headwall and Wingwalls)	Rock Mattress	Not in GIS	Vegetation Clearance	Slight	Council	Appears Safe	Does Not Apply	Culvert going under railway. Inlet not outlet because water flows into the culvert here via farms and drainage channel alongside rail way. In good condition. Rocks have been cemented together as headwall
1_070_F	UNK107	Standard Outlet (Headwall and Wingwalls)	None	Not in GIS	Erosion Protection	Severe	Private	Appears Safe	Does Not Apply	Outlet going under railway tracks. No head or wing walls but there is a loose rock dissipating structure. Moderate to severe erosion around the outlet.
4_023_B	UNK132	Standard Outlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Climber	Outlet for large culvert under railway, has wingwall, headwall and concrete dissipating structure. Dissipating structure has

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										0.15 m step, which in low flow can impact fish passage. At present, there is only 0.02 m drop over the step with water depth 0.01 m.
2_041_A	UNK134	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Erosion Protection	Moderate	Council	Not Safe	Does Not Apply	Masonry block culvert going under railroad. Has wingwall and headwall. Moderate erosion around the inlet with lots of loose soil and undercutting around the wingwalls. Large scour area in front of structure.
1_119_A	UNK135	Standard Outlet (Headwall and Wingwalls)	Rock Mattress	Not in GIS	Structural	Moderate	Private	Not Safe - Drop 1.5m	Does Not Apply	Old stormwater culvert that may not be functional. Has stalactites from ceiling. Smells unused. Some erosion around headwall, may be due to water flowing down from ephemeral stream overhead. Collapsed hole 15 m further upstream.
2_031_A	UNK148	Standard Inlet (Headwall and Wingwalls)	Other	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet dry at present, shows low flow impedance for fish passage. Culvert high above upstream pond, moderate working condition

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										no issues. Loose rock is used for wingwalls structure.
2_028_B	UNK151	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	Slight	Council	Appears Safe	None	Good condition inlet that feeds culvert under railway. Dry at time of survey, so low flow impedance to fish, not permanent stream. Very little erosion.
2_029_A	UNK154	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Moderate	Private	Appears Safe	Does Not Apply	Timber headwall appears rotten with erosion. Dry in front of culvert, but in normal flow conditions would not hinder fish passage.
1_082_A	UNK155	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Moderate	Private	Appears Safe	Does Not Apply	Headwall is decayed and rotting. Erosion underneath top wooden beam. Dry but in normal flows would not hinder fish passage.
1_082_B	UNK156	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Severe	Private	Does Not Apply	Climber	Outlet point has 7 m long channel lining in front of it. No issues with the culvert outlet but there is a 0.5 m drop at the end of structure into dry channel below. Heavy erosion around end of structure and would cause fish passage issues.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
4_025_A	UNK158	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Culvert outlet under major farm access way. Some erosion present (not moderate but more than slight). Has headwall but no wingwalls.
4_023_C	UNK163	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Debris Removal	Slight	Mixed	Appears Safe	None	Inlet for large culvert going under railway, has wingwall, headwall and concrete dissipating structure. No issues in terms of erosion or fish passage except there is likely to be low flow impedance.
2_039_A	UNK175	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Outlet with headwall. Headwall is functional but has some erosion in between concrete rows. Build-up of *Glyceria* could be removed.
2_039_B	UNK176	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Inlet with headwall. Headwall in working order but there is some debris around the inlet, plus *Glyceria* build up.
3_017_A	UNK189	Standard Outlet (Headwall	Timber	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Culvert outlet with timber headwall and no dissipating structure. Headwall is functional but starting to

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		and Wingwalls)								break. No erosion or fish passage issues.
3_018_A	UNK190	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet with timber headwall. Headwall in good condition but large willow branches built up against the inlet. May potentially lead to flooding issues of the farm road.
3_018_B	UNK192	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Inlet with concrete headwall. All functioning. Slight erosion around culvert pipe and minor amounts of debris jam. Not likely to have any significant issues.
2_055_A	UNK193	Standard Outlet (Headwall and Wingwalls)	Other	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Outlet for culvert in vegetation area fenced off. Outlet is mostly underwater in pooled part of stream. Combination of rock and concrete as headwall, slight erosion near outlet.
2_055_B	UNK194	Standard Inlet (Headwall and Wingwalls)	Other	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Debris covered area for entrance of inlet, upstream catchment may not be large enough to lead to flooding risk. Minimal headwall of rock above culvert.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
1_112_B	UNK197	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Severe	Private	Not Safe - Drop 1.5m	Does Not Apply	Perched culvert serving as overflow for pond. Severe erosion at outlet caused by overflow. Remnants of old structure from outfall. Significant drop of outlet to channel below.
1_112_B	UNK199	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Climber	Culvert that drains upstream pond. Erosion above outlet due to stock damage. Probably a partial fish barrier due to intermittent flows and sharp lip of corrugated iron. Small wooden headwall and corrugated iron dissipating structure.
1_112_C	UNK200	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Culvert has broken timber headwall. Culvert is above pond floor, however not likely to cause issue for fish passage other than low flow impedance. No stormwater flow or erosion concerns.
1_112_C	UNK202	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Inlet for pond drainage culvert. Culvert not located but timber over concrete block headwall marks the

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										location. Vegetation is thick up to the edge.
1_113_A	UNK203	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Not Safe	Does Not Apply	Outlet for culvert through upper pond bank. Headwall has collapsed and is in poor condition. No fish passage or erosion issues.
1_113_D	UNK209	Standard Outlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Patching	Slight	Private	Not Safe	Does Not Apply	Culvert outlet for upstream pond with old headwall structure behind. Headwall functional but degraded. May need patching.
3_015_A	UNK213	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Slight	Private	Does Not Apply	Anguilliform	Loose rock dissipating structure around large culvert. Average condition, some slight deterioration. Rock from dissipating structure found downstream.
2_045_A	UNK216	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Anguilliform	Culvert inlet with wooden open topped chamber. Lots of debris build-up around structure, which could be removed or may lead to flow issues. At present, fish in chamber would have to climb 90° wall to get to pond.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
2_045_A	UNK217	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert going under farm road. Timber headwall, with lots of vegetation build up throughout and around. No issues with this structure.
2_046_A	UNK218	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Culvert going under farm road. Timber headwall is in poor condition and relatively eroded underneath.
1_129_C	UNK232	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet has masonry block and corrugated iron structure. Headwall appears to block flow into culvert. Very small upstream catchment, thus not a flood risk. Some erosion behind headwall.
2_049_C	UNK236	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Structural	Severe	Private	Appears Safe	Does Not Apply	Inlet with headwall but no dissipating structure. In poor condition, with moderate to severe erosion.
1_152_B	UNK243	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Culvert outlet which drains upstream ephemeral, has concrete headwall and is under stock access route. Some erosion protection could aid flow efficiency.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
2_060_A	UNK264	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet with headwall under a driveway. Good condition. Some vegetation build-up.
1_128_A	UNK288	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert outlet with headwall but no dissipating structure. Some vegetation removal could be required.
1_128_B	UNK289	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert outlet with headwall but no dissipating structure. Headwall constructed of timber and concrete beams. Some vegetation removal could be required.
1_135_D	UNK298	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet with a timber headwall. Log stuck in the middle of inlet, debris removal needed.
1_135_C	UNK299	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Culvert outlet with a timber headwall, can't be seen as it is lower underwater. Assessment may not reflect submerged part of headwall.
4_018_A	UNK326	Standard Outlet	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Anguilliform	Rust in culverts has led to water flowing underneath

