AUCKLAND WATERWAYS

Our drainage network resource consent project

Oakley Creek Watercourse Management Plan

October 2010

metrowater

AUCKLAND City Council

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Executive Summary

Auckland City Council and Metrowater have developed an integrated stream management framework, based on the city's stream classification system, to provide guidance on stream objectives and management options. One of the central aims being to manage the often competing stream functions and, where possible, to improve the values of urban watercourses.

The framework, as with the classification system, has been developed at a broad city-wide level and provides high-level guidance. At an implementation level, and in order to achieve the management objectives, it is then necessary to determine the stream specific management actions.

A Watercourse Management Plan (WMP) provides a tool to describe specific management actions and restoration opportunities to improve watercourses. WMP's provide a detailed assessment of the structure and nature of the stream, its values, threats, opportunities, and how key stakeholders and the community can play an active role in stream enhancement.

In the development of this WMP, Morphum Environmental Ltd was engaged by Auckland City Council and Metrowater to undertake a detailed assessment of Oakley Creek and the associated stormwater infrastructure and to prepare the management plan.

The detailed stream assessment was based on the Auckland City Urban Stream Classification 2004 (Webster et. al., 2005), Framework for Assessment and Management of Urban Streams in the Auckland Region (Auckland Regional Council TP232, 2004) and the Morphum Environmental Ltd Stream and Asset Survey Methodology (2007).

In-stream and related variables were assessed including ecology, engineering infrastructure, and potential barriers to fish passage. The assessments included identifying riparian vegetation types and overhead cover, channel and bank modifications, in-stream and stormwater outfall erosion.

This WMP includes the following types of information:

i. Ecological, sediment and water quality data;

ii. Engineering Asset Maintenance Schedules and assessment summaries;

iii. Management Zones (MZ) with high level objectives for management;

iv. Areas of Restoration Opportunities (RO) with suggested enhancement and mitigation options; and

v. Spatially mapped information indicating stream ecology, engineering assets and maintenance issues.

In its upper reaches Oakley Creek is highly modified and has been piped, lined and walled in many locations. As the watercourse gets closer to the sea so the degree of naturalness increases. The watercourse has some channel erosion and generally can be described as having moderately stable channel structure, although there are some areas of localised erosion identified as Erosion Hotspots. Erosion at stormwater outfalls is not considered to be a major problem in Oakley Creek.

Restoration Opportunities have been identified at 18 locations. These have been prioritised with RO 3 ranked the top priority, located at the Oakley Creek Waterfall, as it provides the multiple benefit potentials of improving amenity and ecological values as well as potential to enhance conveyance and drainage. The Oakley Creek Waterfall is a unique feature of the creek and is a popular recreation spot. Investigating and implementing adequate fish passage up the waterfall is the top priority for this site. Improving the riparian vegetation on the margins of the waterfall will also improve amenity.

Some of the key values and qualities of Oakley Creek, making it unique and of in interest include:

- The stream mouth of the creek enters Motu Manawa Marine Reserve. It has a broad tidal area with a transitional interface from marine, brackish to freshwater ecologies.
- Included in the stream mouth, in its upper margins, is an area of potential inanga spawning habitat that is characterised by floodplain areas dominated by sedges and grasses at the upper extent of the spring tide margin.
- A spring fed tributary, the Wairaka Stream, flows through Unitec and provides habitat for several fish species.
- Community interest in the waterway is high. This is particularly demonstrated in the lower reaches where extensive riparian planting, weed management and pest control is being carried out by Friends of Oakley Creek.

- The creek is of good ecological value and is an example of a relatively natural stream in the lower reaches. In addition, the Oakley Creek Waterfall is a unique feature, adding to the interest in the waterway.

Some of the main issues identified in Oakley Creek that require active management include:

- Stormwater outfall erosion mitigation (48 Outfalls);
- Improving and maintaining riparian cover along length of creek;
- Erosion mitigation and bank stabilisation as identified in this report;
- Consideration of future changes to the creek and its catchment, particularly as a result of the SH20 Extension;
- Communication with Friends of Oakley Creek as an important stakeholder in the management of the creek and riparian margins;
- Continued collaboration with Friends of Oakley Creek and recognition of their weed management and vegetation restoration plan;
- Weed management in all reaches, but particularly upstream reaches to reduce requirements for weed management downstream;
- Stream mouth management (including specifically potential inanga spawning vegetation);
- Human contact with waterway after combined overflows occur (upstream reaches in particular);
- The need for potential improvement in access to and across the creek in the upper reserves;
- Rehabilitation of Oakley Creek waterfall to encourage upstream passage of native fish;
- Active management of aquatic fauna, through signage, education, pest fish control and monitoring;
- Naturalisation of artificially lined creek bed and banks to increase substrate heterogeneity and habitat complexity; and
- Management that is consistent with Auckland City Parks Services objectives.

A total of 307 engineering structures were assessed during the stream walk and asset survey. A total of 37 assets were recorded as having incorrect data in the Metrowater GIS records and a further 91 not recorded in the GIS system. There were 48 outfalls identified with erosion, 39 with slight erosion and nine with moderate erosion. 77 structures/outfalls were considered to require general maintenance including structural, erosion protection, debris removal and vegetation clearance. Safety issues associated with assets have been identified at six locations and four structures have been assessed to be impacting on fish passage.

The table below summarises the key findings from the stream survey which are discussed further in this report.

Summary Table Stream Walk Survey

Length of Surveyed Stream	16.43km open stream, 1.5km piped
Size of Catchments	12,094,498m^2
Catchment Imperviousness	49%
Receiving Environment	Motu Manawa (Pollen Island) Marine Reserve
Substrate	Predominately silt/sand
Wastewater Overflow Locations	Seven outfalls recorded as known WW or combined outfalls
Upper Bank Stability	Generally Fair to Excellent; Poor (1).
Sediment Load	Moderate sediment load through all reaches
Channel Modification	Modifications throughout including a total of 2.7km of bank lining
Visual Clarity	0.1 – 1 m
Natural Wetlands	Four
Artificial Wetlands	None
Invasive Plant Infestations	Extensive terrestrial weed infestations. Several aquatic infestations, primarily oxygen weed.
Macrophytes	18 reaches with >50% cover
Sewage Fungus at Outfall	Four identified locations. No sewage fungus was recorded at known WW outfalls.
Fish	11 species identified throughout the creek, including three exotics.
Potential Barriers to Fish Passage	Oakley Creek Waterfall forms a significant barrier to swimmers and climbers.
Engineering Assets	Total of 307 assessed. 37 have incorrect data in MW GIS and 91 are not recorded in MW GIS.
Erosion at Structures	Generally good. 48 assets with erosion including slight (39) and moderate (nine) erosion. Refer to Section 5.6 for erosion management recommendations.
Bank Erosion	Ranging with slight to moderate areas. Five reaches with >70% erosion on one or both banks and 13 Erosion Hotspots

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Table of Descriptions for Codes and Abbreviations

Code/ Abbreviation	Description
ACC	Auckland City Council
ANZECC	Australian and New Zealand Environmental and Conservation Council
ARC	Auckland Regional Council
ARC TP	ARC Technical Publication
BOD	Biological Oxygen Demand
CCTV	Closed Circuit Television
DMID	Data Management ID (Metrowater)
ECO ID	Ecological Line ID (Reach ID)
EMS	Auckland Waterways Receiving Environment: Environmental Monitoring Strategy
ENG	Engineering Asset
EUM	Environment and Utility Management
FOC	Friends of Oakley Creek
GIS	Geographic Information Systems
GPS	Global Positioning Systems
H&S	Health and Safety
ICMP	Integrated Catchment Management Plan
MEL	Morphum Environmental Ltd
MW	Metrowater
MU	Management Unit
MZ	Management Zone
NAT	Natural Structure
NSCC	North Shore City Council
NIWA	National Institute of Water and Atmospheric Research
NZFFD	New Zealand Freshwater Fish Database
OAK	Oakley Creek
OLFP	Overland Flow Path
PARP: ALW	Proposed Auckland Regional Plan: Air, Land and Water
PDA	Personal Digital Assistant
RCT	Roy Clements Treeway
RO	Restoration Opportunity
RPMS	Regional Pest Management Strategy (ARC)
SEV	Stream Ecological Valuation (ARC)
SW	Stormwater
TLB	True Left Bank
TRB	True Right Bank
WW	Wastewater
WL	Wetland
WMP	Watercourse Management Plan

Table of Scientific and Common Names for Flora and Fauna

Scientific Name	Common Name
FLORA	
Asparagus scandens	Climbing Asparagus
Araujia sericifera	*Moth Plant*
Avicennia marina	Mangroves
Brugmansia candida	Angels trumpet
Cortaderia spp.	Toetoe
Cyperus eragrostis	Umbrella sedge
Dysoxylum spectabile	Kohekohe
Egeria densa	Oxygen weed
Fissidens berteroi	Rare aquatic moss
Ipomoea indica	Blue morning glory
Juncus articulatus	Jointed rush
Juncus gregiflorus	Wiwi
Leptospermum scoparium	Manuka
Ligustrum lucidum	Tree privet
Ligustrum sinense	Chinese Privet
Lonicera japonica	Japanese honeysuckle
Melicytus ramiflorus	Mahoe
Paraserianthes lophantha	Wattle
Phormium tenax	Flax
Plectranthus ciliatus	Plectranthus
Pittosporum crassifolium	Karo
Salix fragilis	Crack willow
Setaria palmifolia	Palm grass
Solanum mauritianum	Woolly nightshade
Sophora spp.	Kowhai
Tradescantia fluminenis	Wandering jew
Tropaeolum majus	Nasturtium
Typha orientalis	Raupo
Ulex spp.	Gorse
Vitex lucens	Puriri
FAUNA	
Anguilla dieffenbachii	Longfin eel
Anquilla australis	Shortfin eel
Crassius auratus	Goldfish
Cyprins carpio	Koi carp
Galaxias fasciatus	Banded kokopu
Galaxias maculatus	Inanga
Gambusia affinis	Gambusia/mosquitofish
Gobiomorphus cotidianus	Common bully
Gobiomorphus huttoni	Redfin bully
Paratya curvirostris	Shrimp
Retropinna retropinna	Common smelt
Escherichia coli	*E. coli*

SECTION 1: Introduction

The Watercourse Management Plan for Oakley Creek is an innovative document incorporating technical and management aspects to comprehensively and sustainably manage, improve and maintain the main stream functions - stormwater conveyance, habitat and public amenity - of an urban watercourse.

1.1 Purpose

The purpose of this Watercourse Management Plan (WMP) is to provide a management document that can be used by Auckland City Council and Metrowater in conjunction with other community stakeholders in order to effectively manage Oakley Creek. A Management Plan enables a more focused and integrated approach to improving stream management and is a core resource used in achieving multiple objectives within realistic environmental, economic and social constraints.

This WMP recognises the primary stormwater function of the Oakley Creek, while also taking into account aims to improve or maintain the ecological and amenity values of the watercourse. These aims are often competing with the primary stormwater function.

Deliverables for this WMP aim to:

- Summarise strategic high-level objectives for watercourse management;
- Summarise existing studies and review existing datasets;
- Collect data (including stream morphology/function/chemistry/ecology, asset location and condition) where significant gaps exist via a stream walk survey;
- Identify issues (erosion/pollution) and outline solutions to help achieve the high-level objectives;
- Identify Management Zones and describe management options;
- Identify restoration opportunities to help achieve the high-level objectives;
- Provide details for potential liaison with the community; and
- Consider other projects to ensure integration and collaboration.

1.2 Objectives

The ongoing maintenance and management of Oakley Creek aims to achieve the following key objectives:

i. To maintain effective stormwater conveyance;

ii. To manage and maintain discrete assets;

iii. To support the maintenance or improvement of the amenity value of adjacent parks and reserves by identifying opportunities to integrate stream outcomes with Reserve Management Plans;

iv. To implement actions which serve to support watercourses as self sustaining systems that requires less maintenance in the long term;

v. To seek to achieve cultural, social, economic and environmental objectives where possible (quadruple bottom line objectives).

vi. Improved ecological function and values of riparian and in-stream ecosystems;

vii. Improved incorporation of network infrastructure and the watercourse in planning procedures;

viii. To meet regulatory requirements and relevant levels of service; and

ix. To communicate the identified values and opportunities to key stakeholders (E.g. by use of the Metrowater corporate GIS system and/or online information systems).

In summary the objective of the this WMP is to improve the management of the watercourse by documenting its existing state (including in-stream assets) and values, identifying management issues (collapsed structures/stream channel erosion) and opportunities to improve the watercourse. In doing so it is important that enhancement actions and/or management are balanced against the primary stormwater conveyance function the watercourse provides. Management issues and enhancement opportunities can then be considered in the context of other programmes such as that of Auckland City Parks and the Community.

1.3 How to use this Document

The Watercourse Management Plan is a comprehensive document which relies on tables, schedules and maps to provide concise information and potential management actions.

The WMP document consists of background to the watercourse, Management Zones, network and asset maintenance actions, and Restoration Opportunities. These sections are supported by a number of resources provided in the Appendices which should be referred to whilst reading the body of this WMP document.

More technical information, including ecological content, surveying methodologies and data collected during the 'Stream and Asset Survey Assessment', is presented in the Oakley Creek Technical Report.

1.3.1 The WMP

The WMP includes details of the objectives and management actions for Oakley Creek. It draws on information contained in the Technical Report that follows on from the WMP document.

Both the WMP document and Technical Report refer to the same Appendices. Figure 1 provides a guide to the WMP structure.

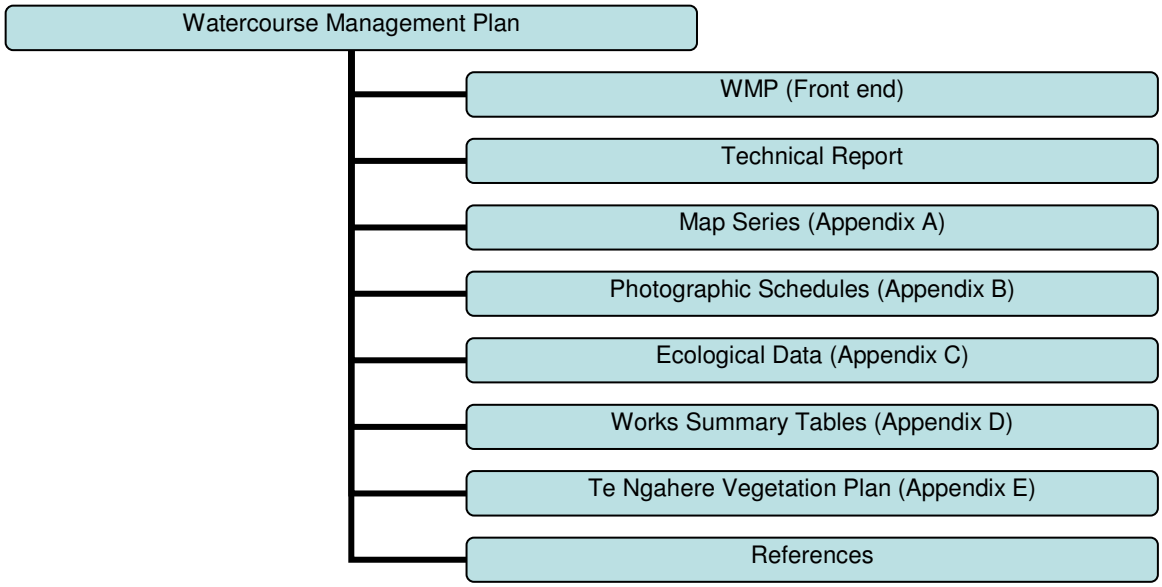

Figure 1: WMP Structure Guide

Reference numbers are used in tables and maps i.e. ECO ID 1, MZ 1, RO 1. Asset ID numbers are included in information tables and on maps and can be used to search the Metrowater GIS system.

A *Table of Codes and Abbreviations* and a *Table of Scientific and Common Names* used throughout this WMP follows the contents page for ease of reference for the reader.

1.3.2 The Technical Report

The Technical Report presents data gathered from a comprehensive stream walk survey carried out by Morphum Environmental Ltd from February to May 2009. It should be used in conjunction with the WMP document as the technical basis for the management objectives identified.

A more detailed background regarding the ecological and environmental aspects of the watercourse is presented in the Technical Report.

SECTION 2: WMP Background

Metrowater undertake the planning and management function of stormwater infrastructure, including watercourses, on behalf of Auckland City Council, Environmental and Utility Management.

This typically involves clearing of channels, removal of noxious materials and riparian management activities including planting, weeding and inspection.

There are five 'public' watercourses that Metrowater maintain and enhance (primarily for stormwater conveyance) through operations and maintenance activities. These include:

- Meola Creek
- Motions Creek
- Newmarket Stream
- Oakley Creek
- Remuera Stream

Their combined total length is 33.6 km with approximately 5.4 km of these being lined (having lined channel bed and lined walls) and 11.3 km being walled. In addition Auckland City Council actively manages sections of other watercourses including:

- Bowden Road, a concrete lined channel
- Kohimarama Stream
- Whau Creek (in part)

Streams are an important environmental asset in Auckland City and form an integral part of the stormwater drainage system. Development has resulted in the removal of riparian vegetation, construction in streambeds and flood plains, and piping or channelisation of streams. This development has resulted in changes to catchment hydrology and flow regimes including increased peak flows and reductions in base flows.

2.1 Watercourse Management

Improved management of the city's five public watercourses requires knowledge of their current state, and potential opportunities and priorities for improvement.

The WMPs are the vehicles for consolidating this information and identifying management requirements to maintain the function of the watercourse. The WMPs also help to identify opportunities and define priorities for improving the state and values of the watercourse. They aim to identify key values, constraints, management actions and restoration opportunities.

The Oakley Creek WMP draws on information from a comprehensive stream walk survey carried out by Morphum Environmental Ltd, the details of which are provided in the Oakley Creek Technical Report. The survey assessed ecological attributes including water quality, stream morphology, erosion, and riparian vegetation, as well as engineered structures and network assets. The survey also identified asset maintenance issues and potential areas for restoration.

2.2 Scope

The scope of this project was to survey Oakley Creek in order to provide the necessary information to assist in the development of a watercourse management plan that could be used to achieve the following:

- Improve channel and asset operation and maintenance;
- Define reach specific management objectives;
- Enhance ecology;
- Increase amenity value; and

- Identify restoration opportunities.

Additionally it is intended that a management plan will be developed to be a resource for key stakeholders to refer to when planning local and catchment scale projects.

The area for management is generally defined by the publicly owned length of Oakley Creek. The upper extent begins in Mt Roskill South and flows through to Waterview in the western suburbs (refer to Appendix A, Map 1 for an overview).

The following documents have been considered when preparing this WMP and have been used to help identify issues, highlight constraints and define opportunities relevant to the management of the Oakley Creek watercourse:

- The Auckland City District Plan (Isthmus) (Auckland City Council, 1999);
- Auckland City Stream Management Framework (Kingett Mitchell, 2006);
- Relevant NIWA and other technical studies;
- Auckland City Council Parks Management Plans;
- Auckland City Council Watercourse Guidelines; and
- The 2010 Auckland City Council Watercourse Maintenance Contract (SW-10-WCMC-1).

2.3 Watercourse Management Integration

Watercourse management is the integrated and dynamic management of an entire watercourse. While it is necessary to manage and maintain assets individually there are often network linkages that should also be considered. Thus it is important the watercourse is assessed as a whole, examined on a reach by reach basis to determine the best possible management approach for the entire waterway, recognising that the issues and considerations may differ between reaches.

The Oakley Creek WMP seeks to encourage collaboration between key stakeholders so that future management efforts can focus enterprises on four main elements:

- Network operations and asset maintenance;
- Ecological functions;
- Community and amenity associations; and
- Existing plans.

These elements should serve to achieve the multiple objectives of the WMP. The diagram shown in Figure 2 illustrates the combination of elements required to develop the WMP.

Figure 2: Watercourse Management Plan Input Diagram

2.4 Auckland City Council Watercourse Maintenance Contract

The routine maintenance of these watercourses is carried out under Metrowater's Watercourse Maintenance Contract to maintain and operate the public watercourses. This includes reactive, planned and routine maintenance such as:

- Regular monitoring and inspection of the waterways, identifying and reporting on faults;
- Cleaning and maintenance of litter traps;
- Mowing and maintenance of streambanks to minimise erosion and maintain stormwater conveyance;
- Minor works on outfalls, erosion protection and walling maintenance;
- Removal of terrestrial and aquatic weeds;
- Removal of trees, debris and deposited sediment to maintain effective stormwater conveyance;
- Monitoring of pollution incidents and dumping of waste;
- Planting of riparian vegetation to enhance ecological function and amenity value; and
- Preparing monthly reports of inspection results, completed works, identified faults, emergencies, major incidents and instructed works.

Existing routine maintenance is shown in Appendix A, Map Series 9. Each maintenance activity is represented by different coloured areas as defined in the map key. The types of maintenance activities and their definitions are presented in Table 1.

Table 1: Auckland City Council Watercourse Maintenance Contract (SW-10-WCMC-1) Activities

ID	Type	Definition
1	Weed Eating and Mowing	Weed eating and mowing
2	Aquatic Weed Control	Aquatic weed removal and control
3	Hand Release/Targeted Control	Terrestrial vegetation hand release taking care not to disturb existing desired plants and targeted control using mechanical and spray removal control
4	Auckland City Council Parks Mulch Gardens	Mulch gardens managed and maintained by Auckland City Council Parks
5	Clean/Remove Debris and Litter	Remove litter and debris from streambanks and adjacent areas
6	No Maintenance Required	No maintenance required by Auckland City Council or other agency responsibility
7	Silt Removal	Areas where silt may build up and need to be removed.

SECTION 3: WMP Process

3.1 Outputs and Outcomes

The tools and processes for WMP reporting and GIS information structure will include but not be limited to the following basic elements:

i. Management Zones (MZ) integrating infrastructure, amenity, conveyance and ecological management objectives for potential implementation;

ii. Engineering Asset Maintenance Schedule;

iii. Areas of Restoration Opportunities (RO) with suggested management and mitigation options;

iv. Spatially mapped information indicating stream ecology, engineering assets, maintenance issues, MZs and ROs; and

v. GIS interface specialised layers available to Auckland City Council/Metrowater.

The WMP is a living document, with information sets that are viewable through GIS and supported through updated information when available. The information flows and outputs are shown in Figure 3 to illustrate these processes.

