StreamWatch Annual Report 1996

The State of Greater Melbourne's Waterways

Melbourne Water
Managing Our Water Resources

Waterways &
Drainage Group

The State of Greater Melbourne's Waterways:
StreamWatch Annual Report 1996

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FOREWORD

The Greater Melbourne area is home to an extensive network of waterways that drain rural and urban areas, eventually discharging into Port Phillip and Western Port bays. Our waterways and bays are amongst the most prominent features of our landscape, and provide us with economic, aesthetic, environmental, recreational and tourism benefits.

For many decades, however, these waterways and bays have endured significant pressures from land clearance and urban development. Land originally covered by indigenous vegetation has been cleared, first for agricultural and later for residential purposes. The waters draining these altered landscapes have been significantly affected by contaminants such as nutrients, sediment, litter and heavy metals.

The regional drainage network and waterways in the Greater Melbourne area are managed by the Waterways & Drainage Group of Melbourne Water. Melbourne Water is also the supplier of bulk sewerage and water services to the three retail water companies. The management of the stormwater system, in conjunction with sewerage and water services, enables the adoption of an integrated approach to the urban water cycle. As an illustration of this, over the last 25 years considerable improvements have been made to Greater Melbourne's waterways, particularly through the provision of sewerage services and the removal of industrial discharges. Environmental flows in the key waterways are maintained by releases from water storage reservoirs. Now, Melbourne Water intends to continue this improvement through the Healthy Waterways Program.

The Healthy Waterways Program is an integrated and comprehensive approach to revitalising the waterways of the Port Phillip and Western Port regions. The program employs world best practice in waterway and urban drainage management. It will lead to a reduction in pollutant loads, assist in the revival of flora and fauna species along stream corridors, and encourage rural communities to better manage their stream frontages. Community participation and awareness will be key factors in the success of this program.

StreamWatch is an important part of the Healthy Waterways Program. This report is the third annual summary of water quality monitoring results, and covers the period 1995-96. The report does not attempt to solve the problems identified, but presents the specific findings for the parameters tested, and identifies some of the likely causes. In essence, the annual StreamWatch report tracks the long-term progress being made to improve Greater Melbourne's waterways. It should be remembered that, although there will always be short-term fluctuations in water quality, the overall trend is one of improvement.

Compared to the waterways of other major world cities, Melbourne's waterways are in relatively good condition: high in oxygen and low in toxicants and organic matter. There are still, however, issues relating to sediment, nutrient and bacteria levels. Clearly, urban runoff is of poor quality throughout the Greater Melbourne area.

Managing stormwater quality is the next major challenge facing Melburnians. This will be addressed through the establishment of a partnership between Melbourne Water, the Environment Protection Authority and local government. Stormwater Agreements covering the management of surface runoff will be established in a major new initiative to deal with polluted stormwater. Effective planning at a local level is one of the most important means by which diffuse source pollution will be reduced.

I would encourage all who share in our waterways and bays to become actively involved in their further improvement. Meanwhile, the StreamWatch Program will continue to track progress in protecting the quality of Greater Melbourne's waterways.

John Morgan
Managing Director
Melbourne Water Corporation
May 1997

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Background

During the past 25 years, there have been noticeable improvements in the water quality and fauna in many of Greater Melbourne's waterways.

There are, for example, fewer major pollution incidents, fish have returned to estuaries and bacterial and organic loads have decreased.

#2 - Hoddles Creek at Gembrook-Launching Place Rd, Launching Place

These improvements are due to the application of more stringent controls over land use and development, sewering of catchments and the licensed control of waste disposal. During this period there has also been a major increase in the community's interest in the health and amenity of our waterways.

It is recognised among waterway managers that many of the improvements remain anecdotal or qualitative and are difficult to measure. Distinct improvements in water chemistry do exist, and have been widely documented. When it comes to ecosystem health, however, improvements can be so subtle that only a well-designed experiment can reveal the trend. Even then, the trend may be missed, or, if found, it is attributed to the incorrect cause, and disappears after further data collection.

The StreamWatch program is designed to detect changes in the long-term and to characterise waterway status at this point in time.

Factors Affecting Waterways

A number of factors affect the condition of our waterways. Land use activities and development works, conducted within catchments, have a significant effect on the short-, and often long-term nature of waterway water quality and habitat availability.

Climate is one major factor having a significant effect on water quality; which is influenced by periods of high rainfall and drought conditions. Stormwater runoff is another factor. During periods of rainfall, stormwater runoff carries contaminants into the waterways network, which then empty into our bays and affect our beaches.

Other contributing factors to water quality include illegal sewer connections to the drainage system, illegal dumping of domestic rubbish and industrial wastes, accidental spills and the discharge of effluent from local sewage treatment plants.

In order to avoid short-lived and ineffectual improvements, a thorough knowledge and understanding of individual waterways is required. This can only be achieved through the analysis of several environmental components.

Scope of StreamWatch

StreamWatch is seen as the means for collecting data from several environmental components, so that a true understanding is gained of waterway status and functioning, based on good science.

StreamWatch now includes water quality monitoring research into platypus numbers and habitat requirements (in conjunction with the Australian Platypus Conservancy), macroinvertebrate population diversity, blue-green algae, *E. coli* and toxicant monitoring. The last assesses the relationship between heavy metal concentrations in stream sediments and the occurrence of midge fly larvae abnormalities.

Aquatic life inhabiting our waterways is sensitive to a range of environmental stresses. These include the introduction of pollutants, habitat modification, changes in water chemistry and stream flow, and the types of land use developments in and around the catchment.

Population numbers and diversity of aquatic life provide valuable information on the health of a waterway, and the likely stresses under which it may be placed.

Changes in aquatic community compositions provide an integrated "snap shot" of changes in the waterway environment and its overall health.

Healthy Waterways Program

For the first time, in an endeavour to improve Greater Melbourne's waterway resources, an integrated and comprehensive program has been established. Melbourne Water's Healthy Waterways Program is an all-encompassing approach to improving water quality and waterway ecosystems.

StreamWatch is one component of the Healthy Waterways Program. Other important components are the:

- Stream Frontage Management Program with land holders;
- Co-operative Research Centre research on freshwater ecology and catchment hydrology;
- construction of wetlands and other water quality improvement projects;
- waterway rehabilitation works; and
- finer scale investigations of tributary water quality.

StreamWatch assumes an even greater importance, for it will be the basis for evaluating whether these components of the Healthy Waterways Program have led to improvements in our waterways.

StreamWatch Results

This StreamWatch report is an annual summary of water quality monitoring data for the period 1995-96. The results indicate that urban and industrialised areas, construction sites and lands cleared for intensive agriculture are contributing factors to the poor water quality in waterways, in and around Greater Melbourne.

A key outcome of the monitoring program was the overall dissolved oxygen results. Admittedly, algal photosynthesis may lead to high results, but excellent ratings were recorded throughout the study area for dissolved oxygen. One site was the exception: Skeleton Creek, Laverton. Further investigation is required to determine the reason for this poor result.

Unlike the positive ratings for dissolved oxygen, the results for turbidity and suspended solids are quite disappointing. Overall the results are poor to moderate, except for sites in the South Eastern and Western waterways, which recorded some excellent results.