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		(Headwall and Wingwalls)								culvert and subsequently underneath concrete/rock dissipating structure. May limit fish passage up dissipating structure and into culverts. Potential for erosion to cause issues with driveway.
1_151_A	UNK332	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Concrete headwall is starting to slump and there is some erosion behind piles. Potential for future issues but all currently functional.
1_160_A	UNK334	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Minimal erosion around the headwall itself but in the wider 5 m area there is significant erosion on both banks. Slight debris build-up against inlet. Headwall doesn't appear to be at risk of failure.
1_160_A	UNK335	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Culvert outlet with remnants of headwall. Significant erosion around outfall so erosion protection is needed.
1_156_A	UNK336	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Moderate	Private	Does Not Apply	Swimmer	Asset outlet with dissipating structure made up of broken Chen concrete slabs.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										Average condition with minimal erosion around the dissipating structure but moderate erosion within 5 m along both banks.
1_156_A	UNK337	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Headwall slightly above culvert. Moderate to severe erosion on either side of the culvert but not in the receiving channel. One section of headwall no longer in place.
1_156_A	UNK338	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Minimal erosion around the headwall itself but in the wider 5 m area there is significant erosion on both banks. Headwall doesn't appear to be at risk of short term failure.
2_061_E	UNK345	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Not Safe	Does Not Apply	Headwall made of concrete pillars. Asset in good condition. Moderate amounts of erosion in receiving channel and some signs of past bank slumping beside headwall on TLB. Culvert is perched.
2_061_F	UNK346	Standard Inlet	Concrete	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	No dissipating structures. No signs of fresh erosion.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		(Headwall and Wingwalls)								Vegetation in front of inlet may cause debris build-up resulting in flooding.
2_061_F	UNK347	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Headwall made of concrete pillars. Asset in average condition with one pillar across outlet, has the potential to alter flow paths. Moderate amounts of erosion in receiving channel with a large deep scour pool having formed.
2_062_C	UNK349	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Slight	Private	Appears Safe	Does Not Apply	Headwall made of concrete pillars. Asset in good condition. Minor erosion at this stage but erosion starting to form behind culvert on TRB and below culvert invert. Potential for future issues.
2_062_C	UNK350	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Replacement	Moderate	Private	Appears Safe	Does Not Apply	Asset leading to stream on TRB. Headwall made of concrete above confluence of two culverts. Large pine tree has buckled and broken headwall, while ponga is growing out underneath. Large eroded pool at outfall

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										with moderate erosion around outlet.
2_062_C	UNK351	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Replacement	Moderate	Private	Appears Safe	Does Not Apply	Asset leading to stream on TLB. Headwall made of concrete above confluence of two culverts. Large pine tree has buckled and broken headwall, while ponga is growing out underneath. Large eroded pool at outfall with moderate erosion around outlet
1_161_A	UNK352	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Slight	Private	Appears Safe	Does Not Apply	Headwall functional however gap in middle of wall may be susceptible to erosion.
1_161_B	UNK353	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Replacement	Moderate	Private	Appears Safe	Anguilliform	Headwall completely rotten. Timber race built channel moves water from culvert to downstream however this is largely broken and non-functional. Erosion around dissipating structure and deep scoured pool at terminus.
1_160_A	UNK355	Standard Inlet (Headwall	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Headwall and inlet in good working condition. No erosion issues. Upstream is

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		and Wingwalls)								ephemeral stream so not flowing for large parts of the year.
1_156_A	UNK356	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Headwall in ok condition, not in risk of short term failure. Lots of stock damage around the asset leading to some degradation of the banks within 5 m.
1_156_B	UNK358	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Headwall comprises of rotten timber. Not serving any functional purpose. Starting to see erosion around the inlet. Wooden berms beside headwall plus wooden debris in from of inlet.
3_037_A	UNK367	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Debris Removal	Slight	Mixed	Appears Safe	Does Not Apply	Inlet would be in good condition but has some debris build up, particularly on left hand culvert. Timber wall above concrete brick wall adding extra height.
2_063_A	UNK369	Inlet point (no structure)	None	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	Bubble up chamber in paddock that services downstream culvert and upstream piped network of farm streams. Some deterioration, particularly

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										where upstream pipe connects.
2_067_A	UNK392	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Farm track over stream, timber and concrete headwall that has partially collapsed. Significant erosion around the outfall.
2_067_B	UNK393	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Cannot see culvert inlet as it is blocked by significant amount of debris. Large stump as well as small debris. Water flowing underneath debris jam but likely to create an issue during storm events.
2_067_C	UNK394	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Severe	Private	Appears Safe	Does Not Apply	Large log for a headwall and logs also placed on TLB to prevent erosion, however this has not worked and there are signs of significant erosion behind this wall, along with underneath headwall. Large scour channel below culvert.
2_067_D	UNK395	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Moderate	Private	Appears Safe	Does Not Apply	Cannot see culvert inlet as it is blocked by significant amount of debris. Some water flowing through culvert but likely to create

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										issues during rainfall events and may contribute to further damage to the asset.
2_067_D	UNK396	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Culvert outlet for section of piped farmland. Headwall in place but serves little function, erosion behind and around the area. Most of the erosion caused by stock damage.
2_067_E	UNK397	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Not Safe	Does Not Apply	Inlet for section of piped farm paddock. Erosion around headwall and sediment has buried/ obscured culvert. Small coiled drainage pipe sticking up but not sure if this is the actual culvert which would flow through here.
2_068_A	UNK400	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Headwall made of timber, however there is a gap between headwall and culvert which has created points of erosion behind the headwall. Large log lying across inlet.
1_176_B	UNK409	Standard Inlet (Headwall	Timber	Not in GIS	Replacement	Moderate	Private	Appears Safe	Does Not Apply	Headwall no longer functional, and it has

