# Eastern Bays and Glendowie Watercourse Assessment Report

Morphum Environmental Ltd, April 2020

Auckland Council
Te Kaunihera o Tāmaki Makaurau

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Auckland Council
Healthy Waters Department
Watercourse Assessment Report

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# Executive Summary

Morphum Environmental Ltd was engaged by Auckland Council to undertake a detailed assessment of the watercourses in the Glendowie and Eastern Bays stormwater catchments, collectively referred to as the 'survey area' in this report. Overall, a total of 15.4 km of watercourse was surveyed with 8.07 km in Eastern Bays and 7.33 km of stream in Glendowie including 594 stormwater pipes, culverts and inlet/outlets. A total of 1.1 km of overland flow paths (OLFPs) were surveyed but have been excluded from the analysis as per the watercourse assessment methodology. The watercourse assessment was conducted according to the Watercourse Assessment Methodology: Infrastructure and Ecology version 2.0 (WAM), between March and April 2019.

This watercourse assessment report provides baseline information on the existing condition of the watercourses in the survey area. The report aims to provide information that can be used to maintain streams with heterogeneous in-stream and riparian habitat and enhance degraded streams while recognising the constraints within an urban environment. The outputs are used by Auckland Council as a key resource in the management of waterways. They serve to support achieving multiple objectives within realistic environmental, economic and social constraints and inform the effective management of:

- Stream ecological health (e.g. degraded habitats);
- Stormwater infrastructure (e.g. eroded pipes); and,
- Stormwater conveyance (e.g. flooding).

The Eastern Bays catchment encompasses a total area of 6.03 $km^2$ and is drained primarily by Mission Bay Stream, Kohimarama Stream and the Dingle Dell Stream. The Glendowie catchment is 4.3 $km^2$ and is primarily drained by Glendowie Stream and Tāhuna Tōrea Stream. The Eastern Bays and Glendowie catchments are situated within the Tāmaki Ecological District. They are on a heavily urbanised isthmus between the Manukau and Waitematā Harbours, have high imperviousness and lie within one of the most modified ecological districts in New Zealand. Few areas of indigenous vegetation remain, covering just 11% of the area. The two catchments have fragmented watercourses which are interspersed with old stormwater infrastructure, with the pipe network in Eastern Bays dating back to the 1960s.

The underlying geology of the survey area is Waitematā sandstones dominated by mud and turbidite in Eastern Bays and an assemblage of basalt on Taylor Hill (dormant volcano), tuff, turbidite and sands in the Glendowie catchment.

The Eastern Bays receiving environment has arguably the most popular urban beaches in central Auckland: Mission Bay, Kohimarama and Saint Heliers which are situated in the Waitematā Harbour. With equal popularity, Glendowie discharges into the Tāmaki Estuary which is of ecological value and a key transport corridor for Auckland. Ultimately, the coastal receiving environment is the Hauraki Gulf. Long-term monitoring of 43 sites in the Hauraki Gulf indicates that the Tāmaki Estuary has poor and declining benthic health and water quality due to elevated heavy metal concentrations (Seachange, 2014). Continued positive action is required catchment wide to mitigate pressures of erosion and sedimentation on the receiving environment.

To protect the streams and coast in the catchments, key issues and opportunities have been highlighted below.

## Stormwater Assets

A total of 594 engineering assets including: 325 inlet/outlet structures and a total of 269 pipes/culverts were assessed using the methodology outlined in the WAM.

The following sections describe assets with potential issues of concern including Auckland Council stormwater assets, private assets and fish passage barriers.

**Auckland Council Stormwater Inlets and Outlets.**

- A total of 230 Council inlet/outlet assets were assessed:
    - 16 Auckland Council owned inlet/outlets observed as being in poor condition and require maintenance.
    - 18 Council owned; easily/moderately accessible structures have been identified to be a safety risk due to an unprotected drop from the top of the headwall/wingwalls.
    - 24 Council owned assets are incorrect in GIS.
    - 30 Council assets are not in GIS.

**Auckland Council Pipes and Culverts**

- A total of 205 Council owned pipes and culverts were assessed:
    - 31 Council owned assets are incorrect in GIS due to incorrect location, pipe size or material.
    - 14 pipes required some form of maintenance:
        - Two pipe/culverts are in poor condition requiring maintenance for structural work, patching, debris removal and erosion protection.

**Flooding Issues**

A total of 29 inlet and outlets, 17 pipes and one miscellaneous point pose a potential risk for the flooding of habitable floors, roads and other infrastructure. Debris and fences across inlets are common causes of potential flooding risk as well as residential floor levels with less than 1 to 2 m of freeboard (as estimated on site).

**Private Assets**

Of the 29 inlets/outlets and 25 pipes that have been assessed using the methodology outlined in the WAM, almost all are not in GIS (25/22). Most assets are easily/moderately accessible and have a safety risk due to unprotected drops from the top of the structures (headwall/wingwalls). The other issues with private assets include poor construction, buried and safety issues with unprotected drop from structure.

**Barriers to Fish Passage**

A total of 95 engineering structures are a barrier to fish passage. These barriers are located throughout both catchments and affecting a total of 9.56 km of open watercourse. The most significant of these barriers is a coastal outlet (triple culvert SAP ID 2000621796) which is a complete barrier to 200 m of upstream open watercourse.

**Bank Lining**

A total of 2,082 m of watercourse has some bank or channel lining. An additional 400 m of watercourse was recorded as having bank lining without an associated bank lining feature. Due to the and time constraints they were only recorded as part of the ecoline feature class.

Of note, is the lined reach at 18a Godden Crescent (MIS_TRIB5a_1) which has timber lining which is being eroded from underneath causing mass wasting behind the timber walls. Not only is the section in bad shape and has the potential to fail but the downstream section runs through a concrete lined

channel underneath the house at 15b Rukutai Street. This could be unsafe for the homeowners who are living above it as high flows could weaken the houses foundations (Asset ID: UNK_009).

## Key Issues and Pressures

The ecological health of the watercourses in Eastern Bays and Glendowie is impacted by the surrounding urbanised land use and intensified residential development. The most common issues in the survey area are:

- Fragmented and highly modified open watercourses with limited available habitat for freshwater fishes;
- Increased imperviousness and associated changes in the stream hydrographs;
- Increased potential of channel erosion and reduced base flow levels due to changes in stream hydrograph;
- Privately owned bank and channel lining in poor condition;
- Low shading and poor temperature regulation of watercourses due to the clearance of riparian vegetation;
- Conveyance demands and localised flooding of sports fields and private properties (gardens) during rainfall events;
- Water quality contamination issues associated with wastewater;
    - Two pollution events – chlorine and paint discharges.
    - One location with sewage fungus and sewage discharge.
- Fish passage barriers on private and council owned assets; and
- Aging stormwater network and localised erosion associated with stormwater assets.

## Opportunities for Enhancement

In an urban environment where extensive sections of the catchment have been severely modified and piped it is a challenge to preserve the natural character of streams. Areas of outstanding natural character include watercourse in Dingle Dell reserve and the wetland and saltmarsh habitats of Tāhuna Tōrea. The key opportunities for these catchments include:

- Daylighting of piped watercourses within Auckland Council parks and reserves:
    - Crossfield Reserve and Glendowie College (EO1, 1 km of piped watercourse),
    - Glendowie Park (470 m of piped watercourse).
- Proposed offline stormwater treatment wetland at Aotea Reserve (Nihill Crescent),
- Enhancement of modified watercourses with focus on those with bank and channel lining.
- Remediation of fish passage barriers.
- Enhancement of instream and riparian habitat by utilising soft-engineering approaches.
- Promote community awareness and engagement to protect and enhance waterways.
- Community programmes for urban stream management and water sensitive design including advice on flooding, erosion, riparian planting, fish passage and water quality.

The findings of the field survey were used to categorise the watercourse reaches into five Management Zones. The Management Zones provide overarching descriptions of reaches with similar pressures and issues. The purpose of categorising the reaches into management zones is to summarise key values, assessments and recommended actions at a high level to guide unified management across the wider catchment.

Across the survey area, a total of seven enhancement opportunities have been identified with three proposed projects in the Eastern Bays catchment and four proposed projects in the Glendowie catchment. The enhancement opportunities highlight discreet areas where ecological, conveyance and, amenity values could be improved.

| Table 1: Summary of Eastern Bay and Glendowie catchments. | | | | | | |
|---|---|---|---|---|---|---|
| **Total Length of Surveyed Watercourse (km)** | **15.4 km** | | | | | |
| **Catchment Area (km²)** | Eastern Bays 6.0 km² | | | Glendowie 4.3 km² | | |
| | Total survey area: 10.3 km² | | | | | |
| **Catchment Imperviousness** | Eastern Bays 51% | | | Glendowie 38% | | |
| | Total survey area 45% | | | | | |
| **Receiving Environment** | Tāmaki Estuary, Waitematā and Hauraki Gulf | | | | | |
| **Dominant Substrate** | Silt and Sand | | | | | |
| **Vegetation** | **0 – 10 %** | **10-30%** | **30-50%** | **50-70%** | **70-90%** | **>90%** |
| Average Overhead Cover (% of total stream length) | 9 | 2 | 5 | 63 | 16 | 5 |
| **Wetlands** | **Natural** | | | **Artificial** | | |
| Number of Wetlands in survey area | 6 | | | 5 | | |
| **Erosion** | **Excellent** | **Good** | **Fair** | **Poor** | | |
| Overall Stability Index (% of total stream length) | 2% | 76% | 22% | <1% | | |
| | **Percentage of reaches with >60% erosion scarring** | | **Total No. Erosion hotspots** | | | |
| | 4 | | 8 | | | |
| **Engineered Assets** | **Total No.** | **Poor-Very Poor Condition** | **Incorrect in GIS** | **Easy Access Unsafe Drops >1.5m** | | |
| Inlet and Outlet Structures | 325 | 16 | 24 | 8 | | |
| Pipes and Culverts | 269 | 3 | 32 | n/a | | |
| Bank and Channel Lining (total length (m)) | 2,082 | 126 | n/a | n/a | | |
| **Fish** | **No. of species observed** | **Percentage of fish points with suitable spawning habitat** | **Percentage of reaches with suitable spawning habitat** | | | |
| | 6 | 33 | 3.3 | | | |
| **Potential Barriers to Fish Passage** | **Swimmers** | **Climbers** | **Anguilliformes** | | | |
| Natural Structures | 5 | 2 | 1 | | | |
| Inlets and Outlet Structures | 57 | 33 | 17 | | | |
| Pipes and Culverts | 23 | 18 | 5 | | | |

**Table 2: Summary of Management Zones and Objectives**

| | Management Zones | Stream Naturalisation | Water quality treatment | Fish Passage Remediation | Erosion Remediation | Water sensitive Communities | Fencing | Riparian vegetation enhancement | Weed Control | Sediment control | Ecological connectivity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MZ1 | Vegetated gully pockets | | | | ✓ | | | | ✓ | | ✓ |
| MZ2 | Public – intact riparian vegetation corridors | | | ✓ | | | | | ✓ | | ✓ |
| MZ3 | Public – high potential for ecological improvements | | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| MZ4 | Coastal watercourses | ✓ | | ✓ | | ✓ | | ✓ | ✓ | | ✓ |
| MZ5 | Streams isolated by piped networks | | | ✓ | | | | | | ✓ | ✓ |

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# 1.0 Introduction

The objective of this project was to undertake a Watercourse Assessment and prepare a Watercourse Assessment Report (WAR) and geodatabase that will provide a framework for prioritised management of the watercourses in the two urban stormwater catchments; Eastern Bays and Glendowie.

The scope of this project is described as follows and detailed in Table 3:

- Undertake a Watercourse Assessment and prepare a Watercourse Assessment Report (WAR) for the Eastern Bays and Glendowie catchments including associated maps and completed geodatabase.
- All services must 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 must be surveyed.
- Stormwater assets associated with the stream length to be surveyed are to be assessed per the Watercourse Assessment Methodology: Infrastructure and Ecology Document (Version 2.0).
- Five Stream Ecological Valuations will be undertaken in the survey area.

The stream survey was conducted in accordance with the Watercourse Assessment Methodology: Infrastructure and Ecology (Version 2.0) which replaces the former Auckland Council Specification for Stream Assessment Surveys and Watercourse Management Plans.

**Table 3: Watercourse Assessment scope matrix**

| Watercourse Management Plan Component Protocol | Eastern Bay and Glendowie Catchment |
|---|---|
| Pre-survey Desktop Assessment | Yes |
| Literature Review | Yes |
| Field Stream Assessment | Yes |
| Reach Assessment (Ecoline) | Yes |
| Natural Structures | Yes |
| Fish Survey | Yes |
| Stream Mouths | No |
| Inanga Spawning | Yes |
| Wetlands | Yes |
| Asset Inspection (Inlets/Outlets) | Yes |
| Asset Inspection (Culverts/ Pipes) | Yes |
| Bank and Channel Lining | Yes |
| Erosion Hotspots | Yes |
| Enhancement Opportunities | Yes |
| Miscellaneous Points | Yes |
| Post-survey Desktop Assessment | Yes |
| Management Zones | Yes |
| Stream Ecological Valuations (SEVs) | Yes |
| Electrofishing | Yes |
| Clarity Measurements | No |
| Sediment Chemistry and E. Coli | No |

## 1.1 How to use this document

### 1.1.1 Overview

The Watercourse Assessment Report document summarises comprehensive data collected during the field watercourse assessment. 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), watercourse management (Section 3.0), summary of the watercourse assessment findings (Section 4.0), and Enhancement Opportunities (Section 6.0). 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 document (Lowe and Young *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.

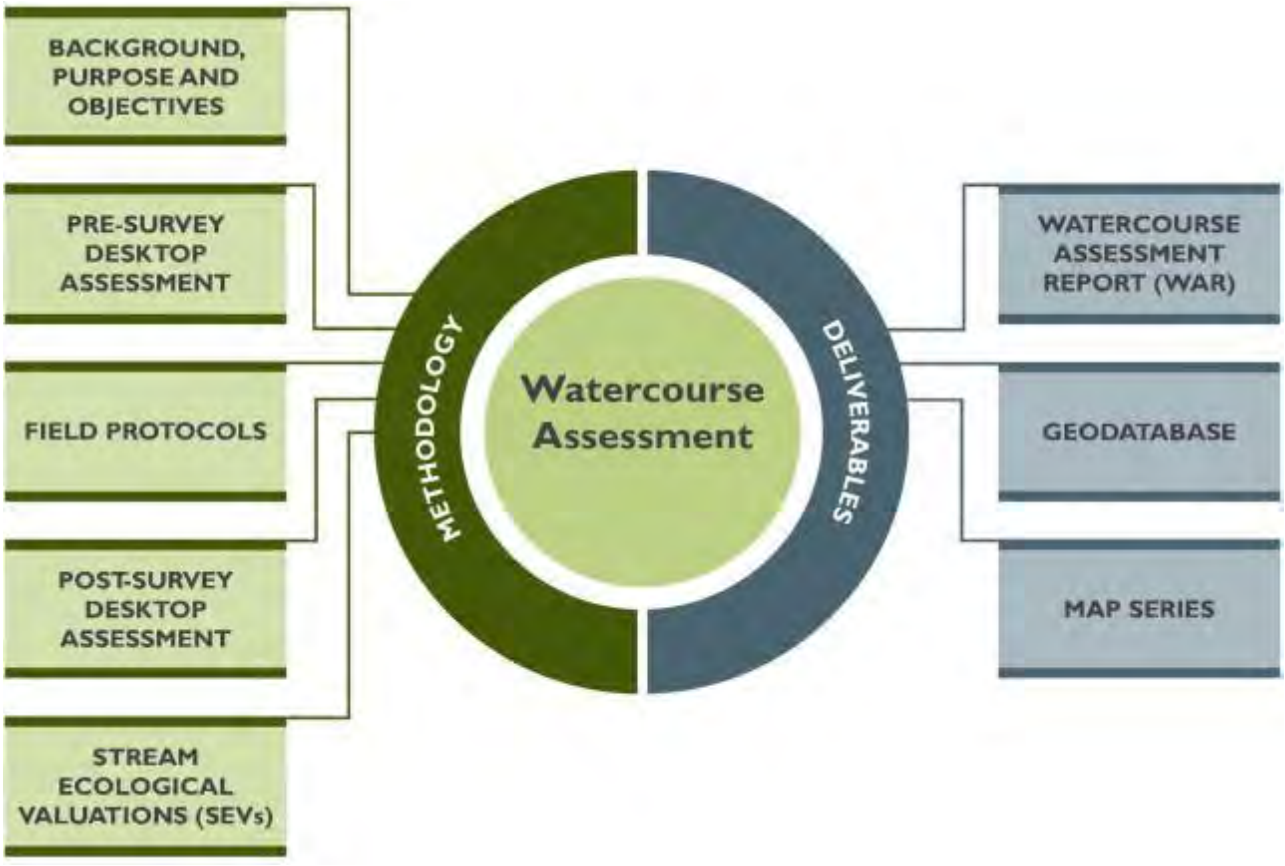



**Figure 1: Watercourse Assessment Structure**

## 1.2 Limitations

The only watercourses which were surveyed were those within the scope. The methodologies implemented and the scope are such that there is potential that streams may have been missed and that only portions of some streams are assessed.

### 1.2.1 Identified Options

Auckland Council is not obligated to undertake any works identified as enhancement or management options identified, 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 Council's obligations, constraints, drivers, project identification, and catchment prioritisation undertaken or identified by Auckland Council.

### 1.2.2 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.

### 1.2.3 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.

### 1.2.4 Rapid Assessment Methodology

It is acknowledged that the Watercourse Assessment Methodology is a 'rapid' assessment of engineering assets as well as biological and geomorphological stream state for the purpose of 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).

## 1.3 Relationship to prior watercourse assessments

This assessment builds on the watercourse assessment undertaken by Morphum and reported on in 2009. It should however be noted that the methodologies have developed over the interim period and that data from the 2009 study may not be able to be directly compared or collated with this study.

# 2.0 Literature Review

A review of existing plans and documentation for the Eastern Bay and Glendowie catchments highlights three main issues relevant to the two urban central catchments:

- Localised flooding issues during or following heavy rainfall.
- Poor stormwater quality measured in the coastal environmental. Heavy metals zinc, copper and lead are the most prevalent contaminants of concern.
- High concentrations of enterococci in marine environment following heavy rainfall. The upgrades to the network and ongoing maintenance has improved water quality issues associated with enterococci concentrations in the marine environment (Auckland Regional Council, 2006).

The review also highlights strategic plans and works which have been undertaken to address these issues across the Ōrākei area.

## 2.1 Overview of Existing Management Plans

The stormwater pipes in the Eastern Bay catchment were installed before 1940 and are amongst the oldest in the region (Auckland Council, 2015). Given new growth in the wider Auckland region, there are opportunities to improve stormwater infrastructure. The Auckland Council Stormwater Asset Management Plan 2015–2045 states that stormwater services in areas with degrading or outdated stormwater infrastructure should be improved to address existing and potential issues associated with growth, flooding and adverse environmental effects in streams and coastal areas (Auckland Council, 2015). These issues are particularly relevant in the Eastern Bays and Glendowie catchments.

A masterplan has been developed within the Ōrākei Local Board Plan 2011 policy framework 'Priority Five: Sport fields that meet our needs' which includes a masterplan for Crossfield Reserve, Glover Park and Madills Farm. The key objectives of the masterplans are to identify demands and need for green spaces and spaces for recreational use in the area (Eastern parks masterplan, 2012).

### 2.1.1 National Freshwater Policy Statement

The National Policy Statement for Freshwater Management (NPSFM) provides direction on how local authorities should carry out their responsibilities under the Resource Management Act 1991 for managing fresh water. Regional councils are required to implement the NPSFM in their policies, plans and programmes. The NPSFM introduces a range of new responsibilities and requirements including the identification of freshwater management units, development of freshwater accounting and monitoring frameworks for defined values and attributes, and the introduction of freshwater specific objectives and limits (for both quality and quantity) into planning frameworks.

The information and data from this report contributes to current state assessments and opportunities required to accomplish the NPSFM. Recommendations made within this section (and the report as a whole) can inform the NPSFM process in terms of identifying remedial options, however the recommendations also need to be considered in terms of the outcomes from the NPSFM process itself, including community values and cost/benefit analysis.

### 2.1.2 Auckland Unitary Plan – Operative in Part

The Auckland Unitary Plan provides the primary regulatory framework to manage Auckland's natural and physical resources whilst enabling growth and development in the region. The Unitary Plan supersedes the previous Auckland Regional Policy Statement, Auckland Regional Plans, and Auckland Council District Plans. The Unitary Plan has also introduced interim guidelines for managing the adverse effects of activities on freshwater and coastal waters in accordance with the National Policy Statement for Freshwater Management.

To this effect, discharges, subdivision, use, and development should be managed to maintain or enhance water quality where the existing condition is above the national bottom lines and Macroinvertebrate Community Index (MCI) Guidelines, or to enhance water quality where the current condition is below these guidelines.

### 2.1.3 Local Plans

The 2017 Ōrākei Local Board Plan outlines a strategic three-year plan to outline the prioritises and preferences of the community. The plan outlines five key outcomes to guide work between 2017–2020. These outcomes are:

- Local parks and open space areas are valued and enjoyed.
- Residents are proud of their community facilities and public places.
- People can move around the area easily and safely.
- The natural environment is valued, protected and enhanced by our communities.
- A thriving economy which supports local businesses and town centres.

The management zones and enhancement opportunities identified in this watercourse assessment report aim to align with these five key outcomes.

## 2.2 Catchment Overview

The Eastern Bays catchment encompasses a total area of 6.03 $km^2$ and is drained primarily by Mission Bay Stream, Kohimarama Stream and the Dingle Dell Stream (Figure 2). The Glendowie catchment is 4.3 $km^2$ and is primarily drained by Glendowie Stream and Tāhuna Tōrea Stream (Figure 2). The Eastern Bays and Glendowie catchments are situated within the Tāmaki Ecological District. They are on a heavily urbanised isthmus between the Manukau and Waitematā Harbours, have high imperviousness and lie within one of the most modified ecological districts in New Zealand. Few areas of indigenous vegetation remain, Dingle Dell Reserve being the largest in the catchment. The two catchments have fragmented watercourses which are interspersed with old stormwater infrastructure, with the pipe network in Eastern Bays dating back to the 1940s.