Nutrient levels were found to be high on the whole, rating fairly poor percentage performance results. Moderate results, however, were achieved for total phosphorus in the downstream reaches of the Yarra catchment and South Eastern waterways, and excellent in the upstream reaches of the Western waterways (Deep Creek, Bulla).

E. coli levels were generally poor to moderate throughout the program area, with an improved good (for 1995) to excellent rating for the Maribyrnong River.

Heavy metals (lead and zinc) continue to be a concern in the Yarra catchment, where monitoring results were poor to moderate. The results ranged from good to excellent for the South Eastern and Western waterways.

The condition of the macroinvertebrate populations ranged broadly from poor to excellent, with the South Eastern and Western areas achieving consistently good results. The urban waterways, however, showed lower fauna diversity and were inhabited by species of organisms known to be more tolerant to poor water quality. Results support the understanding that stream habitat, as well as various water quality indicators, does have a significant impact on ecosystem health.

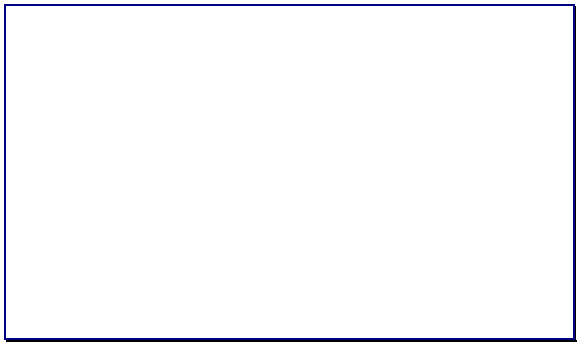
Generally good results were recorded for toxicant levels throughout the study area. Stream sediments in agricultural and forested catchments generally had low levels of metals. Some streams receiving runoff predominantly from the outer urban and industrialised areas, however, demonstrated a higher concentration of metals in stream sediments.

This report presents results of the third year of monitoring. Insufficient time has elapsed to begin drawing trends, but StreamWatch must be tuned so that important trends are not missed. A review of StreamWatch is currently underway, and one aspect of the review will cover the statistical basis required to support the program's objectives.

Future Improvements

Melbourne Water's Waterways & Drainage Group is committed to continuing its work to improve the valuable resource of Greater Melbourne's waterways. Application of knowledge gained from the various investigative and research programs will ensure a more value added approach to the improvement of our waterways network.

Further success will be gained from the implementation of sound strategic planning and review, flood mitigation and drainage developments, and the many waterway management activities currently underway. Melbourne's waterways will continue to receive the respect and attention they deserve, and that Melburnians expect.



#3 - Maribyrnong River near Browns Rd, Keilor

INTRODUCTION

Melbourne's waterways contribute significantly to the livability of the city. They are such an integral part of the urban landscape, that most Melburnians live no more than a few kilometres from a creek or river. With more than a million people visiting part of this network of waterways one or more times a week, Melburnians have a special concern about maintaining the health of their rivers and streams.

Melbourne Water is working to improve our waterways. Not only does it ensure the efficient transport of flood waters, but it addresses key issues involving water quality improvement, bank erosion, landscape values, revegetation and recreational use.

In 1993, the StreamWatch Program was introduced to monitor the condition and health of Greater Melbourne's waterways. StreamWatch replaced a number of independent monitoring programs that were originally conducted by various agencies. The program is EPA endorsed and was established as a co-operative venture between MWC, EPA and Melbourne Parks and Waterways (now Parks Victoria). The objective of the program is to track progress in protecting the quality of Melbourne's waterways, improving both the instream habitats and surrounding areas.

The Program consists of three monitoring components: water quality (physico-chemical), biological and toxicants. The latter two investigate the macroinvertebrates in the waterways, heavy metals in sediments, *E. coli* and blue-green algae. This information complements the water quality data by describing the ecological health of the waterway.

This annual summary outlines water quality data for the period 1995-96 for the 60 StreamWatch sites as shown in Map 1. The waterways network has been divided into three main geographical areas: the Yarra catchment, the South Eastern waterways (including Western Port) and the Western waterways (including the Maribyrnong River). Each of these large areas has then been divided into smaller "sub-catchments" for reporting purposes.

Results are reported here by catchment. Other related information is provided in the form of fact sheets. A full list of these fact sheets and other relevant information currently available is at the end of this report.

HEALTHY WATERWAYS PROGRAM

StreamWatch is one component of Melbourne Water's "Healthy Waterways Program"; a comprehensive, integrated approach to revitalising the waterways of the Port Phillip and Western Port region. Funded by an annual expenditure in excess of $10 million, it consists of the following elements:

- monitoring and investigations (StreamWatch);
- waterway management planning;
- waterway works to improve stability, environmental values and water quality;
- waterway and vegetation management, pest and weed control, pollution cleanup, and silt and litter removal;
- co-operative stream frontage restoration works on private rural properties;
- working with developers, state and local governments on source control of pollutants;
- research through partnerships with the CRCs for Freshwater Ecology and Catchment Hydrology; and
- community education.

Melbourne Water's Healthy Waterways Program employs world best practice in waterway management and will provide, over time, the following benefits:

- significant reduction in sediment levels in the Yarra and South Eastern waterways;
- reduction in the long-term nitrogen loads to the Bay, in line with recommendations of the Port Phillip Bay Study;
- reduction of *E. coli* in waterways and bay beaches for the protection of swimming areas;
- reduction of litter in waterways and on beaches; and
- enhancement of the environmental condition of waterways.

The secondary benefits include the revival of fauna associated with waterways and wetlands, along with an improved amenity for waterway users.

#4 - Yarra River at rear of sawmill site, Warburton

STREAMWATCH PROGRAM

Water Quality Monitoring

Water sampling runs are conducted either fortnightly or monthly for each of the 60 StreamWatch sites. The data collected help to determine whether water quality meets policy objectives and standards, thus providing direction as to where further work or investigation may be required.

StreamWatch measures a series of physico-chemical indicators for each site, and six heavy metals for a core of 15 sites. The indicators measured are: flow, temperature, dissolved oxygen (DO), % saturation of DO, conductivity, pH, turbidity, suspended solids (SS), ammonia, total nitrogen (T-N: nitrate, nitrite and organic nitrogen), ortho-phosphate, total phosphorus (T-P) and *E. coli*.

The heavy metals tested for are: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni) and zinc (Zn). A full description of each indicator and how it affects water quality is given in the Fact Sheet "Water Quality Monitoring of Greater Melbourne's Waterways".

Biological Monitoring

The biological monitoring component involves the assessment of aquatic macroinvertebrate populations of each waterway to determine overall stream quality (ie. an integration of effects of flow regime, water and habitat quality). The type and diversity of macroinvertebrates that inhabit a waterway provide an indication of its health. The diversity of aquatic life is expected to be greater at sites with good water quality, a diverse range of habitats, and not too extreme a range in flows. Population numbers and diversity can be greatly affected by land use and pollution incidents in the area.

Aquatic macroinvertebrate samples were taken from pool and riffle habitats at 45 sites around Greater Melbourne. A summary of the sites monitored is presented, along with biological and toxicant results, in Appendices 4 and 5 respectively. The results identify ecosystem condition (as indicated by the macroinvertebrates) and key factors which appear to be influencing ecosystem health.

