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For more information the health of the Yarra or Maribyrnong rivers contact Melbourne Water as the caretaker of river health (131 722)

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Strengthening the Management of the Yarra and Maribyrnong Rivers:

A Background Report for Future Water Quality Management

Report prepared by the
Yarra and Maribyrnong Rivers Steering Committee

December 2005

Contents

Abbreviations

CCI	Coastal Catchments Initiative
CMA	catchment management authority (in this report referring to the Port Phillip and Westernport CMA)
CRC	Cooperative Research Centre
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EPA	Environment Protection Authority, Victoria
ESC	Essential Services Commission
EWR	Environmental Water Reserve
IRC	Index of River Condition
ISC	Index of Stream Condition
LG	local government
MAV	Municipal Association of Victoria
MW	Melbourne Water
OCGC	Office of Commonwealth Games Coordination
PCBs	polychlorinated biphenyls
PIC	Plumbing Industry Commission
PV	Parks Victoria
RCS	regional catchment strategy
SEPP	State environment protection policy
SIAV	Stormwater Industry Association of Victoria
VLAA	Victorian Litter Action Alliance
VRHS	Victorian River Health Strategy
WHO	World Health Organisation
WoV	Waters of Victoria (used in conjunction with SEPP)
WQIP	water quality improvement plan
WSUD	water sensitive urban design

Executive summary

The Yarra and Maribyrnong rivers have played a key role in the way Melbourne has developed and grown. They support industry and tourism, and are highly valued by the people who live and work around them.

Our attitudes and expectations for these rivers have changed significantly over the years. The rivers are no longer the dumping ground for industrial and domestic waste that they once were and subsequently water quality is vastly better.

This report was prepared by a Steering Committee of relevant agencies convened by the State Government in February 2005:

- to consolidate and review existing information and programs for addressing water quality issues that affect recreational use and environmental health in both the Yarra and Maribyrnong rivers, and subsequently
- to make recommendations to Government about necessary actions and the resources necessary to strengthen management of both the rivers.

The health of rivers and creeks in the Yarra and Maribyrnong catchments varies reflecting major land use patterns. While the upper reaches of the forested Yarra River are in good condition, water quality progressively declines downstream due to the effects of agricultural and urban run off. Water quality in the Maribyrnong River is also moderate in the upper to middle rural reaches and deteriorates progressively downstream.

Major storms, as seen in the record rains in Melbourne in February 2005, can have significant short-term impact on river health. This is not a phenomenon unique to Melbourne and bacterial water quality in the Yarra River compares favourably with many urban rivers overseas.

Water quality in the Yarra and Maribyrnong improved significantly in the 1970s and 1980s, and compares favourably with many urban rivers overseas, mainly because of massive investment in infrastructure projects, such as diversion of industrial waste away from stormwater drains and into sewerage systems and large scale sewering of Melbourne's suburbs. The overall trend is positive due to a significant effort and investment by the Victorian Government, local government and the community.

Over the past five years the Government has spent around $140 million on Yarra projects to protect the health of the Yarra. They include:

- $36 million invested by Melbourne Water on works in the Yarra catchment to improve waterway and stormwater quality, maintenance and grants to volunteers and property owners with river frontage.
- $1 million invested by Melbourne Water to clean up and undertake repair work on the Yarra after the February 2005 floods.
- More than $100 million invested by Melbourne Water and Yarra Valley Water to maintain and upgrade the sewerage system, including connecting properties using septics to the reticulated sewerage system and increasing the capacity of the system to reduce sewage spills. While the actual volume of sewage spilt depends on both the intensity and frequency of rainfall, from 1992/93 to 2004/05 the total number of wet weather spills in the Yarra Catchment reduced from 950 to 144.
- $1.75 million invested by Parks Victoria on Yarra water quality programs, including litter traps.
- $3.6 million invested by EPA Victoria on a number of Yarra improvement projects including new stormwater management designs and improving the control of diffuse sources of pollutants entering the Yarra River.
- $500,000 invested by the Department of Sustainability and Environment (DSE) on planning and engagement, to better coordinate government and the community's efforts to improve water quality in the Yarra River.

- $200,000 for some councils in the Yarra catchment to develop domestic wastewater management plans to identify priority areas for the replacement of septic tanks with reticulated sewerage.

In addition, local government has spent in the order of $3.5 million implementing priority actions in local government stormwater management plans.

The majority of water quality improvements over the last twenty years appear to have been gained in the first decade to a large extent due to mass sewering and management of point source discharges. Throughout the past ten years the ongoing program of improvement works, including those detailed above, has managed to maintain water quality levels, during a period of expansive urban development and population growth, and intensification of agriculture. This is a major achievement.

Managing water quality, then, remains a major challenge for Melbourne, as continued urban growth and intensification of agriculture increase the risk of further deterioration of water quality. The key risks of this are acknowledged by Government and are identified as:

- Increasing contaminant loads, particularly carried by stormwater and rural run-off, impacting on river health.
- Faecal contamination in rivers and creeks, particularly in the lower Yarra.
- Increasing litter impacting on user satisfaction and position of the Yarra as a focus for tourism.
- Localised risks to river health and recreational risk from poorly maintained septics tanks in rural areas.

As this report indicates, there are already a significant number of programs in place to mitigate these risks including local government stormwater management plans, sewerage system upgrades, agricultural best practice programs and sewerage backlog programs. These are resulting in long-term sustainable improvements or at best, in some cases, 'holding the line' in the face of population growth and increased urbanisation.

Despite the success of existing programs, there is still a need for more to be done. The priority recommendations identified by the Steering Committee include:

- Develop a Regional Water Quality Improvement Plan to determine priority areas for action and to guide regional investment in the management of water quality in the region's rivers and creeks, Port Phillip Bay and Westernport Bay.
- Accelerate the implementation of stormwater management plans and other high priority stormwater management actions, including capacity building for local government and industry.
- Improve the management of septic tanks, including implementation of recommendations from domestic wastewater management plans.
- Accelerate Yarra Valley Water's Backlog Sewerage program.
- Initiate the construction of the Northern Sewerage Project.
- Accelerate the adoption and implementation of agricultural best management practice programs.
- Improve understanding of faecal sources of contamination through targeted investigations.
- Provide additional resources for litter control projects.
- Strengthen community education and involvement activities in the management of the rivers.
- Improve reporting and communication of water quality information to the public.
- Improve formal coordination of agency responsibilities for water quality management including the establishment of a Coordinating Committee for the Yarra River.

This report recognises that improving water quality in the Yarra and Maribyrnong catchments requires commitment to long-term support and cooperation between stakeholders and the community. Water quality problems cannot be resolved with quick fixes or in an ad hoc manner. Much of this work is already underway and the foundations laid. The challenge now is to complete the job that has been started.

Chapter 1: Introduction

The Port Phillip and Western Port region will have people working to achieve productive land, habitat for native plants and animals and clean water in catchments, rivers and bays, making it a healthy, attractive and prosperous place to live, work and visit.

Port Phillip and Westernport Regional Catchment Strategy 2004-2009

The Melbourne community considers the Yarra and Maribyrnong rivers to be valuable environmental and recreational assets. The rivers support a number of industries and services that greatly benefit our community and the economy, including the provision of drinking water and water for agriculture including aquaculture, irrigation and for stock and domestic purposes. Both rivers support a wide range of water and land-based recreation activities in highly valued parks such as Brimbank and Yarra Bend. The city section of the Yarra is becoming a prime focal point for tourism in Melbourne.

The economic, social and environmental services provided by rivers and creeks are closely linked to water quality. Water quality in the Yarra and Maribyrnong is much better today than it was in the 1970s and has remained relatively stable over the last ten years despite increased pressure from continued urbanisation and population growth. The rivers compare well with many urbanised rivers elsewhere around the world. However, more can be done to improve water quality in the rivers.

In June 2004, the State Government launched Victoria's comprehensive *Our Water Our Future* action plan to ensure sustainable management of Victoria's water resources and the *Melbourne 2030* planning framework (released in October 2002) to manage sustainable growth in and around Melbourne.

In February 2005, the State Government convened a Steering Committee of relevant agencies to review existing water quality information and programs about the Yarra and Maribyrnong and make recommendations to Government to strengthen management of both the rivers and assess the resources necessary to address water quality issues.

Agencies participating in the Steering Committee include those with responsibilities for catchment and water quality management or those that influence water quality:

- Department of Sustainability and Environment (DSE)
- Department of Primary Industries (DPI)
- Melbourne Water (MW)
- Parks Victoria (PV)
- Environment Protection Authority, Victoria (EPA)
- Port Phillip and Westernport Catchment Management Authority (CMA)
- Department of Human Services (DHS)
- Yarra Valley Water (representing retail water authorities) (YVW)
- Municipal Association of Victoria (representing local government) (MAV).

Scope of the project

This report consolidates existing data and strategies for addressing water quality issues that affect recreational and environmental health in both the Yarra and Maribyrnong rivers. While the focus is on the two rivers, water quality inputs via their tributaries have also been considered.

The report clarifies governance arrangements and, where necessary, identifies coordination and actions across agencies and organisations in relation to water quality policy, works, monitoring and community engagement. The report:

- Provides a snapshot of current condition of the Yarra and Maribyrnong.

- Outlines strategies currently in place to improve water quality in the Yarra and Maribyrnong rivers.
- Clarifies government objectives and measurable targets for the rivers.
- Recommends a more targeted approach to water quality management, including a number of new or expanded programs, to tackle specific water quality problems in the two rivers.
- Recommends strengthened arrangements for governance and management of the rivers and arrangements for stakeholder and community engagement.

Policy context

There is a strong policy framework supporting the integrated management of water quality within the Yarra and Maribyrnong rivers at the national, State and regional level.

The *National Water Quality Management Strategy* is implemented in Victoria through the *Victorian River Health Strategy* (VRHS) (Government of Victoria 2002) and the *State environment protection policy* (SEPP) *(Waters of Victoria*) (WoV). The VRHS and the SEPP (WoV) are based on the principles of ecologically sustainable development and integrated catchment management.

The *Victorian River Health Strategy* provides a statewide policy framework for managing the health of Victoria's rivers.

State environment protection policies are the statewide policy instrument for the protection of beneficial uses of water environments in Victoria. Beneficial uses are defined as the uses and values of the water environment that the community and Government want to protect.

The two State environment protection policies of relevance to the Yarra and Maribyrnong are *State environment protection policy (Waters of Victoria) - Schedule F7 Waters of the Yarra Catchment* and the *State environment protection policy (Waters of Victoria)*. These provide objectives required to protect beneficial uses of the rivers.

Furthermore, the *State environment protection policy (Waters of Victoria) - Schedule F6 Waters of Port Phillip Bay* provides nitrogen reduction objectives for the waterways entering the Bay. These objectives are specified in the *Port Phillip Bay Environmental Management Plan*. Associated annual Bay Action Reports outline progress to meet these objectives.

In June 2004, the Victorian Government released its *Our Water Our Future* action plan with a range of initiatives designed to ensure sustainable management of Victoria's water resources.

At a regional level, the *Port Phillip and Westernport Regional Catchment Strategy* (RCS) is accredited by the State and Australian Governments and sets natural resource objectives, targets and programs and identifies priorities for investment across land and water within the region. The draft *Regional River Health Strategy* is an umbrella strategy under the RCS that details all river health objectives, targets and programs in the region.

Planning issues are considered in *Melbourne 2030,* which provides the policy context for managing the future growth of Melbourne. *Melbourne 2030* makes a specific commitment to enhance the metropolitan open space network and ensure major open space corridors are protected and enhanced.

Parks Victoria's *Linking People and Spaces* (2002) complements *Melbourne 2030* and provides direction for the growth and improvement of Melbourne's open space network. It focuses on meeting the recreational needs of Melburnians and supports other plans that focus on aspects such as native vegetation, water quality and tourism. The Yarra and Maribyrnong rivers, together with the Port Phillip Bay coastline, are among the most important elements in this open space network.

The Yarra is increasingly becoming a focus for tourism and is being adopted as the image of Melbourne. The *Tourism Plan for Melbourne's Waterfront* (2004) presents the following vision:

> *Melbourne's waterfront will be Melbourne's focal meeting place and prime leisure precinct, offering internationally renowned high quality experiences in a vibrant and appealing environment.*

Similarly, Parks Victoria's *Lower Yarra River Future Directions Plan* (2001) and the Government's *Yarra Development Plan: Towards a Vision for the Heart of Melbourne* (2002)

reinforce the prime importance of the Yarra from the perspective of recreational use, urban design and major projects.

Community expectations

As well as government policy, management of the rivers is driven by community expectation. Community standards and expectations have changed substantially in recent years, and this has been reflected in more community involvement in caring for rivers and creeks.

At a planning level, the extensive community consultation in the development of key strategies and plans, including the *Regional Catchment Strategy* and *Regional River Health Strategy*, has captured community expectations for the Yarra and Maribyrnong.

Melbourne Water has also undertaken research over the past 10 years to seek community views on rivers and creeks. Since the first surveys, the community's expectations have increased, particularly with regard to environmental condition. Surveys on the Yarra River, undertaken in 2002, indicated that most people (82% for the upper Yarra and 72% for the lower Yarra) were satisfied with the condition of the river. Half the people surveyed thought the condition of the river was improving (46%). Rubbish and dirty water are the key issues reported to influence dissatisfaction within the lower Yarra River.

The growth of Melbourne means that increasing numbers of people are living and working in both catchments. The challenge will be to continue making improvements to the water quality of Melbourne's two 'icon' rivers and to meet increasing community expectations.

Chapter 2: The Yarra and Maribyrnong rivers: current condition

Our reliance on Victoria's rivers and aquifers has taken its toll. Today, one third of Victoria's major streams and two thirds of wetlands are in poor or very poor condition.

Our Water Our Future, June 2004

The Yarra catchment

The Yarra catchment lies to the north and east of Melbourne. The catchment covers an area of approximately 4000 square kilometres. Average annual rainfall in the catchment ranges from 615 mm at Burnley, near Melbourne, to 1080 mm at Upper Yarra Reservoir near Warburton.

The Yarra River begins in the forested Yarra Ranges National Park on the southern slopes of the Great Dividing Range and flows generally westwards to Port Phillip Bay. Numerous waterways join the Yarra River from both the north and south – the Little Yarra River, Woori Yallock Creek, Diamond Creek, Plenty River, Mullum Mullum Creek, Merri Creek, Darebin Creek, Gardiners Creek, Merri Creek and Moonee Ponds Creek.

The upper reaches of the Yarra River and its major tributaries flow through forested, mountainous areas, which have been reserved for water supply purposes for more than 100 years.

Figure 1. Port Phillip and Westernport region showing the location of the Yarra and Maribyrnong catchments

The middle and lower sections of the Yarra River and many of its tributaries cross wide floodplains that are dispersed with gorges. While much of the land along the middle and lower rivers and creeks has been cleared for agriculture or urban development, significant areas have been created as parkland and open space for community use.

Today, approximately 21% of the catchment retains its natural vegetation, 57% is agricultural and 22% is urbanised. Key agricultural industries include viticulture, nurseries, orchards, market gardens and broad-acre grazing. Forestry occurs in upper parts of the catchment and tourism is an important industry. Urban growth on Melbourne's fringe is being confined to the Whittlesea and part of the Hume growth areas.

The Maribyrnong catchment

The Maribyrnong catchment lies north-west of Melbourne and covers an area of approximately 1430 square kilometres. Average annual rainfall varies from 843 mm at Macedon to 553 mm in the lower Maribyrnong.

The Maribyrnong River, the major waterway in the catchment, has two main branches: Deep Creek and Jacksons Creek – both of which are wholly outside the Urban Growth Boundary. Deep Creek, the larger of the two, originates west of Lancefield. Jacksons Creek originates near Macedon. All rivers and creeks tend to be deeply incised, exhibit a high variability in flow and are subject to extended periods of low flow.

The landscape of the catchment ranges from foothills around Romsey to the plains of the middle catchment through which Jacksons and Deep creeks cut great gorges. Around 8% of the catchment retains its natural vegetation, 81% is agricultural and 11% is urbanised.

The dominant agriculture in the catchment is broad-acre cropping and grazing. Market gardens also exist in the lower catchment on the floodplains around Keilor and Sunbury. A small forestry industry (both hardwood and plantation) occurs in the upper reaches of the catchment.

The lower catchment is dominated by urban development associated with Melbourne's western suburbs. Urban growth continues to encroach on rural land both within the western part of the Hume growth area on the metropolitan fringe and in a number of major rural townships such as Macedon, Sunbury, Gisborne and Romsey.

Past water quality management in the Yarra and Maribyrnong rivers

Several key milestones have resulted in significant protection or improvements in water quality in Melbourne's rivers and creeks. Early planners showed considerable foresight in closing the upper reaches of the Yarra River and its major tributaries as water catchments for town water supply, and for dedicating large tracts of land for parks, as these have made a positive long-term contribution to water quality.

In the 1890s, Melbourne residents were gradually connected to the sewerage system, and dramatic improvement in river water quality resulted.

Since the early 1970s, with the introduction of the *Environment Protection Act 1970* and establishment of Australia's first Environment Protection Authority, industrial discharges to rivers and creeks have been significantly reduced. The 1970s also saw the establishment of the Yarra Valley Metropolitan Park (now Yarra Valley Parklands), extending from Burke Road to Warrandyte and the Maribyrnong Valley Metropolitan Park (now Maribyrnong Valley Parklands) in Keilor, thereby preventing urbanisation of an extensive floodplain and riparian zone.

In the 1980s, minor wastewater treatment plants were constructed replacing many septic systems. Later, some of these plants that were discharging to waterways were closed and wastes diverted to major plants such as the Eastern and Western treatment plants. Today, only seven wastewater treatment plants discharge treated water into creeks and rivers that ultimately flow into the Yarra River.

Since the late 1990s, there has been an increased focus on the impacts of stormwater in urban areas and nutrient management in rural areas, and the effects of water quality from these catchments on Port Phillip Bay. By 2003, all municipalities in the Melbourne metropolitan area had completed stormwater management plans. New urban developments and major roads are being designed and constructed to minimise the adverse impacts of stormwater run-off on waterways. New approaches to stormwater management use a range of measures to intercept and treat water.

In rural areas, awareness of the need for more environmentally sustainable practices, growing urban fringe pressures and market requirements have led many primary industry groups to identify environmental issues and employ appropriate best management practices.

For example, the Yarra Valley Wine Growers Association has taken significant steps towards the development of an Environmental Management Systems approach to farm management practices.

Over the past five years the Government has spent around $140 million on Yarra projects to protect the health of the Yarra. They include:

- $36 million invested by Melbourne Water on works in the Yarra catchment to improve waterway and stormwater quality, maintenance and grants to volunteers and property owners with river frontage.
- $1 million invested by Melbourne Water to clean up and undertake repair work on the Yarra after the February 2005 floods.
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- $200,000 for some councils in the Yarra catchment to develop domestic wastewater management plans to identify priority areas for the replacement of septic tanks with reticulated sewerage.

In addition, local government has spent in the order of $3.5 million implementing priority actions in local government stormwater management plans.

Current condition of the Yarra and Maribyrnong rivers

The Index of Stream Condition (ISC) is an integrated measure of the environmental condition of rivers. The overall ISC rating combines information on five aspects of river health – flow, water quality, physical form, streamside zone and aquatic life. Melbourne Water has modified the ISC and developed an Index of River Condition (IRC) which takes into account urban rivers and creeks (which the statewide methodology does not).

Melbourne Water's 2002-03 IRC data show that in the Yarra catchment 37% of rivers and creeks are in good or excellent condition and 25% are in moderate condition. In the Maribyrnong catchment only 2% are in good or excellent condition and almost half of the rivers and creeks are in moderate condition (47%).

Overall condition within the catchments reflects the major land use patterns. The forested reaches of the catchments have excellent water quality, and remain generally at low risk from human disturbance. Condition deteriorates progressively downstream due largely to poor quality run-off from urban and agricultural land. Further downstream in metropolitan Melbourne, stormwater affects water quality and severely diminishes river health.

