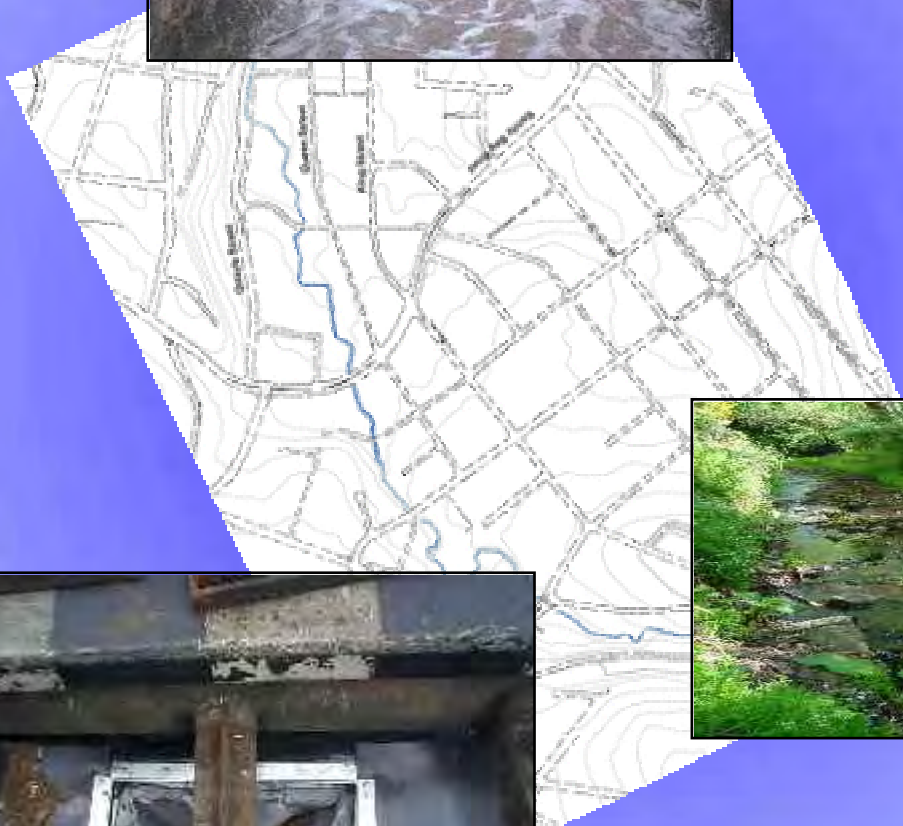
Sandy Bay Rivulet



March 2002

This consultation draft management plan has been prepared by Hobart City Council with the assistance of the community of the Sandy Bay Rivulet Catchment

HOBART
CITY COUNCIL

Sandy Bay Rivulet

Draft Catchment Management Plan

Prepared for the Hobart City Council

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ISBN

Acknowledgments

Hobart City Council has developed the Sandy Bay Rivulet Catchment Management Plan in an attempt to improve flood management, improve water quality, strengthen the ecological integrity and increase the social and environmental value of the rivulet.

Sincere thanks are extended to the people who have contributed to the development of this management plan and whose advice has shaped the management objectives. These people include staff within the Hydraulic Engineering and the Bushcare Unit of Hobart City Council, Juliet Chapman from Waterwatch, the Waterworks Valley Landcare Group and members of the community who reside along the banks of Sandy Bay Rivulet.

It is envisaged this management plan will provide an insight into the cultural, social and environmental values of the Sandy Bay Rivulet and will provide a basis in which rehabilitative work can continue in this area.

Executive Summary

This management plan for the lower Sandy Bay Rivulet Catchment has been developed by the Hydraulic Engineering Unit within Hobart City Council in an attempt to improve the long-term management of this urban rivulet and to maintain its ecological integrity. The lower reaches of Sandy Bay Rivulet is a natural feature of an urban setting and is valued by members of the community as natural resource and asset to the area. This management plan aims to provide sustainable solutions and outcomes for the long-term management of the lower, urbanised section of the rivulet, and involves the integration of skills and commitment of both Council and the community.

This management plan has been developed to complement additional management plans for other areas of the Sandy Bay Rivulet Catchment. Previous management plans have focused on the top of the catchment and more natural areas, the mid catchment area and Waterworks Valley. This management plan provides information and management guidelines for the lower reaches of the catchment, which is heavily urbanised and largely modified for human habitation and use. Stormwater and sewerage contamination issues are heavily emphasised in this plan and are considered crucial factors in the long-term sustainability of the rivulet.

Monitoring of the Sandy Bay Rivulet has been sporadic and variable over the past several years. Results from various monitoring events have been analysed and included in this management plan, most of which are outlined in Chapter 5. A biological assessment of the rivulet has been based on AUSRIVAS (Australian River Assessment System) where the aquatic macro-invertebrate fauna found insitu is used to determine the ecological health of a site, and is dependent on the presence or absence of species that are either tolerant or sensitive to environmental stress. Monitoring results to date have been used to create a 'snapshot' of the current state of Sandy Bay Rivulet, and offer guidelines as to what actions can be taken to improve the rivulet's long-term water quality.

The outcome of this management plan is to provide a working document that highlights current environmental problems, provides guidelines in what actions can be taken and by whom, and provides a strategic view of the Sandy Bay Rivulet and it's sustainable future.

Table of Contents

List of Figures

List of Tables

List of Plates

Glossary

ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUSRIVAS	Australian River Assessment System
CSIRO	Commonwealth Scientific & Industrial Research Organisation
DEP	Derwent Estuary Program
DO	Dissolved Oxygen
DPIWE	Department of Primary Industries, Water and Environment
EMPCA	Environmental Management and Pollution Control Act
EMS	Environmental Management System
HECEC	Hydro-Electric Corporation, Tasmania Water Resources Department
ICM	Integrated Catchment Management
ISO	International Standard Series
LUPAA	Land Use Planning and Approvals Act
NTU	Nephlometric Turbidity Unit
NWQMS	National Water Quality Management Strategy
RMPS	Resource Management and Planning System
SoER	State of the Environment Reports
SPPA	State Policies and Projects Act
UNCED	United Nations Conference on Environment and Development

Chapter 1 Introduction

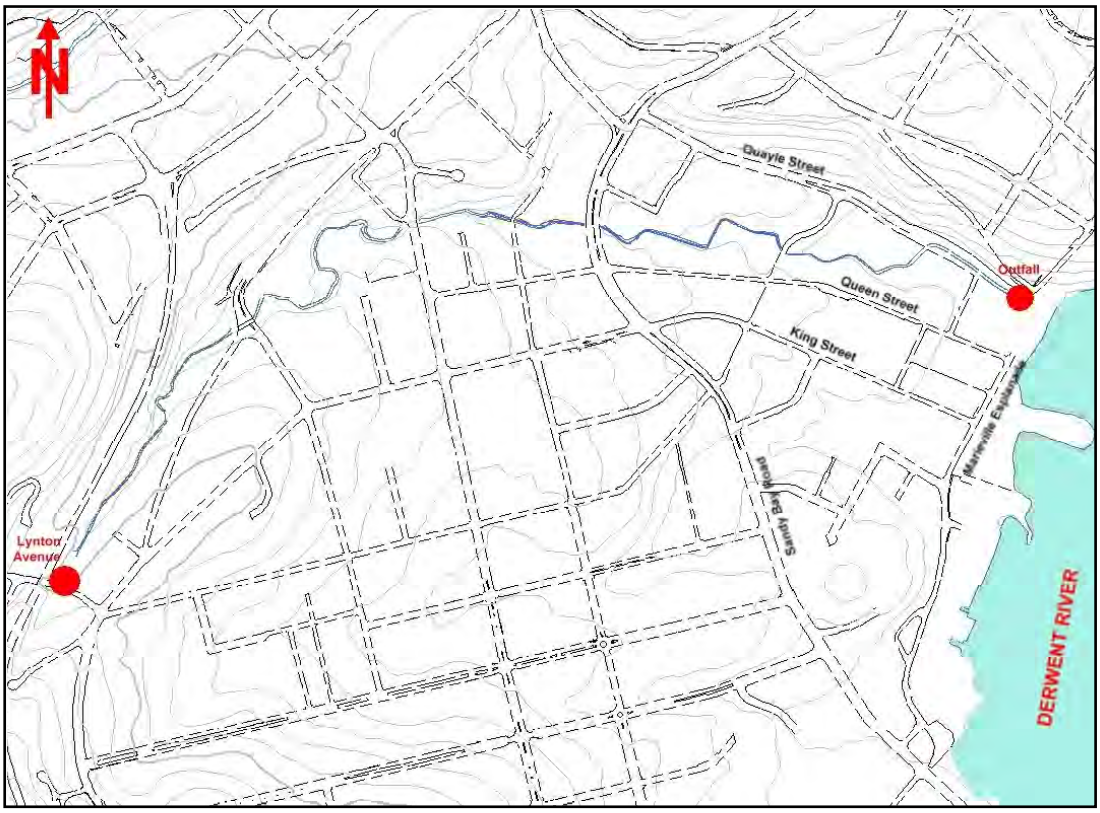
1.1 Background

This document is a management plan for the Sandy Bay Rivulet Catchment in Hobart, Tasmania and is located within the jurisdiction of the Hobart City Council. The Sandy Bay Rivulet Catchment Management Plan is initiated by the Hydraulic Engineering Unit within the Hobart City Council and follows a series of projects already completed within the catchment. These completed projects included a study on the sewerage system and an assessment on the hydrology and hydraulics of the rivulet that verified the flood flows and water levels. Regular water quality testing within Sandy Bay Rivulet indicates that a range of pollutants is entering the urban storm water system, largely via urban run-off. Sedimentation rates are also noted to be relatively high. These findings disclose a need for further investigation into point sources of contamination and the necessary management strategies required to ensure the rivulet's long-term health and sustainability.

This Catchment Management Plan aims to highlight the environmental issues associated with stormwater quality and provides management guidelines aimed at improving flood management, water quality, environmental amenity and the ecological integrity of Sandy Bay Rivulet. A management plan already exists for part of the Waterworks Valley, which covers an area between the Waterworks Reserve and the Fitzroy Gardens (Sinclair Knight Merz 1999). Extensive research has been conducted in the Waterworks Reserve area (North 1997, Small & Douglas 1998) and in the upper reaches of the catchment towards Mt Wellington (Wellington Park Management Trust 1998). Although some overlapping of information will occur, this management plan will largely focus on the heavily urbanised areas of the catchment between Lynton Avenue and Short Beach (Figure 1.1).

Catchment use and community values will be discussed and integrated into the recommended urban stormwater management actions. This management plan incorporates the principles of Integrated Catchment Management (ICM) and highlights the role of the wider community in managing their surrounding environment. An integrated approach to the management of a natural and shared resource is the key factor in this plan's success as a management tool.

Figure 1.1 Lower Sandy Bay Catchment



This catchment plan reviews the management process and the development of stormwater management programs by using the Environmental Management Systems (EMS) Model ISO 14004, which is consistent with the concept of sustainable development and is compatible with diverse cultural, social and organisational frameworks. The recommendations for stormwater management in the Sandy Bay Rivulet Catchment are based on the principles of AS/NZS ISO 14001 which aims to provide order and consistency for organisations to address environmental concerns through resource allocation, assignment of responsibilities, and the evaluation of practices, procedures and processes (Hornsby Shire Council, 1996). In addition,

this management plan will discuss the State legislation that is in place for the long-term environmental protection and sustainability of Tasmania's watercourses, including the provisions of the *National Water Quality Management Strategy* and the *State Policy on Water Quality Management* 1997, which exist under the umbrella of the *State Policies and Projects Act* (SPPA) 1993.

This management plan is comprised of an abstract, which summarises the plan, a description of the Sandy Bay Rivulet Catchment, historical information, an indication of stormwater quality and detail on the flora and fauna found within the lower Sandy Bay rivulet. Recommendations and concluding comments on the long-term management of the catchment and rivulet are made in the final Chapter.

1.2 Objectives of the Sandy Bay Rivulet Catchment Management Plan

The Hydraulic Engineering Unit within the Hobart City Council has developed the objectives of the Sandy Bay Rivulet Catchment Management Plan and project. The objectives of this plan are driven by the need to improve water quality in the Sandy Bay Rivulet and to identify the catchment activities and processes that are contributing to significant stormwater pollution. The objectives of this plan are divided into the following categories:

1.2.1 Flood Management

- Identify areas subject to significant risk from flooding during and/or after storm events.
- Develop stormwater management strategies that assist in flood mitigation
- Improve flood control measures through community consultation and on-ground works

  (Refer to HECEC 1999 study).

1.2.2 Water Quality

- To maintain a water quality monitoring regime on the Sandy Bay Rivulet.

- Involve local school or community groups in water quality monitoring and equip those groups with the skills necessary to maintain water quality testing.
- Use the concept of Integrated Catchment Management as the primary water quality management tool.
- To isolate point sources and non-point sources of water pollution.
- To isolate point sources of contamination from sewerage leaks, overflows or cross connections into the stormwater system.
- To prevent further contamination of the Sandy Bay Rivulet and Derwent Estuary through the construction and implementation of stormwater treatment and control devices such as gross pollutant traps, litter trapping devices and floating booms.

1.2.3 Environmental Amenity

- To improve the environmental amenity of the rivulet for the surrounding community and users of the catchment, through improved rivulet maintenance and community group participation.
- To maintain the cultural and recreational values of the rivulet and catchment area and address the concerns of residents who live along the rivulet boundaries.

1.2.4 Ecological Integrity

- To preserve and maintain areas available for wildlife habitat.
- To improve water quality for the benefit of freshwater and marine fauna.
- To raise the awareness of community members about the linkages between human action and storm water quality.
- To highlight the importance and raise awareness about the importance of bushland links in urban settings.
- To maintain regular water quality monitoring program in association with Waterwatch and other community interest groups.

1.2.5 Community Participation

- To involve staff and students from local primary schools in water quality monitoring and/or awareness programs.
- To involve and consult with community members who reside in the vicinity of Sandy Bay Rivulet in the formulation of management strategies for the rivulet and its ongoing rehabilitative maintenance.
- To encourage members of the community to provide comment and feedback on current stormwater management practices.
- To consult and work with existing community groups within the catchment area.

1.2.6 Educational Benefits

- To provide a learning opportunity for the staff and students of local schools in catchment processes and their link to stormwater quality in urban environments.
- To raise the awareness among community members of the natural and cultural values associated with Sandy Bay Rivulet.
- To encourage a better general understanding of how the behaviour of individuals can assist in addressing stormwater objectives and lead to improved stormwater quality.

1.2.7 Weed Control

- To remove extensive growth of exotic weeds in and along the Sandy Bay Rivulet and include weed monitoring in rivulet maintenance programs.
- To reduce the spread of invasive weed species from neighbouring gardens through raising community awareness about specific weed species and their dispersal properties, and providing guidelines on how to minimise their distribution into the native environment.

1.2.8 Garden Waste Management

- To ensure residents living along the banks of the rivulet dispose of their garden waste in a responsible manner.
- To encourage members of the community to act as environmental "watchdogs" and to notify the Hobart City Council if any garden waste is seen being discarded into the rivulet.

1.3 Catchment Description

1.3.1 Location

The Sandy Bay Rivulet catchment is one of the largest catchment areas within the Hobart municipality. The catchment area is comprised of 574 hectares, of which 106 hectares are classified as urban (Andrews 1997). The Sandy Bay catchment and rivulet originate from just below the Springs on Mount Wellington at an altitude of 570 metres, and extends through the Waterworks Reserve. The urban drainage includes most of Dynnyrne, parts of battery Point and northern Sandy Bay (Figure 1.2). The water supply to Sandy Bay Rivulet is fed by 13 tributary streams from the upper reaches of the catchment that are located above the Waterworks Reservoirs, which were originally supplied by the waters of Sandy Bay Rivulet. Today, however, the waters of the rivulet by-pass the reservoirs in freestone channel and act as a collection point for urban run-off further down the catchment.

Prior to the development of the underground reticulation system, residents of Sandy Bay utilised the resources of the rivulet. In this largely urbanised area of the catchment, 23 stormwater drains are linked to the rivulet (Andrews 1997), and are thus a point source of pollution for the urban watercourse. A total of 800 private dwellings exist within the urbanised area of the Sandy Bay Catchment, and are largely concentrated between the Lower Reservoir at Waterworks Reserve and Marieville Esplanade on the foreshore of the Derwent Estuary. The catchment population is estimated at 3100 (McReynolds 1991, cited in Andrews 1997) and the extent of urbanisation in the lower reaches of the catchment is evident in the aerial photograph illustrated in Figure 1.3.

As the Sandy Bay Rivulet flows through the urbanised areas of the catchment, it becomes increasingly channelised and becomes subject to neighbouring properties encroaching the urban stream banks (Sinclair Knight Merz 1999). The majority of the catchment area (81%) is comprised of permeable surfaces and includes all vegetated and agricultural areas. With the remaining area (19%) made up of impermeable surfaces and includes roads, buildings and paved surfaces (Andrews 1997).

Figure 1.2 Map of Sandy Bay Catchment Area

Source: Andrews, 1997.

Figure 1.3 Aerial Photograph of the Lower Sandy Bay Catchment

Scale: 1:7500, Hobart City Council 2001.

1.3.2 Hydrology and Hydraulics

Precipitation levels within the Sandy Bay catchment are typically seasonal, with rainfall decreasing over summer months and increasing throughout winter and spring. With the effects of urban stormwater run-off, the rivulet can appear to be a slow trickle during summer and transform to a watercourse of substantial volume during periods of heavy rain.

Rainfall data varies considerably between the upper reaches of the catchment and the lower reaches, due to variations in elevation, aspect and topography. The rainfall data has been broken down into three main areas that include (i) the lower reaches of the catchment that are

largely urbanised, (ii) the middle of the catchment area at the Waterworks Reserve, and (iii) the upper catchment area at the Springs on Mount Wellington. The average rainfall for these three areas of the catchment is based on rainfall data over the past 119 years (Bureau of Meteorology). The average rainfall for the Sandy Bay Catchment over this time period shows significant variation between the top, middle and bottom of the catchment, being highest in the upper reaches with precipitation decreasing further down the catchment. Figure 1.4 highlights these variations in rainfall.

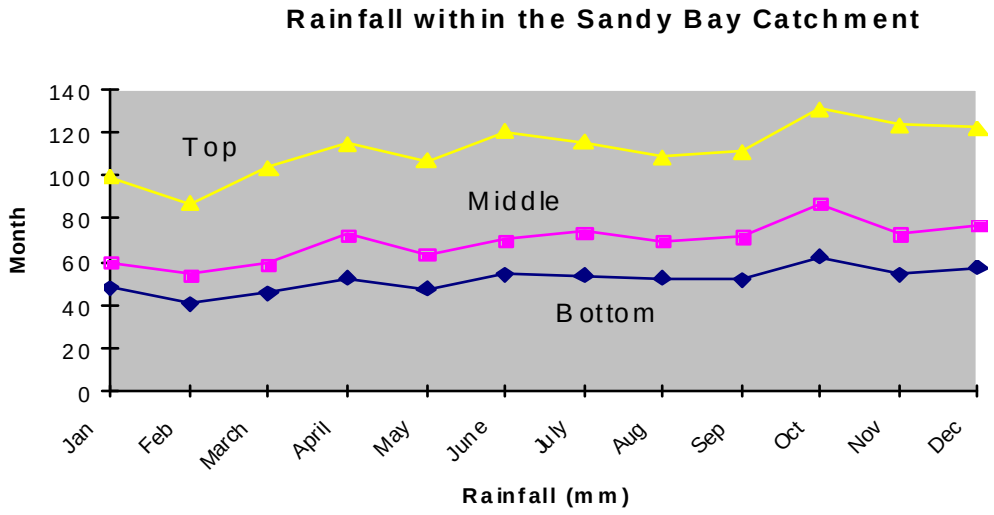


Figure 1.4 Rainfall across the Catchment

A recent flood study was conducted by the Hydro-Electric Corporation, Tasmania for the Hobart City Council on Sandy Bay Rivulet in 1999. This study analysed the effects and extent of flooding in the Sandy Bay Rivulet, and investigated flood mitigation options that would contain or limit the potential extent of flooding (HECEC Australia Pty Ltd 1999). Within this study, rainfall intensities were estimated for the catchment and illustrated in a Flood Frequency Curve for rainfall events in the range of 1:20 to 1:1000 (HECEC Australia Pty Ltd, 1999, p.23). The information derived from this study can be used in predicting catchment behaviour and stormwater design, and highlights areas along the rivulet where the flow overtops the confines of the channel. While no flood mitigation options were recommended or modelled in this study, the Hobart City Council has undertaken further investigations into other non-structural solutions to reduce the impacts of flood events.