Toxicant Monitoring

The toxicant monitoring program assesses the levels of toxic contamination in key waterways throughout Greater Melbourne. Heavy metal and biological impact data collected from 35 sites over two years are discussed here.

It is difficult to assess the severity of toxicant contamination. Currently there are no Australian, and few overseas, guidelines for assessing acceptable levels of heavy metals in aquatic sediments.

Two criteria are used to assess metal concentrations:

- the lowest effect level (LEL) that each metal has on benthic invertebrates, based on overt toxicity tests (Ontario Ministry of the Environment); and
- draft Australian Level B criteria for soils (further investigation is often recommended for metals exceeding these criteria).

Australian Level B values only apply to soils. The values do not necessarily relate to aquatic sediments or ecosystems, and are considerably less stringent than the Ontario LEL criteria.

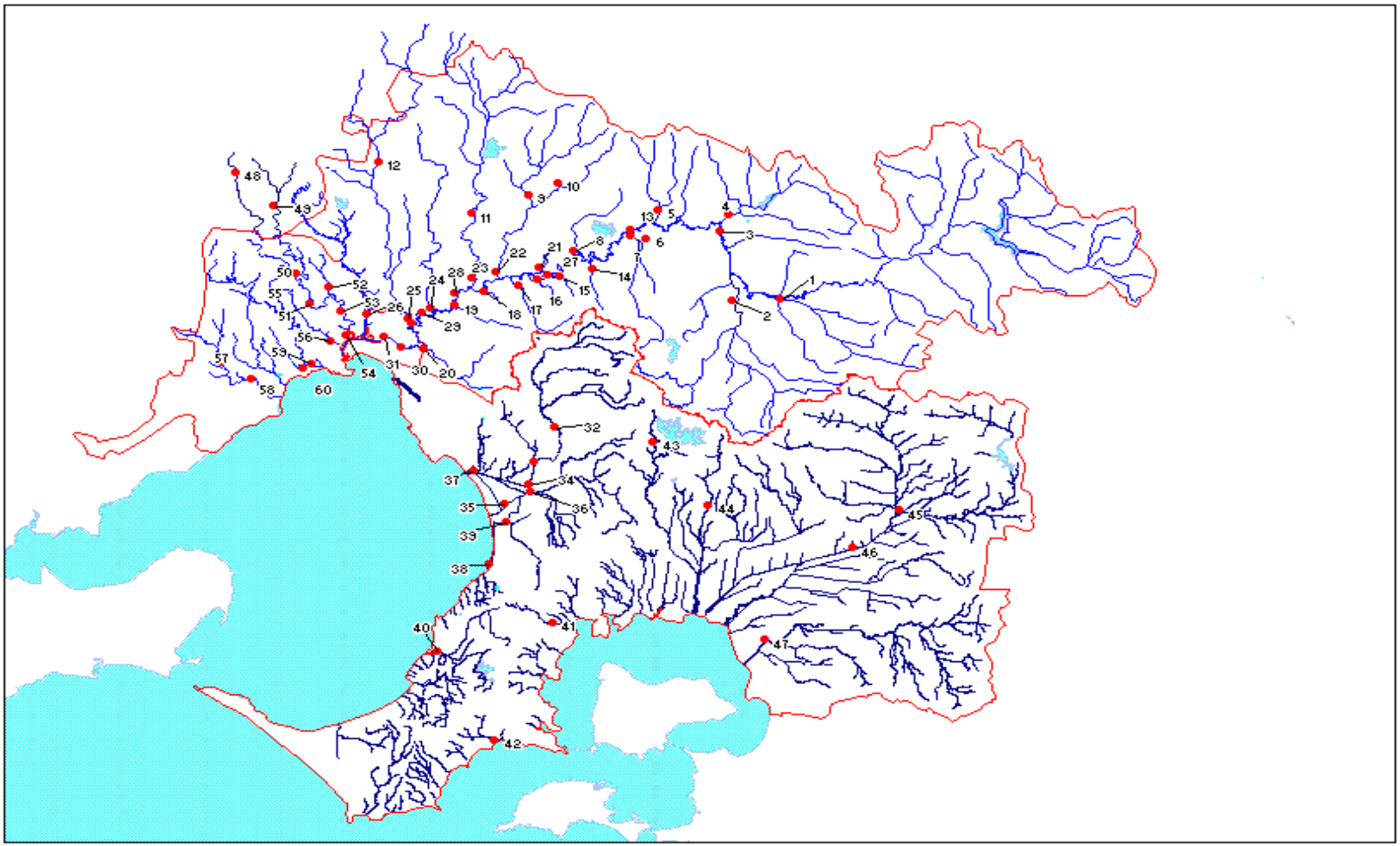
Appendix 5 shows conformance of the median metal concentrations at each site with the Ontario LEL and Australian Level B criteria.

Presentation of Results

Locations of all water quality sites are shown in Map 1. Site descriptions appear in Tables 1 through to 9, along with yearly results and water quality summaries. State Environment Protection Policy objectives for Greater Melbourne's waterways are listed in Appendix 1. The percentage performance[1] for each indicator at each site has been graphed. These are shown in Figures 1 through to 7, which are located in Appendix 3.

[1] Refer to Appendix 2 "Data Reporting" for explanation of 'percentage performance'.

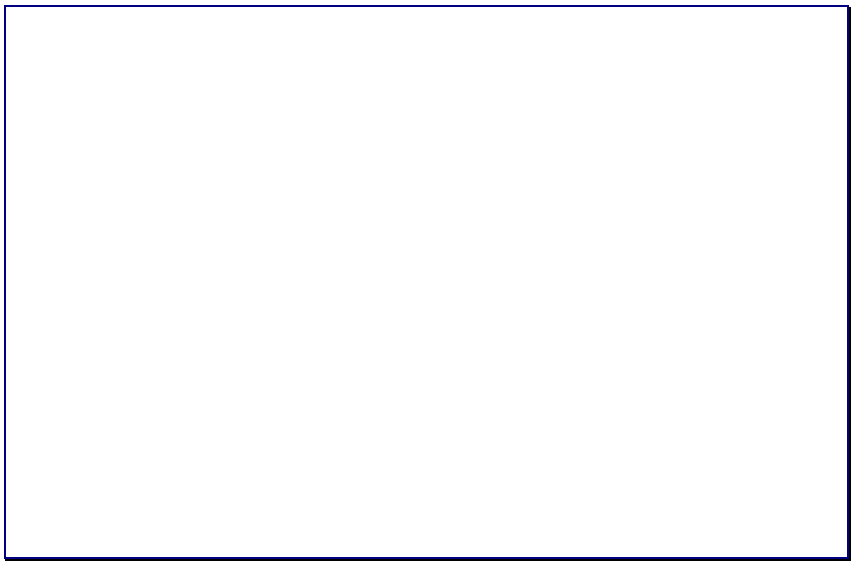
Map 1: Location of StreamWatch sites in the Greater Melbourne area (site numbers refer to those mentioned throughout the report)



THE YARRA CATCHMENT

The StreamWatch program monitored 31 sites in the Yarra catchment during 1995-96. With the release of the revised draft Yarra SEPP in December 1996, it was decided to use the new draft SEPP objectives. Overall, there are some minor changes to the geographical area segments, with some objectives more strictly defined than those in the existing SEPP.