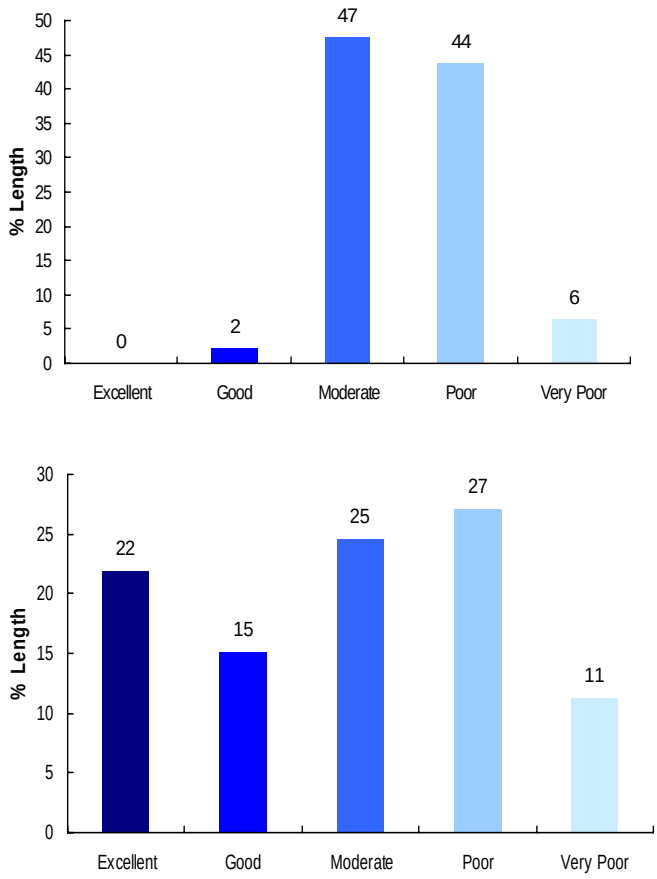

Figure 2. Waterway condition 2002-03 in the Maribyrnong (top) and Yarra (bottom) catchments based on the Index of River Condition

Current water quality of the Yarra and Maribyrnong rivers

What and how is water quality measured?

Water quality in the Yarra catchment is principally measured by Melbourne Water's major monitoring program (incorporating the EPA Fixed Site Network). Under these programs, water quality is monitored regularly at 33 sites – seven sites on the Yarra River (all downstream of Millgrove) and 26 sites on tributaries. In the Maribyrnong catchment, water quality is measured at eight sites (Appendix 1).

In Victoria, water quality can be assessed by comparison with the objectives outlined in State environment protection policies. These specify the environmental quality objectives required to protect identified beneficial uses for the rivers. Environmental quality objectives can also be used to define pollution, as they reflect the levels of water quality that represent impairment of beneficial uses. Water quality can also be assessed against the IRC (or ISC) water quality sub-index to provide an overall rating of the condition of water quality in rivers and streams (which includes consideration of water quality against some SEPP objectives) (see Figure 3).

The two appropriate State environment protection policies are *Schedule F7 - Waters of the Yarra Catchment* for the Yarra River and tributaries, and *Waters of Victoria* for the Maribyrnong River. These policies set objectives for water quality in different segments of the catchment, recognising natural changes in water quality and the potential impacts of land use.

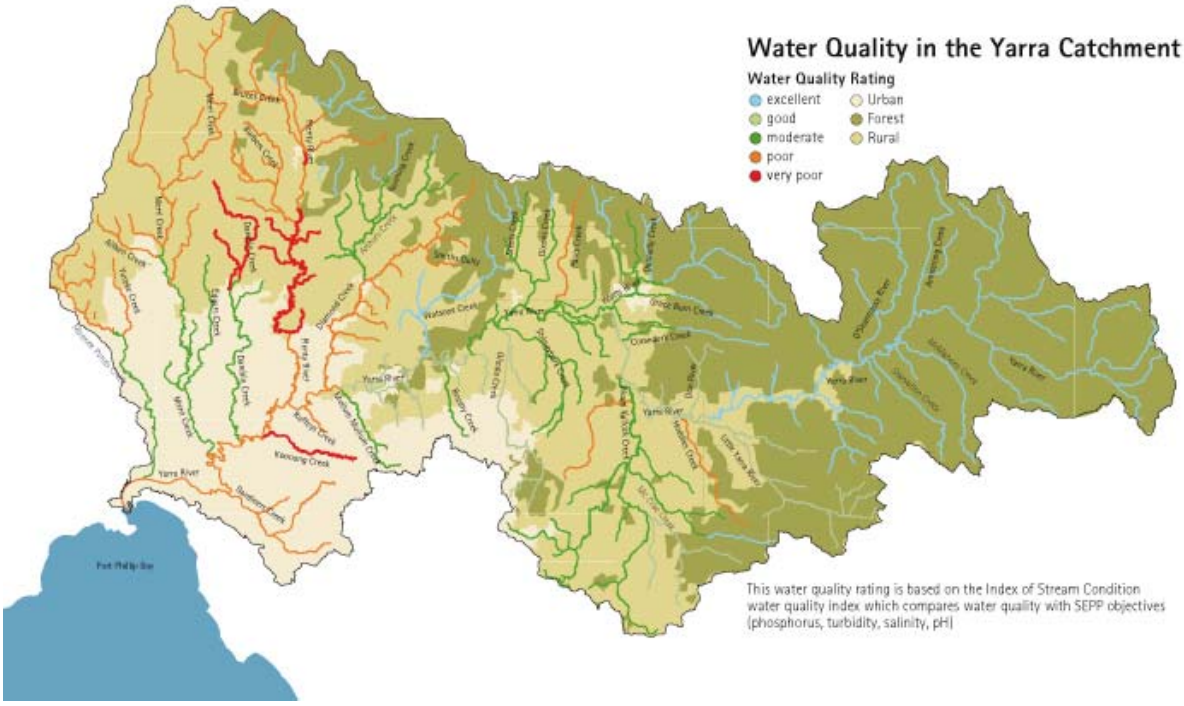

Figure 3. Water quality in the Yarra catchment

Beneficial uses to be protected are specified for different segments in the Yarra River (*Schedule F7*) and the Maribyrnong River (*Waters of Victoria*). Beneficial uses are:

- Maintenance of aquatic ecosystems
- Passage of indigenous fish
- Maintenance of indigenous riparian vegetation (not for the Yarra estuary or Port segments)
- Water based recreation:
  - Primary contact, e.g. swimming (not for the lower Yarra and Maribyrnong)
  - Secondary contact, e.g. boating, fishing
  - Aesthetic enjoyment, e.g. walking
- Commercial and recreational use of edible fish
- Drinking water supply
- Agricultural water supply
- Other commercial purposes.

A variety of substances can be detected in river water that may have detrimental consequences for the ecosystem and the beneficial uses it can support. These substances are collectively referred to as **contaminants** when they are present, but they do not necessarily cause harm.

Substances are referred to as **pollutants** when they are thought to be at levels that have a deleterious effect (Walsh *et al.,* 2004). For example, nutrients are contaminants that, at natural levels, have a beneficial effect on plants, but in excess can cause algal blooms. **Toxicants** are contaminants that have directly deleterious effects on organisms (Walsh *et al.,* 2004).

The main contaminants considered in this report include those that:

- Impact most on environmental health – nutrients (phosphorus and nitrogen), sediment (turbidity and suspended solids), toxicants and litter.
- Impact the most on the risk to human health through recreation – microbial contamination and toxicants.

Water quality – nutrients

Nutrients in rivers and creeks, mainly nitrogen and phosphorus, have a vital role in providing organisms with food for growth. However, excessive levels can result in problems such as nuisance weed and algal growth, and reduced biodiversity (particularly among smaller macroinvertebrates living in the rivers).

Nutrients enter rivers and creeks either in the dissolved form, or attached to particles. Nutrient sources may be from clearly defined points (point sources such as stormwater drains or wastewater treatment plants) or from diffuse non-point sources (such as agricultural or septic tank run-off).

Current condition

Yarra River

Nutrient concentrations in the Yarra through the forested areas of the catchment are good to excellent. There is an increase in nutrient concentrations in the rural areas, and a further decline in the urban areas (although conditions improve through the Warrandyte gorge section of the river).

Since the 1980s, sewering of catchments and diversion of industrial discharges into the sewerage system has led to steady and dramatic improvements in nutrient water quality in the Yarra River (Figure 4[1]). Between 1980 and 1995, phosphorus and nitrogen levels in the lower Yarra River decreased by almost half.

Over the past 10 years, phosphorus levels in the lower Yarra have generally remained constant, with only a slight downward trend at Chandler Highway (Figure 5). Nitrogen levels in the lower Yarra have increased slightly (a small but statistically significant trend) during the past decade (Figure 5).

The lack of change in the past 10 years is difficult to accurately assess. It is likely gains made by sewering and management of point source discharges have already occurred. But extensive works to improve water quality and catchment management programs have continued to keep pace with population and urban and agricultural growth. Given the level of this additional development, this lack of further decline is a significant achievement.

Recent water quality condition in the Yarra River can be established by comparing the available data against the SEPP objectives (Appendix 2). Since 2000, results of water quality monitoring have been expressed as a rating, determined by the percentage of samples that meet the SEPP concentration objectives (WaterEcoscience, 2001). The rating adopted is:

- High (> 95% of samples attain SEPP objectives)
- Medium (90-95% of samples attain SEPP objectives)
- Low (< 90% of samples attain SEPP objectives).

Because of the extensive development and changes to the ecology of the river, few of the water quality monitoring sites in the Yarra River have met SEPP objectives for nutrients in recent years (Table 1). However, total phosphorus objectives were met more than 95% of the time in the upper part of the Yarra sampled (at Millgrove).

The results in the main stem of the Yarra River reflect the results in the tributaries. Of the 26 sites sampled in Yarra River tributaries in 2002, all sites showed low attainment of SEPP objectives for total nitrogen, and 23 sites showed low attainment for total phosphorus (Melbourne Water, 2004)[2].

Macroinvertebrate samples have been collected from over 150 sites throughout the Yarra catchment. The SIGNAL[3] (Stream Invertebrate Grade Number – Average Level) index is affected by overall water quality conditions and habitat. However, it is particularly sensitive to changes

[1] Figures are provided for the Yarra River at Chandler Highway, but similar conclusions can be made from data at other Yarra River sites.

[2] Note that all sites were located in rural or urban segments of the catchment.

[3] SIGNAL is a biotic index that grades macroinvertebrate families according to their tolerance to various pollutants (mainly organic). The index is calculated by averaging the scores for all families collected, and can be related to the quality of the water at the site. SIGNAL scores are one component of the SEPP objectives for Victorian Waters. This analysis is, however, based on absolute quality, not as a comparison to SEPP objectives.

in nutrient levels. For this reason, the index is an important part of both the ISC and IRC scores.

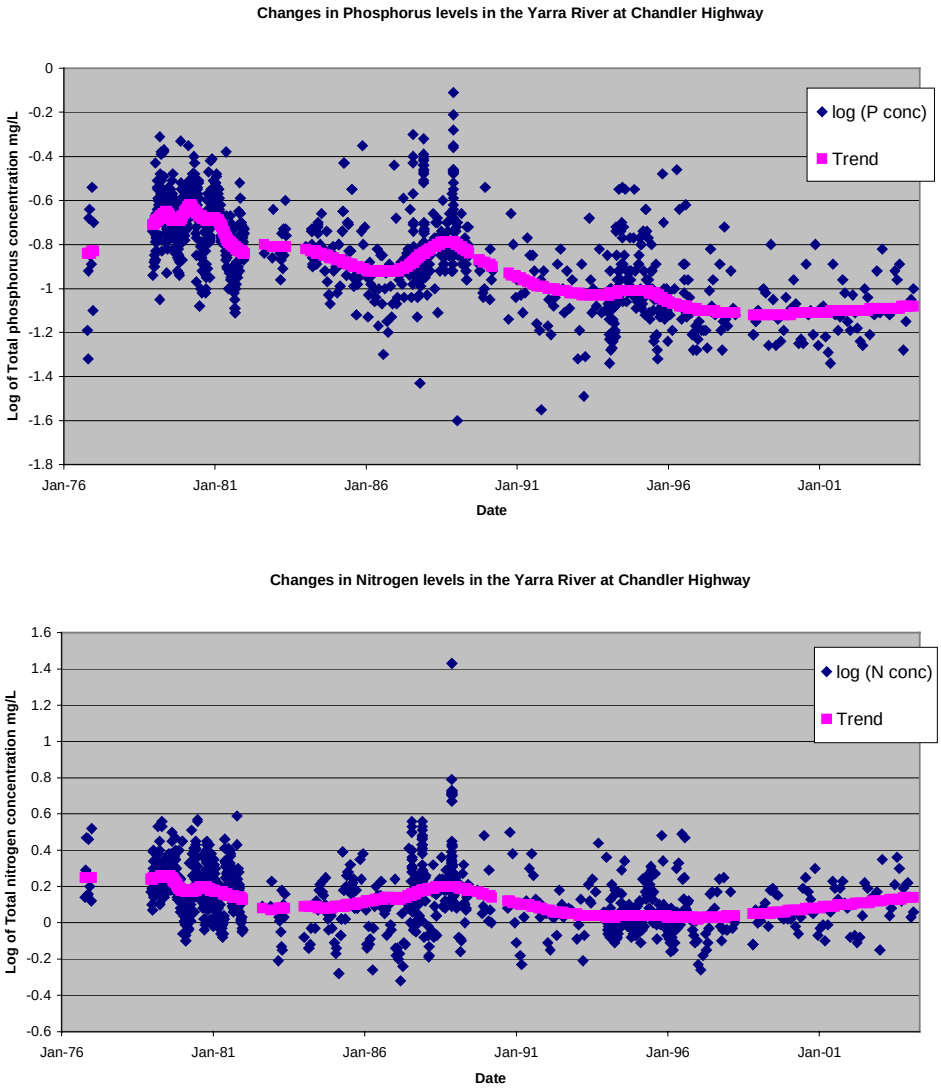

Figure 4. Trends in phosphorus (top) and nitrogen (bottom) levels in the Yarra River at Chandler Highway between 1976 and 2004

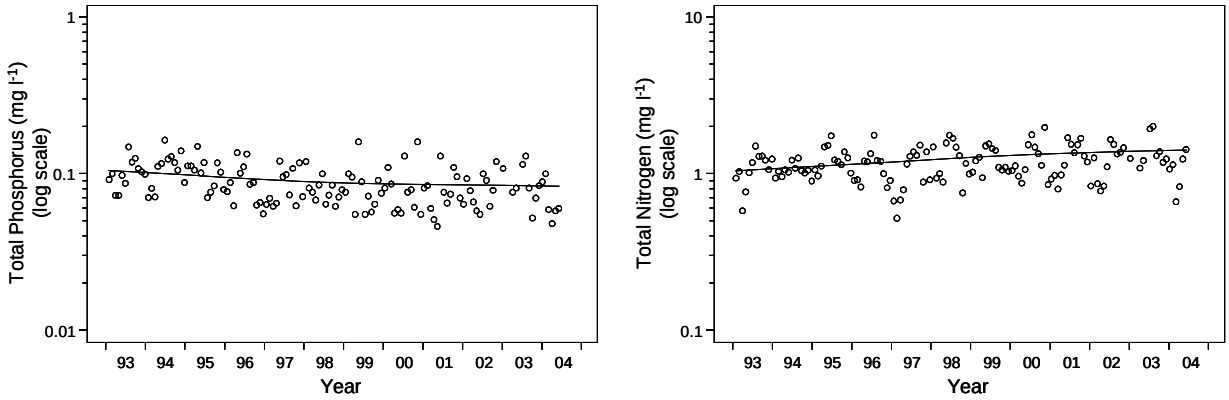

Figure 5. Trends in total phosphorus (left) and total nitrogen (right) at Chandler Highway in the Yarra River between 1993 and 2004

Table 1. Achievement of SEPP objectives at Yarra River sites in 2000 and 2002
L – less than 90% of samples meet objectives; M – 91-95% of samples meet objectives; H – more than 95% of samples meet objectives; n.a. – not sampled.

Yarra River site	2000		2002	
	TN	TP	TN	TP
Millgrove	L	H	L	H
Healesville	L	M	L	M
Launching Place	L	L	L	M
Spadonis Reserve	n.a.	n.a.	L	L
Warrandyte Road bridge	L	M	L	M
Chandler Highway	L	L	L	L
Princes Bridge	L	L	L	L

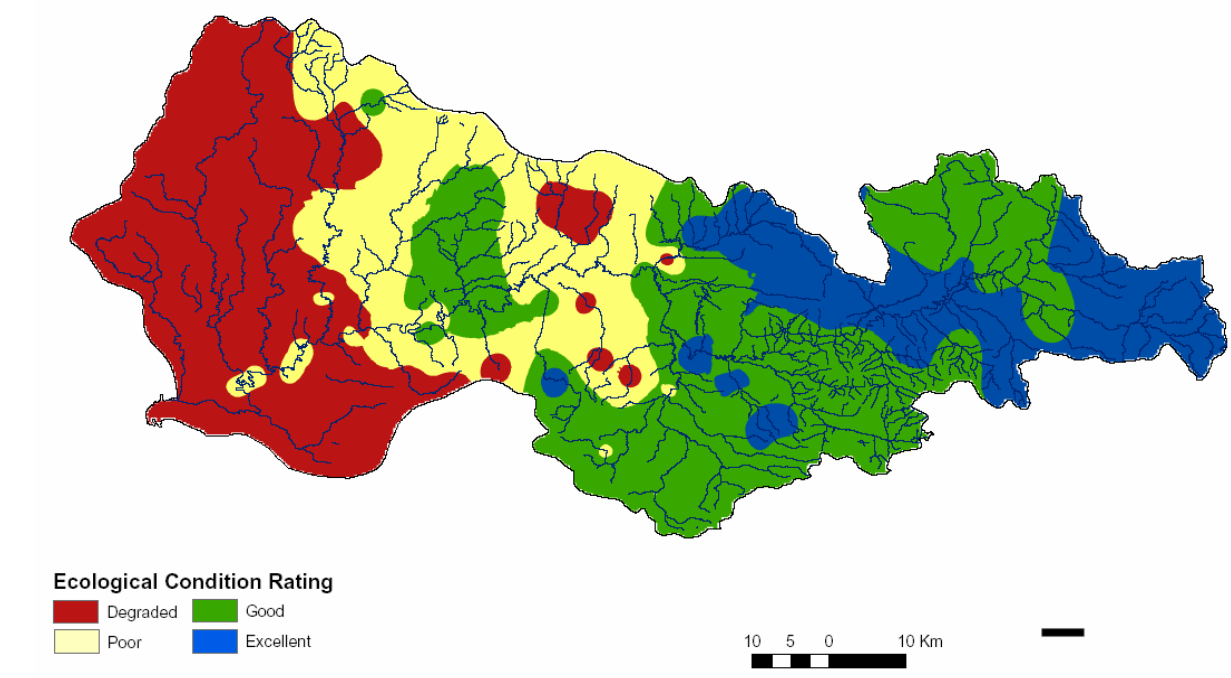

Figure 6. Ecological condition in the Yarra catchment based on macroinvertebrate communities and the SIGNAL index
Note that the SIGNAL index is particularly sensitive to changes in nutrient levels.

Based on SIGNAL (Stream Invertebrate Grade Number – Average Level) scores, conditions through the forested areas of the Yarra catchment (there are insufficient data from the Maribyrnong catchment for this analysis) are good to excellent (Figure 6). There is a decline in conditions in the rural areas, and a further decline in the urban areas (although conditions improve through the Warrandyte gorge section of the river – similar to the phosphorus results suggested by the water quality data in Table 1). Water quality declines downstream of various wastewater treatment plants but in most cases recovers quickly.

Maribyrnong River

Changes in total phosphorus levels in the Maribyrnong River shows a similar pattern to the lower Yarra River, with fairly dramatic changes from the late 1970s to the mid 1990s, but little change in water quality since (Figure 7). On the other hand, total nitrogen concentrations have remained fairly constant over the entire period of record (Figure 7).