The Central Eastern Bay and Glendowie catchments are developed areas dominated by urban land use with a number of open green spaces. The Glendowie catchment has 20% public open space land use. In the Auckland Unitary Plan, they are designated as residential – large lot zone and mixed housing urban zone. The catchments are heavily developed, with the 50.5% impervious area in the Eastern Bay catchment and 37.9% impervious in the Glendowie catchment (Table 4 and Table 5).

### 2.2.1 Geology

The geology of the area is detailed on the Geological Map of New Zealand Map 3, Auckland (1:250,000 scale) (Edbrooke, 2001). This shows the area to be predominantly underlain by mudstone and graded sandstone of the East Coast Bays formation of the Waitematā Group (Edbrooke, 2001). Auckland Volcanic Field deposits are shown near Taylor Hill and Saint Heliers. Recent deposits of the Tauranga Group are also present adjacent to the beaches at Mission Bay, Kohimaramara and St Heliers (Edbrooke, 2001). The Waitematā Group comprises alternating siltstone and sandstone that weathers in the top 5m to 8m to form silt and clay with varying sand content (Edbrooke, 2001).

The Auckland Volcanic Field comprises ejecta deposits ranging in size from ash and lapilli, through to pebble to bounder sized basaltic fragments, with inclusions of comminuted country rock (Edbrooke, 2001). The deposits usually consist of unconsolidated beds of very angular to rounded, well sorted dense to very vesicular basalt and basanite fragments (Edbrooke, 2001). Finer grained ash and lapilli deposits usually weather to produce very soft sandy clays to around 2m depth (Edbrooke, 2001).

The Tauranga group comprises recent alluvium that are usually deposited in a river or estuarine environment (Edbrooke, 2001). It is variable in composition with unconsolidated sand, silt, mud and clay with local gravel

and peat beds (Edbrooke, 2001). While not shown on the geological map, recent alluvial deposits may also be located around watercourses and low-lying areas (Edbrooke, 2001).

The surface soils within the watercourses will generally comprise clay, silt and sand deposits which are only weakly consolidated. They can therefore be easily eroded by hydraulic action and abrasion.

### 2.2.2 Coastal Receiving Environment

The Eastern Bays receiving environment has arguably the most popular urban beaches in central Auckland: Mission Bay, Kohimarama and Saint Heliers which are situated in the Waitematā Harbour. With equal popularity, Glendowie discharges into the Tāmaki Estuary which is of both ecological value and is a key transport corridor for Auckland. Ultimately, the coastal receiving environment is the Hauraki Gulf. Long-term monitoring of 43 sites in the Hauraki Gulf indicates that the Tāmaki Estuary has poor and declining benthic health and water quality due to elevated heavy metal concentrations (Seachange, 2014). Continued positive action is required catchment wide to mitigate pressures of erosion and sedimentation on the receiving environment.

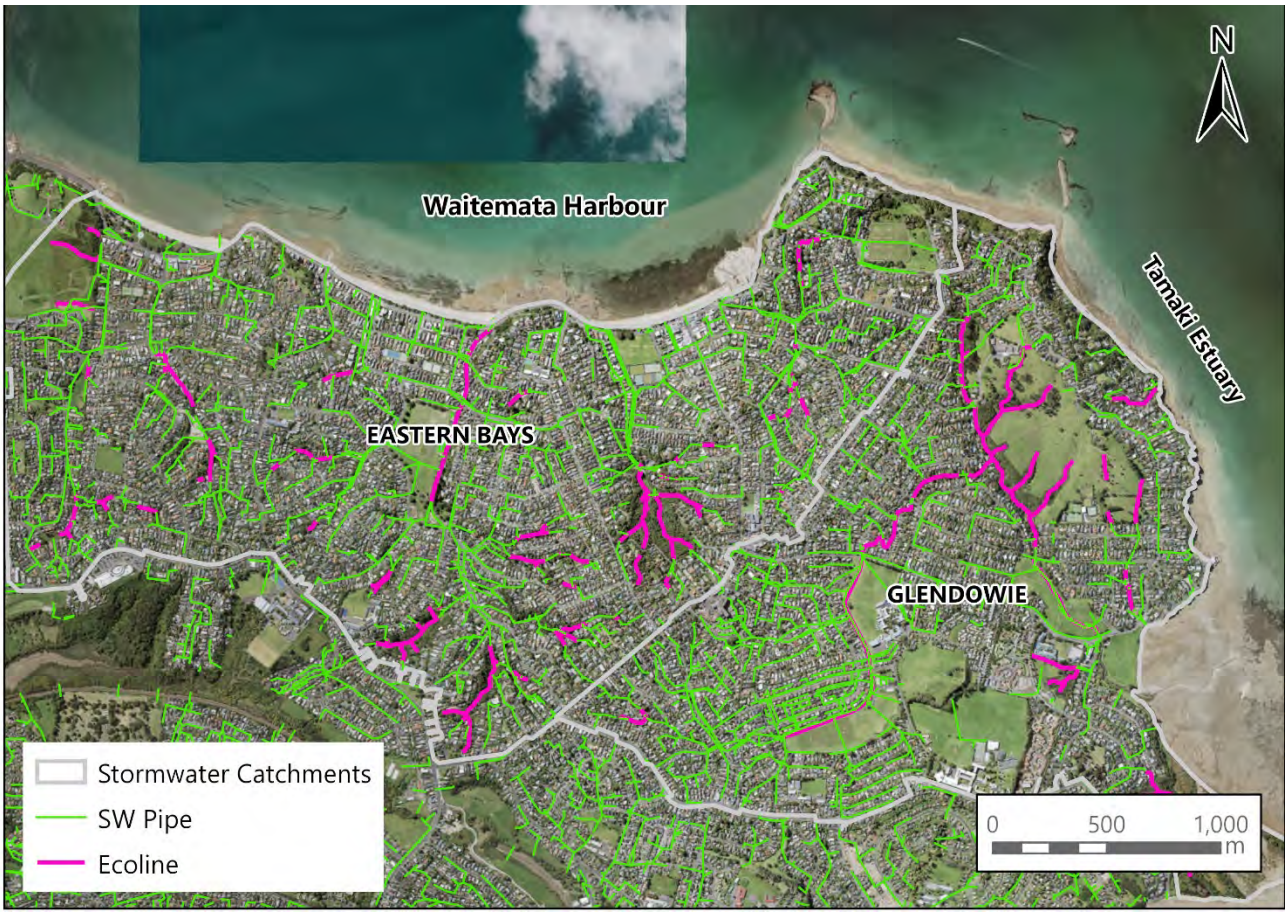



**Figure 2: Overview of the Survey Area: Eastern Bays and Glendowie Catchments.**

| Table 4: Eastern Bays Catchment Overview | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Catchment Area (km²)** | **6.03 km²** | | | | | | | |
| **Geology** | Waitematā Sandstone | | | | | | | |
| **Imperviousness** | 51% | | | | | | | |
| **Land Use Type** | **Public Open Space** | **Rural** | **Residential** | **Business** | **Special Purpose** | **General** | **New Growth** | **Coastal** |
| **Land use (% catchment)** | 10 | 0 | 70 | 1 | <1% | 18 | 0 | <1% |
| **Receiving Environment** | Waitematā Harbour and Hauraki Gulf | | | | | | | |

| Table 5: Glendowie Catchment Overview | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Catchment Area (km²)** | **4.3km²** | | | | | | | |
| **Geology** | Waitematā Sandstone | | | | | | | |
| **Imperviousness** | 38% | | | | | | | |
| **Land Use Type** | **Public Open Space** | **Rural** | **Residential** | **Business** | **Special Purpose** | **General** | **New Growth** | **Coastal** |
| **Land use (% catchment)** | 19 | 0 | 59 | <1% | 5 | 14 | 0 | 3 |
| **Receiving Environment** | Tāmaki Estuary, Waitematā Harbour and Hauraki Gulf | | | | | | | |

## 2.3 Catchment Development

By 1840, the Auckland Isthmus had been cleared of native forest and contained a mixture of shrub-land, bracken, and regenerating pockets of forest. Historic imagery shows that by 1940 much of the native vegetation in Eastern Bays and Glendowie catchments had been cleared for pastoral land use (Eastern Parks Masterplan, 2015, Figure 3 and Figure 4). By the 1940s, much of the vegetation in the Eastern Bays catchment was constrained to gully pockets around Madills Farm and residential land use dominated the catchment. In the 1940s, the residential land use was occurring largely along the coastal cliffs in Glendowie with the majority of the catchment remaining predominately rural. Today, rural land use is restricted to Churchill Park in the Glendowie catchment which functions as a "working farm park" with cattle grazing in the park.

As per Singers *et al*. (2017), the remaining remnant vegetation predominately consists of coastal broadleaved forest dominated by pohutukawa (*Metrosideros excelsa)* and puriri (*Vitex lucens)*. The IUCN threat status of this vegetation type is endangered in the region (Singers *et al*. 2017). As such, significant efforts have been undertaken to protect this cliff vegetation with the designation of Tāmaki Drive as a cultural heritage site and the development of groups such as The Tāmaki Drive Protection Society whose main objective is to promote the protection and preservation of Tāmaki Drive and Ōrākei Ward for its amenity, ecological, economic and transport value.

The remaining green spaces in the central Eastern Bay catchment include sports and recreational fields and the terrestrial Significant Ecological Areas; Dingle Dell Reserve (SEA_T_6186) and Whenua Rangatira (SEA_T_6138). These areas are designated as significant ecological areas due to representativeness and threat status. The two sites are predominately regenerating native forest dominated by regenerating coastal forest. The two vegetation communities are *Leptospermum* and *Cordyline/Melicytus*.

The Glendowie catchment consists of nine SEA situated along the coast- extending from Ladies Bay to Tāhuna Tōrea Nature Reserve. These SEAs are described in section 2.6 below.

The watercourses situated within Roberta Reserve (SEA-M1-49d) and Tāhuna Tōrea (SEA-M1-49c) drain into receiving environments designated as marine significant ecological areas. These areas are important breeding sites for wading birds.

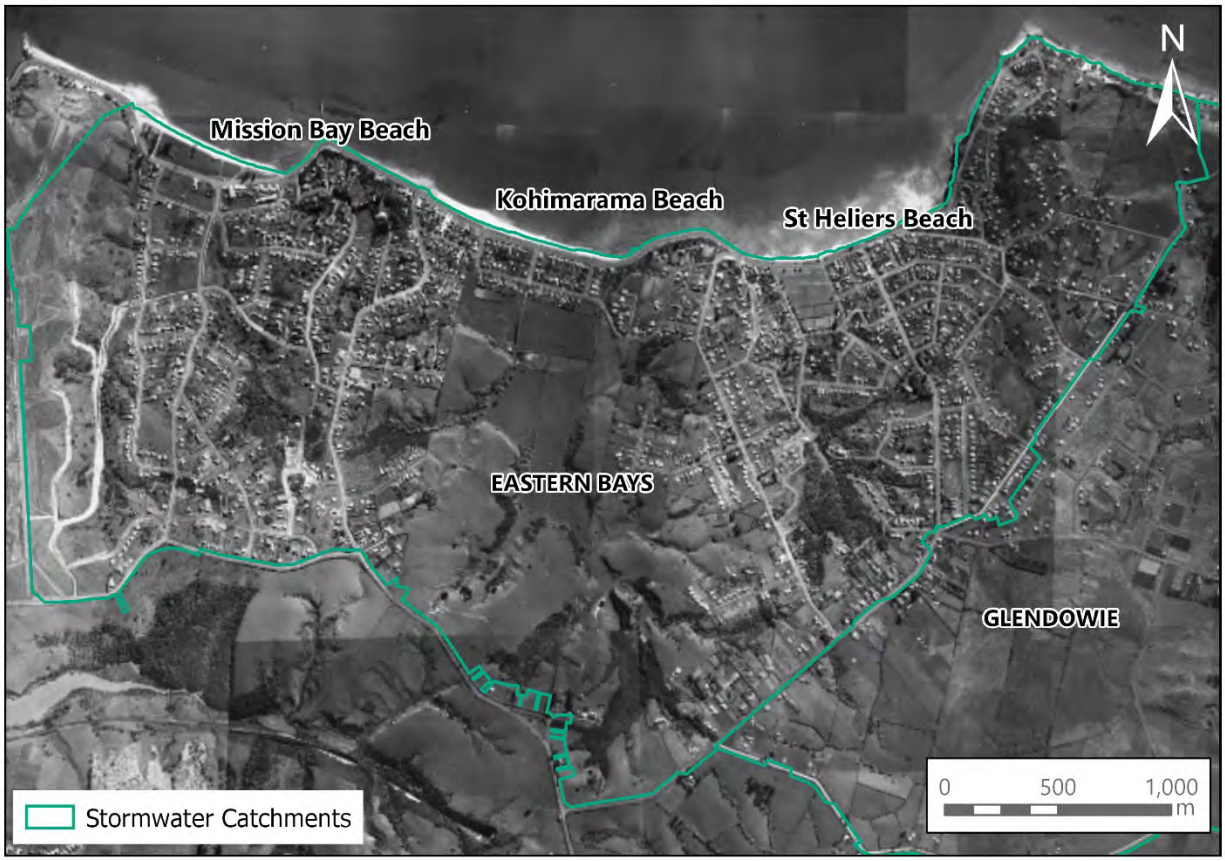



**Figure 3: Historic aerials showing the Eastern Bays catchment in 1940 with mixed urban and pastoral land cover. Note the vegetated gully areas around Madills Farm.**

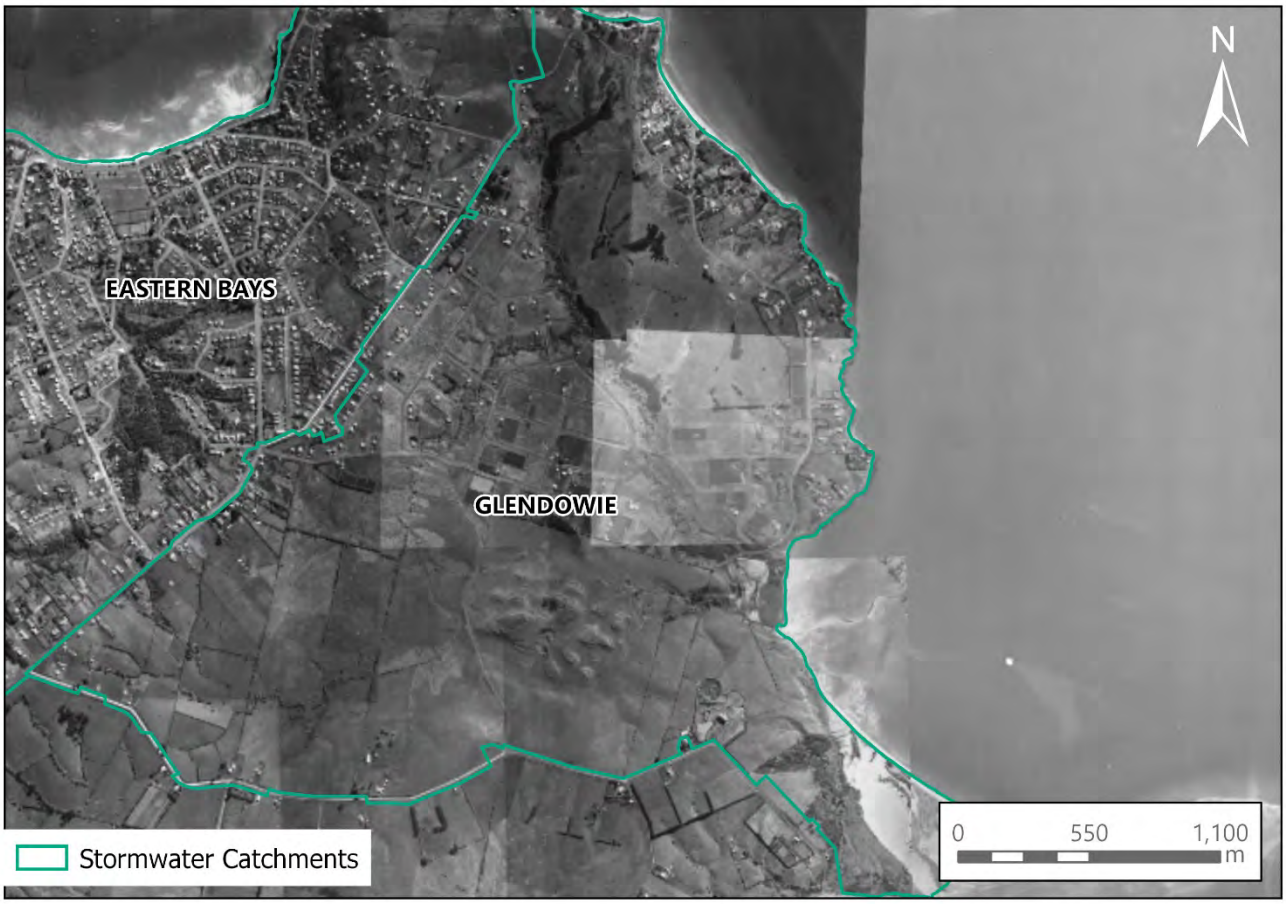



**Figure 4: Historic aerial photography showing the Glendowie catchment in 1940, dominated by pastoral land cover.**

## 2.4 Prior Watercourse and Erosion Assessments

A summary of previous watercourse assessments in the two catchments is summarised below. To date, most watercourse assessments have focused on addressing localised erosion issues around stormwater assets.

Between 2009-2010, Morphum Environmental undertook a stream erosion survey in Kohimarama Stream and adjoining tributaries (Morphum Environmental, 2010). The survey found severe erosion throughout the upper reaches of the stream, likely due to the steep topography and the soft underlying geology. The reaches had good canopy cover but groundcover was lacking or dominated by invasive weeds such as *Tradescantia* sp.

Additional erosion issues have been previously identified in these catchments. In the Central Eastern Bay catchment, Morphum undertook localised erosion mitigation option assessments at 34 Comins Crescent to mitigate existing erosion issues and provide resilience against future issues for the private property.

In 2010, 20 stormwater inlets located in the Mission Bay and Kohimarama catchments were inspected as part of maintenance works. Of these inlets, 5 were in excellent condition, 9 were in good condition, and 1 let was in poor condition requiring urgent attention (Morphum, 2010).

Morphum Environmental has also been engaged by Auckland Council to address flooding issues in the Central Eastern Bay catchment. During intense stormwater events the Kohimarama Stream flowing through Madills Farm Reserve overtops leading to flooding of land on private properties in the area. The upgrade of a large culvert at Melanesia Road in 2016 and improved connectivity to outlets at Kohimarama Beach was undertaken to improve the stormwater network.

Morphum was engaged by Auckland Council, in conjunction with Ngāti Whātua Ōrākei (NWŌ) to provide detailed design for erosion protection and stream naturalisation of a section of open watercourse at Atkin Avenue located near the mouth of the MIS_TRIB1_1 (Appendix 1, Map ). The project aimed to naturalise the stream and provide erosion protection on both banks, particularly important on the TRB which is near private residential properties (Morphum Environmental, in draft 2019).

### 2.4.1 Auckland Council Environmental Monitoring

Auckland Council have undertaken monitoring of 10 small stormwater outlets within the Eastern Bays area between Ōkahu Bay and St Heliers Beach between 2001 and 2003 to record hydrographic and enterococci concentration data over time. This monitoring found that there was a significant increase in enterococci concentrations following rainfall events. At one outfall, enterococci concentrations increased from 2,000 MPN/mL to 12,000 MPN/mL during rainfall events (Oldman, Tuckey and Walker, 2015). Auckland Council stormwater quality monitoring has identified a large suite of chemical contaminants washing from urban catchments including heavy metals, particularly zinc, copper and lead, and organic compounds including polycyclic aromatic hydrocarbons, herbicides, and hydrocarbons (Oldman, Tuckey and Walker, 2015). Long-term stormwater quality monitoring at Mission Bay indicates high zinc, copper and lead concentrations (ANZECC, 2000 and Oldman, Tuckey and Walker, 2015). Galvanised iron roofing is likely to be greater source of lead, with road run-off a relatively small source of zinc (Oldman, Tuckey and Walker, 2015).

Auckland Council's State of Environment reporting indicates that the Ōrākei area has a freshwater quality grade of E due to poor water quality, low habitat quality and biodiversity (SoE Report card, 2016). The Ōrākei area, which encompasses the study catchments, has 57% impervious cover which is very high when compared to the regional average of 9% (SoE Report card, 2016). Glendowie Stream and Kohimarama Stream both have long-term Auckland Council State of Environment freshwater quality monitoring sites (SoE Report card, 2016).

### 2.4.2 Safeswim and Safe Networks Programmes

Morphum was engaged by Auckland Council Healthy Waters in 2017 to undertake validation sampling of the Safeswim contract recreation forecasting model. The forecasting system simulates tidal and wind-driven currents to predict how contaminants will be circulated throughout the Waitematā Harbour. This model calculates the quantity of contaminants that might be discharged and simulates the discharge from key overflow outlets. Model simulations are carried out every 12 hours using the latest three-day forecasts of rain and wind provided by MetService.

To validate the model, 10 sampling days were carried out at each of 9 beaches throughout central Auckland. During each sampling day three runs were undertaken at three transects along the beach, each with three samples. The results were collated into average value per run per transect. The overall average value for the beach was found for each run, giving 30 average samples of enterococci concentration per beach. The study showed that all beaches had high enterococci during wet weather and these were over Ministry of Environment guidelines for contact recreation (MfE, 2011, Figure 5). Herne Bay, St Heliers and Pt Chevalier having the highest results in the study (Figure 5). Since 2018, the Healthy Waters programme, Safe Networks has been undergoing water quality investigations in the Eastern Bays and Glendowie catchments (*Pers Cores*).