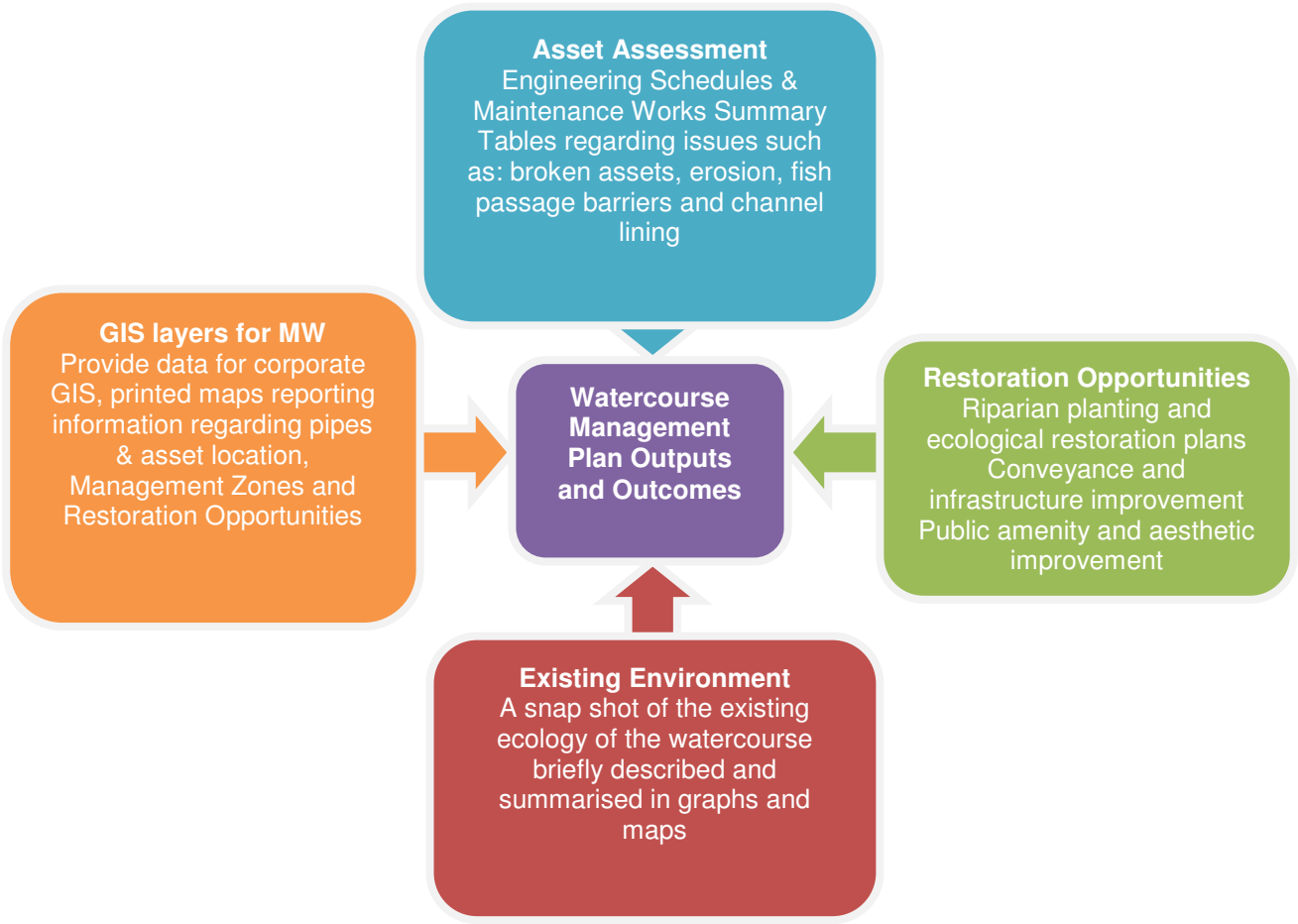

Figure 3: Outputs and Outcomes of the WMP

3.2 Management Zones

Oakley Creek has been divided into Management Zones (MZ) in order to group similar areas in the watercourse for the purposes of having functional management units and geographic terms of reference. This zoning has been defined by considering similarity in stream morphology, presence of channel and bank modification, erosion, riparian vegetation, and major structures such as roads dividing stream sections. Restoration Opportunities (RO) such as habitat enhancements are referred to within each MZ and are presented in Appendix A, Map Series 7.

Management objectives and actions have been developed in consideration of existing plans and each MZ includes a general description, details of linkages with parks/reserves and outlines objectives for the area.

It should be noted that detailed plans should take into account objectives of the Auckland City Council Parks Services, and other key stakeholders as appropriate. It is recommended that the Planning and Works Scoping checklist, as presented in Section 3.3, is considered when planning management actions.

Section 10 Oakley Creek Management Zones provides the detailed outputs and recommendations within each Management Zone, summarising the key values, assessments and recommended actions. The summary is supported by Section 11 Oakley Creek Restoration Opportunities which present, in detail, possible management interventions. Table 2 includes a summary of the MZs and the reaches and ROs within them.

Table 2: Management Zone Summary

Management Zone (MZ)	Location/Stream Reaches	Restoration Opportunities (RO)
MZ1	Oak1-11, Wai_1-13 Oak Trib 1	RO1, RO2, RO3
MZ2	Oak 12-24 Oak Trib 2	RO4, RO5, RO6, RO7, RO8, RO9
MZ3	Oak 25-34 Oak Trib 3 Oak Trib 4	RO10, RO11, RO12, RO13
MZ4	Oak 35-41 Oak Trib 5	RO14
MZ5	Oak 42-53 Oak Trib 6 Oak Trib 7 Oak B1 1 and 2	RO17
MZ6	Oak 54-58	None
MZ7	Oak B1 3-9 Oak B1 Trib 1, 2, 3, 4	RO15, RO16
MZ8	Oak 59-62	None
MZ9	Oak 63-66 Oak Trib 8 Oak Trib 9a, b	RO19
MZ10	Oak 67-70 Oak Trib 9c, d	None
MZ11	Oak B21-8 Oak Trib 10	RO18

3.3 Planning and Works Scoping Process

When preparing restoration plans and maintenance works the scoping process should integrate ecological, amenity and network infrastructure requirements. Additionally scoping should reflect the purposes and objectives of the WMP.

It is important that stream improvement works do not result in adverse impacts on the other stream functions, such as reduced floodwater conveyance increasing the potential risk of flooding habitable floors. The list below provides a summarised checklist that has been used as a guide in the preparation of Restoration Opportunity tables as

shown in Section 11. A similar checklist is recommended when planning maintenance and infrastructure works. Example as follows:

- Date, location, stream name, stream classification;
- Description of works, resource consent details, identified landowners and other stakeholders;
- Details of relevant management plans (including Integrated Catchment Management Plans (ICMP), WMP);
- Flood risk, importance for conveyance, overland flows;
- Bank stability/erosion, channel access;
- Engineering asset ID number, asset access, maintenance requirements;
- Existing vegetation, weed management required, planting unit to be used;
- Basis for approval of works, commencement and completion dates; and
- Project responsibility.

SECTION 4: Oakley Creek Overview

Oakley Creek is an urban stream which flows from Mt Roskill South through to Waterview in the western suburbs of Auckland City (refer Figure 5 for location). Oakley Creek suffers from pollution inputs from stormwater runoff and wastewater overflows. This is typical of many of the urban waterways in Auckland City. Presently management of Oakley Creek is the responsibility of Metro Water Limited (Metrowater) for Auckland City Council (ACC).

The Auckland Regional Councils' (ARC) Proposed Regional Plan: Air, Land and Water Plan as shown in Appendix A, Map 1, defines Oakley Creek as a permanent watercourse. Oakley Creek passes through a number of historical, cultural and archaeological sites. It is valuable to the people of Auckland for its amenity, historical and stormwater conveyance values.

The primary function of Oakley Creek is for drainage as defined by the Auckland City Urban Stream Classification devised by NIWA (Webster et. al., 2005). As part of the WMP process the same method has been used and resulted in no significant change with the primary function of Oakley Creek being drainage. This is because the stream is highly modified and the catchment has a high level of imperviousness. Habitat scores range from 2 to 10 with an average of 6 throughout the stream. Habitat scores vary throughout the creek. For reaches Oak_13, 18, 21, 30, 31, 33, Oak_Trib_1, Wai_2 & 4 habitat is the highest scoring function. Amenity scores are relatively high throughout the creek but are highest in the reaches downstream of Oak_48).

Oakley Creek flows through a largely urban watershed that is highly modified, with an average catchment imperviousness of 48%. The upper reaches are highly modified and the headwaters are fed predominantly by surface flow, stormwater and wastewater discharges. The high level of catchment imperviousness is reflected in the modified nature of the watercourse. The middle to lower reaches of Oakley Creek are less modified and have a large area of open space which acts as a buffer between the creek and surrounding houses. Approximately 57% of the creek is buffered by more than 27 council parks and reserves. The potential for improvement of Oakley Creek has been recognised as being extremely high (Webster et. al., 2005).

The lower reaches are in a relatively unmodified natural state with public access pathways a common feature. A 6m high waterfall in the lower reaches is a significant natural feature and marks a change in fish fauna populations as it is a barrier to most fish species.

A very dedicated community group, the Friends of Oakley Creek, led by Wendy John, have ensured restoration and enhancement of the lower reaches occurs. An estimated 23,000 plants have been planted in the lower reaches (below New North Road) over a 5 year period (Wendy John, personal communication, October 1, 2009).

The Western Ring Route motorway extension, joining the Auckland Airport and the Northwestern Motorway, has had significant impacts on the upper reaches of the creek. This has resulted in the loss of open sections of channel. The ongoing motorway construction works has and will continue to put further pressure on stream health. Connectivity between reaches in the upper sections has been lost as a consequence of piping. At least three sections of the creek are separated by long lengths of piping. Continued works are proposed for the next 4-8years beginning in 2009, extending the existing motorway (to Maioro Street, New Windsor) to the meeting of Great North Road and the Northwestern Motorway at Waterview. Current plans suggest there will be varying degrees of impact on the entire length of stream. This is discussed further in Section 4.3.

Receiving Environment

Oakley Creek discharges to the Motu Manawa (Pollen Island) Marine Reserve in the Waitemata Harbour. The point of discharge is near the Waterview on-ramp to the Northwestern Motorway and the reserve is located around the motorway (See Figure 4).

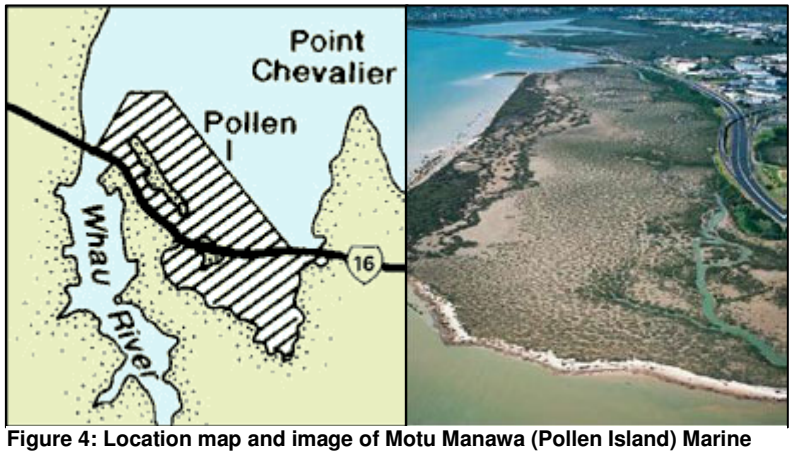

Figure 4: Location map and image of Motu Manawa (Pollen Island) Marine Reserve, Waitemata Harbour, Auckland.

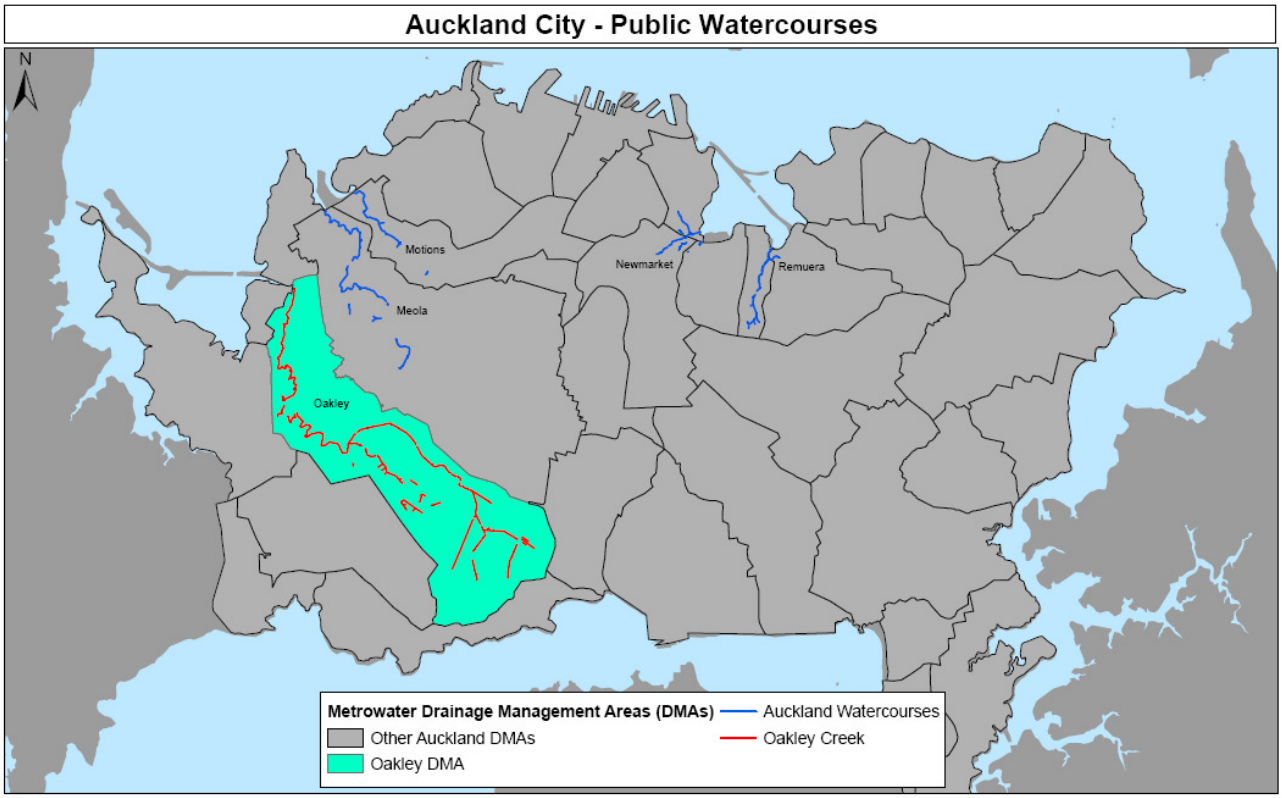

Figure 5: Auckland City public watercourse and DMA's including Oakley Creek, highlighted in green and red.

4.1 Literature Review

There have been a number of stream studies in Auckland City, involving assessments of natural, physical and cultural characteristics. Most of these studies have been limited to representative reach lengths or spot sampling, however these investigations have been well resourced and of a high standard. There has been some physical habitat mapping but this has often utilised aerial photography for these broader scale assessments rather than full stream walk surveying.

Oakley Creek and its catchment have been the focus of a number of assessments and studies particularly in the context of the State Highway 20 Motorway Extension. Studies have been extensive, including assessments of the riparian margins, pests, weeds, heritage sites in addition to in-stream values. Previous studies for Oakley Creek and its contributing catchment are discussed below.

4.1.1 Proposed Auckland Regional Plan: Air, Land and Water (PARP: ALW) (and ARC TP232)

The PARP: ALW classifies waterways into permanent or intermittent depending on their continuity of flow. Auckland Regional Council Technical Publication 232 (ARC TP 232, 2004) assesses stream reaches depending on the extent of stream modifications and catchment imperviousness providing a guiding methodology for assessment. However, as streams in Auckland City are generally modified and the catchments highly impervious, this method has limitations. Most streams tend to fall into the type of Highly Modified Urban streams. Physical habitat mapping of the entire waterways was not undertaken during these studies.

4.1.2 NIWA Stream Classification Report

Auckland City and Metrowater have built on the PARP: ALW stream classification system, and the breadth of information on the nature and quality of the city's streams. They have developed a classification system that has been applied to the city's main watercourses to assist in their management (Webster et. al., 2005 and Kingett Mitchell & Associates, 2006).

The primary difference between the Urban Stream Classification system and the PARP: ALW is that it explicitly recognises the drainage and public (amenity) values of a watercourse in addition to the more traditional values of ecology/habitat. The classification system ranks each of the three primary values separately, providing a relative measure of each.

This system also provides a greater differentiation of the values found in the city's urban streams and allows more targeted management. In broad terms, the classification system concludes:

- The city's streams all play an important role in stormwater conveyance;
- Habitat quality, including riparian margins and degree of modification, varies significantly across the city's stream reaches; and
- Public amenity values, which include naturalness and accessibility, are also variable across the city with a slightly lower median score than habitat.

Specifically for Oakley Creek, this report identified that the upper reaches of the creek are in a very poor to poor-fair state due primarily to extensive channel modification. It is recommended that the main biological objective for these channels is fish passage as at low flows passage may be restricted. The mid to lower reaches of Oakley Creek are rated from fair-good to good and are in a more natural state. Riparian condition is improved, though there is localised erosion possibly due to high peak flows – an expected phenomenon given the large, highly urbanised contributing catchment. This report notes that the potential for improvement to Oakley Creek is extremely high. Improvements recommended include; planting the buffer of land between houses and the stream to improve shading and amenity, bank and channel stability and public access. It is noted that improvements would need to consider impacts on hydraulic performance of the creek.

4.1.3 KMA Stream Classification Report

To assist in better managing the city's urban streams, Auckland City Council and Metrowater commissioned Kingett Mitchell & Associates Ltd (KMA) to prepare a stream management framework, based on the city's stream classification system This framework provides guidance on stream objectives and options to improve the management of the competing functions and values of an urban watercourse.

Key elements of the framework include:

- Different stream objectives depending on the current state (classification) of the watercourse;

- Recognition of the competing functions and values of streams; and
- Different methods for working toward the stream objectives depending on the nature of stream ownership.

Like the stream classification system, the framework provides a high level view of objectives and actions. Therefore, an important tool for key watercourses is the development of Watercourse Management Plans that provide a detailed assessment of the structure and nature of the stream, its values, threats, opportunities and key stakeholders. This study supports a more focused and integrated approach to improving stream management. Physical habitat mapping of the entire waterways was not undertaken during this study.

4.1.4 Review and Summary of Aquatic Ecology of Urban Streams

Suren (2001) describes the aquatic ecology of Oakley Creek as an urban stream receiving stormwater. The study assessed 10 sites, the upper sites in Keith Hay Park, and the lower sites by the Oakley Creek Walkway near Unitec. The report discusses riparian vegetation, bank and channel attributes, substrate and in-stream flora, water quality and biological quality which includes previous macroinvertebrate and fish surveys. Of note is that the report states that the pH ranged from 8-10. At pH of greater than 9.5 for long periods can be hazardous to aquatic life. Sides and Bennet (1998, in Suren 2001) suggest that macroinvertebrate fauna was species poor, indicative of typical urban streams, which differs from the results of the Bioblitz held in 2006 (see Section 4.1.10)(Moore, 2006). They also found only 2 eel species (longfin and shortfin) and *Gambusia affinis* in the creek, again contrasting with current information. The information presented in this report refers to a number of previous studies as well, and in summary states that Oakley Creek is of low quality in the upper reaches and moderate to high quality in the lower more natural reaches.

4.1.5 Environmental Weed Control and Native Revegetation Programme for Oakley Creek. Prepared by Te Ngahere for Auckland City Council. (Habgood, 2005)

Te Ngahere prepared a report for Auckland City Council regarding a restoration programme for the lower reaches of Oakley Creek (Habgood, 205). A survey of existing vegetation was carried out concluding that kauri podocarp-broadleaf forest is likely to have been the original vegetation cover through this area. Given the largely modified nature of the area presently this vegetation has been removed and it appears that mahoe (*Melicytus ramiflorus)* is one of the only native species remaining in any abundance that has not been planted.

This report also outlines existing restoration efforts in particular those carried out by Friends of Oakley Creek and partners. Management units are identified for planned restoration and areas requiring weed control.

See Appendix E for a copy of the document.

4.1.6 Benthos and Sediments of Motu Manawa (Pollen Island) Marine Reserve

This report documents the results of surveying of the benthos and sediment of the marine reserve during May 2002 (Sivaguru and Grace, 2002). Further information regarding this report can be found in Section 4.2.3 of this report.

4.1.7 Ongoing invertebrate monitoring by Auckland Regional Council (TR200810)

Surveys carried out between 2003 and 2007 are summarised in ARC TR200810 State of the environment invertebrate report document (Moore and Neal, 2008). Details from these surveys are summarised below:

- Oakley is representative of other soft bottomed urban streams with relatively low taxa richness (average of 12 taxa).
- Oakley Creek is representative of other soft bottomed urban streams with a relatively low MCI-sb score (average of 52) indicating an absence of sensitive invertebrates.
- Overall, Oakley Creek is defined as Poor (based on invertebrate data obtained over the surveyed period), which is consistent with other Auckland Metropolitan Area streams.

4.1.8 ARC TP327. Stream and River Water Quality Report 2005.

ARC TP327 defines Oakley Creek as being of urban land use and high disturbance (ARC, 2007). Regular monitoring of water quality allows for trends comparisons across different variables. 22 parameters were assessed between 2001 and 2005. Parameters included dissolved oxygen and temperature through to soluble and total metals and faecal coliforms.

4.1.9 ARC TP336: River water quality state and trends in Auckland Region.

Oakley Creek ranked 12 out of 25 Auckland streams in the ARC TP336 summary of water quality results from sampling between 1995 and 2005 (Scarsbrook, 2007). Results are included below (Table 3).

Table 3: ARC TP336 results for Oakley Creek

Site	Name	DO	TEMP	FAEC	NH_4-N	NO_X-N	DRP	TP	PH	SS	Turb	CL	COND	Mean rank
ARC 8110	Oakley @ Carrington Creek	8.3	15.5	1300	0.048	1.650	0.020	0.060	7.5	3.6	3.7	23.05	23.70	12

4.1.10 Bioblitz carried out by Wai Care and Stephen Moore (LandCare Research) and Unitec April 2006.

The BioBlitz event undertaken 22 April 2006 showed Oakley Creek as having moderate to high macroinvertebrates for an urban stream (Moore, 2006). Of particular note was the presence of freshwater mussels (*Hyridella* sp.) which indicate reasonably good water quality – something unusual for urban streams. In addition it has been noted that the habitat below the waterfall is very valuable for native freshwater fish (significant for an urban Auckland City stream).