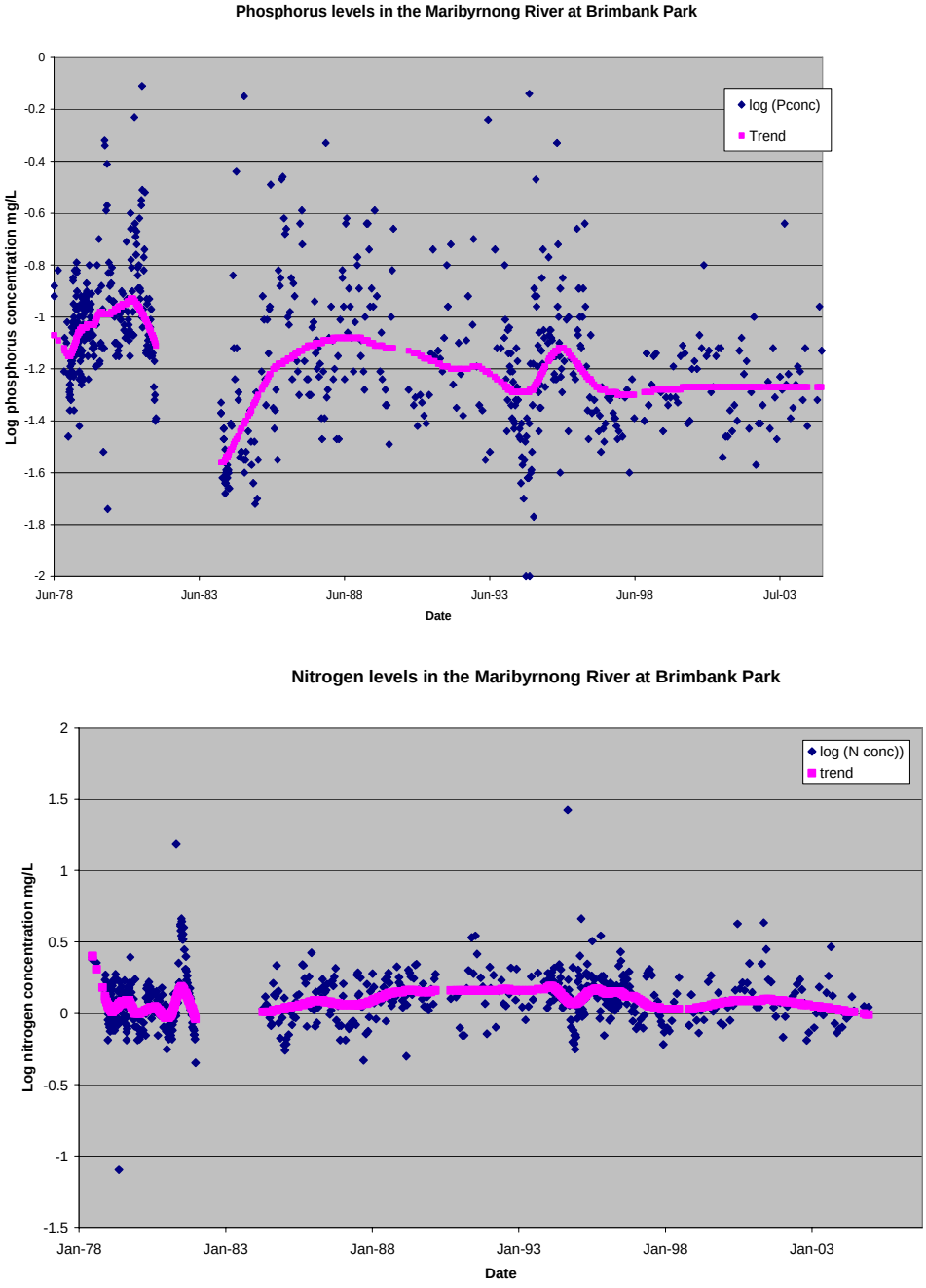

Figure 7. Trends in total phosphorus (top) and total nitrogen (bottom) concentrations in the Maribyrnong River at Brimbank Park between 1978 and 2004

In 2000, all of the sites sampled in the Maribyrnong River showed low attainment (less than 90% of samples) of SEPP objectives for total nitrogen (Table 2). Total phosphorus objectives were met more than 95% of the time at only one site, with all other sites showing low attainment. In 2002, insufficient samples could be collected for analysis due to the absence of flows through most of the year.

Table 2. Achievement of SEPP objectives at Maribyrnong River sites in 2000
L – less than 90% of samples meet objectives; M – 91-95% of samples meet objectives; H – more than 95% of samples meet objectives.

2000	TN	TP
Maribyrnong River at Brimbank Park	L	L
Maribyrnong River at Canning St Ford	L	L
Jackson's Ck at Sunbury	L	L
Deep Ck at Bulla	L	H
Deep Ck at Bolinda	L	L
Barringo Ck at Barringo	L	L
Steele Ck at Rose Ave, Niddrie	L	L
Stony Ck at Bena St, Yarraville	L	L

Sources

Sources of nutrients in the Yarra and Maribyrnong rivers have been collated through use of the FILTER model. The FILTER model was developed as a computer-based decision support system that can quantify annual nutrient and sediment loads from urban and rural sources in the sub-catchments of the Port Phillip catchment. Note that an updated and expanded decision support system is being developed for the *Regional Water Quality Improvement Plan*.

The FILTER model suggests that in the Yarra catchment, the generation of both phosphorus and nitrogen was shared equally between urban (including residential, industrial and commercial) and rural pasture areas (Table 3) at around 40% of the total each.

While the contributions from urban and rural sources are similar in the Yarra catchment, the area of urban land is only 22% of the catchment area compared to 57% rural. Based on load per unit area, urban areas contribute over twice the load of rural pasture (although intensive horticulture contributes a greater load per unit area than other sources).

Local wastewater treatment plants are also a relatively small source of nutrients in the Yarra.

In the Maribyrnong catchment, nutrient generation is dominated by rural pasture sources, contributing 65% of phosphorus loads (compared to 32% from urban sources) and 79% of nitrogen loads (compared to 13% from urban sources). The area of urban land in the Maribyrnong is only 11%, compared to 81% rural. Urban areas seem to be contributing more phosphorus per unit area than rural pasture, but nitrogen generation is similar for all land uses.

Nitrogen levels need to be reduced by 350 tonnes from the catchments of the Yarra and Maribyrnong to protect the environmental health of Port Phillip Bay (*Port Phillip Bay Environmental Management Plan*).

Table 3. Major sources of nutrients in the Yarra and Maribyrnong rivers

Source	TP (tonnes per year)	TN (tonnes per year)
Yarra catchment		
Urban	41	537
Rural (pasture)	42	524
Rural (horticulture/broad-acre)	14	102
Forested	3	96
Wastewater treatment plants	3	62
Maribyrnong catchment		
Urban	13	47
Rural (pasture)	28	295
Rural (horticulture/broad-acre)	1	15
Forested	1	14

Conclusions

Nutrient concentrations in the Yarra through the forested areas of the catchment are good to excellent. There is an increase in nutrient concentrations in the rural areas, and a further increase in the urban areas. Similarly, nutrient levels are moderate in the rural areas of the Maribyrnong and decline further into the urban areas. In general, nutrient levels (both phosphorus and nitrogen) exceed SEPP objectives within developed rural and urban areas of the Yarra and Maribyrnong rivers. Objectives were met in the majority of results in the upper Yarra.

Large reductions in phosphorus concentrations in the Yarra and Maribyrnong rivers were accomplished between the late 1970s and mid 1990s largely due to sewering of catchments and diversion of industrial discharges into the sewerage system.

Over the past 10 years, phosphorus and nitrogen levels in the lower Yarra have remained relatively constant. But extensive works to improve water quality and catchment management programs have continued to keep pace with population and urban and agricultural growth. Given the level of this additional development, this lack of further decline is a significant achievement. Urban areas and rural pastures are the major sources of nutrients in the Yarra catchment, while rural pasture sources dominate in the Maribyrnong catchment.

Nutrients are likely to have an impact on the health of rural freshwater ecosystems, but are likely to have little impact in urban streams (that are more affected by toxicants). However, nitrogen reductions are required to ensure the environmental health of Port Phillip Bay.

Water quality – turbidity and suspended sediment

Sediment (particles of material suspended in the water column or deposited on the streambed) is a natural component of rivers and creeks. Natural erosion and decay processes constantly deliver sediment to rivers, so that all rivers and streams carry some level of sediment.

This is normally low in upland streams, but can be relatively high in lowland rural and urban rivers. Natural inputs of sediment are intrinsic to the functioning of freshwater ecosystems and are important in channel formation and maintenance. However, artificially increased loads of sediment, resulting from human activity, can have adverse effects on the physical form of the river, and aquatic flora and fauna. Deposits of sediment in urban rivers and creeks can also affect recreational use, especially boating.

Most human activities on the landscape have the potential to increase sediment levels, with important sources being agricultural and urban stormwater run-off, stream bed and bank erosion, unsealed roads, construction activities, mining, dredging and some industrial processes.

Current condition

Since the 1980s, a variety of catchment management works (sewering of catchments, diversion of industrial discharges and management of agricultural practices) have led to steady and dramatic improvements in suspended sediment levels in the Yarra River (Figure 8[4]).

Between 1980 and 1995, suspended sediment levels in the lower Yarra River decreased by almost one-third. Over the same time, suspended sediment levels in the Maribyrnong River increased, almost doubling in value (however they remained lower than the Yarra).

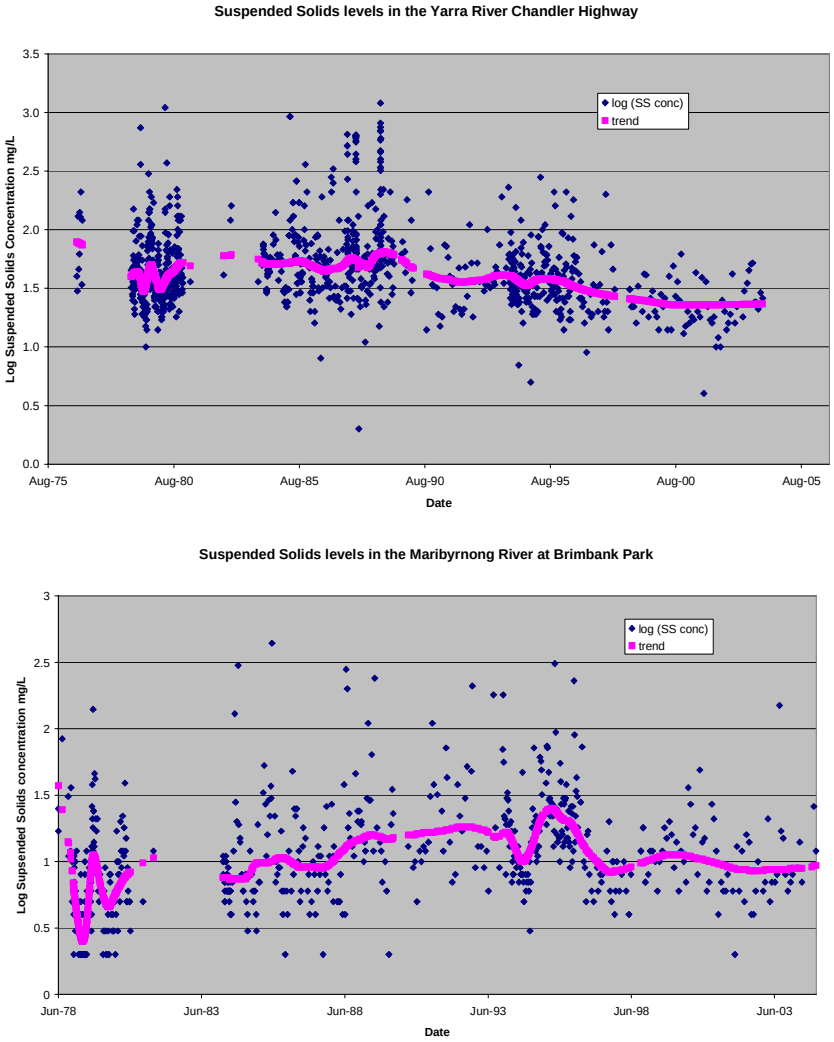

Figure 8. Trends in suspended sediment levels in the Yarra River at Chandler Highway (top, between 1976 and 2004) and the Maribyrnong River at Brimbank Park (bottom, between 1978 and 2004)
Note: Suspended solids is the same measure as suspended sediment

[4] Figures are provided for the Yarra River at Chandler Highway, but similar conclusions can be made from data at other Yarra River sites.

Since 1995, there has been a slight (but statistically significant) downward trend in suspended sediment concentrations in the lower Yarra River and a dramatic decrease in the Maribyrnong River to levels similar to the early 1980s (Figure 8). These trends may be due to the impact of improved catchment management or are as a result of lower rainfall (and thus lower sediment inputs) during the recent drought period, or a combination of both factors.

In 2000, all water quality monitoring sites on the Yarra or Maribyrnong rivers showed high or medium attainment of SEPP objectives for suspended sediments (and low attainment was recorded at only nine percent of Yarra River tributary sites). In 2002, only one site on the Yarra River (which was not sampled in 2000) showed low attainment for suspended sediments and two sites for turbidity (Table 4). Both sites on the Maribyrnong River showed high attainment for suspended solids (but insufficient samples could be collected to analyse turbidity data).

Sources

By far the major sources of sediment generated from the Yarra and Maribyrnong catchments are from urban and rural run-off.

The FILTER model suggests that, in the Yarra catchment, over half of the total annual sediment transport of about 41,000 tonnes was derived from the urban residential, industrial and commercial areas (Table 5). Just under one third was derived from rural pasture sources with less than 3% from horticultural/broad-acre sources.

In the Maribyrnong catchment, almost half of the 4000 tonnes transported per year was from rural pasture sources, with just under 40% from the urban area.

In both catchments, the contribution of urban sources per unit area far outweighs the contribution from rural pasture.

Table 4. Achievement of SEPP objectives for turbidity and suspended sediments at Yarra and Maribyrnong River sites in 2000 and 2002
L – less than 90% of samples meet objectives; M – 91-95% of samples meet objectives; H – more than 95% of samples meet objectives.

	2000		2002	
	Turbidity	**SS**	**Turbidity**	**SS**
Yarra River at Millgrove	H	H	H	H
Yarra River at Healesville	H	H	L	M
Yarra River at Launching Place	M	M	M	M
Yarra River at Spadonis Reserve	n.a.	n.a.	L	L
Yarra River at Warrandyte Road bridge	H	H	M	M
Yarra River at Chandler Highway	H	H	M	H
Yarra River at Princes Bridge	H	H	M	M
Maribyrnong River at Brimbank Park	H	H	-	H
Maribyrnong River at Canning St Ford	H	H	-	H

Table 5. Major sources of sediments in the Yarra and Maribyrnong rivers

Source	SS (tonnes per year)	Percent of total
Yarra catchment		
Urban	22,930	55.9
Rural (pasture)	12,496	30.5
Rural (horticulture/broad-acre)	1,039	2.5
Forested	4,562	11.1
Maribyrnong catchment		
Urban	1,630	39.9
Rural (pasture)	2,035	49.9
Rural (horticulture/broad-acre)	184	4.5
Forested	231	5.7

Conclusions

Large reductions in suspended sediment levels in the Yarra River were accomplished between the 1980s and present, although the rate of decline has slowed in the past 10 years. Given the level of additional urban and agricultural development, this lack of further decline is a significant achievement.

Suspended sediment levels in the Maribyrnong River increased between 1980 and the mid 1990s, but have declined since then to near 1980 levels. Improved catchment management and the drought may be two reasons for this decline.

Suspended sediment and turbidity levels conform to SEPP objectives at a medium (> 90% of samples) or high (> 95% of samples) frequency throughout much of the rural and urban sections of the Yarra and Maribyrnong rivers.

Urban and rural run-off are the major sources of suspended sediment in the Yarra and Maribyrnong rivers.

Water quality – toxicants

Toxicants such as heavy metals (e.g. zinc, lead, copper, nickel, cadmium), petroleum hydrocarbons, polychlorinated biphenyls (PCBs) and pesticides have been detected in many urban streams (Pettigrove and Hoffman 2003a). These chemical contaminants can enter waterways via natural and anthropogenic sources. In some circumstances, persistent chemicals can enter the food chain when ingested by bottom-dwelling organisms and smaller fish that are in turn eaten by larger fish. The concentration of toxicants increases along the food chain via the process of bioaccumulation. For example, predatory fish may contain elevated concentrations of toxicants such as lead or mercury in their tissues.

People may be exposed to toxicants in water by direct contact (with absorption through skin and mucous membranes), by inhalation or by ingestion. Also, consumption of fish and shellfish caught in polluted areas can pose a risk to human health.

Furthermore, the accumulation of toxicants may directly impact on the health of aquatic organisms.

Current condition

The data available indicate that the concentrations of some common heavy metals are increasing in sediments and surface waters. Most toxicants are in very low concentrations in surface waters but may have high concentrations in sediments, as they are bound to sediment particles.

Toxicants in surface water

In 2002, most metals in the water column in the Yarra met SEPP objectives for the protection of aquatic ecosystems (see Table 6). However, copper exceeded SEPP objectives at all Yarra River sites and lead and zinc did not always meet SEPP objectives at the two most downstream sites (Chandler Highway and Princes Bridge). Furthermore, zinc has gradually increased in surface waters of the Yarra River at Chandler Highway (Pettigrove and Hoffman 2003a).

The observed concentrations in the water column are unlikely to be directly toxic to aquatic organisms as a large percentage of these metals are likely to be adsorbed to sediment particles. A better determination of heavy metal toxicity can be obtained by measuring the filtered (i.e. dissolved) fraction of metals and hardness in surface waters. Only a small proportion of the total metals may be in dissolved form. For example, a study of two wetlands in the Merri and Darebin creeks found that, on average, between 17 and 52% of zinc present at these sites was in dissolved form.

Copper and lead levels in the Yarra were substantially below the National Health and Medical Research Council's screening levels for chemicals in recreational water, both for aesthetics and public health measurements. Zinc levels in the Yarra are also well below the Council's screening levels for aesthetics (the Council has no public health limit for zinc – there are insufficient data to set a guideline value based on health considerations).

All metals in the water column showed high attainment against SEPP guidelines in the lower Maribyrnong River (Table 6).

Table 6. Achievement of SEPP objectives in surface waters for a variety of metal toxicants at Yarra and Maribyrnong River sites in 2002
L – less than 90% of samples meet objectives; M – 91-95% of samples meet objectives; H – more than 95% of samples meet objectives

2002	As	Cd	Cr	Cu	Ni	Pb	Zn
Yarra River at Millgrove	H	H	H	L	H	H	H
Yarra River at Healesville	H	H	H	L	H	H	H
Yarra River at Launching Place	H	H	H	L	H	H	H
Yarra River at Warrandyte Road bridge	H	H	H	L	H	H	H
Yarra River at Chandler Highway	H	H	H	L	H	L	M
Yarra River at Princes Bridge	H	H	H	L	H	L	L
Maribyrnong River at Brimbank Park	H	H	H	H	H	H	H
Maribyrnong River at Canning St Ford	H	H	H	H	H	H	H

Toxicants in sediments

In recent times there has been a greater focus on the presence of toxicants in sediments. Urban stream sediments are sinks for heavy metals and many other pollutants and produce toxic effects on aquatic ecosystems. Heavy metal deposits in sediments affect overlaying water quality conditions and animals that live on or in the river bed (Pitt 1995), particularly during base flow periods (Mederios *et al.,* 1983). Petroleum hydrocarbons have been identified as having a major impact on the macroinvertebrates that can inhabit sediments (Pettigrove and Hoffmann, 2005).

Based on investigation of a few sites in the Maribyrnong and Yarra rivers and their tributaries, including wetlands, approximately one-third of sediments sampled in urban Melbourne exceed SEPP objectives for metal levels in sediment (by exceeding trigger values from ANZECC/ ARMCANZ guidelines that indicate the potential for high risk to aquatic ecosystems). The results also indicate that the concentrations of some common heavy metals are increasing in sediments in the rivers and creeks with increased urbanisation in their catchments. However, the heavy metal concentrations in sediments have declined in some cases in areas where industrial discharges have reduced (Pettigrove, 1999). For example, zinc, mercury and chromium have significantly increased in the sediments of many urban streams, while lead concentrations significantly decreased between the early 1980s and mid 1990s, presumably from reduced use of leaded petrol (Pettigrove, 1999).

Organochlorines were widely used prior to the 1990s in agricultural and domestic pest control. However, they were replaced by less persistent pesticides in past decades and there is some evidence from limited studies that there has been a decline in concentrations since the 1980s. Contamination of organochlorines occurs in the sediments at a variety of sites. There is also evidence suggesting that there has been a substantial decline in PAHs (polycyclic aromatic hydrocarbons, a type of petroleum hydrocarbon) in past decades, and this may be due a variety of factors, including the use of cleaner fuels and better combustion technologies in vehicles and the control of industrial discharges.

Further research is being conducted to identify the contaminants present in urban sediments and their impact on macroinvertebrates. There is also a need to better understand the risk to human health of the consumption of fish caught in the rivers due to the concentration of toxicants in the fish. Small-scale surveys undertaken in the lower Yarra and Maribyrnong rivers over the last ten years, showed that heavy metal concentrations and organochlorines in a range of fish, including mulloway, black bream, short finned eels and sea mullet were within standards for human consumption set in the Australian and New Zealand Food Standards Code (www.foodstandards.gov.au). These standards provide guidance on the risk to human health from consuming various contaminated foods that may contain traces of toxicants. However, in a recent investigation, two of 16 eels collected had PCB levels above the food consumption standard. Further investigation of contaminant levels in fish and sediments are underway to provide agencies and the community with more comprehensive information and to assess whether precautionary advice on fish consumption is necessary.

Sources

Copper, zinc lead and other heavy metal concentrations in sediment increases with increased catchment urbanisation. Urban stormwater is the main contributor of heavy metals and petroleum-hydrocarbons in the Yarra and Maribyrnong rivers. These contaminants originate from a variety of sources. Run-off from roads (from vehicles and the degradation of asphalt) often contains high levels of heavy metals, PAHs, grease and other oils. Industrial estates with small to medium sized businesses have been identified as a primary source of heavy metal pollution (Pettigrove and Hoffman 2003b). Galvanised roofing is also a major source of zinc.

Local catchment characteristics also have an important influence on the effects of urbanisation on sediment pollution. For example, waterbodies located in the basaltic northern and western regions of Melbourne are more prone to have higher levels of heavy metal pollution than those in more clayey catchments with similar levels of urbanisation (Pettigrove and Hoffman 2003c).

Endocrine disrupting chemicals

The endocrine system acts as the chemical messenger for communication throughout our body. The main purpose of the endocrine system is to control and regulate body functions especially growth and development.