There are seven segments in the Yarra SEPP. Four are monitored as part of the StreamWatch Program: Rural Eastern waterways, Rural Western, Urban (southern and northern tributaries) and the Upper Estuary segment.



#5 - Moonee Ponds Creek, original rock pool upstream Mickleham Rd, West Meadows

Yarra Catchment - Rural Eastern & Rural Western Waterways

Results for the ten Rural Eastern (sites 001 - 010) and two Rural Western (sites 011 and 012) waterways are in Table 1.

These waterways flow mainly through rural floodplains and valleys, with some urban development. In the past, much of the original riparian vegetation was removed to allow stock access to the waterways, while the land itself was cleared for agricultural use.

Water quality in these segments varied considerably across the different waterways. No site was able to meet all objectives for all indicators tested.

Dissolved oxygen results were good to excellent at all sites, easily achieving the SEPP objective. Seven of the 12 sites achieved 100% performance.

Turbidity results were generally poor. Only three of the 12 sites achieved moderate ratings, with nine sites classed as poor, four of which achieved zero percentage performance.

Suspended solids results were marginally better. One site, Watts River, Yarra Glen (004), achieved excellent percentage performance for suspended solids. All other sites, however, recorded moderate to poor results.

The degree of land disturbance from agricultural activities in the surrounding area, may be the cause of the high turbidity and suspended solids results. The results may also be seen as indicative of the catchment's geology, which also contributes to channel and catchment erosion.

Results for T-N were poor, with six of the 12 sites recording zero percentage performance. Phosphorus was slightly better with only four sites recording zero, and one site, Watts River (004), 100% performance.

Given the area is predominantly unsewered, septic runoff and agricultural fertilisers are possible causes for such high nutrient levels. Small sewage treatment plants in some of the catchments and stream erosion are other sources.

E. coli was measured at four sites, three of which recorded poor percentage performance.

In the Yarra River at Launching Place (site 001), the Pb result was excellent, and good for Zn. This level of performance, however, progressively decreased moving downstream. Good to moderate results were found in the Yarra River at Healesville (003), while only a moderate to poor percentage performance was achieved at the Yarra River, Coldstream (007).

Biological

Aquatic macroinvertebrates were monitored from five sites on the Yarra River and six sites from the Woori Yallock Creek catchment. Fauna in the Upper Yarra at Reefton and Woori Yallock were found to be in good to excellent condition. Fauna around Healesville and Spadonis Reserve, Coldstream, were also in good condition, but possibly being affected by the degraded stream habitat. Fauna from the Woori Yallock catchment were found to be in generally good to excellent condition.

Toxicants

Metal concentrations in stream sediments were monitored at four locations on the Yarra River and six within the Woori Yallock catchment. All sites, except the Yarra River at Reefton, had metal concentrations below Australian Level and Ontario LEL criteria. The Reefton site had As concentrations exceeding Ontario LEL criteria, the source of which may be leachates from past gold mining activities in the region.

Table 1: Yarra Catchment - Rural Eastern & Rural Western Waterways

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Rural Eastern Waterways								
001	Yarra River at Don Rd, Launching Place	10.1	12	12	0.64	0.03	280	0.001	0.003
002	Woori Yallock Creek at Warburton Hwy, Woori Yallock	9.1	38	22	1.17	0.05	125	ns	ns
003	Yarra River at Everard Park Maroondah Hwy, Healesville	9.6	28	23	0.86	0.05	345	0.001	0.005
004	Watts River, Kinglake Rd, Healesville	9.8	14	12	0.68	0.05	ns	ns	ns
005	Steels Creek at Healesville Rd, Yarra Glen	8.2	45	24	0.95	0.06	ns	ns	ns
006	Stringybark Creek at Melba Hwy, Yering	7.1	25	12	1.38	0.05	ns	ns	ns
007	Yarra River at Spadonis Reserve, Coldstream	9.1	27	30	0.97	0.06	295	0.001	0.006
008	Watsons Creek at Henley Rd, Kangaroo Ground	9.3	22	11	0.88	0.06	ns	ns	ns
009	Arthurs Creek at Burkes Bridge, Hurstbridge	8.9	36	13	0.88	0.08	ns	ns	ns
010	Diamond Creek at Cottles Bridge, Strathaven Rd	8.0	70	20	1.31	0.12	ns	ns	ns
	Rural Western Waterways								
011	Plenty River at Plenty Gorge, South Morang	9.1	22	9	1.18	0.15	ns	ns	ns
012	Merri Creek at Summerhill Rd, Craigieburn	8.4	42	14	1.19	0.12	ns	ns	ns

ns - not sampled

Yarra Catchment - Urban Waterways (Southern & Northern)

Results for the eight southern (sites 013 - 020) and the six northern (sites 021 - 026) tributaries of urban waterways are shown in Tables 2 and 3. No sites were measured for heavy metals, and only three were measured for *E. coli.*

The southern tributaries flow through mainly urbanised areas, although some native vegetation still exists in these catchments. Small sewage treatment plants also exist in the area, some of which discharge to the waterways. The sewering of catchments, however, and the improved treatment of stormwater runoff within wetland retarding basins over the past 20 years, has seen some positive changes to water quality.

The northern tributaries flow through both urban and rural areas, with some industrial and commercial activities downstream. A series of parks and open space corridors in the area act as vegetation buffer strips, or pollution runoff filters, along some areas of the streams. Stormwater runoff, however, still discharges directly to these streams, carrying contaminants such as litter, nutrients, organic material, heavy metals and suspended solids into the receiving waters.

Dissolved oxygen results showed 100% performance for all but two sites: Olinda Creek at Coldstream (013) and Plenty River, Lower Plenty (023).

Percentage performance was generally poor to moderate for turbidity and moderate to good for suspended solids. Koonung Creek at Bulleen (019) was the only site to record zero percentage performance for turbidity and suspended solids, while Brushy Creek at Wonga Park (014) recorded the only excellent result.

Freeway works appear to have affected the Koonung and Gardiners Creek sites, while other development works appear to be having an impact on the Diamond Creek site. Sediment runoff from construction sites is a major problem, particularly during periods of high rainfall. Sediment entering the waterways has a negative impact on waterway water quality and ecosystem balance, and reduces the effective drainage capacity of the watercourse.

A majority of sites recorded poor performance for T-N and T-P. Eight of the 14 sites achieved zero percentage performance for T-N, and three of the 14, zero for T-P. In this instance, the presence of local sewage treatment plants and badly performing septic tanks, may be contributing factors to the high nitrogen and phosphorus levels found. Phosphorus is also linked with high turbidities.

E. coli results were recorded as poor to moderate at all three sites tested. Again, this is most likely due to septic tank discharges in the area.

No metals were sampled within these segments.

Biological

Aquatic macroinvertebrates were surveyed from five sites on Gardiners Creek and two sites on its major tributaries (namely, Scotchmans and Back Creeks).