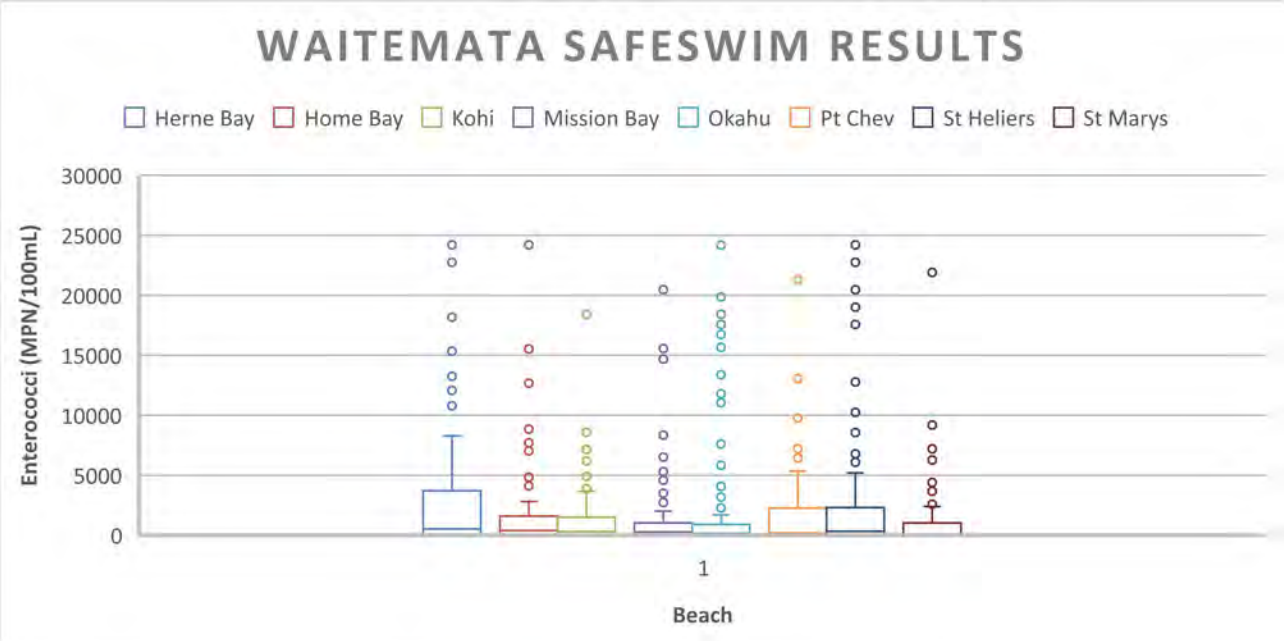



**Figure 5: Comparison of marine bacteria (enterococci MPN/100mL) across eight central Waitematā beaches (Morphum, 2017).**

## 2.5 Other Ecological Surveys

In collaboration with DHI New Zealand, Auckland Council used a calibrated hydrodynamic model to quantify the dynamics of stormwater discharges along the Eastern Bays area. The modelling showed the potential for increased saline intrusion into stormwater systems under future sea level rise scenarios. From a planning perspective, the report recommended undertaking a probability analysis to understand the impact of extreme rainfall and sea level rise on stormwater infrastructure and flooding in the area.

An ecological survey of the vegetation community at Dingle Dell Reserve in the Central Eastern Bay catchment was undertaken by Esson (n.d). The survey found that the regenerating coastal forest consists mainly of two communities, the *Leptospermum* communities on the ridgelines and broadleaf communities in the gullies. Ti kouka (*Cordyline australis*) and mahoe (*Melicytus ramiflorus*) dominates as a canopy species and *Pseudopanax* dominants among the seedlings (Esson, n.d.).

A survey and quantification of cliff top Pohutukawa forest in the Ōrākei Ward was undertaken by Wildlands in 2016. Desktop and field surveys found that indigenous-dominated vegetation is the most abundant vegetation types; with pohutukawa forest making up to 64% of the total area surveyed. It is acknowledged that much of this indigenous vegetation is amenity planting; with the exotic weeds including pampas grass (*Cortaderia selloana*), boneseed (*Chrysanthemoides monilifera*), sweet pea shrub (*Polygala dalmaisiana*), and gorse (*Ulex* sp.) dominating the understorey. These planted areas are maintained by the not-for-profit Tāmaki Drive Protection Society (Wildlands, 2016).

## 2.6 Significant and Existing Ecological Values

Significant Ecological Areas (SEAs) are identified based on their values for representativeness, threat status and rarity, diversity, stepping stones, and overall uniqueness in accordance with Schedule 3 of the Unitary Plan. These factors are summarized below:

- Representativeness – example of an indigenous ecosystem that contributes to the 10% of the natural extent of each of Auckland's original ecosystem types in each ecological district.

- Threat Status and Rarity – Habitat that has been assessed using the IUCN threat classification as threatened, habitat of threatened fauna or flora, indigenous vegetation in LENZ IV <20%, indigenous vegetation within indigenous wetlands or dunes.
- Diversity – Extends across at least one environmental gradient, supports a typical species richness or species assemblage for its type.
- Stepping Stones Migration pathways, buffers – facilitates movement of fauna across the landscape, buffer for protection areas, part of a network of sites that cumulatively provide habitat.
- Uniqueness/Distinctiveness – fauna or flora endemic to the Auckland region, unusual combinations of species, type localities, intact sequence of outstanding condition, largest specimen or population.

The terrestrial SEAs within the Central Eastern Bay and Glendowie catchments and the criteria that they meet are summarised below in Table 6. The SEAs areas in the Central Eastern Bay catchment are mostly small, remnant and regenerating pockets of native forest dominated by *Leptospermum* and *Cordyline/Melicytus* communities.

Urban remnants such as the SEAs in the two catchments, despite the presence of exotic vegetation, tend to have disproportionately high ecological values, given the small percentage of forested area in the urban matrix. These values include important local habitat for native flora and fauna, erosion and flood control, and maintaining the quality of water draining into Auckland's Harbours (Goldwater, 2015).

The Glendowie catchment has seven marine SEAs situated along the coast within the Tamaki Estuary – extending from Ladies Bay to Tāhuna Tōrea Nature Reserve and two adjacent, one on Musick Point (SEA-M2-50a) and on the pest free Browns Island (Motukorea, SEA-M2-96).

Of the seven within the Tamaki Estuary, three have a Type One (M1) designation (vulnerable to adverse effects of inappropriate subdivision, use and development) for protection of the wading bird roosts and for Tāhuna Tōrea spit which has a complex diversity of freshwater, terrestrial and marine habitats (SEA-M1-47, 49c and 49d). Tāhuna Tōrea is designated a SEA due the shellfish beds in the sand spit and banks which are a feeding ground for wading bird species as well as diverse habitat types including salt marsh and salt meadow, mangrove forest, seagrass meadows, sublittoral seaweed fringe, estuarine mud and rocky shores (Hayward and Morley, 2005). The entire Tāhuna Tōrea spit is also a designated coastal natural character area (142) and an outstanding natural feature (197). The Tamaki River East Roost is home to the nationally critical shore plover, nationally vulnerable Caspian tern, Banded dotterel and Wrybill as well as other declining wading bird species (Lee, 2019).

The remaining type 2 SEAs in the Tamaki Estuary are designated for the protection of threatened wading bird species and their feeding grounds; intertidal shellfish beds and shell banks. As well as mangrove, saltmarsh and salt meadow habitat sequences, which are biogenic habitats providing the building blocks of the ecosystems in this area (SEA-M2-48 and 49a, SEA-M2-49w1 and 49w3).

Eastern Bays has no marine SEAs in the immediate receiving environment, however, is near Hobson Bay which is a designated significant ecological area (SEA-M2- 51a and b, SEA-M2-51w1). The site is valuable as breeding habitat for a variety of shag species as well as a foraging habitat for shags and other coastal and wading birds. The open mud and sand flats not covered by mangroves are also a designated significant wading bird area. Around 48 bird species have been observed using mangrove habitat, including 'At Risk' or 'Threatened' species including; banded rail, pied oystercatcher, and pied shag (Bell & Blayney 2017).

**Table 6: Significant Ecological Areas in Central Eastern Bay and Glendowie catchments (Schedule 3 SEA - Terrestrial Schedule, 2016)**

| Significant Ecological Area | Catchment | Nearest Ecoline | Representativeness | Threat Status and Rarity | Diversity | Stepping Stone / Migration pathway / Buffer | Uniqueness or distinctiveness |
|---|---|---|---|---|---|---|---|
| SEA_T_6186 | Eastern Bay | KOH_MAIN_13 | | ✓ | ✓ | | |
| SEA_T_6138 | Eastern Bay | MIS_TRIB1_1 | ✓ | ✓ | ✓ | | |
| SEA_T_6183 | Eastern Bay | DIN_MAIN_8 | ✓ | ✓ | | ✓ | |
| SEA_T_6181 | Eastern Bay | KOH_TRIB6_1 | ✓ | ✓ | | ✓ | |
| SEA_T_6180 | Eastern Bay | KOH_TRIB7_1 | ✓ | ✓ | | | |
| SEA_T_6179 | Eastern Bay | KOH_TRIB4_1 | ✓ | ✓ | | | ✓ |
| SEA_T_6146 | Glendowie | STH_TRIB1_3 | ✓ | ✓ | ✓ | | |
| SEA_T_6153 | Glendowie | STH_TRIB1_5 | ✓ | ✓ | ✓ | | |
| SEA_T_6155 | Glendowie | STH_TRIB1_5 | ✓ | ✓ | ✓ | | |
| SEA_T_6165 | Glendowie | STH_TRIB1_2 | ✓ | ✓ | | | |
| SEA_T_6114 | Glendowie | KAR_MAIN_1 | ✓ | ✓ | | | |
| SEA_T_6117 | Glendowie | GEE_MAIN_2 | ✓ | ✓ | | | |
| SEA_T_6116 | Glendowie | GEE_MAIN_2 | ✓ | ✓ | | | |
| SEA_T_6187 | Glendowie | GEE_MAIN_2 | ✓ | ✓ | | | |
| SEA_T_5250 | Glendowie | STH_TRIB1_2 | | ✓ | ✓ | ✓ | |

## 2.7 Cultural and Heritage Values

This report does not attempt to cover the history and cultural associations and values within the rohe of each iwi and the summary presented here should not be considered in lieu of appropriate consultation for any subsequent enhancement opportunities or projects.

The Tāmaki area has a rich history from early Māori and European settlement to modern tourism, recreation and coastal living. The following section discusses the various cultural and heritage values of the Eastern Bays and Glendowie catchments.

**Pre-European History:**

The iwi (tribes) of the Tāmaki region were well placed to take advantage of the trade routes; north / south across Tāmaki Makaurau (Auckland) and the network of waterways between Manukau and Waitematā Harbours (Waiotaiki, 2018). The Tāhuna Tōrea sandspit and mudflat area was a traditional food gathering site for local Hapū, whose people collected shellfish, fish and birds (Waiotaiki, 2018). The remnants of historic Māori fish dams in the upper lagoon of the Tāhuna Tōrea Reserve are one of only five remnants of this type in the Auckland region (Morphum, 2016, Figure 6).

Up to 2,000 people lived in a strongly fortified pā on the slopes of the volcanic cone Te Taurere (Taylors Hill). Extensive horticulture was also performed by the Tāmaki iwi who planted over 2,000 hectares of kumara gardens and is believed to have been the dominant land use at the time between 1600 and 1750 (Waiotaiki, 2018).

**Figure 6: Tāhuna Tōrea Fish Dams circa 1976.**

**European History:**

European settlement began in the 1850s with residential development beginning in the early 1880s. Prior to European settlement, Māori occupied the area as it was of strategic significance. Its commanding views over the entrance to the Waitematā Harbour made it a key site for the defence of Māori settlements and later of Auckland City. Land which had formerly belonged to the Ngāti Whātua iwi had been acquired cheaply for public works many decades before. Ngāti Whātua gifted part of the central Tāmaki isthmus to the Crown, expecting that European settlement would bring trade and protection from hostile tribes. Much of the area, now known as Glendowie and Glen Innes was settled by William Innes Taylor. Taylor took up farming on the land and eventually his farm occupied two-thirds of the residential area now known as Glen Innes (Figure 7). By the beginning of the 20th century farmer families such as Taylors eventually sub-divided and sold land back to the Crown (Waiotaiki, 2018).

Important landmarks in the Eastern Bays and Glendowie area include:

- Bastion Point.
- Trevor Moss Davis Memorial Fountain.
- Tāhuna Tōrea.
- Parks such as Madills Farm Recreational Reserve, Mary Atkin Reserve, Kohimarama Beach Reserve, Sage Road Reserve, Dingle Dell Reserve, Glover Park.

**Figure 7: Historic imagery from 1920. Looking south from West Tāmaki Head showing Glendowie and Glen Innes in the foreground and Mouth Wellington in the background. Image derived from Auckland Libraries, Sir George Grey Special Collections, 4-4560.**

## 2.8 Community Involvement

The Tāmaki Drive Protection Society is a locally elected not-for-profit organisation whose main objective is to promote the protection and preservation of Tāmaki Drive and Ōrākei Ward for its amenity, ecological, economic and transport value. The society are involved in planting, weeding and pest management in the green spaces in the Eastern Bay catchment. The Tāmaki Estuary Protection Society and local iwi (Ngāi Tai ki Tāmaki) protected the Tāhuna Tōrea Nature Reserve from being turned into a land fill (Tāhuna Tōrea Mangrove Management plan, Morphum 2016).

Tāhuna Tōrea Rangers are a volunteer group involved in the restoration of the Tāhuna Tōrea Nature Reserve (Figure 8). The Reserve sites on a long sandbank extending into the Tāmaki Estuary.

**Figure 8: Looking North over Tāhuna Tōrea wetland (Drone Morphum 2016).**

# 3.0 Watercourse Management

## 3.1 Management Zones

Management Zones are overarching descriptions of reaches with similar pressures and issues. The purpose of the Management Zones is to summarise key values, assessments, and recommended actions at a high level to guide unified management across the catchment and wider central Auckland area.

In the survey area, a total of five management zones were identified using the criteria outlined in the Watercourse Assessment Methodology: Infrastructure and Ecology (version 2). Each management zone consists of reaches with similar pressures and issues, channel morphology, channel and bank modifications, extent of erosion and riparian vegetation types (Table 7). The key issues and management objectives for each management zone are detailed in Sections 3.2-3.6.

General outcomes sought through the identification of the six management zones include:

- Protection and enhancement of areas of significant habitat.
- Protection of natural drainage through the catchment.
- Protection from reclamation and diversion of watercourses.
- Managed removal of exotic riparian species to maintain ecological functions and replace with native species.
- Remediation of fish passage barriers.
- Improve ecological value of watercourses while maintaining conveyance function.

There is a need to integrate coastal and catchment management where the planning and management of catchments considers their coastal receiving environments (Feeney and Gustafson, 2010). Integrated management should consider Interdecadal Pacific Oscillation (IPO) patterns (affecting sea level, extreme tides, rainfall, storms, winds and sea temperatures), ongoing sea level rise and climate change effects (Bell *et al.*, 2017). Catchment management of erosion and sediment should consider climate change effects, as higher intensity storms lead to higher sediment runoff. These events unmanaged, could increase in stream erosion and result in higher sediment loads being deposited in coastal receiving environments (Hart, 2011). Protection from and resilience to the adverse effects of climate change can be achieved through embedding appropriate mechanisms and actions into planning decisions.

For urban land use, an overarching management approach is outlined below with reference to mechanisms to achieve ecological enhancements. This is to be achieved through sustainable development/management through the Auckland Unitary Plan or alternatively through community engagement initiatives.

### 3.1.1 Overarching Recommendations for Urban Land Use

Most of the common pressures on watercourses within the Eastern Bays and Glendowie is impacted by the surrounding urbanised land use and intensified residential development. The most common issues in the survey area are:

- Fragmented and highly modified open watercourses;
- Low shading and poor temperature regulation of watercourses due to the clearance of riparian vegetation;
- Conveyance demands and localised flooding of sports fields and private properties (gardens) during rainfall events;
- Water quality contamination issues associated with wastewater;
- Fish passage barriers on private and council owned assets; and
- Aging stormwater network and localised erosion associated with stormwater assets.

Additional overarching recommendations that should be considered within development processes, based on the results of this baseline survey, are also outlined below.

*Terrestrial Ecological Outcomes*

- Use of native tree planting (e.g. street trees) to extend and connect existing riparian networks.
- Protection and enhancement of areas of significant habitat, as well as incorporating buffers to protect sensitive habitats, improve weed control, and facilitate natural regeneration processes.
- Removal of litter and debris to support wider ecological functioning and amenity.
- Support the development of conservation corridors to promote ecological connectivity.
- Support local community group objectives and efforts to preserve and enhance native ecosystems, including private stream management.
- Maintain existing native vegetated and SEA areas in the catchment.
- Implementation of weed and pest control programs for restored reaches with infill planting of native species where large areas of weeds are removed. This includes the possible supply of weed collection bins for certain times in the year.

*Freshwater Ecological Outcomes*

- Strongly advocate for adherence to the principle of avoidance of development impacts to preserve remaining open watercourses, both permanent and intermittent, within the survey area.
- Streams and wetlands in the catchment are only to be piped and culverted in exceptional circumstances where no other practical alternative exists. Any diversion of watercourses should consider the groundwater recharge implications and maintain pre-diversion hydrology and habitat.
- For essential stream crossings, bank-to-bank bridges with minimal riparian and stream bed disturbance are preferred.
- Enhancement of streams and wetlands, especially those with no riparian vegetation, to a minimum of 10m width on both banks, preferably more were practicable.
- Removal of exotic riparian species (such as willows and poplars) and replace with native species to a minimum of 20m width on both banks where practicable.
- Monitor stream bank erosion post development and remedy or mitigate identified erosion impacts.
- Removal of barriers to fish passage, through removal/retrofitting of culverts.

*Stormwater Outcomes*

- Advocate for best practice stormwater management controls in accordance with the principles identified for Flow 1 areas (AUP E10) in consideration of observed erosion susceptibility.
- Provide stormwater management to mimic as far a practical the pre-development hydrology.
- Best practice water sensitive design devices including rain gardens, swales, rain tanks and permeable pavements to reduce impacts of increased stormwater from development in the catchment.
- At source (or as close as possible) stormwater management methods are preferred. Where specific site constraints require centralised devices, their proposed efficiency should be considered.
- Stormwater design should, where required and following reasonable mitigation measures, consider erosion protection due to the nature of the watercourses being susceptible to erosion.
- Treatment of high contaminant generating areas.
- Promote reduced soil compaction during development and promote infiltration options.
- Encourage sensitive design that incorporates minimising impermeable areas and sediment control, particularly during development.
- Empower communities through sharing water sensitive design and environment information and actions.

**Table 7: Common pressures across management zones in the Eastern Bays and Glendowie catchments**

| Pressure | Description | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Bank erosion susceptibility** | Increased sediment deposition resulting in habitat changes, loss of interstitial space, reduced availability of food supply and reduced spawning habitat for fish species<br>Increased suspended sediment impacts macroinvertebrate feeding and damages fish gills<br>Increased suspended sediment increases temperatures and thus lowers dissolved oxygen | | | ✓ | | |
| **Loss of riparian margin vegetation** | Reduced shading and thermal regulation | ✓ | | ✓ | | ✓ |
| | Reduced bank stability | ✓ | ✓ | ✓ | | ✓ |
| | Reduced filtering capacity | ✓ | ✓ | ✓ | | ✓ |
| | Reduced habitat and spawning habitat | | | ✓ | ✓ | |
| | Reduced riparian corridor connectedness and ecological connectivity | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Reduced amenity and aesthetic values | ✓ | | ✓ | ✓ | ✓ |
| **Drainage and piping of freshwater systems** | Limited or prevented interaction with groundwater | ✓ | | ✓ | ✓ | ✓ |
| | Loss of habitat | ✓ | | ✓ | ✓ | ✓ |
| | Reduction in organic material retention as a food source | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Reduction in particle retention for the assimilation of nutrients, protecting downstream receiving environments | | | | | |
| | Change in flow regime | | | | | |
| | Potential barriers to fish passage | ✓ | | ✓ | ✓ | ✓ |

| Pressure | Description | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Online farm / amenity ponds** | Reduced base flows in streams during summer months<br>Increase stream temperatures<br>Reduced dissolved oxygen levels<br>Preferential habitat for exotic fauna and flora<br>Change in flow regime<br>Potential barriers to fish passage | | | | | |
| **Fish passage barriers** | Impacts on fish recruitment, abundance and population dynamics | | | ✓ | ✓ | ✓ |
| **Urban development pressures** | Change in land use and the associated contaminants of concern<br>Increased erosion, stream silt load and siltation of the Waitematā Harbour and Tāmaki Estuary, particularly during development<br>Increased imperviousness and associated changes in hydrograph and impacts on watercourses including increased potential for channel erosion and reduced base flows<br>Loss of riparian vegetation<br>Loss of first and second order streams, and wetlands through piping, diversions and altered topography<br>Further potential barriers to fish passage with the development of more roads, private accessways, and associated culvert structures<br>Increased fragmentation of natural vegetation areas reducing ecological connectivity | ✓ | ✓ | ✓ | ✓ | ✓ |

## 3.2 Management Zone 1 – Vegetated Gully Pockets.

*Tributaries*

Management Zone 1 (MZ1) includes reaches located in steep gully areas, often in the upper reaches of the sub-catchments in the Eastern Bays. Refer to Map 7 in Appendix 1 for the location of these reaches in the survey area.

*Characteristics:*

The reaches in MZ1 are characterised as narrow, meandering channels with soft, eroding lower banks located predominately in the upper reaches of Eastern Bays. The natural topography and the dense riparian vegetation provide good shading over the stream channels. The surrounding riparian vegetation in the gully is dominated by noxious weeds such as wild ginger (*Hedychium gardnerianum*), privet (*Ligustrum sinense*) and nasturtium (*Tropaeolum majus*). However, it is important to note that this exotic vegetation provides ecological services in addition to the shading, organic inputs in the form of leaf litter, and habitat substrates such as woody debris to the stream.

The stream hydrology in these reaches includes some natural riffle run sequences and deeper pools with potential for fish spawning habitat. However, due to the severe erosion and mass wasting, no stable undercuts banks were recorded. Shortfin eels (*Anguilla australis*) were recorded along two reaches in this management zone during the field survey (MIS_TRIB4_1 to 5).

The land ownership of these gully areas is largely private so there are opportunities to engage residents and landowners through initiatives led by the Ōrākei Local Board. Local Board overarching objectives outlined in Ōrākei Local Board Plan include maintaining and improving green spaces and water quality. These actions should focus on urban stream management e.g. improvements for riparian planting and water quality, reducing litter dumping in the stream and on banks as well as weed plant and pest removal. These actions promote the enhancement of amenity and ecological values of the watercourses and more efficient conveyance of stormwater flows. For instance, debris jams caused by tires and other large rubbish cause channel constrictions and the development of scour pools over time, exacerbating erosion scarring in the channel. Litter dumped in the upper reaches of these sub-catchments has the potential to reach the ultimate receiving coastal environment and adversely impact water quality.