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		and Wingwalls)								collapsed. Erosion around the headwall now evident.
1_168_A	UNK412	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Severe	Private	Not Safe	Does Not Apply	Headwall starting to slump due to severe erosion behind the culvert, allowing water to erode the area around.
1_168_B	UNK413	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Headwall is starting to fall apart but is still functional. No significant issues.
2_070_A	UNK420	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	Slight	Private	Appears Safe	Does Not Apply	No significant issues. Outlet obscured by vegetation. Large scour pool in receiving channel but no obvious bank erosion.
2_077_A	UNK442	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Not Safe	Does Not Apply	Erosion on either side of asset. TRB below wooden timber structure. Deep scour pool in front of outlet. Erosion along banks of receiving channel.
2_077_A	UNK443	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Slight	Private	Appears Safe	Does Not Apply	Erosion underneath headwall and in behind culvert, has future potential to cause issues but not significant at present.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
2_078_B	UNK445	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Erosion behind headwall with eroded hole forming on stock bridge above. Can see down hole to eroded cavern on TLB beside culvert. Headwall is slumping and starting to fail.
1_189_A	UNK446	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Timber headwall above slightly perched culvert. Erosion on both banks exposing white clay, possible cause of turbid conditions downstream.
1_189_B	UNK447	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Headwall has debris build up against it and evidence that water has topped the headwall, flowing across the above access way. Water has now pushed through on portion of blockage and is flowing through the culvert. Flooding may affect erosion at outlet.
1_184_B	UNK458	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	There appears to be some debris build up at the inlet, not causing any significant issues as water flow in stream equal to that exiting the culvert downstream. No

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
										signs of flooding as a result. Culvert set back from headwall, not located.
1_193_C	UNK469	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Section of concrete headwall has broken off and fallen into the stream along with cobble from the above drive way. Not a significant issue but may lead to future problems.
2_083_B	UNK476	Standard Outlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Not Safe	Does Not Apply	Two culverts running through stream crossing. Headwall has partially collapsed but is still functional. Minimal erosion at outfall other than scour pool.
1_191_A	UNK479	Outlet point (no structure)	None	Not in GIS	Patching	Slight	Private	Does Not Apply	Climber	Some rock has been placed in receiving environment to create a dissipating structure. Could use improvement but is functional. Steep gradient and velocities likely to inhibit fish passage for swimmers and some climbers. Multiple culverts.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
2_081_D	UNK485	Outlet point (no structure)	None	Not in GIS	Patching	None	Private	Does Not Apply	Climber	Some rock has been placed in receiving environment to create a dissipating structure. Could cause fish passage issues particularly for swimmers.
2_082_A	UNK496	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Severe	Private	Does Not Apply	Climber	Some rock has been placed in receiving environment to create a dissipating structure. This may have been done to help with existing erosion, particularly on TLB. Erosion around outfall and first 10 m of receiving channel.
2_082_B	UNK498	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Severe	Private	Does Not Apply	Climber	Some rock has been placed in receiving environment to create a dissipating structure. Not overly effective. This may have been done to help with existing erosion, particularly on TLB. Erosion around outfall and first 10 m of receiving channel.
1_187_D	UNK501	Standard Inlet (Headwall	Timber	Not in GIS	Debris Removal	Slight	Private	Appears Safe	Does Not Apply	Possible some of the wall has collapsed inward as there are bricks in the inlet. Debris has also built up

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
		and Wingwalls)								against inlet. Has recently flooded but suggest this is infrequent.
2_004_B	UNK525	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Old headwall that has rotted away. No erosion issues but has potential for future issues.
1_012_B	UNK530	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Appears Safe	Does Not Apply	Culvert inlet. No significant issues. Headwall slumping slightly but not in any danger of short term failure.
1_017_E	UNK546	Outlet point (no structure)	None	Not in GIS	Patching	Slight	Private	Appears Safe	Swimmer	Riprap in and around outlet to help dissipate flow. Covered in root mass.
2_005_B	UNK551	Standard Inlet (Headwall and Wingwalls)	Timber	Not in GIS	Structural	Slight	Private	Not Safe - Drop 1.5m	Does Not Apply	Grill out in front of culvert to stop debris build up. Headwall has soil washed away throughout, needs attention or will worsen. Land owner has stated increased stormwater flows in recent years due to upstream development. May not cope in future.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Erosion	Access	Safety	Fish Barrier	Notes
1_015_A	UNK555	Inlet point (no structure)	None	Not in GIS	Structural	Slight	Private	Does Not Apply	Climber	Bricks and sandbags put in place to help dissipate water. Little in the way of erosion. Evidence of recent flooding up over the culvert.
1_020_C	UNK574	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Significant erosion around this outlet. Deep scour pool and erosion around old concrete making up side of access way.
1_020_H	UNK580	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	Appears Safe	Does Not Apply	Two smaller outlets that run into a concrete chute. Erosion on TRB where water has flowed overland due to culvert inlet blockage.
2_018_A	UNK587	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Vegetation Clearance	None	Private	Not Safe	Does Not Apply	Cannot access due to vegetation and safety. Appears to have apron structure. No obvious erosion issues. Water flowing through. Deep pool in outfall. Submerged.