Fauna in this catchment were generally in poor condition. Back (Glen Iris) and Scotchmans Creeks (Warrigal Rd) were the most affected communities of the 45 sites surveyed as part of this study. Fauna in the Gardiners Creek catchment appear to be influenced by the poor water quality (which is particularly due to the presence of turbidity and metals). At the Hawthorn site (020), sedimentation appears to be the major factor.

Toxicants

Sediments from Gardiners Creek sites were also analysed for metals. All five sites exceeded Ontario LEL and Australian Level B criteria for Zn, and Ontario LEL criteria for Cu and Pb. These elevated metal concentrations were high, even among the urban waterways. This is probably a reflection of the light industrial character of the catchment.

Table 2: Yarra Catchment - Urban Waterways (Southern)

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Urban Waterways - Southern Tributaries								
013	Olinda Creek at Macintyre Lane, Coldstream	6.2	21	18	2.86	0.12	ns	ns	ns
014	Brushy Creek at Lower Homestead Rd bridge, Wonga Park	7.1	14	11	8.62	2.32	ns	ns	ns
015	Jumping Creek at Jumping Creek Rd bridge, Lower Plenty	10	23	9	1.39	0.08	ns	ns	ns
016	Andersons Creek at Everard Dve bridge, Warrandyte	9.5	39	18	4.19	0.33	ns	ns	ns
017	Mullum Mullum Creek at Deep Creek Reserve, Warrandyte	9.6	43	20	3.02	0.22	ns	ns	ns
018	Ruffey Creek at Parker St, Templestowe	10.5	30	18	2.09	0.18	ns	ns	ns
019	Koonung Creek at Bulleen Rd, Bulleen	9.4	76	46	1.73	0.15	ns	ns	ns
020	Gardiners Creek at South Eastern Fwy, Hawthorn	10.9	55	44	2.27	0.15	2502	ns	ns

ns - not sampled

Table 3: Yarra Catchment - Urban Waterways (Northern)

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Urban Waterways - Northern Tributaries								
021	Stoney Creek at Research-Warrandyte Rd, Nth Warrandyte	10.6	13	7	0.64	0.04	ns	ns	ns
022	Diamond Creek at Main Rd, Eltham	9.2	57	23	1.36	0.12	ns	ns	ns
023	Plenty River at Henty Rd bridge, Lower Plenty	8.2	56	24	1.66	0.15	ns	ns	ns
024	Darebin Creek at Clark Rd footbridge, Ivanhoe	9.5	22	8	1.58	0.12	356	ns	ns
025	Merri Creek at Roseneath St, Yarra Bend	9.7	40	14	2.26	0.20	ns	ns	ns
026	Moonee Ponds Creek at Mt Alexander Rd, Parkville	10.5	27	16	2.78	0.17	668	ns	ns

ns - not sampled

Yarra Catchment - Yarra Mainstream & Estuary

There were five sites sampled in three sub-segments of the Yarra mainstream and estuary areas (sites 027 - 031, refer to Table 4). The Yarra River, downstream of Prahran Main Drain in South Yarra (030), was only sampled for *E. coli*.

The lower Yarra flows through floodplains with industrial, commercial and residential development. Due to urbanisation, much of the original vegetation has been removed or replaced with exotic species. The channel has been extensively modified, particularly downstream of Dights Falls. This has been done to improve drainage during high flows and to protect residential properties close to the river.

Historically, the Yarra River (like many waterways in Melbourne) has received highly contaminated discharges from industrial premises, such as tanneries and abattoirs, unsewered areas, septic tanks, sewage treatment plants, landfills and sewer overflows. During the past twenty years, however, there has been a general improvement in water quality. Catchments have been sewered, and industrial discharges are controlled by EPA licences, or diverted to the sewer system.

All sites recorded 100% performance for DO.

Overall, poor to moderate percentage performance results were achieved for suspended solids and turbidity. An exception to this was the tidally influenced site on the Yarra River, South Melbourne (031), which achieved 87% (good) performance for suspended solids. General catchment disturbances, runoff from urbanised areas, and catchment geology, account for much of the suspended solids and turbidity levels measured at these sites.

Total phosphorus results recorded a poor to moderate rating on the whole. The Yarra River at Warrandyte (027), however, achieved 78% (good) performance for T-P.

Four sites were measured for *E. coli*; two under primary contact objectives (<200 org/100mL) and two under secondary contact (<1000 org/100mL). Percentage performance was poor to moderate at most sites, except the Yarra River at South Melbourne (031), which achieved a good rating.

Zinc performance figures were very poor (0 - 31%) at all three sites measured for metals. Lead results were more positive at Warrandyte, with a good percentage performance, while Heidelberg and Kew only achieved poor ratings.

Biological

Aquatic macroinvertebrates and metal concentrations in stream sediments were monitored at five sites on the Yarra River, downstream of Warrandyte. Fauna between Warrandyte and Lower Templestowe (Fitzsimons Lane) were found to be in relatively good condition. They do, however, seem to be affected by elevated turbidities and nutrient levels. Condition of the fauna deteriorated progressively downstream, as these areas tend to receive a larger proportion of poor quality urban runoff, and possess poorer stream habitats.

Toxicants

All metals, except mercury, were below Australian Level B and Ontario LEL criteria in the Yarra River at Warrandyte. The slightly elevated mercury concentrations may be due to its use in past gold mining activities in this area. There was a substantial increase in most metals in stream sediments between Lower Templestowe and Dights Falls. All metals, except As, exceeded Ontario LEL criteria at Dights Falls. Copper and Zn results also exceeded Australian Level B criteria.

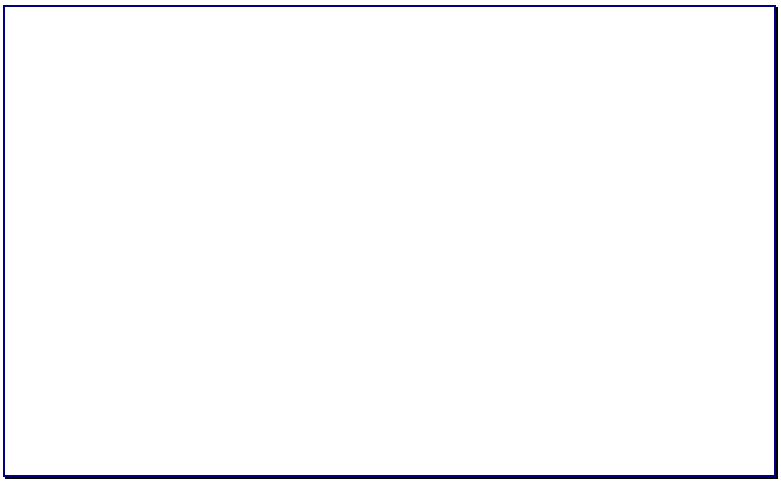
Table 4: Yarra Catchment - Yarra Mainstream & Estuary

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean
	Mainstream - u/s confluence Diamond Creek							
027	Yarra River at Warrandyte Rd bridge, Warrandyte	9.8	24	20	1.00	0.08	197	0.002
	Mainstream - d/s confluence Diamond Creek							
028	Yarra River at Banksia St bridge, Heidelberg	9.5	35	32	1.18	0.12	ns	0.002
029	Yarra River at Chandler Hwy, Kew	9	34	36	1.19	0.10	450	0.004
	Upper Estuary							
030	Yarra River d/s Prahran Main Drain, South Yarra	ns	ns	ns	ns	ns	1190	ns
031	Yarra River at Princes Bridge, South Melbourne	8.9	27	21	1.23	0.10	664	ns

THE SOUTH EASTERN WATERWAYS

Sixteen sites were monitored in the South Eastern waterways. These waterways are covered by three SEPPs: W-28A *Waters of the Dandenong Valley* (sites 032 - 039), *Waters of Victoria* (site 040) and W-28 *Waters of Western Port Bay and Catchment* (sites 041 - 047).