Specific issues and management objectives for Management Zone 1 are shown in Table 8 below.

Erosion scarring on lower banks, noxious weed groundcover along KOH_MAIN_16.

Low baseflow and exotic riparian cover along KOH_TRIB7_2.

**Figure 9: Representative reaches in Management Zone 1.**

| Table 8: MZ1 Issues and Objectives | |
|---|---|
| **Specific Issues** | **Suggested Objectives and Actions** |
| Erosion issues for Auckland Council owned assets on private land. | Local Board initiatives which guide landowners on how to manage watercourses on their properties and water sensitive design principles.<br><br>Encourage actions such as keeping stream clear of obstructions e.g. fences, walls, improvements to channel shape and planting with floodplain tolerant riparian vegetation.<br><br>AC owned assets that require maintenance or potential issues such as fish passage barriers should be addressed.<br><br>Opportunities to provide guidance to landowners on minimal maintenance of stormwater structures; debris removal, fish passage and maintenance of erosion mitigation structures such as rock rip rap. |
| Dense weed infestations and widespread litter and rubbish in the stream channel. | Local board-led initiatives supporting residents who are actively involved in the maintenance and restoration of streams on private property through funding initiatives e.g.<br>• Offering discounted rates on native plants and herbicides,<br>• Services such as 'weed bins' which manage the collection and disposal of green waste.<br><br>These initiatives would encourage residents to manage their local watercourses. |
| Moderate bank erosion - as assessed using the Pfankuch scores and percentage of erosion scarring on channels. | Use of appropriate riparian stream species along riparian margins to retain soils and stabilise banks (as described in the Auckland Council Streamside Planting Guide).<br><br>Guidance on the placement of rock at the toe of bank on outside bends as erosion protection.<br><br>Weed plant management should be managed to minimise the area of bare soil during restoration planting.<br><br>Align with objectives of Sea Change, the Hauraki Gulf Marine Spatial Plan to set catchment sediment load limits to minimise adverse impacts on water quality. |

## 3.3 Management Zone 2 – Intact Riparian Vegetation Corridors.

*Tributaries:*

The reaches in Management Zone 2 (MZ2) are in the large public reserves of Dingle Dell Reserve (Eastern Bays), Churchill Park and Tāhuna Tōrea (Glendowie). Refer to Map 7 in Appendix 1 for the location of these reaches in the survey area.

*Characteristics:*

The reaches in MZ2 have good instream habitat and intact riparian vegetation dominated by native plant species.

The reaches in Churchill Park have mixed canopy cover with some sections dominated by mature, exotic pine (*Pinus* sp.) and bamboo (Bambusoideae), whilst other reaches are dominated by species such as kohekohe (*Dysoxylum spectabile*), karaka (*Corynocarpus laevigatus*) and kanuka (*Kunzea ericoides*). Collectively, this riparian vegetation provides good shading of the stream channel and stabilisation of banks. The water clarity was noted as good (i.e. the stream bed was clearly visible) and several fish observations were recorded in the area. These fish survey points included areas of potential good fish habitat such as gradual sloping banks with dense groundcover vegetation overhanging the stream, as well as actual records of observed fish in the channel. Most noticeably, approximately 15 eels of variables sizes were observed in one pool (GLE_MAIN_6). However, it was also noted that there are a series of weirs between GLE_MAIN_2 and GLE_MAIN_8 which are a complete fish barrier to swimming fish species.

The reaches in Churchill Park have considerable amenity value as there are walking paths which run adjacent to the stream and enable the public to engage with the stream. The TRB is private land and some reaches have been modified with the construction of foot bridges and removal of riparian vegetation.

Similarly, the reaches in Dingle Dell Reserve have good riparian cover and amenity values. Many of these streams flow adjacent to walking tracking and under bridges where the public have opportunities to view and engage with the stream.

The reaches in Tāhuna Tōrea are in an area of high ecological value. Here, 'high ecological value' refers to the heterogenous in-stream and riparian habitats. These reaches have intact riparian cover extending more than 20m latitudinally along most sections and is dominated by native species. These reaches are composed of a mixture of intermittent and permanent streams and dominated by native vegetation on both banks. The vegetation is composed of native species which are commonly used in restoration planting such as kanuka (*Kunzea ericoides*), flax (*Phormium* spp.) and ti kouka (*Cordyline australis*), as well as native wetlands sedges such as purei (*Carex secta*) and toetoe (*Austroderia fulvida*). Community groups and local iwi, particularly Ngāti Whātua are actively involved in the management of Tāhuna Tōrea.

The ecological and cultural values of these reaches is recognised by Council and iwi, and Morphum has previously worked in collaboration with these stakeholders to undertake an options assessment for the management of mangroves in the historic fish dams (Morphum, 2016).

Due to their location in the urban environment, these reaches have erosion issues associated with flash flows, and mass wasting.

The reclamation or further modification of reaches in this management zone should be strongly avoided. Protecting and enhancing the watercourses in this management zone is important in urban catchments which have been piped and modified.

| Table 9: MZ2 Issues and Objectives | |
|---|---|
| **Specific Issues** | **Suggested Objectives and Actions** |
| Extensive modification of the stream channel through the construction of a series of fish passage barriers (weirs) in Churchill Park. | Investigate the remediation of potential fish passage barriers of the reaches in Churchill Park (refer to EO4) for further detail.<br>Working with landowners who share property boundaries with Churchill Park to provide guidance on maintaining the ecological health of these waterways. |
| Impacts of the surrounding land use including densification of residential housing around the park and pollution incidents. | Two pollution incidents were observed at Dingle Dell Reserve. A strong chloride smell and cloudy odour was observed at the outlet SAP ID: 2000382206 and two dead banded kokopu were found downstream in Dingle Dell Stream (Tributary ID: DIN_MAIN_3). It is unknown whether the incidents are related.<br>Advocate for local board initiatives provide guidance for 'what goes down drains' and the impact of the potential pollutants on water quality downstream.<br>Establish or support Water Sensitive Communities and Water Sensitive Schools Programmes particularly at nearby schools and private properties adjoining the reserves. |
| Enhancing and protecting the habitats in the Tāhuna Tōrea wetland.<br>Shoreline on eastern side of Tāhuna Tōrea wetland is eroding from wave energy from storms and peak tides. Coastal inundation of this wetland is reducing the size salt marsh habitat that is available for endangered coastal birds. | Support/implement predator control initiatives to protect endangered coastal birds e.g. banded rail and Australasian bittern.<br>Protect coastal wetland from coastal inundation and predicted sea level rise through beach nourishment programmes and fish friendly flap gate or weir control on southern end of wetland by bridge. |

Good riparian cover, meandering channel morphology and in-stream habitat heterogeneity along reaches in Dingle Dell Reserve (Tributary ID: DIN_MAIN_3).

Native dominated riparian cover in Tāhuna Tōrea (Tributary ID: TAH_MAIN_FORK_2).

**Figure 10: Representative reaches in Management Zone 2.**

## 3.4 Management Zone 3 – Highly Modified Watercourses

*Tributaries:*

Management Zone 3 includes reaches located across both catchments. Refer to Map 7 in Appendix 1 for the location of these reaches in the survey area. The tributary codes for reaches in this management zone are MIS_TRIB1_1 to MIS_TRIB3_1.

*Characteristics*

Management Zone 3 is comprised of reaches which are severely modified through extensive bank and channel lining (Figure 11). The management zone also includes piped reaches which have open watercourses upstream and downstream, and high potential for improving ecological and hydrological connectivity. The reaches in this zone have efficient stormwater conveyance and act as effective drains for diverting flows away from the surrounding impervious surfaces to the receiving environments.

Where channels are open, there is little to no riparian vegetation along the watercourse corridors. The set-back of residential dwellings and driveways from the watercourse is typically less than 10m and in some areas less than 5m. Bank and channel modification such as straightening, widening and use of high retaining bank lining has been implemented to contain flows within the channel.

In the urban environment, with land use restrictions, there are limited opportunities to extend the riparian corridor or improve floodplain connectivity using soft-engineering approaches such as battering banks and using rock rip-rap or planting wide (>5m) riparian buffers. However, there are opportunities to enhance the instream habitat with the installation of rock riffles (cross vein weirs) whilst maintaining the primary function of these channels - to direct flows away from the urban environment.

Where sections of stream are piped on public land, with upstream and downstream habitat, there are opportunities to improve ecological and hydrological connectivity through daylighting. Specific areas for potential daylighting have been proposed in the Enhancement Opportunities (6.0). The feasibility of these reaches for daylighting requires detailed hydrological modelling and land surveying.

**Figure 11: Typical examples of reaches in Management Zone 3. Concrete lined channels with timber bank lining on the upper reaches of the Glendowie Stream (GLE_TRIB4_9 left, GLE_TRIB4_5 right).**

| Table 10: MZ3 Issues and Objectives | |
|---|---|
| **Specific Issues** | **Suggested Objectives and Actions** |
| Little to no riparian cover along stream channels. | Where land is available, infill planting with native species could improve ecological function of the riparian vegetation and help regulate stream temperatures and provide organic inputs.<br><br>Opportunities for bank lining remediation and planting of banks exist on GLE_MAIN_5. |
| Poor freshwater ecological instream habitat. | Investigate improving in-stream habitat heterogeneity through the addition of rocks, small cross vein weirs or woody material in the channel. These structures would increase the bed roughness, reducing water velocities and provide potential refugia sites for aquatic biota. These roughness elements would need to be secured in the channel to prevent washing downstream or creating blockages.<br><br>Consider naturalising stream channels on Glendowie Stream (GLE_TRIB4_3) while the ensuring that peak conveyance is provided within flood prone areas and flood plains. |

## 3.5 Management Zone 4 – Coastal Watercourses.

*Tributaries:* Tidally influenced watercourses, identified as two of the stream mouths in the survey area. The tributary codes for reaches in this management zone are KOH_MAIN_1 to KOH_MAIN_5.

*Characteristics:*

Management Zone 4 consists of tidally inundated reaches which are at the interface between the freshwater and coastal habitats (Figure 12). Approximately 2 km of open watercourse in the survey area was observed to be tidally influenced. These areas were identified in the watercourse assessment as stream mouths. The upper limit was identified using indicators like estuarine crab holes, road culverts and other stormwater assets (e.g. bridges). The lower limit of the four stream mouths was identified as the widening of the channel where it flows to the beach. Except for one section of stream mouth (Glendowie Stream, downstream of GLE_MAIN_1), the channels were heavily modified with lined channel beds and banks.

The coastal reaches located along KOH_MAIN 1 to KOH_MAIN_4, Mission Bay sub-catchment stream mouth are concrete lined with narrow riparian margins.

The tidally influenced reaches of the Glendowie Stream (GLE_MAIN_1).

**Figure 12: Coastal reaches (tidally inundated and assessed as stream mouths) typical of Management Zone 4.**

| Table 11: MZ4 Issues and Objectives | |
|---|---|
| **Specific Issues** | **Suggested Objectives and Actions** |
| Heavily modified channels with lined channel beds and banks. | Improvements to potential in-stream habitat by installing naturalised riffle run sequences for fish migrating upstream. |
| Recreational water quality on Mission Bay and St Heliers Beaches is comprised of several engineered overflows, including three major outfalls sampled as part of this assessment (Pipe SAP IDs: 2000567272, 2000514361, 2000372551), possible cross connections, exfiltration from wastewater network or uncontrolled overflows (popping of wastewater manholes). | Further investigation required for the source of anecdotal wastewater issues in catchment e.g. capacity in network vs maintenance (root intrusion, broken pipes or cross connections).<br>Suggest that this is undertaken through the Auckland Council Safe Networks programme. |
| Limited inanga spawning habitat in Eastern Bays and none in Glendowie catchments. | Inanga spawning habitat enhancement of KOH_MAIN_11 in Madill's Farm Recreational Reserve. Enhancement planting with native vegetation e.g. flax (*Phorium tenax*), toetoe (*Cortadaria richarii*) raupō (*Typha orientalis*) and other sedges (Juncus sp.) (see EO6).<br>It is recommended that restoration planting within this zone includes vegetation known to be preferred by inanga for spawning and that specific monitoring for inanga eggs is carried out during the spawning season. Regrading and/or bioengineering of bank topography to allow for inundation of riparian vegetation will further enhance inanga spawning habitat. |

## 3.6 Management Zone 5 – Isolated Streams

The reaches in Management Zone 5 are located on private and Auckland Council land. These open watercourses are surrounded by an extensive piped network and the length of open watercourses in this management zone ranges from 6m to 80m. The vegetation extent is greater than the vegetation extent of reaches in Management Zone 3. However, the vegetation type was predominately noxious weeds and garden species such as *Agapanthus*, arum lily (*Zantedeschia aethiopica*) and morning glory (*Ipomoea indica*).

The specific issues related to these watercourses includes; localised flooding of land beside streams reported by residents, debris jams and the deposition of sediment and litter washed from upstream piped networks. It is recommended that the principle of avoidance is strongly adhered to, to preserve remaining open watercourses within the catchment.

Encourage land owners to consider low-maintenance methods of enhancing streams where possible.

**Table 12: MZ5 Issues and Objectives**

| Specific Issues | Suggested Objectives and Actions |
|---|---|
| Localised erosion issues associated with Council owned assets on private land. | Local Board initiatives which guide landowners on how to manage watercourses on their properties, actions such as keeping streams clear of large debris, and retaining or enhancing vegetation along banks. |
| Dense weed infestations. | Local Board initiatives which support the weed and pest control programme and provide services such as 'Weed Bins' to collect and dispose of green waste, like projects in West Auckland run in collaboration with organisations such as EcoMatters. |

Modified reach along KOH_TRIB3a_6.

Erosion along GLE_TRIB4_12 with bank lining.

**Figure 13: Representative reaches in Management Zone 5**

# 4.0 Summary of Findings

Watercourse assessments for the Eastern Bays and Glendowie catchments were undertaken between March 2019 and May 2019. Refer to Map 1 in Appendix 1 for an overview of stream names and tributary codes referred to in following sections and throughout the report.

The general character and physical variables for these reaches are described in sections, 4.1 below and summarised in Table 14. Refer to Maps 3 and 4 for an overview of bank and channel modification and erosion issues. Additional information on stormwater infrastructure and channel stability is outlined in sections to 4.8 and 4.9.

General patterns in riparian condition are outlined in 4.1.3 section and summarised in Table 14. The dominant vegetation cover type in the survey area is scrub (Table 17: Summary of riparian vegetation across the extent of watercourse surveyed). This scrub vegetation is attributed to the surrounding urban land use, consisting of residential gardens largely dominated by amenity garden planting and noxious weeds such as wild ginger (*Hedychium gardnerianum*). Public green spaces such as Dingle Dell Reserve and Tāhuna Tōrea were the only areas that had continuous riparian vegetation that consisted of remnant native vegetation.

Relative to open, agricultural streams, the percentage of macrophyte and periphyton cover was low across the two urban catchments. While the percentage of shading from riparian vegetation was limited along some of the reaches, the surrounding buildings and infrastructure contributes to the overall shading of these channels.

Refer to Appendix 1: Map 5 for an overview of overhead cover, significant ecological areas, and notable trees.

Additional information on freshwater ecological values including habitat types, fish communities and barriers to fish passage, the marine receiving environment, and wetlands are outlined in sections 4.1.4 to 4.7. Refer to Appendix 1 Map 6 for an overview of locations of fish observations and recorded barriers to fish passage.

## 4.1 Ecoline

The Eastern Bays catchment encompasses a total area of 6.03 km$^2$ and is drained primarily by Mission Bay Stream, Kohimarama Stream and the Dingle Dell Stream. The Glendowie catchment is 4.3 km$^2$ and is primarily drained by Glendowie Stream and Tāhuna Tōrea Stream. A total of 1.1 km of overland flow paths (OLFPs) were surveyed but have been excluded from ecoline analysis as per the watercourse assessment methodology. A summary of reaches and the length of watercourses surveyed is summarised in Table 13.

**Table 13: Summary of reaches and length of watercourses (including OLFPs) within each of the catchments in the survey area.**

| | Number of reaches | Length of watercourse (km) | Percentage of the survey area |
|---|---|---|---|
| **Eastern Bays** | 155 | 8.07 | 58 % |
| **Glendowie** | 58 | 7.33 | 42 % |

### 4.1.1 Physical Attributes

The watercourses in the survey catchments are predominately soft-bottom streams dominated by silt and sand (Figure 14). 76% of the total assessed stream length has been recorded as having good Pfankuch upper bank stability. Natural modifications such as incision were also very common throughout both catchments, leading to bank instability and mass wasting, reflected in the 20% of the length of watercourse with a Pfankuch stability of fair or poor. One of the main drivers of reduced upper bank stability was poor quality bank vegetation.

Although these are urban catchments, there is stock damage in the Churchill Park reaches, as it is a working farm (Glendowie catchment). Several reaches have been greatly modified through residential development and high impermeable areas which appears to contribute to a large proportion of fine silt in deposited in stream and erosion scarring observed. The most common channel modification observed is bank lining and 19% of the surveyed stream length had some form of artificial bank lining (Table 14). The predominant land use is parks / open public spaces, followed by residential land use (Table 14).

**Eastern Bays**

A reach of Mission Bay Stream through residential properties with riprap as bank lining (MIS_TRIB4_3).

**Glendowie**

Upper reach of Glendowie Stream (GLE_TRIB6_1) that flows through Churchill Park.

Kohimarama Stream that is straightened through Madill's Farm Reserve (KOH_MAIN_8).

Lower reaches of Glendowie Stream (GLE_TRIB1a_1) are dominated by volcanic igneous bedrock on Taylors Hill.

Soft bottomed stream in Dingle Dell Reserve (DIN_MAIN_6).

Approximately 70 m of Karaka Bay Stream is lined with concrete and rip rap (KAR_MAIN_1).

**Figure 14: Representative examples of streams within the survey area.**

| Table 14: Summary of physical variables across the extent of watercourse surveyed | | | | | | |
|---|---|---|---|---|---|---|
| **Total Length of Surveyed Watercourse (m)** | 15,374 | | | | | |
| **No. Reaches** | 212 | | | | | |
| **Class** | **Permanent** | | **Intermittent** | | **OLFP** | |
| **% of total stream length** | 76 | | 17 | | 7 | |
| **length of stream (m)** | 11,630 | | 2,638 | | 1,106 | |
| | **Mean** | | **Min** | | **Max** | |
| **Reach Length (m)** | 62 | | 6 | | 271 | |
| **Average Width (m)** | 0.8 | | 0.1 | | 6.1 | |
| **Depth (m)** | 0.12 | | 0 | | 5 | |
| **Bank Angle (degrees)** | 67 | | 10 | | 90 | |
| **Bank Height (m)** | 0.75 | | 0.1 | | 3 | |
| **Sediment Deposition (% accumulation)** | 28 | | 0 | | 100 | |
| **Adjacent Land Use** | **Vegetation** | **Park** | **Agricultural** | **Residential** | **Light Industry** | **Impervious Surface** |
| % of total stream length | 5 | 59 | 0 | 35 | 0 | 1 |
| length of stream (m) | 1,404 | 16,846 | 0 | 10,010 | 0 | 276 |
| **Dominant Substrate** | **Artificial** | **Bedrock** | **Boulder** | **Cobble** | **Gravel** | **Silt/Sand** |
| % of total stream length | 4 | 3 | 1 | 2 | 5 | 85 |
| length of stream (m) | 579 | 472 | 111 | 215 | 737 | 12,154 |
| **Channel Modification** | **Widened** | | **Straightened** | **Deepened** | | **Lined** |
| % of total stream length | 0.5 | | 11 | 1 | | 19 |
| length of stream (m) | 77 | | 1,514 | 171 | | 2,752 |
| **Erosion Scarring** | **0%** | **≤20%** | **20-40%** | **40-60%** | **≥60%** | |
| % of total stream length | 10 | 44 | 29 | 13 | 4 | |
| length of stream (m) | 2,791 | 12,544 | 8,204 | 3,824 | 1,171 | |
| **Stock Damage** | **None** | **Minor** | **Moderate** | **Severe** | **N/A** | |
| % of total stream length | 2 | 1 | 2 | 0 | 95 | |
| length of stream (m) | 233 | 175 | 231 | 0 | 13,629 | |

*Note: Adjacent Land Use and Erosion Scarring is assessed separately for the TRB and TLB therefore the total length will be double the surveyed area. The reach summaries exclude intermittent streams, OLFP and desktop assessment reaches where parameters such as width and depth was recorded as the default 999.*

| Table 15: Summary of Pfankuch bank stability assessment of the total length of watercourse (m) | | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Fair** | **Poor** |
| **Land Slope (m)** | 1167 | 10718 | 1400 | 983 |
| **Mass Wasting (m)** | 734 | 11304 | 1675 | 555 |
| **Debris Jam (m)** | 10382 | 2251 | 1438 | 197 |
| **Bank Vegetation (m)** | 1180 | 2997 | 8685 | 1406 |
| **Overall Stability Index**<br>**% of total stream length**<br>**length of stream (m)** | 2%<br>236 | 76%<br>10,807 | 22%<br>3,168 | <1%<br>57 |

### 4.1.2 Water Quality Attributes

The most commonly recorded water quality issue in the survey area was anaerobic conditions (Table 16). The watercourses with anaerobic conditions were mostly located in reaches which had piped upstream and downstream reaches. At the time that the survey was undertaken, there had been little rainfall and these reaches were largely stagnant and iron bacteria was prevalent especially in outlets.

Water quality conditions were particularly poor in the reach MIS_MAIN_3 located in the Eastern Bays catchment, where sewage fungus, anaerobic and petroleum contamination observed in the reach. The resident at 50A Godden Crescent was on site at the time of survey and called Watercare to report the likely wastewater contamination issue.

| Table 16: Summary of watercourse contamination | |
|---|---|
| **Attribute** | **Number of observations** |
| Sewage Fungus | 1 |
| Petroleum/Hydrocarbons | 1 |
| Anaerobic Conditions | 7 |
| Other | 0 |

### 4.1.3 Biological Attributes

The dominant vegetation cover type in the survey area is scrub, low diversity vegetation dominated by weed species (Table 17). This scrub vegetation is attributed to the surrounding urban land use, consisting of residential gardens largely dominated by amenity garden planting and noxious weeds such as wild ginger (*Hedychium gardnerianum*). Public green spaces such as Dingle Dell Reserve and Tāhuna Tōrea were the only areas that had continuous riparian vegetation that consisted of remnant native vegetation.