Summary of freshwater biological sampling of Oakley Creek carried out on 22 April 2006:

- Supports native freshwater species likely to be valued by conservationists and water managers including:
    - Common bullies, inanga, estuarine triplefin, freshwater mussels and freshwater sponges.
    - An invertebrate sample taken from above the waterfall near Phyllis Reserve granted an MCI value of 69 and QMCI of 4.0.
    - No sensitive mayfly or stonefly species were observed, however *Triplectides* caddis were found which are of medium sensitivity.
- Key values of the stream can be summarised as follows:
    - Provide a valuable habitat for native fish species, particularly when compared to other Auckland City streams.
    - Water quality is good enough to support adult freshwater mussel species which are of medium sensitivity and do not usually occur in urban streams.

4.1.11 Ngati Whatua o Orakei Cultural Heritage Report

A cultural heritage report on five of Auckland streams by Ngati Whatua o Orakei in December 2006 describes the cultural significance of Oakley Creek and its catchment (Papa and Blair, 2006). This report is based on archaeological and historical studies undertaken by various parties and provides good background to the significance of the creek and the catchment.

Te Auaunga is the Maori name for Oakley Creek and means 'the whirlpool or swirling waters'. Occupation of Maori is evident from the extensive middens and archaeological features along the banks in the lower reaches. There are also a number of archaeological sites located within Unitec grounds. Te Wai-o-Rakataura is a major wetland that covered a large area near the headwaters of the creek. Historically the area of Mt Roskill Grammar and Keith Hay Park was a swampy lake, formed by lava flows from Mt Roskill (Puketapapa). It is these wetlands and swamps which served as valuable food resources and eel nursery grounds for Maori. Artefacts recorded from throughout the catchment include stone work, tools, pa sites, middens and various remnants of shellfish and fish.

Recommendations from the Cultural Heritage Report include developing a Catchment Management Plan that addresses: wahi tapu protection, signage and interpretation, wetland restoration, streambed restoration and riparian enhancements, water quality improvements, waka passage and provision of accessible cultural resources along the stream.

4.1.12 Summary

Existing studies are useful in detailing site specific habitat quality, localised stream health and providing management objectives. Further to this, they provide details of deleterious effects from water pollution and habitat degradation to in-stream faunal assemblages.

Total length waterway mapping can spatially define physical habitat parameters such as erosion extent/severity, sedimentation, habitat limitations, in-stream fish barriers and riparian vegetation quality and provide site by site resolution. Analysis of current literature indicates that this type of investigation has not been conducted to date.

4.2 Special Values

Oakley Creek has many ecological, historical and cultural special values that should be considered when developing management objectives and creating restoration plans. This section summarises these values, and any specific management actions that may relate to them. These special values are presented together in Appendix A, Map 3, Oakley Creek Special Values.

4.2.1 Oakley Creek Waterfall

Oakley Creek waterfall is a 6m high waterfall in the downstream reaches near the Unitec student village on Great North Road. There is a picnic area below the fall which is currently in a state of disrepair. There are plans to improve the amenity value of the recreation area and enhance existing riparian vegetation at time of writing. A public footpath is situated to the true left bank of the creek and allows access to a viewing platform at the top of the fall. Signage is currently in place to dissuade the public from swimming or playing in or near the water due to pollution and risk of falling. Members of the public who do not live in the area or do not frequent the public walkways often do not realise the waterfall exists.

The waterfall is considered to be a complete barrier to swimming fish species. However, due to the undercut face of the waterfall it is also a barrier to climbing species as the face inverts near the base. Additionally current public access to the top of the waterfall has impacted the marginal plants and mosses that would form a climbing substrate for fish passage. Also the waterfall, in a more un-impacted state, would have had a dense closed riparian canopy providing shade for light sensitive marginal species. It is possible with appropriate planting around the margins of the fall, in conjunction with restricted public access, that climbing species could be encouraged to access the extensive upstream habitat available.

4.2.2 Wairaka Stream

Wairaka Stream is a spring fed tributary entering Oakley Creek on the True Right Bank in the lower reaches behind Unitec. The stream starts in the Unitec campus, where clear spring water can be seen bubbling from a hole under rocks. At the time of the survey a number of banded kokopu (*Galaxias fasciatus*) were seen schooling near this discharge. The stream flows through the Unitec Campus and is moderately modified in parts. Several bullies (*Gobiomorphus* sp.) were found in the downstream reaches where overhead cover and substrate heterogeneity is improved. At the confluence of the lower reaches and the main channel a wetland has been restored as a result of revegetation planting by Friends of Oakley Creek. A footbridge has been installed to improve public access and connectivity with the environment. Wairaka Stream is a small tributary with huge potential given the clean water input at its headwaters and the single landowner.

4.2.3 Motu Manawa Marine Reserve

The Motu Manawa (Pollen Island) Marine Reserve was created in 1995 as a representative example of inner harbour ecosystems. Oakley Creek discharges into the Motu Manawa (Pollen Island) Marine Reserve in the inner reaches of the Waitemata Harbour. The Motu Manawa Marine Reserve is managed by the Department of Conservation Auckland Area Office and protects 500 hectares of intertidal mudflats, tidal channels, mangrove swamp, salt marsh and shell banks. The reserve is bounded by the industrial area of the Rosebank Peninsula to the south and the residential suburb of Waterview to the east. The Northwestern motorway runs through the centre of the reserve.

Marine Reserves are areas of sea and foreshore where all marine life is protected. The intertidal flats to the west of Pollen Island provide a rich feeding ground for white faced herons, pukeko, spotless crake and banded rail. Many other birds, native and migratory, frequent the marine reserve. The marine reserve is also home to many fish and shellfish as well as an abundance of tidal macrophytes and plants.

Marine sediments often capture heavy metals and contaminants and as a result are sensitive to high levels of contaminated discharge. As Oakley Creek discharges directly into the reserve, maintenance of acceptable levels of heavy metals and contaminants is necessary. Auckland Regional Council carries out regular monitoring of heavy metals in marine sediment. Oakley Creek is one of the sites monitored. Further information can be found in the following Auckland Regional Council Technical Publications:

- TP246: Marine Sediment Monitoring Results 2003 (Reed and Webster, 2004).
- TP203: Regional Discharges Project Marine Receiving Environment Status Report 2003 (Williamson and Kelly, 2003).

Since its inception in 1995, few surveys of Motu Manawa Marine Reserve's biological composition have been conducted. None have been systematic surveys and classifications of benthic community composition.

Evaluations of the bethos and sediments of the reserve were carried out in May 2002 by the Department of Conservation. The purpose of this survey was to document existing biota and provide recommendations for future monitoring regimes (Sivaguru and Grace, 2002).

The marine reserve has two main benthic associations; the enclosed inlet contains soft mud with relatively few species. In contrast the northern side of the embankment has a higher diversity of marine life, likely to be a result of the improved habitat consisting of shelly sandy sediments.

Ongoing monitoring has been recommended to determine changes in community composition and population boundaries. A notable recommendation relating to Oakley Creek is as follows:

"Oakley Inlet should be included in the sampling design to detect changes in species abundance and composition due to the increase in the accumulation of soft sediment because of the presence of motorway embankment." (Sivaguru and Grace, 2002).

Although a separate entity to Oakley Creek implications of change to Motu Manawa Marine Reserve should be taken into consideration when implementing management plans. Changes to sediment inputs, contaminants levels and flow regimes may influence the fundamental composition of the reserve, particularly in the Oakley Inlet area and immediate surrounds.

4.2.4 Inanga Spawning

Extensive riparian planting by community groups in the downstream reaches of Oakley Creek has resulted in an increase in the area of potential inanga spawning habitat available. The area immediately above the Great North Road culvert experiences tidal inundation making it suitable for inanga spawning along the marginal floodplain. Populations of adult inanga were observed and recorded in the lower reaches of Oakley Creek and the mouth of Wairaka Stream. Further studies are recommended to determine whether inanga currently spawn in this area.

4.2.5 Rare aquatic moss - *Fissidens berteroi*

Members of the Auckland Botanical Society recently carried out a vegetation survey in the lower reaches of Oakley Creek and found the elusive aquatic moss *Fissidens berteroi* (Wendy John, personal communication, 02 December 2009), previously only described at three localised sites within Auckland City (Bodmin & Wells, 2009). The moss is a nationally endangered aquatic moss, found in only two geographic regions, Auckland City and on the western side of Lake Wairarapa. The locations and density of the moss is unconfirmed at the time of going to print.

It is important to define the implications that changes in water flow, light and habitat provision may have on this rare moss when developing future management objectives and the watercourse maintenance contract for this area of Oakley Creek. For example, it is recommended that willows are not removed as this is where *F. berteroi* predominantly occurs. Beever (1995) discusses the morphology, ecology and distribution of *F. berteroi* in greater detail with implications for management.

4.2.6 Freshwater Mussel

Oakley Creek is likely to retain a small population of the native freshwater mussel *Hyridella menziesi* in the lower reaches. Previous macroinvertebrate studies (e.g. Moore, 2009) have noted specimens near the litter trap in the very lower reaches of the creek. During the course of the stream walk another specimen was located further upstream, near the Unitec entrance to the creek walkway. Freshwater mussels are a 6 on the MCI-SB index and are indicative of moderate to good water quality (Stark & Maxted, 2004). This is a significant finding for the creek as it shows the water quality is sufficiently high to support good quality fauna.

Figure 6: Freshwater mussel found in lower reaches of Oakley Creek during Stream Walk (10/03/09)

4.2.7 Historic Walled Reaches

In the upper reaches of Oakley Creek near Memorial Avenue there is a section of creek which is very contained within rock lined banks. These sites are recognised by Auckland City Council as being historic and contributing to a sense of place.

4.2.8 Historical & Cultural Special Values

The district plans identify a number of archaeological and ecological sites along the length of Oakley Creek with many of the most significant sites located in the lower catchment.

Pre-European history along Oakley Creek is well documented following an archaeological survey by Brent Druskovich (2003, unpublished), who describes the large number of Maori archaeological sites along the right bank of Oakley Creek as being an "archaeological landscape".

Thomas Star Flour Mill & Garrett Brothers Tannery is the only remaining large industrial flourmill site within the urban Auckland area. It is located near the stream mouth on the downstream side of Great North Road. Still in existence is the basalt lined mill-wheel cut (built in 1859) plus extensive sea walls, retaining walls, and a base for the mill-wheel flume. It is expected that basalt from same time era has been "recycled" and used to create the culvert that carries Oakley Creek under Great North Road. The mill was abandoned in 1909, and buildings demolished by 1913. There are still extensive remains from the site however both from the mill and the tannery (Mason and McCurdy, 2006).

These sites are of such significance they have been recommended to be included on any and all Transit plans for proposed motorway extensions in the area. In addition, works carried out for revegetation by Friends of Oakley Creek have been put on hold until an 'authority to modify' has been granted for the area downstream of the rail tracks due to historical and cultural significance.

There are 42 reported archeological sites identified in relevant district plans, including middens, pa, mills and historic buildings. These relate to various sections of the creek and surrounding catchment, however they are more significant in the lower reaches.

Most of the special value areas identified along Oakley Creek are located close to the watercourse itself. It is recommended to consider the implications of watercourse management and restoration projects on the surrounding catchment and the potential impact on any special value features.

4.3 SH20 Motorway Extension

The 4.5km State Highway 20 extension forms part of the Western Ring Route, an alternative north-south motorway that links three state highways, the Southwestern Motorway (SH20), the Northwestern Motorway (SH16) and the Upper Harbour Highway (SH18). Construction for the project is expected to start in 2011, and take 4-5 years to complete. It is one of seven roads of national significance announced in March 2009 by the National government (Joyce, S., 2009).

The completion of the Western Ring Route will have national and regional economic benefits. The connection will improve travel times and access between the west and the south including Auckland Airport for commuters and businesses and provide a motorway link from the CBD to the airport.

In the south, it will start at Maioro Street and emerge from under Richardson Road and through the Alan Wood Reserve next to the rail corridor and parallel to Oakley Creek. It will then pass through a tunnel under New North Road and Avondale Heights emerging near the intersection of Blockhouse Bay and Great North Roads. It will then be built under Great North Road before connecting to SH16.

Plans current at August 13 2009 for the extension of this motorway have been included in this report. The expected impacts of this on Oakley Creek are discussed briefly below.

Please note, the inclusion of this information is to aid in development of Management Plans only and is not intended to be used as opinion material advocating or opposing the motorway development. The information referred to in this WMP is correct at the time of writing. Current proposed motorway plans should be checked prior to commencing works in Oakley Creek.

In the upper reaches the tributary referred to in this report as Oak_B1 is likely to be impacted by further motorway development. This section of the creek is narrow, shallow, has little riparian cover and is in an industrial land use area. The motorway is a surface road through this area and into Hendon and Alan Wood Reserves. These reserves are designated railway development land in the Auckland City District Plans. Currently the reserves are used for recreation and weekend sport. The creek is modified to varying degrees through these reserves from

channel and bank lining in the upper section to a more natural meander through the mid to lower section. The motorway is proposed to be aligned with the true right bank. As the creek meanders significantly through these reserves it is expected that 'dog-legs' of the creek will need to be either diverted or piped under the motorway. A proportion of the creek will remain unmodified in these reserves. Stormwater management from the motorway to the creek will need to be considered, and the potential impacts on water quality assessed and mitigated. The motorway will form a tunnel underneath New North Road and will have a minor to no measurable effect on Oakley Creek in this area. At the intersection of Great North Road and Blockhouse Bay Road, the motorway surfaces for a short distance, before a cut-and-cover methodology is introduced. Effectively this will have minimal long term impacts on Oakley Creek, however, during the construction period, removal of fill and stormwater management will be very important.

The method and nature of implementation of the development will be key if objectives of the community, water utility providers and the catchment are to be facilitated.

SECTION 5: Engineering Asset Assessment and Management

The following section includes the assessment of network infrastructure and/or engineering assets, such as stormwater outfalls discharging to the stream, structures crossing over e.g. pipe bridges or forming part of the open channel including walls and linings. All assets within the riparian margins were considered. A total of 307 engineering structures were assessed during the stream walk survey.

Asset locations are presented in Appendix A, Map Series 6, showing their location within the stormwater and wastewater network. streambank, outfall erosion and combined wastewater overflows are also mapped. Appendix B, Photographic Schedule 4 presents a summary of data including photographs and relevant details including maintenance, safety or GIS information accuracy.

A summary of actions for engineering assets requiring maintenance or GIS corrections is presented in Maintenance Works Summary Sheets in Appendix D. This information is intended to support operations and maintenance activities and if required planned capital work's programming. Any interventions should also consider the Planning and Works Scoping Process outlined in Section 3.3 of this plan.

5.1 Engineering Assets

The engineered assets and structures including culverts, outlets, and inlets inspected during the survey often have Metrowater DMID (Data Management Identification) numbers. This information was recorded where available, along with a number of other features designed to document and assess the asset following the MEL Stream Walk and Asset Survey Methodology including:

- Asset type;
- Location;
- Photographs;
- Physical parameters;
- Maintenance requirements;
- Extent of associated erosion;
- Potential as a barrier to fish passage; and
- Health and safety risk (i.e. drops > 1.5 metres).

A total of 307 engineering structures were assessed during the stream walk and asset survey. A total of 37 assets were recorded as having incorrect data in the Metrowater GIS records and a further 91 were not recorded in the GIS system. There were 48 outfalls identified with erosion, 39 with slight erosion and nine with moderate erosion. 77 structures/outfalls were considered to require general maintenance including structural, erosion protection, debris removal and vegetation clearance. Safety issues associated with assets have been identified at six locations and four structures have been assessed to be impacting on fish passage.

5.2 Asset Maintenance

To efficiently maintain the stormwater and combined/wastewater assets that Metrowater is responsible for, routine inspections are carried out on inlets, outlets and channels. Assets requiring maintenance have been identified during the survey. Assets that were deemed to require maintenance for issues such as:

- Erosion mitigation;
- Compromises to structural integrity;
- Poor function;

- Impacting amenity value; and
- Safety issues.

For a full list of assets that are considered to require maintenance refer to Appendix D Maintenance Works Summary Sheets and Map Series 6: Engineering Asset Locations, Streambank and Outfall Erosion. These may require further inspection and more detailed engineering analysis to define the appropriate remedial actions.

5.3 New and Missing Assets

Assets with incorrect information or missing from the GIS records, identified during the field inspection, have been highlighted in Appendix B, Photographic Schedule 4 and are summarised in the Maintenance Works Summary Sheets in Appendix D.

Previously unrecorded assets, identified during the survey, may be added to the routine inspection list to improve maintenance, avoid failures and manage safety issues. A total of 37 assets were recorded as having incorrect data in the Metrowater GIS records and a further 91 not recorded in the GIS system. This information has been collected to potentially rationalise and update the corporate information sets.

5.4 Litter Trap Maintenance

Figure 7: Floating Litter Trap (NT1416) in Oak_3, Oakley Creek

There is a floating litter trap (NT1416) located at 1404 Great North Road in reach Oak_3 in the Oakley Creek Esplanade Reserve (see Appendix A, Map 6a).

This is a Bandalong type and is designed to trap floating solids. Maintenance of the device is carried out under the Auckland City Council Watercourse Maintenance Contract by the appointed contractor.

The litter trap may not be performing at its optimum performance due to excessive debris and litter. In addition it appears that the trap may be exacerbating localised erosion. This may be due to the inefficient nature of the litter trap blocking and diverting flows. It is recommended that routine cleaning and maintenance increases in frequency and measures are taken to decrease erosion.

5.5 Stormwater Outfall Erosion

There were 48 outfalls identified with erosion, 39 with slight erosion and nine with moderate erosion. Erosion at stormwater outfalls is shown in Map Series 6 and can be generally described as slight. This is largely due to the nature of flow conveyance through the creek.

Engineering assets with slight to moderate erosion are highlighted in Appendix B, Photographic Schedule 4, and summarised in Appendix D, Maintenance Works Sheets.

Priority for remedial works of outfall erosion should consider a number of factors as follows:

- The severity of the erosion (slight - severe);
- The location of the erosion and its potential to intensify other issues (e.g. safety issues, flooding, bank instability and environmental impact); and
- Amenity impacts.

Erosion at stormwater structures such as culverts, weirs and pipes is a typical part of their design life. The rate at which erosion occurs can directly reflect the quality of the design or construction. Additionally, physical conditions can alter following their installation; such as the removal of riparian vegetation which can lead to bank instability and slumping.

Outfall erosion can contribute to the amount of sediment discharged into the receiving watercourse. Outfalls with severe erosion have the potential to discharge many cubic metres of sediment, which can smother stream channels and affect conveyance capacity by altering channel morphology.

Outfall erosion also has the potential to compromise the structural integrity of an asset, causing pipes to become misaligned or hydraulic conditions in the channel to change, further accelerating erosion.

There are a number of natural and artificial methods of stabilising banks and channels to reduce the severity of erosion. Lining the banks or modifying the channel morphology can have a positive impact on the flow velocity and decrease flow pressures on the streambanks. However this may also reduce natural in-stream habitat and alter natural processes. Further methods of erosion control are outlined in the ARC TP90 (1999).

Varied and diverse riparian planting along streambanks can provide extensive root masses to assist in stabilising the soil, reducing bank instability and slumping. Such management actions are recommended where applicable in MZ and RO Sections 10 and 11.

Some of the fundamental points to consider in any potential solutions are:

- Pipe realignment (to 45 degrees to stream flow);
- Lowering of outlet invert closer to channel invert;
- Control of overland flow paths;
- Slope stability;
- Vegetation management and; and
- Structural modifications and energy dissipation.

5.6 Culvert Inlet Condition

A photographic record of inlets was collected at the time of survey. In addition the potential for the inlet to block and result in flooding from the secondary flow path was assessed. This information is available in the data delivered as part of this study and summarised in Appendix D, Maintenance Works Sheets. This information could potentially be entered into HANSEN.

5.7 Bank Stability, Channel Erosion and Erosion Hotspots

Erosion in streams is a natural process, however external factors can adversely influence the rate of erosion and thus the state of the watercourse. Increases in catchment imperviousness and riparian vegetation removal can increase bank instability and accelerate erosion. Engineering assets with erosion may reduce the structural integrity and/or safety of the asset and result in erosion of surrounding channels.

Overall Oakley Creek has minor erosion and generally can be described as having stable channel structure. Localised erosion, referred to as erosion hotspots, has been identified in 13 locations spread throughout the watercourse. Additional details of erosion hotspots are given in Appendix D, Maintenance Works Summary Sheet.

An Erosion Hotspot database has been developed across the city identifying the most at risk erosion sites. When considering management it is recommended this is referred to. All Erosion Hotspots should be monitored and action taken to reduce or eliminate the current state of degradation with remediation measures including:

- Bank reinforcing;
- Bed stabilisation;
- Channel reengineering to a more natural state; and
- Bioengineering techniques.

Severe bank erosion is defined as erosion affecting greater than 60% of the channel banks (Morphum Environmental Ltd, 2006). Reaches with severe erosion have been highlighted in Appendix C, Table 1E – Bank Factors. Also highlighted in this table are issues associated with bank slope, mass wasting, debris jams and vegetative bank protection.

Stream erosion has been identified within the draft Auckland Waterways Environmental Monitoring Strategy (EMS) as an important factor to monitor. Part of the EMS programme entails regular and continued monitoring of the erosion hotspots identified during the stream surveys to identify changes in severity or extent which may trigger maintenance or stabilisation works.

The location, extent and severity of streambank and outfall erosion are presented in Appendix A, Map Series 6 along with the locations of engineering assets and erosion hotspots.

5.8 Sewage Discharges at Outfalls (Observed Sewage Fungus)

There are a number of reasons why wastewater can be present in the stormwater system, such as illegal connections, designed overflow points or leaks from septic tanks. Wastewater discharges can have an adverse impact on streams as they degrade water quality through high nutrient inputs.

During the survey all outfalls assessed were considered in terms of the likelihood of sewage discharges. This was achieved through the use of a biological indicator, 'Sewage Fungus' or *Sphaerotilus*, which is a filamentous bacterium often found living in water polluted with organic wastes. This is only an indicator and does not necessarily confirm the presence or absence of organic wastes.