There will be no further discussion in this management plan on the hydrologic and hydraulic characteristics of the Sandy bay Catchment, however, if additional information is required, please refer to the Sandy Bay Rivulet Study (HECEC, 1999).

1.3.3 Geology

The predominant geological feature in the Sandy Bay catchment is Jurassic dolerite, which occurs in the lower catchment area and the southern edge of the Waterworks Reserve (Davies 1988). This type of substrate generates rocky soils that are slightly acidic, have high nutrient quality and vary in depth from 0.6-0.8 metres (Sinclair Knight Merz 1999). In the Sandy Bay catchment this soil type varies from clay loam of moderate permeability on the upper slopes to medium clay of low permeability on the drainage flats (Andrews 1997). The vegetation in these areas is represented by low woodland and open forest.

In the upper reaches of the catchment, and the source of the Sandy Bay Rivulet, Permian sandstone, siltstone and mudstone occurs. At the Waterworks Reservoirs the geology becomes quite variable with the upper reservoir supported by Triassic sandstone, while Permian mudstone predominates the lower Waterworks reservoir (Hofto 1990). The soil type from this bedrock is slightly acidic, has high to moderate permeability, and is characterised by a shallow soil profile of 0.4-0.6 metres. This soil type supports vegetation types typical of low woodlands or open forests (Davies 1988).

The nature of the substrate in the Waterworks Reservoir area led to some severe tunnel erosion problems in the year 2000. The problem was initially caused by uncontrolled run off that caused surface scouring of the soil. The soil structure was weakened by a water main blowout many years ago further up the catchment. The nature of the soil at this site exacerbated the erosion process and continued down the slope to form a network of tunnel erosion. To remedy the problem the unstable soil was excavated, removed and subsequently backfilled with a graduated filter, or a grading of different sized rock. The surface of the site was treated by creating an open channel lined with geotextile material accompanied by stone headwalls and culverts to divert run-off to a natural watercourse.

In the urban areas of the lower catchment the main geological feature is represented by Tertiary sediments comprised of agglomerate, clay, sand and cemented gravel valley fill

sediments (Hofto 1990). The soils generated from this type of substrate vary from thin grey yellow sand to brown sandy clay and is subject to both gully and tunnel erosion on cleared slopes (Hofto 1990). Due to the urban nature of this part of the catchment, most of the vegetation that is present is not native to the area and is comprised of a range of exotic garden species.

1.3.4 Vegetation

The vegetation types within the Sandy Bay catchment vary considerably between the upper more natural regions of the catchment, and the lower urban areas where vegetation communities have been modified by land use and human activities. The variations within vegetation type reflect the environmental gradients that exist within the catchment, such as aspect, slope and geology (Small & Douglas 1998). An extensive botanical survey was conducted in the Waterworks Reserve over a two-year period, and highlights community boundaries, conservation status of plant species and identifies major weed infestations in the area (North 1997).

The upper reaches of the Sandy Bay catchment provide habitat for a high diversity of plant species. The vegetation in the Waterworks Reserve study area has been divided into 4 vegetation types that reflect the dominant eucalypt species. These include:

1. *Eucalyptus obliqua* (Stringybark) Wet Sclerophyll Forest - occupying sheltered gullies and cooler south facing slopes
2. *Eucalyptus obliqua* (Stringybark) Dry Sclerophyll Forest - occurring over a dry shrubby understorey on the north side of the reservoirs and on shallow north facing gullies
3. *Eucalyptus tenuiramis* (Silver Peppermint) Dry Schlerophyll Forest - occurring in the driest sites south of the reservoirs in sites that reflect variation in geology
4. *Eucalyptus amygdalina* (Black Peppermint) Dry Schlerophyll Forest - confined to a narrow strip along a ridge south east of the reservoirs between *E.tenuiramis* and *E.obliqua* communities (North 1997).

The botanical survey within the Waterworks Reserve reported three species of conservation significance: Forest Fingers (*Caladenia aff. catenata);* Spreading Knaewl (*Scleranthus*

fasiculatus); and Ploughshare Wattle (*Acacia gunnii).* A species list of all vascular plants is included in Appendix 1.

The lower, more urbanised reaches of the catchment support a mixture of both native and exotic plant species. The exotic species range from cultivated garden plants to naturalised 'weeds' that have spread from neighbouring gardens. The banks of Sandy Bay Rivulet suffer infestations of Crack Willow (*Salix fragilis*); Blackberries (*Rubus fruticostus*); Broom (*Genista monspessulana*); Gorse (*Ulex europaeus*) and Mirror Bush (*Coprosma repens*). Other environmental weeds have established themselves within the catchment and pose a potential threat to native vegetation. These include: Tree Mallow (*Lavatera arborea*); Cape Weed (*Arctotheca calendula*); Prickly Sow-Thistle (*Sonchus asper*); Hemlock (*Conium maculatum*); Broome Grass (*Bromus sp*); Cocksfoot Grass (*Dactylis glomerata*); and Perriwinkle (*Vinca major*) (Andrews 1997).

Community and Landcare groups play a crucial role in the control and removal of many weed species. The Waterworks Valley Landcare Group have been working together to revegetate sectors of the Sandy Bay Rivulet in the Waterworks Valley region. Their primary objectives are to stabilise the banks and to encourage the return of native flora and fauna. There is huge potential for the development of similar groups in urban sectors of catchments where property boundaries merge with local rivulets and streams.

1.3.5 Fauna

Fauna types recorded within the Sandy Bay catchment area are diverse, some of which are recognised as species of conservation significance. These are listed in Appendix 2. The Sandy Bay catchment is also home to a range of nocturnal mammals including possums, quolls, bandicoots, bettongs and potoroos and two species of owl (Appendix 2).

Forty-one species of native birds have been recorded in the Waterworks Reserve area, including 9 of the 12 Tasmanian endemic species (Brereton 1997). These include: the green rosella (*Platycercus caledonicus*), scrubwren (*Sericornis frontalis*), thornbill (*Acanthiza pusilla* and *Acanthiza ewingii*), yellow wattle bird (*Anthochaera paradoxa*) and a variety of honeyeaters (*Lichenostomus flavicollis, Melithreptus affinis, Melithreptus validrostris* and *Phylidonyris novaehollandiae*) (Andrews 1997). Migratory bird species also exist within the

Sandy Bay catchment and have been observed in the Waterworks Reserve and urban areas. Most migratory species arrive in Tasmania in spring and return to their origins in autumn; however some waterfowl species have taken up permanent residence in or near the reservoirs, causing concerns over potential pollution. Of particular concern are the large flocks of kelp gulls that are not uncommon on the banks of the lower Waterworks reservoir (Brereton 1998).

A range of reptiles can also be found in the catchment area, 3 of which are endemic to Tasmania and include: the she-oak skink (*Cyclodomorphus casuarinae*), Tasmanian tree skink (*Niveoscincus pretiosus*) and ocellated skink (*Niveoscincus metallicus*). All other reptiles recorded in the catchment area are listed in Appendix 2. Snakes can also be found in the bushland areas of the catchment, with the Tiger Snake (*Notechis scutatis*) being the most common species encountered in the Waterworks Reserve area (Brereton 1998).

1.4 The Catchment Management Plan

The primary aim of this plan is to raise the awareness about stormwater issues and water quality control among members of the community, working interest groups, local businesses and industry and council staff. The program unites community consultation with environmental science to develop a range of individual projects to enhance the water quality and social amenity of Tasmania's key waterways.

The aim of the investigation into Sandy Bay Rivulet and its associated catchment is to develop a catchment management plan that aims to improve the water quality in the rivulet and long-term health of the Derwent Estuary through effective urban stormwater management. The plan has been developed in liaison with Landcare Groups, local schools, Waterwatch and members of the catchment community to ensure that all catchment values are included in the management strategy.

Hobart City Council has developed a Strategic Plan for the Sandy Bay Rivulet, which addresses three major themes for the sustainable management of the rivulet. Included in these themes are (i) *Long-term community involvement*, (ii) *Improving Water Quality* and (iii) *Protecting and conserving native vegetation* within the catchment. The Strategic Plan is outlined in the following table and provides an overview of these themes and the associated objectives and tasks involved. A further breakdown of objectives and tasks is further illustrated in subsequent Chapters where individual Action Plans are provided for each goal.

Strategic Plan for Sandy Bay Rivulet

Theme 1: To Promote Community Involvement in the Management of the Sandy Bay Rivulet

OBJECTIVE	TASKS	PRIORITY
1. To develop and maintain a strong community network in the active management of the Sandy Bay Rivulet catchment	Promote wider community understanding of environmental issues affecting the rivulet through consultation	HIGH
2. Keep the community informed on environmental change in the rivulet on a regular basis	Establish long-term monitoring groups and provide access to relevant data	HIGH
	Encourage school children and teachers to play an active role in monitoring and learning about the rivulet	MODERATE
	Encourage residents who live along the rivulet to extend their backyard care to the rivulet banks	MODERATE
3. Address all cultural and heritage values associated with the rivulet	Ensure valued sites are acknowledged in management strategies and make existing sites known to the community	HIGH
4. Enhance and protect the natural values of the rivulet	Encourage active participation of the community in monitoring and management through organised workshops	MODERATE
	Include appropriate land use and management policies in Hobart City Council Planning policies	HIGH
	Ensure proposed developments in the catchment undergo assessment for ecological impacts prior to development	

Theme 2: To Improve Water Quality in The Sandy Bay Rivulet

OBJECTIVE	TASKS	PRIORITY
1. Improve water quality in the Sandy Bay Rivulet	Educate community in urban links to water quality	HIGH
	Provide information to community members on ways in which to improve water quality through independent actions	HIGH
	Allow access to data available on water quality status within the rivulet	MODERATE
2. Reduce the amount of pollution entering the rivulet	Isolate point and diffuse pollution sources	HIGH
	Encourage improved stormwater practices for local businesses through the installation of stormwater treatment devices and litter traps	HIGH
3. Minimise sewage contamination of the rivulet	Early detection of infiltration from sewer to stormwater	HIGH
	Effective management strategies are in place for sewage overflows	HIGH
4. Develop and maintain a regular water quality monitoring program	Ensure that the frequency of monitoring is consistent so that early detection of pollution is evident	HIGH
	Transfer water quality monitoring data to a database that allows public access	MODERATE
	Consistently follow up on abnormal or high fluctuations in results	HIGH

Theme 3: To Protect and Conserve Native Vegetation within The Sandy Bay Rivulet Catchment

OBJECTIVE	TASKS	PRIORITY
1. Encourage community interest and involvement in the preservation of native flora within the catchment	Involve community members in organised field days on weed identification workshops	HIGH
	Inform the community on methods which are successful in eradicating noxious weeds	MODERATE
	Involve community members in workshops involving native seed propagation	MODERATE
2. Control the spread of non-native vegetation from backyards to natural areas	Map distribution of weeds in the lower Sandy Bay catchment	HIGH
	Monitor the reduction or spread of weeds over time	HIGH
	Inform community members on ways in which to reduce the spread of non-native plants	MODERATE
	Remove or eradicate non-native plants species from the banks of the rivulet in stages and replace with native vegetation	HIGH
3. Ensure and protect stream bank stabilisation along the rivulet	Assess the role non-native vegetation plays in stream bank stabilisation prior to removal	HIGH
	Stabilise stream bank sections of the rivulet where necessary to avoid further erosion and sedimentation	HIGH

Chapter 2 Project Development

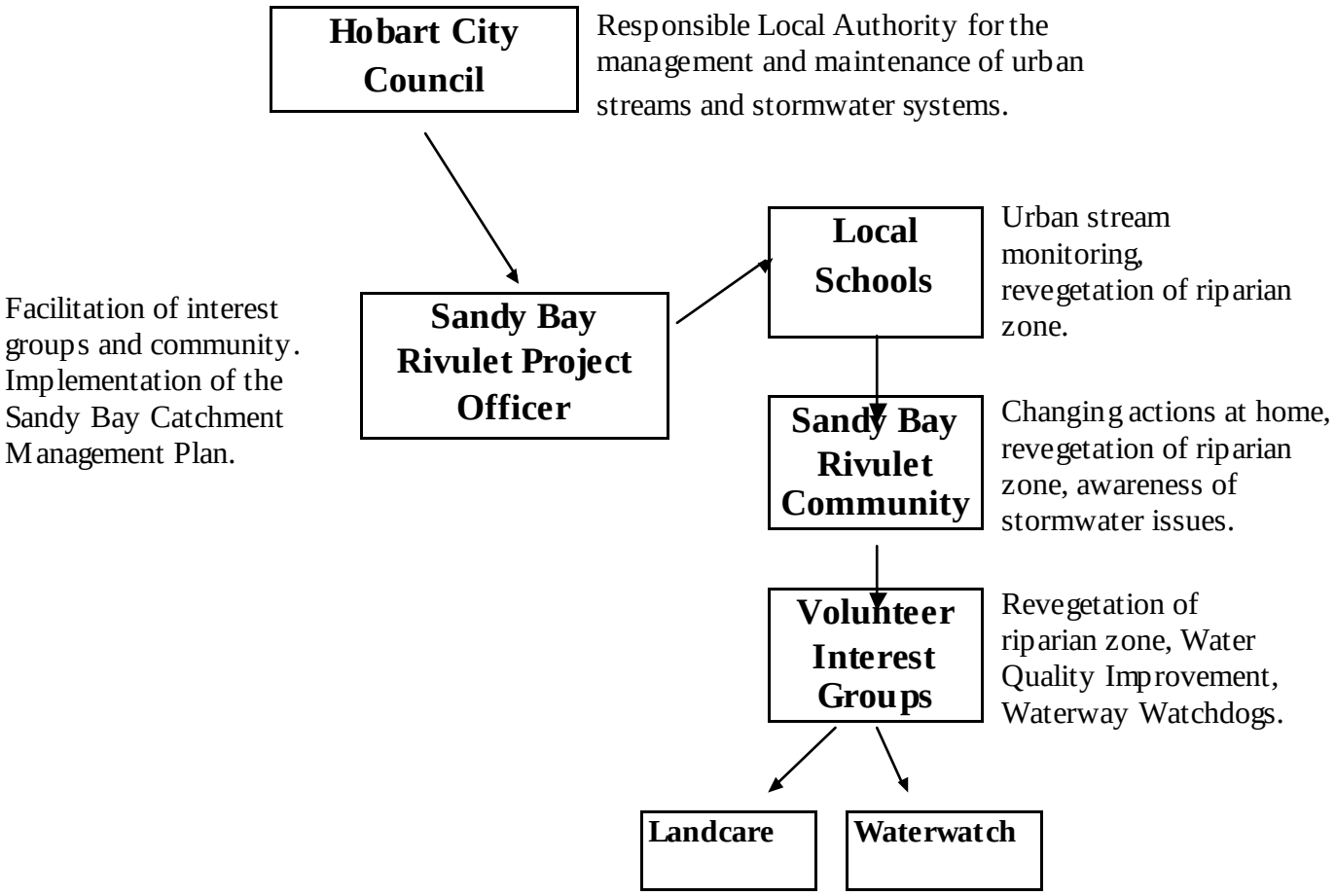
2.1 Sandy Bay Rivulet Catchment Project

Hobart City Council is responsible for the maintenance and management of urban streams and rivulets within the municipality of Hobart. Council aims to address the management issues associated with urban streams and waterways through an integrated approach to their management. This approach includes the involvement of community members, interest groups, local schools and Council staff in the remediation and management of local urban streams. An integrated approach to the management of Sandy Bay Rivulet facilitates the concept of integrated land and water management while simultaneously encouraging the transition towards a sustainable future.

The natural, social, ecological and cultural values of the Sandy Bay catchment provide the foundations on which this management plan is formulated. It is crucial to address these values to ensure that community expectations are met in the management of any local urban stream. The involvement of community members in the long-term management of streams provides individuals with a learning opportunity about urban stream processes and fosters a sense of ownership toward the stream environment. It is the aim of this project to inform the Sandy Bay Rivulet community on ways in which individuals can contribute to the long-term improvement of urban stormwater quality, involve them in remediation activities and re-establish the riparian zone where possible.

The structure of this project is outlined in the following diagram and illustrates the players and their role in the future of the Sandy Bay Rivulet (Figure 2.1).

Figure 2.1 Sandy Bay Rivulet Project Structure



2.2 Management Plan Implementation

The implementation of this management plan will commence following its completion and approval by the Hobart City Council and any community groups who express interest in the plan during consultation. Community consultation will commence alongside the development of this plan to ensure that all community values are adequately addressed and acknowledged in the long-term management objectives for the Sandy Bay Rivulet. Implementation of this management plan and major works scheduled for the rivulet will occur in stages and in accordance with priority ratings. The priority ratings will be determined by Council and will be dependent on safety issues, community interest/benefits, maintenance requirements and long-term sustainability objectives.

Some on-ground work activities may be carried out alongside the development of this plan as the need arises, as some actions may require immediate attention such as stream bank stabilisation or stormwater maintenance and repair. The involvement of local schools and community groups will occur throughout this plan's development as monitoring programs are established and individuals are involved in rehabilitative works.

While Hobart City Council is responsible for reactive and planned maintenance of the rivulet, it is envisaged that community groups and individuals will contribute to the long-term management of the Sandy Bay Rivulet through an increased awareness and understanding about catchment processes and stormwater issues.

2.3 The Community and Urban Stormwater

2.3.1 Urbanisation and Stormwater Quality

The greatest source of local and downstream pollution is urban run-off. Urbanisation typically increases the amount of impermeable surfaces present in a catchment area, increasing the volume of surface water run-off and decreasing run-off times. This inadvertently results in increases in velocities and flow rates (Walesh 1989). Urbanisation has many effects on the quality of run-off. Pollutants enter urban watercourses via run-off over a range of different land types and carry with it substances that have the potential to cause toxic, organic, nutrient, pathogenic and sediment pollution. These substances are often generated in urban areas through activities such as vehicle operation, leaf litter, application of pesticides and organic fertilisers, human littering, poor property maintenance, construction and demolition, and animal excrement (Walesh 1989). Combined with rainfall these toxic substances are transported and deposited in local urban streams and waterways.

The contamination of rivulets and streams commonly occurs via the sewerage system via undetected leaks, overflows, cracked pipes and cross connections from sewer to stormwater. Contamination of this type will be discussed in Chapter 5 where stormwater and sewerage infrastructure and its impact on water quality are explored. It is vital that water quality monitoring occurs on a regular basis so that leaks or overflows of this kind are detected early and rectified as soon as possible.

2.3.2 The Role of the Community

The objectives of stormwater management have changed considerably over the years from being the purpose of flood protection to objectives that include pollution abatement, ecological regeneration and the enhancement of environmental amenity for community members (Thomas *et al.* 1997). Environmental awareness and the preservation and enhancement of urban waterways are now seen as essential components of the decision-making process in land and water management. In 1999, the Derwent Estuary Program (DEP) was established as a joint initiative between the State, Local and Commonwealth Government. Its aim is to restore and protect the Derwent Estuary and to plan, manage and maintain the intrinsic values and public uses of the estuary (Derwent Estuary Program 2001). The Derwent Estuary receives stormwater from 57 urban and suburban catchments via 13 major rivulets and over 270 outlet pipes. Thus it is crucial that the management of the Derwent Estuary starts at these sources before contaminated stormwater reaches the waters of the Derwent.

Public education and public involvement are crucial elements in any stormwater management program. The transition to whole catchment management is becoming evident in rural Australia through Landcare and other similar community interest groups. It is also apparent that the philosophy of whole catchment planning needs to be adapted to the urban environment where streams and rivers are subject to pollution from urban run-off, stormwater and sewer contamination, and spillage, all of which, in the long-term, can cause significant ecological damage. Greater community participation in urban stream management is linked to increasing project efficiency and effectiveness while encouraging self-reliance in natural resource management. Moreover, and increase in the control and management responsibilities for local people brings resources, volunteers, enthusiasm and a sense of ownership to environmental management (Foster 1997).

There are numerous ways in which individual community members and interest groups can get involved in urban stream management. Some of these ways include:

- **Drain stencilling**: drain labelling increases public awareness and may be an activity a catchment group adopts as a specific task. The presence of stencils on drains may prevent further dumping of paints; oils, solvents and garden refuse into the stormwater system.
- **Backyard Rehabilitation**: if residents living alongside a stream or rivulet were encouraged to include the riparian zone in their backyard maintenance, the overall health of urban streams would increase. The provision of plants and a co-ordinator for such a project has the potential to result in improved urban stream water quality and an increase in habitat for native species.
- **Compliance**: compliance should be recognised as the key to the success of stormwater management policies e.g. cleaning up after dogs, proper disposal of chemicals and paints. Compliance can be achieved through strict enforcement and community education and co-operation.
- **Behaviour Modification**: changing people's behaviours at home and in business can be achieved through public education and awareness raising programs that can result in reduced pesticide and herbicide use, washing cars on permeable surfaces, and proper disposal of leaf litter, chemicals, cigarette butts and sidewalk litter.