Relative to open, agricultural streams, the percentage of macrophyte and periphyton cover was low across the two urban catchments. While the percentage of shading from riparian vegetation was limited along some of the reaches, the surrounding buildings and infrastructure contributes to the overall shading of these channels.

| Table 17: Summary of riparian vegetation across the extent of watercourse surveyed, excluding OLFPs | | | | | | |
|---|---|---|---|---|---|---|
| **Length of Surveyed Watercourse (m)** | | | | 14,268 | | |
| **No. reaches (Ecolines)** | | | | 213 | | |
| **Average Overhead Cover** | **≤10 %** | **≤30%** | **≤50%** | **≤70%** | **≤90%** | **>90%** |
| % of total stream length | 9 | 2 | 5 | 63 | 16 | 5 |
| length of stream (m) | 1250 | 354 | 772 | 8932 | 2245 | 715 |
| **Average Riparian Width** | **0m** | **≤5m** | **≤10m** | **≤15m** | **≤20m** | **>20m** |
| % of total stream length | 44 | 24 | 8 | 7 | 7 | 10 |
| length of stream (m) | 12477 | 6917 | 2338 | 1957 | 1874 | 2973 |
| **Vegetation Tier Categories** | **None** | | **Exotic** | **Mixed** | | **Native** |
| **Canopy** % of total stream length | 22 | | 12 | 51 | | 15 |
| length of stream (m) | 6363 | | 3390 | 14597 | | 4186 |
| **Understorey** % of total stream length | 20 | | 11 | 59 | | 10 |
| length of stream (m) | 5863 | | 3091 | 16853 | | 2729 |
| **Groundcover** % of total stream length | 2 | | 63 | 31 | | 4 |
| length of stream (m) | 679 | | 17727 | 8892 | | 1238 |
| **Dominant Vegetation Type** | **Grassed** | **Planted** | **Low Growing** | **Scrub** | **Regenerating** | **Mature** |
| % of total stream length | 17 | 10 | 2 | 56 | 14 | 1 |
| length of stream (m) | 4715 | 2863 | 594 | 16088 | 3921 | 355 |
| **Instream Vegetation** | **<20%** | | **20-50%** | | **>50%** | |
| **Emergent Macrophytes** % of total stream length | 53 | | 4 | | 2 | |
| length of stream (m) | 7557 | | 538 | | 264 | |
| **Submerged Macrophytes** % of total stream length | 48 | | 1 | | 2 | |
| length of stream (m) | 6792 | | 181 | | 242 | |
| **Green Filamentous Periphyton** % of total stream length | 4 | | 3 | | 0 | |
| length of stream (m) | 483 | | 408 | | 408 | |
| **Other Periphyton** % of total stream length | <1 | | 1 | | 0 | |
| length of stream (m) | 23 | | 171 | | 0 | |

*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.*

### 4.1.4 Habitat

The most common hydrological feature, recorded for the surveyed streams, was runs. Of all the watercourses assessed 64% were dominated by this habitat type (>70% total habitat). The greatest diversity of habitat was observed in Dingle Dell reserve (Figure 15, DIN_TRIB4_4, DIN_MAIN_6, DIN_TRIB4a_2, DIN_TRIB6,1), Glendowie stream in Churchill Park (GLE_MAIN_5, GLE_TRIB1_1) and Kohimarama stream (KOH_TRIB5b_2, KOH_TRIB5b_1), where the watercourse contained riffles, runs, pools and small cascades. However, these reaches lacked stable undercut banks and in stream fish spawning habitat.

At the time of survey, 3.1 km of reaches were completely dry. Many of these were classed as intermittent streams. A small number of historically permanent reaches were dry likely attributed to the less than average rainfall that fell in the months surrounding the survey. It is possible that there is a seasonal effect on habitat availability there may be more habitat available when the water table is higher and stream depth is deeper in winter (*Pers Obs*).

Overall, there was very limited habitat diversity, and very little fish spawning habitat (Table 18). There was only one area of potential inanga spawning habitat identified in the Eastern Bays catchment. There were no areas where potential inanga spawning habitat was found in the Glendowie catchment. Further detail on inanga spawning habitat is provided in section 4.6.

**Figure 15: Reach in Dingle Dell Reserve with gravel beds potentially suitable for fish spawning (DIN_MAIN_3).**

| Table 18: Summary of watercourse habitat diversity, excluding OLFPs | | | | | |
|---|---|---|---|---|---|
| **Attribute** | **Mean** | | **Min** | | **Max** |
| **Number of Habitat Types within reach** | 1.6 | | 1 | | 4 |
| **Fish Spawning Habitat present** | **In stream** | | **Bank** | | **In stream & Bank** |
| **Percentage of Reaches (length of stream)** | 5%<br>678 m | | 0% | | 0% |
| **Stable Bank Undercutting** | **None** | **Some** | **Moderate** | **Good** | **Extensive** |
| **% of total stream length** | 95 | 5 | 0 | 0 | 0 |
| **length of stream (m)** | 13575 | 693 | 0 | 0 | 0 |

*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 500m of reach with 'Good' undercutting then <50% of this total length is undercut. Refer to the methodology document for further details.*

## 4.2 Natural Structures

A total of five natural structures were identified within the Eastern Bays and Glendowie catchments. Three cascades were in Glendowie catchment and one cascade and waterfall in Eastern Bays in Kohimarama and St Heliers streams respectively. Of the two natural structures categorised as 'Not Safe', only one cascade on reach GLE_TRIB1_1 was on public land with moderate access (the other was in private land).

The following four partial and one temporary barrier are summarised below:

- A waterfall on Kohimarama Stream (KOH_TRIB5a_3) is a temporary barrier to fish passage surveyed; this was in a headwater sub-catchment and only affected 110m of upstream habitat.
- A cascade in Churchill Park (GLE_MAIN_9) is acting as a barrier to climbers affects 470m of upstream habitat.
- A cascade on Glendowie Stream tributary (GLE_TRI4_3) had high velocity at the time of survey, acting as a swimmer barrier for 1.1 km of upstream habitat.
- A cascade on a Glendowie Stream tributary (GLE_TRIB1_1), which was covered in the weed Morning Glory, is a partial barrier to swimmers, affecting 127 m of upstream habitat.
- A cascade on St Heliers Stream tributary is a partial barrier to swimmers and climbers, however, only affects approximately 30 m of upstream habitat.

| Table 19: Natural structure safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m | | | | |
|---|---|---|---|---|
| **Attribute** | | | | |
| **Total number of natural structures:** | | 5 | | |
| | | **Access** | | |
| **Not Safe** | | **Easy** | **Moderate** | **Difficult** |
| **Land Ownership** | Public | 0 | 1 | 0 |
| | Private | 0 | 0 | 1 |
| **Not safe, Drop >1.5m** | | **Easy** | **Moderate** | **Difficult** |
| **Land Ownership** | Public | 0 | 0 | 0 |
| | Private | 0 | 0 | 0 |

## 4.3 Fish Survey

A total of 19 fish observations were recorded in the survey area. Most of these observations (63%) were shortfin eels. The other fish recorded included banded kokopu, inanga and unidentified bully. One observation were recorded of a large school of inanga in the Glendowie Stream mouth (100 individuals). A single observation of mosquito fish was recorded in the KOH_MAIN_7 tributary. A shortfin eel was recorded in the Glendowie Stream (GLE_TRIB4_3). These observations are summarised in Table 20.

In addition to the species observed during the field survey, the New Zealand Freshwater Fish Database (NZFFD) records show data from other surveys and observations. The NZFFD shows two records in the Glendowie catchment and four records in the Eastern Bays. These are summarised below:

- In the Glendowie catchment, a population of 20 grass carp (*Ctenopharyngodon idella*) was recorded at Tāhuna Tōrea. The grass carp was introduced to New Zealand in the 1960s because of their potential to control the growth of aquatic plants (NIWA, 2018). The record shows a population of 30 banded kokopu was present at Dingle Dell Reserve. One observation of longfin eel was recorded downstream of Madills Farm. Lastly, records of banded kokopu were recorded at Aotea Reserve at MIS_MAIN_1.

Electrofishing at five 100m stream reaches found banded kokopu, shortfin eel at Churchill Park and Madills Farm. These results are described in the SEV section (5.0).

Direct comparison and quantitative measures of fish populations are not possible from these data sources. Consequently, fish distribution in the catchment is indicative only. A range of sampling techniques have been used, ranging from estimated abundance to direct counts.

**Table 20: Fish observed during the field survey of the Eastern Bays and Glendowie catchments**

| Common name | Scientific name | Eastern Bays | Glendowie |
|---|---|---|---|
| Shortfin Eel | *Anguilla australis* | 9 | 2 |
| Unidentified Eel | NA | 0 | 10 |
| Inanga | *Galaxias maculatus* | 102 | 0 |
| Banded Kokopu | *Galaxias fasciatus* | 2 | 0 |
| Unidentified Bully | NA | 0 | 3 |
| Mosquito Fish | *Gambusia affinis* | 20 | 0 |
| Unknown | NA | 0 | 20[1] |

[1]Likely mosquito fish.

### 4.3.1 Native Fish Distribution

Several native fish were recorded across the survey area, including banded kokopu, shortfin and unidentified bullies. These fish were recorded at Dingle Dell Reserve, Churchill Park and Madills Farm during the field survey and via electrofishing. Unidentified eels were recorded in the upper reaches of the Glendowie Stream (GLE_TRIB4_3) during the field survey.

### 4.3.2 Exotic Fish Distribution

There was a single observation of the invasive mosquitofish (*Gambusia affinis*) at Madills farm (KOH_MAIN_7). The NZFFD database indicates the exotic grass carp have been utilised in the Tāhuna Tōrea Reserve to manage exotic weed species in the wetland.

## 4.4 Barriers to Fish Passage

The presence of natural or artificial structures within the watercourse can prevent the upstream migration of native fish species and therefore significantly reduce the amount of habitat that fish have access to.

The degree of impact on particular species is largely due to their locomotory ability. This results in species such as inanga, which can only employ 'burst swimming' to get past in-stream barriers, being restricted by structures that would be passable by species that are able to climb using wetted margins, such as banded kokopu or eels.

All barriers to fish passage were classified into one of three categories (Swimmer, Climber or Anguilliform) according to the locomotory function of the fish that were likely to impede. Barriers to swimmers will affect species that are only capable of swimming (e.g. inanga, common bully), while barriers to climbers will also prevent species such as banded kokopu and redfin bully from migrating upstream. The most difficult instream barriers will also affect anguilliformes (adult eels), which are capable of traversing short distances across land between waterbodies.

### 4.4.1 Summary of Fish Passage Barriers.

The fragmented nature of the Eastern Bays and Glendowie catchment means that the streams are often separated by extended sections of the piped stormwater network. A total of 10.66km of open watercourse was affected by a fish passage barrier of some kind (complete, temporary or partial). A total of 104 structures were found to be some form of barrier to fish passage, with five of these being natural structures: cascades and waterfalls (Table 21). The quality of the habitat above fish barriers varies from reaches with deep pools, abundant stable undercut, good riparian vegetation, and overall good quality habitat such as those in the upper Glendowie Stream (GLE_MAIN_9) to reaches with few deep pools, highly modified stream bed and banks, no stable bank undercuts, sparse stream shading, and overall poor quality fish habitat (MIS_MAIN 3, MIS_TRIB5_3, KOH_TRIB8_3).

There were 22 miscellaneous points that acted as fish barriers in stream including debris jams, bridges and weirs (section 4.12). Generally, the weirs and other in stream engineering structures were on private land and appeared to be installed to create in stream riffles and pool habitats. In the upper reaches of Mission Bay Stream, there were a series of artificial rock cascades that are complete fish passage barrier affecting 280 m of upstream habitat (MIS_TRIB4_5 and MIS_TRIB4_6).

**Table 21: 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 | 0 | 0 | 1 |
| Barrier to Swimmers | 5 | 57 | 23 |
| Barrier to Climbers | 2 | 33 | 18 |
| Barrier to Anguilliformes | 1 | 17 | 5 |

*Note that barriers to swimmers, climbers, anguilliformes are not additive e.g. of 60 culvert barriers to swimmers, 35 of these were also barriers to climbers and 19 were also a barrier to anguilliformes.*

**Eastern Bays**

There are six key barriers to fish passage present within the Eastern Bays that are caused by artificial in-stream structures, and which currently restrict the upstream migration of native fish species:

1. The coastal outlet on the western end of St Heliers beach (2000582780) has a grill that is catching debris and preventing swimmers likely only during low tide. This affects 1.5km of upstream habitat within Dingle Dell reserve (1.58km) through 750m of stormwater network.
2. The most significant in terms of upstream habitat (affecting 1.58km of open watercourse with high quality habitat) was an Auckland Council owned inlet in Dingle Dell reserve (DIN_MAIN_2, 2000919661). A steep concrete ramp into the inlet was causing a barrier to swimmers but partial barrier to climbers and Anguilliformes.
3. 7a Atkin Ave (2000082507, 2000258552) stormwater pipe dry at low tide and is affecting 1.28km of upstream habitat.
4. A culvert at the bottom of Dingle Dell reserve (2000919661) has a steep slope and a drop of 1m preventing swimmers but not climbers to access the 1.63km of habitat upstream.
5. The culvert bridge in Dingle Dell reserve (EBS_004, EBS_005, EBSP_003) acts as a complete barrier to 440m of upstream habitat.
6. In the upper reaches of Mission Bay Stream, there were a series of naturalised rock cascades that are complete fish passage barrier affecting 280m of upstream habitat (MIS_TRIB4_5 and MIS_TRIB4_6).

Auckland Council owned St Heliers coastal outlet with grill to trap debris is a partial barrier to swimmers and is likley to be temporal due to tides.

Auckland Council owned inlet in Dingle Dell reserve (DIN_MAIN_2, 2000919661). A steep concrete ramp into the inlet was causing a barrier to swimmers.

**Figure 16: Fish Barriers associated with Auckland Council owned assets in Eastern Bays.**

**Glendowie**

There are three key barriers to fish passage present within the Glendowie Catchment that are caused by artificial in-stream structures, and which currently restrict the upstream migration of native fish species:

1. The Auckland Council owned coastal triple culvert on Glendowie Stream (GEE_MAIN_1, 2000621796, 2000816917 2000674479) which had a 0.04m drop from the apron to the coastal marine area/stream bed was affecting 550m of upstream habitat. This asset was assessed at low tide, so it is possible that it may be a temporary barrier that is tidally dependent (Figure 17).
2. An Auckland Council owned coastal outlet (2000473115) which discharges into the Glendowie Stream Mouth and coastal marine area has a 1m drop height across reno mattress into the channel bed. There is approximately 471m of open watercourse available upstream of this barrier however fish would have to swim up 118m of stormwater network (Figure 17).
3. A series of weirs present in Glendowie Stream (Tributary Code: GLE_MAIN_3) are causing complete barriers to a potential 760m of upstream habitat.

An Auckland Council owned asset (2000473115) is a complete barrier to fish passage. This pipe discharges into the Glendowie Stream Mouth and coastal marine area has a 1m drop height across reno mattress into the channel bed.

The Auckland Council owned coastal triple culvert on Glendowie Stream (GEE_MAIN_1, 2000621796, 2000816917 2000674479) which had a 0.04m drop from the apron to the channel bed.

**Figure 17: Fish barriers associated with Auckland Council assets in the Glendowie Catchment.**

## 4.5 Stream Mouths – Waitematā Harbour and Tāmaki Estuary

The Eastern Bays receiving environment has arguably the most popular urban beaches in central Auckland: Mission Bay, Kohimarama and Saint Heliers which are situated in the Waitematā Harbour. With equal popularity, Glendowie discharges into the Tāmaki Estuary which is of both ecological value and is a key transport corridor for Auckland. Ultimately, the coastal receiving environment is the Hauraki Gulf. Long-term monitoring of 43 sites in the Hauraki Gulf indicates that the Tāmaki Estuary, has poor and declining benthic health and water quality due to elevated heavy metal concentrations (Seachange, 2014). The Auckland Council state of environment report card gave the overall environmental health grade of D to the Tāmaki Estuary reflecting over a decade of sedimentation and contamination from urban areas (Auckland Council, 2016). Continued positive action is required catchment wide to mitigate pressures of erosion and sedimentation on the receiving environment.

Four stream mouths were assessed in the survey area, two in Glendowie catchment and two in Eastern Bays.

### 4.5.1 Glendowie Catchment and the Tāmaki Estuary

The Glendowie catchment drains via the Glendowie Stream (GLE_MAIN_1) and the Glendowie East Stream (GEE_MAIN_2) into the Tāmaki Estuary which is a low energy environment characterised by mudflats and mangroves (*Avicennia marina* subsp. *Australasica*).

The upper banks of the Glendowie Stream Mouth have been densely planted with native vegetation such as flax and manuka and fenced (Figure 19). The upper boundary of the stream mouth was identified as the upper limit of the mangrove forest at the culvert on Riddell Road (2000884658) and the lower limit is the pedestrian bridge to give access to Roberta Reserve. Modifications to the stream mouth include multiple stormwater outlets and bank lining for erosion protection such as gabion baskets and reno mattresses.

The Glendowie East Stream mouth is defined by the concrete apron of the triple box culvert under Riddell Road (Figure 18). A large Pohutakawa is situated on the TRB and the channel banks are defined by mangroves (*Avicennia marina* subsp. *Australasica*). Modifications to the stream mouth are gabion baskets on the TRB to protect bank from outlet erosion. It is likely that the mangroves are providing coastal erosion protection for these outlets as well as other important ecosystem services e.g. carbon sequestion, habitat for benthic and fishes and act as a primary producer in estuarine habitats (Linquist, *et al.,* 2017).

The Glendowie stream mouth looking towards the Tāmaki Estuary.

Glendowie East Stream Mouth looking towards Tāmaki Estuary.

**Figure 18: Glendowie catchment stream mouths.**

### 4.5.2 Eastern Bays and the Waitematā Harbour.

Two stream mouths were identified in the Eastern Bays catchment, located downstream of Mission Bay Stream (MIS_MAIN_1) and Kohimarama Stream (KOH_MAIN_1) (Figure 19). Both stream mouths are modified with straightened and lined channels.

The upper boundary of the Mission Bay Stream mouth was identified as twin box culvert (2000728182). The lower seaward boundary was identified as where the streams flow under the bridge on Tāmaki Drive between the seawall and Tāmaki Drive and out onto the western end of Mission Bay beach.

Long term water quality trends for the Waitematā show an improved water quality score over the last three years (Auckland Council, 2016c). However, it is noted that this is due to additional reference sites rather than an actual improvement in water quality (Auckland Council, 2016).

Mission Bay Stream mouth looking downstream towards Mission Bay Beach.

Kohimarama Stream mouth looking upstream towards Melanesia Road.

**Figure 19: Stream mouths in the Eastern Bays catchments**

## 4.6 Inanga Spawning

There was only one area of potential inanga spawning habitat were identified in the Eastern Bays catchment (Figure 21). There were no areas where potential inanga spawning habitat was found in the Glendowie catchment. In general, the tidally inundated reaches were artificially modified by bank and channel lining which restricted the available land on both banks of the stream that could be regraded and planted for spawning habitat.

The stream mouth of Mission Bay Stream (MIS_TRIB1_1) on Atkin Ave in the was initially identified as having potential for inanga spawning due its location in the catchment (tidally inundated) and approximately 50 m of riparian vegetation on the TLB of the reach. It is possible that the bank slope could be regraded to an angle of <10° and planted with native sedges and grasses. This would require vegetation removal. This is reach has recently been upgraded as part of the Atkin Ave stream naturalisation project. Due to budget constraints, these works focused on energy dissipation and replacing a failing timber retaining wall on the TRB with rip rap rather than regrading both banks for inanga spawning enhancement.

It is recommended that the following is undertaken in the future with consultation with Ngati Whatua Orakei (landowner):

- Planting of the small sandy area (6 m) with salt tolerant sedges (e.g. giant umbrella sedge *Cyperus ustulatus* and oioi/jointed wire rush *Apodasmia similis*) on the TLB of Mission Bay Stream mouth, opposite the triple box culverts (SAP ID: 2000048193, 2000359099 and 2000671763, see EO3 in section 6.0, Figure 20).
- Removal of existing brick bank lining on TRB (112 m) of the Mission Bay stream mouth (MIS_TRIB1_1), regrade bank and plant with salt tolerant sedges for inanga spawning enhancement.

**Figure 20: Potential area for inanga spawning enhancement in the Mission Bay stream mouth.**

A reach (KOH_MAIN_11) in Madill's Farm Recreational Reserve has the potential to be suitable for inanga spawning if planted with suitable vegetation e.g. sedges (*Juncus* sp.) and oioi/jointed wire rush *(Apodasmia similis*) (see EO6). This area was identified as potential inanga spawning habitat due to wide low gradient floodplains with grass and flattened sedges that appear to be periodically inundated by tides (Figure 21).

**Table 22: Total length of potential inanga spawning habitat (m)**

| Inanga Spawning | Sedge/Rush | Pasture | Park | Other |
|---|---|---|---|---|
| **No Potential for enhancement (or already enhanced and protected)** | 0 | 0 | 0 | 0 |
| **Potential for Enhancement** | 0 | 0 | 120 | 121 |

**Figure 21: Potential inanga spawning habitat with floodplain both banks that is periodically inundated by tides (KOH_MAIN_11).**

## 4.7 Wetlands

A total of 12 wetlands were recorded in the survey area, with six recorded in Glendowie catchment and six recorded in the Eastern Bays catchment (Figure 22). The number of wetlands and ponds in the survey area is relatively low as most of the area has been modified by dense urban development. The most common natural wetland type recorded in the survey area was riverine wetland, while wetlands types such as dry detention ponds were the most common artificial wetland type.