Sewage fungus was recorded at four stormwater outfalls, seven outfalls are recorded as known overflow points but showed no evidence of sewage fungus and one was seen to be discharging at the time of investigation. Their locations are shown in Appendix A, Map Series 6.

The outlet Oak_Eng_52 (NS3305) is a known overflow from a combined line with a low sided weir. An odour was detected while assessing this asset. Neither Oak_Eng_119 (NS2418) nor Oak_Eng_107 (NS2380) are known overflow points but both had sewage fungus present and should be investigated further to determine the sources of their pollution. Oak_Eng_260 is a private drainage pipe that appears to run from the changing rooms at Keith Hay Park. This may be an overflow. Further investigation is required to determine the discharge source from this pipe.

Seven other outfalls are recognised in the GIS as being designed wastewater overflow (WW OFL) points however they showed no evidence of sewage fungus at the time of survey:

- Oak_Eng_16 (NS3290),
- Oak_Eng_19 (392842),
- Oak_Eng_61 (NS3320),
- Oak_Eng_63 (NS3325),
- Oak_Eng_64 (NS3322),
- Oak_Eng_71 (NS3329),
- Oak_Eng_231 (No asset name).

Oak_Eng_235 was a private line from a factory, the line may be a WW OFL. Further investigations are required to confirm.

Oak_Eng_205 was observed discharging wastewater during a rainfall event on 13/3/2009. This is a known WW OFL point. Oak_Eng_21 (193016) is an open top manhole that was overflowing during the same storm event. It was unclear whether this included wastewater due to the large volume of flow.

Their locations are shown in Appendix A, Map Series 6.

5.9 Pipe Bridges

Pipe bridges are deemed to be a pipe that is above ground around its entire circumference anywhere along the pipe. They are considered to be Key Assets due to their vulnerability and consequence of failure.

A summary of all pipe bridges surveyed is included in Table 4.

Pipe bridges were defined based on the Metrowater Asset Data Management Specification (MADMS). Pipes that partially protrude above the ground but do not clear the ground entirely are classified as Above Ground pipes in the MADMS. They are also considered to be Key Assets due to their vulnerability and consequence of failure.

Of the four Above Ground pipes inspected, three are Watercare Services Ltd (WSL) pipes and one is a Metrowater asset and all are in sound condition.

Table 4: Summary table of pipe bridges surveyed on Oakley Creek

Ownership	Number of pipe bridges	Usage
Metrowater (MW)	21	20 WW, 1 Comb
Watercare (WSL)	19	16 WW, 3 Water
Private (PVT)	2	1 WW, 1 Unknown
Unknown (UNK)	9	All unknown
Total	43	33 WW, 1 Comb, 3 Water, 10 unknown

Pipe bridges were inspected based on the methodologies developed by North Shore City Council as part of the network consent in 2004 (NSCC KC 1, 2004). Additional information regarding ownership was obtained from GIS.

Oak_Pipe_Bridge_10 (UNK) is in poor condition and needs to be inspected for maintenance. Oak_Pipe_Bridge_29 (WSL) and Oak_Pipe_Bridge_40 (UNK) are in average condition.

The data obtained from the field survey was compared with the existing Metrowater d_pipe_bridge table in GIS. Not all pipe bridges are recorded on this table, it is recommended that the existing data be supplemented and updated with the surveyed data.

Refer to Appendix B, Photo Schedule 6 for reference and Appendix A, Map Series 6.

5.10 Potential Flood Issues

There are 14 critical inlets in 11 locations on the Oakley Creek that are considered to potentially cause flooding should the inlet block. These inlets have been identified based on field assessments as well as GIS confirmation using the Metrowater Flood Hazard Maps.

13 of the inlets are at least 1.5 m in height and width and as such are probably unlikely to block. However in the event of blocking, the consequence of failure is likely to be habitable floor flooding. All of these pipes are noted as being managed by Environment and Utility Management, but none appear on Metrowater's critical inlet list.

One inlet is located on the grounds of Unitec; this inlet should be privately maintained. It is a small inlet but is damaged and should be repaired to prevent blocking.

Refer to Appendix B, Photo Schedule 8 for reference.

SECTION 6: Ecological Attributes and Stream Management

This section provides background information regarding key ecological aspects of urban streams incorporated with findings from the Oakley Creek stream walk survey including:

- **Channel morphology;**
- **Springs and groundwater base flows;**
- **Riparian vegetation;**
- **Aquatic vegetation;**
- **Wetland habitats;**
- **Stream mouths; and**
- **Fish populations.**

This section also provides a summary of ecological findings, with management recommendations where appropriate. Information gathered for each of the reaches surveyed is presented in detail in the Technical Report and Appendix C, Table1. A snapshot of each of the surveyed reaches is presented in Appendix B, Photographic Schedule 1.

6.1 Ecological Objectives

Key ecological objectives that should be taken into consideration when undertaking stream management are as follows (modified from Allibone et. al., 2001):

- To control bank and channel erosion and sedimentation;
- To reduce the impact of barriers to fish passage;
- To increase in-stream flow variability;
- To minimise habitat modification;
- To control riparian vegetation loss and degradation; and
- To improve riparian overhead cover and extent.

6.2 Channel Morphology

The morphology of a stream system is an integral part of its environment because it defines flow velocity, substrate stability, and provides habitat for aquatic plants, invertebrates and fish. Morphological features are a reflection of catchment processes and change along with land use and anthropogenic influences such as channel and bank modification, vegetation removal and the creation of engineering assets such as culverts and stormwater outlets (Suren, 2000).

The morphology of Oakley Creek varies and is influenced by the modified nature of its predominantly urban catchment. The shape of the stream was predominantly 'V-shaped' entrenched (Quinn, 2001). Substrates were predominantly silt and sand, followed by large cobbles and small gravel. Channel widths were generally narrow and ranged from 0.4-3.5 m, depths varied along the creek ranging from 0.02-2.1 m. Flow velocity was highly variable ranging between 0.001-1 m/s. Additional data is presented in Appendix C, Table 1b.

The extent of channel and bank modifications is presented in Appendix A, Map Series 4 and 5. Existing channel and bank modifications have been considered when developing this WMP as they will influence restoration opportunities and maintenance options.

6.3 Springs, Seepages and Groundwater Base-flows

Wairaka Stream flows through the Unitec Campus grounds and is a spring-fed tributary supplemented by stormwater discharges. No other springs entering the watercourse were identified during the course of the stream

surveys. However it is expected that Oakley Creek receives spring inputs as the geology of the area is volcanic. Appendix A, Map Series 7 shows the locations of natural springs along with riparian cover, wetlands and restoration opportunities. Additional details of natural structures are presented in Appendix B, Photographic Schedule 2.

These springs are valuable to the ecological function of the watercourse as clean water inputs, which can dilute pollutants, and significantly improve water quality. Management Zones and Restoration Opportunities have incorporated the presence of springs within management objectives.

6.4 Aquatic Vegetation

Aquatic plants including periphyton and macrophytes are an important part of freshwater communities. These provide many benefits to fish, wildlife, water quality and people (NIWA, 2008). However, over abundant aquatic vegetation can choke streams and instead degrade aquatic ecosystems.

Macrophytes do not appear to be a significant problem in Oakley Creek. Reaches with greater than 50% cover of oxygen weed have been highlighted in Appendix C, Table 1B and should be investigated further to ensure appropriate and effective management. However there are reaches where aquatic weeds including *Egeria densa* proliferate and form large mats. These locations need to be monitored and managed to reduce the extent and density of the populations.

During the summer months these weeds tend to proliferate. However in the late autumn when light energy reduces, the large volumes of organic material can then breakdown removing dissolved oxygen from the water and reducing the life supporting capacity of the waterway.

Presently Auckland City Council and ARC are aware of these invasive plants in Auckland City's waterways and management is recommended as per the ARC Regional Pest Management Strategy (ARC, 2007). Additionally it is suggested that careful consideration also be given to the New Zealand Periphyton Guidelines and Stream Periphyton Monitoring Manual (Biggs and Kilroy, 2000) when managing nuisance algal growths.

Currently, aquatic weed management is conducted through the Watercourse Maintenance Contract. Aquatic weed maintenance should consider the drainage function of the watercourse as well as the effect of weed removal on in-stream processes and wildlife. Watercourse maintenance contractors should consider timing and techniques to prevent adverse effects on spawning fish wherever possible.

6.5 Wetland Habitats

The Resource Management Act (RMA, 1991) defines wetlands as 'permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.'

Five wetlands were identified in Oakley Creek and were generally small in size, weedy and of poor quality. The exception to this is the Wairaka wetland (Oak_WL_001) which has had extensive infill planting improving its quality.

Wetlands are shown in Appendix A, Map Series 7 along with riparian cover, springs and restoration opportunities. Dominant vegetation types were recorded and the extent of invasive exotic plant species to assist with restoration and management plans.

Wetland management should aim to facilitate improvements in water quality as well as habitats for wildlife. Reference should be made to the ARC's Proposed Auckland Regional Plan: Air, Land and Water (PALW Plan), as well as the New Zealand Wetland Management Guide (Buxton, 1991), when undertaking management actions for each of Oakley Creeks wetlands (WL), detailed in Appendix B, Photographic Schedule 3.

6.6 Stream Mouths

Stream mouths are an important transition between freshwater and saline environments. The stream mouth of Oakley Creek is defined by the area of freshwater and marine interface. Stream mouths are particularly important as spawning habitat for one of New Zealand's indigenous fish, inanga, which have a migratory life cycle typical of many native New Zealand fish species.

The mouth of Oakley Creek is approximately 1,200m long extending the length of the streams' estuary, shown in Appendix A, Map 8a with the associated inanga spawning habitat. There have been some modifications to banks of the stream mouth directly downstream of the culvert under Great North Road. Historic modifications including bank lining and reinforcing near the old mill site are present. The banks are dominated by native infill, low grass plantings and some exotic tree species in locations above the road culvert, whilst mangroves dominate tidal margins. The stream mouth is considered to be very important as it links the Motu Manawa Marine Reserve and the high quality lower reaches of Oakley Creek. The stream mouth is in good condition, and should be protected during the construction process of the SH20 Waterview Extension.

6.6.1 Stream Mouth Management and Inanga Spawning

Improving the ecosystem of Oakley Creek stream mouth and enhancing the potential inanga spawning habitat is dependent on appropriate management of grassy vegetation on the lower streambanks located within the natural flood plain.

Conditions along the margins of the upper stream mouth have the potential to provide spawning habitat for inanga. The low banks of the flood plain areas are covered in grasses and sedges that may provide a suitable substrate for spawning (Richardson, J. and Taylor, M J., 2004).

An extended area of potential inanga spawning was identified and is situated in reaches Oak_2 and Oak_3 (see Appendix A, Map 8a). It is suggested that the riparian area is planted with native grass species shown in Table 3, which encourage inanga spawning (ARC, 2000).

Table 5: Native plant species to support Inanga spawning

Common Name	***Scientific Name***
Wiwi	*Juncus gregiflorus*
Jointed rush	*Juncus articulatus*
Flax	*Phormium tenax*
Raupo	*Typha orientalis*
Umbrella sedge	*Cyperus eragrostis*

In addition it is recommended to introduce signs to inform the public of the site, and to undertake regular weed removal. Weeds such as blackberry and gorse can establish in spawning areas inhibiting the growth of grasses and sedges, which provide essential habitat for spawning (ARC, 2000).

6.7 Water and Sediment Chemistry

The Auckland City Urban Streams Classification method (Webster et. al., 2005) was used to determine the primary function of Oakley Creek as part of the WMP process. Part of this method involved water and sediment testing to determine the habitat score. Results of note are included below:

- Sediment:
  - Oak_WQ_3 had levels of zinc (470 mg/kg dry wt) that exceeded undesirable levels as described by Webster et. al. (2005).
  - Oak_WQ_5 and WQ_8 (1.72 mg/kg) were found to exceed undesirable levels of PAH (Polycyclic Aromatic Hydrocarbons), site WQ_5 significantly so (2.68 mg/kg).
  - Six of the 11 sites sampled had levels of zinc that were between desirable and undesirable levels as defined by Webster et. al. (2005).
  - Oak_WQ_2 and WQ_3 had levels of copper that were between desirable and undesirable.
- Water:
  - Dissolved Zinc (g/m^3) exceeded undesirable levels as defined by Webster et. al. 2005 for all samples taken, except for Oak_WQ_1.
  - Dissolved Copper (g/m^3) exceeded undesirable levels as defined by Webster et. al. 2005 for six of the 11 samples taken. Two samples had levels of dissolved copper between desirable and undesirable.

Guideline levels for the classification are based on Australian and New Zealand Environment and Conservation Council (ANZECC) guideline values (ANZECC, 2000). For further detailed information including graphs and the summary of results please refer to Section 4 in the attached Technical Report of this document. Refer to Appendix A, Map Series 11 for representation of NIWA classification scores through the stream. Water and sediment sampling sites are shown in Appendix A, Map 11b.

SECTION 7: Riparian Vegetation and Management

The riparian zone plays an important role in stream ecosystems as the interface between terrestrial and aquatic ecosystems. Assessing the quantity and quality of riparian vegetation provides a good indication of ecosystem function.

7.1 Overview

There is a strong relationship between riparian overhead cover and the extent of erosion in a stream channel. Without healthy vegetation along the stream, the banks tend to have less structural strength and are prone to erosion and slumping.

It is widely accepted that to be most beneficial, riparian vegetation should extend 8-10m either side of the stream to reduce the impacts of edge effects and to encourage ecosystem growth and development (Harding et al., 2009). Additionally, to reduce the effects of solar radiation and maintain stable in-stream temperatures, overhead cover is believed beneficial when greater than 60%.

In urban environments, there is often limited stream-side land available for plantings, particularly when planting 10m may preclude or reduce public access. Thus, it is important that riparian planting is well planned, taking into consideration different expectations and values for the reach and coordinating restorative efforts with others throughout the watercourse. Planting should also consider the Planning and Works Scoping Process outlined in Section 3.3 of this plan.

A priority action drawn from Auckland City Councils' Urban Forest Plan is to work to "… protect, enhance and restore a range of urban forest patches and corridors, providing connections for wildlife sanctuaries and stepping stones for native species"(Auckland City Council, accessed 21/10/08). The MZ and RO outlined in this WMP aim to encourage effective planning and coordination between stakeholders to improve the success of riparian restoration along Oakley Creek.

Auckland Regional Council (ARC) has developed a guide to riparian zone management (ARC TP148) (Becker et. al., 2001). This document outlines the benefits of riparian zone management and provides a planting guide for different stream locations and resource management issues including invasive plant management. Reference to this document is recommended when planning riparian restoration.

7.2 Management Objectives

The key objectives for riparian management along Oakley Creek are (as set out in Sections 1.2 Objectives and 1.2.1 Ecological Objectives):

- To maintain effective stormwater conveyance;
- To support the maintenance or improvement of the amenity value of adjacent parks and reserves by identifying opportunities to integrate stream outcomes with parks management plans;
- To Improve ecological function and values of riparian and in-stream ecosystems;
- To control riparian vegetation loss and degradation; and
- To improve riparian overhead cover and extent.

These objectives can be achieved by:

- Improving overhead cover to greater than 60% where practicable;
- Reducing pest exotics and enhancing native plant species;
- Identifying and supporting microhabitats (e.g. fish spawning areas);
- Eliminating or controlling invasive weed species; and
- Increasing communication with the key stakeholders when developing planting plans.

It is important that riparian improvement works do not result in network inefficiencies such as reduced floodwater conveyance increasing the potential risk of flooding habitable floors. Reference should be made to the checklist presented in Section 3.3 Planning and Works Scoping Process when planning riparian works.

Summarised actions for Management Zones (MZ) and Restoration Opportunities (RO) aim to achieve the above objectives where appropriate and realistic. Where these are restricted by adjacent landuses and ownership, the creation of more specific riparian planting plans will be necessary. An example of this is the proposed SH20 motorway extension through Alan Wood/Hendon Reserve, where planting plans should only be considered after comprehensive consultation with all parties is undertaken.

7.3 Oakley Creek Existing Riparian Vegetation

Riparian overhead cover is shown in Appendix A, Map Series 7 along with wetlands, springs and restoration opportunities. When interpreting the displayed data it should be noted that lower overhead cover values can be attributed to stream width. For example, reaches with a wide channel and low upper banks (e.g. stream mouth) will have lower overhead cover.

There were 107 reaches with less than 60% cover and of these 34 reaches had 0-5% overhead cover indicating areas for improvement and highlighting a number of riparian planting opportunities. These reaches are highlighted in data tables in Appendix C, Table 1C. Further riparian planting recommendations are outlined within MZ (refer Section 10) and RO (refer Section 11) where appropriate. In the context of streams in Auckland City the amount and extent of riparian cover is moderate to high as they have generally been highly modified.

Riparian vegetation type, whether native, exotic or mixed, has been additionally mapped along with inanga spawning habitat, fish locations and potential barriers to fish passage in Appendix A, Map Series 8.

Riparian vegetation type is strongly influenced by adjacent land use and ownership. Along Oakley Creek, sections of native riparian vegetation occur in the lower reaches where extensive revegetation work has been carried out although these areas are also quite weedy. Upstream sections of the creek are generally bordered by exotic vegetation, however in many sections no riparian vegetation is present. Improvements to riparian vegetation can be made through appropriate management, taking land use and ownership into consideration. Recommendations are outlined for each MZ in Section 10.

7.4 Weed Control and Maintenance

Weed infestations in riparian or aquatic zones can have detrimental effects on the riparian biodiversity and in-stream values. Weeds often out-compete existing vegetation and cause overarching changes in the composition of the vegetation, soil properties and drainage processes. Where soil composition is significantly changed, some native species can no longer tolerate soil conditions and cannot survive.

Weeds proliferate in sections of the downstream part of Oakley Creek; in particular climbing asparagus, woolly nightshade and wandering jew are common. In the case of climbing asparagus the infestations are widespread. Extensive weed control and management is required throughout the entire creek. It is recommended that to achieve this, collaboration between Metrowater, Auckland City Council Parks Services and Friends of Oakley Creek occur to determine realistic objectives and actions.

Currently, weed control and maintenance is conducted by the Watercourse Maintenance Contractor on behalf of Metrowater and by Auckland City Council Parks Services contractors. Appendix A, Map Series 9 shows the different maintenance areas defined by the Watercourse Maintenance Contract and by Auckland City Council Parks Services. As it is not feasible to eradicate weeds from the waterway, targeted control and replacement with native and non-invasive exotics should be conducted throughout the riparian margins. Some of the plants identified during the survey are noted in the ARC Regional Pest Management Strategy 2007-2012 (RPMS). Some (but not all) are included in Table 6 below:

Table 6: Weed species identified during survey and relevance to RPMS 2007-2012

Common Name	Scientific Name	RPMS Definition
Climbing Asparagus	*Asparagus scandens*	Surveillance
Moth Plant	*Araujia sericifera*	Containment
Wandering jew	*Tradescantia fluminensis*	Surveillance
Nasturtium	*Tropaeolum majus*	N/A
Woolly nightshade	*Solanum mauritianum*	Containment
Angels trumpet	*Brugmansia candida*	N/A
Brush wattle	*Paraserianthes lophantha*	Surveillance
Blue morning glory	*Ipomoea indica*	Surveillance
Japanese Honeysuckle	*Lonicera japonica*	Surveillance
Chinese Privet	*Ligustrum sinense*	Surveillance
Palm Grass	*Setaria palmifolia*	Surveillance
Plectranthus	*Plectranthus ciliatus*	Surveillance

Part II of ARC's RPMS for the Auckland region outlines pest plant species management and guidelines which should be referred to when planning weed maintenance for the Oakley Creek watercourse. Additionally it is advised to engage a specialist terrestrial ecologist to assist with detailed riparian planting plans and restorative goals.

SECTION 8: Fish Ecology and Management

New Zealand's freshwater habitats support some 35 different native fish species. Changes in land use typical of urbanisation can reduce the quality of freshwater habitats and adversely affect native fish populations. Understanding limitations to the distribution and abundance of native fish species is integral in developing improved watercourse management practices.

Fish distribution in stream systems is dependent on a number of factors including:

- **Water quality and chemistry;**
- **Habitat availability;**
- **Food resources;**
- **Overhead riparian cover;**
- **Elevation; and**
- **Barriers to migration.**

8.1 Populations

In Oakley Creek more than 31 records of eight fish species have been documented in the National Institute of Water and Atmospheric Research New Zealand Freshwater Fish Database (NIWA NZFFD). As at 13 August 2008 these included the following fish species as follows (for scientific names please refer to the Table of Common and Scientific Names page 2):

- Shortfin eel
- Longfin eel
- Banded kokopu
- Common smelt
- Common bully
- Inanga
- Gambusia/mosquitofish
- Goldfish

Fish caught and identified during the stream walk survey include the following species:

- Redfin bully
- Common bully
- Unidentified bully
- Unidentified eel
- Shortfin eel
- Inanga
- Unidentified galaxiid
- Banded kokopu
- Goldfish
- Unknown – Possibly koi carp
- Gambusia/mosquitofish

Native fish are important indicators of water quality and stream health. The number and diversity of fish found indicates water quality is good. All of the native fish (excluding eels) were found below the waterfall. The waterfall is a significant barrier to fish passage for swimmers and climbers. This is due to the inverted section of the face at the base which prevents climbing species negotiating the barrier. This is discussed further in Section 8.2.1.

An issue identified by Friends of Oakley Creek chairperson, Wendy John in 2009, is the occurrence of eeling of the native eels in the creek. Most of the eeling appears to be taking place in the Oakley Creek Esplanade and Alan Wood Reserve. It is recommended that appropriate signage is erected to advise the public, in particular new immigrants, about conservation and biodiversity and the value of the eels to the stream ecosystem.

8.1.1 Pest Fish

Management of pest fish should refer to ARCTP305 Recommendations for Management of Auckland Region's Freshwater Pests (Champion and de Winter, 2005).

Gambusia
Mosquitofish or gambusia (*Gambusia affinis*) were originally introduced in the 1930's, from the Gulf of Mexico, to control mosquito larvae. Now defined as an unwanted organism by the Department of Conservation (DoC), gambusia have become a virulent pest in the Auckland region. Females bear live young, meaning population expansion happens rapidly. They are aggressive and attack native fish by nipping at fins and eye and prey on their eggs. Members of the Galaxiid family are particularly vulnerable as they inhabit similar habitats.