While the Dandenong Creek catchment is predominantly urbanised, Western Port and the Mornington Peninsula are rural catchments. Western Port sites in particular, have been developed from swamp land to intensive agricultural sites. Historically, the waterways were modified into long, straight channels for quick removal of runoff towards Western Port.



#6 - Toomuc Creek within growth corridor, upstream Henry Rd, Pakenham

Dandenong & Eumemmerring Creeks

There are four sites monitored on Dandenong Creek (sites 032 - 035) and one at Eumemmerring Creek (site 036, refer to Table 5).

Dandenong Creek catchment is extensively urbanised with large pockets of industry, some open space corridors and parkland. Waterways have been substantially modified, with channelised sections, primarily for efficient removal of high flows, in order to prevent flooding to surrounding properties. Eumemmerring Creek catchment contains rural, dense residential and large industrial areas, including a local sewage treatment plant.

Results for DO show 100% performance for all sites.

Turbidity results were found to be poor at all sites, while suspended solids rated poor to moderate for percentage performance. The best result achieved was 61% performance on Dandenong Creek, Dandenong North.

Four of the five sites monitored for T-N and T-P achieved poor percentage performance results, with Dandenong Creek at Dandenong South (034) achieving 51% for T-P. The National Water Sports Centre, Bangholme (035), and Eumemmerring Creek, Bangholme (036), achieved zero percentage performance for T-N and T-P.

The Eumemmerring Creek site has been adversely affected by discharges from the Cranbourne Treatment Plant. These discharges, however, are due to cease about mid 1997, when they are diverted to the Eastern Treatment Plant. Nutrient levels should therefore decrease in the receiving waterway.

Following the diversion of the Dandenong South Treatment Plant discharge to the Eastern Treatment Plant at Carrum, in July 1994, T-N and T-P levels in Dandenong Creek (site 034) decreased significantly.

Percentage performance results for *E. coli* were found to be poor to moderate, except at the National Water Sports Centre site (035). This site achieved a figure of <200 org/100mL, which is the SEPP primary contact objective. The other two Dandenong Creek sites, and the Eumemmerring Creek site, recorded *E. coli* results slightly above the SEPP objective.

The Dandenong livestock market is found to be a source of *E. coli* to the Dandenong Creek, as a result of stock waste overflows. The situation is expected to improve in the near future, with the installation of a more effective sewer connection.

Heavy metal results were quite good considering the degree of urbanisation in the catchment. Zinc results showed a 100% performance rating at all three sites, and at two sites for Pb. The Dandenong Creek at Dandenong South (034) achieved a good performance rating with 87%.

Biological

Aquatic macroinvertebrates were monitored at three sites on Eumemmerring Creek and five sites on Dandenong Creek. Fauna in Dandenong Creek ranged from excellent condition in the Doongala State Forest area, to an overall "mildly affected" status in the lower catchment, between Wantirna and Dandenong South.

Similarly, Eumemmerring Creek fauna ranged from good (at Narre Warren) to mildly affected in the lower section of the stream around Dandenong. Fauna in Dandenong and Eumemmerring Creeks are primarily influenced by the limited diversity in stream habitat and poor water quality. Rehabilitation of the riparian zone, including shading, helps instream habitat, but preventing sedimentation itself, may yield better results overall.

Toxicants

Metal concentrations in stream sediments throughout Dandenong Creek were generally low. The Wantirna site (near Boronia Rd), however, had elevated levels of Zn, Pb and Cu. The Eumemmerring Creek site at Narre Warren had low metal concentrations, while the more urbanised Worsley Rd site had As, Cr, Cd, Cu, Pb and Zn concentrations, all exceeding Ontario LEL criteria. The Cr concentration also exceeded the Australian Level B criterion.

Table 5: Dandenong & Eumemmerring Creeks

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Lower Dandenong Creek and Eumemmerring Creek								
032	Dandenong Creek at Stud Rd, Dandenong North	8.7	35	18	1.63	0.11	600	0.013	0.066
033	Dandenong Creek d/s Mile Creek, Keysborough	11.4	35	19	1.60	0.11	1465	0.018	0.11
034	Dandenong Creek at Pillars Crossing, Dandenong South	9.4	35	19	1.63	0.12	1177	ns	ns
035	Dandenong Creek at NWSC, outlet, Bangholme	8.4	56	39	3.04	0.30	195	0.015	0.047
036	Eumemmerring Creek at Worsley Rd, Bangholme	7.7	40	28	5.08	0.99	1280	ns	ns

NWSC - National Water Sports Centre
ns - not sampled

Mordialloc Creek, Kananook Creek & Tributaries, & Mornington Peninsula Waterways

There are six sites monitored in these waterways, which vary considerably in water quality (sites 037 - 042, refer to Table 6).

All these waterways discharge to recreational bay beaches (Port Phillip Bay and Western Port). Lower Mordialloc (037) and Kananook Creeks (038) are used extensively for secondary contact recreational activities, such as boating. During low flow, the entire volume of water from Dandenong Creek discharges into Mordialloc Creek, while during high flows the water is diverted to Patterson River. Balcombe Creek (site 040) is in a sewered and predominantly rural catchment. Watsons (041) and Merricks Creeks (042), on the other hand, are unsewered and discharge to Western Port. The catchment is a rural area with coastal villages largely comprising holiday homes.

Dissolved oxygen results rated 100% performance at all sites.

Results for turbidity and suspended solids ranged broadly from poor to excellent. Mordialloc Creek, Mordialloc (site 037), failed both turbidity and suspended solids with a poor percentage performance. Eel Race Drain, Seaford (039), failed turbidity but passed suspended solids with a good percentage performance.

Total nitrogen results recorded poor percentage performance for all sites, with four of the six sites rating poor for T-P. Balcombe Creek, Mt Martha (040), achieved 85% performance and Merricks Creek, Merricks (042), rated 62%. Urban runoff and catchment disturbances are likely to be the most significant contributing factors.

Nutrient levels are decreasing in Mordialloc Creek (037). Again, this is due to the Dandenong South Treatment Plant discharge being diverted to the Eastern Treatment Plant at Carrum. It is expected that these figures will stabilise as the sediments and water column come to equilibrium.

E. coli was measured at all sites, with excellent percentage performance recorded at two sites: Balcombe Creek, Mt Martha (040), and Merricks Creek, Merricks (042). The other sites recorded moderate to good performance figures.