Aside from disseminating public information there needs to be more effort devoted to allowing the community to provide public comment and feedback on stormwater management practices (Thomas *et al.* 1997). This type of involvement instils a sense of ownership among community members and results in a more accountable and responsible working group.

The aim of this management plan is to provide a range of ways in which members of the community can become involved in the management of their catchment and contribute to the sustainable management of urban streams. This plan can be used as a tool for local council, community interest groups and schools within the Sandy bay Rivulet catchment, although can also be applied to other catchments with similar characteristics and available resources.

Chapter 3 Catchment History

3.1 Introduction

In the past, stormwater drains and rivulets were seen as a means in which to remove surplus water as quickly as possible to avoid flood damage to nearby properties. Its presence in the urban environment was for flood mitigation purposes only with little regard given to the pollutants being received into these urban waterways. Today, stormwater run-off is responsible for transporting many of the pollutants responsible for degrading urban rivulets (Hunter 1999), including hydrocarbons, heavy metals and organic nutrients. With an increased awareness about stormwater issues, we have seen the emergence of community-based action and willingness to amend the errors made in the past. Thus, the value of urban streams as a natural resource has been realised by members of the community and as a result, attempts are being made to restore the natural values of areas and manage them sustainably for generations to come.

This Chapter addresses the historical values associated with Sandy Bay Rivulet, including its early settlement to modern day use. Included in this Chapter are the values that are associated with the Sandy Bay Rivulet, and the associated management objectives that have been extrapolated from these values. The many values of the Sandy Bay Rivulet have been derived from members of the community who reside on the banks of the rivulet, and those individuals who use the rivulet environment.

3.2 Catchment History

Prior to European settlement, the Mouheneenner and Nuenonne bands of Aborigines hunted and gathered in the rivulets and foreshores of the Derwent Estuary for thousands of years. The coastal zone of the river provided these people with fresh fish and shellfish where they gathered mussels, limpets, oysters and crayfish (Goc, 1997). The lightly wooded foothills of this region consisted of dry schlerophyll forests with an abundance of native fauna for food. The aboriginal bands of this area fed on speared kangaroo, wallaby, emu and possum. The rivulet's that carved their way down the mountain side were places where aboriginal women and children

searched for thick white grubs in the banksias and rotting logs that lay beside the streams (Goc, 1997).

The arrival of the European's in February 1804 forced the aboriginal families to retreat into the sanctity of neighbouring woodlands. In the months and years that followed the landscape was transformed from one of traditional hunting grounds to widespread European settlement. The Mouheneenner and Nuenonne bands were driven from their homes by encroaching settlement and had little choice but to disappear from the area, never to return (Goc, 1997).

3.2.1 Early Settlement

Between early European settlement in 1804 and the late 19th Century, most of Hobart's population was centred in the immediate Hobart district. The Sandy Bay Rivulet formed Hobart Town's southern most boundary, with all outlying areas primarily used for farming (Sinclair Knight Merz 1999). The development of this area began as early as 1805 when 100 acres of land behind the beach and beside the Sandy Bay Rivulet was granted to Captain William Sladden (Rowntree 1959).

In 1892, the Queenborough Health Board and the Hobart Corporation received several complaints from landowners about the dumping of night soil into the rivulet in Battery Point. The dumping of night soil into the rivulet was seen by many as polluting the rivulet and was deemed a health issue for local residents (Goc 1997). It was not until 1900 that the Queenborough Town Board and the Hobart Corporation agreed to combine efforts in improving the quality of the Sandy Bay Rivulet. However, the pollution of the rivulet and Marieville Esplanade remained a contentious issue for decades (Figure 3.1).

The Sandy Bay area surrounding the rivulet became known as the district for market gardens, nurseries and orchards (Rowntree 1959). These properties were described as having water on three sides, and were bound by the water of the Sandy Bay Rivulet and Marieville Esplanade. Further up the rivulet, areas of land were much larger and were used for dairy farming and grazing pastureland. Aside from agricultural

practices, there is also evidence that an industrial activity such as a flock mill was established in the Romilly Street area (Sinclair Knight Merz 1999).

Figure 3.1 Pollution of Marieville Esplanade from Sandy Bay Rivulet

This photo was taken in the 1930's to illustrate the end of pipe pollution from Sandy Bay Rivulet into Marieville Esplanade.
Source: Goc, 1997.

In 1914, the Queenborough district (otherwise known as Sandy Bay) was to be included in the Hobart drainage scheme, which was completed in 1912 (Paltrow 1995). In 1920 a sewerage system was installed for Queenborough residents, however it took many years before the system was operationally effective. The most prominent change to the Sandy Bay Rivulet occurred in 1997 when the wood lining at the end of the rivulet was removed due to the smell and rotting wood. The wood lining was previously installed as a flood mitigation measure, and then replaced with a cement channel for the same purpose in 1997. In combination with the new cement lining a new siltation trap was installed and litter traps were erected to minimise the amount of gross litter entering the Derwent Estuary. Although the cement lining of the rivulet aids in flood mitigation, this section of the rivulet is where it varied most from its natural state further upstream (Andrews 1997).

3.2.2 Modern Day Use of the Catchment

The Sandy Bay Rivulet Catchment area is utilised for a range of land use activities. Natural vegetation comprises the majority of the catchment area, particularly in the upper reaches of the catchment where little development has occurred. Vegetated areas (including all forest types) make up 402 hectares of the total 574 hectares (Landsat Landuse Classification 2001). Urban areas utilise 106 hectares of which there are approximately 800 private houses, 20 public buildings, roads, driveways and parking areas, with an estimated catchment population of 3100 (Andrews 1997). Other land use areas are classified as agricultural (53 ha), clear or bare land or water (6.6 ha).

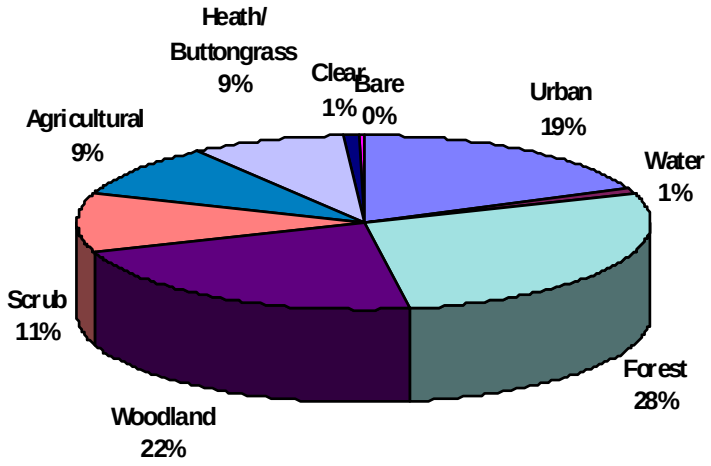


Figure 3.2 Land Use Classification of the Sandy Bay Catchment

Source: Department of Primary Industries, Water & Environment, 2001.

Within the urban area of the Sandy Bay Rivulet Catchment, (the area of the catchment from the Southern Outlet to Marieville Esplanade), many commercial businesses operate. Approximately 20 restaurants and cafes, 2 major supermarkets, 2 service stations and 3 Hotels operate within the urban area. Many of these businesses have the need to dispose of liquid trade waste from the business premises. Trade waste is defined as:

> *" any waste liquid and any substance contained in it, which is produced at the premises of an industrial, commercial or institutional activity, but does not include normal domestic wastewater"* (Liquid Trade waste Policy 1998).

It is the environmental responsibility of these businesses to ensure that all liquid trade waste is disposed of through the sewerage system and that adequate measures are in place to ensure the protection of stormwater quality. The stormwater system must only be used for the disposal of uncontaminated stormwater runoff. Guidelines for the control of trade waste are outlined in Hobart City Council's *Liquid Trade Waste Policy* (1998). Businesses in the Sandy Bay business area are monitored regularly by Hobart City Council to ensure that they comply with the specifications for stormwater drainage outlined in the policy.

While disposal methods are provided for liquid trade waste, many businesses provide the public with car parking facilities. Car parking areas in the lower Sandy Bay business district will often include areas that have impermeable surfaces and therefore contribute to significant amounts of run-off entering the stormwater system. The run-off from these sites will often contain high levels of petrol, oil and hydrocarbons, all of which are detrimental to urban stream health. It is therefore vital that source control measures are put in place on site to prevent contamination of the stormwater system and the Sandy Bay Rivulet. Coupled with the installation of these devices, the general public and business community need to be better informed about stormwater and it's potential impact on the Sandy Bay Rivulet. Recommendations on the range of options available for stormwater treatment will be discussed in following chapters.

3.3 Catchment Values

The catchment values associated with the Sandy Bay Rivulet include the natural, cultural and intrinsic values held by the surrounding community and users of the catchment. These values were derived from individual community members who reside within the catchment via a survey, the details of which are outlined in Appendix 3. It is important that from these community values the management

objectives for the Sandy Bay Rivulet catchment are formulated and is the foundation on which sustainable management practices can be built.

Involving members of the community in the catchment's environmental monitoring and management is crucial to the long-term sustainability of the rivulet and to the achievement of Integrated Catchment Management (ICM). ICM is defined as:

> *The co-ordinated and sustainable use and management of land, water, vegetation and other natural resources on a regional water catchment basis so as to balance resource utilisation and conservation.*
> (Department of Primary Industries, Water and Environment 1999, p1.)

ICM includes the integration of physical planning, water management, nature conservation and general environmental management directed towards catchment processes (Glasbergen & Klijn 1991). With this in mind, it is important to develop management strategies that are seen to address both the environmental qualities and functions of a catchment whilst at the same time acknowledging the values held by community members and users of the catchment area. The following sections discuss the responses given by community members of the catchment in relation to the community survey. Results of the survey highlight those values that are considered most important to the community members and users of the Sandy Bay Rivulet catchment area.

3.3.1 Waterworks Valley Landcare Group

The Waterworks Valley Landcare Group is comprised of community members who are interested in preserving and protecting the Waterworks Valley area in an ecologically sustainable manner. The Waterworks Valley Management Plan area has been defined as the area from below Waterworks Reserve to the Fitzroy Gardens along the Sandy Bay Rivulet (Sinclair Knight Merz 1999). The Management Plan area connects the surrounding suburbs to a place of natural beauty and recreation and links the urbanised lower rivulet and the natural bush land of the upper catchment. The area is valued for its native flora and fauna, and for its cultural and recreational value to the users of the catchment.

The Waterworks Valley Landcare Group is actively involved in the monitoring and rehabilitation of the Water works Valley area. The group initiated the development of a Management Plan for the Waterworks Valley through funding provided by the Natural Heritage Trust. The Plan examines the uses and values if the Waterworks Valley and provides a range of Action Plans that aim to protect and enhance the identified values of the Waterworks Valley.

This Plan is written to link with other management plans that are written for the catchment and is complementary to the Waterworks Master Plan and Management Review (Draft 1998) and the City of Hobart Open Space Strategy (1997). The objectives and Action Plans outlined in the Waterworks Valley Management Plan will be supported throughout the development of the Sandy Bay Rivulet Catchment Management Plan. It has been previously stated that the Rivulet Catchment Management Plan will focus on the lower urbanised area of the catchment, that is the area of Sandy Bay located from the Southern Outlet to Marieville Esplanade. The primary focus of this Management Plan will be on the Sandy Bay Rivulet itself, its surrounds and point sources of pollution.

The remainder of this Chapter highlights the community values of the Lower Sandy Bay Rivulet Catchment. Individual values have been determined through extensive community consultation with residents of the lower catchment area. These values are discussed in further detail throughout this Chapter and include an Action Plan for each value, highlighting the primary goal and recommended actions for each community value expressed.

3.3.2 Community Value and Action Plan

The long-term involvement of the community in aspects of the Sandy Bay Rivulet Project is a key objective in managing a natural resource and fostering the development of a stewardship ethic towards the environment. There are numerous ways in which to describe a community, but for the purpose of this management plan, the community referred to throughout this document includes all individuals who reside within the catchment, volunteer interest groups and users of the catchment area.

It is evident, that through community-based programs such as Landcare, Waterwatch and school involvement, that environmental action via the community is an integral component in raising community awareness about catchment processes and environmental issues. Community involvement in projects such as this enables individuals to contribute to important decision-making processes regarding the management of natural assets. The following table outlines the community values concerning Sandy Bay Rivulet residents and the ways in which their values can be addressed in future management strategies.

Results of the community survey reveal that members of the Sandy Bay Rivulet community value the rivulet and surrounds in many ways, but particularly for its natural beauty and intrinsic value. The community survey was distributed to 120 households that are positioned along the banks of the Sandy Bay Rivulet of which seventy two percent (72%) of households responded. The purpose of the community survey was to ascertain those values held by community members regarding the rivulet (Appendix 3) what concerns they had about the rivulet's future, and how they wished to be involved in the rivulet's long-term management and health. People within this community utilise the rivulet through a number of ways including;

- Aesthetics
- Recreation/Play
- Education
- History/Culture
- Flora and Fauna

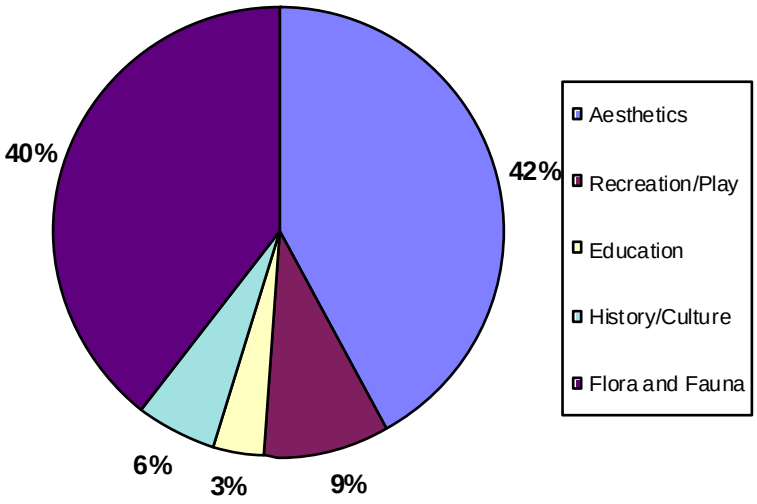


Figure 3.3 Community Values for Sandy Bay Rivulet

The results obtained from additional questions within the survey have been outlined in Appendix 3.

A series of Project Data Sheets have been complied for various projects that may be initiated in the Lower Sandy Bay Rivulet Catchment. These data sheets can be used as a guideline for project development and implementation. A range of projects have been selected from some of the goals outlined in this management plan and are all included in Appendix 4 in Project Data Sheets. The project data sheets can be easily adapted for other projects within additional catchment areas, but for the purpose of this management plan, are specific to Sandy Bay Rivulet.

Community Values Action Plan

GOAL: To develop and maintain a strong community network in the active management of the Sandy Bay Rivulet Catchment

Objectives	Actions	By Whom
1. To involve members of the community in the long-term management of Sandy Bay Rivulet	1. Determine the willingness of community members through a consultative process and distribution of a survey 2. Encourage residents living along the rivulet to extend their backyard care to the rivulet 3. Conduct information field days for community members and practical workshops	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer Community members Sandy Bay Rivulet Project Officer
2. To keep the community informed on environmental change (positive and negative) on a regular basis	1. Develop and distribute community newsletters to members of the community 2. Establish a database that can be accessed by the public for information on water quality and other testing results	Community members with the assistance of the Sandy Bay Rivulet Project Officer Community member/school with the assistance of the Sandy Bay Rivulet Project Officer
3. To inform school children and teachers on the ecological values of urban streams and create educational packages on how we can all contribute to cleaner waterways	1. Give small talks on stream ecology to interested schools 2. Involve school children in elements of water quality testing and bug identification	Sandy Bay Rivulet Project Officer Waterwatch Sandy Bay Rivulet Project Officer

3.3.3 Cultural Heritage Value and Action Plan

The aboriginal heritage of the Sandy Bay Rivulet Catchment has been discussed earlier in this Chapter (Section 3.2) and acknowledges that the Sandy Bay Rivulet and surrounding areas were once used for foraging and hunting grounds for aboriginal people. Extensive development and urbanisation now predominates the area, however it is important to acknowledge that the rivulet area remains an important element of aboriginal history.

The heritage associated with the early settlement in this catchment remains evident in some of the older homes and buildings that still remain in the area.

The Heritage Schedule (Schedule F) in the City of Hobart Planning Scheme 1982 states that those parts of the Planning Area shown as Heritage Areas or listed on the Council's Heritage Register shall be conserved (Section F.3). Any development that is proposed will be consistent with those characteristics of the Area that contribute to its cultural significance (City of Hobart 1982).

Cultural Heritage Value Action Plan

GOAL: To address all cultural and heritage values associated with the Sandy Bay Rivulet Catchment Area

Objectives	Actions	By Whom
1. Identify and record the sites along the length of the rivulet that have cultural heritage values	1. Ensure that those sites or values are acknowledged and addressed in future management strategies	Hobart City Council
2. Inform community members on the cultural significance and value of those areas concerned	1. Inform residents on culturally significant areas via information flyers or during personal consultation.	Sandy Bay Rivulet Project Officer

3.3.4 Natural Value and Action Plan

The natural values associated with Sandy Bay Rivulet are centred on the ecological integrity of the rivulet itself. It is often rare to see a stream still existing in an urban environment, and not being replaced with pipes and culverts to hide it from view. Like many of the smaller rivulets around Hobart, Sandy Bay Rivulet has been modified over time and has been perceived as a creek, a drain and a natural waterway by the people who have resided in the area.

It is important to improve and maintain the water quality of Sandy Bay Rivulet as it is home to a range of macro-invertebrates and is one of the few rivulets in Hobart that have abundant fish populations of native trout. The rivulet and its fish populations have been subject to numerous studies over the past 10 years. Dr Peter Davies from the University of Tasmania has been conducting the studies and regarded the Sandy Bay Rivulet as relatively healthy breeding grounds, despite the presence of contaminants (Andrews 1997). These native fish have been located in many lower lying areas of the rivulet and are not present in the upper reaches of the catchment due to physical barriers such as the highway. It is therefore crucial that the lower, heavily urbanised section of the rivulet is managed effectively so that the integrity of native fish populations is not compromised. In addition to this factor, the waters of the Sandy Bay Rivulet discharge into the Derwent Estuary, which provides habitat for many marine species, some of which are endangered. The quality of the water within the rivulet also affects species within the Derwent as waters are received along with any contaminated sediment or discharge.

The flora within the catchment varies considerably between the upper and lower reaches. While the native vegetation in the lower reaches of the catchment has been replaced with European garden species the upper catchment area remains in its native form, providing refuge for a range of native fauna. The vegetation types within the catchment have already been discussed in Chapter 1 (Section 1.3.2) and will not be discussed any further in this section. The following table outlines the objectives of this management plan and actions required in relation to the long-term management of the catchment's natural values.

Natural Value Action Plan

GOAL: To enhance and protect the natural values within the Sandy Bay Rivulet Catchment

Objectives	Actions	By Whom
1. To inform community members on the diversity of fauna that utilise the Sandy Bay Rivulet area	1. Distribute information in the way of newsletters and flyers that highlight the ecological importance of the rivulet	Sandy Bay Rivulet Project Officer
	2. Provide ways in which members of the community can become actively involved in the monitoring and management of native areas through hands on workshops	Sandy Bay Rivulet Project Officer
	3. Integrate the above mentioned actions with the current Bushcare Program within Hobart City Council	Hobart City Council
2. To implement effective protection measures for the species of the catchment	1. HCC to include appropriate land use and management policies in its planning for natural areas of the catchment	Hobart City Council
	2. Any development or proposed works undergo and assessment for ecological impacts prior to development	Hobart City Council
3. To actively involve members of the community in the management of the rivulet in their back yard Refer to Project Data	1. Provide the community group with advice on ways in which they can add to their backyard amenity	Sandy Bay Rivulet Project Officer
	2. Assist with the provision of native plants and materials to	Sandy Bay Rivulet Project Officer

Sheet 1 (Appendix 4)	re-vegetate the riparian zone and to improve bank stability	Sandy Bay Rivulet Project Officer Hobart City Council Bushcare Program

Schedule 1 Clearing of Land in the City of Hobart Planning Scheme states in its assessment criteria (Clause 1.4) that when considering applications for the destruction and removal of soil or vegetation, Council will take into account:

- The protection of the amenity value of the vegetation and the general area, including cultural landscape and heritage significance, and
- The protection of biodiversity, including species, genetic and ecosystem diversity, rare, vulnerable or endangered species, habitat and wildlife corridors (City of Hobart 1982).