Engineering Maintenance Works Summary – Culverts and Pipes

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
2_002_F	SWM8788	Culvert	Concrete	Correct in GIS	Vegetation Clearance	Council	None	Culvert fully submerged.
1_003_A	SWM8789	Culvert	Concrete	Correct in GIS	Vegetation Clearance	Council	None	Pipe itself presents no barrier to fish passage but macrophyte root at inlet will present barriers to swimmers.
1_178_C	42815	Pipe	Perforated Drainage Coil	Incorrect in GIS	Erosion Protection	Private	Does Not Apply	Pipe flows down side of hill into wetland below, causing erosion in the paddock by scouring out channel which is very deep in some points.
2_001_A	UNK003	Culvert	Other	Not in GIS	Replacement	Private	Anguilliform	Man-made wooden culvert connecting pond to downstream. Flow has caused erosion under culvert. Complete barrier to fish as culvert empties over a 1 m high retaining wall. Moderate erosion.
1_001_B	UNK005	Culvert	Ceramic/Earthenware	Not in GIS	Vegetation Clearance	Council	None	Culvert has some damage on downstream side. Lack of structure means there is some erosion around culvert.
1_002_A	UNK006	Pipe	Concrete	Not in GIS	Debris Removal	Private	Anguilliform	Pipe/culvert running under a few properties. Some broken patches of pipe on downstream end. Upstream end appears in ok condition but with some erosion. Receives water from greenhouses. Low flow means pipe is dry and would restrict fish passage.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
1_002_B	UNK007	Culvert	Unknown	Not in GIS	Structural	Private	Anguilliform	Culvert in poor condition and appears fully blocked. No flow at outlet or inlet. Submerged and lots of fine sediment.
1_002_A	UNK008	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Culvert connecting tributary to man-made pond. Water flowing at pond end but appears blocked in upstream areas. Culvert above water level however on previous inspection culvert was at the water level. Likely to pose a barrier to swimmers and climbers.
1_003_D	UNK013	Culvert	Concrete	Not in GIS	Structural	Council	Does Not Apply	Culvert running under Jesmond Road. Both ends of culverts are chipped. No upstream habitat. Services stormwater flow from the side of Jesmond Road. Some sediment build-up around inlet and outlet of culvert.
1_025_A	UNK014	Culvert	Concrete	Not in GIS	Replacement	Private	Anguilliform	Culvert is broken. Downstream half has slumped and pipe pieces have pulled apart with water now flowing out underneath. Significant erosion around culvert.
3_005_D	UNK015	Culvert	Concrete	Not in GIS	Replacement	Private	None	Large culvert likely to handle high flow. However, culvert at upstream end has separated. Water has eroded up out of culvert leading to slumping. No issue with fish passage but some concern around erosion. Pipe should be fixed.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
1_025_F	UNK016	Culvert	Concrete	Not in GIS	Replacement	Council	Does Not Apply	Culvert outflow in private property. Culvert is broken at downstream end and needs replacing. Water has eroded out between pipe sections. Most likely an issue at high flow. Culvert services Oira Road stormwater flow and ephemeral upstream reach.
3_005_F	UNK018	Culvert	Concrete	Not in GIS	Erosion Protection	Private	None	Moderate erosion around inlet. Stock access-way over culvert is undercut.
3_006_A	UNK019	Culvert	Concrete	Not in GIS	Debris Removal	Council	None	Upstream end of culvert is severely blocked by debris. Couldn't see the culvert because it was so blocked. Issues around storm water flow and erosion but not fish barrier.
2_014_A	UNK020	Culvert	Concrete	Not in GIS	Debris Removal	Private	None	Culvert could do with debris removal at inlet and outlet.
3_008_A	UNK021	Culvert	Unknown	Not in GIS	Vegetation Clearance	Private	Anguilliform	Culvert appears to be blocked but is unlocatable as it is below water level. Owner said there was a flood over the road last year.
2_013_A	UNK022	Culvert	Concrete	Not in GIS	Vegetation Clearance	Council	Anguilliform	Culvert under Karaka Road. Inlet end could do with vegetation removal. Downstream end might be partially blocked due to erosion. Possibly needs erosion control. Temporary fish barrier if downstream end is blocked.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
2_017_A	UNK023	Pipe	Unknown	Not in GIS	Debris Removal	Private	Anguilliform	Culvert/pipe is not identifiable but large amount of debris at outlet suggests possible issue for fish.
1_044_F	UNK025	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Culvert overflow pipe for small pond. Well above water level at present time. Completely dry and would not allow fish passage upstream. Stormwater flows appear to use overland flow path not culvert.
2_016_B	UNK027	Culvert	Polyethylene	Not in GIS	Debris Removal	Private	None	Plastic culvert. Outlet is in good condition but inlet is inaccessible. Some rubble from major farm road above but most likely not blocking culvert itself. Minor to moderate erosion.
2_016_D	UNK028	Culvert	Polyethylene	Not in GIS	Erosion Protection	Private	Climber	Black plastic culvert sits slightly above stream at present. Would present issues for swimmers and climbers as erosion is causing culvert to hang over downstream channel. No issues upstream end. Lots of erosion around culvert area.
1_095_C	UNK030	Culvert	Concrete	Not in GIS	Replacement	Private	Anguilliform	Culvert inverted 0.3 m above upstream channel, 1 m above downstream end. Upstream channel not pooling suggests it goes through the ground to get to the downstream habitat. Culvert completely dry. Downstream section has a slump. Large drop from culvert to downstream.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
1_040_B	UNK031	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	None	Low flow impedance uncertain. Vegetation around the culvert. Culvert is semi submerged in the water. Sediments in the culvert.
2_008_B	UNK032	Culvert	Polyvinyl Chloride	Not in GIS	Vegetation Clearance	Private	Does Not Apply	Light blue plastic overflow culvert outlet. No water flowing at the moment. Culvert feeds from pond used for irrigation in greenhouse.
2_008_D	UNK033	Culvert	Perforated Drainage Coil	Not in GIS	Vegetation Clearance	Private	None	Two white plastic culverts next to each other. Low velocity of water flow due to mud and vegetation of the culvert inlet in upstream.
2_008_B	UNK036	Culvert	Galvanised Iron or Steel	Not in GIS	Vegetation Clearance	Private	Anguilliform	Culvert in ok condition but has timber wall across inlet which would hinder fish passage. Wall has slowed flow through culvert and is likely to dry out in dry conditions making it difficult for fish passage.
1_038_B	UNK037	Culvert	Concrete	Not in GIS	Erosion Protection	Council	Anguilliform	Culvert running under Oira Road. No upstream habitat. Outlet end has erosion issues while inlet end has significant debris jam. Large pool formed at inlet.
1_041_B	UNK038	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	None	Culvert through private property. Could use some vegetation removal.
1_041_D	UNK039	Culvert	Polypropylene	Not in GIS	Vegetation Clearance	Private	None	Black plastic culvert. Low velocity of water flowing inside the culvert. Vegetation around and above the culvert. No

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								structure above it. In low flow could be a barrier to swimmers.
1_041_F	UNK040	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Culvert potentially blocked at the upstream end, causing formation of a pond. Water running over land from pond to downstream. Cannot find culvert inlet, suggest that debris/sediment removal undertaken. Blockage creates temporary fish barrier.
1_042_A	UNK041	Culvert	Concrete	Not in GIS	Debris Removal	Private	Does Not Apply	Culvert under driveway, connecting to ephemeral upstream habitat. Inlet not located. Outlet mostly buried. Needs to be cleared at both ends.
2_019_B	UNK042	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	Does Not Apply	Culvert that connects to pond upstream. Culvert outlet is between two trees. Root mass in front of outlet has created a small waterfall. Difficult to assess pipe state due to location.
1_041_D	UNK043	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	At the inlet, the culvert opens on the top as opposed to the end, creating a 90 degree climb out of the culvert to the upstream habitat, hence fish barrier. No issue with downstream end.
1_041_G	UNK044	Pipe	Polypropylene	Not in GIS	Patching	Private	Does Not Apply	Pipe disappears under construction site. Water flowing, however broken section near outlet means water flowing under last section of pipe as opposed to through.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
1_056_F	UNK046	Pipe	Concrete	Not in GIS	Vegetation Clearance	Private	Does Not Apply	Concrete pipe coming from the KPH factory. Vegetation surrounds pipe.
1_056_C	UNK047	Culvert	Polypropylene	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert overflow pipe from farm pond. Drop from culvert outlet to downstream. Water flowing at the moment but pond level will soon be below inlet level.
1_056_D	UNK048	Culvert	Polypropylene	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert inlet unlocated however additional overflow pipe in pond is L shaped meaning there is. 90-degree gradient for fish to get out of culvert and into pond. A total of three overflow pipes at different water levels all with same issue.
1_054_B	UNK049	Culvert	Polypropylene	Not in GIS	Replacement	Private	Anguilliform	White cracked plastic culvert. Fish barrier during dry periods and steep section getting out of culvert might limit swimmers even during higher flow. Pipe could be replaced.
5_031_C	UNK050	Culvert	Polyethylene	Not in GIS	Vegetation Clearance	Private	None	Culvert that feeds from farm hill through overland flow path. Good condition, no upstream habitat.
3_010_A	UNK051	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	None	Culvert in average working condition, water flowing through it without pooling at the inlet. There is sediment and vegetation build up near inlet.
3_010_D	UNK052	Culvert	Polyvinyl Chloride	Not in GIS	Vegetation Clearance	Private	None	White plastic pipe culvert in average condition. Macrophyte growth in area could inhibit fish passage, needs vegetation clearance.