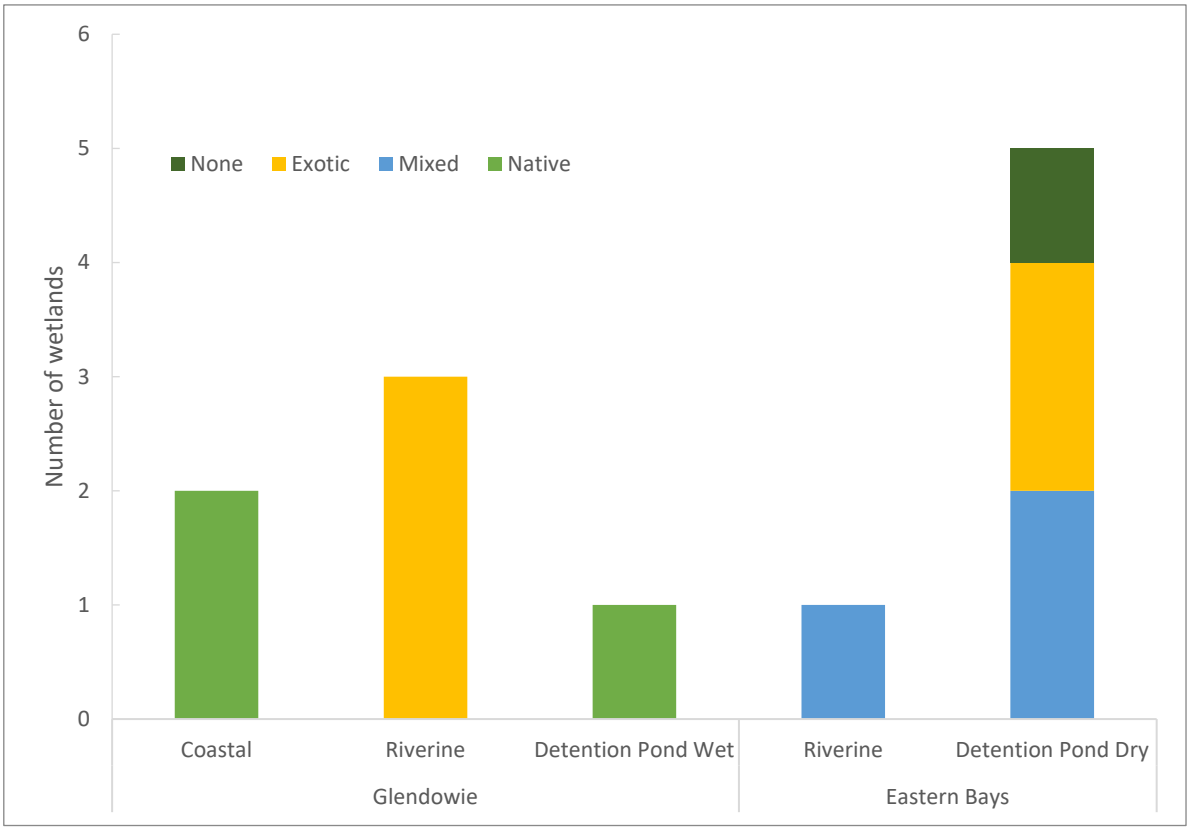



**Figure 22: Summary of wetlands in the Glendowie and Eastern Bays catchments. The dominant vegetation type (none, exotic, mixed or native) is indicated by the colour of the bar.**

### 4.7.1 Artificial Wetlands

A total of six artificial wetlands were recorded in the survey area which are likely constructed for stormwater management. The most common type was dry detention ponds (five) located in parks or other areas of Auckland Council owned land (Figure 23). These limited ability for water treatment as they are dominated by lawn grasses rather than wetland vegetation and likely are designed to provide storm flood attenuation. One wet detention pond was surveyed in Glendowie, characterised by Kanuka/manuka shrubs, flax and other native vegetation (Figure 24).

**Figure 23: Dry Detention Pond located near (Tributary ID: KOH_TRIB6_1) constructed for stormwater management. The Council stormwater asset is located adjacent to private residential properties.**

**Figure 24: Wet stormwater detention pond, in the Glendowie catchment.**

### 4.7.2 Natural Wetlands

The largest natural wetland, in the catchment, is the coastal wetland in Tāhuna Tōrea Nature Reserve (Figure 25). The 1389m$^2$ wetland is in a Significant Ecological Area (SEA_T_5250) and is dominated by native vegetation species such as harakeke (*Phormium tenax*), manuka (*Leptospermum scoparium*), pohutukawa (*Metrosideros excelsa*) and toetoe (*Cyperus ustulatus*).

The other natural wetlands recorded in the survey area are linked to anthropogenic modification. For instance, the riverine wetlands in Churchill Park have been created through the removal of riparian vegetation, stock access and stock damage (Figure 26). These riverine wetlands may have historically been streams with well-defined channels and banks, however due to severe pugging and channel modification, these reaches lacked defined channels with flowing water and had facultative wetland species such as mercer grasses (*Paspalum distichum*) and juncus (*Machaerina juncea*).

**Figure 25: Natural coastal wetland in Tāhuna Tōrea Nature Reserve, dominated by native harakeke and manuka vegetation.**

**Figure 26: Natural riverine wetland in Churchill Park (Tributary ID: GEE_MAIN_FORK2a_1) caused by stock damage and pugging.**

## 4.8 Engineering Assets (inlets/outlets)

Information about the condition, function and location of engineered stormwater assets is required to manage them effectively.

Where assets were recorded in Council GIS the SAP ID is referred to. All assets that were not in GIS were assigned with an asset ID:

- Inlet/Outlet assets were prefixed with an asset ID EBS_XXX or GLDS_XXX based on the catchment they were in.
- Pipe/culverts were prefixed with asset ID EBSP_XXX or GLDSP_XXX.
- Any roading infrastructure asset also included an R in the prefix (e.g. EBSR_XXX or GLDSPR___).

A total of 325 inlet and outlets were scoped to be assessed in the Eastern Bays and Glendowie catchments. Of these assets, a total of 262 inlets and outlets were assessed:

1. 230 Auckland Council (AC) owned.
    i. 30 AC owned inlets or outlets that did not appear in GIS.
    ii. 24 AC assets were labelled as incorrect in GIS:
        a) 9 had the incorrect location.
        b) 15 twin culverts were connected to the wrong pipe or bubble up pits in GIS.
2. 63 assets were not able to be assessed.
    i. 23 had access denied from private landowners.
    ii. 40 not located due to excessive vegetation, burial or removal in some cases.
3. 29 assets were privately owned.
    i. 25 did not appear in GIS.
4. Three had unknown ownership (none appeared in GIS). These were due to the structures not being in the Auckland Council network, having informal structures and being on land that is private but may have been Council owned.
5. 28 inlets have potential flood risks due to debris, fences, decking and other structures across or near the inlet as well as residential floor levels with less than 1 to 2 m of freeboard (as estimated on site).

Of the 230 AC assets assessed:

- 24 were inlets or outlets with no headwall, wingwall or dissipating structures;
- 4 were inlets or outlets with no headwall or wingwall, but some dissipating structure;
- 75 were inlets or outlets with a structure but no dissipation; and,
- The remaining 127 were inlets or outlets with a structure and dissipation.

Of the 29 private assets:

- Five were inlets or outlets with no headwall, wingwall or dissipating structures;
- Three were inlets or outlets with no headwall or wingwall, but some dissipating structure;
- Eight were inlets or outlets with a structure but no dissipation; and,
- The remaining 13 were inlets or outlets with a structure and dissipation.

Of the three unknown assets:

- All were inlets or outlets with a structure and dissipation.

**Auckland Council Assets (inlets/outlets).**

A total of 131 Council structures were assessed as in good condition, 60 were average and 14 of the structures were in poor condition with maintenance involving structural work, patching, debris removal and erosion protection (Table 23).

The 14 Auckland Council assets observed as poor are discussed in detail below:

1. Three box culverts on the Atkin Ave are set back beneath the floor of a residential carport with parts of this floor spanning over the stream. It was deemed unsafe to enter this area to complete a full inspection of each individual outfall. The main column (cast in-situ) supporting the carport was identified to have a large crack that appears to be compromising its structural integrity with the potential to fail. The soil stream banks, beneath this spanned area, appear to be subject to active erosion caused by stormwater flows and bioturbation from the mud crab holes in the bank. The erosion extends 0.5-1.0m into the bank past the downstream rock wall channel lining (2000359099, 2000671763, 2000048193, see EO3 in section 6.0).
2. An inlet at 118 Long Drive (200018412) was completely covered in debris, restricting water flow into it and causing a complete fish barrier.
3. An inlet near 35 Lammermoor Drive (2000081613) was completely infilled with sediment and debris, causing overland flow to surge around the inlet toward a detention pond further downstream.
4. An outlet in Madills Farm (2000799090) had its apron detach from the headwall and left wingwall, with the right wingwall also being broken. There were two tide gates which had snapped off, potentially leading to coastal inundation further up the pipe. Erosion was also occurring behind the headwall of the structure.
5. An inlet at 43 Tarawera Terrace (Asset ID: EBS_022) had become completely blocked by debris, causing a complete fish barrier. There was also some slight erosion around the inlet due to lack of conveyance.
6. A twin culvert in Crossfield Reserve (SAP ID: 2000031833) had been boarded up, restricting flow and causing a fish barrier as well as providing an unsafe drop greater than 1.5m in easy to access Council land.

Six assets classified as poor have been identified for replacement (two have been considered together at Dingle Dell (Asset ID: EBS_004, EBS_005) (Figure 27):

6. A section of the headwall in Dingle Dell Reserve (2000649833) had become detached and was slumping toward the stream channel, the structure had a greater than 1.5m drop.
7. Severe erosion was occurring beneath the outlet point of the pipe at 92 Allum Street (2000565387) causing the dissipation structure to fall away. The structure had a greater than 1.5m drop. It was noted that although this asset might require replacement, it is not close to any structures nor is it posing any public risk.
8. The culvert outlet structure at 45 Clarendon Road (2000677856) had erosion along the TRB below the house retaining wall, undercutting of the apron and cracks were observed and the culvert appeared to be slumping toward the stream, the structure was assessed as unsafe due to a greater than 1.5m drop.
9. The informal concrete outlet at 23 Tarawera Terrace (2000780248) is undercut and had the potential of breaking off into the stream. It had an unsafe drop but difficult access and posed no flood risk.
10. An inlet and an outlet on the culvert bridge at Dingle Dell (Asset ID: EBS_004, EBS_005, EBSP_003) had cracking in the headwalls and wingwalls. Moderate erosion was occurring behind the headwalls and wingwalls, in an area of easy access and an unsafe drop greater than 1.5m.

Detached headwall in Dingle Dell Reserve (2000649833).

The dissipation structure for the outlet at 92 Allum street (2000565387) has completely fallen away due to erosion.

Informal cast in-situ concrete headwall that is cracked and erosion of the bare earth banks on both banks at 53 Clarendon Rd (2000677856).

Informal concrete outlet at 23 Tarawera Terrace is undercut and may fall into stream channel (2000780248).

Cracked culvert bridge in Dingle Dell Reserve (EBS_004, EBS_005, EBSP_003).

Outlet with detached wingwall, apron and snapped off tide gates (2000799090).

**Figure 27: Auckland Council owned inlets and outlets in poor condition.**

**AC Assets with Erosion Issues**

There were 29 structures associated with moderate to severe erosion. Erosion protection works are recommended at locations not already requiring replacement or structural work to prevent further degradation of the stream banks and prevent structural damage to the pipe outlets.

The most severe erosion was associated with following assets:

a. An asset at 29a Geraldine Place had severe erosion underneath the apron causing undercutting and undermining of the surrounding structures as well as unsafe drops above 1.5m (2000161438). The erosion was escalated to Auckland Council as it was 10m away from a private property floor level.
b. An asset at 35 Nihill Crescent (EBS_029) had severe erosion due to poor protection and a lack of riparian vegetation leaving bare earth to be washed away by high flows.

**Auckland Council owned assets with safety issues.**

69 inlets or outlets were associated with unsafe drops, with 25 of these associated with a drop greater than 1.5m (Table 23). Of the outlets considered unsafe, 20 were in areas of easy access (Table 24). The greatest public health and safety concerns due to a drop greater than 1.5m were observed at:

- SAP ID 2000031833, by Mt Taylor Drive Playground was a boarded-up outlet for twin culverts within an enhancement opportunity area. This is within public land and close to a playground.
- SAP ID 2000473115 was within 5m of the walkway alongside Roberta Ave. This outlet discharges directly into the TRB of the stream, however vegetation above the headwall makes it difficult for public to perceive the drop.
- SAP ID 200011573 was behind a reach of flax in the public reserve next to Madills farm and was again difficult to identify from behind.
- SAP ID 2000649833 in Dingle Dell reserve was not next to walking areas but was slumping into the stream.
- SAP 2000498005 was within 5m of the walkway alongside Roberta Ave. This outlet discharges directly into the TRB of the stream, however vegetation above the headwall makes it hard to notice.
- SAP 2000467516, a culvert under the driveway of 57 Clarendon Road was on private land but provided an unsafe walking space and driving space for residents.
- Asset ID EBS_004 and Asset ID EBS_005, a culvert bridge in Dingle Dell reserve not only had no safety structures across the bridge, but the culvert bridge was also in poor condition, requiring replacement.
- SAP ID 2000229311 was within 5m of the walkway at Madill Farm, but labelled as does not apply for structure safety as there was no structure.

**Private Assets**

7 private inlets or outlets were in good condition, 12 in average condition and 2 in poor condition, outlined below:

1. At 477 Riddell Road, a private culvert had been created out of cinder blocks (mentioned below).
2. An outlet at 35 Nihill Crescent (Asset ID: EBS_029) was undercut, causing a complete fish barrier and the bare earth surrounding the outlet was eroding, especially on the TRB wingwall.

As well as the two poor structures, at 471 Riddell Road, a private PVC pipe had been placed in the stream channel to pipe it (Asset ID: GLDS_013, GLDSP_010). The inlet of this was poorly constructed and it was

unsure if consent had been granted for piping of this stream. Condition was given as does not apply as it was unsure as to whether this was even a permanent structure.

**Table 23: Summary of engineering assets (inlets and outlets), significant issues and remedial actions**

| | Assets Surveyed | Assets Correct in GIS | Assets Incorrect in GIS | Assets Not in GIS |
|---|---|---|---|---|
| **Number of assets (inlets/outlets)** | 263 | 180 | 25 | 58 |

| **Condition Assessment** | **Very Good** | **Good** | **Average** | **Poor** | **Very Poor** |
|---|---|---|---|---|---|
| **Condition of structure** | 0 | 138 | 75 | 16 | 0 |

| **Erosion Assessment** | **None** | **Slight** | **Moderate** | **Severe** |
|---|---|---|---|---|
| **Extent of erosion** | 179 | 52 | 22 | 7 |

| **Maintenance Assessment** | **Replacement** | **Structural** | **Patching** | **Debris Removal** | **Vegetation Clearance** | **Erosion Protection** |
|---|---|---|---|---|---|---|
| **Maintenance required** | 15 | 12 | 8 | 15 | 13 | 30 |

**Table 24: Engineering structure safety risk matrix for structures (inlets/outlets)**

| | | Access | | |
|---|---|---|---|---|
| Not safe | | **Easy** | **Moderate** | **Difficult** |
| Land Ownership | Council | 9 | 2 | 1 |
| | Private | 2 | 15 | 15 |
| Not safe, Drop >1.5m | | **Easy** | **Moderate** | **Difficult** |
| Land Ownership | Council | 7 | 0 | 1 |
| | Private | 1 | 9 | 7 |

## 4.9 Engineering Assets (culverts, pipes)

A total of 269 culverts and pipes were assessed in this survey. This includes 34 pipes identified from Auckland Council GIS but were not able to be assessed due to a lack of access or not located due to debris jams or incorrect location. A summary of the condition of assess culverts and pipes is provided in Table 25.

A total of 205 pipes were identified as Auckland Council (AC) owned, 24 as privately owned and six had unknown ownership.

A total of 31 AC owned and one private pipe were labelled as incorrect in GIS. These were due to a wrong location or diameter in GIS. A total of 186 AC owned pipes and 26 private owned pipes were in good condition, 11 AC owned and two private owned pipes were in average condition.

| Table 25: Summary of engineering pipes (pipes and culverts), significant issues and remedial actions | | | | | | |
|---|---|---|---|---|---|---|
| | **Assets Surveyed** | | **Assets Correct in GIS** | | **Assets Incorrect in GIS** | **Assets Not in GIS** |
| **Number of assets (inlets/outlets)** | 235 | | 153 | | 32 | 50 |
| **Condition Assessment** | **Very Good** | **Good** | **Average** | | **Poor** | **Very Poor** |
| **Condition of structure** | 0 | 212 | 13 | | 3 | 0 |
| **Maintenance Assessment** | **Replacement** | **Structural** | **Patching** | **Debris Removal** | **Vegetation Clearance** | **Erosion Protection** |
| **Maintenance required** | 3 | 2 | 3 | 8 | 0 | 1 |

### Maintenance Requirements for AC owned Culverts and Pipes

There were 14 pipes or culverts that were recorded to be in average condition, requiring debris removal, patching, structural work, erosion protection and two requiring replacement (Figure 28). The AC owned culvert and pipes that are in poor condition are listed in detail below:

1. A Council owned culvert at 23 Yattendon Road (2000176700) is made of corrugated iron, showing signs of rust and is beginning to buckle under the weight of earth above it. It is located on private land and has a swimming pool near it. It is recommended that this culvert is monitored and if required, lined to reduce further corrosion or damage which may cause the culvert to collapse. There is a flood risk as the house appears to be within 5m of the pipe and 2m of the outlet.
2. An AC owned pipe in poor condition in Churchill Park (GLDSP_003) has been completely buried by sediment and is causing overland flow over top of the structure with ponding surrounding the asset.

AC owned corrugated iron culvert on 23 Yattendon Road (2000176700) on private land needs lining with concrete or full replacement.

Culvert in Churchill Park that is blocked and in poor condition (GLDSP_003).

**Figure 28: AC owned culverts or pipes in poor condition.**

**Private Pipes Requiring Maintenance**

The other culvert and pipe that was in poor condition was a private culvert on the edge of 477 Riddell Road (GLDSP_011) (Figure 29). This has been poorly constructed from cinder blocks and with an undersized rip rap outfall. The whole structure is experiencing erosion from the wingwalls and from the earth above the headwall which may eventually take the fence down. The structure is within 10m of a house on one side and 6m of a private swimming pool on the other and has been classified as a flood risk.

On 471 Riddell Road, a private PVC pipe had been placed in the stream channel to pipe it (Asset ID: GLDS_013, GLDSP_010). The inlet of this was poorly constructed and it was unsure if consent had been granted for piping of this stream. It is recommended that this is investigated further to ascertain whether replacement is necessary and whether consent requirements have been met.

17 pipes have potential flood risks due to adjacent residential floor levels with less than 1 to 2 m of freeboard (as estimated on site). It is recommended that the potential risk is investigated further.

Cinder block culvert GLDSP_011.

Nova coil pipe placed in stream channel (GLDSP_010).

**Figure 29: Private culverts in poor condition.**

**Table 26: Summary of engineering assets (culverts and pipes), significant issues and remedial actions.**

| | Assets Surveyed | Assets Correct in GIS | Assets Incorrect in GIS | Assets Not in GIS |
|---|---|---|---|---|
| **Number of Assets (pipes/culverts)** | 235 | 153 | 32 | 50 |

| **Condition Assessment** | **Very Good** | **Good** | **Average** | **Poor** | **Very Poor** |
|---|---|---|---|---|---|
| **Condition of assets** | 0 | 212 | 13 | 3 | 0 |

| **Maintenance Assessment** | **Replacement** | **Structural** | **Patching** | **Debris Removal** | **Vegetation Clearance** | **Erosion Protection** |
|---|---|---|---|---|---|---|
| **Maintenance required** | 3 | 2 | 3 | 8 | 0 | 1 |

## 4.10 Bank and Channel Lining

A total of 2,082 m of watercourse has some bank or channel lining (Table 27). An additional 400 m of watercourse was recorded as having bank lining without an associated bank lining feature. Due to the and time constraints they were only recorded as part of the ecoline feature class.

The majority of Council owned bank lining was in good condition except the lining on GLE_MAIN_5 I Churchill Park which was in average condition, with an unsafe drop and moderate access (Asset ID: UNK_004). The lining was made up of poorly placed concrete blocks and gabion baskets. This lining required structural work in some areas and locals noticed scour during high flow events.

Of the private bank lined reaches, five sections recorded poor condition, three of these had unsafe drops but were locations that were difficult to access, and another has moderate access but appeared safe. The five sections recorded in poor condition were:

1. A section of bank along KAR_MAIN_2 was lined with grouted stone (Asset ID: UNK_005), the owner had built a shed over top of this which was compromising the structure (the lining was beginning to show cracking) and it could potentially fall into the stream.
2. At MIS_MAIN_4 there was a concrete base lining and grouted rock bank lining however the watercourse was not following the contours of the channel and undercutting it in some areas (Asset ID: UNK_015).
3. At KOH_TRIB3a_5 the rock lining integrity has been undermined by a scour pool that has formed under it from high flows coming from the nearby outlet (SAP ID: 2000161438) and sections of the undercut timber fence on the opposite bank have fallen into the channel. Both sides have an unsafe drop of greater than 1.5m and are within 10m of the nearest building footprint (Asset ID: UNK_037).
4. At KOH_TRIB3a_5, the timber fence was in poor condition, severely undercut and sections have fallen into the channel (Asset ID: UNK_038).
5. At STH_TRIB4_4 an informal lining of materials such as corrugated iron, timber and rocks had been placed haphazardly on the TRB, within 1m of the nearby shed (Asset ID: UNK_056).

Another section of bank lining was labelled as very poor:

- At MIS_TRIB5a_1, the reach at 18a Godden Crescent (MIS_TRIB5a_1) has timber lining which is being eroded from underneath causing mass wasting behind the timber walls. Not only is the section in bad shape and has the potential to fail but the downstream section runs through a concrete lined channel underneath the house at 15b Rukutai Street. This could be unsafe for the homeowners who are living above it as high flows could weaken the houses foundations (Asset ID: UNK_009).

Bank lining in Churchill Park (AC land) (UNK_004) made up of poorly placed concrete blocks and gabion baskets.

Bank lining at 18a Godden Crescent on private property (MIS_TRIB5a_1) (UNK_009).

Bank lining undercut at 2/21 Geraldine Place (KOH_TRIB3a_5) (UNK_038).

Haphazard bank lining encroaching on a nearby shed (STH_TRIB4_4) (UNK_056).