3.3.5 Intrinsic Value and Action Plan

The intrinsic values people place on an area is an important factor in the management of natural resources. These values are as equally important as those values that are cultural or natural. An intrinsic value can be described as something that is valued for its existence alone. An individual may value a rivulet because it provides them with a sense of relaxation, peace and tranquillity. A natural bush area may provide hours of satisfaction for an avid bird watcher. Thus, the individual determines the intrinsic value of a location and in what way they utilise the catchment area.

Intrinsic Value Action Plan

GOAL: To consider the intrinsic values associated with the catchment area in the management and planning of the Sandy Bay Rivulet Catchment

Objectives	Actions	By Whom
To acknowledge the intrinsic values community members have for the Sandy Bay Rivulet Catchment	Include the community's intrinsic values in the long-term management and planning strategies	Hobart City Council

The aforementioned goals and management actions are supported by those legislative mechanisms in place for the protection of natural waterways and resources. Policy development plays an integral role in the protection of natural assets and contributes to the development of local planning schemes. There are many Acts and Policies in place for the protection and management of urban waterways, all of which are pertinent to improving the quality and sustainability of Sandy Bay Rivulet. Stormwater pollution is becoming a major problem and hampering efforts in nationwide efforts to protect and enhance the value of natural waterways. As a result there has been a recent increase in the number of policies and management plans that address stormwater pollution issues. The following Chapter examines this legislation from a State and local level.

Chapter 4 Protective Legislation for Rivulets in Tasmania

4.1 Introduction

Legislative mechanisms at the State level are influential in the sustainable management of natural resources. Within Tasmania there exists a Resource Management and Planning System (RMPS) that was established in 1994. This planning system consists of a tiered framework (detailed in Figure 4.1) designed to integrate State and Local Government planning (Haynes 1996), and to offer protection and guidelines for the management and planning of the environment.

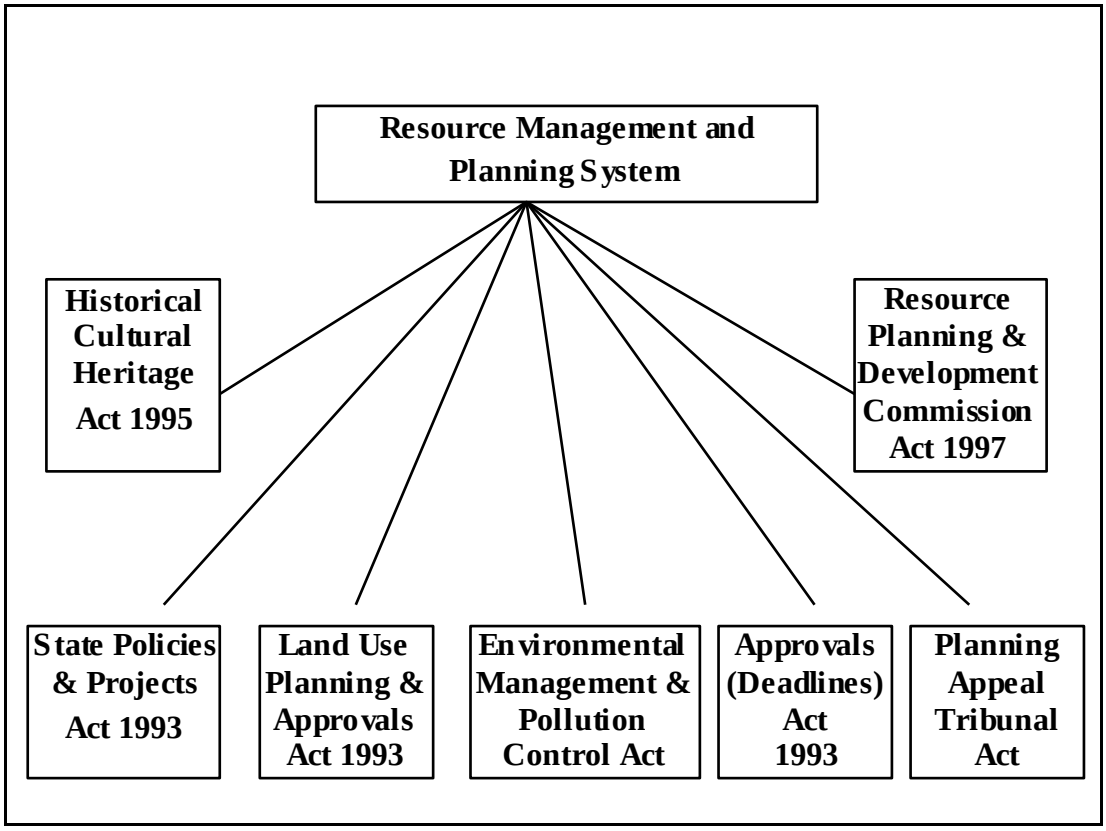


Figure 4.1 Tasmania's Resource Management and Planning System

Source: Department of Primary Industries, Water & Environment 1999.

The objectives of the Resource Management and Planning System are:

- To promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity
- To provide for the fair, orderly and sustainable use and development of air, land and water
- To encourage public involvement in resource management and planning
- To facilitate economic development in accordance with the preceding objectives, and
- To promote the sharing of responsibility for resource management and planning between the community and industry in the State (Department of Primary Industries, Water & Environment 1999).

The aforementioned objectives focus on the potential environmental and cumulative impacts associated with development, whilst encouraging sustainability and an integrated approach to management. The Acts and Policies that are pertinent to the management of water resources in Tasmania, and therefore Sandy Bay Rivulet, are discussed in the following sections.

4.1.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) is a joint initiative developed by the Commonwealth, State and Territory Governments under the auspices of the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC). The strategy aims to provide a nationally consistent approach to water quality management (ARMCANZ & ANZECC 2001).

The Strategy's objective is to:

> "**achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development".**

Within one of the suite of documents in the NWQMS, ***Draft Guidelines for Urban Stormwater Management 1996 have*** been developed. These guidelines provide a national framework for the management of urban stormwater in an ecologically sustainable manner. The Guidelines aim to:

1. **Highlight limitations of many existing stormwater management practices;**
2. **Incorporate catchment wide issues in decision-making processes;**
3. **Assist the community and water managers to formulate and implement stormwater management plans that are most appropriate to local interests and takes into account the environmental, social and economic concerns of the community;**
4. **Promote the protection of the agreed environmental values and the need to determine the maximum concentrations and loadings of pollutants that meet the environmental values;**
5. **Determine the management practices across urban catchments necessary to limit the transfer of pollutants consistent with sustainable levels.**

The Draft Guidelines for Urban Stormwater Management (1996) provides the framework in which States and Territories are able to develop policies and strategies that suit their specific legislative and resource management situations (NWQMS 1996).

4.1.2 State Legislation

The *Sewers and Drains Act* 1954 is an Act to make better provisions for schemes and systems of sewerage and drainage (Tasmania 1954). Included in this Act if the management of 'natural water', which includes water, found naturally on land from rain, snow, natural flow in watercourses or over the ground, and through soakage (Tasmania 1954). This Act addresses the management issues associated with a sewerage system or an urban drainage system of a district or catchment area.

The *Land Use Planning and Approvals Act* (LUPAA) 1993 provides for the making and amendment of planning schemes. LUPAA permits the assessment of a wide range of planning matters and is founded on a permit system, where a permit is required from planning authorities prior to development (Tasmania 1993). It also

provides for development control, enforcement and agreements between planning authorities and landowners (Department of Primary Industries, Water & Environment 1999).

In 1997, an amendment was made to the *Land Use Planning and Approvals Act* 1993, to issue a model framework for use by planning authorities in the development of planning schemes (Department of Primary Industries, Water & Environment 1999). The framework is designed to bring consistency to the drafting of planning schemes in Tasmania and to ensure that use or development in the planning is in accordance with the objectives of the RMPS (Resource Development & Planning Commission 1998). It's adoption by local council's may represent the transition from traditional zoning practices to criteria-based performances that address issues of sustainability.

The *Environmental Management and Pollution Control Act* (EMPCA) 1994 facilitates the protection of the environment by negotiating outcomes through environmental audits, impact assessments, improvement programs and agreements (Haynes 1996). The Act permits the management of point sources of pollution; a major problem encountered in urban waterways. The Act facilitates a more co-ordinated approach by councils to planning assessment and environmental management.

The *State Coastal Policy* 1996 and the *State Policy on Water Quality Management* 1997, were developed under the *State Policies and Projects Act* (SPPA) 1993. The SPPA provides for the making of State Policies, integrated assessment of Projects of State Significance and for State of the Environment Reports [SoER] (Department of Primary Industries, Water & Environment 1999). The *State Coastal Policy* and the *State Policy on Water Quality Management* are implemented at a statewide level with each local government obliged to adopt them in their planning schemes. The Policies are statutory documents that aim to set standards for water quality and the management of the coastal zone.

The *State Policy on Water Quality Management* 1997 includes a number of clauses applicable to local government concerning stormwater management, particularly the

achievement of improved water quality and appropriate management strategies. The purpose of the Policy is to achieve the sustainable management of Tasmania's surface water and groundwater resources by protecting or enhancing their qualities while allowing for sustainable development in accordance with the objectives of Tasmania's Resource Management and Planning System. (Schedule 1 of the *State Policies and Projects Act 1993*). One of the core objectives for the Policy is in the setting of *Protected Environmental Values* (PEVs) for all waters of the State while allowing for sustainable development. The degree of protection is based on the values and uses of the environment for which a watercourse should be protected. The PEVs listed in the Policy include:

1. Protection of Aquatic Ecosystems
    - *(i) Protection of pristine or nearly pristine ecosystems*
    - *(ii) Protection of modified ecosystems*
        - *(a) from which edible fish, crustacea and shellfish are harvested*
        - *(b) from which edible fish, crustacea and shellfish are not harvested*
2. Recreational Water Quality and Aesthetics
    - *(i) Primary contact water quality*
    - *(ii) Secondary contact water quality*
    - *(iii) Aesthetic water quality*
3. Raw Water for Drinking Supply
    - *(i) Subject to coarse screening only*
    - *(ii) Subject to course screening plus disinfection*
4. Agricultural Water Uses
    - *(i) Irrigation*
    - *(ii) Stock watering*
5. Industrial Water Supply

    (specify industry)

(Department of Primary Industries, Water and Environment, 2000).

The *Water Management Act* 1999 is an Act to provide for the management of Tasmania's water resources and for other purposes (Tasmania 1999). Schedule 1 of

the Act addresses the objectives of the RMPS and the sustainable management and protection of Tasmania's natural and physical resources.

The integration of the aforementioned Acts into the regional planning system provides the framework for the sustainable management of urban waterways. Under the *Local Government Act* 1993, municipal government is granted greater responsibility in the planning and management of the environment, particularly where land use control and catchment management are concerned (Tasmania 1993). An integrated approach to the management of the environment is encouraged through strategic and operational plans that local councils are required to submit for their municipal areas.

4.1.3 Hobart City Council and Sandy Bay Rivulet

A priority for Hobart City Council is to involve members of the community in the long-term management and monitoring of Sandy Bay Rivulet. This transition towards community-based management and integration is a principal theme within *Local Agenda 21* where marshalling the capabilities of groups within a community is seen as primary environmental care. The Agenda also states that an integrated approach to management provides the framework for land use planning and the establishment of processes for public participation, which in turn, lead to resource stability and long-term sustainability (UNCED 1992).

Hobart City Council's *Liquid Trade Waste Policy* 1998 provides for the protection of stormwater by ensuring that liquid waste is discharged to the sewerage system. Under the *Environmental Management and Pollution Control Act 1994,* Council is responsible for any polluted waters from stormwater outfalls under its control and therefore the stormwater system must only be used for the disposal of uncontaminated stormwater runoff. It is illegal to discharge waste, other than uncontaminated stormwater, either directly or indirectly to a stormwater drain or system (Hobart City Council 1998).

The Catchment Management Plan for Sandy Bay Rivulet is based in the environmental management system principles stated in the International Standard Series ISO 14000. The environmental management system is viewed as an organising framework that should be continually monitored and periodically reviewed to provide

direction for environmental activities in response to changing internal and external factors (Australian/New Zealand Standard 1996). The principles and elements of the Environmental Management System (EMS) are:

1. **Commitment and Policy**: An organisation should define its environmental policy and ensure its commitment to EMS;
2. **Planning**: An organisation should formulate a plan to fulfil its environmental policy;
3. **Implementation**: An organisation should develop the capabilities and support mechanisms necessary to achieve its environmental policy, objectives and targets;
4. **Measurement and Evaluation**: An organisation should measure, monitor and evaluate its environmental performance;
5. **Review and Improvement**: An organisation should review and continually improve its environmental management system, with the objective of improving its overall environmental performance (Australian/New Zealand Standard 1996).

The Sandy Bay Rivulet Catchment Management Plan highlights the importance for ongoing environmental monitoring and the implementation of best management practices for urban stormwater. The involvement of the catchment community is viewed as a crucial element to the project in that community participation increases public ownership of resources and generates broader decision-making perspectives. It is important to Hobart City Council that the community values and concerns are explored, resulting in the identification of responsive strategies.

The following Chapter is devoted to highlighting the water quality associated with Sandy Bay Rivulet. Results that have been obtained through regular water quality testing will be discussed, including their effect on the long-term sustainability and health of the catchment. The next Chapter will also highlight the management actions that are considered necessary to achieve improved water quality within Sandy Bay Rivulet, including ways in which individual members of the community can work together to restore and preserve some of the natural values in the catchment area.

Chapter 5 Stormwater and Sewerage Infrastructure and Water Quality Issues

5.1 Introduction

A river, floodplain and all tributaries within a catchment are recognised as a single functioning unit, but each catchment has its own individual characteristics, which in turn, give a stream its unique presentation. These characteristics are extremely variable and may include the permeable/impermeable surface ratios, population of the catchment, operational industries within the catchment, and human behaviour to name a few. It is the latter that causes much concern in controlling urban stormwater pollution, and is now recognised as a major issue that required immediate action. In Australia at least $50 million is being spent annually on efforts to improve the health of streams, particularly through programs such as the Natural Heritage Trust (Rutherford *et al.* 2001).

Stormwater run-off is the major cause of massive accumulations of toxic contamination in Australia's waterways (Waste Management and Environment 2001). The current state of our waterways confirms that the current methods of managing stormwater run-off are inadequate for capturing and retaining silt and sediment and completely ineffective against toxic dissolved pollutants. These pollutants enter our waterways via run-off from building sites, surface cleaning activities and erosion resulting from earthworks (Waste Management and Environment 2001) (Plate 5.1).

The water quality in Sandy Bay Rivulet has been the topic of investigation for many years. There has been a series of studies and reports produced for the rivulet including *Quantification of Urban Stormwater and Land Use in the Sandy Bay Rivulet, Hobart, Tasmania* (Andrews 1997), *Sandy Bay Rivulet Flood Study* (HECEC 1999), and *The Transport and Deposition of Suspended Sediment in the Sandy Bay Rivulet* (Tuit 2001). The Waterworks Valley Landcare Group initiated the development of the *Waterworks Valley Management Plan* (Sinclair Knight Merz 1999), which includes a section on water quality, urban stormwater pollution and results of water quality testing.

The Wellington Park Management Trust manages the upper reaches and origin of the Sandy Bay Rivulet. The Trust has developed the *Wellington Park Management Plan* (January 1997), which incorporates management objectives for the Natural Zone, or areas of relatively undisturbed forested landscapes and some alpine areas (Wellington Park Management Trust 1997). The Plan states that it is important to protect and preserve water quality within these undisturbed areas.

Plate 5.1 Litter accumulating in the streets and entering river systems via stormwater

Water quality within Sandy Bay Rivulet is directly linked to the activities that occur within the catchment boundaries. Activities that involve water use and water disposal have considerable impact on the quality of water that flows throughout the catchment. It is therefore necessary to inform members of the catchment community (the users) about the linkages between human behaviour and urban stream water quality. Individual actions, no matter how small, are the key in improving and maintaining stormwater quality for generations to come.

Stormwater pollutants may be derived from a number of sources which are transported to waterways by a number of natural and constructed drainage features

(Andrews 1997). In urban areas, constructed drainage features are the norm and act as conduits for stormwater and its contaminants into natural waterways. In order to reduce stormwater pollution it is necessary to gain an understanding on the common sources. These are outlined in Table 5.1.

This Chapter of the management plan examines the Best Management Practices (BMP's) for urban stormwater and discusses the current state of the Sandy Bay Rivulet in terms of water quality. Results from water quality testing in Sandy Bay Rivulet depict the appropriate management strategies required to improve the rivulet's current water quality status. These results are outlined in section 5.2 of this Chapter.

Table 5.1 The Common Sources of Stormwater Pollutants

Type of Pollutant	Residential Activities	Vehicles and Roads	Construction Activities	Industrial Activities	Atmospheric Deposition
Sediment	erosion	pavement wear	erosion		airborne dust
Nutrients	organic matter	roadside fertiliser		solvents	airborne dust
Phosphorus	fertiliser			cleaners	
Nitrogen	cleaners			waste water	
Pathogens	organic matter septic systems sewerage system				
Toxic materials	herbicides pesticides	fuels herbicides pesticides	herbicides pesticides	fuels herbicides pesticides	PCBs herbicides pesticides
Heavy metals	Cd, Cr, Cu, Pb, Zn corrosion pesticides herbicides fertilisers roofs paint weathering	Cr, Cu, Pb, Zn, Fe, Cd, Mi, Mn bearings emissions brake wear tyre wear lubricants		Cd, Cr, Cu, Fe, Ni metal finishings combustion products	
Litter	litter	litter	litter wastes	litter	
Oil and Grease	paint solvents	lubricants motor fluids		oil lubricants	

Adapted from Andrews 1997, p.13.

5.1.1 Faecal Contamination of Stormwater

Stormwater is potentially the major contributor to faecal pollution in the Derwent Estuary, particularly after rainfall where a large amount of contaminated run-off is received by urban rivulets (Green & Coughanowr 2000). It has been estimated that stormwater contributes to 80-91% of total faecal input into the Derwent Estuary (Green 1997). Faecal bacteria counts have been conducted on many of the rivulets within Hobart, including Sandy Bay Rivulet, and have revealed counts well above the recommended guidelines for primary and secondary contact. These guidelines are 150 colony forming units (cfu)/100ml for primary contact and 1,000 cfu/100ml for secondary recreational contact (Green & Coughanowr). Sandy Bay Rivulet has displayed faecal coliform bacteria counts in the range of 0-1,600 cfu (Andrews 1997) and reflects localised sources of contamination.

In Hobart the sewerage system operates independently from the stormwater system. The sewage system can also contribute to faecal contamination within the Sandy Bay Rivulet via spills and leakages and cross-connections to the stormwater system. The majority of households are connected to a sewerage system that was constructed in 1912 (Sinclair Knight Merz 1999). The sewerage system is therefore extremely old in many parts of Sandy Bay and is therefore susceptible to cracking and leaking into the rivulet via the stormwater system. Regular water quality monitoring for faecal coliform bacteria in the Sandy Bay Rivulet is conducted by Hobart City Council and is a method by which the bacteria can be detected early and traced to the source.

5.2 Water Quality Results for the Sandy Bay Rivulet

5.2.1Bacteria

Hobart City Council conducts regular water quality testing on major rivulets every 3 months, including Sandy Bay Rivulet. Tests are conducted for faecal coliforms and *E.coli* bacteria. Regular and continued monitoring of the rivulet's water quality ensures that any variation or fluctuation in bacteria is detected at an early stage. Measures of faecal coliform bacteria in urban waterways indicate the presence of excrement from humans, pets or wildlife. The Draft ANZECC Guidelines (1999) state that the bacterial indicator index over the bathing season should not exceed 800 for faecal coliform or 300 enterococci per 100ml of water. Intensified monitoring of

water quality needs to be initiated when the bacterial index exceeds 550 for faecal coliform or 200 for enterococci (Recreational Water Quality and Public Health 1997). The Draft Australian & New Zealand Conservation Council's (ANZECC) Guidelines 1999 state that in secondary recreational contact, such as boating, the bacterial index should not exceed 5000 for faecal coliform or 2000 for enterococci per 100ml of fresh or marine water.

Table 5.2 details the recommended levels of various parameters for fresh water streams and estuaries and are based on water quality standards outlined in the ANZECC Guidelines. The following table can be used as a guideline to assist in interpreting results for the management and ongoing monitoring of urban streams. Standards for point source pollution should be based on these standards.

Table 5.2 Recommended Water Quality Standards for Freshwater and Estuaries

Element	Fresh Water	Estuary
Dissolved Oxygen (DO)	6mg/L	>6mg/L
Biological Oxygen Demand (BOD)	<2mg/L	<2mg/L
pH (acidity)	6.5-9.0	-
Orthophosphate (mg/L)	<0.008	<0.02
Soluble Phosphate	-	5-15 µg/L
Nitrates (NO3-N)	-	10-100µg/L
Ammonia (NH3-N)	5µg/L	5µg/L
Faecal Coliform	Median <cfu/100mL	Median <150cfu/100mL
Conductivity (µS/cm)	20-500	51-500
Turbidity (NTU's)	<5	-

Source: Adapted from the Huon Catchment Healthy Rivers Project 1997, p.25.