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
1_070_D	UNK053	Culvert	Concrete	Not in GIS	Structural	Private	Does Not Apply	Culvert is in poor condition with collapsed outlet and vegetation covers the inlet. Stock damage is apparent at this culvert, and needs structural attention.
1_066_B	UNK054	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	Does Not Apply	Culvert under railway track, in good condition. No erosion or flood risk, no upstream habitat present.
2_027_A	UNK055	Culvert	Polyethylene	Not in GIS	Vegetation Clearance	Private	None	Culvert outlet not located as it is fully submerged. May present fish barrier due to shallow water depth and during dry periods. Vegetation clearance at inlet would be beneficial.
1_070_B	UNK057	Culvert	Perforated Drainage Coil	Not in GIS	Erosion Protection	Private	None	Private culvert. Plastic drain coil. No issues with fish passage or erosion/stormwater flows.
1_070_F	UNK058	Culvert	Ceramic/Earthenware	Not in GIS	Erosion Protection	Mixed	Does Not Apply	Culvert, with access from outlet side only. In poor condition due to erosion around outlet. Debris has partially blocked culvert. No upstream habitat, most likely to feed from ephemeral channel and railway.
1_070_F	UNK059	Culvert	Perforated Drainage Coil	Not in GIS	Erosion Protection	Private	Does Not Apply	Culvert under stock crossing. Moderate erosion caused by water flow and stock damage. Could do with erosion protection. No flooding risk. No upstream habitat.
1_086_B	UNK061	Culvert	Polyvinyl Chloride	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert is hanging at outlet end and water drops 0.15 m down into pond. When pond

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								water level is higher fish would be able to access pipe however for a large part of the year it is inaccessible. Stock damage around culvert.
1_087_F	UNK062	Culvert	Unknown	Not in GIS	Erosion Protection	Mixed	Anguilliform	Culvert runs under railway. Not located from outlet end and cannot access from inlet. Completely blocked at outlet. Likely to cause stormwater and fish passage issues. Needs fine sediment cleared.
1_086_B	UNK063	Culvert	Polyethylene	Not in GIS	Erosion Protection	Private	None	This culvert has no apparent barriers to the fish passage or stormwater network. Good working condition, some vegetation clearance and erosion protection would benefit stream flow.
1_087_B	UNK065	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert is full of soil erosion from livestock and has no water going through it. Needs soil maintenance to work effectively.
1_087_E	UNK066	Culvert	Concrete	Not in GIS	Structural	Private	Anguilliform	The culvert is in poor condition with no flow coming through from upstream pool. Erosion surrounding culvert. Culvert is hanging and would restrict upstream fish movement.
2_034_B	UNK067	Culvert	Unknown	Not in GIS	Debris Removal	Private	Anguilliform	Low flow culvert. Erosion and sediment around outlet. Vegetation covers the inlet. Low flow impedance.
5_041_A	UNK070	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	Anguilliform	Thick *Glyceria* build up at both ends. Sediment build up associated with *Glyceria*. Needs vegetation clearance as

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								inlet end is likely blocked. Blockage also prevents fish passage.
4_023_A	UNK071	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	None	This culvert also serves as a bridge and the outlet doesn't have any effect on the upstream passage as it is shaped structurally above the banks and wouldn't encounter water. Structure has wing walls above the stream channel.
4_023_C	UNK072	Culvert	Other	Not in GIS	Debris Removal	Council	Does Not Apply	Large culvert under railway, sediment build-up on TLB. Some larger material in culvert channel. Culvert doesn't present barrier for fish passage however outlet does. Overall in good condition, could use sediment removal.
2_041_A	UNK074	Culvert	Concrete	Not in GIS	Structural	Mixed	Does Not Apply	Brick culvert running under railway. Sloping downstream. Changes to a circular concrete culvert at the downstream end. Some sections of pipe have come away at outlet end.
1_119_A	UNK075	Pipe	Other	Not in GIS	Erosion Protection	Private	Does Not Apply	Cemented rock pipe. Appears none functional. 15 m upstream there is a large eroded hole where water falls into the pipe. Can hear it dripping at present.
2_022_C	UNK076	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	None	Rural asset no issues. Culvert in stream channel in good condition. Some surrounding vegetation like lilies need to be cleared to enhance flow path for both

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								outlet and inlet. Deep water level on both sides.
1_065_A	UNK077	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	None	Culvert in average condition, no impact to stormwater flows. Some vegetation clearance required to aid flow. Likely to have low flow impedance issues for swimmers, as water level is low and upstream there is an intermittent watercourse.
2_023_B	UNK078	Culvert	Concrete	Not in GIS	Replacement	Private	Climber	Broken culvert, stock damage has led to section slumping and separation. No flow in through culvert. Build-up of fine sediment. Barrier to swimmers and climbers.
2_031_A	UNK081	Culvert	Concrete	Not in GIS	Debris Removal	Private	None	Culvert completely dry, and above level of upstream pond, low flow impedance would create barrier for most of the year. Average condition.
2_031_B	UNK082	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	Does Not Apply	Private asset, no issues. No fish passage as there is no suitable upstream habitat.
2_028_C	UNK083	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Pipe is broken at outlet end and has potentially split in the centre. Not obstructed so water can pass. Culvert invert above channel and would pose an issue for swimmers and climbers when water levels are low.
4_025_A	UNK086	Culvert	Concrete	Not in GIS	Structural	Private	None	Large culvert under major farm access way/bridge. No issues preventing

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								stormwater flow or fish passage. The two pipes making up the culvert have separated and this has potentially lead to undercutting of the bridge.
1_063_A	UNK089	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert between two ponds. Culvert is hanging at both ends and is likely to be non-functional. Erosion at inlet end.
1_063_A	UNK091	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert is in ok condition but would see very little use as pond bank has burst and water was flowing from pond to pond. Culvert is hanging at both ends so would prevent fish passage.
2_044_C	UNK095	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert is functional however erosion at the inlet end may be causing some flow issues. *Glyceria* built up around the area. Slumping at inlet end, may cause fish passage issues.
3_017_A	UNK101	Culvert	Polyvinyl Chloride	Not in GIS	Debris Removal	Private	None	Culvert under farm road. Culvert has no significant stormwater flow or erosion issues. Some woody bedload within culvert at inlet end.
2_055_A	UNK103	Culvert	Concrete	Not in GIS	Debris Removal	Private	None	Private asset with no issues, just some debris removal at the inlet would aid fish passage from upstream habitat. Structural maintenance for headwall would improve structure.
2_054_A	UNK104	Culvert	Concrete	Not in GIS	Erosion Protection	Private	None	Culvert fully submerged. Potential erosion issues at both ends may lead to future