Koi Carp
Koi carp (*Cyprinus carpio*) were accidentally introduced into New Zealand in the 1960's. No koi carp were caught during the field survey, but anecdotal evidence suggests they reside within Oakley Creek. These fish contribute to water quality deterioration because of the way they feed. Feeding is similar to the action of a vacuum cleaner, sucking up everything and blowing out what they don't want, which stirs up sediment on stream and pond beds. This in turn damages aquatic plants and destroys habitat of other fish. Legally koi carp are defined as an unwanted organism and a noxious species. A containment policy applies within the Auckland region where all koi carp if caught must be killed.

Goldfish
Goldfish (*Crassius auratus*) were introduced into New Zealand in the 1860's and are not a designated pest fish in Auckland. However recent research indicates they are a 'new' pest fish as they do impact on water quality and native fish populations. Goldfish look similar to the noxious pest koi carp but lack the 2 barbels that koi have. They feed in a similar manner to koi carp increasing water turbidity and depleting aquatic vegetation. They prey upon the eggs, larvae and adult of native fishes and may contribute to algal bloom occurrence.

8.2 Potential Barriers to Fish Passage

The majority of New Zealand's 35 indigenous fish species are diadromous, migrating to and from the sea as part of their lifecycle. Barriers to fish passage can be natural structures such as waterfalls, manmade including engineered structures such as culverts, or chemical barriers as a result of point source pollution or wastewater overflows (ARC, 2000).

Modification of sections of Oakley Creek, particularly piping and channelisation has reduced water depths and refuge habitat which are limiting factors to fish migration. Further details regarding specific barriers to fish passage are discussed below.

8.2.1 Physical Barriers

Potential barriers to fish passage were identified and assessed throughout the stream walk survey. These have been mapped along with fish locations and riparian vegetation type in Map Series 8 and are summarised in Appendix B, Photographic Schedule 5. It is important to map all barriers to fish passage for consideration in future projects. This may include the construction of fish passes, removal/modification of in-stream structures and/or ameliorating impacts of chemical barriers, such as wastewater overflows.

The most significant barrier to fish passage is the Oakley Creek waterfall. The waterfall is 6 m in height and minimal vegetation to provide for a wetted margin. The face of the fall is inverted near the base which contributes to limiting passage.

Additionally current public access to the top of the waterfall has impacted the marginal plants and mosses that would form a climbing substrate for fish passage. In a less impacted state the waterfall would have had a dense closed riparian canopy providing shade for light sensitive marginal species. It is possible with appropriate planting around the margins of the fall, in conjunction with restricted public access, that climbing species could be encouraged to access the extensive upstream habitat available.

It is recommended that marginal planting is conducted to provide a wetted margin for climbing species to negotiate. Below the waterfall is a wide diversity of fish species, some of which could climb this barrier if a wetted margin was provided.

8.2.2 Chemical Barriers

Given the nature of urban waterways, chemical barriers as a result of wastewater overflows are often unavoidable. Stormwater inputs often contain heavy metals (zinc, lead and copper) and hydrocarbons (petrol and oil). Wastewater inputs include bacteria (faecal coliforms and *E. coli*) as well as surfactants and ammonia which significantly increase Biological Oxygen Demand (BOD).

A study of the ammonia tolerances of eight native fish species found eels and inanga to have higher tolerances compared to common bully, common smelt, and shrimp (Richardson et al., 2001). Encouragingly shrimp were common in Oakley Creek indicating the levels of ammonia from wastewater overflows may also be low enough for inanga survival. In view of this it is important to manage wastewater overflows.

The health of the watercourse would benefit if wastewater overflows were reduced, where it is practical and affordable. Wastewater overflow points within the Oakley Creek catchment have been mapped along with engineering asset locations, streambank and outfall erosion, presented in Appendix A, Map Series 6.

SECTION 9: Oakley Creek Social Attributes and Management

9.1 Parks and Reserves

Auckland City Council is responsible for the management of all parks and reserves in Auckland City. Following the Reserves Act (1977), parks and reserves meeting certain criteria are required to have a park specific management plan.

Management plans do not specify the layout of the park, but outline the Council's intention for the protection, preservation, maintenance and development of the park in line with the Council objectives.

Parks and reserves make up 57% of the land use surrounding Oakley Creek. These are detailed in Table 7 below.

Table 7: Oakley Creek Parks and Reserves

Name	Address	District Plan Zone	MZ	Area m^2
Marine Reserve: Motu Manawa Pollen Island Reserve	North Western Motorway, Waterview	Unknown	Stream Mouth	4,993,076
Oakley Park	Cowley St	Open Space 1	1	25,294
Oakley Creek Esplanade	Great North Road	Open Space 1	1	109,780
Albie Turner Field/Phyllis Street Reserve (Links to Heron Park)	Phyllis Street, Avondale	Open Space 1	2	72,105
Harbutt Reserve	39 Harbutt Avenue, Mt Albert	Open Space 1	2 and 3	78,462
Alan Wood Reserve	Hendon Avenue, Mt Albert	Open Space 1/Special Purpose	5	233,079
Hendon Reserve	Hendon Avenue, Mt Albert	Open Space 1/Special Purpose	5	13,530
Valonia Reserve	Valonia Street, Avondale	Open Space 1	5	Unknown
Underwood Park	O'Donnell Avenue, Mt Roskill	Open Space 1	6	41,988
Owairaka Park	Summit Drive, Mt Albert	Open Space 1	N/A	81,127
Walmsley Park	O'Donnell Avenue, Mt Roskill	Open Space 1	6	36,532
Race Course/War Memorial Park	Gifford Avenue, Mt Roskill	Open Space 1	6	143,572
Keith Hay Park	Arundel Street, Hillsborough	Open Space 1	10	260,188
Akarana Golf Course	Dominion Road, Mt Roskill	Open Space 1	10	353,760
Molley Green Reserve	Molley Green Place, Mt Roskill	Open Space 1	10	14,599

Under the Reserves Act 1977, Alan Wood Reserve is not defined as a 'reserve'. However, Auckland City Council considers that it is of importance and has, despite no statutory obligation, produced a Reserve Management Plan (2002). The specific objectives identified in this plan are as follows:

- To develop and maintain the reserve as a predominantly casual, unstructured recreation area for general public usage with some provision for limited structured recreation;
- To preserve the open space character of the area;
- To link the reserve with other adjoining or neighbouring open space areas;
- To protect the natural flow, overflow, and ponding within the reserve of Oakley Creek; and
- To minimise any possible conflict between activities on the reserve and adjoining land uses.

The following reserves have Reserve Management Plans which are old and not necessarily current:

- Walmsley and Underwood Reserves (1989);
- Keith Hay Park (1989); and

- Phyllis Street Reserve.

9.2 Access, Walkways and Amenity

The parks and reserves running adjacent to Oakley Creek range from grassed areas and sports grounds to regenerating or remnant areas of native bush. Parks are primarily used by the local community for recreation whilst the native bush reserves are crisscrossed with walking tracks frequented by walkers and joggers.

Oakley Esplanade Reserve is a popular reserve located next to Great North Road, behind Unitec. Extensive plantings in the lower section have improved amenity of the site as well as increasing habitat value. The reserve is used often for recreation and exercise and provides access between Great North Road and Carrington Road.

Albie Turner Fields in Phyllis Reserve is used primarily for sport, however also facilitate pathways along the edge, joining the walkway along the creek and providing additional access points.

Alan Wood and Hendon Reserves are use for sport and recreation, in addition to amenity pathways along the creek edge. Access is possible from several points along the reserves.

Auckland City Council is currently drafting improvement plans for many of the parks and reserves along Oakley Creek. Any restoration plans or opportunities identified for parks and reserves as a result of the Oakley Creek WMP will need to integrate with existing objectives outlined in relevant Reserve Management Plans and include consultation with key stakeholders.

9.3 Heritage Values

Oakley Creek catchment is rich in history. Pre-European history along Oakley Creek is well documented following an archaeological survey by Brent Druskovich (2003), who describes the large number of Maori archaeological sites along the right bank of Oakley Creek as being an “archaeological landscape”.

Thomas Star Flour Mill & Garrett Brothers Tannery is the only remaining large industrial flourmill site within the urban Auckland area. It is located near the stream mouth on the downstream side of Great North Road. Still in existence is the basalt lined mill-wheel cut (built in 1859) plus extensive sea walls, retaining walls, and a base for the mill-wheel flume. It is possible that the culvert under Great North Road has been built from ‘recycled basalt’ from the same time era. The mill was abandoned in 1909, and buildings demolished by 1913. There are still extensive remains from the site however both from the mill and the tannery.

These sites are of such significance they have been recommended to be included on all Transit plans for proposed motorway extensions in the area. In addition, works carried out for revegetation by Friends of Oakley Creek have been put on hold until an ‘authority to modify’ has been granted for the area downstream of the railtracks due to historical and cultural significance.

Ngati Whatua o Orakei produced a Cultural Heritage Report on the 5 public streams in Auckland City, managed by Metrowater (Papa and Blair, 2006). Management objectives and actions must take cultural elements into consideration when planning works. Refer to Section 4.1.11 for more information.

Development of the catchment has altered the mauri of the waterway, originally providing the Tangata whenua with abundant food resources and materials. Mauri is a Maori term and refers to “*an energy which binds and animates all things in the physical world*”. This was diminished following changes in land use and modifications to the stream causing degradation of water quality. Often the water in Oakley Creek is not safe for human contact or to provide food resources for the local Maori community.

The objectives of the WMP seek to enhance the natural values of the waterway and thus improve the mauri by improving the environmental values such as water clarity, flow heterogeneity and recreational contact.

9.4 Public Health

Currently Metrowater is working in conjunction with Watercare Ltd to mitigate the effects of combined sewer overflows, which periodically input wastewater into public watercourses. This includes infrastructure works comprising sewer separation, storage and/or capacity increases. Over time this will lead to a significant reduction in wastewater flows entering the watercourse.

During the course of the stream survey wastewater solids were identified in places throughout the watercourse, often retained within stream debris jams. The frequency and magnitude of wastewater outputs including raw sewage was greatest closer to the outfalls. However, public health risk is considered relatively low, despite combined overflows, due to limited exposure pathways and dilute nature of the wastewater concentrations in combined flows.

Wastewater overflows into the creek occur more frequently over winter and in some places can restrict public access. In the area of reserves in the upstream section of the creek, namely Walmsley, Underwood and War Memorial Park the creek often overtops the channel as it is shallow and dished. During the course of the survey, members of the public expressed concern regarding the overflows and requested that measures are taken to prevent exposure to contaminated water following wastewater overflows.

Designed wastewater overflows have been identified from GIS and onsite observations and are shown in Appendix A, Map Series 6.

9.5 Community Involvement

Communities in New Zealand have long been associated with getting involved in local projects. Many of Auckland's streams have community groups associated with them, contributing to their maintenance and development. Oakley Creek has two community groups heavily involved in its maintenance; Friends of Oakley Creek and Wai Care, a region-wide group monitoring and contributing to stream health.

Metrowater considers community involvement as being an integral part of the WMP and ongoing management of the watercourse. This management plan encourages community consultation and involvement, particularly in the implementation of Restoration Opportunities and ongoing localised management. This would hopefully involve the community more in planting days and stream related activities.

9.5.1 Friends of Oakley Creek

Friends of Oakley Creek (FOC) is a community group established in 2004 with the aim to see 'Oakley Creek and its environs restored and protected as a natural ecosystem, incorporating a range of wildlife habitats, indigenous species and recreational amenities, for present and future generations'. The group is led by Wendy John who has recently received funding to manage the restoration of Oakley Creek for 2009/2010. Te Ngahere created a weed removal and revegetation plan for FOC in 2005 which identified management units that are being used as a guide for ongoing management (Habgood, 2005).

FOC works closely with Auckland City Council Parks department and other agencies to co-ordinate community involvement in the creek activities. Friends of Oakley Creek have regular working bees involving weed and pest control, as well as planting, cleaning and restoration activities. They have designed and implemented a monitoring and pest control programme.

Approximately 23,000 plants have been planted in the downstream reaches of the creek. In addition weed management and clean ups are becoming more central to the group's activities.

FOC works with various Gladstone Primary, Unitec, and Buchanan Rehabilitation Centre, all in conjunction with Wai Care.

9.5.2 Buchanan Rehabilitation Centre

The Buchanan Rehabilitation Centre is located across the road from Unitec and has a garden group that works with Wai Care and FOC to care for the floodplain area where the Wairaka Stream merges with Oakley Creek. The garden group is involved in clean-ups, monitoring and pest control, growing and planting native plants and is looking to develop the centre itself to be more sustainable.

9.5.3 Wai Care

Wai Care currently monitors several sites along Oakley Creek. Macroinvertebrate results are encouraging with caddisflies and damselflies frequently identified. Previous one-off studies with freshwater invertebrate specialist Stephen Moore, has identified invertebrates in the lower reaches of the waterway, including the freshwater mussel (*Hyridella* sp) which is indicative of medium to high quality streams.

9.5.4 Unitec

Unitec encourages students and staff to be involved in research, monitoring and restoration efforts on Oakley Creek. Students have been conducting testing of the water chemistry for more than 20 years. The plants and geology of the area provides a living laboratory for study and appreciation as well as being an inspiring backdrop to campus activity.

An unfortunate event was observed in December 2008 involving Unitec contractors discharging moss and mould killer into the stormwater system which then entered the creek. This resulted in fish and insect kills for more than 300 m downstream. It is understood that Unitec is taking precautions to ensure this does not happen again. Although unfortunate it was a valuable learning experience for the contractors and Unitec in better understanding the management required when working adjacent to receiving environments.

9.5.5 Gladstone Primary School

Gladstone Primary School is located on Carrington Road opposite Unitec and is very involved in riparian planting, maintenance and monitoring of an area of Oakley Creek behind Unitec. This is carried out in conjunction with Wai Care and Friend of Oakley Creek.

9.5.6 Waterview Primary School

Waterview School are involved in a variety of activities related to the restoration and enhancement of Oakley Creek including clean ups and planting.

9.5.7 Mt Roskill Intermediate

Mt Roskill Intermediate students, under the guidance of teacher Sean Carroll, are involved in the growing of native plants for the Oakley Creek catchment as well as planting along Oakley Creek adjacent to the school.

9.5.8 Kodesh and A. Rocha

The Kodesh Community is a Charitable Trust located at the end of Craddock Street in Avondale. The group works with members of A Rocha conservation organisation, Wai Care and Friends of Oakley Creek to monitor water quality and undertake riparian plantings. The community uses regular water quality monitoring sessions as a training exercise for international students as well as for awareness raising locally.

SECTION 10: Oakley Creek Management Zones

Eleven Management Zones (MZ) have been defined for Oakley Creek. Specific management objectives for all areas have been provided. Management objectives have been determined for each MZ reflecting specific issues with regard to stormwater conveyance, erosion or restoration opportunities. Restoration Opportunities (RO) such as habitat enhancements are referred to within each MZ and are presented in Appendix A, Map Series 7.

Each MZ has been defined by grouping stream reaches based on similarities between ecological, engineered and social attributes. The MZs begin at the stream mouth and continue to the uppermost reaches, as shown in Appendix A, Map 2.

Management objectives and actions have been developed in consideration of existing plans including:

- Existing Reserve Management Plans;
- Proposed Transit SH20 Motorway Extension Plans;
- Auckland City Council Watercourse Maintenance Contract; and
- Restoration Opportunities as outlined in Section 11 of this report.

Due to the complexity and size of the MZ's, they have been further classified into sub-categories which are known as Management Units (MU). Each MZ includes a general description, details of linkages with parks/reserves and outlines objectives for the zone overall and for Management Units (MU) within the zone including:

- Objectives and stakeholders;
- Potential amenity improvements;
- Habitat enhancements;
- Improving stormwater conveyance;
- Improving asset maintenance;
- Erosion reduction and mitigation;
- Improving floodplain connectivity; and
- Riparian planting.

Any detailed plans should take into account objectives of the Auckland City Council Parks Services and other key stakeholders as appropriate.

10.1 Prioritising Management Zones

Although Management Zones (MZ) can be prioritised there are many complex issues within any given reach of a stream that might supersede this priority. For example it would be important to attend to a stormwater outfall with severe erosion irrespective of the MZ priority it is located in. For this reason no strict priority has been provided for MZ as part of this plan. They should be considered as a way of defining management actions for areas that share similarity in ecological, engineered and social attributes.

10.2 Identified Management Requirements

The main problems identified in Oakley Creek that require active management to improve the function of the waterway include (in no order of priority):

- Consideration of future changes to the creek and its catchment, particularly as a result of the SH20 Extention; and,
- Communication with Friends of Oakley Creek as an important stakeholder in the management of the creek and riparian margins.

- Improve riparian cover along entire length of creek;
- Weed management in all reaches, but particularly upstream reaches to reduce requirements for weed management downstream;
- Erosion mitigation and bank stabilisation;
- Stormwater outfall erosion mitigation (48 Outfalls);
- Stream mouth management including specifically potential inanga spawning vegetation management;
- Continued support for existing weed management and vegetation restoration plans;
- Contact with waterway after combined overflows occur (upstream reaches);
- Improved access across creek in upper reserves;
- Rehabilitation of Oakley Creek waterfall to encourage upstream passage of native fish; and
- Active management of aquatic fauna, through pest fish removal and signage/education.
- Management that is consistent with Auckland City Parks Services objectives;

10.3 Management Zone 1

MZ	1	**Outfalls with Erosion**	4 slight
# of MU	4	**Erosion Hotspots**	1
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Parks Services
Reaches	Oak 1-11, Wai_1-13, Oak Trib 1	**Stakeholder 2**	Metrowater
Length (m)	2440	**Stakeholder 3**	Friends of Oakley Creek
Dominant substrate	Silt/Sand	**Stakeholder 4**	Unitec
Mean channel width (m)	2	**Restoration Opportunities**	RO1, RO2, RO3
Mean depth (m)	0.42	**Wetlands**	1 (Oak_WL_1)
Water clarity (m)	0.91	**Mean Riparian Cover (%)**	25
Special Values	Waterfall Multiple historical sites	**Parks & Reserves**	Oakley Park Oakley Creek Esplanade Waterview Glades
Spatial Definition of Zone	Management Zone 1 is defined as the area between the stream mouth, and the Oakley Creek Waterfall at 1510 Great North Road. Reasons for this spatial definition include: - Characteristics below the waterfall are similar (morphology, riparian vegetation and native fauna); - Native fauna abundant including fish (galaxiids, bullies and eels) and vegetation; - High amenity value (pathways, vegetation rehabilitation and the waterfall); - Presence of potential inanga spawning area; - Friends of Oakley Creek is a well recognised community group and has worked extensively in this area; - There is an existing weed management and revegetation plan developed by Te Ngahere; - This section of the creek will be impacted on by SH20 Extension; and - Unitec is a major stakeholder on TRB.		
Goals and Objectives	The high level goals for management in MZ1 are to retain public access, support ecological health and improve amenity. These are supported by the following including: - Improve bank stability in the downstream reaches through reinforcing; - Enhance existing riparian revegetation to improve shading, amenity and bank stability; - Improve awareness of the Wairaka Stream; - Recognise Wairaka Stream as an important source of spring water and stormwater to Oakley Creek; - Improve bank vegetation at tidal interface to encourage inanga spawning; - Education to the public regarding the receiving environment and ensure awareness of risks of pollution and discharges; - Incorporate signage regarding trees, history, fauna, water etc for public education and awareness; - Improve safety and amenity at the Oakley Creek waterfall and update signage regarding Health and Safety; - Mitigate and manage erosion at outfalls; - Identify and minimise where feasible sources of wastewater into the creek; - Identify and survey unaccounted for outfalls to determine type and source; - Naturalise engineered channels; - Improve amenity at waterfall; and - Investigate the feasibility of providing fish passage up Oakley Creek waterfall.		

Identified Engineering Issues Refer Appendix D for more detail	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 5, 7 **Maintenance required** - Erosion Protection: Oak_Eng_ID: 8, 19 - Structural: Oak_Eng_ID: 9, 13 **Erosion at outfalls** - Slight: Oak_Eng_ID: 8, 10, 13, 19 - Moderate: No issues identified - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - Oak_HS_020
Management Units	The stream mouth forms a separate management unit and is discussed in Section 6.5.
MU 1: Wairaka Stream	Wairaka Stream is mainly spring-fed above its confluence with the adjoining subcatchment which flows through the Unitec Campus stormwater ponds. The stream is narrow and generally shallow, and provides valuable habitat to many native fish along its entire length. a. Collaborate with Unitec to assess potential and improve stream i. Consider ARCTP302 SEV to model potential improvements in reaches with low riparian cover and minor channel modification. b. Improve fish habitat by increased planting and monitoring of SW inputs i. Bullies in downstream, fast flowing, cobbly sections. ii. Galaxiids in slower sections upstream and near spring input c. Manage in conjunction with MU2 objectives identified for inanga spawning d. Encourage and collaborate with Unitec to develop and implement a Stormwater Management Plan in an effort to: i. Identify and survey unaccounted for outfalls to determine usage and source ii. Minimise erosion at outfalls through mitigation works as appropriate iii. Encourage management of service outlet (**Oak_Eng_225**) at the Unitec stormwater ponds to avoid blocking e. Encourage involvement of the Unitec marae (Ngakau Mahaki)
MU 2: Tidal Interface/Inanga Spawning	Inanga were found during the stream walk and existing vegetation is suitable as potential spawning habitat. It is unknown whether inanga currently spawn in the tidal area, however management of the bankside vegetation is recommended. a. Enhance bank vegetation in tidal area to encourage inanga spawning (e.g. grasses - see Section 6.5.1) b. Restrict access and erect educational signage c. Support initiatives of Friends of Oakley Creek whereby the goal of improved spawning area is achieved d. Assess effectiveness of litter trap in current location and ensure regular maintenance

MU 3: Main Channel	Friends of Oakley Creek have been fundamental in the improvement in the native biodiversity and amenity value of this section of the creek. In particular they have initiated and carried out regular plantings with approximately 23,000 plants established. More recently they have become involved in monitoring, pest management and encouraging lizards and wetas to inhabit the area. This section of the creek is one of the more unmodified sections and as such should be managed to enhance the existing values. a. Enhance vegetation cover for bank stability and in-stream habitat and temperature stabilisation i. Support objectives of Friends of Oakley Creek and the Te Ngahere vegetation plan b. Address bank stability through a combination of reinforcing and planting where appropriate c. Manage erosion at outfalls d. Consider surveying benthic macroinvertebrates to quantify presence of freshwater mussels (*Hyridella*) e. Encourage regular and continued maintenance of floating litter trap (**NT1416**) as per Watercourse Maintenance Contract
MU 4: Waterfall	The Oakley Creek waterfall is a significant feature of the waterway. The recreation area below the waterfall provides amenity value. The waterfall has the potential to be improved to benefit biodiversity. This could primarily be achieved by improvements to the waterfall at the point at which it drops (its crest). The waterfall is currently accessed by the pubic which has resulted in a reduction in riparian vegetation which borders the wetted margin of the waterfall. This vegetation is important in providing a corridor for upstream fish migration. There are a number of ways this might be mitigated by improving safety, fish passage and amenity value. a. Enhance recreation and amenity value (existing LA4 Landscapes Architect Plan) b. Investigate and implement wetted margin planting to facilitate fish passage past waterfall c. Restrict access to top of waterfall to improve safety and reduce risk of vegetation damage required for fish passage

10.4 Management Zone 2

MZ	2	**Outfalls with Erosion**	6 slight, 1 moderate
# of MU	3	**Erosion Hotspots**	None
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Parks Services
Reaches	Oak 12-24 Oak Trib 2	**Stakeholder 2**	Unitec
Length (m)	1367	**Stakeholder 3**	Friends of Oakley Creek
Dominant substrate	Boulders	**Stakeholder 4**	Metrowater
Mean channel width (m)	3	**Mean Riparian Cover (%)**	60
Mean depth (m)	0.7	**RO**	RO4, RO5, RO6, RO7, RO8, RO9
Water clarity (m)	1	**Wetlands**	None
Special Values	Waterfall	**Parks & Reserves**	Oakley Creek Esplanade Phyllis Street Reserve Harbutt Reserve
Spatial Definition	Management Zone 2 includes the area between the Oakley Creek Waterfall and the public walkway at Cradock Street. Reasons for this spatial definition include; - Channel morphology is similar and consists of bedrock and large boulders; - Reserves and parks on the TRB and residential land use on the TLB; - Extensive public walkways and amenity areas; and - Extensive weed issues throughout the zone. Sections of the banks are very weedy – in particular *Tradescantia* near the Cradock Street bridge. The *Tradescantia* appears to be mown which may be detrimental for downstream weed management. Areas of prolific weed infestation are more prominent in the more confined reaches where public access is limited. This is between the footbridge above the waterfall and the large open area of grass just downstream of the Cradock Street bridge. Weeds are more extensive on the TRB than the TLB, in particular nasturtium, privet, tobacco weed and climbing asparagus.		
Goals and Objectives	Overall management objectives include: - Manage terrestrial weeds and revegetate where applicable; - Maintain conveyance throughout MZ, managing in-stream obstructions and bank stability; - Minimise erosion at outfalls through mitigation works as appropriate - Improve amenity in line with existing and proposed reserve management plans and Friends of Oakley Creek objectives; and - Extend existing access to link pathways with reserves.		