**Figure 30: Summary of poor condition bank lining in the survey area.**

| Table 27: Summary of channel lining assessed over the surveyed extent. | | | | | |
|---|---|---|---|---|---|
| **Physical Factors** | | | | | |
| **Total length of lined watercourse (m)** | 2,082 | | | | |
| **No. reaches** | 63 | | | | |
| **Total length of bank lining (m)** | 2,011 | | | | |
| **Total length of base lining (m)** | 1,428 | | | | |
| | **Mean** | | **Min** | | **Max** |
| **Bank Height (m)** | 1.25 | | 0.25 | | 3.7 |
| **Length of bank lining (m)** | 40.1 | | 1.7 | | 170 |
| **Length of base lining (m)** | 33.6 | | 1.7 | | 170 |
| **Condition Assessment** | **Very Good** | **Good** | **Average** | **Poor** | **Very Poor** |
| **Condition of bank lining % of total bank lining length** | 7 | 73 | 14 | 5 | 1 |
| **length of lining (m)** | 146 | 1,466 | 274 | 93 | 32 |
| **Condition of base lining % of total base lining length** | 8 | 84 | 8 | <1 | 0 |
| **length of lining (m)** | 119 | 1,190 | 114 | 5 | 0 |
| **Impact on Stormwater Flows** | **Not Significant** | | **Significant** | | **Critical** |
| **% of total bank and base lining** | 80 | | 20 | | 0 |

*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.*

## 4.11 Erosion Hotspots

A total of eight erosion hotspots, which met the definition outlined in the Watercourse Assessment Methodology 2.0 document, were observed within the Eastern Bays and Glendowie catchment.

An erosion hotspot is defined as:

- Severe erosion located within the channel and/or lower or upper banks resulting in slumping and/or exposed soil surfaces.
- The hotspot must also:
    - exceed two metres in length and/or have a total surface area of disturbed soil >5m$^2$; and,
    - be actively eroding; and,
    - be detrimental to stream health and/or causing significant and/or immediate safety or infrastructure concerns.

Five of the erosion hotspots were associated with AC owned stormwater outlets and two hotspots were within 10m of building footprints (KOH_TRIB5ai_1, KOH_TRIB3a_5) (Table 28):

1. The erosion hotspot on KOH_TRIB3a_5 was 5m away from a property boundary. The hotspot is at the outlet of a Council owned asset (2000161438), directly downstream of new subdivision, at 27 Geraldine Place. On the TLB the house is approximately 5-7m away from the rock retaining wall which is been undermined and has poor structural integrity. On the TRB the timber lining is in very poor condition and several posts have fallen into the channel. There appeared to be sediment or similar washing down from the pipe which could indicate that the erosion and sediment controls in the development directly upstream are not working effectively (Figure 33).
2. A 5 m erosion hotspot and section of mass wasting (KOH_TRIB7a_1) occurred as a result of instability from outlet (2000874449) above the channel, posing a safety risk, however, it is 25 m from the nearest building, access is difficult and is on private land (Figure 32).
3. Mass wasting and slumping of the TRB in Dingle Dell Reserve (DIN_TRIB4a_2) is likely attributed to a 500mm PVC nova coil pipe in the upper bank of stream, under the walking track (EBS_002).
4. Localised scour on the upper reaches of Kohimarama stream, downstream of a concrete apron which has been informally stabilised with rock rip rap below the outlet structure (2000537871).
5. Undercutting of bank and erosion scour of both banks on the upper reaches of Kohimarama stream downstream from AC outlet (2000565387). Large trees are fallen into stream channel.

In one of the cases on MIS_MAIN_6, an erosion hotspot appeared to be exacerbated by a lack of riparian planting in a resident's backyard (Figure 31). The houses on each side had good riparian planting and showed no signs of mass wasting, the property had banks of grass and bare earth, which was contributing to sediment accretion downstream.

**Figure 31: Erosion hotspot exacerbated on private property by poor riparian planting on MIS_MAIN_6.**

**Figure 32. The erosion hotspot at KOH_TRIB7a_1 is associated with the stormwater outlet (Asset ID: 2000130324) shown on the top left-hand corner of the image.**

**Figure 33: Erosion associated with under the retaining wall at 27 Geraldine Place along KOH_TRIB3a_5.**

**Table 28: Summary of erosion hotspots.**

| **Attribute** | | | | |
|---|---|---|---|---|
| **Total Length of Surveyed Watercourse (m)** | | | | 14,268 |
| **No. Reaches** | | | | 204 |
| **Total Length of Erosion Hotspots (m)** | | | | 33 |
| **Total Area of Erosion Hotspots ($m^2$)** | | | | 85 |
| **Total Number of Erosion Hotspots** | | | | 8 |
| | | **Mean** | **Min** | **Max** |
| **Length (m)** | | 4.1 | 1 | 6 |
| **Bank Height (m)** | | 1.4 | 0.4 | 1.8 |
| **Area ($m^2$)** | | 10.6 | 5 | 30 |
| **Access** | | **Easy** | **Moderate** | **Difficult** |
| **Land Ownership** | Council | 2 | 0 | 0 |
| | Private | 0 | 2 | 4 |

**Table 29: Summary of Pfankuch bank stability assessment of the 10 m upstream of erosion hotspots.**

| | Excellent | Good | Fair | Poor |
|---|---|---|---|---|
| **Land Slope** | 0 | 30 | 20 | 30 |
| **Mass Wasting** | 0 | 0 | 30 | 40 |
| **Debris Jam** | 0 | 20 | 20 | 40 |
| **Bank Vegetation** | 10 | 40 | 10 | 20 |
| **Overall Stability Index** % of total stream length | 0 | 0 | 62.5 | 37.5 |
| Length of stream (m) | 0 | 0 | 50 | 30 |

## 4.12 Miscellaneous Points

A total of 180 miscellaneous points were identified in the study area, covering a range of features such as discharges, pollution, weirs, debris jams, bridges and pipes.

### 4.12.1 Flooding Issues

One miscellaneous point pose a potential risk for the flooding of habitable floors. A pedestrian bridge that crosses a tributary of Dingle Dell Stream, at the driveway of 35 Fern Glen Road had been completely blocked by debris and has the potential to flood habitable floors on 35 Fern Glen Road (DIN_TRIB4a_4) (Figure 34).

Two miscellaneous points considered to have a significant impact on stormwater flows due to the potential for flooding of private property and council reserves:

1. A possible stormwater manhole in the backyard of 4/36 Dingle Road (close to DIN_TRIB2_1) was reported to be popping open and causing local flooding in the back yard in rainfall events (Not in GIS) (Figure 34).
2. At Crossfield Reserve adjacent to EO1, flooding has been noted across the length of the field and onto the road in most rainfall events (see EO1 in section 6.0).

There were no miscellaneous points with a critical impact on stormwater flows.

A possible stormwater manhole in the backyard of 4/36 Dingle Road (close to DIN_TRIB2_1) was reported to be popping open and causing local flooding in the back yard in rainfall events (Not in GIS).

A pedestrian bridge that crosses a tributary of Dingle Dell Stream, at the driveway of 35 Fern Glen Road had been completely blocked by debris and has the potential to flood habitable floors on 35 Fern Glen Road (DIN_TRIB4a_4).

**Figure 34: Summary of miscellaneous features that may have a significant impact on stormwater flows.**

### 4.12.2 Discharges

A total of 15 miscellaneous points are recorded as discharges. These were tributaries, groundwater seepage, a dam and OLFPs. The two pollution events and sewage fungus location is outlined below:

1. Sewage fungus was recorded in a private property on Mission Bay Stream (MIS_MAIN_3). There was an unknown discharge point and grey fungus with a sewage smell.
    a. The resident logged the incident with Watercare to address the issue.
2. Chlorine from an upstream pool was discharging from 15 Fern Glen Road South into a road catchpit at a high flow rate from an overland flow path on the property. In the Dingle Dell Reserve, approximately 300m downstream, two dead kokopu were found, potentially a result of the chlorine discharge. Although a chlorine type smell was not noticed at this location (DIN_MAIN_3) (Figure 35).
    a. Pollution response was notified on 12/03/2019 (incident report number 60218882) but no outcome of the investigated has been communicated back to Morphum, at the time of writing.
3. During the SEV assessment a white discharge was spotted coming out of an outlet (2000077826) into Mission Bay Stream (MIS_MAIN_1) in Aotea Reserve. At the property next door, a person was washing paint brushes into the stormwater drain and this is the likely source of the white milky discharge (Figure 35).
    a. An incident was logged with Pollution hotline (incident report number 60221393) and investigated by a compliance officer.

An upstream pool was discharging from 15 Fern Glen Road South into a road catchpit. In the Dingle Dell Reserve, approximately 300m downstream, two dead banded kokopu were found, potentially a result of the chlorine discharge (DIN_MAIN_3).

A white discharge was spotted coming out of an outlet (2000077826) into Mission Bay Stream (MIS_MAIN_1). At the property next door, a person was washing paint brushes into the stormwater drain and this is the likely source of the white milky discharge.

**Figure 35: Summary of pollution incidents during the field work for Eastern Bays and Glendowie WAR.**

### 4.12.3 Engineering

A total of 90 miscellaneous points was attributed to engineering type points, 10 of these were debris jams caused by fallen vegetation, built up sediment or refuse, other points were found to be:

- 8 pipe bridges.
- 50 cases of stormwater pipes <0.225m in diameter.
- 3 weirs.
- 1 dam.
- 6 engineering structures such as bubble up pits, gross pollutant traps (GPTs) and cast in-situ naturalised cascades.

### 4.12.4 Other

In addition, 30 bridges were found, two land slips/slides, one litter dump, one manmade ford, four cases of significant trees or vegetation, four cases of recorded weed infestation. There are also 28 extra miscellaneous points, made up of artificial fish barriers such as cascades, fences over or in streams and deck or house foundations within stream.

# 5.0 SEV assessments and Additional Variables

## 5.1 Stream Ecological Valuation Assessment

A total of five Stream Ecological Valuations (SEVs) were performed within the surveyed area on 14th and 16th May 2019 (Table 30, Figure 36). All sites were in accessible areas and representative of the range of land use types in the survey area. Two SEVs were undertaken in the Glendowie catchment and three SEVs were undertaken in the Eastern Bays catchment.

The five SEV scores ranged from 0.370 to 0.580 indicating low to moderate ecological condition in the survey area. Table 30 provides an overview of the five SEV sites and Table 31 summarises the SEV scores for the five sites.

**Table 30: Overview of SEV sites and catchment sizes**

| SEV number | Stream and Catchment name | Riparian land use | Catchment area ($m^2$) | Classification and Flow | SEV method |
|---|---|---|---|---|---|
| EBG01 | Glendowie Stream<br>Glendowie | Regenerating riparian cover with public access | 2264 | Permanent. Slow, almost no flow. | Standard |
| EBG02 | Glendowie Stream<br>Glendowie | Regenerating riparian cover | 1939 | Permanent. Flowing | Standard |
| EBG03 | Mission Bay Stream<br>Eastern Bays | Regenerating riparian cover | 2686 | Permanent. Flowing | Standard |
| EBG04 | Kohimarama Stream<br>Eastern Bays | Regenerating riparian cover with public and dog access | 4961 | Permanent. Flowing | Standard |
| EBG05 | Mission Bay Stream<br>Eastern Bays | Regenerating riparian cover with public access | 3628 | Permanent. Ponding water, but not flowing | Standard |

**Table 31: Summary of mean SEV scores across sites**

| Site Code | Tributary Code | Hydraulic | Bio-geochemical | Habitat Provision | Biodiversity | Total SEV Score |
|---|---|---|---|---|---|---|
| EBG01 | GLE_MAIN_9 | 0.65 | 0.73 | 0.46 | 0.32 | **0.580** |
| EBG02 | GLE_TRIB4_4 | 0.53 | 0.68 | 0.56 | 0.15 | **0.505** |
| EBG03 | MIS_TRIB4_1 | 0.37 | 0.56 | 0.49 | 0.12 | **0.401** |
| EBG04 | KOH_MAIN_8 | 0.65 | 0.57 | 0.28 | 0.32 | **0.498** |
| EBG05 | MIS_MAIN_1 | 0.55 | 0.47 | 0.22 | 0.07 | **0.370** |

### 5.1.1 Glendowie Stream – EBG01

The Glendowie Stream SEV site is representative of regenerating riparian cover with public access. It had good vegetation cover with both exotic and native vegetation on public property. The SEV score of 0.580 indicates moderate ecological condition. EBG01 received the highest biogeochemical scores (0.73) due to high quality riparian vegetation (1.0) and overhead shading (0.7), as well as an absence of in stream macrophytes (0.84) and low channel modification (Vchann 0.74, Vlining 0.96). The limiting factor in the reach was biodiversity, likely to be a result of not only poor habitat provision but also as a result of the fish barriers further downstream in Glendowie Stream.

### 5.1.2 Glendowie Stream – EGB02

The Glendowie Stream SEV site is representative of the streams in residential areas with poor vegetation cover but good shading and longitudinal vegetation extent. The vegetation was dominated by exotics such as bamboo and wild ginger. The SEV score of 0.505 indicates moderate ecological condition with a very low biodiversity score as no native fish had been observed at this location.

### 5.1.3 Mission Bay Stream – EGB03

The Mission Bay Stream SEV site is representative of variable condition stream in private land with areas of high erosion and pockets of good in stream habitat where native fish (shortfin eel) were recorded. The SEV score of 0.401 indicated low ecological condition with biodiversity as the limiting factor and poor hydraulic qualities and fish barriers contributing.

### 5.1.4 Kohimarama Stream – EGB04

The Kohimarama Stream SEV site is representative of regenerating riparian cover with public and dog access, yet continuing erosion and areas of poor vegetation. This reach was also representative of inanga spawning areas in Eastern Bays. The SEV score of 0.498 indicates moderate ecological condition, habitat provision was the limiting factor in this case and could be remedied by bank regrading, stabilisation and further revegetation of the riparian margin to a further longitudinal extent (as of the observations a planting day was planned in the area which may help to improve the habitat provision).

### 5.1.5 Mission Bay Stream – EGB05

The Mission Bay Stream SEV site is representative of a public access stream with poor longitudinal extent of riparian cover and small to no banks. The SEV score of 0.370 indicates poor ecological condition as a result of very poor biodiversity and very poor habitat provision.

**Glendowie Stream EBG01 (GLE_MAIN_9)**
Regenerating riparian vegetation.

**Glendowie Stream EBG02 (GLE_TRIB4_4)**
Representative of residential reaches where weed infestations are common.

**Mission Bay Stream EBG03 (MIS_TRIB4_1)**
Reach on private land in variable condition with areas of bank erosion and other areas with good instream habitat.

**Kohimarama Stream EBG04** (**KOH_MAIN_8)**
Adjacent to Madill's Farm Recreational Reserve and sport fields.

**Mission Bay Stream EBG05 (MIS_MAIN_1)**
Representative of streams with poor riparian vegetation and shallow banks.

**Figure 36: Representative photos showing the five Stream Ecological Valuation (SEV) survey sites.**

## 5.2 Biodiversity

### 5.2.1 Fish IBI

Electric fishing was carried out at all sites, with the data combined with fish observed during the SEV assessments in order to calculate the Fish IBI scores for these sites. The scores ranged from 0 to 30 indicating 'very poor' to 'fair' ecological values.

At EGB05, no fish were observed in the SEV assessment or electric fishing survey, giving it a score of 0 reflecting no native species. At EGB02 and EGB03, only shortfin eels (*Anguilla australis*) were observed, at EGB02 one eel was observed during the SEV and none during electrofishing and at EGB03, six eels smaller than 200mm and three eels larger than 200mm were observed during electrofishing. At EBG01 and EBG04, both shortfin eels and banded kokopu were observed, with an abundance of eight eels and two kokopu at EGB01 and seven eels and two kokopu at EGB04.

Additionally, a specimen of gambusia was preserved in the MCI sample for EGB04, however this did not act to increase the Fish IBI value as it is not a native species.

**Table 32: Attributes and suggested integrity classes for the Index of Biotic Integrity: Fish (2016).**

| Total IBI score | Integrity class | Description |
|---|---|---|
| 54-100 | Very Good | Comparable to the best situations without human disturbance; all regionally expected species for the stream position are present. Site is above the 80th percentile of Auckland sites. |
| 50-53 | Good | Site is above the 60th percentile of all Auckland sites species richness is slightly less than best for the region. |
| 38-49 | Fair | Site is above the 40th percentile of Auckland sites but species richness and habitat or migratory access reduced some signs of stress. |
| 26-37 | Poor | Site is less than average for Auckland region IBI scores, less than the 40th percentile, thus species richness and or habitat are severely impaired. |
| 1-25 | Very poor | Site is below the 20th percentile meaning site is impaired or migratory access almost non-existent. |
| 0 | No native fish | Site is grossly impacted or fish access non-existent. |

### 5.2.2 Macroinvertebrate Community Index

Macroinvertebrate Community Index (MCI) samples were taken at the same five sites as the SEV sites within the survey area. The summary of biodiversity index values for the five sites are listed in Table 33. Overall, MCI scores in the catchment were poor, indicating low ecological values within the catchment (Table 34).

The highest MCI score (76.0) was recorded in the Glendowie Stream (EBG01). No sites observed pollution-sensitive EPT taxa.

The most common taxa recorded across the five survey sites was the true fly mosquito larvae (*Culicidae*), the mud snail *Potamopyrgus* and worms *Oligochaeta*. MCI guidelines proposed for urban areas (68) under the AUP-MCI guidelines suggests that discharges, subdivision, use and development in EGB02, EGB03 and EGB05 should be managed to enhance freshwater values.

**Table 33: Summary of biodiversity index values across sites.**

| Site Code | MCI | No. Taxa | EPT Taxa | Fish IBI Scores |
|---|---|---|---|---|
| **EBG01** | 76.0 | 3 | 0 | 28 |
| **EBG02** | 45.3 | 9 | 0 | 0 |
| **EBG03** | 49.4 | 7 | 0 | 0 |
| **EBG04** | 71.4 | 14 | 0 | 20 |
| **EBG05** | 59.8 | 9 | 0 | 0 |

*All sites were surveyed and assessed as soft-bottom sites.

**Table 34: Interpretation of Macroinvertebrate Community Index Scores.**

| Quality | MCI score |
|---|---|
| **Excellent** | >119 |
| **Good** | 100-119 |
| **Fair** | 80-99 |
| **Poor** | <80 |

## 5.3 Summary

The overall scores for the five SEV sites indicate that all five sites have low to moderate ecological values when compared to reference urban streams in the SEV method (Storey *et al.,* 2011). The SEV scores of the assessed reaches suffered due to poor habitat provision and corresponding very low biodiversity values. Other than EBG01 (0.58), the sites fell between the mean SEV score (0.52) and lower quartile (0.29) for reference urban streams in Auckland, which is to be expected given the residential development in this catchment with high channel modification. The highest scoring site were EBG01 and EBG04 located in Glendowie stream and Kohimarama stream respectively, under regenerating native vegetation with a variety of habitat types. Fish IBI scores at the sites indicated fair ecological condition and MCI indicated poor ecological values.

The primary limiting factors of ecological values in the remaining sites were due to poor riparian vegetation impacting several functions including filtration, shading, and habitat values. Channel morphology and floodplain connectivity was also affected by channel incision.

Consequently, key opportunities to improve SEV scores in the survey area include naturalisation to restore natural hydrology and improve floodplain connectivity and riparian planting to improve bank stability.

# 6.0 Enhancement Opportunities

A total of seven enhancement opportunities were identified within the Eastern Bays and Glendowie area. Each enhancement opportunity is assigned a high-level prioritisation score based on the potential benefits to public and local amenity values, ecological values such as biodiversity and habitat improvements, and conveyance improvements.

The methodology used to derive the prioritisation scores is outlined in the Watercourse Assessment Methodology: Infrastructure and Ecology (Version 2).

**Table 35: Summary of prioritisation of enhancement opportunities.**

| Enhancement Opportunity | Management Zone | Description | Amenity | Ecology | Conveyance | Overall Score | Prioritisation Score |
|---|---|---|---|---|---|---|---|
| **EO1** | MZ3 | Daylighting at Crossfield Reserve and Glendowie College. | M | H | M | 10 | 3 |
| **EO 2** | MZ3 | Stock Exclusion and Riparian Planting at Churchill Park. | H | H | M | 12 | 1 |
| **EO 3** | MZ3 | Potential Stormwater Structure Failure on Atkin Ave Stream. | L | L | H | 8 | 5 |
| **EO 4** | MZ4 | Instream and Riparian Habitat Enhancement at Churchill Park. | M | M | L | 8 | 5 |
| **EO 5** | MZ3 | Stormwater Detention at Aotea Reserve (Nihill Crescent). | M | M | M | 9 | 4 |
| **EO 6** | MZ3 | Mitigation of Outfall Erosion at Madills Farm. | M | H | H | 11 | 2 |
| **EO 7** | MZ4 | Daylighting at Glendowie Park . | M | H | H | 11 | 2 |

## EO1 – Daylighting at Crossfield Reserve and Glendowie College.


**Location:** Crossfield Road, Glendowie, Auckland**.**

**Tributary ID:** GLE_TRIB4_11 **Ownership** Council

**Asset ID:** 2000756293 and 2000503242 **Area:** 18,564 $m^2$

**Description**

In the upper catchment, approximately 1 km of stream is piped under Crossfield Reserve (1350 to 1000 mm diameter pipe). An OLFP follows the alignment of the piped channel with evidence of extended periods of inundation i.e. Mercer Grass (*Paspalum distichum*) and sediment entrainment. Residents have reported flooding of Crossfield Reserve during certain rainfall events. The extent and frequency of this flooding in the park is unknown.

**Opportunities:**

- Daylighting to improve ecological function, flow attenuation and flood control while maintaining stormwater conveyance. Naturalising of stream channel will attenuate flows to benefit downstream reaches (GLE_TRIB4_10 to 1) where residents have reported erosion of stream banks.
- Riparian planting and integration of the existing walkway for amenity benefits.
- Work with Glendowie College to establish water sensitive programme.

**Considerations**

- Hydrological modelling to understand downstream and upstream impacts of daylighting this reach.
- Depth to invert is around 1500 mm, affecting feasibility and footprint required to daylight.
- Riparian planting design which allows path users to feel safe, especially students Glendowie College.
- Stormwater pipe is crossed by 3 wastewater pipes, one abandoned and one below invert, however one (Asset ID 833377) would require a pipe bridge.