Endocrine disruption (via various mechanisms) to the hormonal system of an organism results in adverse effects. This can be caused by a variety of chemicals and hormones, such as oestrogen, pesticides, herbicides, PCBs and some heavy metals that could be present in urban run-off.

The information on the presence and potential impacts of endocrine disruptors on the Yarra is currently limited but some research work is being developed to determine levels and any effects of endocrine disrupting chemicals on fish in the Yarra estuary and in wetlands in the Yarra catchment.

Conclusions

Toxicants have been detected in many rivers and creeks within the Yarra and Maribyrnong catchments. For surface water, most sites meet SEPP objectives with a high level of attainment for most metal toxicants (except for copper in the Yarra catchment, and lead and zinc in the lower Yarra).

There is a low level of attainment with SEPP and ANZECC/ARMCANZ guidelines for sediment quality, with about one-third of urban streams and wetland sediments sampled exceeding these guidelines. Recent research has shown that sediments found to exceed these sediment quality guidelines reduce biodiversity and general stream health.

The concentrations of some common heavy metal concentrations are increasing in sediments and surface waters.

Urban stormwater is the main contributor of heavy metals and petroleum-hydrocarbons in the Yarra and Maribyrnong rivers.

Endocrine disrupting chemicals are another potential contaminant that requires further investigation.

There is currently no regular monitoring of sediment quality in the Yarra or Maribyrnong or their tributaries.

Water quality – microbial contamination

Micro-organisms are essential to a living river system and are found in all rivers. Some are harmless while others, known as pathogens, can cause disease to humans. Levels of micro-organisms increase after rain when they get washed into rivers from the catchment. Health risks associated with recreational use of the Yarra and Maribyrnong rivers are mainly from microbial and chemical contamination. Microbial contamination comes mainly from faecal pollution. Water contaminated by human or animal excreta may contain viruses, bacteria and protozoa. These micro-organisms can come from a range of sources, including sewage effluent, people using the water for recreational activities, livestock, industrial processes, farming activities, domestic animals and wildlife. In addition, recreational water may contain free-living pathogenic micro-organisms.

The degree of contact with infectious and toxic agents found in water influences the likelihood of contracting illness. The most intensive type of exposure is primary contact, where the whole body or face and trunk are frequently immersed, or the face is frequently wetted by spray and some water may be swallowed (e.g. swimming, diving, water-skiing). Secondary contact occurs when people undertake water-based activities that do not necessarily require swimming or immersion. This includes water sports such as boating and rowing.

In general, the greater the degree of faecal pollution of the water, and the greater the person's contact with the water, the greater the likelihood of illness. In most cases the ill-health effects of exposure to contaminated water are considered to be minor and short-lived.

The most likely illness from swimming in faecally-polluted water is enteric illness, such as self-limiting gastroenteritis. Other associations between swimming in polluted water and illness include respiratory infections, eye and ear symptoms and skin irritation. Because of the mild and often non-specific nature of much of these illnesses the cause can be difficult to detect through routine surveillance systems.

There is the potential in faecally-polluted waters for more serious disease, such as hepatitis, giardiasis, cryptosporidiosis, campylobacteriosis, and salmonellosis, particularly in children, the elderly and people with impaired immune systems.

Many of the micro-organisms that cause disease are difficult to measure directly, but we can test for a number of indicator bacteria that give us a good idea of how likely disease-causing microbes are to be present. Faecal indicator bacteria are natural inhabitants of the gastrointestinal tracts of humans and other warm-blooded animals. Generally they are not harmful to humans. They survive in the environment at varying rates depending on a variety of factors such as sunlight and temperature.

Commonly used indicator organisms include *E.coli* for fresh water, and enterococci for marine water. National environmental agencies in the United States, New Zealand and the European Union use *E. coli* as an indicator of faecal contamination in fresh water and enterococci in marine waters. These indicators are also used in Victoria.

No single indicator is ideal for all circumstances, and in recent years we have gained a better understanding of which indicators are most useful for trying to predict human health risk.

The World Health Organisation (WHO) developed *Guidelines for Safe Recreational Water Environments* (2003) that provide some guideline values for microbiological quality of recreational waters. As part of this process, WHO reviewed the epidemiological data linking indicators to human health outcomes. For marine waters, only enterococci showed a dose-response relationship with both gastrointestinal and respiratory illness. Enterococci are also considered suitable indicators for freshwater systems. However, there were inadequate data to directly derive a water quality guideline value for freshwater. Continuing studies may be able to address this gap. The WHO guidelines and recently released National Health and Medical Research Council's *Australian Guidelines for the Recreational Use of Water* (2005) recommend the use of a risk assessment and management approach to develop appropriate local guidelines using microbial indicators and sanitary surveys.

It is desirable that monitoring programs of microbial water quality in the Yarra and Maribyrnong rivers collect data in such a fashion that they are useful for assessing human health risk. Investigations are underway to identify additional and/or better indicators for assessing potential health risks from recreational use of our rivers, and looking at the feasibility of adopting the risk assessment and management approach (WHO, 2003; NHMRC, 2005).

Current condition

Bacterial water quality in the Yarra River compares favourably with many urban rivers overseas (see Figure 9). It is much better now than it was in the 1970s. There has been little change in quality over the last ten years, despite increased pressure from continued urbanisation and population growth.

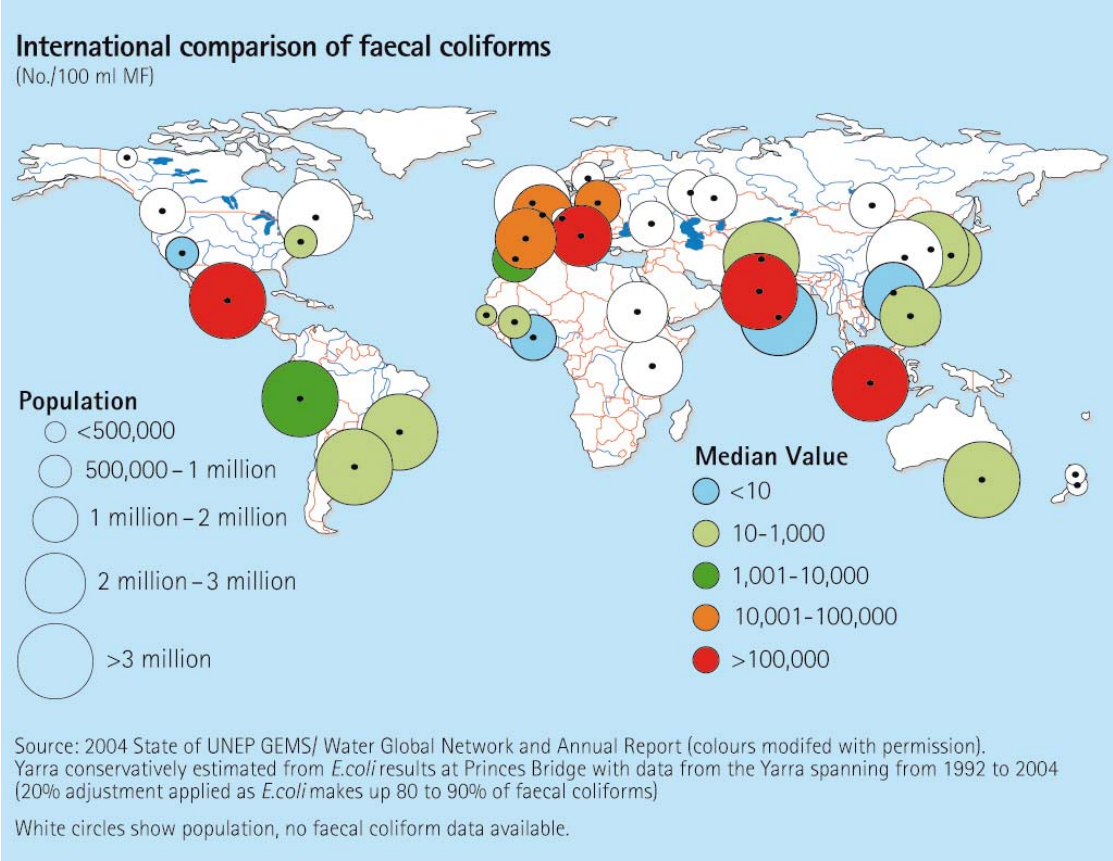

Figure 9. Median faecal coliforms for major urban rivers

As Melbourne's sewerage system continues to be upgraded, *E. coli* levels in the lower Yarra (measured at Princes Bridge) have shown a dramatic decrease. In the 1970s, annual means were generally in the 1000-5000 organisms per 100 ml range, whereas in the last decade the annual means have been approximately within the 400-900 organisms per 100 ml range (Figure 10).

E. coli levels in the Yarra increase from upstream to downstream, and also show increases after rainfall events (see Figure 10).

E. coli levels have only been measured in the Maribyrnong River regularly since 1994. Over that time, average values have been reduced by approximately 50%. *E. coli* levels have plateaued in the lower Yarra River and the Maribyrnong River over the last 10 years.

Water quality at most sites in the Yarra upstream of Warrandyte has generally met SEPP standards for all forms of recreation, including swimming, except sometimes after rain. At most sites in the Yarra below Warrandyte, *E. coli* levels meet the standard for water sports such as boating, canoeing and kayaking (except following very heavy rainfall events) but not for swimming.

In 1999, the former Government set and endorsed an aspirational target for the lower Yarra (excluding the Port area) to be suitable for swimming. This aspirational target has been the driver for further investigations into major sources of microbial contamination that prevent the target from being met. It is now clear that this target will be extremely difficult to achieve in the lower Yarra.

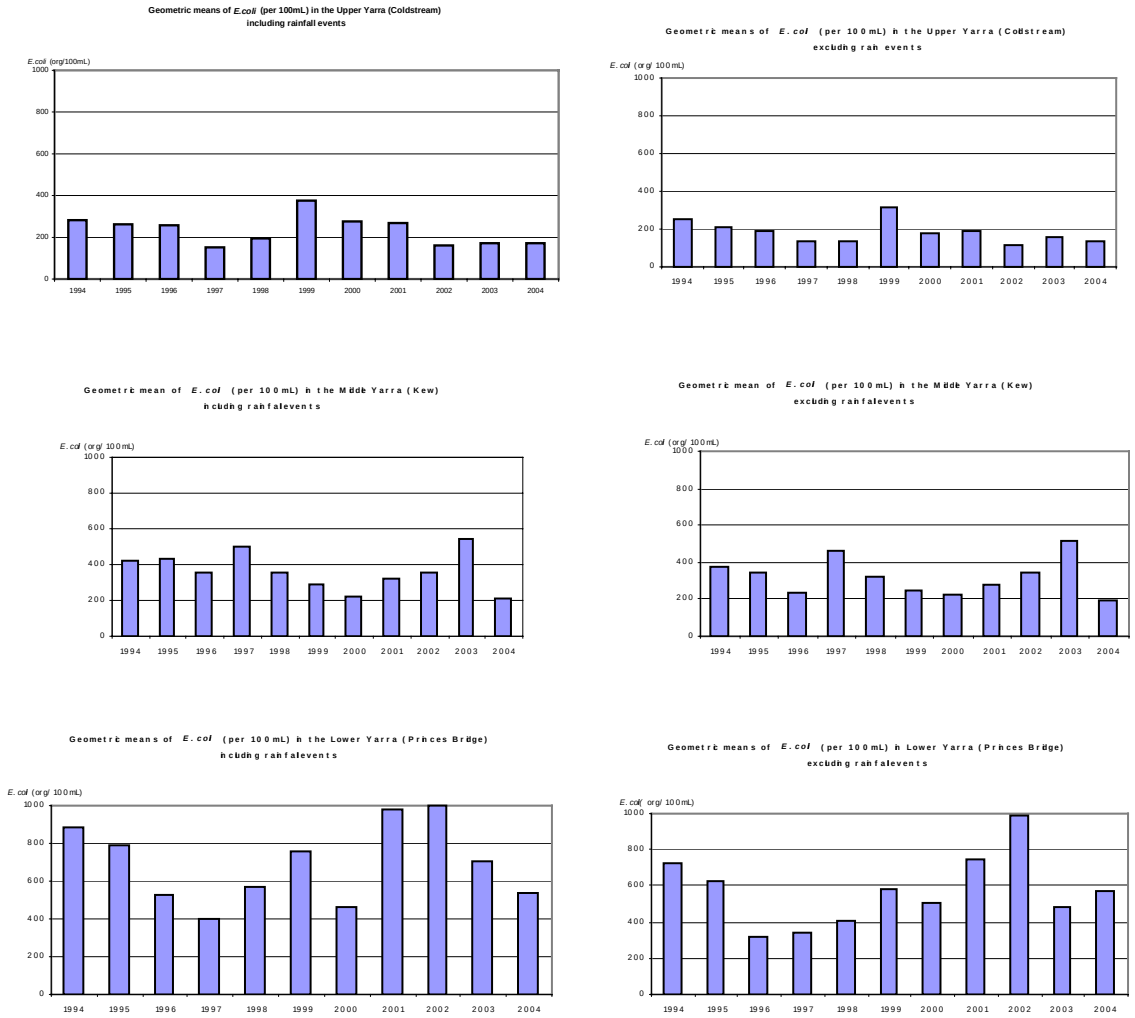

Figure 10. ***E. coli*** **levels in the Yarra River at Coldstream (top), Chandler Highway (middle) and Princes Bridge (bottom) (including rainfall [left column] and excluding rainfall [right column], between 1994 and 2005)**

However, the lower Yarra is not typically used by Melburnians as a swimming spot. In fact, swimming is prohibited in the lower reaches of the Yarra River (between the Gipps Street Bridge and the Bolte Bridge) because of the danger posed by boats. A conservative estimate of recreational and small commercial vessel movements on the lower Yarra River is about 55,000 per annum based on river traffic counts undertaken in 2004.

In general, swimming is allowed only after a permit is issued by Parks Victoria.

Similarly, swimming is prohibited in the lower reaches of the Maribyrnong between the Canning Street Bridge to the Port. As with the Yarra, swimming is allowed only after Parks Victoria issues a permit.

However, as noted above, the water quality is generally acceptable for the water sports that are currently undertaken in the lower Yarra and Maribyrnong rivers.

E. coli levels can vary considerably with stream flow and over time. Storm event sampling by Melbourne Water during 2003 and 2004 in the estuarine reach of the Yarra River, showed that flow had a strong influence on faecal indicator levels. Many of the high readings were associated with periods of high flow (when recreational groups such as kayakers often used the river). Compared to the large number of people using urban rivers and creeks such as the Yarra and Maribyrnong, very few people are known to have become ill as a result of recreational water use of the rivers.

However, given that the two rivers are heavily urbanised, people will always need to use commonsense when using them for recreation.

Sources

Faecal sterols can be used to assess the animal origins of faecal matter, distinguishing human sources from herbivores (cattle, horses, sheep and possums) or other (dogs, cats, rats and birds).

A study undertaken by EPA Victoria (Bate *et al.*, 1997) used sterols to investigate the source of faecal material at four sites on the Yarra River. These sites were between Fairfield and Prahran, at the outfall of three major stormwater drains (Fairfield, Alexandra Parade and Prahran), and at sites on the lower Merri Creek and Gardiners Creek. At most sites, samples were analysed during two low flow periods and one high flow period.

Indicators of human faecal matter were found at varying levels in high and/or low flow conditions from all drains and tributaries sampled (Figure 11). These results indicated that inputs were not always constant and could vary according to: sewerage usage, soil dampness (affecting run-off rates) and run-off from street cleaning.

Contamination from herbivore sources formed the other major source of faecal material. These were attributed to a variety of sources, depending on the catchment condition – Merri Creek had high levels of herbivore faecal material, presumably from livestock in rural areas, while possums living in local parklands were possibly contributors to high faecal levels in the Alexandra Parade Main Drain.

Within the Prahran Main Drain, an old council drain was a major source of organic contamination. Investigation revealed that an old fish storage and cleaning area was a particular problem that has since been rectified. However, the Prahran Main Drain continues to be a source of faecal contamination to the lower Yarra.

Other sources (dogs, cats, rats and birds) were less common than human or herbivore sources, only occasionally reaching high levels.

High levels of human faecal contamination in the lower Yarra, downstream of Dights Falls, are a concern. It is difficult to accurately assess causes and extent, however, the data suggest it could be due to illegal connections of sewers into the drainage system. A program of faecal investigations (discussed later in this report) will assist in identifying the causes and extent of faecal contamination in the lower Yarra.

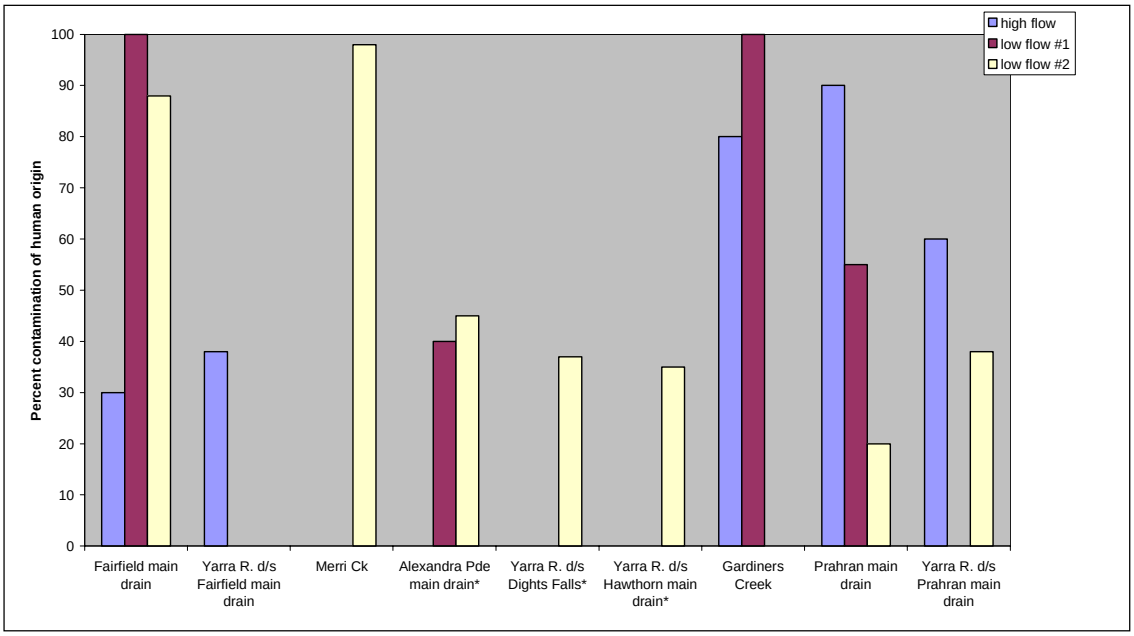

Figure 11. Human faecal contamination as a percentage of total contamination in the Yarra and some tributaries (from Bate *et al.*, 1997)
* not sampled during high flows. Note the results shown are eight years old and specific numbers of *E. coli* are not provided.

Conclusions

Water quality generally meets standards for boating, canoeing and kayaking except after heavy rainfall when stormwater flows are highest and carry the most pollutants and debris.

Water quality at most sites in rural areas of the Yarra has generally met current SEPP standards for all forms of recreation, including swimming, except sometimes after rain. At most sites in urban areas of the Yarra and Maribyrnong rivers, *E. coli* levels have met the standard for water sports such as boating, canoeing and kayaking (except following heavy rain), but not for swimming.

Swimming in the lower Yarra between the Gipps Street Bridge and the Bolte Bridge is not allowed because of the danger posed by boats. Exceptions, requiring a permit, are made during special events.

E. coli levels are much better now than they were in the 1970s. There has been little change over the last ten years, despite increased pressure from continued urbanisation and population growth. Human and herbivore faecal material is the major source of bacterial contamination. The cause and extent of high levels of human faecal contamination in the lower Yarra is difficult to accurately assess. Investigations are ongoing into these sources.

Water quality – litter

Possibly the most widely known and visible water contaminant is litter. Each year, approximately 230,000 cubic metres, or two billion items, of litter enter the rivers and creeks in the Port Phillip and Westernport region (*Port Phillip and Westernport Regional Catchment Strategy 2004-2009*).

There are currently 14 floating litter traps in use on the Yarra and Maribyrnong rivers and many other traps exist on the drainage system. Parks Victoria collects approximately 1500 cubic metres per year of litter, debris and organic matter from the Yarra and Maribyrnong rivers. Examples of the type of litter collected are plastic and glass bottles, syringes, milk and fruit juice cartons, cigarette butts and lighters.

Litter removal across the region can be reported in a variety of measurements such as truckloads, cubic metres or kilograms (typically, cubic metres is now the common measure of the amount of litter). Therefore, it has been difficult to report on changes in litter levels collected. Data from Parks Victoria at Grange Road in Toorak suggests variable litter levels, but an overall reduction over the past four years (2000-2004) following an increase during the previous four years (1997-2000; Figure 12).

The majority of litter items in the Yarra and Maribyrnong rivers have been discarded onto suburban streets where they are washed into gutters and then into the stormwater systems that discharge to rivers, creeks and the bays. Most litter comes from commercial and industrial areas and building sites through the stormwater system.