Identified Engineering Issues **Refer Appendix D for more detail**	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 24 - Unsafe (drop>1.5m): Oak_Eng_ID: 207 **Maintenance required** - Erosion Protection: Oak_Eng_ID: 24 - Structural: Oak_Eng_ID: 21, 26, 207, 210 - Debris Removal: Oak_Eng_ID: 18, 22, 206, 208 - Vegetation Clearance: Oak_Eng_ID: No issues identified - Patching: Oak_Eng_ID: 20 **Erosion at outfalls** - Slight: Oak_Eng_ID: 20, 22, 23, 24, 208, 210 - Moderate: Oak_Eng_ID: 27 - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - Oak_HS_012
Management Units	
MU 1: Waterfall to edge of Phyllis Reserve	a. Implement weed management and revegetation on both banks for amenity and stability b. Investigate aquatic vegetation and assess for removal to improve conveyance d. Address bank stability on both banks through a combination of reinforcing and planting where appropriate e. Manage outfalls entering creek including bank reinforcement where discharge velocity has potential to cause bank instability f. Enhance vegetation cover for bank stability and in-stream habitat and temperature buffering i. Support objectives of Friends of Oakley Creek and the Te Ngahere vegetation plan (See Appendix E)
MU 2: Between Phyllis Reserve and Harbutt Reserve	a. Implement weed management on both banks for amenity and stability b. Enhance vegetation cover for bank stability and in-stream habitat and temperature stabilisation i. Support objectives of Friends of Oakley Creek and the Te Ngahere vegetation plan c. Address bank stability through a combination of reinforcing and planting where appropriate d. Minimise erosion at outfalls through mitigation works as appropriate e. Ensure ongoing maintenance contractors are aware of access restrictions and undertake regular checks of area for debris jams
MU 2: Open section downstream of Cradock St footbridge	a. Implement weed management and revegetation on both banks for amenity and stability i. In particular, management of *Tradescantia* on TRB immediately below footbridge b. Enhance vegetation cover for bank stability and in-stream habitat and temperature stabilisation i. Support objectives of Friends of Oakley Creek and the Te Ngahere vegetation plan c. Improve amenity by enhancing existing access and connectivity between reserves and implementing recreational area with picnic tables d. Investigate aquatic vegetation and assess for removal to improve conveyance

10.5 Management Zone 3

MZ	3	**Outfalls with Erosion**	2 slight, 1 moderate
# of MU	4	**Erosion Hotspots**	3
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Parks Services
Reaches	Oak 25-34 Oak Trib 3 Oak Trib 4	**Stakeholder 2**	Metrowater
Length (m)	980	**Stakeholder 3**	OnTrack
Dominant substrate	Silt/Sand	**Stakeholder 4**	Friends of Oakley Creek
Mean channel width (m)	2.35	**Mean Riparian Cover (%)**	48
Mean depth (m)	0.4	**RO**	RO10, RO11, RO12, RO13
Water clarity (m)	0.8	**Wetlands**	None
Special Values	Numerous Archaeological sites	**Parks & Reserves**	Harbutt Reserve
Spatial Definition	Management Zone 3 includes the area between the Cradock Street footbridge and the downstream side of Western Route rail tracks at Trent Street, Avondale. Reasons for this spatial definition include: - Land use includes reserves (TRB) and residential properties to (TLB); - Erosion and bank instability in the lower section; - Terrestrial and aquatic weeds are common in the lower section; - Public access to the creek is limited; - Upper banks are steep and with dense riparian tree cover; - Eels recorded under Cradock Street footbridge (well known population); - Potential conveyance issues in upper section due to Willow trees in-stream; - Channel morphology consists of primarily bedrock and boulders in the lower to mid section with increasing sedimentation in the upper section; - Riparian overhead cover ranges from 25-60%; and - Pest fish (*Gambusia affinnis*) occur in pools throughout zone.		
Goals and Objectives	Overall management objectives include: - Manage terrestrial weeds and revegetate where applicable; - Investigate erosion in lower section and reinforce or plant where appropriate; - Mitigate and minimise erosion at outfalls; - Survey aquatic vegetation and determine status under ARC RPMS (Regional Pest Management Strategy) and take appropriate action, where feasible in line with conveyance objectives; - Maintain conveyance throughout MZ, managing in-stream obstructions and bank stability; - Encourage local community to play active management role of the creek; - Improve amenity in line with existing and proposed reserve management plans and Friends of Oakley Creek objectives; and - Extend existing access to link pathways with reserves.		

Identified Engineering Issues **Refer Appendix D for more detail**	**Safety issues** - Safety Uncertain: No issues identified - Unsafe (drop>1.5m): Oak_Eng_ID: 217 - Unsafe: Oak_Eng_ID: 42 **Maintenance required** - Erosion Protection: Oak_Eng_ID: 31 - Structural: No issues identified - Debris Removal: Oak_Eng_ID: 33, 36 - Vegetation Clearance: No issues identified - Patching: No issues identified **Erosion at outfalls** - Slight: Oak_Eng_ID: 31, 36 - Moderate: Oak_Eng_ID: 33 - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - Oak_HS_004, 001, 002
Management Units	
MU 1: Cradock Street footbridge to end of Powell Street	a. Install educational signage regarding eel population under Cradock Street footbridge b. Implement weed management and revegetation on TRB for amenity and stability and support objectives of Friends of Oakley Creek c. Investigate aquatic vegetation and assess for removal to improve conveyance d. Address bank stability on both banks through a combination of reinforcing and planting where appropriate e. Erosion protection on TLB near residential properties at the end of Cradock Street f. Extend and upgrade existing public access from footbridge along creek to join with Harbutt Reserve
MU 2: End of Powell Street to Cascades	a. Reduce impact of stormwater outfalls entering creek including bank reinforcement where discharge velocity has potential to cause bank instability b. Implement weed management on upper banks of TRB and support objectives of Friends of Oakley Creek c. Encourage awareness of historic stonewalls and ensure maintenance complies with preservation objectives
MU 3: Cascades	a. Manage for flood flow and ensure conveyance is maintained i. Investigation required to model impact of willows in-stream b. Implement weed management (particularly bamboo) on both banks and support objectives of Friends of Oakley Creek c. Manage debris and rubbish dumping on TRB to reduce potential of in-stream debris jams d. Enhance plantings close to stream to assist with in-stream temperature stabilisation and shading to reduce periphyton cover
MU 4: Cascades to rail tracks	a. Assess safety of outlet (**DMID192976**) as currently access is easy and extensive graffiti inside ii. Consider installing a grille if feasible and inline with conveyance objectives b. In line with objectives for MZ 4, investigate methods to reduce (anaerobic) sediment deposition below rail tracks c. Investigate and CCTV pipe (DMID 332722) and outfall (DMID 192987) for capacity assessment due to severe erosion in Tributary 4

10.6 Management Zone 4

MZ	**4**	**Outfalls with Erosion**	4 slight, 1 moderate
# of MU	3	**Erosion Hotspots**	None
Stream	Oakley Creek	**Stakeholder 1**	Metrowater
Reaches	Oak 35-41 Oak Trib 5	**Stakeholder 2**	Residents
Length (m)	663	**Stakeholder 3**	Light commercial businesses
Dominant substrate	Silt/Sand	**Stakeholder 4**	OnTrack
Mean channel width (m)	2	**Mean Riparian Cover (%)**	45
Mean depth (m)	0.35	**RO**	RO14
Water clarity (m)	0.7	**Wetlands**	None
Special Values	None	**Parks & Reserves**	None

Spatial Definition	Management Zone 4 includes the area of stream upstream of the rail tracks to the downstream side of Bollard Avenue, including stream on both sides of New North Road. Reasons for this spatial definition include: - Residential land use both sides of the creek; - Unconsolidated soils leading to bank instability throughout zone; and - Extensive *Tradescantia* cover in the lower section.
Goals and Objectives	Overall management objectives include: - Improve bank stability through reinforcement and planting where appropriate; - Investigate methods to reduce sediment inputs to (and effects on) stream; - Weed management (particularly *Tradescantia* and bamboo) to reduce risk of transportation downstream; - Engage with local community to ensure consistency in restoration and use throughout MZ o St Judes Scout group; - Minimise overflows in upper section, including restricting access of public to stream; and - Improve bankside vegetation where appropriate to reduce sediment runoff, erosion and stabilise in-stream temperatures.
Identified Engineering Issues **Refer Appendix D for more detail**	**Safety issues** - Safety Uncertain: No issues identified - Unsafe (drop>1.5m): No issues identified - Unsafe: Oak_Eng_ID: 46, 47 **Maintenance required** - Erosion Protection: No issues identified - Structural: Oak_Eng_ID: 218, 234 - Debris Removal: Oak_Eng_ID: 54 - Vegetation Clearance: Oak_Eng_ID: 49 - Patching: No issues identified **Erosion at outfalls** - Slight: Oak_Eng_ID: 44, 52, 54, 234 - Moderate: Oak_Eng_ID: 218 - Severe: No issues identified

	Erosion Hotspots: Refer to erosion hotspot database. - No issues identified
Management Units	
MU 1: Rail tracks to New North Road	a. Address bank stability through reinforcing and planting where appropriate b. Implement weed management (*Tradescantia*) to reduce risk of transportation downstream c. Encourage and support ongoing restoration work undertaken by St Judes Scout group d. Maintain New North Road culvert and improve safety and conveyance
MU 2: Tributary 5	a. Encourage and support residential community gardens i. Include education about potential health and safety risk associated with access during high flows and potential wastewater contamination b. Assess and improve conveyance in open, weedy area at 'headwater' of tributary c. Improve upper bank stability and take action to reduce dumping of household rubbish d. Monitor presence of pest fish, following capture of a goldfish (*Crassius auratus*)
MU 3: Between New North Road and Bollard Avenue	a. Minimise where feasible wastewater overflows and restrict resident access to stream as appropriate b. Improve planting density to assist with restricting access c. Address bank stability through reinforcing and planting where appropriate directly downstream of Bollard Avenue d. Ensure ongoing maintenance of bank lining throughout reach e. Implement weed management to reduce risk of transportation downstream

10.7 Management Zone 5

MZ	5	**Outfalls with Erosion**	3 slight
# of MU	8	**Erosion Hotspots**	6
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Council
Reaches	Oak 42-53 Oak Trib 6 Oak Trib 7 Oak B1 1 and 2	**Stakeholder 2**	Metrowater
Length (m)	2939	**Stakeholder 3**	Transit
Dominant substrate	Silt/Sand	**Stakeholder 4**	Friends of Oakley Creek
Mean channel width (m)	2	**Mean Riparian Cover (%)**	18
Mean depth (m)	0.5	**RO**	RO17
Water clarity (m)	N/A	**Wetlands**	None
Special Values	Exposed lava flows	**Parks & Reserves**	Hendon Avenue Reserve Alan Wood Reserve Valonia Reserve
Spatial Definition	Management Zone 5 includes the creek in Hendon Avenue and Alan Wood Reserves, on the upstream side of Bollard Avenue to Richardson Road. Reasons for this spatial definition include: - Primarily parks and reserves, with some residential land use; - Will be impacted by proposed SH20 Motorway Extension; - Varying degrees of modification (bank and channel) throughout MZ; - Areas of bank instability and erosion; and - Wide, deep channel with areas of aquatic plant proliferation.		

Goals and Objectives	Overall management objectives include:
	
	- Naturalise channel where feasible in line with conveyance objectives;
	- Improve connectivity and access across creek and between reserves;
	- Improve amenity by introducing cycleways and picnic areas;
	- Investigate and address erosion and bank stability through reinforcing and planting where appropriate;
	- Highlight geological value of area, identifying exposed lava flows (significant natural feature);
	- Consider and provide options for offset mitigation regarding SH20 motorway extension
	  o Including stormwater treatment ponds, swales and wetlands; and
	- Introduce extensive riparian planting to improve amenity, bank stability and stabilise in-stream temperatures
	  o Also potential to buffer noise and provide stormwater filtration following motorway development.		

Identified Engineering Issues **Refer Appendix D for more detail**	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 65, 82 - Unsafe (drop>1.5m): No issues identified - Unsafe: No issues identified **Maintenance required** - Erosion Protection: No issues identified - Structural: Oak_Eng_ID: 75 - Debris Removal: Oak_Eng_ID: 66, 77 - Vegetation Clearance: Oak_Eng_ID: 280 - Patching: No issues identified **Erosion at outfalls** - Slight: Oak_Eng_ID: 56, 57, 58 - Moderate: No issues identified - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - Oak_HS_005, 019, 006, 003, 007, 008
Management Units	
MU 1: Bollard Avenue to boundary of 44 Bollard Avenue	a. Implement weed management to reduce risk of transportation downstream b. Address bank stability through reinforcing and planting where appropriate c. Improve flow conveyance through channel widening and bank battering d. Enhance riparian margin, including use of polishing species on flooded margins e. Maintain (and improve) connectivity and access to creek and entrances of reserve f. Ensure all management plans consider downstream effects on two culverts at Great North Road and Bollard Avenue i. Potential to block
MU 2: 44 Bollard Avenue to start of bank lining opposite 106 Methuen Road entrance	a. Implement weed management to reduce risk of transportation downstream b. Maintain (and improve) connectivity and access across creek and to entrances of reserve c. Address bank stability through reinforcing and planting where appropriate d. Improve floodplain engagement and efficiency through bank battering and floodplain planting e. Restoration as identified in RO 17 (See Section 11.18)
MU 3: Bank lined section between 106 and 164 Methuen Road	a. Re-engineer a more naturalised channel where feasible in line with conveyance objectives b. Encourage floodplain connectivity by widening channel cross-section on TRB into public reserve c. Improve bank heterogeneity and planting including polishing species near water's edge d. Enhance planting on both banks to ensure stabilisation of in-stream temperatures e. Maintain (and improve) connectivity and access across creek and to entrances of reserve

MU 4: Bank lined section between 164 and 194 Methuen Road	a. Re-engineer a more naturalised channel where feasible in line with conveyance objectives b. Introduce floodplain connectivity by widening channel cross-section on both banks c. Improve bank heterogeneity and planting including polishing species near water's edge d. Enhance planting on both banks to ensure stabilisation of in-stream temperatures e. Maintain (and improve) connectivity and access across creek and to entrances of reserve
MU 5: Bank lined section between 194 Methuen Road and 33 Whittle Pl	a. Address bank in-stability on TLB through reinforcing, considering long term effects on neighbouring residential properties b. Re-engineer a more naturalised channel where feasible in line with conveyance objectives c. Introduce floodplain connectivity by widening channel cross-section on TRB into public reserve d. Maintain (and improve) connectivity and access across creek and to entrances of reserve e. Introduce extensive riparian planting on TRB to improve amenity and stabilise in-stream temperatures f. May also be useful for mitigation following SH20 development
MU 6: 33 Whittle Pl to opposite 21 Valonia Pl, including Valonia Reserve	a. Re-engineer a more naturalised channel where feasible in line with conveyance objectives b. Introduce floodplain connectivity by widening channel cross-section on both banks c. Improve bank heterogeneity and planting including polishing species near water's edge d. Enhance planting on both banks to ensure stabilisation of in-stream temperatures e. Maintain (and improve) connectivity and access across creek and to entrances of reserve f. Investigate and improve connectivity of pipes and outlets to main channel from Valonia Reserve
MU 7: Opposite 21 Valonia Pl to confluence with Oak_B1	a. Highlight and protect geological value of area, identifying exposed lava flows b. Address bank in-stability through reinforcing and planting where appropriate c. Re-engineer a more natural channel where feasible in line with conveyance objectives d. Introduce floodplain connectivity by widening channel cross-section on both banks e. Improve bank heterogeneity and planting including polishing species near water's edge f. Enhance planting on both banks to ensure stabilisation of in-stream temperatures g. Maintain (and improve) connectivity and access across creek and to entrances of reserve
MU 8: From confluence of main channel and Oak_B1 to Richardson Road, including Oak_B1	a. Consider developing amenity area behind residential area (currently willows), between B1 and main channel or b. Encourage connectivity with overland flow path from TLB c. Improve access across main channel and Oak_B1 d. Introduce floodplain connectivity by widening channel cross-section where possible e. Improve bank heterogeneity and planting including polishing species near water's edge

10.8 Management Zone 6

MZ	6	**Outfalls with Erosion**	1 slight
# of MU	3	**Erosion Hotspots**	1
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Council
Reaches	Oak 54-58	**Stakeholder 2**	Metrowater
Length (m)	2169	**Stakeholder 3**	Friends of Oakley Creek
Dominant substrate	Concrete	**Stakeholder 4**	Local Community
Mean channel width (m)	1.9	**Mean Riparian Cover (%)**	8
Mean depth (m)	0.9	**RO**	None
Water clarity (m)	N/A	**Wetlands**	None
Special Values	None	**Parks & Reserves**	Underwood Park Walmsley Park War Memorial Park
Spatial Definition	Management Zone 6 includes the reserves between Richardson Road and May Road (including only stream to the North of Stoddard Road). Reasons for this spatial definition include: - Public reserves: Underwood, Walmsley, War Memorial; - Low riparian overhead cover (typically <10%); - Extensive public access through reserves, but varying to creek edge; and - Shallow stream with varying levels of modification.		
Goals and Objectives	Overall management objectives include: - Improve connectivity and access across creek and between reserves; - Improve amenity by introducing cycleways and picnic areas; - Naturalise channel where feasible in line with conveyance objectives; - Introduce extensive riparian planting to improve amenity, bank stability and stabilise in-stream temperatures; and - Minimise where feasible wastewater overflows and reduce public contact as appropriate.		
Identified Engineering Issues Refer Appendix D for more detail	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 93, 94, 97, 98, 101, 103, 213 - Unsafe (drop>1.5m): No issues identified - Unsafe: No issues identified **Maintenance required** - Erosion Protection: No issues identified - Structural: Oak_Eng_ID: 88, 91, 107, 214, 219, 231, 232, 233 - Debris Removal: No issues identified - Vegetation Clearance: Oak_Eng_ID: 84 - Patching: Oak_Eng_ID: 96, 99, 100, 101, 103, 104, 220, 239 **Erosion at outfalls** - Slight: Oak_Eng_ID: 219 - Moderate: No issues identified - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.**		

	- Oak_HS_021
Management Units	
MU 1: Underwood Park	a. Improve connectivity and access across creek and within reserves b. Improve amenity by implementing recreation and picnic areas c. Naturalise channel where feasible in line with conveyance objectives i. Improve substrate heterogeneity by removing lining in appropriate areas d. Introduce extensive riparian planting to improve amenity and stabilise in-stream temperatures
MU 2: Walmsley Park	a. Improve connectivity and access across creek and within reserves b. Naturalise channel where feasible in line with conveyance objectives c. Introduce extensive riparian planting to improve amenity, bank stability and stabilise in-stream temperatures d. Improve amenity by implementing recreation and picnic areas
MU 3: War Memorial Park	a. Naturalise channel where feasible in line with conveyance objectives i. Improve substrate heterogeneity by removing lining in appropriate areas b. Introduce extensive riparian planting to improve amenity and stabilise in-stream temperatures c. Minimise where feasible wastewater overflows and reduce public contact to these high flow events d. Improve amenity by implementing recreation and picnic areas