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								issues. Some bamboo debris build up at inlet end.
1_112_B	UNK105	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert serving as overflow for pond. Sections of pipe disjointed, large drop to downstream habitat would present complete fish passage barrier.
1_112_C	UNK106	Culvert	Polyvinyl Chloride	Not in GIS	Erosion Protection	Private	Climber	Culvert over flow for farm pond. Currently flowing, outlet is approximately 2 m lower than inlet suggesting 45 degree decline which may present barrier for climbers and swimmers. No stormwater flow issues.
1_112_C	UNK107	Culvert	Polyvinyl Chloride	Not in GIS	Vegetation Clearance	Private	Climber	Culvert acting as a drain for pond. Inlet fully submerged and outlet mostly blocked by sediment. Drop from inlet to outlet approximately 2 m and a gradient of 50 degrees.
1_113_A	UNK109	Culvert	Concrete	Not in GIS	Patching	Private	Does Not Apply	Culvert in good working condition. Some damage to culvert at outlet end. Pipe is broken with pieces falling into culvert outlet.
1_113_D	UNK111	Culvert	Concrete	Not in GIS	Debris Removal	Private	Anguilliform	Hanging culvert, that acts for overflow of pond upstream. Culvert inlet almost completely submerged. Evidence of debris blockage and disuse from vegetation at outlet end. Drop height causes fish barrier.
1_105_B	UNK112	Culvert	Concrete	Not in GIS	Replacement	Private	Does Not Apply	Culvert under stock access across stream. In poor condition and practically was the same level as stream. Culvert has separated

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								in middle so is functioning poorly however only services small upstream catchment.
2_045_A	UNK114	Culvert	Concrete	Not in GIS	Debris Removal	Private	Anguilliform	Culvert at outlet end is cracked with vegetation growing within. Water depth significantly higher in the inlet end and trickling at outlet, could mean blockage. Could lead to flooding over farm road. Fish barriers at inlet and outlet.
2_046_A	UNK115	Culvert	Concrete	Not in GIS	Debris Removal	Private	None	Culvert under farm road. Some debris build-up at inlet end may restrict flows and pooling at outlet end from potential blockage. Erosion issues with inlet headwall.
1_118_B	UNK118	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	Anguilliform	Culvert in good condition. Above level of pond and downstream channel. Low flow issues in greater area may negate fish passage issues specifically related to this culvert. Vegetation build up could be cleared.
1_129_A	UNK121	Culvert	Corrugated Iron	Not in GIS	Replacement	Private	Does Not Apply	Culvert in very poor condition due to collapse of ground above culvert. Inlet end has debris build-up, while outlet is half buried with sediment. Services ephemeral upstream reach, however water flows seem likely to have damaged this asset.
2_049_C	UNK124	Culvert	Concrete	Not in GIS	Debris Removal	Private	Anguilliform	Culvert was completely blocked by sediment. Likely to lead to erosion issues at inlet during rainfall events. Temporary fish

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								passage issues, however streams around asset are completely dry so low flow impedance is present.
2_050_B	UNK126	Culvert	Polyvinyl Chloride	Not in GIS	Debris Removal	Private	Climber	Culvert under farm road, mostly blocked by root mass at outlet end and fine sediment at inlet end. Can see through culvert, however partial blockage is likely to present a fish barrier. Sediment and debris removal will aid fish passage.
2_060_F	UNK131	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Swimmer	Culvert has moderate erosion issues, erosion has created secondary channels through soil beside culvert. Water currently flowing through culvert as well as channels beside culvert. Debris covering inlet.
1_132_A	UNK134	Culvert	Concrete	Not in GIS	Structural	Private	Anguilliform	Pipe appears to be broken at inlet end as end of pipe is slumping down. Erosion and broken pipe suggest debris blockage within pipe, at least partially. Inlet end has erosion issues. Condition of pipe likely to hinder fish passage.
2_049_A	UNK135	Culvert	Polyvinyl Chloride	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert in stream bed, serving as pond overflow. Outlet end within larger concrete pipe. Water and channel below, appeared to be running below the culvert. In good condition. Drop height likely to inhibit fish passage. Erosion at outlet end.
1_139_A	UNK136	Culvert	Polypropylene	Not in GIS	Erosion Protection	Private	Anguilliform	Perched culvert overhanging stream below. Would present complete fish passage

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								barrier. Culvert is free of debris and would function adequately for stormwater flows. Moderate erosion at outlet. Overflow for pond.
2_060_A	UNK139	Culvert	Cast Iron	Not in GIS	Replacement	Private	Anguilliform	Iron culvert acting as stormwater overflow for upstream pond. Four culverts, all in similar condition, rusted and broken. Would allow water through but is eroding away under culvert where pipe has rusted through. Some vegetation debris.
1_127_B	UNK147	Culvert	Unknown	Not in GIS	Debris Removal	Private	Climber	Culvert running under farm access way. Bank height around channel approximately 2 m so no flood risk even though culvert is very blocked by debris and sediment at inlet end. Channel at inlet was filled due to sediment deposition. Some water flowing through culvert.
1_135_D	UNK151	Culvert	Unknown	Not in GIS	Debris Removal	Private	Climber	Culvert not located but can hear water flowing through. Lots of fine sediment at outlet suggests partial blockage. Potential fish passage issues.
1_135_C	UNK155	Culvert	Steel	Not in GIS	Debris Removal	Private	Does Not Apply	May be some debris in culvert but nothing major. Rural private asset, with no significant issues.
1_144_A	UNK161	Culvert	Unknown	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert appears fully blocked by fine sediment plus some coarser material. Upstream pond formed in heavy rain and has overtopped bank. Culvert not able to

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								deal with the water volume. Eroded subterranean channel has formed through bank above culvert.
3_020_C	UNK163	Culvert	Concrete	Not in GIS	Debris Removal	Private	None	Private rural asset. Good condition, however flooding has pushed *Glyceria* into inlet. May lead to potential blockages.
1_155_A	UNK166	Culvert	Polypropylene	Not in GIS	Erosion Protection	Private	Anguilliform	Overflow culvert for pond. Large drop to downstream habitat and will drop to upstream if pond level recedes. No major erosion but there is loose clay on bank above culvert which is likely to wash downstream during heavy rain.
4_016_A	UNK168	Culvert	Corrugated Iron	Not in GIS	Patching	Private	Climber	Culvert had no stormwater flow or erosion issues. Outlet end has rust that has eaten away bottom of the culvert allowing water to flow beneath the culvert for the last metre.
4_018_A	UNK169	Culvert	Corrugated Iron	Not in GIS	Replacement	Private	Anguilliform	Three same size culverts. Rust holes in pipes caused water to flow under pipes and cause erosion issues. Sharp rusty edges and having to swim up eroded channel under dissipating structure may cause fish passage issue.
1_151_A	UNK171	Culvert	Corrugated Iron	Not in GIS	Replacement	Private	Does Not Apply	Corroded corrugated iron culvert under rural access way, connecting to pond banks. Water flowing underneath culvert, creating an erosion issue under culvert. Not functional as water flows underneath