Generally, people are much more litter conscious today than they were ten years ago. However, litter in rivers is still a major problem. This reinforces the need for an integrated approach to litter management that involves source controls, water sensitive urban design as well as litter removal.

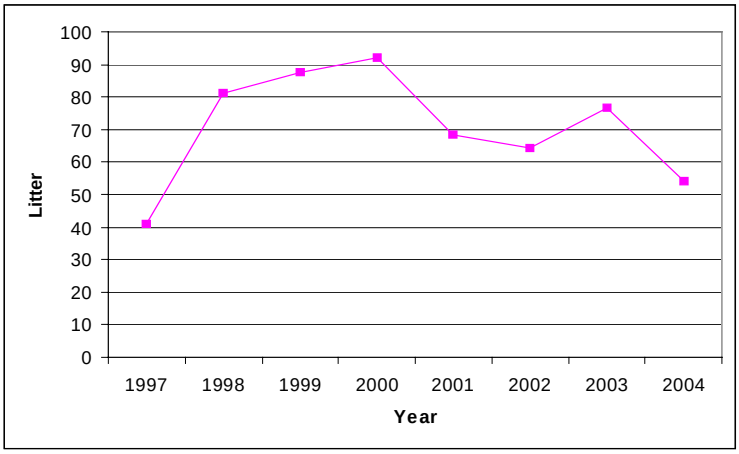

Figure 12. Litter volumes (in cubic metres) at the Grange Road, Toorak litter trap (1997 to 2004)
Source: Parks Victoria Litter removal data
Note - Parks Victoria litter collection has varied over the years shown (e.g. use of staff vs contractors; different numbers of people used; different methodologies employed).

Conclusions

Litter is a major contaminant throughout the urban sections of the Yarra and Maribyrnong rivers.

The major source of litter in the Yarra and Maribyrnong rivers is stormwater run-off from commercial and industrial areas and building sites.

Chapter 3: Yarra and Maribyrnong river objectives and targets

> *The Government will significantly improve the health of Victoria's rivers, floodplains and estuaries by 2010 to ensure that they are capable of delivering a wide range of services to the community.*
>
> *Our Water Our Future,* June 2004

Objectives and targets for water quality in the Yarra and Maribyrnong rivers are important instruments that drive the selection of appropriate actions to improve water quality.

Objectives and targets relating to the Yarra and Maribyrnong rivers are documented in a range of strategies and policies, primarily the State Environment Protection Policies (*Waters of Victoria*, *Schedule F7: Waters of the Yarra and Catchment* and *Schedule F6 Waters of Port Phillip Bay* [which provides nitrogen reduction objectives for the waterways entering the Bay]) the *Port Phillip and Westernport Regional Catchment Strategy* and draft *Regional River Health Strategy*.

Goal

The goal for rivers and creeks in the Port Phillip and Westernport Region, including the Yarra and Maribyrnong rivers, is for:

> *healthy rivers and creeks, with increased numbers of native fish, platypus and plants. Our rivers will continue to be a hub for recreation and our communities will actively participate in improving their condition.*
>
> Draft *Port Phillip and Westernport Regional River Health Strategy*

Targets

State environment protection policies specify the environmental quality objectives required to protect specified beneficial uses in the aquatic environment. Environmental quality objectives can also be used to define pollution as they indicate the levels of contaminants that are likely to cause impairment of those beneficial uses.

The SEPP (WoV) recognises that:

> *Although environmental quality objectives need to be attained as soon as practicable, the variation of environmental quality of surface waters on a Statewide scale will mean that:*
>
> *(1) the environmental quality of some surface waters will be better than the environmental quality objectives. In these cases, environmental quality should remain as close as practicable to background levels;*
>
> *(2) the environmental quality objectives for some surface waters may not be attained due to natural variation. In these cases, the background level becomes the environmental quality objective;*
>
> *(3) the environmental quality objectives may not be attained in all segments within the 10-year lifetime of the Policy. In these cases, regional targets need to be set for environmental rehabilitation;*
>
> *(4) the environmental quality objectives for some surface waters may not be attained due to extensive environmental modification. This should be taken into account when developing and prioritising actions to improve environmental quality and protect beneficial uses.*
>
> *SEPP (Waters of Victoria)* p. 13

Non attainment due to extensive environmental modification may be the case in the Yarra and Maribyrnong rivers. Schedule F7 (pertaining to the Yarra River) recognises that in certain parts of the Yarra and tributaries, primary contact recreation is protected only during baseflow and after a minimum period of five days after rain. Targets aimed at achieving these objectives need to be set in light of the extensive environmental modification of the Yarra and Maribyrnong rivers and in light of the prohibition of swimming in the lower Yarra.

It is the role of regional planning to determine what is feasible and affordable for government, industry and the community to achieve together over the short (five year) to medium (10-20 year) term and this may involve setting medium and short term targets.

Existing regional planning for the Yarra and Maribyrnong rivers provides a basis for establishing regional targets for the environmental condition of each river in the medium term (10 years).

In the *Port Phillip and Westernport Regional Catchment Strategy*, targets have been stipulated for the region, including the Yarra and Maribyrnong rivers, and their receiving waters (Port Phillip Bay). This is because the systems are connected and Port Phillip Bay targets will only be achieved by managing the rivers and creeks that flow into them. These targets include:

- Reduce the average annual nitrogen levels entering Port Phillip Bay by 1000 tonnes by 2006 (from SEPP).
- Reduce the amount of litter and other gross pollutants entering Port Phillip Bay and Western Port by 70% by 2015.

The process of defining what is achievable in river health over the next 10 years will occur through finalisation of the draft *Regional River Health Strategy* and development of a *Regional Water Quality Improvement Plan*.

These strategies will provide a clear objective for each river, and achievable targets to progress towards reaching environmental and recreational objectives specified in the relevant SEPP and priorities in the broader river health context. For example, the draft *Regional River Health Strategy* includes a target of 80% of water quality monitoring sites meeting SEPP objectives by 2015.

Furthermore, the draft *Regional River Health Strategy* contains condition targets based on the Index of River Condition. Long-term water quality condition targets for the main stem of the Yarra and Maribyrnong are:

- Upper Yarra River – Excellent
- Middle and lower Yarra – Good
- Maribyrnong River – Good.

It is recognised that these resource condition targets may need to be modified during the production of the *Regional Water Quality Improvement Plan*.

The Steering Committee recommends water quality targets in the Yarra and Maribyrnong rivers and their tributaries be refined through the development of a *Regional Water Quality Improvement Plan*.

Priority actions	Date	Lead	Partners	Status
3.1 Develop and refine regional water quality targets during the preparation of a Regional Water Quality Improvement Plan *	2007	MW	EPA, Urban water retailers, DSE, DPI, CMA, PV, Community, Industry	Existing program Funding from Australian Government CCI and State agencies Part of Rec 4.1 Very high priority

* Priority action in the *Regional Catchment Strategy* and draft *Regional River Health Strategy*

Chapter 4: Achieving water quality outcomes: issues and responses

The management of water quality is the most complex issue to be dealt with in the management of river health.

Victorian River Health Strategy, 2002

There are many different sources of contaminants to rivers that impact on water quality. Urban areas and rural pasture are major sources of nutrients and suspended sediments. Urban areas provide the greatest degree of toxicant and litter input, while urban and rural areas contribute microbial contamination. Within these broad areas, more specific sources can be identified associated with different contaminants (Table 7). An equally diverse program of actions is needed to address these diverse contaminant sources.

Table 7. Contaminants and their major sources

Source	Nutrients (N and P)	Suspended sediments	Toxicants	Litter	Pathogens
Urban stormwater	✓	✓	✓	✓	✓
Increased urbanisation	✓	✓	✓	✓	✓
Septic systems and unsewered areas	✓	✓	✓		✓
Illegal connections to stormwater or sewer	✓	✓	✓		✓
Sewerage spills	✓	✓	✓		✓
Rural run-off	✓	✓	✓		✓
Poor quality streamside zones	✓	✓			
Bed and bank erosion	✓	✓			

Assessment framework

A qualitative assessment was undertaken as part of the preparation of this report to evaluate actions to tackle water quality problems in the two rivers. Information from previous program evaluations, such as an evaluation of the Victorian Stormwater Action Program and an analysis of economic benefits of nutrient reduction in the Port Phillip catchment, informed the conclusions and recommendations outlined in this report.

Each program was assigned priorities on the basis of:

- degree of public concern and support
- feasibility (is it technology available, is it easy to implement)
- return on investment
- management effectiveness (likelihood of achieving desired change in water quality)
- pollutant weighting – link to the major source and number of pollutants to be managed (undertaken for intervention programs that directly influence water quality included in Chapter 4).

The top priorities are:

- Stormwater and rural land management to cut contaminant loads – nutrients, suspended sediments, pathogens, toxicants - carried by stormwater and rural runoff.

- Collating more information to manage faecal contamination in the lower Yarra effectively.
- Managing septic tanks, sewered areas, sewage spills and illegal connections. These are a high priority for managing microbial contamination and human health risks as well as local nutrient 'hot spots'.
- Managing litter is a medium priority in the whole of catchment context but high priority in urban rivers and creeks that have higher levels of litter, such as the lower Yarra.

Developing a *Regional Water Quality Improvement Plan* is a high priority to set regional targets and help managers identify where each management action will prove the best value.

Issue: Planning for water quality improvements

Water quality is difficult to manage because pollution can be caused by different actions at thousands of locations within the Yarra and Maribyrnong catchments. These can range from dropping a piece of litter, making an illegal connection to the stormwater system, breaching an EPA discharge licence, leaking sewerage systems or undertaking an inappropriate agricultural practice. Controlling 'point' sources is theoretically straightforward through regulatory mechanisms. But, controlling diffuse sources is more difficult because it involves a range of different kinds of land use and many diverse activities.

Coordinating and integrating the agency responses to water quality management is the best way to reduce pathogen, nutrient, toxicant and litter entering the Yarra and Maribyrnong rivers.

Response: Integrated water quality planning

Water quality in the Yarra and Maribyrnong catchments is a subject of several integrated regional plans in Victoria and the Port Phillip and Westernport region. These include the *Regional Catchment Strategy* that sets the framework for the overall coordination of natural resource management in the region.

Sitting under the *Regional Catchment Strategy* are many other plans that deal with specific issues or sites. These include:

- the draft Regional River Health Strategy
- the Yarra Catchment Action Plan
- the Maribyrnong Catchment Action Plan
- the Port Phillip Bay Environmental Management Plan
- stormwater management plans and domestic wastewater management plans prepared by each local council.

These plans provide some guidance on water quality priorities, but they are either broad (the *Regional Catchment Strategy* and draft *Regional River Health Strategy*), focus on a single specific issue and do not cover the range of water quality contaminants across the catchments in an integrated manner (such as nutrients) or are area specific (stormwater management plans).

The *Regional Catchment Strategy* and draft *Regional River Health Strategy* acknowledge these gaps in current planning and propose development of a *Regional Water Quality Improvement Plan*. Such a plan will also assist in achieving the objectives of the *Port Phillip Bay Environmental Management Plan*. Work recently began on the water quality improvement plan to guide regional investment in water quality initiatives that cover all contaminants discussed in this report. A draft plan will be completed by 2007, with the final proposed by 2008.

The Steering Committee recommends integrated water quality planning for the Yarra and Maribyrnong catchments to be strengthened with all responsible agencies.

Priority actions	Date	Lead	Partners	Status
4.1 Develop a Regional Water Quality Improvement Plan *	Draft 2007; Final 2008	MW	EPA, Urban water retailers, DSE, DPI, CMA, PV, DHS, Community, Industry	Recently commenced program Funding from Australian Government CCI ($450,000) and state agencies ($550,000) Very high priority
4.2 Complete development of the *Port Phillip and Westernport Regional River Health Strategy*	2006	MW	EPA, Urban water retailers, DSE, DPI, CMA, PV, Community, Industry	Existing program High priority

* Priority action in the *Regional Catchment Strategy* and draft *Regional River Health Strategy*

Issue: Urban stormwater and increased urbanisation

> *Urban stormwater can provide a range of community benefits. Its proper management can assist river health.*
>
> *Local government (together with Melbourne Water in Melbourne) will continue to be responsible for drainage assets and ensuring that the quality of stormwater meets river health objectives and satisfies broad community and aesthetic and amenity values.*
>
> *Our Water Our Future,* June 2004

Impervious areas such as roads, carparks and roofs are the major sources of contaminants entering the Yarra and Maribyrnong rivers through the stormwater system.

Stormwater is now the most significant source of pollution in Melbourne streams and wetlands, mainly heavy metals (zinc, cadmium, copper, nickel, lead), petroleum hydrocarbons, faecal matter, pesticides, nutrients and litter.

Urban drainage systems were designed to dispose of stormwater rapidly to minimise the risk of flood damage to property. But this efficient drainage system rapidly carries contaminants in stormwater to rivers and creeks. The drainage approach also did not consider the value of stormwater as a water resource.

In addition, rapid delivery of large volumes of water changes stream hydrology, habitat and channel form. Only a small part of a catchment needs to be developed and conventionally drained before water quality deteriorates and the biology of the receiving stream is severely degraded (Walsh *et al.,* 2004).

Melbourne is expected to continue growing over the next 30 years. Population increases (Figure 13) of around 20% are expected in the Yarra catchment and 15% in the Maribyrnong catchment by 2031. Expected increases in the built-up area will put pressure on water availability and sewerage infrastructure and increase stormwater contaminant loads.

Population projections suggest that the residential impervious area in the Yarra catchment is expected to increase by 1400 hectares by 2015, and 2600 hectares by 2030. This increase equates to about 2.2 tonnes of additional nitrogen entering the Yarra River in 2015 and an additional 4.2 tonnes of nitrogen entering the Yarra River in 2030. Similar rates of increase can be expected for other stormwater contaminants including phosphorus, suspended sediment and toxicants and litter.

Using a range of tools such as litter traps, retarding basins, wetland systems and vegetated drainage lines can improve the quality of stormwater. Some of these tools can be installed for existing stormwater systems; all can be installed for new urban developments by applying water sensitive urban design (Walsh *et al.,* 2004). In addition, as inner Melbourne becomes more urbanised, methods of treating urban runoff from established urban areas should be

investigated. This includes investing in new treatment technologies for confined urban areas. An example is the recently installed Barry Road Pilot Toxicant Filter.

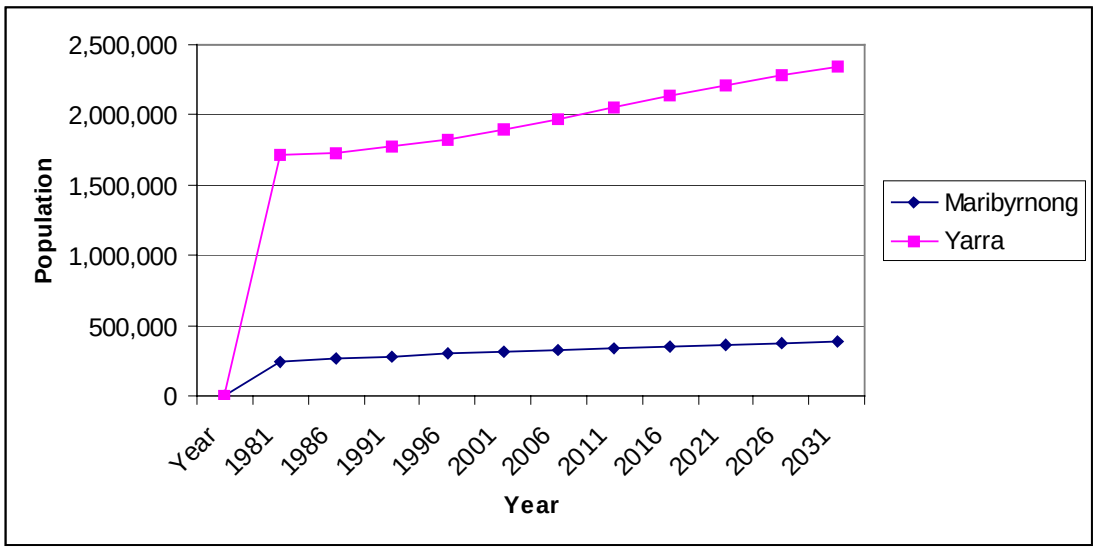

Figure 13. Population projections for the Maribyrnong and Yarra catchments

Response: Managing existing urban stormwater systems

All local councils within the Yarra and Maribyrnong catchments have developed stormwater management plans.

The estimated cost to implement priority stormwater management actions for all 38 councils in the Port Phillip and Westernport region is $65 million. Funding for plans focussed on councils in the Yarra and Maribyrnong catchments is expected to cost $20 million.

The plans identify risks to stormwater quality and priority actions to improve the quality of stormwater before it enters rivers and creeks. The plans aim to reduce stormwater contaminants through a range of mechanisms including:

- Infrastructure - wetlands and litter traps.
- Non-structural approaches including planning, operational activities, education and awareness programs, capacity building, regulation and enforcement.
- Implementation of stormwater management plans varies throughout the region and the plans vary in how they deal with contaminants, particularly microbial contaminants and toxicants.

There is a need for additional resources to implement stormwater management plans and other key stormwater management actions, especially focussed on areas that will impact on water quality in the lower Yarra.

A lack of capacity (skills and knowledge) has also been identified as a key factor limiting the systematic implementation of stormwater management by local government.

The availability of performance objectives and the development of design resources and assessment tools over the last five years has helped industry apply water sensitive urban design principles and practices. But in many cases councils have held back from applying these resources and tools because of insufficient skills and reluctance to accept the perceived risks involved in approving and implementing water sensitive urban design projects.

To assist in overcoming this problem, the Clearwater Program was developed. It is a joint initiative of the Municipal Association of Victoria (MAV) and the Stormwater Industry Association of Victoria (SIAV). It is funded through the State Government's Victorian Stormwater Action Program. The Program has developed and delivered education and training packages for local government and stormwater industry professionals, addressing the sustainable management of urban stormwater, and providing information and resources to assist in the implementation of best practice principles. A key component of Clearwater is

facilitating the establishment of partnerships and networks across the state ensuring local government and industry professionals can continue to build knowledge and capacity, and remain at the forefront of sustainable urban stormwater management. Negotiations are currently underway between the MAV, EPA Victoria, SIAV and Melbourne Water to continue funding for the program beyond 2005-06.

Domestic wastewater management plans being prepared in municipalities with significant numbers of septic tanks will also assist in deciding where to focus stormwater management activities. (See later in report for a further explanation of these plans and the issue of septic tanks.)

The Steering Committee recommends that implementation of stormwater management plans and other key stormwater management actions are accelerated.

Priority actions	Date	Lead	Partners	Status
4.3 Develop stormwater action program(s) including a program to implement urban stormwater management plans and domestic wastewater management plans	2005/06	MW	MAV, LG, DSE	New program [5] Estimated $20M Very high priority
4.4 Continue the *Clearwater* urban stormwater capacity building program to support local government and industry in best practice stormwater management	Ongoing	MAV	MW, EPA, SIAV, DSE	Existing program Not funded past 2006 Estimated $350,000/year High priority

Response: Water sensitive urban design

> *Include water sensitive design criteria in amended Clause 56 (residential Subdivision Provisions) of the Victorian Planning Provisions.*
>
> *Melbourne 2030*

Water sensitive urban design (WSUD) is likely to be the most effective management action for protecting and restoring ecosystem health and improving water quality in local rivers and creeks (Walsh *et al.*, 2005).

WSUD involves a practical balance between traditional and contemporary approaches to drainage and requires a change in practice from large, end-of-pipe treatment systems to a distributed approach where problems are addressed before they enter waterways.

WSUD recognises stormwater and wastewater as a resource and promotes re-use to cut demands on high quality drinking water and impacts on the environment.

A key component of WSUD is improving stormwater flow control and water quality by minimising the export of untreated stormwater through pipes to waterways and bays.

WSUD can be introduced to greenfield land development sites, redevelopment sites in built-up areas and, in some instances, to retrofits in urbanised catchments. The scale of application can range from individual houses, streetscapes and precincts, to whole catchments.

The *Sustainable Neighbourhoods* provisions propose revised residential subdivision provisions in all planning schemes to support water sensitive urban design. Draft integrated water management provisions include potable water conservation provisions, water reuse and recycling, potable water substitution, and urban stormwater run-off management (including urban run-off quality). Public consultation has occurred on the draft provisions, prior to further revision and consideration by the Minister for Planning. Implementation in planning schemes is expected by mid 2006.

[5] Stormwater management plans and domestic wastewater management plans are existing programs, but require new dollars to implement. The implementation of these plans is a priority.

The bulk of new development within the Yarra and Maribyrnong catchments will be in the form of infill development (such as in activity centres). Subdivision provisions will therefore have less impact in these areas. The *Sustainability in the Built Environment* project is examining environmental sustainability requirements for residential development through the development approvals framework and includes energy (greenhouse), water and stormwater management components. *Our Water Our Future* includes a commitment to align the statutory planning and building approvals systems to support water conservation and enable the use of recycled water and alternative supplies. Consistent with the Sustainability in the Built Environment project, this will provide for a consistent, performance-based approach to sustainable urban water management.