10.9 Management Zone 7

MZ	7	**Outfalls with Erosion**	11 slight, 4 moderate
# of MU	3	**Erosion Hotspots**	1
Stream	Oakley Creek	**Stakeholder 1**	Metrowater
Reaches	Oak B1 3-9 Oak B1 Trib 1, 2, 3, 4	**Stakeholder 2**	Auckland City Council
Length (m)	1754	**Stakeholder 3**	Transit
Dominant substrate	Silt/Sand	**Stakeholder 4**	Unknown Landowner
Mean channel width (m)	1	**Mean Riparian Cover (%)**	10
Mean depth (m)	0.2	**RO**	RO15, RO16
Water clarity (m)	N/A	**Wetlands**	WL003, WL004
Special Values	Wooden Artefacts (MU3)	**Parks & Reserves**	None
Spatial Definition	Management Zone 7 includes Oak_B1 (upstream Richardson Road) to May Road (including only the stream to the South of Stoddard Road). Reasons for this spatial definition include: - Light industrial land use; - Low amenity value and limited public access; and - Existing and potential future impact from SH20 motorway extension.		
Goals and Objectives	Overall management objectives include: - Reduce debris and rubbish entering stream from industrial sites; - Address bank stability through reinforcing and planting where appropriate; - Introduce extensive riparian planting to improve amenity of area (view from motorway), buffer noise and improve natural filtering capacity; - Identify and survey unaccounted for stormwater outfalls to determine usage and source; - Ensure ongoing maintenance of critical inlets to reduce potential for flooding; and - Survey and update corporate GIS with changes to pipe network following motorway development.		
Identified Engineering Issues Refer Appendix D for more detail	**Safety issues** - Safety Uncertain: No issues identified - Unsafe (drop>1.5m): No issues identified - Unsafe: No issues identified **Maintenance required** - Erosion Protection: Oak_Eng_ID: 133, 134, 137, 269, 272, 273, 275 - Structural: Oak_Eng_ID: 123, 235, 274 - Debris Removal: Oak_Eng_ID: 270 - Vegetation Clearance: Oak_Eng_ID: 237, 276 - Patching: No issues identified **Erosion at outfalls** - Slight: Oak_Eng_ID: 123, 131, 133, 134, 140, 142, 143, 269, 270, 271, 274 - Moderate: Oak_Eng_ID: 137, 272, 273, 275 - Severe: No issues identified		

	Erosion Hotspots: Refer to erosion hotspot database. - Oak_HS_018
Management Units	
MU 1: Immediately upstream of Richardson Road	a. Address bank stability through reinforcing and planting where appropriate b. Reduce debris and rubbish entering stream from industrial sites c. Introduce riparian planting to stabilise in-stream temperatures d. Consider and provide options for offset mitigation regarding SH20 motorway extension
MU 2: Stoddard Road	a. Plant extensively to reduce amount of debris entering stream and improve in-stream values i. This may result in access and maintenance issues b. Alternatively consider piping this short section of stream to improve in-stream values downstream ii. Currently rubbish and debris entering stream have potential to block culverts iii. Very little ecological value and no amenity or recreation value
MU 3: Roma Road	a. Identify and survey unaccounted for outfalls to determine usage and source b. Re-engineer a more natural channel where feasible in line with conveyance objectives c. Reduce debris and rubbish entering stream from industrial sites and potentially blocking downstream culverts d. Potential to form an urban stormwater treatment wetland (similar to Waiatarua wetland) i. Land ownership unknown

10.10 Management Zone 8

MZ	8	**Outfalls with Erosion**	1 slight
# of MU	0	**Erosion Hotspots**	none
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Council
Reaches	Oak 59-62	**Stakeholder 2**	Metrowater
Length (m)	546	**Stakeholder 3**	Residents
Dominant substrate	Large Cobble	**Stakeholder 4**	Friends of Oakley Creek
Mean channel width (m)	2	**Mean Riparian Cover (%)**	19%
Mean depth (m)	0.25	**RO**	None
Water clarity (m)	0.75	**Wetlands**	None
Special Values	Historic stonewalling	**Parks & Reserves**	None
Spatial Definition	Management Zone 8 includes stream between May Road and the confluence of Tributary 8 with the main channel at the boundary of Mt Roskill Intermediate school. - Existing historic stonewalling along entire reach; - Confined space and limited access for contractors; and - Residential land use in close proximity to the creek. One of the main options for significant restoration is to extend riparian margins and restore natural channel morphology. However, the proximity of adjacent residential properties to the creek means this is not currently feasible.		
Goals and Objectives	Overall management objectives: - Maintain and repair as required historic stonewalling for conveyance and amenity purposes; - Limited access for contractors so specific health and safety plans required when accessing for maintenance; - Residential properties close to boundary, maintain bank stability and conveyance to reduce risk of flooding and property damage; and - Ensure ongoing maintenance of culverts as blocked culverts in storm events may become critical.		
Identified Engineering Issues Refer Appendix D for more detail	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 117 - Unsafe (drop>1.5m): No issues identified - Unsafe: No issues identified **Maintenance required** - Erosion Protection: Oak_Eng_ID: 111 - Structural: Oak_Eng_ID: 114 - Debris Removal: Oak_Eng_ID: 248 - Vegetation Clearance: No issues identified - Patching: No issues identified **Erosion at outfalls** - Slight: Oak_Eng_ID: 111 - Moderate: No issues identified - Severe: No issues identified		

	Erosion Hotspots: Refer to erosion hotspot database. - No issues identified
Management Units	No individual management units – manage entire MZ as above.

10.11 Management Zone 9

MZ	9	**Outfalls with Erosion**	2 moderate
# of MU	3	**Erosion Hotspots**	None
Stream	Oakley Creek	**Stakeholder 1**	Mt Roskill Intermediate and Grammar Schools
Reaches	Oak 63-66 Oak Trib 8 Oak Trib 9a, b	**Stakeholder 2**	Residents
Length (m)	2113	**Stakeholder 3**	Metrowater
Dominant substrate	Silt/Sand	**Stakeholder 4**	N/A
Mean channel width (m)	2.15	**Mean Riparian Cover (%)**	18
Mean depth (m)	0.2	**RO**	RO19
Water clarity (m)	0.2	**Wetlands**	None
Special Values	Mt Roskill Intermediate School	**Parks & Reserves**	None
Spatial Definition	Management Zone 9 includes between the boundary of Mt Roskill Intermediate and the end of the open channel underneath Somerset Road including Tributary 8 and reaches Oak_Trib_9a & b. Reasons for this spatial definition include: - Channel wide and generally shallow, with steep banks and very little riparian overhead cover; - Land use is primarily residential on the TLB; - Mt Roskill Intermediate and Grammar Schools occupy land on the TLB; - A lot of potential for improvement; and - There are no known future impacts from SH20 motorway extension.		
Goals and Objectives	Overall management objectives include: - Survey and update corporate GIS with changes to pipe network following motorway development; - Improve bank stability through reinforcing or planting as appropriate; - Enhance existing riparian revegetation to improve shading and bank stability; - Improve bank vegetation to reduce contractor maintenance requirements; - Collaborate with Mt Roskill Intermediate and Grammar Schools to improve creek appearance; - Introduce signage regarding trees, history, fauna, water etc for public education and awareness; and - Identify and minimise where feasible sources of wastewater into the creek.		
Identified Engineering Issues Refer Appendix D for more detail	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 121, 122, 154, 250, 263 - Unsafe (drop>1.5m): No issues identified - Unsafe: No issues identified **Maintenance required** - Erosion Protection: Oak_Eng_ID: 252, 254 - Structural: Oak_Eng_ID: 119 - Debris Removal: No issues identified - Vegetation Clearance: Oak_Eng_ID: 253 - Patching: No issues identified		

	Erosion at outfalls - Slight: No issues identified - Moderate: Oak_Eng_ID: 252, 254 - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - No issues identified
Management Units	
MU 1: Tributary 8	a. Enhance riparian planting on steep banks to encourage stability and reduce public access b. Maintain bank stability (TRB) and conveyance to reduce risk of flooding and property damage due to proximity of residential property fences
MU 2: Mt Roskill Intermediate School	a. Encourage school involvement in creek management (Wai Care) b. Planting on both banks for shading and bank stability i. Potential safety issues with currently mowing maintenance on steep banks – planting will reduce this c. Advise contractors against mowing into streams – grass decomposition decreases oxygen in-stream
MU 3: Tributary 9	a. Improve amenity of confluence by planting i. Will also improve bank stability and shading b. Upstream (over road): investigate bank reinforcing for stability c. Enhance riparian planting on steep banks to encourage stability

10.12 Management Zone 10

MZ	10	**Outfalls with Erosion**	None
# of MU	3	**Erosion Hotspots**	None
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Parks Services
Reaches	Oak 67-70 Oak Trib 9c, d	**Stakeholder 2**	Akarana Golf Course
Length (m)	1357	**Stakeholder 3**	Roskill Aquasport Centre
Dominant substrate	Concrete	**Stakeholder 4**	Residents
Mean channel width (m)	1.2	**Mean Riparian Cover (%)**	10
Mean depth (m)	0.14	**RO**	None
Water clarity (m)	N/A	**Wetlands**	None
Special Values	None	**Parks & Reserves**	Keith Hay Park Molley Green Reserve Akarana Golf Course
Spatial Definition	Management Zone 10 includes all channels within the bounds of Keith Hay Park and Molley Green Reserve. Reasons for this spatial definition include: - Open space land use – Keith Hay Park, Akarana Golf Course and Molley Green Reserve; - Extensive public access and recreational reserve (including sports fields); and - High level of channel modification sections.		
Goals and Objectives	Overall management objectives include: - Improve amenity through planting and naturalisation where practical; and - Minimise where feasible wastewater overflows and reduce public contact to these high flow events.		
Identified Engineering Issues Refer Appendix D for more detail	**Safety issues** - Safety Uncertain: Oak_Eng_ID: 164 - Unsafe (drop>1.5m): Oak_Eng_ID: 301, 302, 303 - Unsafe: No issues identified **Maintenance required** - Erosion Protection: Oak_Eng_ID: 163 - Structural: No issues identified - Debris Removal: Oak_Eng_ID: 162, 261 - Vegetation Clearance: Oak_Eng_ID: 166, 168, 169, 256, 257, 304 - Patching: No issues identified **Erosion at outfalls** - Slight: No issues identified - Moderate: No issues identified - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - No issues identified		

Management Units	
MU 1: Keith Hay Park drainage channel	a. Trim and maintain pine trees to reduce risk of debris jams from low branches in stream b. Currently it is regularly dredged – investigate options to reduce the frequency of this. i. Potential to improve wetland at top of reaches as natural filtering systems, rather than channels bypassing, to reduce sediment entering creek.
MU 2: Keith Hay Park concrete channel	a. Conduct a feasibility study to determine if naturalising channel will meet conveyance objectives b. Improve planting to reduce access to creek in high flows
MU 3: Molley Green Reserve	a. Currently a health and safety issue next to children's playground b. Regularly blocks with debris causing pooling and odours – ensure regular maintenance regime followed c. Two main improvement options i. Naturalise channel and plant to improve amenity. ii. Consider piping section of stream to improve health and safety, amenity and maintenance issues

10.13 Management Zone 11

MZ	11	**Outfalls with Erosion**	7 slight
# of MU	2	**Erosion Hotspots**	None
Stream	Oakley Creek	**Stakeholder 1**	Auckland City Council Parks Services
Reaches	Oak B2 1-8 Oak Trib 10	**Stakeholder 2**	Metrowater
Length (m)	831	**Stakeholder 3**	Private Residents
Dominant substrate	Silt/Sand	**Stakeholder 4**	Industrial landowners
Mean channel width (m)	0.9	**Mean Riparian Cover (%)**	34
Mean depth (m)	0.11	**RO**	RO18
Water clarity (m)	N/A	**Wetlands**	None
Special Values	None	**Parks & Reserves**	None
Spatial Definition	Management Zone 11 includes two sections of creek which will have no foreseeable future impact from motorway development. Location: Open watercourse flowing between residential properties between 19 Eaton Road and 80 Olsen Avenue. - Narrow channel through residential area; - Private culverts and outlets throughout length of reach; and - Varying level of modification. Corner of Hayr Road and Motorway overbridge, extending along the length of the motorway towards Hillsborough Road. - Back of industrial area; - Small reach and wet area; - Impacted by motorway; and - Some existing plantings from motorway development.		
Goals and Objectives	Overall management objectives include: - Improve amenity through planting and naturalisation where practical; and - Maintain conveyance through these channels to reduce risk of damage to private property.		
Identified Engineering Issues **Refer Appendix D for more detail**	**Safety issues** - Safety Uncertain: No issues identified - Unsafe (drop>1.5m): No issues identified - Unsafe: No issues identified **Maintenance required** - Erosion Protection: Oak_Eng_ID: 195, 287 - Structural: Oak_Eng_ID: 190, 191, 292 - Debris Removal: Oak_Eng_ID: 189 - Vegetation Clearance: No issues identified - Patching: No issues identified		

	Erosion at outfalls - Slight: Oak_Eng_ID: 195, 286, 287, 288, 291, 294, 296 - Moderate: No issues identified - Severe: No issues identified **Erosion Hotspots: Refer to erosion hotspot database.** - No issues identified
Management Units	
MU 1: Carr Road	a. Plant entire area for motorway amenity, reduce noise and maintenance; b. Remove debris and in-stream structures for improved conveyance; and c. Identify and validate post-motorway pipe network in area.
MU 2: Olsen Avenue	a. Assess private culverts to identify risk of blockage and flooding to residents; and b. Where possible improve planting in lower sections in conjunction with bank stabilisation works.

SECTION 11: Restoration Opportunities & Management

A number of restoration sites were identified during the stream walk survey and are detailed in this section and summarised for each defined Management Zone. The locations of Restoration Opportunities (RO) are presented in Appendix A, Map Series 7. Sites have been selected based on their potential to achieve multiple benefits including:

- Improving aquatic and terrestrial environments;
- Enhancing amenity and access for the community;
- Improving land in public ownership; and
- Maintaining flood water conveyance.

The following restoration schedules have been designed to provide important background information that can be used to generate detailed restoration plans. They are a guide to focus more detailed study or to direct management actions. Restoration schedules include:

- Details of the restoration opportunity;
- Identification of Stakeholders;
- Description of the current ecological state of the site;
- Objectives for the site;
- Recommended restoration actions;
- Prioritisation Ranking Score (PR);
- Reference to other existing plans; and
- Additional details and comments regarding the site.

The level of detail provided should be augmented with vegetation surveys (including exotic weeds) and detailed enhancement plans (including planting plans) before any onsite activities begin.

ARC has developed a guide to riparian zone management, TP 148 (Becker et. al.., 2001). This document outlines the benefits of effective riparian zone management and provides a planting guide for different stream types and resource management issues including invasive plant management. Specific references to planting unit types are made for relevant RO's, taking into account the location of the site, aspect, slope and hydrology.

When planning stream restoration it is also important to consider the in-stream environment and methods which can enhance aquatic habitats and communities. A lack of substrate heterogeneity in streams is known to inhibit macroinvertebrate communities and it has been suggested that improving substrate diversity and coarseness can significantly enhance stream restorations (Harding & Winterbourn, 1995). Additionally slow, sluggish flow velocities can also reduce the success of restoration schemes as dissolved oxygen levels remain low and sediment deposits remain.

Where feasible, adding coarse substrates and small debris structures can improve flow velocities by encouraging systems of runs, pools and riffles as well as providing habitat for macroinvertebrates and fish.

These restoration schedules can be used in conjunction with Metrowater's watercourse maintenance activities to target best practical options for stream management. Current watercourse maintenance activities are shown in Appendix A, Map Series 9, and should be considered carefully when preparing detailed restoration plans.

It is anticipated that where possible, restoration projects will involve community groups in a collaborative and inclusive approach. Detailed site specific characteristics and recommended management actions for each Restoration Opportunity are included below.

11.1 Prioritising Restoration Opportunities

Each RO has been assigned a Prioritisation Ranking (PR) based on Prioritisation Scores (PS). Each RO project was scored in terms of the potential benefits to amenity, ecology and conveyance should restoration activities be undertaken. The ranking of each RO has been derived from the total potential benefit scores as shown in Table 9.

Prioritisation scores range from 1-4 and have been designed to provide a coarse filter in order to highlight the RO's that will benefit most from restoration activities. The PR derived from these scores provides an overall ranking structure for the consideration of all stakeholders involved in the management of the watercourse. Prioritisation scores are defined in Table 8.

Table 8: Definition of prioritisation scores and the potential benefits

Score	Potential Benefit	Type of Benefit
1	**No Potential Benefit**	there would be *minimal or no benefit* from undertaking proposed restoration activities
2	**Low Potential Benefit**	there would be *measurable benefit* from undertaking proposed restoration activities
3	**Moderate Potential Benefit**	there would be *tangible benefit* from undertaking proposed restoration activities
4	**High Potential Benefit**	there would be *significant benefit* from undertaking proposed restoration activities

Table 9: Restoration Opportunities Prioritisation Table

	Potential Benefit Scores			Prioritisation and Ranking Scores	
RO	Amenity	Ecological	Conveyance	**PS**	**PR**
1	3	4	2	9	7
2	3	3	3	9	9
3	4	4	3	11	1
4	3	3	2	8	13
5	3	3	2	8	12
6	2	3	2	7	16
7	3	3	2	8	14
8	4	3	3	10	2
9	4	3	2	9	8
10	4	3	3	10	5
11	3	4	3	10	4
12	2	2	3	7	15
13	2	3	4	9	10
14	2	2	2	6	17
15	3	3	3	9	11
16	4	3	3	10	6
17	2	2	2	6	18
18	4	3	3	10	3

Restoration Opportunity 3 (RO3) has the highest score (PS=11, PR=1) as there is an excellent opportunity to improve amenity and ecological values as well as improve health and safety of the site.

The Oakley Creek Waterfall is a unique feature of the creek and is a popular recreation spot. Investigating and implementing adequate fish passage up the waterfall is the top priority for this site. Improving the riparian vegetation on the margins of the waterfall will also improve amenity. The proposed enhancements to the existing amenity infrastructure (including a bench and rubbish bin) will encourage more frequent attendance. The falls are visible from a viewing platform along the Oakley Creek Walkway path. This viewing platform allows access to the top of the waterfall, which is a health and safety risk and damages the in-stream vegetation vital for fish passage.

Biodiversity improvements through enhanced riparian planting will also improve amenity. Conveyance is not an issue at this site, however immediately downstream the creek will benefit from bank stabilising vegetation. Encouraging fish passage up the waterfall will have effects on the ecological value of the creek along its entire length.

11.2 Restoration Site 1: Engineered Channel

Restoration Opportunity	**ID**	**RO-1**	**Area m²**	356	**Objective 1**	Naturalise channel
	Stream		Oakley Creek		**Objective 2**	Improve amenity
	Location		Behind Unitec residential accommodation		**Capital Works Proposed**	Unknown
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Back wetland or spring
	Key Stakeholders 2		Metrowater		**Type**	Wetland
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	No
Current State	**Current Riparian Vegetation**		Mixed		**Improve Substrate Heterogeneity**	Yes
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	Te Ngahere Vegetation Management Plan

Actions / Plans

Comments

Located at the head of a concrete lined channel, a suspected leaking stormwater manhole has created a wetted area. This is adjacent to existing (and ongoing) planting carried out by Friends of Oakley Creek.
Some minor erosion scars are evident below the rock dam in the main channel, but there is no significant erosion in the surrounding area.

Restoration objectives:
- Re-engineer a naturalised channel in line with conveyance objectives
- Create wetland at head of engineered channel and plant appropriately
    - Investigate assets at head – potentially wet due to damaged assets

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	4	2	9	7

Photo

Figure 8: Oakley Creek RO 1. (Photocode: 8365)

11.3 Restoration Site 2: Waterview Glades

Restoration Opportunity	**ID**	**RO-2**	**Area m²**	170	**Objective 1**	Erosion Control
	Stream		Oakley Creek		**Objective 2**	Riparian Restoration
	Location		Waterview Glades, Great North Road		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services	Actions	**ARC TP148 Planting Unit**	Clay Slope
	Key Stakeholders 2		Metrowater		**Type**	Streambank/In-stream
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	No
Current State	**Current Riparian Vegetation**		Grassed Area		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No	Plans	**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	SH20 Proposed Motorway Extension Te Ngahere Revegetation Plan

Comments

Waterview Glades is a reserve on the TLB of Oakley Creek, running alongside Great North Road. A relatively stable erosion hotspot has been identified on the TLB of the creek which requires maintenance.

Additional to regular maintenance, it is recommended that the area is restored to improve amenity and bank stability/conveyance. There are four juvenile trees currently planted but more are required. There is a deep pool directly below the erosion and a pest fish (goldfish or koi carp) immediately upstream.
The reserve maybe impacted during construction of the SH20 Motorway extension.

Restoration objectives:

- Plant on TLB to a minimum of 10 m and reinforce as necessary to improve bank stability. This may require battering back the bank.
- All restoration plans need to consider conveyance efficiency
- Potential to improve amenity from the TLB by building a platform to look over the creek and into the planted area on the TRB

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	3	3	9	9

Photo

Figure 9: Oakley Creek RO-2. (Photocode: 8371)

11.4 Restoration Site 3: Waterfall

Restoration Opportunity	**ID**	**RO-3**	**Area m²**	108	**Objective 1**	Amenity
	Stream		Oakley Creek		**Objective 2**	Facilitate Fish Passage
	Location		Behind 1510-1544 Great North Road		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	No
	Key Stakeholders 2		Metrowater		**Type**	Wetted Margin and biodiversity enhancement
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Mixed		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	LA4 Waterfall Landscape Concept Te Ngahere Revegetation Plan

Actions / Plans

Comments

The waterfall area is a significant feature of the downstream reaches of Oakley Creek both ecologically and socially. The waterfall forms a barrier to passage of fish species including climbers, restricting access to suitable habitat upstream. The existing recreation area adds amenity value to the already unique waterfall feature.

Auckland City Council, Friends of Oakley Creek and a landscape architecture company have designed a Waterfall Landscape Concept design which should be referred to when considering plans. In addition an existing weed management and revegetation plan for the creek, by Te Ngahere, should be considered when planning.

Restoration objectives:

- Improve amenity and recreational value of the existing recreation area (e.g. through provision of picnic table and information board)
- Assess and manage access to waterfall to reduce health and safety risk and reduce damage to top of waterfall important for fish passage
- Conduct feasibility assessment for provision of wetted margin planting on side of waterfall to facilitate fish passage
- Improve biodiversity by enhancing existing planting
- Improve public access by upgrading existing pathways
- Collaborate with Unitec and Friends of Oakley Creek to enhance existing biodiversity to complement downstream restoration efforts.