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								culvert and should be replaced to prevent further issues.
1_161_A	UNK173	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert under farm road. Culvert in good condition with minimal deterioration. Recent rainfall event led to flooding according to farmer. Perched at outlet, creating complete fish barrier. Erosion issues at both ends.
1_160_A	UNK174	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Does Not Apply	Culvert is perched and overhanging but no upstream habitat so no fish issues. Some chipping around outlet but erosion at outfall is the concern.
1_156_A	UNK175	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert was perched above downstream creating fish passage barrier. Pipe is functioning ok with some degradation at inlet and outlet. Erosion is the concern.
1_156_A	UNK176	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Does Not Apply	Culvert running through upper pond bank. Culvert in good condition with minimal deterioration. Perched above pond creating a fish barrier. Heavily eroded on either side of the outlet.
2_061_B	UNK177	Culvert	Concrete	Not in GIS	Debris Removal	Mixed	None	Large culvert under Tuhimata Road would be in good condition but a gate across inlet end has potential to cause flooding and erosion issues.
2_061_F	UNK180	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert perched at outlet end creating fish barrier. Culvert didn't cope with previous weeks heavy rain and overtopped the

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								banks according to farmer. Despite this there appeared to be minimal flood damage. Erosion in outlet receiving channel.
2_062_B	UNK181	Culvert	Concrete	Not in GIS	Debris Removal	Private	Anguilliform	Culvert perched at outlet end creating fish barrier. Culvert in good condition with no obvious obstructions. Erosion at inlet end.
1_161_A	UNK182	Culvert	Concrete	Not in GIS	Structural	Private	Swimmer	Culvert above downstream channel but enough wetted margins to allow climbers and eels to pass. Pipe slumped, buckled and cracked at outlet due to large pine tree growth. Upstream end is in good condition. Flows overtopped culvert in last rain.
2_061_F	UNK184	Culvert	Concrete	Not in GIS	Erosion Protection	Private	None	Water overtopped culvert during recent rain and flowed across farm road above according to farmer. There are erosion issues on both ends that need to be addressed but culvert was flowing fine.
4_020_B	UNK189	Culvert	Concrete	Not in GIS	Vegetation Clearance	Council	None	Large twin culvert under Tuhimata Road. Both are in good condition. Culvert would benefit from vegetation clearance above inlet.
2_063_A	UNK190	Culvert	Concrete	Not in GIS	Debris Removal	Private	Does Not Apply	Culvert likely blocked at downstream end by erosion and debris. Inlet is within bubble up chamber. Property owner said it floods periodically over driveway. Erosion at outlet potentially caused by flooding.

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1_163_A	UNK192	Culvert	Unknown	Not in GIS	Vegetation Clearance	Council	Does Not Apply	Culvert could not be located due to thick vegetation build-up at inlet and outlet. Culvert runs under Tuhimata Road. Vegetation clearance is required.
3_038_A	UNK194	Culvert	Galvanised Iron or Steel	Not in GIS	Debris Removal	Council	Does Not Apply	Culvert runs under road. Blocked by debris at inlet and erosion has pushed soil and gravel over culvert outlet. Some flow going through but in heavy rain this may cause blockage issues and road flooding.
1_157_A	UNK195	Culvert	Concrete	Not in GIS	Replacement	Mixed	Does Not Apply	Culvert runs under Tuhimata Road. Inlet in paddocks. Section between paddock and road has multiple pipe lengths that are broken. Runs through concrete channel at this point. Outlet not located due to accessibility issues. Culvert functional but has deteriorated.
2_066_A	UNK196	Culvert	Galvanised Iron or Steel	Not in GIS	Patching	Private	Climber	Culvert perched above downstream habitat, hole in culvert creating sharp vertical drop which would create fish barrier. Eroded margins may allow eels and some swimmers to access the culvert. Asset functional for water flows but is degraded.
1_164_B	UNK197	Culvert	Cast Iron	Not in GIS	Replacement	Private	None	Culvert completely warped at inlet end, which may restrict flows and cause further erosion around the asset. Fine sediment build-up felt within culvert. Thick macrophyte growth at inlet end.

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2_067_A	UNK203	Culvert	Polyvinyl Chloride	Not in GIS	Structural	Private	None	Culvert within larger culvert. Culvert functional but in very poor condition, large debris jam at inlet preventing assessment.
2_067_C	UNK204	Culvert	Ceramic/Earthenware	Not in GIS	Replacement	Private	Anguilliform	Perched culvert creating fish passage issues. Culvert functioning fine for water flows, but was crack at outlet end. Debris build-up at inlet end, contributing some bedload to culvert. Erosion issues at outlet.
2_067_E	UNK205	Culvert	Polypropylene	Not in GIS	Erosion Protection	Private	Anguilliform	Long section of culvert piped under paddock, with significant issues at both inlet and outlet. Difficult to assess, as only small drainage coil pipe was evident. Sediment build-up and length of culvert are likely to prevent fish passage.
3_027_A	UNK207	Culvert	Concrete	Not in GIS	Structural	Private	None	Culvert has separated in the middle and there was a large erosion hole above this site. High flow rates likely to further damage the asset and the bridge above. No fish passage issues. Erosion issues and large log across inlet.
1_172_D	UNK209	Culvert	Concrete	Not in GIS	Structural	Private	Climber	Culvert functional but had come apart and a hole had formed due to water seeping. Perched at downstream end creating a barrier for simmers and possibly some climbers.
1_174_A	UNK210	Culvert	Unknown	Not in GIS	Debris Removal	Private	Anguilliform	Culvert blocked at upper end by debris, likely to be creating a barrier for fish passage to good upstream habitat.

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1_168_B	UNK213	Culvert	Concrete	Not in GIS	Replacement	Private	Swimmer	Culvert has separated towards outlet creating large eroded hole in farm road. Pipe potentially too small to handle stream volume. Fish barrier where pipes have separated causing a drop. Water flows out and around end section of culvert.
2_074_D	UNK221	Culvert	Concrete	Not in GIS	Patching	Private	Anguilliform	Culvert in good working condition. Some cracking and chipping at outlet end. Slightly perched, with low flow impedance, was potentially create a fish passage barrier.
1_189_D	UNK223	Culvert	Concrete	Not in GIS	Structural	Private	Anguilliform	Culvert in good working condition. Some cracking and chipping at inlet end. Culvert was perched, creating fish barrier.
2_081_C	UNK225	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Pipe has some deterioration at outlet but is working. Culvert is perched but rocks around outlet may aid some climbing species in accessing culvert.
2_078_A	UNK229	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Build-up of debris on fence above inlet suggests flooding. Erosion hole on bridge side of fence potentially caused by flood waters overtopping culvert. Perched culvert with fish passage issues. Turbulence and velocity high due to recent rain.
1_189_B	UNK230	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Culvert is slightly perched and likely to cause issues for swimmers and some climbers. Debris build-up at inlet likely to be contributing bedload to culvert.