The *Clean Stormwater* Project establishes a broader framework that local planning authorities can use to deliver on-site performance objectives for stormwater management. The *Clean Stormwater* Planning Framework incorporates all the elements required at the local level to support environmentally responsible stormwater management for small-scale urban renewal and infill developments.

Industrial or road development currently sits outside these WSUD mechanisms, so there is opportunity to expand their scope to include these additional sources of contamination.

Local government's capacity to enforce planning and building requirements requires attention. The EPA *Code of Practice on Sedimentation from Construction Sites* is already incorporated into Victoria Planning Provisions. Although this is intended to prevent sediment runoff from construction sites (a major source of sediment in urban catchments) local government is inadequately resourced to monitor building sites and enforce the provisions.

The Steering Committee recommends water sensitive urban design to be required for all urban development though the statutory planning process and building regulation system.

Priority actions	Date	Lead	Partners	Status
4.5 Continue existing WSUD program in residential areas	Ongoing	DSE	Building Commission, MAV, Melbourne Water, EPA, DHS	Existing program Part of Rec 4.3 Funded Very high priority
4.6 Extend WSUD program to non residential areas	Ongoing	DSE	Building Commission, MAV, Melbourne Water, EPA, DHS	Existing program Part of Rec 4.3 Funded Very high priority
4.7 Continue to implement a comprehensive WSUD capacity building program for local government and industry through the *Clearwater* program	Ongoing	MAV	MW, EPA, SIAV, DSE, LG	Existing program Not funded past 2006 Part of Rec 4.4 and CCI funded project ($400,000 CCI and $410,000 state/local partners) Very high priority

Issue: Lack of understanding of causes and extent of faecal contamination

High levels of human faecal contamination in the Yarra River are a concern. The causes and extent of this contamination are not fully known. Improved knowledge is required to target on ground works in priority areas.

Response: Faecal investigation

Faecal investigation programs enable targeted actions to manage areas of unacceptable faecal contamination.

Melbourne Water, in consultation with EPA Victoria and the Department of Human Services (DHS), is investing $930,000 in a three-year program to investigate the likely origins and sources of faecal contamination in the lower and middle reaches of the Yarra River. The program will identify priority sources of contamination, clean-up measures and ongoing management actions.

In 2005, 40 potential input sources to the Yarra River are being assessed, from Warrandyte to Southgate, including major input streams and stormwater drains, in addition to 12 sites within the Yarra itself. The investigation is attributing the likely origins of faecal material in a waterbody to one of three groups: human, herbivore (cattle, horses, sheep and possums) or other (dogs, cats, rats and birds). It will also quantify the relative contributions of contamination to the Yarra from various input streams and drains. For example, recent testing of the Prahran Main Drain has identified human contaminants.

The Steering Committee recommends knowledge on faecal contamination be improved.

Priority actions	Date	Lead	Partners	Status
4.8 Continue to implement a faecal investigation program in the Yarra	2005-2008	MW	EPA, DHS	Recently commenced program ($930,000) Very high priority

Issue: Illegal stormwater to sewer connections

Illegal stormwater to sewer connections are not common across the entire stormwater and sewerage network.

Of the possible illegal connections, the more common is where stormwater is connected directly into the sewerage system. This can occur if a property owner or plumber connects the stormwater plumbing directly into the sewerage pipework via a gully trap or inspection point. Illegal connections can lead to sewerage systems being overloaded and spilling, mostly in wet weather events.

Water industry hydraulic modelling and experience indicates that infiltration of stormwater into the sewerage system makes up a small percentage of overall sewage flows, with illegal connections contributing only a small percentage of general infiltration rates. Furthermore, while infiltration of water into sewers can occur through cracks in pipes and leaking joints, exfiltration (flows out of sewers) is less likely to occur as water inside the pipes is usually not under pressure.

Illegal connections are not common and are dispersed throughout the metropolitan system; comprehensively identifying them (generally through smoke testing) is not viable economically. Yarra Valley Water uses hydraulic models to identify areas where significant infiltration comes from and carry out any necessary further investigation.

Another type of illegal connection is where the sewer is connected directly into the stormwater system. In this case, sewage can flow directly into a creek. This type of illegal connection can cause localised increases in microbiological organisms, suspended solids, nutrients and heavy metals. Sewers connected into the stormwater system appear to be rare (based on urban water retailer data), however, given their potentially direct connection to the stream network should be a priority for investigation.

Response: Managing illegal connections

Tracking illegal connections is an expensive operation, however given their potential for local contamination of rivers and creeks, they should be a priority for investigation. The responsibilities for identifying illegal connections are:

- Illegal stormwater connections to the sewer - the government-owned urban water retailers.
- Illegal plumbing connections of sewerage directly to stormwater drains - the local council or Melbourne Water, depending on the drain.
- Any non-conforming plumbing undertaken by a registered plumber - the Plumbing Industry Commission (PIC).

If an illegal sewer to stormwater connection is found, the *Health Act 1958* provides local councils with sufficient powers to require the property occupier or owner to rectify the problem.

The Steering Committee recommends that locally significant illegal connections be managed as a matter of priority.

Priority actions	Date	Lead	Partners	Status
4.9 Target high priority illegal connections (as identified by the faecal investigation)	Ongoing from 2006	Local government, MW	EPA, PIC, urban water retailers	Funded from existing operational budgets High priority (where problem identified)

Issue: Septic tanks and unsewered areas

Septic tanks are used to treat domestic wastewater in the outer suburban and rural areas where there is no reticulated sewerage system. About 35,000 properties are currently serviced by septic tanks in the Yarra catchment. Increasing densities of septic tanks may potentially cause water quality problems in many areas, especially the outer metropolitan areas of the catchment.

Septic tanks can provide sustainable treatment of domestic wastewater provided the lot size and land capability are suitable and they are properly installed, operated and maintained, and replaced when necessary. Conversely, septic tanks can malfunction when they are old, poorly maintained, improperly operated, or situated in an unsuitable area. Older systems (typically pre-1988) were not necessarily designed to manage greywater.

Overloaded or malfunctioning systems lead to elevated bacteria, nutrient, toxicant and suspended solids. There is limited data on pollutant loads entering rivers and creeks from overloaded or malfunctioning septic tanks, but much higher concentrations of contaminants are present within septic systems than those discharged from tertiary treatment plants (Table 8).

In managing the impact of domestic wastewater on the Yarra River (and elsewhere), it is critical that land is not developed unless it can be sewered or domestic wastewater is capable of being treated and disposed of on-site, including the possibility of recycling. Consequently, attention must be paid to the process for undertaking land capability assessments in regard to the disposal of domestic wastewater, including the role of local councils in the process.

Preliminary analysis in FILTER has shown that nutrients and suspended solids from septic tanks are considerably less than from residential sources and agricultural runoff. However, poorly maintained and leaking septics can be a significant local contributor of pathogens into nearby creeks, especially where contaminated groundwater contributes to base flow, and lead to localised increases in nutrients.

The *Regional Catchment Strategy* identifies failing and poorly maintained septic tanks as a serious issue for surface water and a priority for management. The strategy urges and encourages acceleration of Yarra Valley Water's Sewerage Backlog Program.

Furthermore, alternative wastewater treatment systems may be the best solution in some areas where it is not feasible to connect to the existing reticulated sewerage system and domestic wastewater cannot easily be treated adequately and disposed of on-site.

The Steering Committee recommends that the impact of domestic wastewater on domestic and public health be reduced through improved management of septic tanks.

Table 8. Estimated nutrient concentrations and loads for septic tanks compared with a typical wastewater treatment plants (TP = total phosphorus, TN = total nitrogen)

	Volume (l/day)	TP (mg/l)	TN (mg/l)	TP (kg/y)	TN (kg/y)
From septic tank	700	10	50	35,770	178,850
From treatment plant	700	0.5	5	1,789	17,885

Response: Increased sewerage servicing

In the Maribyrnong catchment, City West Water has completed residential backlogs and is examining options to accommodate growth.

As noted above, within the Yarra Catchment about 35,000 properties are currently serviced by septic tanks. Of this number, local councils have identified about 18,500 properties to date as requiring a reticulated sewerage service.

Where nitrogen, pathogens and toxicant pollution is coming from on-site septic systems, sewering, although expensive, is an effective means of reducing pollution entering both rivers and creeks. Yarra Valley Water's Sewerage Backlog Program therefore should remain a priority for managing nutrient hot spots and human health issues within the Yarra catchment.

Complete sewering of all properties identified in the current program with conventional sewerage services would cost more than $250 million. Yarra Valley Water is proposing that its current 40-year time frame be reduced to 20 years (with works complete in 2025). The YVW water plan identifies expenditure of $143 million over 10 years, with the ESC approving $25.7 million for the next three years.

Furthermore, councils located on the urban fringe and rural councils are encouraged under the SEPP (Waters of Victoria) to develop and implement domestic wastewater management plans. Development of these plans is being funded under the Country Towns Water Supply and Sewerage Program - $200,000 has been provided to five councils in the Yarra catchment to develop and improve existing plans. These plans identify the threats domestic wastewater poses to water quality in local areas. The plans will assist with the long term planning for backlog sewerage and address public health issues associated with septic tanks and consider a range of monitoring, maintenance and improvement options for managing septic tanks.

The Steering Committee recommends an acceleration of Yarra Valley Water's backlog sewerage program.

Priority actions	Date	Lead	Partners	Status
4.10 Accelerate Yarra Valley Water's backlog sewerage program to become a 20 year program	2025	Yarra Valley Water		Accelerated program Requires approx $250M ESC approved $25.7M for next 3 years High priority

Response: Regulation and enforcement of septics

Sewering properties in the Yarra Valley Water Sewerage Backlog Program will take many years. Not all properties with septics will be connected to sewerage services. Therefore, it is important that septic tanks be operated and maintained appropriately, with replacement when required, and with regular inspection and monitoring to reduce off-site impacts to waterways.

Regulations governing unsewered properties require that they contain wastewater on site. Where soils, rainfall and topography can accommodate this, appropriate and regular maintenance is required to keep septic systems operating appropriately and prevent them from failing.

Councils are responsible for compliance and regular monitoring of domestic waste water systems. But, historically, septic tank permit conditions have rarely been enforced. There is

also some confusion about roles and responsibilities and what powers exist for the proper regulation and management of septic tanks.

The MAV has run a Smart Septics Program for councils throughout Victoria to improve council's capacity to manage septic tanks effectively.

As noted earlier, councils are preparing domestic wastewater management plans. As a result of the plan process, it is anticipated that issues will be identified which may help to highlight roles and responsibilities for septic tank management and what (if any) changes to legislation and powers of enforcement are required for the ongoing management of septic tanks.

The Steering Committee recommends that roles and responsibilities and the regulatory framework for the management of septic tanks be clarified and strengthened if required.

Priority actions	Date	Lead	Partners	Status
4.11 Councils monitor and enforce compliance with septic tank installation and operational conditions, esp., in priority areas identified through domestic wastewater management plans	Ongoing	Local government		Existing Part of core operations High priority
4.12 Government consider roles and responsibilities and adequacy of current regulatory framework for the management of septic tanks	2006-07	DSE	Local government, MAV, EPA	New action Funded from operational budgets High priority

Issue: Sewage spills

Melbourne's sewerage network is mainly gravity based, transporting sewage from suburbs as far away as Hurstbridge to the Eastern and Western treatment plants. Occasionally, the sewerage systems spill, particularly after high rainfall, leaking highly diluted sewage into rivers and creeks.

Preventing sewage spills is critical to protecting the environment and public health.

Spills occur:

- in wet weather when:
  - water leaks into the sewers, and
  - the sewers are not large enough to cope with the flow
- in dry weather when:
  - the sewer becomes blocked, or
  - a sewer collapses.

The volume and number of spills have been systematically reduced in the past few years through major sewerage upgrades by Melbourne Water and the urban water retailers (Yarra Valley Water, South East Water and City West Water). Parts of Melbourne's sewerage system were installed more than 100 years ago and, as Melbourne has grown, new areas have been progressively connected to the system. As a result, flows in some of the older sewers during wet weather exceed their original design capacity.

Emergency relief structures are typically located at low points in the sewerage system and are designed to act as 'safety valves' and direct the flow of highly diluted sewage into the stormwater system during high rainfall events. These arrangements minimise the risk of sewage spills occurring on customers' properties.

Response: Reducing sewage spills

The SEPP (WoV) requires that "Sewerage infrastructure contains flows associated with a one in five year rainfall event."

Melbourne Water and the urban water retailers are upgrading sewers to comply with this SEPP objective by 2011. For larger rainfall events (less frequent than one in five) installing emergency relief structures is the most cost–effective approach to managing and mitigating risks associated with sewage spills because they allow flow to escape from the system in a controlled manner, in preference to spills on properties.

The North-Western Trunk Sewer was completed in 1998. This eliminated all significant non-compliant emergency relief structures in the Maribyrnong River system. The remaining non-compliant emergency relief structures will be eliminated under Stage 3 of the Spills Abatement Program.

The Northern Sewerage Project will commence construction in late 2006. It will connect the sewerage system near the Merri Creek at Coburg and the Moonee Ponds Creek in Pascoe Vale to Melbourne's North Western Sewer in Essendon and will virtually eliminate sewage spills into these Yarra tributaries. The project has an estimated capital cost of $300 million split between Melbourne Water and Yarra Valley Water and is due for completion in 2011.

In total, during the next 10 years, Yarra Valley Water ($280 million) and Melbourne Water ($179 million) will spend an estimated $459 million to reduce spills within the Yarra and Maribyrnong catchments, including a significant component for the Northern Sewerage Project.

The Steering Committee recommends that Melbourne Water and Yarra Valley Water upgrade the sewerage system to reduce sewage spills.

Priority actions	Date	Lead	Partners	Status
4.13 Upgrade sewerage system and reduce sewage spills (including the Northern Sewerage Project)	2011	MW, YVW		Proposed program Funded ($459M over 10 years incl, $300M over 6 years for NSP) High priority

Issue: Litter

Litter is the most visible sign of water pollution and is the aspect most disliked by the general community. It can affect tourism by discouraging repeat visits or through negative feedback to other potential visitors.

A recent study of litter hot spots in the Yarra catchment identified the Prahran Main Drain, a 725 hectare catchment that drains into the Yarra, as a major source of litter entering the Yarra River.

Response: integrated litter management

An integrated approach to managing litter is needed. This incorporates source management such as education (see community section of this report), enforcement and treatment such as water sensitive urban design (refer to section on WSUD above) and litter traps.

The Victorian Litter Action Alliance (VLAA) was formed in April 2000 as the peak body for litter management and prevention in Victoria and aims to provide a coordinated approach to preventing litter in Victoria across state and local government, industry and community sectors. VLAA members coordinate their own litter prevention activities, but more importantly, VLAA aims to provide coordinated successful litter prevention programs for the whole state based on what works.

Sustainability Victoria was formed in October 2005 and includes the role of the former EcoRecycle Victoria. It assists in developing and implementing litter reduction programs in conjunction with relevant agencies.

The policy context for litter is provided by *Victoria's Litter Reduction Strategy* (1995). The strategy sets the directions and priorities for litter reduction for the large number of organisations that have a responsibility for some part of litter management. In the Yarra and Maribyrnong, these principally are local government, Sustainability Victoria, Parks Victoria and Melbourne Water, as well as industry and non-government organisations, and EPA Victoria in terms of the enforcement of littering regulations.

Since the introduction of the *Victoria's Litter Reduction Strategy,* local government, state agencies and industry have implemented a range of anti-litter programs including litter education officers across the state, various anti litter campaigns (e.g. "Drains to the Bay"), studies into littering behaviour and the installation of litter infrastructure.

Sustainability Victoria, in partnership with the Office of Commonwealth Games Coordination (OCGC) and the Victorian Litter Action Alliance, aims to help make the Commonwealth Games successful through a campaign to stop littering. For example, the Commonwealth games litter barge was launched last year and has cleared more than 1800 cubic metres of litter from the Yarra and Maribyrnong rivers.

State Government has recently provided $4.3 million to reduce litter in the lead up to and after the Commonwealth games, including public education and awareness campaigns, placement of new recycling bins at key locations, such as sporting grounds, and litter traps on the Yarra.

Furthermore, Melbourne Water will design and install a series of nets along the Prahran Main Drain to capture litter coming from the Chapel Street area. Parks Victoria will also support litter reductions by installing three floating litter traps on the Yarra. The floating traps will capture residual materials escaping the main drain. These projects will reduce litter load to the Yarra River by 182 cubic metres per year.

Melbourne Water has recently formed a steering committee to implement the project and has completed a strategic review of opportunities for litter management within the cities of Melbourne, Yarra, Stonnington and Boroondara. The strategy provides a summary of each council's litter management activities and identifies actions to improve and better coordinate those activities. A project manager has been appointed and is working with the councils to implement priority actions.

The Steering Committee recommends integrated implementation of litter management initiatives across key agencies.

Priority actions	Date	Lead	Partners	Status
4.14 Continue current litter collection and management programs	Ongoing	Yarra: Downstream Dights Falls - PV, Upstream Dights Falls – MW; Maribyrnong: Downstream Canning Street Ford – PV, Upstream Canning Street Ford - MW	Local Government	Existing program Funded (approx. $200,000/year) Medium[6] priority
4.15 Implement the Commonwealth Games Litter Campaign in the lead-up to and post the Commonwealth Games	2005-06	Sustainability Victoria	VLAA, MW, PV, OCGC, LG	Existing program Funded (with additional $4.3M funding) Medium priority

Issue: Rural and forest run-off

Rural land occupies 60% of the Yarra and Maribyrnong catchments. The diverse profile of land management and agricultural industries within the Yarra and Maribyrnong catchments ranges from livestock grazing through to highly productive horticultural or intensive animal enterprises. Run-off from rural land has been identified as a major source of contaminants, including nutrients (nitrogen and phosphorus), toxicants (pesticides), suspended solids and pathogens (as measured by *E. coli*), to rivers and creeks.

In rural areas, intensive agriculture occupying less than 5% of a catchment area leads to a doubling in pathogen concentration and risk (CRC for Water Quality Treatment, 2004). Analysis using the FILTER model also has shown a substantial increase in nutrient and

[6] If litter strategy recommends more litter collection, then additional funds will be required.

suspended sediment generation associated with a change from cropping to intensive horticulture. Increased viticulture is also changing the types of substances being used in rural catchments for example, use of nitrogen fertilisers, fungicides and insecticides.

Many management practices can adversely affect water quality in rural and forested areas. These include:

- Inappropriate use of land (where the enterprise does not match the capability of the land)
- Over/under grazing
- Unrestricted stock access to gullies and streams
- Poor irrigation, drainage, nutrient (fertiliser and effluent) and biocides management
- Poorly sited and maintained septic tanks
- Discharge from unsealed roads to rivers and creeks.

Preliminary analysis of nutrient and sediment loads in the Yarra catchment using the FILTER model is presented in Chapter 2. While *E. coli* is not modelled in the FILTER model, research has shown that dairy cow crossings and cattle access to unfenced streams in grazed pasture, can considerably affect water quality (Davies-Colley *et al.*, 2004). Faecal contamination, as indicated by *E. coli*, was particularly marked (a sharp spike peaking at 50,000 organisms/100 ml was noted at one cattle crossing), but there was also appreciable mobilisation of nitrogen and fine suspended matter causing turbidity. Excluding cattle from channels by riparian fencing should greatly improve water quality.

Response: Managing run-off from rural and forested areas

The challenge for land managers in rural areas is to ensure that run-off from their land into tributaries and the Yarra and Maribyrnong rivers is of the highest possible standard before moving through the urbanised catchments of Melbourne. This can only be achieved through implementing well-informed best practice rural and forestry land use and land management activities.

The Catchment Management Authority, the Department of Primary Industries and the Department of Sustainability and Environment utilise a range of mechanisms to encourage best practice including educational programs and incentives.

Current gaps in the program include:

- Limited research and extension programs targeting diffuse pollution sources on intensively managed farms in hot spot catchments.
- Many rural land managers work full-time elsewhere. Consequently, a lack of time, resources and knowledge is a major barrier to implementing sustainable land management practices.

In forested areas, it is vital that the Code of Forest Practices is adhered to and roads are managed according to best practices to minimise the impact of run-off into rivers and creeks. The Code is currently being reviewed with a revised Code expected in 2006. Water quality impacts will be a major consideration in the review.

Additional resources to develop and implement best management practices in rural areas are a priority for improving water quality in the Yarra and Maribyrnong catchments. Implementing best management practices through Landcare and primary industry programs, coupled with targeted incentives schemes, have succeeded in achieving increased awareness, knowledge and practice change.