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
4	4	3	11	1

Photo

Figure 10: Oakley Creek RO-3. (Photocode: 8443)

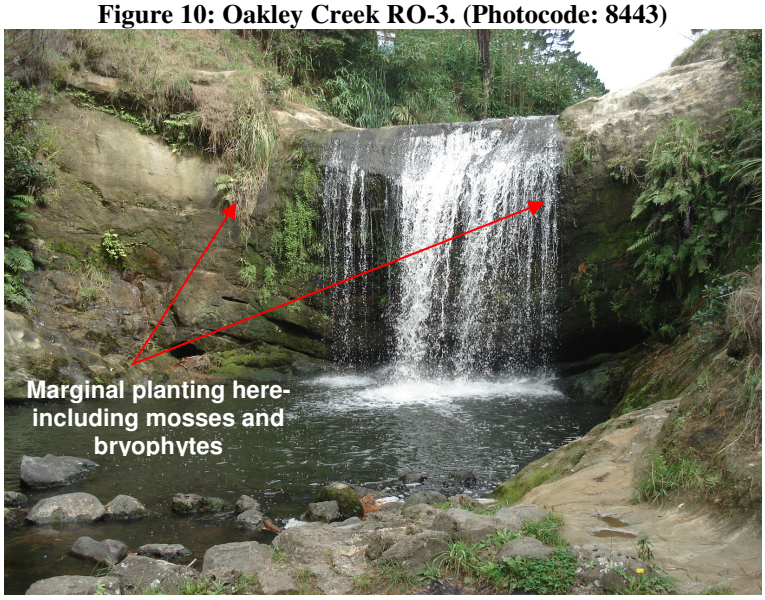

Figure 11: Oakley Creek Waterfall. (Photocode: 8427)

11.5 Restoration Site 4: Waterview Downs

Restoration Opportunity	**ID**	**RO-4**	**Area m²**	770	**Objective 1**	Riparian Restoration
	Stream		Oakley Creek		**Objective 2**	Amenity
	Location		1590 Great North Road, Avondale		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services	Actions	**ARC TP148 Planting Unit**	Stream Edge
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		None/Exotic		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No	Plans	**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	Te Ngahere Revegetation Plan

Comments

The walkway beside Oakley Creek is elevated in relation to the creek and looks down over weedy slopes toward the creek. The ground slopes steeply and has an uneven surface with inorganic debris throughout. Brown filamentous algae in-stream could be reduced through improved riparian shading. A 'grassy-knoll' on the TLB provides an ideal location for dense planting to provide shade and amenity for recreational walkers and joggers along the walkway. Planting on the TRB would assist with shade and bank stabilisation as well as improving amenity.

Restoration objectives:

- Improve amenity by removing weeds and debris from both banks
- Encourage ongoing weed management and enhance riparian planting in line with the Friends of Oakley Creek revegetation plan and conveyance objectives

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	3	2	8	13

Photo

Figure 12: Oakley Creek RO-4. (Photocode: 1585

11.6 Restoration Site 5: Blockhouse Bay Accessway

Restoration Opportunity	**ID**	**RO-5**	**Area m²**	305	**Objective 1**	Riparian Restoration
	Stream		Oakley Creek		**Objective 2**	Amenity
	Location		1628 Great North Road, Avondale		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services	Actions	**ARC TP148 Planting Unit**	Flood area
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No	Plans	**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	Te Ngahere Revegetation Plan

Comments

The footbridge linking Blockhouse Bay Road and Great North Road with the TRB side of Oakley Creek. Upstream of the bridge is an accessible area that is currently weedy and overgrown. Weed control and installation of a bench seat or other amenity facility would improve the amenity of the site and provide a relaxing streamside resting place. Improving shading along the length of the RO would improve native biodiversity on the banks and assist in maintaining bank stability. Close to the waters edge, low growing, floodplain plants are recommended to assist in filtering and slowing water in high flows.

Restoration objectives:

- Improve shading and amenity by improving native vegetation density back from the walkway
- Improve biodiversity by carrying out weed removal and ensuring ongoing management in line with the Friends of Oakley Creek weed management plan
- Improve amenity by installing a bench seating
- Consider safety by upgrading pathways and providing lighting

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	3	2	8	12

Photo

Figure 13: Oakley Creek RO-5. (Photocode: 1632)

11.7 Restoration Site 6: Albie Turner Fields/Phyllis Reserve

Restoration Opportunity	**ID**	**RO-6**	**Area m²**	224	**Objective 1**	Weed Management
	Stream		Oakley Creek		**Objective 2**	Erosion Protection
	Location		Opposite 10 Blockhouse Bay Road, Avondale		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Stream Edge
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic Groundcover		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	Te Ngahere Revegetation Plan

Actions / Plans

Comments

Bank stability is poor along this stretch of the creek and the banks are smothered in *Tradescantia*. Improving the variety and quality of riparian vegetation will assist with bank stability and will improve biodiversity. Weeds are a significant problem in this section of the creek and reducing the volume will have flow-on effects by reducing transportation of weeds downstream.

Restoration objectives:

- Improve amenity by controlling weeds and removing debris from site
- Control weeds and encourage ongoing weed management
- Enhance riparian margin with native planting, considering the Friends of Oakley Creek revegetation plan

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
2	3	2	7	16

Photo

Figure 14: Oakley Creek RO-6. (Photocode: 8630)

11.8 Restoration Site 7: Phyllis Street Reserve

Restoration Opportunity	**ID**	**RO-7**	**Area m²**	510	**Objective 1**	Weed Management
	Stream		Oakley Creek		**Objective 2**	Amenity
	Location		Below Phyllis Street Reserve		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Volcanic Slope
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	Te Ngahere Revegetation Plan

Actions / Plans

Comments

The walkway beside Phyllis Street Reserve is elevated in relation to the creek and looks down over weed infested upper banks toward the creek. Weed management is the main priority for this site, particularly to reduce transportation of weed material downstream. The ground is very sloping, with uneven surface material.

Restoration objectives:

- Improve amenity by removing weeds and debris from site
- Remove weeds and encourage ongoing weed management
- Enhance riparian margin with native planting, considering the Friends of Oakley Creek revegetation plan

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	3	2	8	14

Photo

Figure 15: Oakley Creek RO-7. (Photocode: 8672)

11.9 Restoration Site 8: Downstream Harbutt Reserve

Restoration Opportunity	**ID**	**RO-8**	**Area m²**	735	**Objective 1**	Amenity
	Stream		Oakley Creek		**Objective 2**	Erosion Control
	Location				**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Stream Edge
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	No
Current State	**Current Riparian Vegetation**		None		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	Te Ngahere Revegetation Plan

Actions / Plans

Comments

Currently an area of mown grass links Harbutt Reserve and the Cradock Street footbridge, forming a peninsula-like area. There is not a defined pathway connecting the reserves and access. There is a great opportunity to improve the area for amenity by developing a recreation or picnic area and improving connectivity between reserves.

The streambanks are steep, although relatively stable and access to the edge of the creek is possible. Macrophytes are present in the creek and currently provide habitat to the pest fish *Gambusia affinnis*. Introducing some plantings along the bank edge will improve stability and safety by restricting access and providing shade, discouraging the proliferation of in-stream macrophytes and potentially Gambusia.

Restoration objectives:

- Improve amenity through the provision of a picnic area and installation of a defined pathway to provide connectivity between reserves and access points
- Enhance bank stability and shading through planting of flax and low growing grasses on the stream edge to maintain visibility (amenity)
- Plant specimen trees on peninsula to provide shade for the proposed amenity area
- Investigate culvert rehabilitation to improve amenity and functionality

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
4	3	3	10	2

Photo

Figure 16: Oakley Creek RO-8. (Photocode: 8735)

11.10 Restoration Site 9: Downstream Cradock Street 1

Restoration Opportunity	**ID**	**RO-9**	**Area m²**	607	**Objective 1**	Enhance Native Biodiversity
	Stream		Oakley Creek		**Objective 2**	Weed Management
	Location		Cradock Street		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Flood area
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	Te Ngahere Revegetation Plan

Actions / Plans

Comments

Alongside the path downstream of the Cradock Street footbridge is an area of shaded, shallow creek with potentially high amenity value. Currently the vegetation consists of exotic groundcover (primarily *Tradescantia*) and large willow trees. The watercourse maintenance contractors weed-eat and mow this section of stream edge, which is contributing the distribution of *Tradescantia* downstream.

Restoration objectives:

- Develop alternative maintenance to stop/reduce the incidence of *Tradescantia* being distributed downstream.
- Enhance amenity through improved connectivity between reserves and parks, including path upgrade.
- Assess necessity of public access to the TRB, and consider planting to improve amenity, and privacy for residents on the stream edge
- Consider installing signage to educate public about the known eel population under the Cradock Street footbridge

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
4	3	2	9	8

Photo

Figure 17: Oakley Creek RO-9. (Photocode: 8739)

11.11 Restoration Site 10: Upstream Cradock Street

Restoration Opportunity	**ID**	**RO-10**	**Area m²**	555	**Objective 1**	Erosion Protection
	Stream		Oakley Creek		**Objective 2**	Weed Management
	Location		Cradock Street		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Flood Area
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic Trees		**Improve Substrate Heterogeneity**	Yes
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	Te Ngahere Revegetation Plan

Actions

Plans

Comments

Upstream of the Cradock Street footbridge is an area of stream which has high macrophyte coverage with significant erosion observed. Key actions for this RO include bank stabilisation and aquatic weed management. Amenity values can also be improved by upgrading the existing path and removing terrestrial weeds.

Restoration objectives:

- Improve bank stability through bank reinforcement and planting as appropriate including instigating an ongoing erosion management plan
- Manage aquatic weeds through appropriate measures as per ARC RPMS
- Terrestrial weed removal and ongoing management in line with Te Ngahere Revegetation and Weed Management Plan
- Enhance amenity value by upgrading and extending the existing path
- Specimen planting to improve amenity

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
4	3	3	10	5

Photo

Figure 18: Oakley Creek RO-10. (Photocode: 8779)

11.12 Restoration Site 11: Upstream Harbutt Reserve

Restoration Opportunity	**ID**	**RO-11**	**Area m²**	1,266	**Objective 1**	Weed Management
	Stream		Oakley Creek		**Objective 2**	Erosion Protection
	Location		Harbutt Reserve		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services		**ARC TP148 Planting Unit**	Stream Side
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Friends of Oakley Creek		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic		**Improve Substrate Heterogeneity**	Yes
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	Te Ngahere Revegetation Plan

Actions

Plans

Comments

Public access is limited at this part of the creek. The creek is bordered by reserves to the TRB and residential property on the TLB. Weed management is key goal for this RO. Amenity value could be improved by extending existing pathway to create looping path for connectivity between reserves.

Restoration objectives:

- Reinforcing and planting on both banks to mitigate erosion and bank instability
- Weed removal on TRB and ongoing management as per Te Ngahere Revegetation and Weed Management Plan.
- Extend existing pathway to improve connectivity between reserves
- Encourage community involvement from Kodesh Community

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	4	3	10	4

Photo

Figure 19: Oakley Creek RO-11. (Photocode: 8783)

11.13 Restoration Site 12: Cascades

Restoration Opportunity	**ID**	**RO-12**	**Area m²**	27	**Objective 1**	Improve In-stream Conveyance
	Stream		Oakley Creek		**Objective 2**	Weed Management
	Location		Behind 27 Powell St, Avondale		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Metrowater		**ARC TP148 Planting Unit**	N/A
	Key Stakeholders 2		Friends of Oakley Creek		**Type**	In-stream
	Key Stakeholders 3		Auckland City Parks Services		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Mixed		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	N/A

Actions

Plans

Comments

This section of stream consists of bedrock and boulder substrates forming a series of cascades and has no public access. Willows are currently growing in the centre of the stream and have the potential to cause conveyance issues and debris jams.

Restoration objectives:

- Improve and maintain conveyance through the reach by selected willow removal
- Weed management on both banks
- Rubbish and debris clearance required and ongoing maintenance to ensure limited rubbish enters the stream
- Despite high velocity turbulent flow over the cascades, a significant coverage of periphyton is present. Increase shading where possible to reduce occurrence of periphyton in-stream.

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
2	2	3	7	15

Photo

Figure 20: Oakley Creek RO-12. (Photocode: 8936)

11.14 Restoration Site 13: St Judes Scouts

Restoration Opportunity	**ID**	**RO-13**	**Area m²**	193	**Objective 1**	Riparian Restoration
	Stream		Oakley Creek		**Objective 2**	Improve Bank Stability
	Location		1213 New North Rd, Mt Albert		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Metrowater		**ARC TP148 Planting Unit**	Stream Side
	Key Stakeholders 2		St Judes Scout Group		**Type**	Streambank
	Key Stakeholders 3		Residents		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic		**Improve Substrate Heterogeneity**	Yes
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	No
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	None

Actions

Plans

Comments

Behind the St Judes Scout den on New North Road is a section of Oakley Creek with little planting, moderate erosion and bank instability. The St Judes Scout group have been involved in Wai Care and with the support of Friends of Oakley Creek are undertaking ongoing restoration planting on the streambanks. Immediately downstream of the Watercare pipe bridge all available habitat is smothered by sediment.

Restoration objectives:

- Investigate methods to improve bank stability including reinforcing and planting to reduce sediment contribution in-stream
- Improve safety at upstream culvert crossing under New North Road by fencing around top and investigating feasibility of installing a H&S grille
- Remove and ensure continued maintenance of in-stream debris and tree growth to ensure conveyance objectives are maintained.
- WSL pipe bridge crossing Oakley Creek has metal guard/pedestrian barrier but is still accessible and 'played on'. There is a drop of approximately 2.5 m. Recommend restricting access across the pipe bridge entirely
- Collaborate with and encourage St Judes Scout group to continue planting and manage the existing eel population

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
2	3	4	9	10

Photo

Figure 21: Oakley Creek RO-13. (Photocode:8985)

11.15 Restoration Site 14: Stoddard Road 1

Restoration Opportunity	**ID**	**RO-14**	**Area m²**	2,971	**Objective 1**	Biodiversity Enhancement
	Stream		Oakley Creek		**Objective 2**	Riparian Restoration
	Location		150 Stoddard Rd, Mt Roskill		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Metrowater	Actions	**ARC TP148 Planting Unit**	Stream Side
	Key Stakeholders 2		Auckland City Council		**Type**	Streambank
	Key Stakeholders 3		Industrial Landowners		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic Scrub		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No	Plans	**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		No		**Details of Plans**	NZTA SH20 Motorway Extension

Comments

Located behind industrial land use in Mt Roskill, RO-14 is likely to be affected by the NZTA SH20 Motorway Extension over the next few years. The area in question requires terrestrial and aquatic weed management.

Riparian planting to the stream edge will reduce the proliferation of in-stream macrophytes and reduce the incidence of rubbish and debris dumping on the TRB. Public access is not desirable in this area due to the nature of land use, so fencing the creeks TRB will also reduce rubbish dumping.

Restoration objectives:

- Weed removal and revegetation with native vegetation to enhance aesthetics from the motorway and improve biodiversity

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
2	2	2	6	17

Photo

Figure 22: Oakley Creek RO-14. (Photocode:9258)

11.16 Restoration Site 15: Roma Road

Restoration Opportunity	**ID**	**RO-15**	**Area m²**	31,377	**Objective 1**	Urban wetland
	Stream		Oakley Creek		**Objective 2**	Improve Floodplain Connectivity
	Location		Roma Road		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Unknown Landowner		**ARC TP148 Planting Unit**	Wetland
	Key Stakeholders 2		Metrowater		**Type**	Wetland
	Key Stakeholders 3		Industrial Landowners		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Exotic		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	No
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	None

Actions

Plans

Comments

This section of Oakley Creek is the uppermost point on Branch 1. The section of land is surrounded by industrial land use, with many properties inputting private pipes to the creek. The area is partitioned throughout by short branches of creek of varying angles and lengths. Current watercourse maintenance consists of aquatic weed control and targeted weed control and mowing along the edges of the watercourse. Currently the land is under private ownership so management objectives will need to align with objectives of the landowner.

Restoration objectives:

- Improve floodplain connectivity throughout area
- Encourage awareness of creek to reduce the amount of debris and rubbish entering the creek from industrial sites
- Enhance wetland type, riparian cover throughout the area
- Investigate feasibility of converting the area into an urban wetland for stormwater treatment
- Potentially facilitate public access throughout the area

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
3	3	3	9	11

Photo

Figure 23: Oakley Creek RO-15. (Photocode:9958)

11.17 Restoration Site 16: Alan Wood Reserve

Restoration Opportunity	**ID**	**RO-16**	**Area m²**	2,641	**Objective 1**	Riparian Restoration
	Stream		Oakley Creek		**Objective 2**	Improve Floodplain Connectivity
	Location		Alan Wood Reserve		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Auckland City Parks Services	Actions	**ARC TP148 Planting Unit**	Stream Side
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Transit/NZTA		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Mixed, mown grass		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No	Plans	**Other Relevant Plans**	Yes
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	NZTA SH20 Motorway Extension

Comments

Alan Wood Reserve is a large reserve in Mt Albert. Oakley Creek flows along one side of the reserve with varying levels of modification. Amenity value within the reserve is high with existing paths and walkways near the stream which will benefit from enhanced planting.

The channel is wide, gently sloping and the riparian margins are dominated by herbaceous weedy species. This section occurs immediately downstream of a bank lined section. There is a significant area of exotic weeds on the TRB.

Restoration objectives:

- Plant floodplain species to improve bank stability and flood plain connectivity
- Riparian planting either side of the stream to improve riparian overhead cover for shade and to stabilise in-stream temperatures
- Weed control and revegetation on TRB to reduce weeds on-site, and to reduce negative impacts on downstream weed management
- Reengineer to a more naturalised channel where feasible in line with conveyance objectives

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
4	3	3	10	6

Photo

Figure 24: Oakley Creek RO-16. (Photocode:9761)

11.18 Restoration Site 17: Carr Road

Restoration Opportunity	**ID**	**RO-17**	**Area m²**	7,836	**Objective 1**	Riparian Restoration
	Stream		Oakley Creek		**Objective 2**	Amenity
	Location		Behind 6 Carr Road		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Metrowater		**ARC TP148 Planting Unit**	Stream Side
	Key Stakeholders 2		Industrial Landowners		**Type**	Streambank
	Key Stakeholders 3		Auckland City Council		**Weed control required**	Yes
Current State	**Current Riparian Vegetation**		Mown grass		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No		**Other Relevant Plans**	No
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	None

Actions / Plans

Comments

Behind the industrial area at Carr Road, Mt Roskill, a short section of Oakley Creek remains open following the SH20 motorway extension. The area is very boggy and consists of a single channel similar to a typical road drain. There are some existing plantings close to the motorway, consisting of low growing grasses.
It is recommended that the site be planted extensively along the length to encourage lower in-stream temperatures and to improve amenity, particularly for users of the motorway. Planting will also reduce long-term maintenance costs as the plants mature. Existing overland flow paths may be a result of the motorway extension and could be contributing to the boggy nature of the site. Existing weedy vegetation and debris in stream is causing debris jams which may be reducing conveyance efficiency of the reach.

Restoration objectives:

- Carry out extensive revegetation of the site including planting to the motorway edge for biodiversity, amenity and in-stream ecological functions
- Remove in-stream debris jams to improve conveyance
- Establish a maintenance access point as part of any proposed restoration works

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
2	2	2	6	18

Photo

Figure 25: Oakley Creek RO-17. (Photocode:447)

11.19 Restoration Site 18: Mt Roskill Intermediate

Restoration Opportunity	**ID**	**RO-18**	**Area m²**	22,782	**Objective 1**	Riparian Restoration
	Stream		Oakley Creek		**Objective 2**	Erosion Control
	Location		Mt Roskill Intermediate School		**Capital Works Proposed**	No
Stakeholders	**Key Stakeholders 1**		Mt Roskill Intermediate	Actions	**ARC TP148 Planting Unit**	Stream Edge
	Key Stakeholders 2		Metrowater		**Type**	Streambank
	Key Stakeholders 3		Residents		**Weed control required**	No
Current State	**Current Riparian Vegetation**		None, mown grass		**Improve Substrate Heterogeneity**	No
	Restricted by quality of stormwater /wastewater		No	Plans	**Other Relevant Plans**	No
	Opportunity to reduce flooding risk or flows		Yes		**Details of Plans**	None

Comments

The section of Oakley Creek that flows through Mt Roskill Intermediate grounds has steep banks with minor erosion. There is a small amount of existing riparian planting at the school entrance, planted by students and Friends of Oakley Creek in late 2007. Currently the watercourse maintenance contract specifies the banks are mown. Due to the steepness of the banks, this may be a health and safety risk. The channel is wide and relatively shallow and would benefit from riparian planting on both banks, the entire length of the school grounds. Involvement from the students at the school is encouraged.
Amenity would be increased as a result of planting.

Restoration objectives:

- Improve riparian vegetation for in-stream temperature stability, shade and bank stability
- Include low stature grasses on the streambank to slow flow following heavy rain
- Encourage ongoing involvement from the local schools (Mt Roskill Intermediate and Grammar)

Prioritisation Scoring

Potential Benefit Scores			Prioritisation and Ranking Scores	
Amenity	Ecological	Conveyance	**PS**	**PR**
4	3	3	10	3

Photo

Figure 26: Oakley Creek RO-18. (Photocode:9550)

Oakley Creek Technical Report

APPENDIX A: Maps

Map 1: Oakley Creek Overview and PARP: ALW Stream Class

Map Series 2: Oakley Creek Management Zones, Catchment Land use and SH20 Extension

Map Series 3: Oakley Creek Special Values and existing Te Ngahere Management Units

Map Series 4: Channel Modification

Map Series 5: Bank Modification Type and Extent

Map Series 6: Engineering Asset Locations, Streambank and Outfall Erosion

Map Series 7: Riparian Overhead Cover, Wetlands, Natural Structures and Restoration Opportunities

Map Series 8: Vegetation Type, Fish Locations and Potential Barriers to Fish Passage

Map Series 9: Management Zones and Metrowater Watercourse Maintenance

Map Series 10: Management Units

Map Series 11: NIWA Urban Streams Classification

APPENDIX B: Photographic Schedules

1. Oakley Creek Ecological Reaches

2. Oakley Creek Natural Structures

3. Oakley Creek Wetlands

4. Oakley Creek Engineered Assets

5. Oakley Creek Physical Fish Barriers

6. Oakley Creek Pipe Bridges

7. Oakley Creek Banklining

8. Oakley Creek Flood Issues

APPENDIX C: Ecological Survey Data

APPENDIX D: Maintenance Works Summary Sheets

APPENDIX E: Te Ngahere Vegetation Plan

Environmental Weed Control and Native Revegetation Programme for Oakley (Te Auaunga) Creek

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