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2_079_E	UNK232	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Culvert in good condition but perched at outlet creating fish barrier. Current high-water velocities due to recent rain. Slight debris build up at inlet.
2_079_F	UNK233	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Erosion issues. Debris jam at inlet. Other yellow drainage pipes present.
2_075_A	UNK235	Culvert	Polyvinyl Chloride	Not in GIS	Structural	Private	Anguilliform	Culvert is perched and hangs over downstream channel which would create fish passage issues. Culvert in good working condition. Has cracked and buckled slightly at inlet end.
2_083_B	UNK239	Culvert	Polyvinyl Chloride	Not in GIS	Debris Removal	Private	Anguilliform	Debris jam at inlet may restrict fish passage, however water was flowing through the debris jam with good flow through the culvert. Outlet buckled due to proximity of large tree.
1_193_D	UNK242	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert was perched at outlet leading to fish passage issues. Erosion issues at outlet, requires erosion protection. Inlet not located but flow suggests no blockage.
1_193_G	UNK244	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert in good condition, but perched creating fish passage issues. Water depth in culvert low despite recent rainfall, suggesting low flow impedance. Pipe at inlet is plastic as opposed to concrete.
2_083_C	UNK245	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Climber	Culvert flowing but had debris jam at inlet end. Debris build-up and has led to flooding which is the probable cause of damage to

TribCode	Asset ID	Type	Material	GIS	Maintenance	Access	Fish Barrier	Notes
								the headwall at the outlet. Culvert perched creating fish barrier.
1_191_A	UNK246	Culvert	Concrete	Not in GIS	Structural	Private	Climber	Two culverts. Both perched. Sections of pipe have broken and are now lying in receiving environment. Likely to only be active during rain as an overflow for upstream pond.
1_190_A	UNK247	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Large functional culvert with erosion issues at outlet. Perched creating fish passage issues. Debris build-up at inlet could also be addressed.
2_082_A	UNK255	Culvert	Concrete	Not in GIS	Replacement	Private	Anguilliform	Pipe has come apart in multiple sections. Ground had started to slump where middle section was parted. Perched creating fish barrier. Floods have recently topped culvert.
2_082_B	UNK256	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Flooding is creating erosion problems downstream. Culvert is perched and likely only flowing during wet periods. Partially blocked at inlet end.
1_193_H	UNK261	Culvert	Concrete	Not in GIS	Vegetation Clearance	Private	Anguilliform	Culvert in good condition with slight erosion around inlet and outlet. Perched above downstream habitat creating fish passage issues. Inlet not located but has water flowing through it. *Glyceria* build-up potentially causing slight blockage.

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2_003_A	UNK266	Culvert	Concrete	Not in GIS	Debris Removal	Private	Climber	Three small culverts draining upstream pond. Debris partially blocking inlets. Perched creating fish barrier.
1_009_A	UNK267	Culvert	Concrete	Not in GIS	Erosion Protection	Private	None	Culvert was low-lying with severe stock damage on top of culvert, pushing sediment into the water. Soft sediment build-up within culvert also likely.
2_004_B	UNK270	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Section of pipe has collapsed at outlet due to erosion. Remaining pipe in working condition. Perched creating fish passage issues.
1_018_A	UNK275	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Does Not Apply	Culvert has collapsed at outlet end due to erosion issues. Water flows under culvert, may eventually lead to collapse of stock access way over culvert.
1_017_C	UNK277	Culvert	Concrete	Not in GIS	Debris Removal	Council	Anguilliform	Water was flowing through the culvert however soft sediment and vegetation at inlet end may be partially blocking the culvert. Area around inlet appears to have been sprayed.
1_017_D	UNK279	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Climber	Culvert in fine working condition and is free of obstructions. Slightly perched creating fish barrier. Vegetation around culvert and smaller pipe may assist climbers and eels. Likely to dry up as it is a pond overflow culver, therefore causing low flow impedence.

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2_005_A	UNK283	Culvert	Galvanised Iron or Steel	Not in GIS	Erosion Protection	Private	Anguilliform	Culvert working well according to resident (419 Oira Road), but he has noticed an increase in volume in recent times. Significant enhancement opportunity for fish passage. Perched but large schools of inanga downstream. Daylighting opportunity.
2_005_B	UNK284	Culvert	Concrete	Not in GIS	Replacement	Private	None	Both landowners have mentioned increased stormwater flows coming from intensified greenhouse activity upstream. Pipe may not cope fully with stormwater flows in future if this continues. Evidence that recent rain topped culvert. At present working fine.
1_015_A	UNK285	Culvert	Concrete	Not in GIS	Replacement	Private	Anguilliform	Evidence that pond has flooded. Land owner believes it is due to the increased greenhouse density on the neighbouring property. Pipe may no longer be large enough to cope with stormwater flows.
1_177_A	UNK288	Culvert	Unknown	Not in GIS	Erosion Protection	Private	None	Rural private asset. Needs erosion protection as stock damage around structure is pushing sediment into stream, particularly downstream. Culvert fully submerged but water freely flowing through.
1_020_I	UNK291	Culvert	Concrete	Not in GIS	Patching	Private	Does Not Apply	Culvert under Oira Road. Culvert was broken at inlet end but was still functional.

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1_020_B	UNK293	Culvert	Polyvinyl Chloride	Not in GIS	Erosion Protection	Private	Climber	Three small pipes running through bank. Working fine but size creates fish passage barrier as they have very high flow rates, are perched slightly and will be dry. Suggest replacing with one larger fish friendly culvert. Some bedload in inlet.
1_020_B	UNK294	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Severe erosion at outlet which is causing culvert to slump. Perched creating a permanent fish barrier on top of the intermittent nature of the stream.
1_020_C	UNK295	Culvert	Concrete	Not in GIS	Erosion Protection	Private	Anguilliform	Inlet not located but is below stream channel with water flowing down into it. Recent rains have flooded this culvert and could lead to future damage to the asset. Outlet perched with erosion issues.
1_020_F	UNK297	Culvert	Polyvinyl Chloride	Not in GIS	Replacement	Private	Does Not Apply	Three small plastic drainage pipes. Creating erosion issues at outlet. Blocked by vegetation and cracked/broken at inlet end. Functional but average condition. Replacement with one large culvert would be better.
1_020_H	UNK298	Culvert	Concrete	Not in GIS	Replacement	Private	Does Not Apply	Culvert is blocked at inlet by leaf litter. This has caused water to flow over the culvert and down through the paddock, creating erosion around the outlet. Pipe splits into two and exits outlet as two small pipes. Potential to replace with larger pipe.