Modelling undertaken and an assessment of economic benefits of nutrient load reduction in the Port Phillip catchment have shown that the adoption of best management practices can significantly reduce nutrient and sediment loads. The most cost-effective means of reducing total nitrogen loads is applying best horticultural management practices, with the introduction of buffer strips the most cost-effective means of reducing total phosphorus loads. As part of the development of the Regional Water Quality Improvement Plan, areas of high priority for the implementation of rural and forestry best practices will be determined. A project currently being undertaken by the Department of Primary Industries, and funded by the Commonwealth's Department of Environment and Heritage Coastal Catchments Initiative, is specifically identifying and evaluating a range of agricultural best management practices in the region. Acceleration of implementation of best practice is likely to come from

existing State Government funding, Natural Heritage Trust and industry sources, based upon the need for improved knowledge of where to target these resources.

The Steering Committee recommends acceleration of the implementation of best management practice programs in rural and forested areas.

Priority actions	Date	Lead	Partners	Status
4.16 Continue to implement existing forest and agricultural best management practice programs	Ongoing	Various (DPI, CMA, DSE, LG, Landcare, industry)		Existing program Funded (approx. $500,000/year) High priority
4.17 Determine priority areas for implementation of agricultural and forest management best management practice programs	2007	MW (through WQIP process)	DPI, DSE, EPA, Local Government, CMA, Industry, Landcare	Funded through development of WQIP Very high priority

Issue: Poor quality riparian zones

In rural areas, well-vegetated riparian (streamside) zones filter run-off, reducing pollutants entering rivers and creeks. Riparian vegetation is also important for habitat and food resources for many aquatic animals.

In the Yarra and Maribyrnong catchments, land use changes, vegetation clearing, stock access and weeds are the main factors causing poor riparian zones.

Response: Improving riparian vegetation

The *Regional Catchment Strategy* identifies healthy rivers and riparian zones as important and the underpinning draft *Regional River Health Strategy* identifies specific priorities for action. These priorities have been incorporated into Melbourne Water's Healthy Rivers works program.

The Steering Committee recommends the implementation of priority riparian vegetation management actions identified in the draft Port Phillip and Westernport Regional River Health Strategy.

Priority actions	Date	Lead	Partners	Status
4.18 Implement priority riparian vegetation initiatives identified in the draft Port Phillip and Westernport Regional River Health Strategy	Ongoing	Melbourne Water	DSE, DPI, CMA	Existing program MW frontage program approx $1.1M/year Medium priority

Issue: Bed and bank erosion

Excessive erosion can lead to an increased sediment load in rivers and streams, which smothers habitat and reduces light availability. In addition, nutrients such as phosphorus and nitrogen bind to soil particles so bed and bank erosion can increase nutrient loads. Erosion was more prevalent in the past as rivers and creeks responded to land use changes such as clearing and draining of swamps. This accelerated erosion in many of the rivers and streams in the Yarra catchment has been stabilised, but erosion still is a problem for some rivers and contributes to localised poor water quality, for example, Mullum Mullum Creek.

Response: Bed and bank stabilisation

Priorities for bed and bank stabilisation have been identified in the draft *Port Phillip and Westernport Regional River Health Strategy* and incorporated into Melbourne Water's Healthy Rivers works program.

The Steering Committee recommends implementing actions identified in the draft *Port Phillip and Westernport Regional River Health Strategy* to address bed and bank instability in the Yarra and Maribyrnong rivers.

Priority actions	Date	Lead	Partners	Status
4.19 Implement very high priority bed and bank stabilisation actions identified in the draft Port Phillip and Westernport Regional River Health Strategy	Ongoing	Melbourne Water		Existing program About $1M/year Medium priority

Issue: Dredging and vessel impacts

Dredging

Recreational and commercial boating is an important beneficial use of the Yarra and Maribyrnong rivers. Sediment removal or dredging is required at times to maintain appropriate waterway dimensions.

Any dredging operations in the two rivers require careful planning to minimise the impact on water quality. Water quality issues concern turbidity at the dredge and disposal locations and mobilisation of contaminants in the water column. Low to moderate contamination levels have been detected in Yarra River sediments with lead, zinc, and petroleum hydrocarbons at times exceeding EPA Victoria clean fill criteria.

Vessel impacts

Both recreational and commercial boating have grown significantly in recent years on the Yarra River and, to a lesser extent, on the Maribyrnong River. Boating activity reduces water quality when sewage, bilge and grey water are disposed of inappropriately. Engine oil can also impact on water quality if appropriate precautions are not taken. Pump-out facilities have been provided for the disposal of sewage on the Yarra River at Federation Square, Charles Grimes Bridge and Docklands. A new facility on the Maribyrnong River at Edgewater Estate has been completed (but is awaiting the connection of power and water).

Response: Parks Victoria's "Two Rivers" Project

Parks Victoria is investigating potential solutions to both issues as part of its "Two Rivers" project. Outcomes from this project (when completed) will include actions that seek to address identified issues. The project is also seeking to develop a land and water access plan dealing with key access issues associated with both rivers.

The Steering Committee recommends the continuation of the Parks Victoria "Two Rivers" project.

Issue: Variation in natural flow

Stream flow affects water quality in two ways: through changes in the volume of water and changes in the rate of flow. Changes in volume affect the concentration of contaminants in the river (concentration increases as the volume decreases, all other factors being constant) and may also change the ability of water to buffer physical changes, such as air temperature. Changes to rate of flow affect the mixing of the water column and flushing of contaminants into the river and downstream.

The flow regimes below the Upper Yarra Dam have been significantly altered. Immediately below the dam, the river now flows almost constantly at 10 ML/day (SKM, 2004). From the inflow of Armstrong Creek through Warrandyte to Chandler Highway, the flow regime

mimics its natural pattern with the Upper Yarra Dam impact ameliorated by inflows from Yarra tributaries below the dam. Nonetheless, Yarra River flows have been reduced by 40-50% from natural levels (SKM, 2004).

In most Yarra River tributaries, water is being diverted directly from streams or harvested by farm dams for domestic or irrigation use. In many streams, this has reduced flows from natural levels.

In the more urbanised reaches of the Yarra (the Yarra and tributaries below Warrandyte), the increasing amount of impervious surface in the catchment contributes to very high rates of runoff loading and variation in flows. The smaller urban tributaries, in particular, are subject to very rapid rises in streamflow after relatively minor rainfall events. This extreme hydrographic variability creates a harsh environment for aquatic organisms, leads to marked change in the physical habitat of urban streams and rapid runoff of pollutants into these waterways.

The Maribyrnong River also contains diversions that reduce flows, but has the added impact of artificially higher flows during summer when dam releases from Rosslynne Reservoir are made to supply irrigators downstream.

While reductions in flow may exacerbate existing water quality problems, flows used specifically to dilute or flush pollutants away do not solve water quality problems. Instead, it is preferable to address these problems at the source, as outlined in the previous sections of this report.

Response: Determining and implementing the Environmental Water Reserve

Determining adequate environmental flow regimes to provide a sustainable Environmental Water Reserve (EWR) is recognised as a priority in the *Regional Catchment Strategy* and the draft *Regional River Health Strategy*.

Our Water Our Future has committed to establishing an EWR to provide for river health in the Yarra and Maribyrnong catchments. This will be achieved through the development of the *Central Region Sustainable Water Strategy* and streamflow management plans.

Melbourne Water has a program to enhance the EWR for priority stressed unregulated streams across the Yarra catchment by developing streamflow management plans. These are developed in consultation with water users and the community. Local Management Rules will be developed and implemented for smaller streams.

Streamflow management plans have already been completed for Diamond Creek, Hoddles Creek and the Plenty River catchments. Three new plans are under development for Olinda Creek, Stringybark Creek and the combined catchments of Pauls, Steels and Dixons Creeks. A further two plans will be developed for the Woori Yallock Creek and Little Yarra/Don River catchments.

Local Management Rules have been prepared for urban catchments including Kororoit, Mullum Mullum, Moonee Ponds, Darebin, Gardiners and Merri creeks. In addition, Melbourne Water is finalising an environmental flow study to inform the development of the EWR for the main stem of the Yarra River and the Watts and Plenty rivers.

In the Maribyrnong River, environmental flows have already been set under the bulk entitlement conversion process that granted bulk entitlements to Melbourne Water, Southern Rural Water and Western Water. These environmental flows were developed some time ago and will be reviewed to determine their adequacy for protecting river health. A mechanism to achieve this has not been developed. A streamflow management plan for the Upper Maribyrnong River (Deep Creek) is proposed and will be completed by 2009. Melbourne Water will undertake preliminary investigations into the Maribyrnong's water requirements by the end of 2005.

The Steering Committee recommends the continuation of current initiatives to develop the Environmental Water Reserve for the Yarra and Maribyrnong rivers, through the development of the Central Region Sustainable Water Strategy and streamflow management plans.

Issue: Climate change

Climate change is a major issue facing river and ecosystem health. Climate change predictions for Victoria to 2030 and 2070 (DSE, 2005) include an overall increase in temperature, an overall decrease in rainfall, more intense storms and increased severity of floods and droughts. This is likely to affect water availability for humans and ecosystems and is also likely to exacerbate water quality problems.

The *Our Water Our Future* action plan, which identified climate change as a key risk to the hydrology of water systems, identified the need for better knowledge and understanding. The Government will take part in a three-year collaborative research program with key national climate researchers, to better understand the risk of climate variability and climate change for Victoria. The Regional Water Quality Improvement Plan should consider the impacts of climate change on water quality in the rivers.

The Steering Committee notes the issue of climate change and encourages the continuation of existing research.

Chapter 5: Involving the community

One of the region's most important catchment assets is its community – its people and organisations – and their current and potential capacity to successfully address water quality.

Port Phillip and Westernport Regional Catchment Strategy 2004-2009.

Community standards and expectations for rivers have changed substantially in recent years and this has been reflected in more community interest and involvement in caring for rivers and creeks.

The range of beneficial uses for rivers outlined in the SEPPs (from water supply and active recreation to aesthetic enjoyment) is simply a reflection of the range of values the community associates with our rivers.

All agencies involved in the management of water quality are committed to community engagement. However, the challenge of engaging a population of around two million people is a difficult one.

Community engagement can take a variety of forms, including involvement in decision-making, involvement in on-ground works, and being made more aware of issues regarding water quality and river health.

Community involvement

Communities living in the Yarra and Maribyrnong catchments are involved in decision-making and on-ground works to improve water quality. Individual land managers and landowners, and organisations including Landcare and Friends groups, work on revegetation, erosion control, litter control, habitat conservation and other projects along sections of the Yarra. These and other volunteers make a highly valuable contribution to protecting local rivers and creeks.

Members of the community have participated in determining priorities and targets for rivers and creeks through State environment protection policies, the *Regional Catchment Strategy,* the draft *Regional River Health Strategy*, the *Yarra Catchment Action Plan* and the *Maribyrnong Catchment Action Plan.*

Extensive consultation processes were adopted in developing these strategies and the respective strategies contain information on involving the community in ongoing decision-making and target setting.

Community members also take part in a wide range of committees such as Melbourne Water's advisory committees, CMA committees, and committees established for specific projects such as the development of the waterway activity plans.

The CMA is assessing its community engagement mechanisms. Initial findings show that traditional approaches of engaging stakeholders and the community are insufficient to tackle the challenges of the Yarra and Maribyrnong catchments.

The CMA and Melbourne Water are exploring ways to improve coordinated and complementary community engagement, particularly at the levels of strategy development and standing community engagement structures.

Consequently, Melbourne Water proposes to seek further input from stakeholders and the community to determine whether the establishment of consultative committees for each major metropolitan river catchment using local municipality boundaries would meet their needs, as well as the needs of Melbourne Water.

A community consultation strategy is also currently being prepared for the development of the *Regional Water Quality Improvement Plan.*

Community members in the Yarra and Maribyrnong catchments also actively participate in on-ground works improving water quality in rivers and creeks through involvement in a number of existing programs and grant schemes, including:

- Landcare
- Parks Victoria Friends and Volunteer Groups
- Stream Frontage Management Program
- Local Friends groups
- Corridors of Green
- Clean up Australia Day
- Projects funded through the CMA Community Grants scheme.

These programs are administered through a number of agencies with a role in water quality including Melbourne Water, Parks Victoria, the CMA and local government.

Other opportunities for community involvement include:

- The *Yarra River For Life* project, facilitated by the CMA in collaboration with other partner organisations and local communities. This project is community-driven and is initially focussed in the Yarra Ranges Shire covering sub-catchments identified as priorities for water quality in the *Yarra Catchment Action Plan*. The *Yarra River For Life* project model may also be used in part of the Maribyrnong catchment as a key vehicle for improving agency and community engagement and coordination.
- Primary industry focused best practice implementation.
- Greening Australia's national *River Recovery* project, in which the Yarra is a flagship river. This project aims to deliver environmental improvements through community and corporate support (see www.greeningaustralia.org.au).
- The *Yarra Riverkeepers* is an independent community-based organisation that adopts a whole-of-river view in its planning and strategic work to protect and restore the Yarra (see www.waterkeepers.org.au/yarra).
- Another broad-based community group, Environment Victoria, has identified preserving rivers and creeks as one of its three key campaigns. It has a *Healthy Rivers* website that includes people's personal stories of the Yarra and other Victorian rivers (see www.environmentvictoria.org.au).
- Environment Victoria and Melbourne Water are supporting the inclusion of the Yarra River in Oz GREEN's *MYRiveR Yarra Program* (see www.myriver.org.au).

While many of the Yarra and Maribyrnong catchment communities are involved in on-ground works, a major challenge for water quality management agencies is to increase the number of willing participants in these activities.

The Steering Committee strongly supports continued community involvement in decision-making and on-ground programs about river health and water quality.

Priority actions	Date	Lead	Partners	Status
5.1 Establish a consultative advisory committee structure that will involve the community	2006	Melbourne Water	DSE, CMA, LG	Existing program High priority
5.2 Continue to implement and expand current programs to involve the community in improving water quality, while exploring ways to increase the level of participation in these schemes	Ongoing	Various (through different grant schemes)		Existing program (recently expanded) Funded (part additional $3.8M over 3 years; see Rec 5.3) High priority

Awareness and communication

Across the Yarra and Maribyrnong catchments, education programs have been developed and implemented to raise community awareness and understanding of water quality, including several specifically targeting schools. Eduction programs include:

- Waterwatch (319 groups in the Port Phillip and Westernport region)
- Parks Victoria education program

- Melbourne Water's Frog Census (900 volunteers on the database)
- Marine Park connection to rivers - education web site (Parks Victoria)
- Active Catchment Education stormwater education resource (model)
- Living in a River Catchment – educational exhibit at Melbourne Water Discovery Centre, Werribee
- provision of information to user groups by agencies, such as information from Parks Victoria to rowers and tour guides
- drain stencilling programs / Drains to our Waterways schools kit
- several web-based programs run by various water authorities
- Victorian Litter Action Alliance community awareness program on litter
- Commonwealth games litter awareness campaigns, including additional resources allocated in August 2005 for litter education campaigns
- the Yarra River now has its own website. The site has information about what is being done to improve the Yarra and how the community can help. It allows people to find out the condition of their local rivers, Friends groups and community activities (such as Commonwealth Games and Greening Australia tree plantings) as well as where to find platypus and frogs (see www.melbournewater.com.au/ouryarra).

  A similar website is planned for the Maribyrnong catchment.

Waterwatch and Frog Census

Waterwatch is an educational program for schools and community groups to assess the condition of their local river or creek through surveys of water quality and aquatic life.

Waterwatch not only raises awareness, but also collects valuable data on the condition of rivers and creeks that supplement data collected by other agencies. There are 319 groups across the Port Phillip and Westernport region.

Melbourne Water is the regional coordinator of Waterwatch, with key partners including local government, the Department of Primary Industries, the Port Phillip and Westernport Catchment Management Authority and the Australian Government.

The Melbourne Water Frog Census is undertaken in partnership with the Amphibian Research Centre in Werribee. Volunteers visit local waterways and record frog calls. The Amphibian Research Centre then analyses the results and uses them to map Melbourne's frog populations. Previous surveys have added valuable knowledge on the location of the threatened growling grass frog, and found new locations where introduced frogs such as the Eastern dwarf tree frog are establishing.

Demand for involvement in both the Waterwatch program and the Melbourne Water Frog Census is high.

The Steering Committee recognises the important value of continued community education and awareness programs and recommends the continuation, expansion and development of new programs to inform and educate the community, individuals and groups about river health and water quality issues.

Priority actions	Date	Lead	Partners	Status
5.3 Continue to implement and expand current programs to inform and educate the community in river health and water quality issues	Ongoing	MW	DSE, PV, CMA, Local Government	Existing program (recently expanded) Funded (part additional $3.8M over 3 years; see Rec 5.2) High priority
5.4 Develop a website for the Maribyrnong River	2006	MW	CMA, EPA, DSE, MAV	New program Fund from existing resources Medium priority

Chapter 6: Monitoring and communicating the health of the rivers

> *It is important to properly monitor the quantity and quality of our water resources and the environmental condition of the State's rivers and groundwater to ensure that they are managed sustainably.*
>
> *Our Water Our Future,* June 2004

Monitoring water quality in the Yarra and Maribyrnong rivers involves two main components: monitoring river health and monitoring indicators that inform about risks to human health through recreation. These are carried out through integrated monitoring programs with some additional effort considering indicators for assessing human health risks.

Water quality and trend monitoring

Agency water quality monitoring

Toxicants, nutrients, suspended solids, dissolved oxygen, *E. coli* and other water quality indicators are measured every month at 33 sites on the Yarra and its tributaries. In the Maribyrnong catchment, water quality is measured at eight sites. Results are published on the Melbourne Water website (www.melbournewater.com.au/river_data.asp). This monitoring detects water quality changes over time, and delivers information that is the basis for management decisions.

Also, because *E. coli* are bacteria used to indicate the presence of faecal contamination, *E. coli* has been measured at additional key sites in the Yarra and Maribyrnong during the peak-use period of December to the end of March for over ten years.

Additionally, earlier in 2005, the Government expanded bacterial monitoring along the Yarra, introducing a program known as YarraWatch. This involved moving from weekly monitoring over the peak-use summer period to a year-round weekly program to better understand the water quality associated with recreational river use throughout the year. Twelve sites from the Docklands to the upper reaches at Warburton are being monitored for *E. coli.* Another indicator organism, enterococci, is measured at six of the sites. The results are collected by Melbourne Water and then used by EPA Victoria to give river users clear information about the condition of the river. The *E. coli* results are available to the public through a new YarraWatch website (www.epa.vic.gov.au/YarraWatch; note that the enterococci values are not currently reported on the website; note further that Melbourne Water summer *E. coli* data are on the website). Stormwater and river user alerts are also provided if heavy rain or pollution incidents are expected to significantly affect water quality.

Currently testing regimes focus on the water and there is limited testing of sediments which are a sink for many toxicants. There is also a need for more toxicological information describing the effects of toxicants on aquatic species such as fish and insects and on what risks consumption of fish caught in the lower reaches of the rivers may pose to human health. These gaps are being addressed (see 'Review of monitoring' section below).

Community monitoring

Community groups and individuals also play a part in monitoring and testing water quality through the Melbourne Waterwatch program.

In 2004, there were 100 groups and more than 10,000 participants actively involved in the Waterwatch program throughout the Yarra catchment. Parameters monitored may include turbidity, pH, salinity and nutrients.

Wastewater treatment plant impact monitoring

Since 1995, Yarra Valley Water has implemented a review process for all wastewater treatment plants, which has resulted in the decommissioning of around five plants in the Yarra Valley (Woori Yallock) area to achieve better environmental outcomes consistent with SEPP objectives.

Yarra Valley Water undertook waterway monitoring of all sewage treatment plants that were to remain in operation as part of its forward strategy to achieve SEPP compliance. Due to this monitoring:

- It was found that the treated water discharged from two plants is having no detrimental impact on the Yarra River.
- Two further plants have had significant improvements in treatment technology to improve the quality of treated water discharged to the Yarra River and further monitoring has been undertaken to assess the improvements on the local environment.
- One treatment plant has ceased discharge to the local environment and a 100% reuse scheme has been created.
- YVW is currently finalising the future operation of the two further plants.

Review of monitoring

Environmental monitoring programs within the Yarra and Maribyrnong region are regularly reviewed to ensure they are meeting objectives and to capture new information needs that arise over time. There have been a number of reviews undertaken in recent years including:

- A review of the statewide monitoring program (Victorian Water Quality Monitoring Network) was undertaken in 1997.
- The EPA Victoria reviewed Melbourne Water's water quality monitoring network in 1997.
- The Port Phillip and Westernport Catchment Management Authority reviewed monitoring programs within the region in the late 1990s.

In 2004, monitoring of river health within the region was reviewed in developing the draft *Port Phillip and Westernport Regional River Health Strate*gy.

Implementation of the key findings of this review is currently being investigated and includes, for example, increasing the number of long-term water quality monitoring sites in the Maribyrnong catchment and developing a long-term monitoring program to include a broader range of indicators that adequately captures stream health.

A more detailed examination of water quality monitoring will also be undertaken as part of the development of a *Regional Water Quality Improvement Plan*. This review will examine the current program to measure progress toward water quality targets identified in the plan.

The *Regional Catchment Strategy* also outlines the need for a coordinated catchment-condition monitoring framework of which water quality monitoring is an important element.