5.2.1.1 Bacteria Results

Over the past 12 months the number of faecal coliforms found during testing in the Sandy Bay Rivulet have been in the range of 280 - 40,000 colony forming units (cfu)/100ml. On occasions where counts have been above the recommended 200 cfu,

a thorough investigation by the Hydraulic Engineering Unit within Hobart City Council is conducted. Smoke and dye testing procedures are performed to locate possible leakages, spillages or cross-connections from the sewer to stormwater system. It is also possible that faecal contamination can also occur as a result of septic tank overflows that may occur further up the catchment and then be transported down the catchment via the rivulet. In these instances, regular monitoring is required in septic tank areas to detect sudden changes in the levels of bacteria early. Figure 5.1 illustrates the results from faecal coliform testing in the Sandy Bay Rivulet for the year 2001.

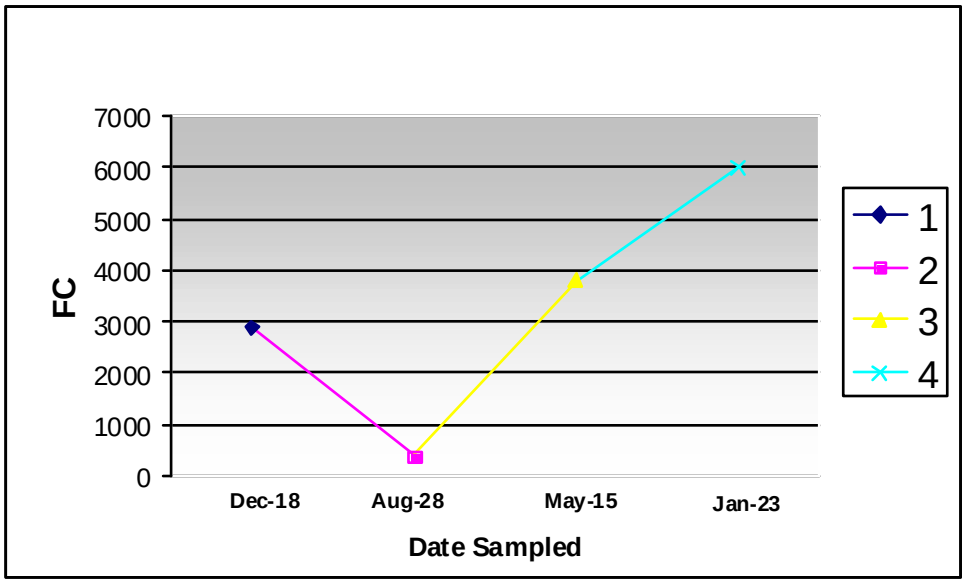


Figure 5.1 Faecal Coliform Bacteria Counts for Sandy Bay Rivulet 2001

The results outlined in Figure 5.1 indicate that there have been several incidents where faecal coliform bacteria counts that have been sporadic in nature and have exceeded the recommended limits. All water quality samples were taken during periods when water flow was normal and no samples were taken during or after high rainfall events. On occasions, through follow up testing, a cracked sewage pipe or sewage overflow has been discovered and repaired immediately. However, the main source of faecal coliform contamination is from urban run-off washing the faeces of cats and dogs from the streets into the stormwater system and into the rivulet (Andrews 1997).

5.2.2 Water Quality Parameters

Local schools in the Sandy Bay district are also involved in water quality monitoring and are guided by Waterwatch. Two local primary schools regularly monitor water quality in the Sandy Bay Rivulet and test for a range of water quality parameters. The parameters include:

- *Temperature* – is important to record at the time of sampling. Water temperature will vary depending on the season, time of day, depth of the water and the amount of cover provided by riparian vegetation. Variations in temperature determine the available oxygen in the water for aquatic life. Water low in temperature has high oxygen availability whereas water high in temperature has low oxygen levels. Variations in temperature can also change the rate at which both chemical and biological processes can occur, and what type of macro-invertebrates can live in the water body.

- *Turbidity* - refers to the cloudiness of water and is the result of suspended particles in the water. Turbid water affects the amount of light that can penetrate the water for plant growth and reduces the level of oxygen available for aquatic life. Silt, microorganisms, plant material, chemicals, and soil erosion can cause high turbidity. Turbidity is measured in units called Nephlometric Turbidity Units (NTU's) and is logarithmic. A tube is used to measure turbidity in relative terms, based on the ability of light to penetrate the water. The ANZECC Guidelines for turbidity in fresh water aquatic ecosystems should not exceed <1000 NTU's.

5.2.2.1 Turbidity Results

Turbidity in the rivulet was one of the variables measured during Tuit's study (2001) on the transport and deposition of sediment in the Sandy Bay Rivulet. Tuit's results indicate that the range of turbidity values in the rivulet during dry weather conditions was quite variable and site specific. Turbidity readings were collected from 15 sites along the length of the rivulet including natural, semi-urban and urban areas. Higher turbidity readings were measured in sites located within the semi-urban land-use zone, whereas the forested and urban land-use zones obtained clear turbidity readings. Tuit recorded the turbidity readings using a Hach DR/2000 Direct Reading

Spectrophotometer that recorded turbidity in Formazine Turbidity Units (FTUs) as opposed to the Nephelometric Turbidity Units (NTUs). Despite the difference in units, one NTU is still comparable to one FTU (Radtke *et al.*, 1998, cited in Tuit 2001). Figure 5.2 illustrates the average turbidity of all sites sampled from in the Sandy Bay Rivulet.

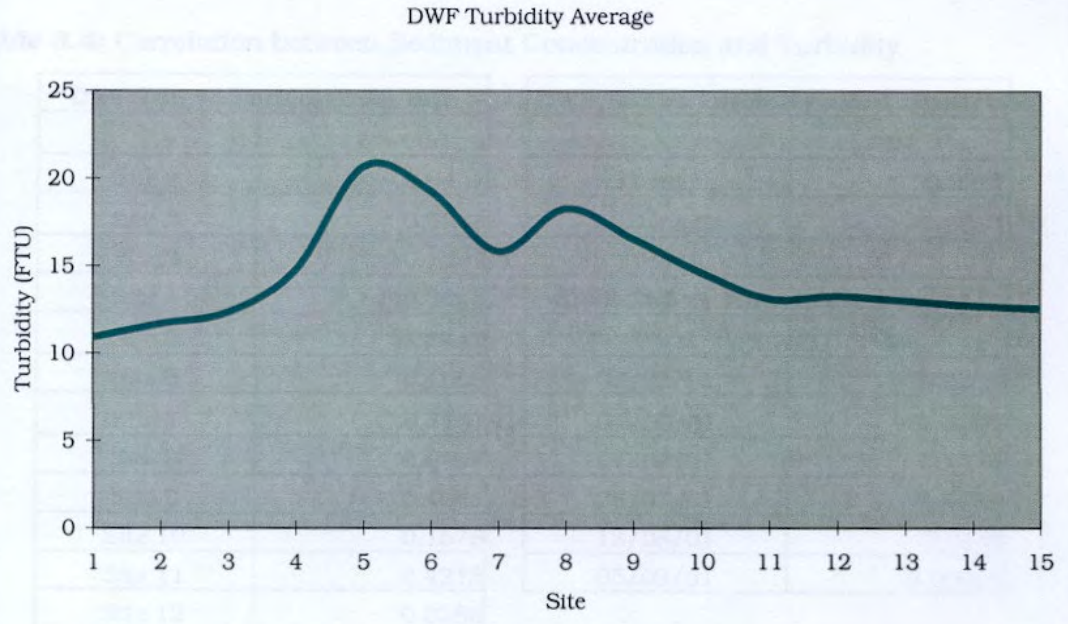


Figure 5.2 Average Turbidity during Dry Weather Flow in the Sandy Bay Rivulet
Source: Tuit (2001)

Despite low levels of suspended sediment Tuit highlighted that there remained a significant level of fluctuation in turbidity values (>10%) at each sampling site and therefore breached the ANZECC Guidelines.

Waterwatch have been monitoring several sites in the Sandy Bay Rivulet in the semi-urban and urban areas of the catchment. High levels of turbidity are indicated in the results throughout the sites and visual observations of rocks being coated in silt have been noted. This is perhaps due to works further up the catchment below the Waterworks Reserve area, and highlights the need for the improved silt management of sites where works are being conducted.

- *Conductivity* - is one way to measure inorganic materials in the water such as chloride, nitrate, sulphate, sodium, ammonium, aluminium and iron. Conductivity is also called salinity or total dissolved solids (Waterwatch 1996). When inorganic

materials dissolve they produce ions that are required by aquatic plants and animals for growth (Waterwatch 1996). Conductivity is affected by temperature, geology, water flow discharges and removal of vegetation. If conductivity levels increase above the recommended range, outlined in Table 5.4, sensitive species of the recommended community can become stressed and will disappear.

5.2.2.2 Conductivity Results

Conductivity was also measured during Tuit's (2001) study on the transportation and deposition of sediment in the Sandy Bay Rivulet. Tuit's findings revealed some important trends where conductivity increased throughout the natural areas of the catchment, but declined in the semi-urban zone, only to rise again throughout the urban zone. Tuit concluded that this result was expected due to the nature of the catchment. An increase in conductivity throughout natural areas can be attributed to the presence of organics in the rivulet from surrounding escarpments and farms. Throughout the semi-urban zone a decline in conductivity is expected due to the distance between the rivulet and major roads in the area. An increase in the urban area of the catchment can be explained by an increase in pollutant levels via stormwater run-off that effects the water quality during base flow conditions (Tuit 2001). Figure 5.3 illustrates the average sediment load during dry weather flow.

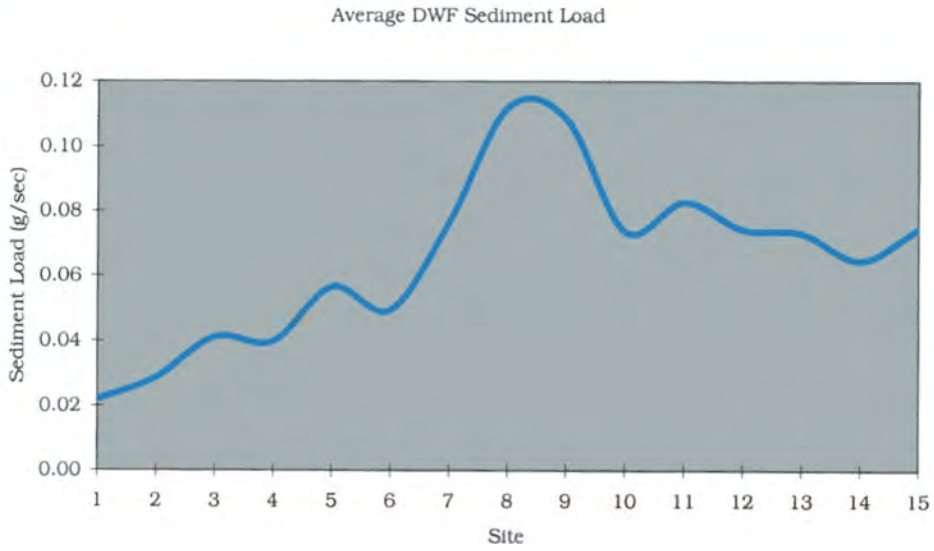


Figure 5.3 Average Sediment Load during Dry Weather Flow

Source: Tuit (2001)

- *pH* – is used determine the acidity of water in a stream; the pH is measured on a scale of 0 to 14, with 7 representing a neutral measurement (that the water contains an equal amount of H ions and OH ions). The pH for fresh water usually lies between 6.5 and 8.2, however wide variations may occur due to catchment geology and unnatural changes. These unnatural changes may include urban and industrial run-off, sewage and other waste management issues.

- *Dissolved oxygen* - (DO) is the small amount of oxygen gas that is dissolved in the water and its presence is essential for the respiration of aquatic animals, microorganisms and aquatic plants (Waterwatch 1996). If a healthy and diverse aquatic ecosystem is to be maintained, dissolved oxygen levels must be high (see Table 5.2). At low DO levels the aquatic environment is limited to those species that are hardy and have low oxygen demands.

- *Reactive orthophosphorus* – measures very low concentrations of phosphorus, down to 0.01mg/L. Very low concentrations can have considerable impact on waterways. Phosphorus is a nutrient that occurs naturally at low concentrations in water and is essential for all forms of aquatic life. An increase in phosphorus in streams has the potential to accelerate plant growth, algal blooms, low dissolved oxygen and the death of certain species.

5.2.2.3 Phosphorus Results

A study by Andrews (1997) on the Quantification of Urban Stormwater and Land Use in the Sandy Bay Rivulet measured reactive phosphorus levels in numerous sites in the rivulet. Andrews states that phosphorus levels at all sites were generally low, however two distinct peaks were noted. Both of these peaks in phosphorus levels occurred following a rain event.

Similarly, a Waterwatch group sampled for phosphorus levels in the rivulet near the Fitzroy Gardens approximately 30 minutes after a rain event. The phosphorus levels showed a significant increase from 0.03 mg/L in dry flow weather to greater than 0.14 mg/L following the rain event. An increase of this magnitude is detrimental to the existence of aquatic stream fauna and therefore requires prompt action in attempting

to trace the source and remedy the problem. It is possible that periods of high flow during rain events can remobilise phosphorus levels from the sediment resulting in an upset in natural nutrient balance. Large amounts of phosphorus can also accumulate on urban impervious surfaces and can then be released into the rivulet via run-off through the stormwater system.

- *Macro-invertebrate sampling* - in a stream can indicate the nature of the water quality based on the individual species tolerance to pollutants. Tolerance levels include sensitive species (e.g. Stonefly nymphs), medium tolerance species (e.g. Backswimmers and Water Boatmen), tolerant species (e.g. Leeches and Crane fly larva) and very tolerant species (e.g. Mosquito larvae and Bloodworms). Species that are tolerant and very tolerant of pollutants in the water will dominate degraded environments (Waterwatch 1996).

5.2.2.4 Macro-Invertebrate Sampling Results

Actively involved community groups and Waterwatch conduct macro-invertebrate sampling on a regular basis. The majority of sampling is conducted in the urban and semi-urban areas within the catchment. Results to date indicate that there is a decrease in the diversity of macro-invertebrates between the top of Waterworks Reserve and Fitzroy Gardens in Sandy Bay. The section of the rivulet in the Waterworks Road vicinity, approximately 500 metres above Lynton Avenue, displays a wide diversity of organisms including dragonfly nymphs and mayfly nymphs, both of which are indicative of good water quality. Conversely, below this site in the urban land-use zone near Fitzroy Gardens only tolerant species remain, including flatworms, snails and other worm species. The presence of tolerant species only and the absence of more sensitive species indicate poor water quality in this area of the catchment. Macro-invertebrate sampling has not been conducted below the Fitzroy Gardens site due to limited access and the channelisation of the rivulet.

5.2.3 Community Involvement in Sandy Bay Rivulet

The students of the primary schools test these water quality parameters approximately 4-5 times a year over the Sandy Bay Rivulet Catchment in eight sites. Testing of these sites has been occurring over the last 2 years and has led to a better understanding of water quality issues within the rivulet and its significance as a habitat for stream fauna. One of these sites has also been a site that has been monitored over the last 4 years by an aquatic ecologist from the Department of Primary Industries, Water and Environment. This site has been the focus of a study that has assessed both water quality parameters and macro-invertebrate diversity.

The presence or absence of specific stream fauna is an important indicator of stream health. AUSRIVAS (Australian River Assessment System) is a prediction system used to assess the biological health of Australian rivers developed under the National River Health Program (NRHP) by the Federal Government in 1994. AUSRIVAS produces a biological assessment that can be used to indicate the overall ecological health of the site and includes river systems, riffle, edge, pool and bed habitats. The AUSRIVAS predictive model and associated sampling methods are appropriate for use by community groups, managers and ecologists and provide the basis for the ecological assessment of the Sandy Bay Rivulet.

The Waterworks Valley Landcare group are also involved in monitoring water quality within a large section of the Sandy Bay Rivulet. The section monitored is in the Waterworks Valley region, that being the section of the rivulet that flows between the lower reservoir at Waterworks Reserve to the section adjacent to the Fitzroy Gardens in Sandy Bay. It appears that this section of the rivulet is subject to high loads of sedimentation and transportation of sediment downstream. The Landcare group actively works in this area and has become an environmental advocate for the region. As a result, a number of sites have been isolated in regard to contamination by grey water or illegal stormwater connections to the rivulet itself. Once isolated these sites are investigated by the Hydraulic Engineering Unit within Hobart City Council and prompt action is taken to rectify existing problems.

5.2.4 Sedimentation of the Sandy Bay Rivulet

A recent study in the Sandy Bay Rivulet (Tuit 2001) revealed that there are several sites along the rivulet that are identified as point sources of erosion. These are the McDermott's Gully and the Romily Trail land clearance site, both of which contribute large amounts of suspended sediment during dry and wet weather flow. Tuit (2001) also stated that during dry weather flows, transported sediments come primarily from the semi-urban and rural land use zones, while the source of wet weather sediment lies primarily in the urban zone. The urban sector of the catchment contributes most to pollutant loads due to the high amount of run-off from surrounding areas.

Plate 5.2 Stormwater outlets are a source of contamination from road run-off

Photo courtesy of J.Tuit 2001

Results of Tuit's study (2001) clearly show that the cumulative transportation of sediment that occurs during dry flow conditions is negligible in comparison to the cumulative transportation of sediment that occurs during storm events. The first flush is a common phenomenon during rain events in the Sandy Bay Rivulet and evidence indicates that pollutants are transported largely during the initial stages of the rain event discharge. The first flush is the characteristic response of the rivulet to rainfall (Tuit 2001). The urban sector of the catchment therefore has a large influence on the

sediment loads that are discharged during storm events, since the first flush phenomenon is strongly tied to urban catchments. An example of the first flush effect is illustrated in Figure 5.4 where a storm event on the 22/03/01 reveals a peak concentration in sediment that is 55 times greater than the average dry weather sediment concentration.

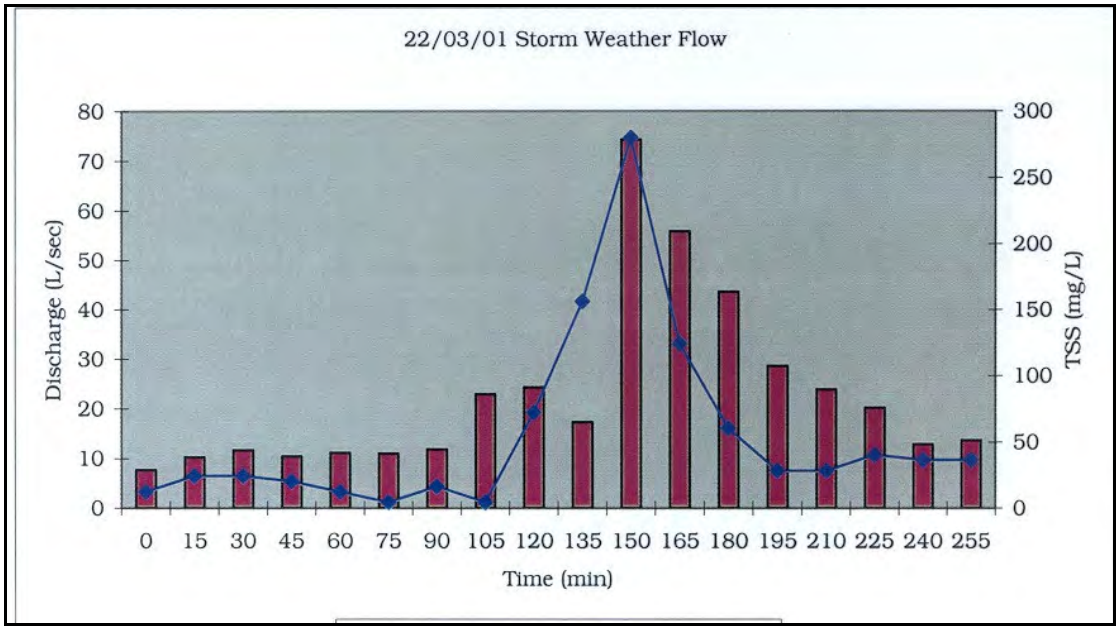


Figure 5.4 Storm Event in Sandy Bay Rivulet – 22/03/01

Source: Tuit, J, 2001.