**Significant Linkages**

Open watercourse downstream which links to EO4.

| **Enhancement Types** | **Stakeholders** |
|---|---|
| Daylighting | AC Healthy Waters |
| Conveyance Improvements | AC Parks |
| Naturalising (habitat enhancement) | Residents |
| Weed Control and Planting | Community groups |

**OLFP (Tributary ID: GLE_TRIB4_11) above the piped channel.**

**The concrete footpath on TLB of the proposed daylighting site.**

**Flooding of field during heavy rainfall event in July 2018, from the TLB. Sent in by residents at 89 Esperance Road.**

## EO2 – Stock Exclusion and Riparian Planting at Churchill Park.


**Location:** Upstream reaches of Glendowie Stream in Churchill Park (320-336 Riddell Road, Glendowie).

**Tributary ID:** GLE_TRIB6_2 – GLE_TRIB6_3 GLE_TRIB6a_2 to GLE_TRIB6a_1

**Ownership:** Auckland Council

**Asset ID:** As shown on the map

**Area:** 29,570 $m^2$

**Description**

Churchill Park is a publicly owned working farm and has approximately 60 grazing cattle. The stock damage to watercourses in the park has resulted in pugged, wetland-like reaches with no defined channels.

**Opportunities**

- Stock exclusion and planting will reduce stock damage and the discharge of sediment into mainstem of the sub-catchment (which has high ecological value).
- Collaboration with active community groups for planting and weed maintenance (Friends of Churchill Park) and Churchill Park School.

**Considerations**

- Promoting the watercourse as part of the landscape – ensuring sight lines of the stream are retained and develop water sensitive programmes.
- Appropriate exclusion fencing and planting of the riparian corridor.

**Significant Linkages**

Enhancing this area in conjunction with the downstream EO projects (EO4, EO7 and EO1) promotes ecological connectivity from the headwaters to the coastal environment.

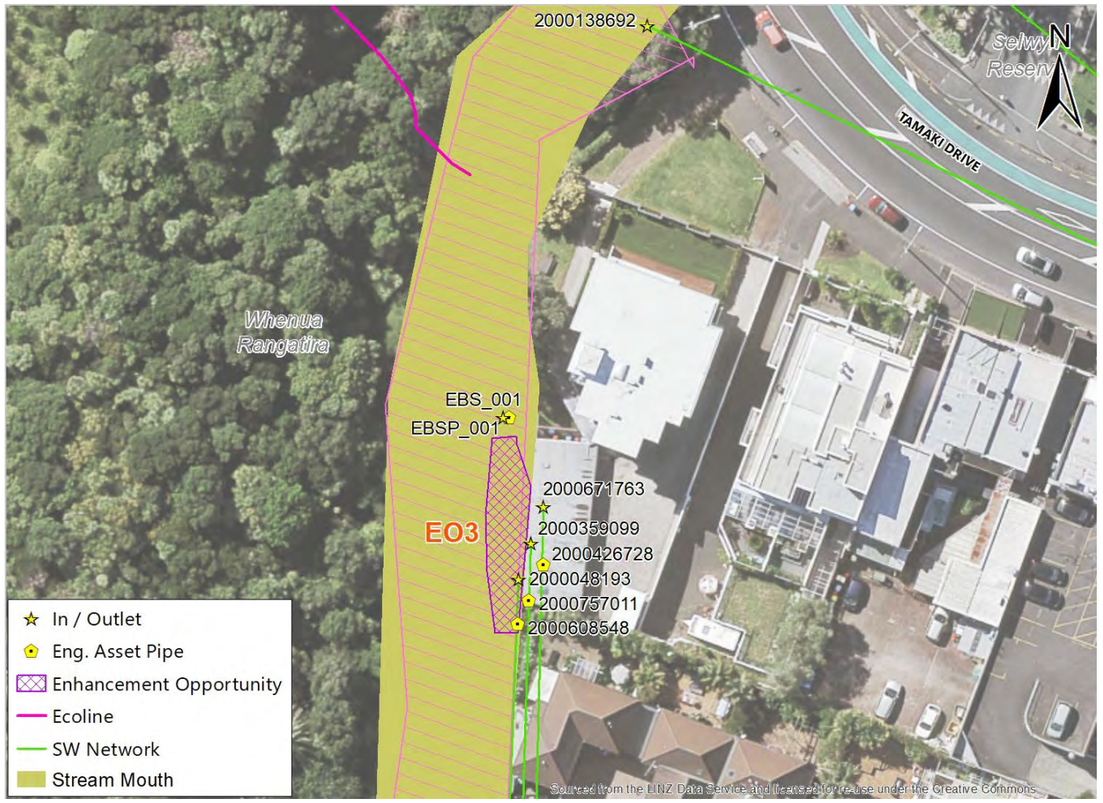
| Enhancement Types | Stakeholders |
|---|---|
| Naturalising (habitat enhancement) | AC Healthy Waters |
| Fencing/Stock Exclusions | AC Parks |
| Weed Control and Planting | Community groups |
| Community Engagement | Local School |

**Modified channels with wetland-like characteristics (TRIB ID: GLE_TRIB6a_1).**

**Stock have open access to the channels and there is sparse vegetation.**

**Modified channel with exotic cover of pine and no understory. Mass wasting of bank and incised channels.**

## EO3 – Potential Stormwater Structure Failure on Atkin Ave Stream.




**Location:** 29 Tamaki Drive, Mission Bay.

**Tributary ID:** Mission Bay stream mouth **Ownership** Mixed

**Asset ID:** As shown on map. **Area:** 91.2m$^2$

**Description**

The three box culverts (SAP ID: 2000048193, 2000359099 and 2000671763) are set back beneath the floor of a residential carport with parts of this floor spanning over the stream. It was deemed unsafe to enter this area to complete a full inspection of each individual outfall. The main column supporting the carport was identified to have a large crack that appears to be compromising its structural integrity.

**Opportunities**

- Erosion protection in coastal inundation zone.
- Physical works to stabilise carpark, stormwater structures and private properties.

**Considerations**

- Extend 3 culverts so that they discharge directly into the main Atkin Stream channel. The overhanging span could be infilled to provide foundation for the car park building floor above.
- Ngāti Whātua Ōrākei are the landowners on the TLB (Whenua Rangatira).

**Significant Linkages**

The area is close to the coastal receiving environment, important to minimise sediment and erosion in the channel. Delivered as Morphum Technical Note on 16/05/2019, since then, remedial works for erosion protection are underway.

| Enhancement Types | Stakeholders |
|---|---|
| Erosion Protection | AC SW |
| Outfall Erosion | Watercare |
| Safety Improvements | Ngāti Whātua Ōrākei |
| Community Engagement | Residents |

**The 3 culverts (2000048193, 2000359099 and 2000671763) set back beneath parking garage.**

**Undermining occurring the wall under the parking garage structure at 29 Tamaki Drive.**

**The main column supporting the parking garage was identified to have a large crack which may be compromising its structural integrity.**

## EO4 – Instream and Riparian Habitat Enhancement at Churchill Park


**Location:** Churchill Park and 15-62 Robley Crescent, Glendowie.

**Tributary IDs:** GLE_MAIN_3 to GLE_MAIN_5 **Ownership** Mixed

**Asset ID:** As shown on map **Area:** 3037 $m^2$

**Description**

Open channel with no riparian vegetation. The lack of riparian filtering of surface run off and shading combined with possible nutrient inputs (presumably from garden fertilisers) has likely resulted in high density of submergent macrophytes in the stream channel. Multiple weirs installed in the channel are complete fish passage barriers (see miscellaneous points in map).

**Opportunities**

- Improve ecological connectivity with the upstream and downstream reaches which have good riparian cover.
- Engage with property owners to encourage riparian planting for filtering and shading of the channel.
- Investigate the remediation of multiple weirs in the channels which are complete fish passage barriers.

**Considerations**

- Hydrological modelling to investigate impact of removal or remediation of the structures.
- Working with 14 residential properties owners who share ownership of the TLB of stream.

**Significant Linkages**

Located downstream of EO1 and upstream of EO7.

| Enhancement Types | Stakeholders |
|---|---|
| Weed Control and Planting | Residents |
| Community Engagement | Community Groups |
| Erosion Protection | Local Schools |
| Fish Barrier | AC Parks |

**Open channel with dominated by lawn grasses providing limited filtering ability and no riparian shading (Trib ID: GLE_MAIN_3).**

**Multiple ad-hoc weirs and dams structures used to create ponding sections of stream.**

**Weirs are complete fish passage barriers (GLE_MAIN_4).**

## EO5 – Stormwater Detention at Aotea Reserve (Nihill Crescent).


**Location:** Nihill Crescent, Orakei.

**Tributary ID** MIS_MAIN_1

**Ownership:** Auckland Council

**Asset ID** As shown on map

**Area:** 10295m$^2$

**Description**

Small section of open channel (65 m) with very little riparian vegetation. Aotea Reserve a passive recreational area that is primarily used a dog park (*Pers Obs*). Most of this sub catchment is piped, serviced by a series of stormwater pipes (1200 mm to 1350 mm) run along western edge of the park. Stormwater from this sub-catchment receives no treatment before reaching the coastal out into Mission Bay beach and the Hauraki Gulf.

**Opportunities**

- Enhancement of riparian vegetation for improved water quality and habitat availability (fish, lizards and birds).
- Convert existing reserve to offline stormwater treatment wetland with bypass connection into open watercourse.
- Improve amenity value with a boardwalk surrounding wetland.

**Considerations**

- Hydrological modelling to distinguish the catchment area that could be treated by a wetland.
- Physical works and earthworks required to convert existing park into wetland is likely to be extensive due to the depth to invert of the stormwater pipes along western side (DTI ~2.2 m).
- Current baseline SEV score is 0.370 which is indicative of poor ecological condition.
- NZFFD shows a record of banded kokopu (*Galaxias fasciatus*)

**Significant Linkages**

Located upstream of E03.

| Enhancement Types | Stakeholders |
|---|---|
| Conveyance Improvements | AC Healthy Waters |
| Naturalisation (habitat enhancement) | AC Parks |
| Amenity | Residents |
| | Community Groups |

**Outlet at the top of stream (SAP ID: 2000077826, 2000077826) showing low banks and poor vegetation.**

**Surrounding passive recreation parkland at Aotea Reserve.**

**Narrow riparian longitudinal extent at MIS_MAIN_1.**

## EO6 –Mitigation of Outfall Erosion at Madills Farm.


**Location:** Madills Farm, 6 Baddeley Ave, Kohimarama.

**Tributary ID:** KOH_TRIB12_1 **Ownership** Auckland Council

**Asset ID:** 2000334580 **Area:** 6921m$^2$

**Description**

Active erosion of both banks with slumping occurring particularly the TLB. Stormwater flows from a 1500 mm diameter pipe (2000334580) are causing scouring and undercutting of bank. The asset is a safety risk to the public as it has an unconstrained drop height of 1.6 m.

**Opportunities**

- Water Sensitive Design programme focused on stormwater attenuation through at source controls on private property e.g. rain tanks.
- Investigate armouring and/or dissipating structures on stormwater outlet or bank batter regrade and planting.
- Investigate the installation of a safety barrier above the pipe to improve public safety.

**Considerations**

- Working with community groups and supporting their existing riparian planting and water sensitive initiatives.
- Surrounding typography, upstream catchment size and land use, geology and soil types, and groundwater.

**Significant Linkages**

Inanga spawning habitat enhancement.

| **Enhancement Types** | **Stakeholders** |
|---|---|
| Conveyance Improvements | AC Healthy Waters |
| Erosion Protection | AC Parks |
| Weed Control and Planting | Community Groups |
| Community Engagement | Residents |

**Mass wasting and slumping in the channel (Tributary ID: KOH_MAIN_10). Floodplain could be enhanced for inanga spawning habitat.**

**Erosion where the flows from the outlet (asset ID: 2000229311) hit the adjacent bank.**

**Asset ID 2000229311 with an unconstrained drop height of 1.6m close to the walking path.**

## EO7 – Daylighting at Glendowie Park


**Location:** Glendowie Park, 146A Riddell Road, Glendowie.

| | |
|---|---|
| **Tributary ID** GLE_MAIN_1 | **Ownership** Council |
| **Asset ID** Shown on map | **Area:** 8451m$^2$ |

**Description**

The approximately 470 m of piped watercourse is situated in Glendowie Park, an off-lead dog park, upstream of the Glendowie stream mouth. The reach has limited ecological value and it is likely that the park functions as an OLFP during certain rain events however there was no evidence of this on site. The upstream open watercourse has high potential ecological value.

**Opportunities:**

- Improve ecological function and value of watercourse through daylighting while maintaining stormwater conveyance and not exacerbating channel erosion.
- Improve habitat connectivity in the sub-catchment.
- Improve flow attenuation and flood control.

**Considerations**

- The alignment of the open channel to maximise usable land for other recreational activities
- Potential constraint formed by the depth to invert of approximately 1.5 m and crossing of a wastewater pipe (855813, unknown invert) at the top of the park.

**Significant Linkages**

Upstream open watercourses in Churchill Park (GLE_MAIN_5 to 12). EO1 and EO2.

| **Enhancement Types** | **Stakeholders** |
|---|---|
| Daylighting | AC Healthy Waters |
| Conveyance Improvement | AC Parks |
| Erosion Protection | Community groups |
| Naturalising (habitat enhancement) | Residents |

**Glendowie Park with the piped channel underneath (GLE_MAIN_1).**

**The stream mouth downstream of the piped reach.**

**Glendowie Park with the piped channel, photo looking downstream.**

# 7.0 Conclusions

## 7.1 Watercourse Summary

The Eastern Bays catchment encompasses a total area of 6.03 km$^2$ and is drained primarily by Mission Bay Stream, Kohimarama Stream and the Dingle Dell Stream. The Glendowie catchment is 4.3 km$^2$ and is primarily drained by Glendowie Stream and Tāhuna Tōrea Stream.

The Central Eastern Bay and Glendowie catchments are developed areas dominated by urban land use, with few public green spaces. In the Auckland Unitary Plan, they are designated as residential – large lot zone and mixed housing urban zone. The catchments are heavily developed, with the 50.5% impervious area in the Eastern Bay catchment and 37.9% impervious in the Glendowie catchment.

Many watercourses in the surveyed area are severely modified through extensive bank and channel lining, with mixed riparian cover with a low longitudinal extent. In many cases the open watercourses were short (the average length was 72 m) interspersed with short culverts and longer sections of piped stormwater network. Only 12 artificial and natural wetlands were found in the survey area, with riverine wetland being the most common natural type and dry detention ponds artificial type.

A total of 10.66 km of open watercourse was affected by a fish passage barrier of some kind (complete, temporary or partial). A total of 104 structures were found to be some form of barrier to fish passage, with five of these being natural structures: cascades and waterfalls (Table 21). A total of 19 fish observations were recorded in the survey area. Most of these observations were shortfin eels, banded kokopu and unidentified bully. The two Auckland Council parks; Dingle Dell and Churchill Park have the most significant, intact regenerating native bush in the surveyed area. However, these reaches were also incised from fluvial processes, had erosion associated with stormwater outlets, noxious weeds, some stock access.

## 7.2 Management Zones, Enhancement Opportunities and Recommendations

In an urban environment, where extensive sections of the catchment have been severely modified and piped, it is a challenge to preserve the natural character of streams. Areas of outstanding natural character include watercourse In Dingle Dell reserve and the wetland and saltmarsh habitats of Tāhuna Tōrea. The key opportunities for these catchments include:

- Daylighting of piped watercourses within Auckland Council parks and reserves.
- Enhancement of modified watercourses.
- Remediation of fish passage barriers.
- Enhancement of instream and riparian habitat by utilising soft-engineering approaches.
- Promote community awareness and engagement to protect and enhance waterways.
- Community programmes for urban stream management and water sensitive design including advice on flooding, erosion, riparian planting, fish passage and water quality.

The findings of the field survey were used to categorise the watercourse reaches into five Management Zones. The Management Zones have overarching descriptions of reaches with similar pressures and issues. The purpose of categorising the reaches into management zones is to summarise key values, assessments and recommended actions at a high level to guide unified management across the wider catchment.

Across the survey area, a total of seven enhancement opportunities have been identified; with three proposed projects in the Eastern Bays catchment and four proposed projects in the Glendowie catchment. The enhancement opportunities highlight discreet areas where ecological, conveyance and, or amenity values could be improved.

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# Appendix 1 Maps

# MAP 1 - OVERVIEW MAP


**Ecoline (WAM)**

- Permanent
- Intermittent
- Ephemeral

**Wetland**

- Natural
- Artifical
- Stormwater Catchments

- SEV Lines
- Piped Section

Client AUCKLAND COUNCIL

Project **EASTERN BAYS WAR**

0 500 1,000 m

Project no. P02062

Date 14 Jun 2019

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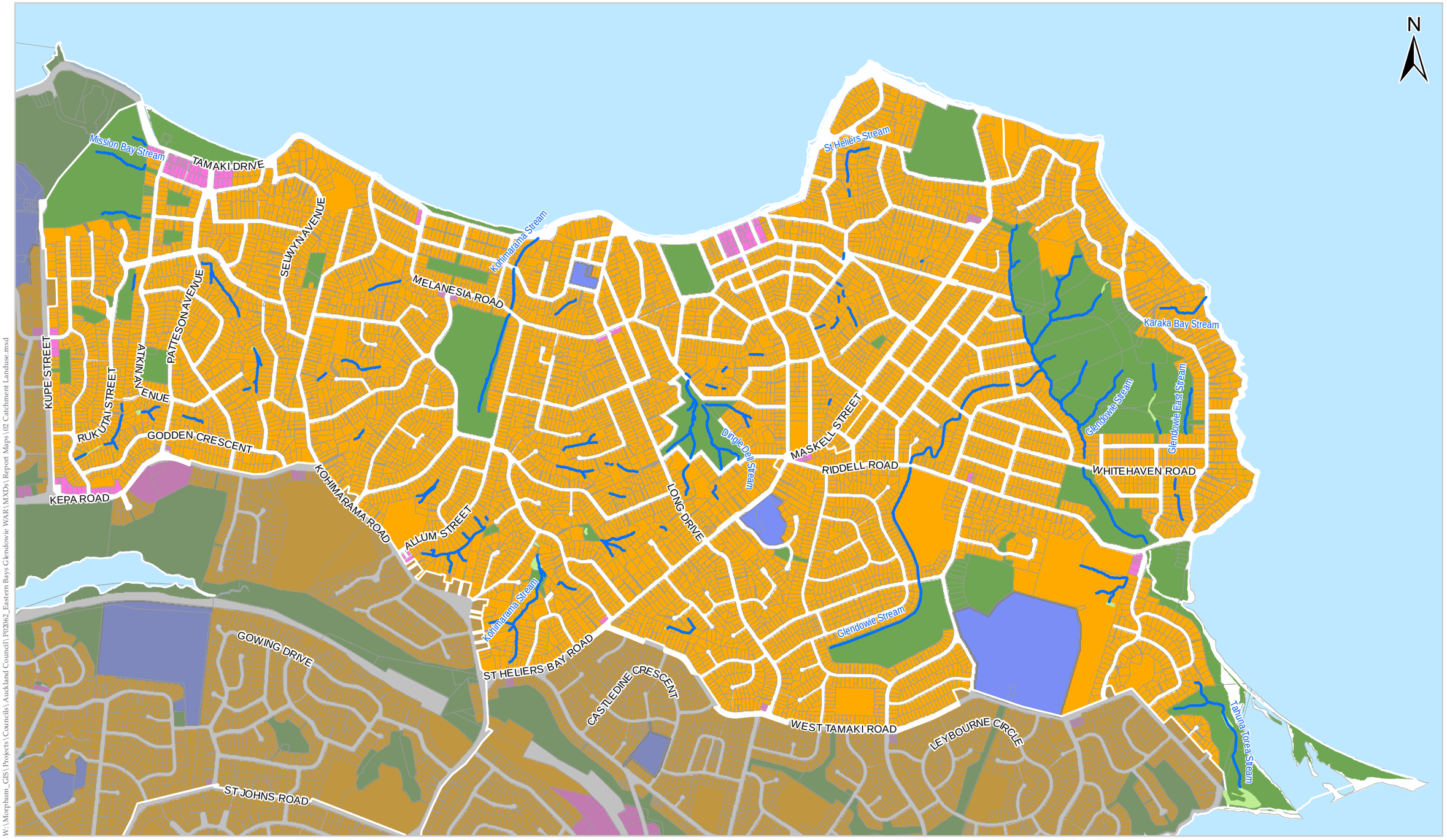
# MAP 2 - CATCHMENT AND LANDUSE

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**AUP-OP Base Zone**

- Business
- Open Space
- Special Purpose
- Rural
- Residential
- General
- New Growth
- Stormwater Catchments
- Ecoline
- Wetland

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# MAP 3 - BANK AND CHANNEL MODIFICATION & EXTENT


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**Bank and Channel Lining**

- Cast In Situ Concrete
- Galvanised iron or steel
- Gabion Basket
- Masonry Block
- Other
- Reno mattress channel
- Rock
- Timber
- Ceramic/Earthenware

**Stormwater Fitting**

- Catchpit
- Inlet or outlet
- Quality/Treatment device
- Stormwater Drain

- Stormwater Catchments
- Ecoline - no modifications
- Ecoline - other channel modifications
- Piped Section

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# MAP 4 - ASSET MAINTENANCE ISSUES


**Erosion Scars**
- <20%
- 20-40%
- 40-60%
- >60%

**Inlet/Outlet Asset Issues**
- Minor
- Moderate
- Severe
- Could not locate

**Bank Stability**
- Excellent
- Good
- Fair
- Poor

**Pipe Asset Issues**
- Minor
- Moderate
- Severe
- Erosion Hotspot

- Stormwater Catchments
- MIsc. Point

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# MAP 5 - RIPARIAN VEGETATION


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**Overhead Shading**

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

- Notable Trees
- Weed Infestation
- Significant Vegetation/Trees
- Covenants
- Public Open Space
- Significant Ecological Areas
- Stormwater Catchments

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# MAP 6 - INANGA AND FISH INCL. MISC DATA

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**Fish Survey**
- Anguilliform
- Climber
- Swimmer
- Exotic

**NZFFDB**
- Anguilliform
- Climber
- Swimmer
- Exotic
- N.A.

**Nat. Barrier to:**
- Anguilliforms
- Climbers
- Swimmers

**Eng. Barrier to:**
- Anguilliforms
- Climbers
- Swimmers

- Barrier to Swimmers
- Stream Mouth

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# MAP 7 - MANAGEMENT ZONES


**Management Zone**

- 1
- 2
- 3
- 4
- 5

Stormwater Catchments

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