There is also a need to further develop and implement investigation and monitoring programs to better understand the impact of pollution on aquatic life and risks to human health from recreation and consumption of fish caught in the rivers, including consideration of:

- sediment concentrations of various toxicants
- chemical residues in fish
- additional and/or better indicators for assessing potential health risks due to micro-organisms from recreational use of our rivers.

Monitoring provides 'data', not 'information' unless it is analysed and communicated in a way that people can understand. Consequently, there is also a need to provide the community with access to clear and accurate information on water quality in the rivers, building on the existing YarraWatch program. This should involve expanding water quality monitoring information to include user-friendly reporting on the condition of the Yarra for water sports such as boating and swimming, for example, a 'traffic light' style reporting system. Similarly, advice on contaminant levels in fish sampled in the rivers may be able to be used by DHS to advise on the suitability of consumption of fish caught in the rivers.

The Steering Committee recommends that a comprehensive environmental monitoring program be implemented in the Yarra and Maribyrnong rivers and that water quality information is adequately provided to the community.

Priority actions	Date	Lead	Partners	Status
6.1 Implement monitoring recommendations outlined in the *Regional Catchment Strategy* and draft *Port Phillip and Westernport Regional River Health Strategy*	Ongoing	MW	EPA, DSE	Existing program Refer to RRHS for priority on specific recommendations High priority
6.2 Review water quality monitoring programs as part of the development of a Regional Water Quality Improvement Plan	2006	MW	EPA, DSE, DHS	Existing program Funded as part of development of WQIP Linked to Rec 6.3 High priority
6.3 Review adequacy of water quality monitoring programs for sediments, fish, microbial contaminants and other contaminants	2006	MW	EPA, DHS	New program Not funded Linked to Rec 6.2 High priority
6.4 Provide community with clear information on water quality	2006	MW	EPA, DHS	Expanded program Additional resources required High priority

Evaluation and reporting

Evaluation and reporting of progress towards targets for water quality form an important component of water quality initiatives within the Yarra and Maribyrnong catchments.

Evaluation of outcomes, such as monitoring the success of water quality programs and works like wetlands and litter traps, enable better planning and provide feedback on the most effective approaches to water quality improvement.

Reporting of monitoring and research results as well as reporting on water quality programs occurs through a number of mechanisms including, reporting in annual reports, publishing data and reports on websites and production of scientific publications.

The Port Phillip and Westernport CMA is establishing a database to track progress towards actions outlined in the *Regional Catchment Strategy*. Links between tracking the actions in the *Regional River Health Strategy* and the *Regional Water Quality Improvement Plan* and the CMA database will be investigated.

The Steering Committee recommends a comprehensive reporting and evaluation framework for the Yarra and Maribyrnong rivers.

Priority actions	Date	Lead	Partners	Status
6.5 Develop a reporting and evaluation framework for the Yarra and Maribyrnong catchments as part of the development of a Regional Water Quality Improvement Plan	2007	MW	CMA, DSE, EPA	New program Funded as part of development of WQIP High priority

Research and investigations

Region-wide research contributes to water quality management programs by providing:

- A more detailed understanding of the condition of rivers and creeks and information on the priority pollutants that affect stream health.
- Information on specific river health issues.
- Information on the impacts of activities on the condition of rivers and creeks and ecological processes.
- Information to fill knowledge gaps, in particular, gaps on the response of streams to management actions and pollutant pathways.

Melbourne Water, DSE and the EPA Victoria are partners in the eWater Co-operative Research Centre (CRC) (formerly the CRCs for Catchment Hydrology and Freshwater Ecology). The eWater CRC aims to be a national and international leader in the development, application and commercialisation of products for integrated water cycle management. It aims to be the major supplier of new technology and knowledge to the water industry.

Melbourne Water also runs a toxicant research program in partnership with the Centre for Environmental Stress and Adaptation Research at Melbourne University. This research program is undertaking studies to better understand urban pollutants and the impact of toxicants on aquatic ecosystems and aquatic animals such as invertebrates and fish.

Further investigation is required to better understand a range of other issues, including: risks to human health from recreation in the rivers, risk to human health from consumption of fish caught in the rivers, the relationship between sediment concentrations of various toxicants and bioaccumulation of toxicants in fish, and improving understanding of potential endocrine disruption in the rivers.

Melbourne Water investigations

To complement long-term monthly monitoring, Melbourne Water has a waterway investigation program that consists of short-term, intensive studies focussing on specific issues or waterways. These studies aim to isolate sources of pollution (or other causes of stream degradation) so that Melbourne Water can initiate targeted management actions.

A number of mechanisms can trigger a study. The primary trigger is a recommendation outlined in the draft *Regional River Health Strategy*. In addition, a pollution incident, discovery of poor water quality through routine data analysis and community concern can lead to additional studies.

Over the last ten years, studies include:

- Water Quality of the Lower Yarra River and Tributary Drains
- Water Quality in the Maribyrnong River and Tributary Drains
- Impacts of Storms on Faecal Indicators in the Lower Yarra River
- Bayside Drains Faecal Origins Study (using Coprostanol and other Sterol technology to determine human vs. non-human sources)
- Investigations of faecal contamination in the Prahran Main Drain
- Fish Survey in Gardiners Creek
- Aquatic macroinvertebrate surveys in the Watts River
- Clydesdale Drain pollution investigation (Steel Creek, Maribyrnong).

The *Regional Catchment Strategy* also identifies the need for research forums to identify and integrate research priorities.

The Steering Committee acknowledges the important role that research and investigation can play in future improvements in water quality in the Yarra and Maribyrnong rivers.

Priority actions	Date	Lead	Partners	Status
6.6 Continue to support and participate in research programs being run by the eWater Cooperative Research Centre	Ongoing	eWater CRC	MW, DSE, EPA	Existing program Funded High priority
6.7 Continue to support and participate in research programs being run by the Centre for Environmental Stress and Research	Ongoing	CESAR	MW	Existing program Funded High priority
6.8 Continue to investigate priority impacts on water quality and river health (including, sediments, toxicant/fish relationships, endocrine disruptors, etc.)	Ongoing	MW	EPA, DHS, DSE	Expanded program Additional resources required High priority

Chapter 7: Roles, accountability and governance

The Government will designate Melbourne Water as the authority responsible for waterway, regional drainage and floodplain management throughout the whole of the Port Phillip and Westernport catchments. This will provide a whole of catchment approach to river health.

Our Water Our Future, June 2004

Issue: Understanding roles in water quality management

Stakeholders such as local government, business and community groups often express confusion about the roles of various Government agencies in the management of water quality and river health and have difficulty finding out who is responsible for a particular river health issue. Various agencies have responsibilities including Melbourne Water, the Department of Human Services, EPA Victoria, Parks Victoria, the Department of Sustainability and Environment, the Department of Primary Industries, Yarra Valley Water, South East Water, City West Water, Western Water and local government.

Roles and responsibilities of agencies involved in river health and water quality management are in Table 9.

Table 9. Roles of organisations involved with water quality management in the Yarra and Maribyrnong rivers

Organisation	Roles	
	Strategic policy and planning	**On-ground programs**
Melbourne Water	Caretaker of river health Manage Melbourne's water supply Removes and treats most of Melbourne's sewage Manages rivers and creeks and major drainage systems Floodplain management Responsible for diversion management on the Yarra and lower Maribyrnong Coordinate development of Regional River Health Strategy Coordinate development of Regional Water Quality Improvement Plan	Water quality monitoring Healthy Rivers Program – management of rivers, riparian zones and stormwater Management of EWR Implement *Regional River Health Strategy* Drainage scheme development Infrastructure – such as dams and weirs Manager of Melbourne Waterwatch Litter collection in the Yarra River above Dights Falls; in the Maribyrnong above Canning Street Ford
Port Phillip and Westernport CMA	Responsible for the coordination of natural resource management within the Port Phillip and Westernport region	Responsible for developing and coordinating implementation of the Regional Catchment Strategy Engagement of stakeholder in planning Grants programs Instigate major integrated projects

Organisation	Roles	
	Strategic policy and planning	**On-ground programs**
EPA Victoria	Responsibility as the regulatory body to set long-term water quality objectives, manage licence discharges, investigate pollution incidents and take enforcement action if necessary Conduct auditing and environmental reporting of environmental condition	Development of State environment protection policies Discharge licences Enforcement Emergency pollution management Neighbourhood Environment Improvement Plans
Department of Sustainability and Environment	Advise government on statewide policy Statewide land use and catchment planning, urban policy and river health policy and planning. Key policies are *Our Water Our Future*, the *Victorian River Health Strategy* and *Melbourne 2030* Purchase or require service delivery from a wide range of agencies including local government	Establish consistent processes and standards for planning and implementation related to river restoration Manages government investment in river health
Department of Primary Industries	Influences improvements in primary industry performance by providing information and advice on the use and management of resources, guided by science and technology. Encourages the adoption of new agricultural technologies and practices through a range of community education and extension programs. In water management, this includes programs on nutrient and salinity reduction in rural areas	Extension programs with agricultural sectors to promote implementation of best management practices. Key partner in Waterwatch
Department of Human Services	Objective is to enhance and protect the health and well-being of all Victorians	Provision of health risk assessment and public health advice
Local councils	Have a role in water management as a local planning, park management and public health authority and as a representative of diverse communities	Stormwater management Domestic wastewater management Key partner in Waterwatch Open space management
Parks Victoria	Under the *Water Industry Act 1994*, Parks Victoria is responsible for the care, protection, management and use of the Yarra and Maribyrnong Rivers for the purposes of recreation, leisure, tourism and water transport. Custodian of a diverse range of parks along the Yarra and Maribyrnong valleys	Linking People and Spaces Strategy Parks management Litter collection in the Yarra River below Dights Falls; in the Maribyrnong below Canning Street Ford Two Rivers project
Urban water retailers	Main regulated responsibility in relation to the Yarra River is in the quality of treated water returned to the environment from the seven small sewage treatment plants	Provision of reticulated sewerage to backlog properties not capable of containing their septic effluent on site (Sewerage Backlog Program)
Port of Melbourne Corporation	State owned enterprise responsible for activities in the port area of both rivers	Integrated land and water management related to port activities
Sustainability Victoria	Responsible for waste management and recycling	Develops litter campaigns and programs Administers litter grant programs and plastic bag reduction programs

Response: improved understanding of roles and responsibilities

Our Water Our Future action plan articulates roles and responsibilities for water quality management. It established Melbourne Water as the "caretaker of river health" for the Port Phillip and Westernport region, including the Yarra and Maribyrnong catchments. Melbourne Water is therefore the lead agency for river health and water quality in the region. Consequently, it is also the key spokesperson for issues related to river health and water quality in the Yarra and Maribyrnong rivers.

As noted previously, a website for the Yarra has been developed (www.melbournewater.com.au/ouryarra). It includes a section defining who is responsible for what aspects of managing water quality. A similar website for the Maribyrnong is planned.

Also, it is important within Government that media response protocols which recognise the roles and responsibilities of various agencies with regard to water quality management be updated so that consistent and clear messages are communicated to the community about water quality issues. As the key spokesperson for river health in the region, Melbourne Water should undertake to do this in collaboration with other agencies.

The Steering Committee recommends roles and responsibilities of various organisations in water quality management to be clearly and consistently be communicated to the community through websites, publications and various media opportunities.

Issue: Coordination of water quality management activities

Effective coordination between all organisations involved in water quality management is vital. Improvements to water quality can only be achieved within an integrated catchment approach involving individuals, community groups, land managers, agencies, industries, developers, local councils and government agencies.

There is an appropriate suite of existing strategic planning documents relevant to river health. While each of the plans has a different subject, purpose and perspective, they are complementary and consistent in their identification of issues and priority actions. These are outlined in Chapter 1.

However, the diversity and sheer number of river health related management activities being undertaken by a range of agencies makes the potential for overlap and confusion a possibility. Therefore, there may be a need for a more formal approach to the coordination of activities that impact on the management of the rivers.

Furthermore, *Our Water Our Future* identified the need for a strengthened relationship and coordination between the Port Phillip and Westernport Catchment Management Authority and Melbourne Water, due to the CMA's role in coordinating the development and implementation of the *Regional Catchment Strategy* and in ensuring a whole-of-region approach to integrated catchment management.

Response: improved coordination and governance arrangements

Melbourne Water, in consultation with the CMA, DSE, local government and the broader community, is developing an advisory committee structure covering each major metropolitan river catchment and based on local municipality boundaries, for the purpose of advising Melbourne Water on waterway and drainage matters.

Also, the CMA and Melbourne Water have developed a Partnership Agreement that covers areas including collaboration in the provision of river health and water quality services.

Further to these arrangements, a formal coordinating committee should be established to improve coordination of river health management arrangements for the rivers.

The Steering Committee recommends improved formal coordination and governance arrangements for river health management activities on the rivers.

Actions to achieve recommendations	Date	Lead	Partners	Status
7.1 Establish high level Yarra Coordinating Committee	2006	DSE	MW, DHS, EPA, PV, CMA	New activity Funded from existing operational budgets High priority

Note: the recommendation for advisory committee structures for river health in the Yarra and Maribyrnong catchments is covered by Recommendation 5.1.

Chapter 8: The way forward

Water quality in the Yarra and Maribyrnong rivers is better than it has been for decades. However, the community rightly expects that more can be done.

Improving water quality in the rivers remains a major challenge due to further urban growth and intensification of agriculture. Effective management of water quality in the Yarra and Maribyrnong rivers to address key water quality risks requires a significant investment in long-term actions identified in this report. In particular, the priority recommendations as described in this report are:

- Develop a Regional Water Quality Improvement Plan to determine priority areas for action and to guide regional investment to improve water quality in the region's rivers and creeks.
- Accelerate the implementation of stormwater management plans and other high priority stormwater management actions, including capacity building for local government and industry.
- Improve the management of septic tanks, including implementation of recommendations from domestic wastewater management plans.
- Accelerate Yarra Valley Water's Backlog Sewerage program.
- Initiate the construction of the Northern Sewerage Project.
- Accelerate the adoption and implementation of agricultural best management practice programs.
- Improve understanding of faecal sources of contamination through targeted investigations.
- Provide resources to litter control projects.
- Strengthen community education and involvement activities in the management of the rivers.
- Improve reporting and communication of water quality information to the public.
- Improve formal coordination of agency responsibilities for water quality management including the establishment of a Coordination Committee for the Yarra.

This report recognises that improving water quality in the Yarra and Maribyrnong catchments requires commitment to long-term support and cooperation between stakeholders and the community. Water quality problems cannot be resolved with quick fixes or in an ad hoc manner. Much of this work is already underway and the foundations laid. The challenge now is to complete the job that has been started.

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Appendix 1: Water quality monitoring sites in the Yarra and Maribyrnong rivers

Yarra catchment

Andersons Creek at Everard Drive Bridge
Arthurs Creek at Burkes Bridge, Hurstbridge
Brushy Creek at Lower Homestead Road Bridge, Wonga Park
Cockatoo Creek at Tschampions Road, Macclesfield
Little Yarra River at Corduroy Road, Yarra Junction
Darebin Creek at Clark Road Footbridge
Diamond Creek at Main Road, Eltham
Diamond Creek at Strathhaven Road, Cottles Bridge
Elster Creek at Cochrane Street
Gardiners Creek downstream of junction with South Eastern Freeway and Glenferrie Road
Jumping Creek at Jumping Creek Road Bridge
Killara Road at Sunnyside Road
Koonung Creek at Bulleen Road
Macclesfield at Woori Yallock Road
Merri Creek at Roseneath Street
Merri Creek at Summerhill Road
Moonee Ponds Creek at Mt Alexander Road
Mullum Mullum Creek at Deep Creek Reserve
Olinda Creek at Macintyre Lane, Coldstream
Plenty Gorge at South Morang
Plenty River at Henty Road Bridge, Lower Plenty
Ruffey Creek at Parker Street, Templestowe
Steels Creek at Healesville Road, Yarra Glen
Stringybark Creek at Melba Highway, Yering
Watts River at Healesville-Kinglake Road
Woori Yallock Creek at Warburton Highway
Yarra River at Chandler Highway
Yarra River at Don Road, Launching Place
Yarra River at Everard Park Maroondah Highway, Healesville
Yarra River at McKenzie-King Drive, Millgrove
Yarra River at Princes Bridge
Yarra River at Spadonis Reserve downstream of Olinda Creek, Coldstream
Yarra River at Warrandyte Road Bridge

Maribyrnong catchment

Barringo Creek at Barringo
Deep Creek at Bolinda
Deep Creek at Bulla (d/s Emu Creek)
Jacksons Creek at Sunbury
Maribyrnong River at Brimbank Park Ford upstream of Taylors Creek and Keilor
Maribyrnong River at Canning Street Ford, Avondale Heights
Steele Creek at Rose Avenue, Niddrie
Stony Creek at Bena Street, Yarraville

Appendix 2: SEPP objectives for nutrients, sediments, toxicants and bacteria in the Yarra and Maribyrnong rivers

SEPP objectives for Total Phosphorus and Nitrogen (mg/l) in different Yarra catchment (top) and Maribyrnong catchment (bottom) segments.
N – no change from background, a – main stream, b – tributaries, f – no objectives set due to lack of data.

Yarra catchment							
	Aquatic reserves	Parks and Forests	Rural Eastern	Rural Western	Urban	Upper Estuary	Yarra Port
Total phosphorus	N	<0.03	<0.05	<0.05	<0.08a/<0.1b	f	f
Total nitrogen	N	<0.2	<0.6	<0.6	<0.9a/<1.0b	f	f

Maribyrnong catchment		
	Uplands	**Lowlands**
Total phosphorus	<0.025	<0.045
Total nitrogen	<0.6	<0.6

SEPP objectives for Turbidity (NTU) and suspended solids (mg/l) in different Yarra catchment (top) and Maribyrnong catchment (bottom) segments.
N – no change from background, b – tributaries, c – upstream of Diamond Creek, d – downstream of Diamond Creek.

Yarra catchment							
	Aquatic reserves	Parks and Forests	Rural Eastern	Rural Western	Urban	Upper Estuary	Yarra Port
Turbidity (median)	N	<5	<15	<25	<20c, <30d, <25b	<30	<20
Turbidity (90th percentile)	N	<10	<30	<80	<50c, <80d, <80b	<80	<50
Suspended solids (median)	N	<5	<20	<25	<25c, <50d, <25b	<50	<25
Suspended solids (90th percentile)	N	<10	<40	<90	<60c, <90d, <90b	<90	<60

Maribyrnong catchment		
	Uplands	**Lowlands**
Turbidity (median)	<10	<10
Turbidity (90th percentile)	<10	<10

SEPP objectives for various toxicants (µg/l) in different Yarra catchment segments.
N – no change from background, * – depending on water hardness, # – provided iron not present as Fe(II). For the Maribyrnong catchment, levels are given in the ANZECC Guidelines.

Yarra catchment							
	Aquatic reserves	**Parks and Forests**	**Rural Eastern**	**Rural Western**	**Urban**	**Upper Estuary**	**Yarra Port**
As	N	<10.0	<50.0	<50.0	<50.0	<50.0	<50.0
Cd	N	<0.04 – 0.4*	<0.2 – 2.0*	<0.2 – 2.0*	<0.2 – 2.0*	<2.0	<2.0
Cr	N	<2.0	<10.0	<10.0	<10.0	<50.0	<50.0
Cu	N	<0.4 – 1.0*	<2.0 – 5.0*	<2.0 – 5.0*	<2.0 – 5.0*	<5.0	<5.0
Fe	N	<200$^{\#}$	<1000$^{\#}$	<1000$^{\#}$	<1000$^{\#}$	NL	NL
Pb	N	<0.2 – 1.0*	<1.0 – 5.0*	<1.0 – 5.0*	<1.0 – 5.0*	<5.0	<5.0
Ni	N	<3.0 – 30*	<15.0 – 150*	<15.0 – 150*	<15.0 – 150*	<15.0	<15.0
Zn	N	<1.0 – 10$^{\#}$	<5.0 – 50$^{\#}$	<5.0 – 50$^{\#}$	<5.0 – 50$^{\#}$	<50.0	<50.0
Mercury (Hg)	N	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05
Methylmercury	N	<0.0008	<0.004	<0.004	<0.004	<0.004	<0.004

SEPP objectives for bacteria (organisms/100mL) in different Yarra catchment segments (top) for the Maribyrnong catchment (bottom).
N – no change from background, NA – no objectives set as swimming not allowed.

Yarra catchment – *E. coli*							
Recreation (geometric mean)	**Aquatic reserves**	**Parks and Forests**	**Rural Eastern**	**Rural Western**	**Urban**	**Upper Estuary**	**Yarra Port**
Primary contact	N	<200	<200	<200	<200	<200	NA
Secondary contact	N	<1000	<1000	<1000	<1000	<1000	<1000

Maribyrnong catchment		
Recreation	***E. coli* (freshwaters)**	***Enterococci* (marine and estuaries)**
Primary contact (median)	≤150	≤35
Primary contact (75th percentile)	–	≤150
Secondary contact (median)	≤1000	≤230