Metal concentrations were only measured at Mordialloc Creek, Mordialloc (037), which passed Pb with an excellent percentage performance, but failed Zn with a very poor performance rating. Urban runoff, containing Zn from pipes and building materials, would be the largest source and contributor to these elevated levels.

Biological & Toxicants

Two sites on Balcombe Creek were monitored for macroinvertebrates and the concentration of metals in stream sediments. Fauna were found to be in good condition and all metal concentrations were below Ontario LEL and Australian Level B criteria.

Table 6: Mordialloc Creek & Tributaries, Kananook Creek & Tributaries, & Mornington Peninsula Waterways

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Mordialloc & Kananook Creeks								
037	Mordialloc Creek at Wells Rd, Mordialloc	8.1	35	26	2.73	0.37	925	0.012	0.11
038	Kananook Creek at Wells St, Frankston	6.5	8	13	1.25	0.15	556	ns	ns
	Kananook Creek Tributaries								
039	Eel Race Drain at Wells Rd, Seaford	7.2	35	17	1.97	0.23	457	ns	ns
	Mornington Peninsula Waterways								
040	Balcombe Creek at Uralla Dve, footbridge, Mt Martha	8.1	8	4	1.39	0.06	321	ns	ns
	Western Port Peninsula								
041	Watsons Creek at Dandenong-Hastings Rd, Somerville	10.3	25	11	5.95	0.41	357	ns	ns
042	Merricks Creek at end of Bridge St, Merricks	8.9	9	5	1.11	0.09	308	ns	ns

ns - not sampled

Western Port Waterways

There were seven sites monitored in the Western Port catchment, five of which are within this segment (sites 043 - 047, refer to Table 7).

Except for Cardinia Creek, Harkaway (043), all sites are located in very disturbed catchments, developed with towns and extensive agricultural properties.

In-stream and bank erosion are significant problems throughout the catchment.

Dissolved oxygen results were recorded at 100% performance for all sites.

All sites, except one, recorded results of poor percentage performance in turbidity, suspended solids, T-N and *E. coli* levels. Total phosphorus results rated poor to moderate for percentage performance. In-stream and bank erosion play a major role in the levels of turbidity and suspended solids in waterways. Runoff from agricultural areas, land disturbances, and unsealed roads are also contributing factors to the problem.

Cardinia Creek, Harkaway (043), recorded excellent percentage performance for turbidity, suspended solids, T-N and T-P. Such good results may be due to the water releases from Cardinia Reservoir, and the site's close proximity to the upper end of the catchment.

The *E. coli* objective in these waterways is <200 org/100mL and only the Harkaway site achieved a percentage performance above poor, at 69%.

Metals were not sampled in this segment.

Biological & Toxicants

Macroinvertebrates and metals in stream sediments were monitored at two sites on the Lang Lang River (at South Gippsland Hwy and the Poowong/ Drouin Rd). One site on Cardinia Creek (at Harkaway) was also monitored. Fauna in Cardinia Creek were in good condition and the sediments had low concentrations of metals. Lang Lang River fauna also appeared to be in reasonably good condition although affected by a degraded stream habitat.

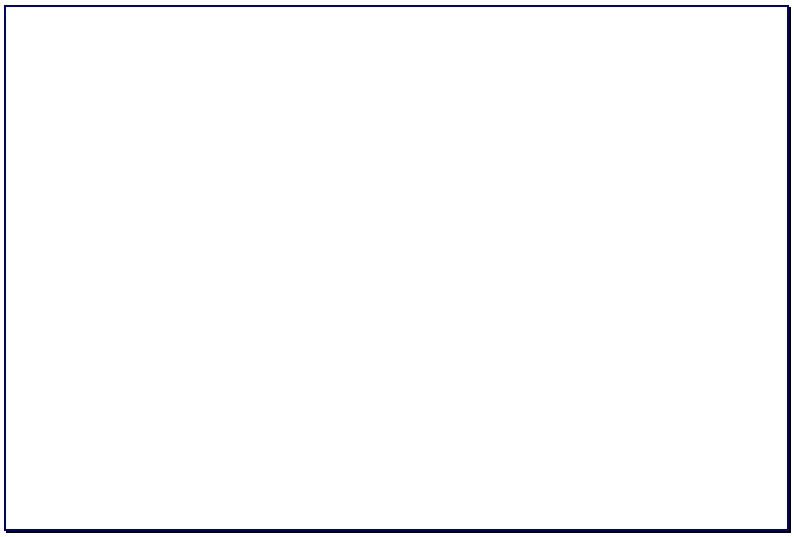
Table 7: Western Port Waterways

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Western Port - Eastern								
043	Cardinia Creek u/s Manestar Rd, Harkaway	9.4	7	4	0.36	0.02	170	ns	ns
044	Toomuc Creek at Princes Hwy, Pakenham	9.8	25	11	1.10	0.08	603	ns	ns
045	Tarago River at Morrisons Rd, Labertouche	9.8	25	20	1.42	0.15	792	ns	ns
046	Bunyip Main Drain, Iona	9.8	25	35	1.09	0.11	439	ns	ns
047	Lang Lang River at South Gippsland Hwy, Lang Lang	9.5	25	17	2.51	0.21	476	ns	ns

ns - not sampled

THE WESTERN WATERWAYS

Western waterways are covered by the SEPP *Waters of Victoria.* These waterways are predominantly modified and many channelised in the lower reaches. The catchments are relatively urbanised with significant industrial areas. Thirteen sites were monitored in eight different waterways. Cherry Lake (060) was only monitored for *E. coli*, as it is extensively used for primary and secondary contact recreation.



#7 - Skeleton Creek, waterhole near confluence with Dry Creek, Werribee

Maribyrnong River & Tributaries

Seven sites were monitored in these waterways. Five freshwater (sites 048 - 052) and two estuarine (sites 053 and 054, refer to Table 8).

The Maribyrnong River flows through urbanised floodplains with some industrial and commercial land use. The river channel and banks have been largely modified to improve drainage during high flows, in order to protect private properties from flooding. These modifications include stabilisation, straightening and realignment to increase channel capacity.

Historically, the Maribyrnong River received highly contaminated discharges from the many industrial premises in the catchment. Sewering has greatly improved water quality over the years, diverting sullage and industrial waste discharges from the waterways to the sewer system.

Deep and Jacksons Creeks flow through mainly agricultural areas, while Steele Creek contains a largely developed catchment with residential and industrial areas.

Percentage performance results for DO were excellent for all sites.

Poor to moderate percentage performances were recorded for turbidity, while suspended solids results ranged from poor to excellent. Deep Creek at Bulla (049) achieved 92% performance for suspended solids.

Large increases in turbidity and suspended solids were recorded at Steele Creek, Niddrie, during the 1995-96 sampling period. This may be attributed to new urban development occurring in the catchment as land is cleared. Works being undertaken on the Western Ring Road project have also been causing disturbances to large amounts of earth, increasing instream turbidity and suspended solids.

Overall, nutrient levels in these waterways were high. Percentage performance was generally poor, except for Deep Creek, Bulla (049), which recorded 100% for T-P, with two other sites achieving good to moderate results. Two sites recorded zero percentage performance for T-N and two for T-P.