5.2.5 Litter Control in Sandy Bay Rivulet

Litter is often the most visible source of pollution in a rivulet and Sandy Bay Rivulet is no exception. Due to the largely urban nature of the lower catchment area, litter enters the rivulet via the stormwater system. The majority of litter is derived from human use and is comprised of any solid material such as packing, paper products, food and drink containers and cigarette butts. The presence of litter in urban waterways is a major concern for our larger river systems, as most rivulets are conduits for such material. The accumulation of litter in Sandy Bay Rivulet reduces the aesthetic value of the stream environment and can have serious consequences to the hydraulic capacity of the rivulet through blockages that can result in localised flooding.

In an attempt to control and manage litter pollution in the rivulet, a litter trap was installed in 1997. The trap was designed to trap any gross litter travelling down the rivulet in periods of high and low flow. During rain events the trap was disconnected from its brackets to minimise obstruction and to mitigate localised flooding. The net from the trap was taken away to be emptied and replaced once water levels returned to normal dry flow conditions. Although the litter trap was effective in trapping gross litter items, several problems arose in the maintenance of the trap during high rainfall events.

During high flows the trap rapidly became blocked with debris and large litter items from further up the catchment and required prompt removal before flooding occurred. The litter nets were difficult to remove and were extremely hazardous for personnel during high flows as the chain to lift the nets from the rivulet needed to be manually connected. In low flow conditions the litter trap was flushed back in the opposite direction due to the tidal nature of the rivulet environment and the traps proximity to the coastal zone. The presence of the trap in its current location blocked the natural migration route for native fish in the rivulet. With these problems in mind, the trap was removed in December 2000 during a high rainfall event and has not been replaced. Staff from the Hydraulic Engineering Unit are currently designing an alternative trap that will allow for easy maintenance, minimise localised flooding and will allow for the easy migration of fish species. Project Data Sheet 2 (Appendix 4) highlights some of the options available for reducing litter and pollutants in urban waterways.

Plate 5.3 Quayle Street Litter Trap During a High Rainfall Event

Plate 5.4 Sedimentation of the Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

Plate 5.5 The sediment trap in Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

5.3 Best Management Practices for Urban Stormwater

While the conventional methods of urban stormwater management focused on the provision of efficient drainage systems, a more holistic approach to urban stormwater management is emerging and is one that involves multiple objectives (Wong 2000). This holistic approach to stormwater management includes the use of preventative measures in combination with control measures to minimise stormwater pollution. Preventative measures, or source controls, are management techniques that reduce the amount of pollutants transported by water (Watershedss 2001). Control measures are designed to reduce the levels of pollutants in stormwater that have already been exposed to pollutant sources.

5.3.1 Preventative Measures

Preventative measures in mitigating stormwater pollution can be summarised as source reduction practices. It is more effective and less costly to prevent a pollutant from entering a waterway to begin with, rather than to remove or treat it once the stormwater has already become contaminated. There are numerous ways in which stormwater pollution can be prevented through source reduction practices. These include:

1. **Animal Waste Collection -** animal waste contributes to the numbers of bacteria and organic matter in stormwater run-off.
2. **Curb Elimination -** elimination of curbs assists in reducing pollution entering the aquatic environment. Curbs function as channels for stormwater, whereas without curbs, run-off can be spread over large vegetated areas where sediments and pollutants can settle and be taken up by plants or grass. Curb elimination is most suitable for proposed development sites and is not always practical in well established urban areas.
3. **Removal of Debris -** stormwater control structures such as litter grates and trash racks accumulate litter and debris that enters the stormwater system. It is essential that the removal of debris and litter from these sites is included in a regular maintenance program.
4. **Educational Programs -** educational programs are a crucial factor in reducing the number of pollutants that enter urban streams, rivers and other waterways. Changes in human behaviour stem from people who are informed about stormwater issues and the best practices for maintaining healthy ecosystems.
5. **Minimisation of Pollutants -** stormwater pollution can be significantly reduced through the removal or minimisation of pollutants within the catchment area. This can be achieved through a number of ways including:
   - **The collection and recycling of hazardous wastes and waste oil in the community,**
   - **Diverting water discharges from vehicle washing areas to the municipal sewer system to prevent discharges into the stormwater system,**

- **Using alternatives to toxic and hazardous materials, such as water-based products, to reduce the amount of solvents and chemicals entering local waterways.**

6. **Parking Lot and Street Cleaning -** street cleaning on a regular basis assists in reducing pollutants that accumulate in the gutters and roadside. Street sweepers can pick up fine material therefore reducing the transport of sediment-bound pollutants.
7. **Stream Bank Stabilisation -** stream bank erosion is a common problem in urban streams that generally result in increased sediment loads discharging into the stream (Weller 2001). Through bank stabilisation techniques the possibility of mass bank failures is minimised and the amount of sediment entering a stream through erosion is drastically reduced. Stream bank stabilisation can be achieved by re-vegetation, soil bioengineering and hardened structural techniques.
8. **Buffers and Easements -** buffer zones or strips of vegetation along a rivulet or stream edge is important for trapping sediment and attached pollutants, encouraging filtration and slowing stormwater flows over a wide area.

5.3.2 Control Measures

Stormwater pollution control measures can be divided into two categories, source control and structural control. Source control measures aim to limit changes to the quantity and quality of stormwater at or near the source, whereas structural control measures aim to improve water quality and control stream flow discharges (CSIRO 1999).

Source controls can be used to avoid stormwater impacts and involve areas associated with land-use planning, education, regulation and operational practices. Attention to stormwater source control in these areas will assist in limiting changes to the quality or quantity of urban run-off before it enters the stormwater system (CSIRO 1999).

Structural control involves the construction and installation of infrastructure that reduces or delays stormwater flows and intercepts or removes pollutants after they enter the stormwater system. There are a number of options available for structural control of stormwater pollutants and can include at source, in-line and end-of-line

treatments. The range of devices and methods available for stormwater treatment are too many to mention in detail in this management plan and new products are continually being developed and are under trial. There is much information available on the range of products, their suppliers and efficiency in stormwater treatment. Specific details on some of the devices available are outlined in Project Data Sheet 2 in Appendix 4.

5.4 Management Objectives and Action Plan

GOAL: To identify source of pollutant(s), to improve and maintain water quality in Sandy Bay Rivulet

Objectives	Actions	Action by
1. Educate the community on urban links to water quality	1. Prepare and distribute educational material on the importance of water use and role of water in the catchment (where wastes & water go when they leave urban homes) 2. Provide ways in which members of the community can become actively involved in the monitoring and management of water quality (use of pesticides, detergents etc)	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer
2. Reduce the amount of sediment, oil and grease and nutrients entering the Derwent Estuary via the Sandy Bay Rivulet **Refer to Project Data Sheet 2 in Appendix 4**	1. Locate point sources of pollution in the rivulet 2. Continue to monitor water quality in consultation with Water Watch 3. Audit local businesses within the Sandy Bay Catchment for illegal stormwater discharges and encourage the installation of stormwater treatment devices	Hobart City Council Sandy Bay Rivulet Project Officer Hobart City Council
3. Minimise the amount of contaminated road-runoff entering the rivulet	1. Prioritise those sites near to Sandy Bay Rivulet where	Hobart City Council

	major road run-off has detrimental impact on the biological health of the stream 2. Encourage improved stormwater management practices for local businesses including the installation of stormwater treatment devices such as Enviropod, Ecosol products (see Project Data Sheet 2).	Hobart City Council
4. Minimise sewage contamination of Sandy Bay Rivulet	1. Monitor sewage and stormwater infrastructure to detect any areas where infiltration is occurring 2. Ensure that sewage overflows are managed effectively and promptly to avoid contamination of the rivulet	Hobart City Council Hobart City Council
5. Maintain a regular water quality monitoring regime **Refer to Project Data Sheet 3 in Appendix 4.**	1. Involve local schools in water quality monitoring (including pH, conductivity, turbidity and macro-invertebrate levels) 2. Transfer water quality monitoring data to Waterwatch groups to allow the wider public to access information 3. Continue regular water quality monitoring and conduct follow up reports on abnormal or high fluctuations in results	Local schools Waterwatch Sandy Bay Rivulet Project Officer Stormwater Management Officer (DPIWE) Waterwatch Sandy Bay Rivulet Project Officer Waterworks Valley Landcare Group

The goals and management actions that are mentioned for water quality are supported by the *Derwent Estuary Environmental Management Plan – Consultation Draft – July 2001*. The *Environmental Management and Pollution Control Act* (EMPCA) 1994 enforces the management of point sources of pollution; a major problem encountered in urban waterways. The *State Coastal Policy* 1996 created under the *State Policies and Projects Act* 1993 promotes the sustainable development of natural resources and identifies the need to protect the coastal zone. The aforementioned water quality management strategies are consistent with the principles under the *Local Government Act* 1993, where municipal government is granted greater responsibility in the planning and management of the environment, land use control and catchment.

The following Chapter highlights the options for vegetation management within Sandy Bay Rivulet. The management of vegetation is directly linked to water quality and is relevant to the preservation of natural values in the area. The next Chapter will also highlight the management actions that are considered necessary to manage vegetation in the lower Sandy Bay catchment.

Chapter 6 Vegetation within the Catchment

6.1 Introduction

In implementing management strategies that facilitate sustainability, it is important to understand the natural movement of watercourses and their associated linkages within the catchment, including vegetation. Riparian vegetation is classified as vegetation that is found on the banks of a river or stream and plays a crucial role in maintaining bank stability and controlling erosion in streams, which can be directly linked to water quality issues. Riparian vegetation with the Sandy Bay Rivulet Catchment is considerably different and varied between the top and more natural areas of the catchment to that vegetation found in the lower densely urbanised reaches, of which this management plan is the focus.

Plate 6.1 Vegetation in the upper Sandy Bay Rivulet catchment

Photo courtesy of J.Tuit 2001

Plate 6.2 Vegetation in the lower reaches of the Sandy Bay Rivulet catchment

Photo courtesy of J.Tuit 2001

6.2 Non-Native Vegetation

Sandy Bay Rivulet courses its way through hundreds of back yards in Sandy Bay to its final destination at Short Beach in Battery Point. The vegetation found along the banks of the rivulet in this area are predominantly non-native species that have found their way to the stream banks from neighbouring gardens. These 'escapees' take up residence on the banks and while many are beautiful flowering species, most end up choking the natural water way or displacing other native species. Many of these non-native species are hardy and opportunistic and they take advantage of any site recently disturbed. The invasion of native vegetation by environmental weeds diverts resources from native plants and animals (Kirkpatrick 1991). Non-native plant species spread through a range of vectors including animals, people, vehicles, birds and wind. Once environmental weeds become established, they have the capacity to displace native plant species, out-competing them for resources and can result in the local extinction of some or native species in that area.

The success of the environmental weed in the natural environment is influenced by a number of factors. These factors may include:

- The degree of disturbance of the natural environment,
- The environmental flexibility of the environmental weed,
- The presence of both male and female plants (where reproductively necessary),
- Climatic suitability,
- The pollination and seed dispersal mechanisms,
- The environmental weed's capacity to avoid predation,
- The fire tolerance levels of the weed (Kirkpatrick 1991).

All of the above-mentioned factors need to be considered when attempting to manage environmental weeds. There are several environmental weeds within the Sandy Bay Catchment area that require more vigorous management if they are to be eradicated from the area. These environmental weeds that are of primary concern for the lower catchment are outlined in the following sections.

6.2.1 Crack Willow

Crack Willow (*Salix fragilis*) along Tasmanian rivers and rivulets has established due to vegetative reproduction where pieces of the tree have broken off due to winds, floods, or falling over and have developed into mature trees (Parker & Bower 1996). As a result, the Crack Willow can be found colonising the banks of streams and rivers state wide and will require a long-term commitment if these species are to be removed from river and stream systems. Willows are generally considered undesirable along watercourses for the following reasons:

- Willows have the potential to modify the shape of river channels and the flow of water that may result in: stream-bank erosion, channel movement, and increased flooding. Willow trees growing in the middle of the Sandy Bay Rivulet have the potential to cause localised flooding during high rainfall events. All willow trees that have the potential to obstruct stream flow have been removed, in

accordance with the recommendations made in the Sandy Bay Rivulet Flood Study (HECEC 1999).

- Willows inhibit the growth of native vegetation due to vigorous growth and shading
- Willow invasion can lead to a monoculture of vegetation resulting in decreased biodiversity
- The deciduous nature of willows provides an altered seasonal food supply to rivers that is much higher than the litter received from native vegetation over summer
- The willows root system spreads extensively underground and in urban areas can cause complications with both stormwater and sewer pipes.
- Willow leaves break down quickly so provide a brief food supply to aquatic insects as opposed to Eucalypt leaves which takes much longer to break down (Green 1999).

Poor management of Crack Willow results in willows that reproduce vigorously at a speed that may quickly displace native vegetation. It is therefore necessary to implement effective management and follow-up procedures in order to restore the natural values of the riparian zone. Willows are beneficial in some circumstances where they enhance bank stability, control run-off and filter excess nutrients (Green 1999). Other benefits include the screening and privacy these large trees give to residents living in Sandy Bay Rivulet. It is therefore imperative that extensive consultation occurs with all residents who may be affected by the removal of a willow tree.

Plate 6.3 Crack Willow in Sandy Bay Rivulet

6.2.2 Blackberry

Blackberry (*Rubus fruticosus* sp agg.) is a common environmental weed throughout Tasmania and is often found in neglected or disturbed sites. Dispersal of this plant is exacerbated by birds and animals, but can also spread through stem tips that establish roots in the soil. The control methods for the Blackberry are suggested in the following text and are recommended by the Department of Primary Industries, Water & Environment (DPIWE 1996).

- Hand grubbing, slashing or bulldozing
- Grazing by cattle and goats
- A range of herbicides (approximately 50 products are registered)
- Biological control methods include a strain of Rust fungus that has been introduced from Europe and is currently being tested
- Burning in autumn when the weed dies back and follow-up treatment in spring to remove new growth.

Blackberries are present in many locations along the urbanised areas of Sandy Bay Rivulet. They are found in areas that are overgrown with other weed species and have poor access for maintenance. Routine maintenance and inspection of the rivulet ensures that weed species are kept under control and do not obstruct of block the water flow from the rivulet. While blackberries are invasive and opportunistic, its presence on the banks of the rivulet can often be an advantage. In many sections of Sandy Bay Rivulet, the blackberry is stabilising the bank and providing habitat for native birds such as the Superb Blue Wren (*Malurus cyaneus*). In this circumstance it is best to gradually replace sections the blackberry bush with native plant species until the bank is well stabilised and alternative habitat is provided. Once native species are established, it is then possible to remove the blackberry bush altogether without risk of mass stream bank failure and habitat displacement.

Plate 6.4 Blackberry infestation in lower Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

6.2.3 Other Weeds

There are additional environmental weeds present along the urbanised section of Sandy Bay Rivulet. These weeds also require effective management and control to allow for native species to germinate and thrive. Other weed species found in the area include:

English Ivy (*Hedera helix*)
Bridal Creeper (*Myrsiphyllum asparagoides*)
Wandering Jew (*Tradescantia albiflora*)
Blue Periwinkle (*Vinca major*)
Mirror Bush (*Coprosma repens*)
Cotoneaster (*Cotoneaster* spp.)

Plate 6.5 Exotic weed species thrive in the riparian zone of Sandy Bay Rivulet

Photo courtesy of J.Tuit 2001

It is recommended in this Management Plan that all of the environmental weeds indicated are removed systematically to minimise the extent of disturbance on the ecosystem in a short time period. This can be achieved with the involvement of the residents who live along the rivulet and who stand to benefit most from an integrated approach to weed management. Community groups can be established which focus on rivulet rehabilitation, or individual residents can be encouraged and involved in restoring and improving sections of the rivulet flowing adjacent to their property boundary.

6.3 Management Objectives and Action Plan

GOAL: To protect and conserve existing native vegetation within the catchment and to adopt sustainable approaches in its management

Objective	Actions	Action by
1. Educate the community on the importance of native vegetation and involve them in its conservation	1. Prepare and distribute educational material on strategies in which to minimise the spread of exotic plant species i.e. 'Garden Plants are Going Bush". 2. Encourage the development of a local Backyard Rivulet Care Group who focus on weed management and regeneration in backyard sections of the rivulet	Hobart City Council Sandy Bay Rivulet Project Officer
2. Encourage interest in the management of the rivulet among local residents	1. Hold workshop days on getting to know Sandy Bay Rivulet 2. Organise field days to collect and propagate native seeds for future planting 3. Involve residents in tree-planting and weed removal working bees along their own section of the rivulet	Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer Sandy Bay Rivulet Project Officer
3. Control and manage the number of exotic plant species that exist in the heavily urbanised section of the rivulet Refer to Project Data Sheet 4 in Appendix 4	1. Map the distribution of environmental weeds prior to removal as a future monitoring tool 2. Remove or eradicate exotic plant species by mechanical or chemical methods 3. Continue to monitor and remove exotic species that re-occur in the region 4. Inform members of the	Sandy Bay Rivulet Project Officer Hobart City Council Local residents Volunteer/Landcare Groups Hobart City Council Local residents Sandy Bay Rivulet Project Officer

	community of the factors that affect the success of an environmental weed 5. Discuss the adverse effect of backyard dumping of garden refuse into the rivulet	Sandy Bay Rivulet Project Officer
5. Control and manage the presence of Crack Willow in sections of the Sandy Bay Rivulet	1. Remove Willows selectively through appropriate methods outlined in the 'Willow Management Guidelines" and consultation with the community 2. Implement follow-up procedures to monitor and remove new growth on cut willows	Hobart City Council Sandy Bay Rivulet Project Officer Hobart City Council
6. Remove and manage Blackberry growth along Sandy Bay Rivulet	1. Assess the role the blackberries play in stream bank stabilisation and habitat prior to removal 2. Remove blackberries using mechanical methods and appropriate chemical means 3. Follow-up on blackberry management by removing new growth as it appears	Sandy Bay Rivulet Project Officer Hobart City Council Local residents/ Landcare Groups

Conclusion

The management objectives and actions that have been outlined in this management plan aim to achieve improved water quality and long-term sustainability for Sandy Bay Rivulet. This management plan for the Sandy Bay Rivulet catchment is based on the natural, cultural, educational and social values of the catchment and surrounding community. These values were ascertained through public consultation with local interest groups and the residents living within the catchment.

Implementation of the management plan will occur in stages and will involve extensive consultation with those residents who will be affected by on-ground works. To ensure the success of these management actions, it is necessary for members of the community to take on an active role in maintaining and preserving the work that is done in stages of the rivulet's rehabilitation. While Council has the capacity to achieve management objectives, it is vital that the community are included in all aspects of the catchment's natural restoration. Acknowledgment of community values in the planning and remediation stages instils a sense of ownership and responsibility for the natural environment among community members. There are currently many community members living within the catchment who are actively involved in managing their backyard and neighbouring sections of the rivulet in a sustainable manner.

Hobart City Council will be responsible for locating and controlling point sources of pollution within Sandy Bay Rivulet. There are continuing investigations into illegal stormwater discharges that are contributing to pollution within the rivulet. Measures will be taken to ensure that adequate stormwater treatment devices are installed or alternative methods are adopted to minimise stormwater pollution. It is envisaged that the majority of works remaining will involve riparian zone rehabilitation, water quality monitoring and weed removal from the banks of the rivulet. Much of this work will be achieved through normal rivulet maintenance and the in kind support provided by interested community members who become actively involved in the rivulets rehabilitation and sustainable management.

This management plan has been written for the Sandy Bay Rivulet catchment to the present time and provides management actions that will have significant impact on the environmental problems that currently exist. Over time, circumstances may change, and therefore priorities for management within the Sandy Bay Rivulet catchment may also change. Thus, this management plan should be referred to as a guide for action and will need to be modified as the need arises. It is essential, however, that communication between local council and community members is maintained to ensure sustainable outcomes in the management of this urban stream.

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Appendix 1 Plant Species Recorded in the Waterworks Reserve

Vascular Plant Species Recorded in the Waterworks Reserve	
Community	**Community**
DICOTYLEDONS	**DICOTYLEDONS**
APIACEAE	Pultanaea daphnoides var.
Hydrocotyle hirta	obocordata
ASTERACEAE	Pultanaea gunnii
Bedfordia salicina	Pultanaea juniperina
Brachyscome spathulata	Pultanaea pedunculata
Cassinia aculeata	GERANIACEAE
Craspedia glauca	Geranium potentilloides
Helichrysum scorpioides	GOODENIACEAE
Olearia argophylla	Goodenia lanata
Olearia stellulata	Goodenia ovata
Olearia viscosa	HALORAGACEAE
Ozothamnus obcordatus	Gonocarpus tetragynus
Ozothamnus purpurascens	Gonocarpus teucrioides
Senecio bisseratus	LAMIACEAE
Senecio glomeratus	Prostanthera lasianthos
Senecio linearifolius	LAURACEAE
Senecio minimus	Cassytha pubescens
Senecio quadridentatus	MALVACEAE
CAPRIFOLIACEAE	Asterotrichion discolor
Sambuxus gaudichaudiana	MIMOSACEAE
CAMPANULACEAE	Acacia dealbata
Wahlenbergia gracilis	Acacia gunnii
Wahlenbergia gymnoclada	Acacia melanoxylon
Wahlenbergia littoricola	Acacia terminalis
Wahlenbergia stricta	Acacia verniciflua
CARYOPHYLACEAE	Acacia verticillata var. vert.
Stellaria flaccida	MYRTACEAE
CASUARINACEAE	Eucalyptus amygdalina
Allocasuarina littoralis	Eucalyptus globulus ssp.
CRASSULACEAE	globulus
Crassula sieberana	Eucalyptus obliqua
DROSERACEAE	Eucalyptus tenuiramis
Drosera peltata ssp auriculata	Eucalyptus viminalis
EPACRIDACEAE	Leptospermum scoparium
Astroloma humifusum	OXALIDACEAE
Epacris impressa	Oxalis perennans
Leucopogon ericoides	PITTOSPORACEAE
Leucopogon virgatus	Billardiera longiflora
Lissanthe strigosa	Bursaria spinosa
Sprengelia incarnata	Pittosporum bicolor
Styphelia adscendens	Rhytidosporum procumbens
EUPHORBIACEAE	POLYGALACEAE
Amperea xiphoclada	Comesperma volubile
FABACEAE	PROTEACEAE
Aotus ericoides	Banksia marginata
Bossiaea prostrata	Lomatia tinctoria
Daviesia ulicifolia	Persoonia juniperina
Dillwynia sericea	RANUNCULACEAE

Indigofera australia Oxylobium ellipticum	Clematis aristata
Community	**Community**
DICOTYLEDONS	**MONOCOTYLEDONS**
RHAMNACEAE	CYPERACEAE
Pomaderris apetala	Carex breviculmis
Pomaderris eliptica	Gahnia radula
ROSACEAE	Isolepis cernua
Acaena novae-zelandiae	Isolepis inundata
RUBIACEAE	Lepidosperma elatius
Coprosma hirtella	Lepidosperma ensiforme
Coprosma quadrifida	Lepidosperma laterale
Opercularia varia	Schoenus apogon
RUTACEAE	IRIDACEAE
Zieria arborescens	Diplarrena moraea
SANTALACEAE	JUNCACEAE
Exocarpus cupressiformis	Juncus bufonis
Leptomeria drupacea	Juncus pallidus
SCROPHULARIACEAE	Juncus planifolius
Veronica calycina	Juncus flaccida
STACKHOUSIACEAE	LILIACEAE
Stackhousia monogyna	Dianella breviculmis
STYLIDIACEAE	Dianella revoluta
Stylidium gramnifolium	Dianella tasmanica
THYMELIACEAE	Drymophila cyanocarpa
Pimelea drupacea	ORCHIDACEAE
Pimelea humilis	Caladenia gracilis
Pimelea linifolia ssp.linifolia	Calochilus robertsonii
TREMANDRACEAE	Chiloglottis gunnii
Tetratheca labillardierei	Chiloglottis grammata
VIOLOACEAE	Chiloglottis triceratops
Viola hederacea	Glossodia major
	Microtis unifolia
	Pterostylis aff. longifolia- all forms
	Thelymitra rubra
	Thelymitra sp.
	POACEAE
	Danthonia setacea
	Danthonia tenuior
	Deyeuxia benthamiana
	Deyeuxia contracta
	Deyeuxia monticola
	Deyeuxia quadriseta
	Dichelachne rara
	Ehrhata distichophylla
	Ehrhata stipoides
	Poa labillardierei
	Poa rodwayi
	Poa sieberiana
	XANTHORRHOEACEAE
	Lomandra longifolia

Source: North, A., 1997.

Appendix 2 Fauna within the Sandy Bay Catchment

FAUNA WITHIN THE SANDY BAY CATCHMENT	
MAMMALS	
Common Name	**Species**
Echidna	***Tachyglossus aculeatus***
Eastern Quoll	***Dasyurus viverrinus***
Southern Brown Bandicoot	***Isoodon obesulus***
Eastern Barred Bandicoot	***Perameles gunnii***
Dusky Antechinus	***Antechinus stuartii***
Little Pygmy Possum	***Cercartetus lepidus***
Eastern Pygmy Possum	***Cercartetus nanus***
Common Ringtail Possum	***Pseudocheirus peregrinus***
Common Brushtail Possum	***Trichosurus vulpecula***
Long-nosed Potoroo	***Potorous tridactylus***
Tasmanian Bettong	***Bettongia gaimardi***
Red-bellied Pademelon	***Thylogale billardieri***
Bennets Wallaby	***Macropus rufogtiseis***
Swamp Rat	***Rattus lutreolus***
Tasmanian Long-eared Bat	***Nyctophilus sp (***sherrini form)
Lesser Long-eared Bat	***Nyctophilus geoffroyi***
Chocolate Wattled Bat	***Chalinolobus morio***
Goulds' Wattled Bat	***Chalinolobus gouldii***
Eastern Falsistrelle	***Falsistrellus tasmaniensis***
Little Forest Bat	***Vespadelus vulturnis***
Southern Forest Bat	***Vespadelus regulus***
Large Forest Bat	***Vespadelus darlingtoni***
Rabbit	***Oryctolagus cuniculus***
Cat	***Felis catus***

BIRDS	
Common Name	**Species**
Pacific Black Duck	***Anas superciliosa***
White-faced Heron	***Ardea novaehollandiae***
Brown Falcon	***Falco berigora***
Masked Lapwing	***Vanellus miles***
Pacific Gull	***Larus pacificus***
Kelp Gull	***Larus dominicus***
Common Bronzewing	***Phaps chalcoptera***
Brush Bronzewing	***Phaps elegans***
Green Rosella	***Platycercus caledonicus***
Swift Parrot	***Lathamus discolor***
Pallid Cuckoo	***Cuculus pallidus***
Fan-tailed Cuckoo	***Cuculus pyrrophanus***

Horsefields Bronze-Cuckoo	***Chrysococcyx basalis***
Shining Bronze-Cuckoo	***Chrysococcyx lucidus***
Masked Owl	***Tyto novaehollandiae***
Southern Boobook	***Ninox novaeseelandiae***
Tawny Frogmouth	***Podargus strigoides***
Australian Owlet-nightjar	***Aegotheles cristatus***
Superb Fairy Wren	***Malurus cyaneus***
Spotted Pardalote	***Pardalotus punctatus***
Striated Pardalote	***Pardalotus striatus***
Tasmanian Scrubwren	***Sericornis frontalis***
Brown Thornbill	***Acanthiza pusilla***
Tasmanian Thornbill	***Acanthiza ewingii***
Yellow Wattlebird	***Anthochaera paradoxa***
Yellow-throated Honeyeater	***Lichenostomus falvicollis***
Strong-billed Honeyeater	***Melithreptus validrostris***
Black-headed Honeyeater	***Melithreptus affinis***
Crescent Honeyeater	***Phylidonyris pyrrhoptera***
New Holland Honeyeater	***Phylidonyris novaehollandiae***
Eastern Spinebill	***Acanthorhynchus tenuirostris***
Scarlet Robin	***Petroica multicolor***
Flame Robin	***Petroica phoenica***
Pink Robin	***Petroica rodinogaster***
Dusky Robin	***Melanodrynas vittata***
Golden Whistler	***Pachycephala pectoralis***
Olive Whistler	***Pachycephala olivacea***
Grey Shrike-thrush	***Collurincla harmonica***
Satin Flycatcher	***Myiagra cyanoleuca***
Grey Fantail	***Rhipidura fuliginosa***
Balck-faced Cuckoo-shrike	***Coracina novaehollandiae***
Dusky Woodswallow	***Artamus cyanopterus***
Grey Butcherbird	***Cracticus torquatis***
Black Currawong	***Strepera fuliginosa***
Grey Currawong	***Strepera versicolor***
Forest Raven	***Corvus tasmanica***
Welcome Swallow	***Hirundo neoxena***
Tree Martin	***Cecropis nigricans***
Silvereye	***Zosterops lateralis***
Bassian Thrush	***Zoothera dauma***
Blackbird	***Turdus merula***

REPTILES AND AMPHIBIANS	
Common Name	**Species**
Mountain Dragon	Tympanocryptis diemensis
Three-lined Skink	Bassiana duperryi
She-oak Skink	Cyclodomorphus casuarinae
Delicate Skink	Lampropholis delicata
White's Skink	Egernia whitei
Tasmanian Tree Skink	Niveoscincus pretiosus
Metallic Skink	Niveoscincus metallicus
Ocellated Skink	Niveoscincus ocellatus
Southern Grass Skink	Pseudemoia entrecasteauxii
Blotched Blue-tongue	Tiliqua nigrolutea
Lowlands Copperhead	Austrelaps superbus
White-lipped Snake	Drysdalia coronoides
Tiger Snake	Notechis scutatis
Common Froglet	Crinia signifera
Brown Tree Frog	Litoria ewingii

Appendix 3 Community Survey

SANDY BAY RIVULET CATCHMENT COMMUNITY SURVEY

All completed surveys that are returned by August 10, 2001 will enter the draw for a chance to win a guided tour of the Wishing Well Waterway for 4 people. The draw will take place at the Hobart Council Centre on Monday August 13, 2001. If you wish to enter the draw, please provide your name and telephone number so that you can be contacted.

NAME:_____
ADDRESS:_____
PHONE NUMBER_____

Please indicate your answer by ticking the designated box ☐

1. Do you or any member of your family use/value the Sandy Bay Rivulet?

   Yes ☐
   No ☐

2. If yes, for what purpose do you most value the Sandy Bay Rivulet? Please order in preference from 1-5, with 1 representing the value of most importance.

   Aesthetics ☐
   Recreation/Play ☐
   Education ☐
   History/Culture ☐
   Flora and Fauna ☐

Other ☐_____

3. Please indicate the issues that concern you about the Sandy Bay Rivulet. Please order in preference from 1- 6.

Flooding ☐
Water quality ☐
Personal/Property safety ☐
Appearance ☐
Regular Maintenance ☐
Cultural Heritage ☐
All of the above ☐
Other
☐_____

_____

4. As a community member would you support the development of a 'Rivulet Care Group'?

Yes ☐
No ☐
Unsure ☐

5. If a 'Rivulet Care Group' was established, which of the following projects would you be interested in?

Managing your own backyard section of the rivulet ☐
Managing your own and neighbours' sections of the rivulet ☐
Writing Newsletters for the community ☐
Distributing newsletters within the community ☐
Becoming a 'Rivulet Watchdog' and notifying Council of sudden changes e.g. rubbish dumping, vandalism. ☐
Planting trees along the banks of the rivulet ☐

Removing invasive weeds from rivulet banks ☐
None of the above ☐
All of the above ☐
Other _____

6. Are you aware of the Waterworks Valley Landcare Group?

Yes ☐
No ☐
Current Member ☐

7. Would you like to receive more information about the Waterworks Valley Landcare Group?

Yes ☐
No ☐

8. In your opinion, what do you consider to be a major priority in terms of the maintenance of Sandy Bay Rivulet? Please order in preference from 1- 4.

Flood Control ☐
Improving Water Quality ☐
Effective Weed Control ☐
Routine Council Inspections ☐
Other ☐
_____

9. Would you be interested in learning more about the Sandy Bay Rivulet environment?

Yes ☐

No ☐
Unsure ☐

10. If yes, which of the following workshop types would you be interested in attending?

Guided tour of the Rivulet ☐
Water quality monitoring ☐
Catching and Identifying Water 'Critters' ☐
Looking after your rivulet backyard ☐
Tree planting along the rivulet ☐

11. Do you have any further suggestions that may lead to the improved management of Sandy Bay Rivulet?

Yes ☐
No ☐

12. If yes, please indicate how the current management of the rivulet can be improved.

_____

_____

_____

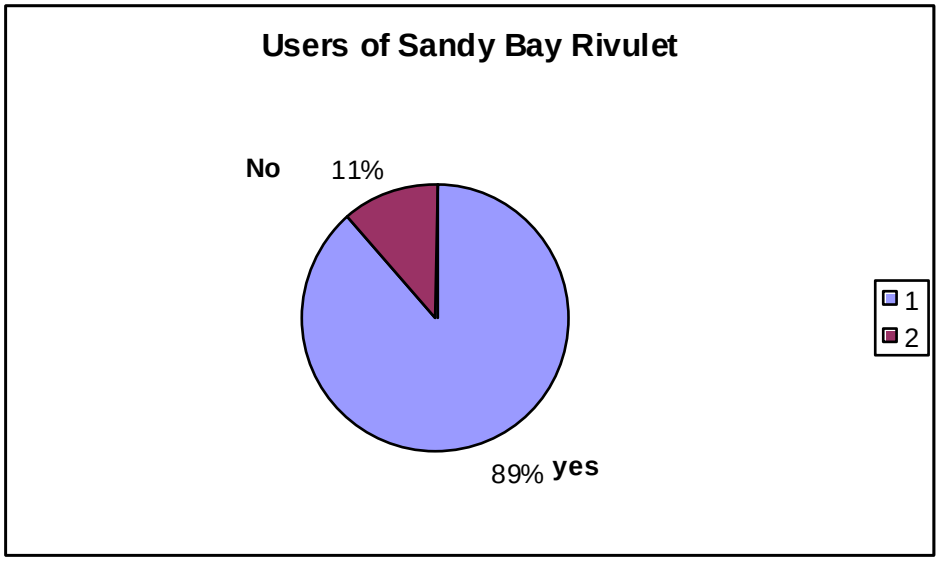
_____

_____

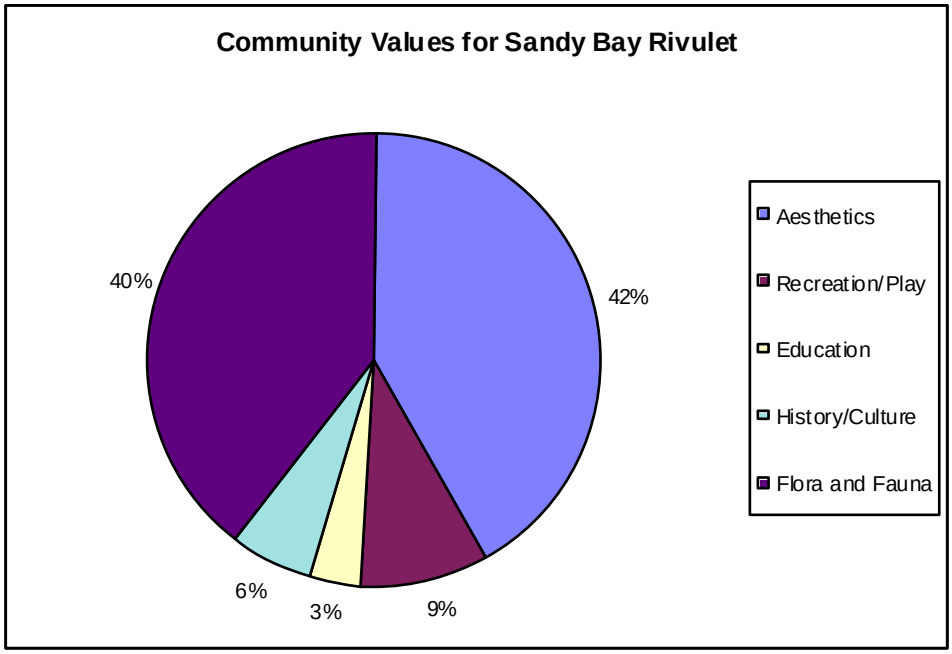
_____

For further enquiries please contact:
Kirsten Leggett
Sandy Bay Rivulet Catchment Planner
Hobart City Council
Phone: 62382106
Email: leggettk@mailnet.hcc.tas.gov.au

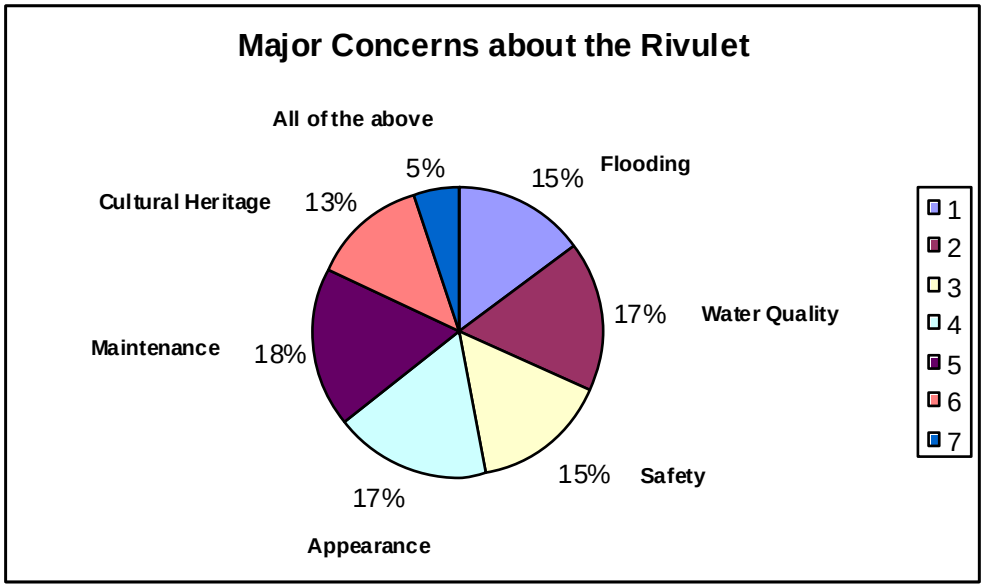
Question 1:
Do you or any member of your family use/value the Sandy Bay Rivulet?



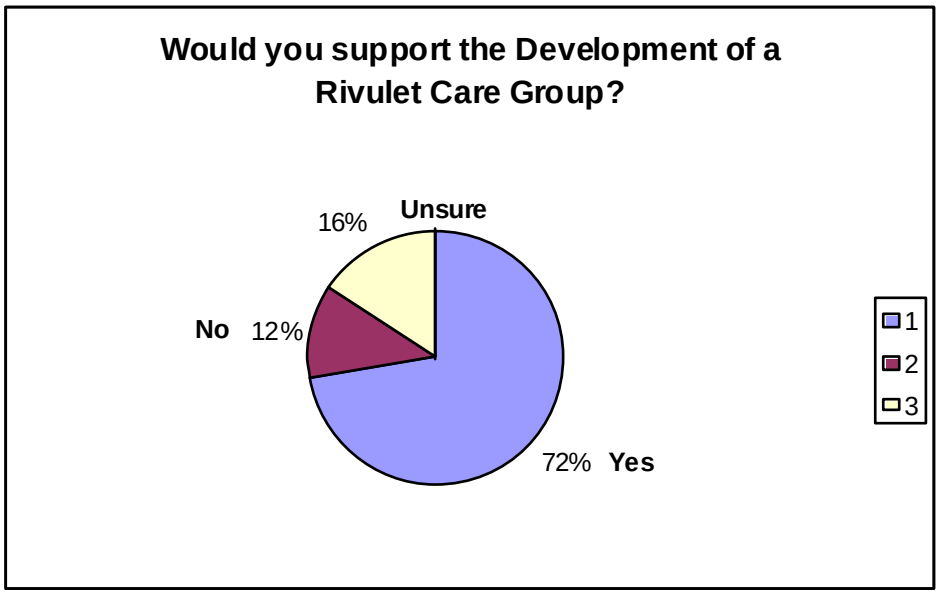
Question 2:
If yes, for what purpose do you most value the Sandy Bay Rivulet?



Question 3:
Please indicate the issues that concern you about the Sandy Bay Rivulet.

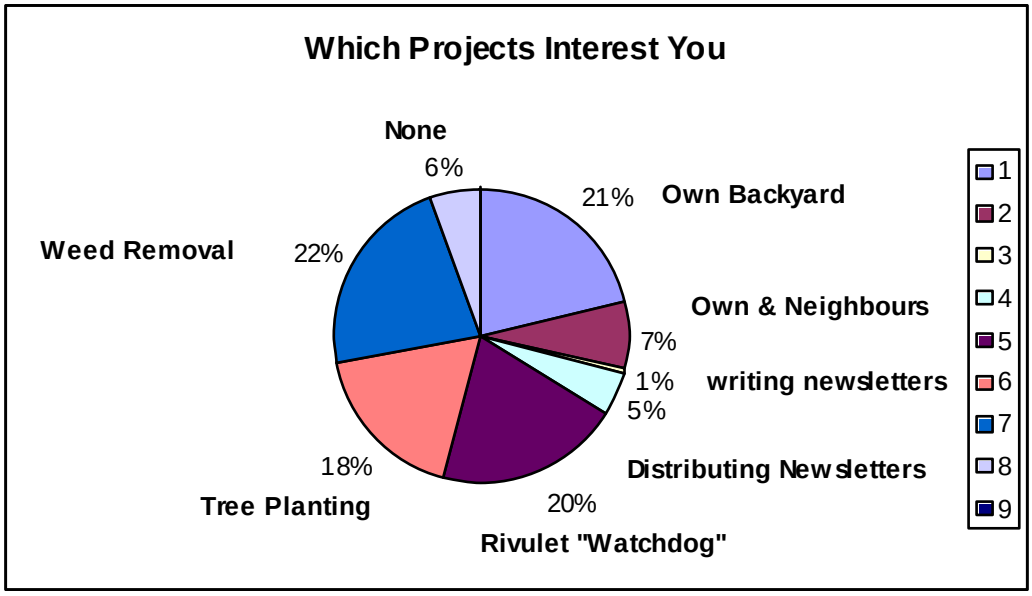


Question 4:
As a community member would you support the development of a 'Rivulet Care Group'?



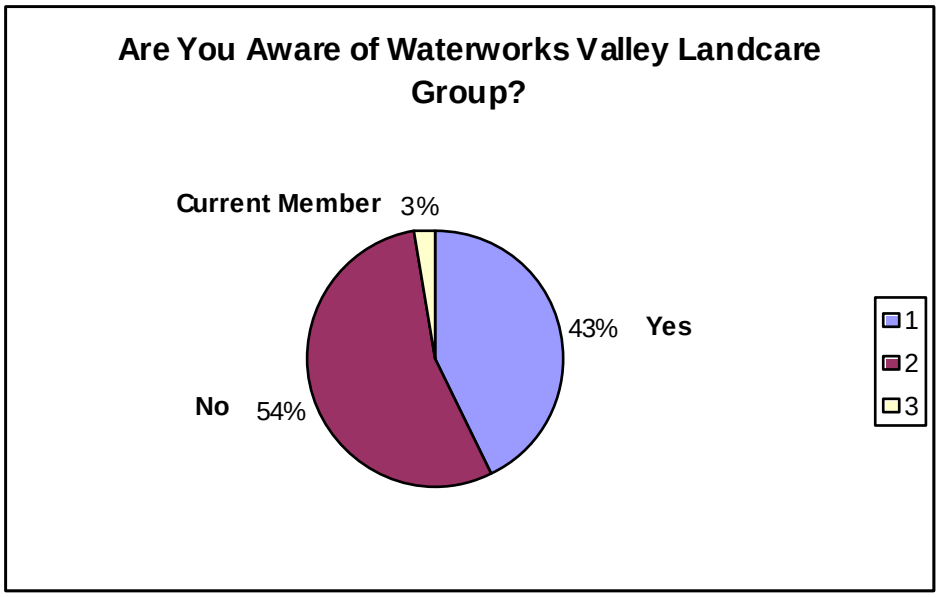
Question 5:

5. If a 'Rivulet Care Group' were established, which of the following projects would you be interested in?



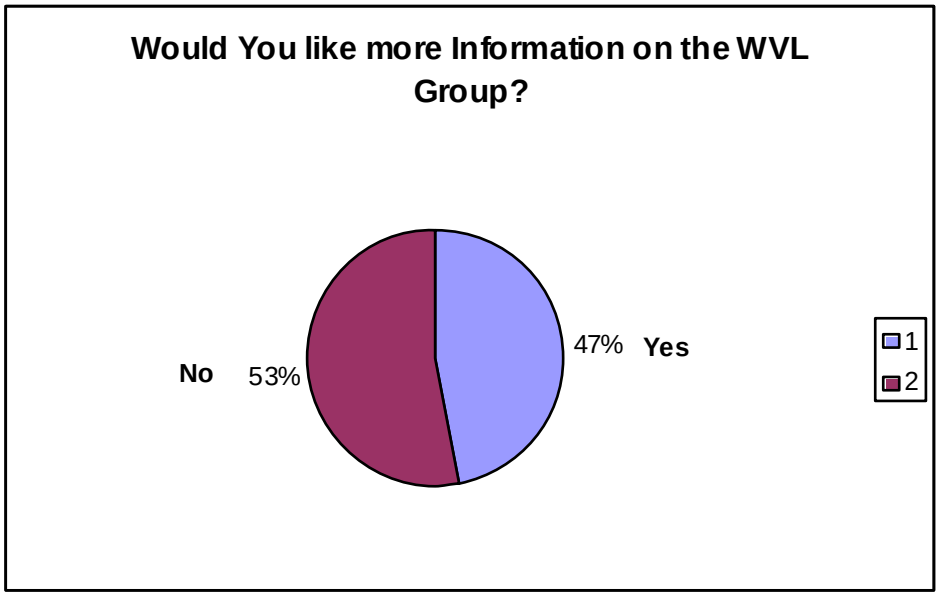
Question 6:

6. Are you aware of the Waterworks Valley Landcare Group?



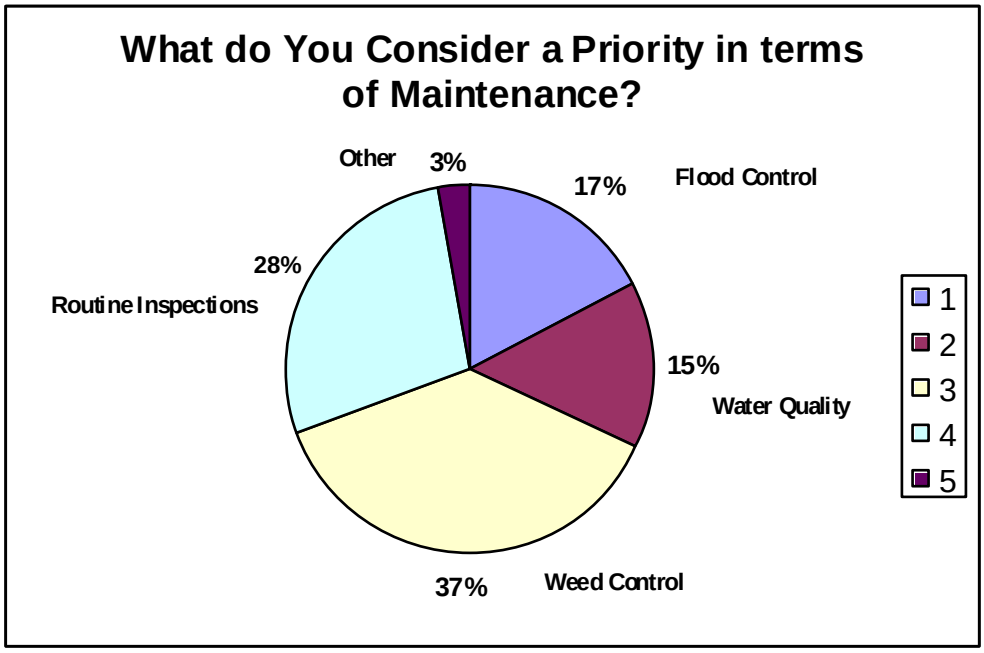
Question 7:

7. Would you like to receive more information about the Waterworks Valley Landcare Group?

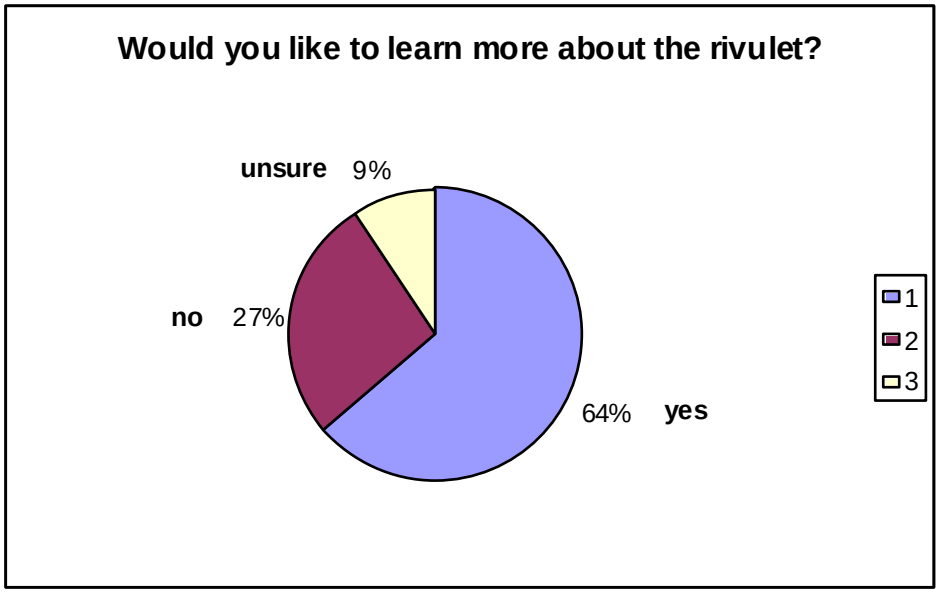


Question 8:

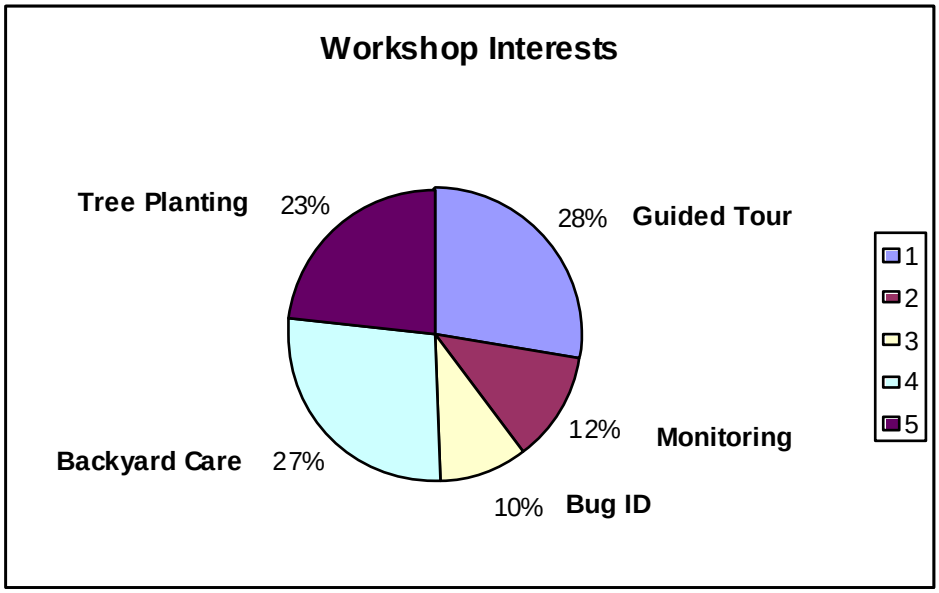
In your opinion, what do you consider to be a major priority in terms of the maintenance of Sandy Bay Rivulet?



Question 9:
Would you be interested in learning more about the Sandy Bay Rivulet environment?



Question 10:
If yes, which of the following workshop types would you be interested in attending?



Appendix 4 Project Data Sheets

PROJECT DATA SHEET 1

New Asset Project selection for 2002/2003 Budget

PROJECT TITLE **VALUE ENHANCEMENT AND PROTECTION OF SANDY BAY RIVULET**

PROJECT DETAILS

Description	To enhance and protect the existing natural values of the Sandy Bay Rivulet held by community members, working interest groups and schools in the rivulet area.
Background	A recent community survey conducted by Hobart City Council revealed that members of the community who use and live along the Sandy Bay Rivulet value the area in a number of ways. The highest value among residents was recorded for the aesthetics of the rivulet and natural value at 42%, followed by the value for recreation and play at 40%. From these results and further community consultation members of the community expressed interest in becoming further involved in the care and maintenance of their own backyard section of Sandy Bay Rivulet (21%).
Outcomes	To ensure the long-term sustainability of the Sandy Bay Rivulet, it is crucial to involve members of the immediate community in the rivulets long-term care and management. It is important to acknowledge the values held by the community and include those values in any long-term management planning. The involvement of community members in the rivulet's management can be organised on a large scale where volunteer groups are organised and implemented, or alternatively on a smaller scale where individuals can contribute to long-term management strategies by focusing rehabilitative efforts on their own backyard section of the rivulet. A "Backyard Rivulet Care Group" could be established for these people and guidance given on rehabilitative action by Council staff.
Organisational Impacts	Through the involvement of community members in the long-term management of Sandy Bay Rivulet, individuals have a better understanding of the natural values and adopt a stewardship ethic towards the rivulet environment. The community's assistance in backyard rivulet care provides the Council with an important asset for a transition towards a more sustainable future.
File	
First year listed	2002
Status	Awaiting approval

PROJECT RANKING	4
Justification	To work towards a more environmentally sustainable future

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget

$	[redacted]
Other funding	
Future funding	
External funding	
Possible staging	
Budget function	
Position in programme	

STRATEGIC PLAN

Key Area	Key Area 6 - Environmental Management
Strategy	To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues
Priority Action	To be decided by Project Manager

PROJECT DATA SHEET 2

New Asset Project selection for 2003/2004 Budget

PROJECT TITLE **LITTER REDUCTION AND CONTROL IN THE SANDY BAY RIVULET**

PROJECT DETAILS

Description	To reduce and control litter and associated pollutants entering the Sandy Bay Rivulet via the stormwater system.
Background	Recent investigations by Hobart City Council into stormwater pollution control devices has led to the installation and trial of new litter treatment devices in the Hobart CBD area. Results from these trials have provided Hobart City Council with the necessary information and supporting evidence to recommend the installation of these devices in other problem areas within Hobart. Sandy Bay Rivulet is subject to high litter loads and pollutants due to the urban nature of the lower catchment and close proximity to the city area. Previous attempts to capture litter and sediment in Sandy Bay Rivulet have proved unsuccessful and is therefore a suitable location to trial products already known to effectively control and reduce litter pollution. Refer to attachments on available devices.
Outcomes	A reduction in litter pollution and contaminants entering Sandy Bay Rivulet ensures a healthier stream environment for aquatic stream fauna and marine life in the Derwent Estuary. The presence of litter treatment devices and accompanying signs will alert members of the public to stormwater issues and ways in which we can all help to minimise stormwater pollution.
Organisational Impacts	Through the installation of litter treatment devices, the concentration of pollutants entering the Sandy Bay Rivulet will be dramatically reduced resulting in a cleaner and healthier urban waterway. Council's involvement in the installation and promotion of these products will assist in the transition towards a more sustainable future.
File	
First year listed	2003
Status	Awaiting aproval

PROJECT RANKING	2
Justification	Is consistent with Hobart City Council's Strategic Plan 2001-2005

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
	[redacted]		
Other funding			
Future funding			
External funding			
Possible staging			

Budget function	Hydraulic Infrastructure
Position in programme	Awaiting to commence

STRATEGIC PLAN

Key Area	Key Area 2 – City Infrastructure Management Key Area 6 – Environmental Management
Strategy	Key Area 2 – To provide and maintain a high standard of infrastructure for the community including water supply, sewerage, stormwater drainage, roadways, parks, public spaces and recreational and sporting facilities. Key Area 6 - To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues.
Priority Action	To be confirmed by Project Manager

Project Data Sheet 2 (a): ECOSOL FILTER

Ecosol Litter Trap: Suitable for small catchment areas with low leaf litter

Project Data Sheet attachment (b):

FLOATING BOOMS

Examples of Floating Booms to be used in lower Sandy Bay Rivulet

Project Data Sheet attachment (C):

ENVIROPOD LITTER TRAP DEVICE

Enviropod basket frame during installation

Enviropod installed and capturing litter

PROJECT DATA SHEET 3

New Asset Project selection for 2002/2003 Budget

PROJECT TITLE **DEVELOP AND MAINTAIN A REGULAR WATER QUALITY MONITORING PROGRAM FOR THE SANDY BAY RIVULET**

PROJECT DETAILS

Description	Establish a strategic water quality monitoring program with local schools, residents, Waterwatch and Landcare groups in the Sandy Bay Rivulet area. Information obtained through monitoring will be included in a database that is accessible to the public.
Background	Recent investigations into Sandy Bay Rivulet reveal that there are a number of continuous and spontaneous monitoring events that take place in the rivulet by various groups. The data obtained from such monitoring events is usually used for individual purposes and is not generally made available for public use.
Outcomes	The collation of water quality monitoring data from various groups or individuals will allow for the development of a water quality monitoring database specific to Sandy Bay Rivulet. This information will be made available for public use, including schools, university, Waterwatch, Landcare groups and Hobart City Council. As a result the interested community will be better informed about water quality issues and will have an overview of the water quality status of the rivulet throughout the catchment area. Individuals and groups who become involved in the monitoring process will develop a better understanding about water quality issues, the associated causes of poor water quality and ways in which the community can respond in order to improve water quality.
Organisational Impacts	A water quality monitoring program will need to be developed and can be a program that can be applied to other rivulets and watercourses throughout Hobart. The initial development of the program will require the assistance of existing water quality monitoring groups to ensure that sampling methods and locations are standardised.
File	
First year listed	2002
Status	Awaiting approval

PROJECT RANKING	4
Justification	To improve and maintain water quality in the Sandy Bay Rivulet and inform members of the public about ways in which we can all contribute to improved water quality.

RANKING CRITERIA

1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
	[redacted]		
Other funding			
Future funding			
External funding			

Possible staging	1st year 2002-2003 for initial establishment of monitoring program, then ongoing
Budget function	Hydraulic Engineering
Position in programme	1st year – awaiting initial set up and available resources

STRATEGIC PLAN

Key Area	Key Area 6 – Environmental Management
Strategy	Key Area 6 - To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues.
Priority Action	To be confirmed by Project Manger

PROJECT DATA SHEET 4

New Asset Project selection for 2004/2005 Budget

PROJECT TITLE **TO CONTROL AND MANAGE NON-NATIVE VEGETATION IN NATURAL AREAS OF THE SANDY BAY RIVULET CATCHMENT**

PROJECT DETAILS

Description	To control and manage non-native species within the Sandy Bay Rivulet Catchment to prevent the spread of exotic garden species into natural areas through a weed management strategy.
Background	Numerous weed species exist in the catchment area as a result of seed dispersion via animals, wind and disturbance. These weed species thrive and tend to displace native plant communities. As a result, native bird species are seen to disappear from areas where non-native species dominate, thus changing the dynamics of the ecosystem. Sandy Bay Rivulet residents value the rivulet and surrounds for its native flora and fauna and have expressed concerns over the disappearance of numerous plant and animal species from the area. The dumping of garden refuse on the banks of the rivulet is problematic in many locations along the length of the rivulet, and is often the catalyst for excessive weed growth in otherwise natural areas.
Outcomes	The development of a weed management strategy for Sandy Bay Rivulet will promote awareness among members of the community about garden escapees and their impact on the natural environment. With an increased awareness and active participation in rehabilitation the community will see the return of native plant and animal species to the area resulting in a more ecologically balanced environment. The weed management strategy will address important issues such as backyard dumping of garden refuse and effective weed control techniques. The Strategy will be made available for the general community and will include a weed map of the rivulet area highlighting weed affected zones and the priorities for management.
Organisational Impacts	A weed survey will be conducted in the first stages of the project from which a map is generated outlining the distribution of weed species in the rivulet catchment area. Once the map is finalised a strategy will be developed to control and manage problem areas. Extensive community consultation will be required in order to ascertain any existing management plans that may exist for vegetation within the catchmnet. The community will play an important role in the development of the strategy.
File	
First year listed	2004
Status	Awaiting approval

PROJECT RANKING	4
Justification	To increase biodiversity along the banks of the rivulet and to effectively control and manage weed species within the catchment to prevent the displacement of native plant communities.

RANKING CRITERIA
1. Contractually committed, or required through legislation to be carried out immediately.
2. There are immediate public health, safety, or legal liability risks. There has been physical commencement of the works, or there is a formal resolution from Council for the project to proceed.
3. There are possible public liability, public health, or legal implications or adverse effects on the operation of the organisation.
4. There is a significant community benefit, or efficiency gain.
5. Initiatives worthy of consideration.

FINANCIAL DETAILS

Carry Forward (new asset funds)	New Funding (new asset funds)	Project Total (new asset funds)	Estimated Impact on Operating Budget
Other funding			
Future funding			
External funding			
Possible staging	1st year – The development of a weed distribution map for the rivulet catchment area and Weed Management Strategy ongoing consultation and monitoring with community groups		
Budget function	Hydraulic Engineering and Parks & Landscape		
Position in programme	Not yet commenced		

STRATEGIC PLAN

Key Area	Key Area 5 – Land Use Planning and Development Key Area 6 – Environmental Management
Strategy	Key Area 5 - To develop and implement a sustainable development model that promotes a balance between investment, development and the use of land through integrated urban planning, resource management and recognition of the economic, environmental and social values of the city. Natural Resource Management Key Area 6 - To establish and develop linkages and partnerships with other levels of government, business and community to ensure a community-wide response to environmental management issues.
Priority Action	To be confirmed by Project Manager