Urban runoff appears to be the most likely cause of these high nutrient loads, not discounting the influences of the Keilor sewage treatment plant. Erosion problems, which increase turbidity, also lead to the increase of T-P.

E. coli achieved good to excellent percentage performances at three sites. *E. coli* levels have decreased in the Maribyrnong River below Keilor, compared to previous years, and the decrease is not attributable to lower flows.

Heavy metal levels were analysed at four sites, all of which passed with 100% performance. This is a very good result given the urbanisation and industry within the catchments.

Biological
Aquatic macroinvertebrates were monitored at three sites on the Maribyrnong River, one site on Deep Creek (Bulla) and another site on Jacksons Creek (Sunbury). Fauna were found to be in good condition at all five sites; probably more affected by water quality (nutrients, metals and conductivities) rather than actual stream condition (channel shape and habitat diversity).

Toxicants
All metals were below Ontario LEL criteria in Jacksons Creek. Elevated levels of Zn, Pb, Cr and Cu were, however, detected in the Maribyrnong River and Deep Creek. Chromium concentrations in the Maribyrnong River at Canning Street Ford were particularly elevated, exceeding Ontario LEL and Australian Level B criteria. Possible sources will be investigated.

Table 8: Maribyrnong River & Tributaries

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Maribyrnong River & Tributaries								
048	Jacksons Creek at Sunbury Rd, Sunbury	9.3	27	14	0.98	0.11	ns	0.002	0.007
049	Deep Creek at Trap St, Bulla	9.5	16	7	0.95	0.04	ns	0.002	0.003
050	Maribyrnong River at Brimbank Park Ford, Keilor	9.2	30	23	1.52	0.09	215	0.003	0.007
051	Maribyrnong River at Canning St Ford, Avondale Heights	8.5	36	29	2.39	0.51	428	0.003	0.014
052	Steele Creek at Rose Ave, Niddrie	10.3	47	42	1.44	0.13	ns	ns	ns
	Maribyrnong River - Estuarine								
053	Maribyrnong River d/s Ascot Vale Main Drain, Ascot Vale	8.8	14	11	1.43	0.22	325	ns	ns
054	Maribyrnong River at Yarraville Wharf 1, Yarraville	8.7	12	13	1.69	1.14	ns	ns	ns

ns - not sampled

Kororoit Creek, Cherry Lake, Skeleton Creek & Stony Creek

Five sites were monitored in these waterways (sites 055 - 059) as well as site 060, which was only monitored for *E. coli* (refer to Table 9).

These waterways flow through both residential and industrialised areas. About 15% of the Skeleton Creek catchment is currently urbanised (mostly residential). Extensive growth, however, is proposed for the future.

Dissolved oxygen levels were found to be poor in Skeleton Creek, Laverton (058); low flow and high organic matter are believed to be the most likely causes. Percentage performance was excellent at the three other sites and moderate at one site.

Turbidity and suspended solids results ranged from poor on Kororoit Creek (site 055, Deer Park, and 059, Altona) to excellent on Skeleton Creek (site 057, Hoppers Crossing, and 058, Laverton) for percentage performance. Development is the likely cause of these elevated turbidity and suspended solids figures.

Nutrient performance results were poor at all but one site (058) for T-N, and ranging from poor to excellent (057) for T-P. High nitrate levels from groundwater, together with organic material loads, are the causes of such high nutrient levels in the Skeleton Creek catchment. High nitrogen levels in Stony Creek are known to be caused by problems with industrial discharges to the waterway.

E. coli was measured at a total of three sites, including Cherry Lake. Two sites have a SEPP objective of <1000 org/100mL, which was achieved with a good performance rating. Cherry Lake, however, has a SEPP objective of <200 org/100mL, and recorded a poor performance rating of 47%. Higher bird populations in the lake area may be contributing to these poor *E. coli* results.

Heavy metals were only analysed in Kororoit Creek (059), which recorded good and excellent percentage performances for Zn and Pb respectively.

Biological

Macroinvertebrates were monitored at three sites on Kororoit Creek and two on Skeleton Creek. Fauna in Skeleton Creek and the upper Kororoit Creek appeared to be in good condition. Fauna from Kororoit Creek between Sunshine and Altona, however, appeared to be adversely affected, possibly due to poor water quality (elevated levels of metals, nutrients and conductivities) and lack of stream habitat.

Toxicants

Concentrations of metals in stream sediments were monitored from one site on Skeleton Creek near Laverton, and two sites on Kororoit Creek, at Altona and Melton East. The Kororoit Creek site (Altona) recorded the most elevated metal concentrations of all the 35 sites monitored in the StreamWatch program. Results exceeded the Ontario LEL and Australian Level B criteria for Cd, Cu, mercury and Zn; and Ontario LEL criteria for Pb.

The highly elevated levels in lower Kororoit Creek may be due to past contamination episodes. Industrial effluent was discharged into this stream over a number of years before the region was sewered. Recent accidental spillages in the catchment area also contribute to this problem.

Elevated metal concentrations were recorded at sites on upper Kororoit Creek and Skeleton Creek. Results exceeded Ontario LEL and Australian Level B criteria for Cr, and Ontario LEL for Cd, Cu and Pb. Skeleton Creek also exceeded Ontario LEL and Australian Level B criteria for Zn. Reasons for these elevated concentrations are unclear. Results may be partly due to the naturally high levels of some metals which exist in catchment soils.

Table 9: Other Western Waterways

SW No.	Site Description	DO mg/L Mean	Turb NTU Median	SS mg/L Median	TN mg/L Mean	TP mg/L Mean	*E.coli* org/100mL Geomean	Pb mg/L Mean	Zn mg/L Mean
	Other Western Waterways								
055	Kororoit Creek at Millbank Dve, Deer Park	7.6	47	39	1.19	0.11	ns	ns	ns
056	Stony Creek at Bena St, Yarraville	12.8	27	28	4.20	0.30	390	ns	ns
057	Skeleton Creek at Sayers Rd, Hoppers Crossing	4.7	3.9	6	1.28	0.06	nr	ns	ns
058	Skeleton Creek at Ayr St, Laverton	6	5.5	7	0.87	0.10	ns	ns	ns
059	Kororoit Creek u/s Racecourse Rd Ford, Altona	9.3	21	25	1.80	0.17	236	0.006	0.026
060[#]	Cherry Lake, Millers Rd, Altona	ns	ns	ns	ns	ns	205	ns	ns

- Cherry Lake has an *E.coli* objective of <200 org/100mL during summer, due to primary contact recreational activities.
ns - not sampled

APPENDIX 1

State Environment Protection Policies & ANZECC Guidelines

State environment protection policies (SEPPs) contain objectives which set environmental standards to ensure the improved water quality of Greater Melbourne's waterways. These policies have been declared by the Governor-in-Council under the *Environment Protection Act, Victoria* (1970).

SEPP objectives vary according to the accepted beneficial uses of the waterway. Catchments have been divided into sub-catchments or segments, where different beneficial uses may occur.

Some water quality indicators are not given objectives under the SEPPs. Therefore, the *"Australian Water Quality Guidelines For Fresh And Marine Waters"* (ANZECC 1992) have been used.

The SEPPs that cover the water quality sites monitored under the StreamWatch program are:

- SEPP *Waters of Victoria*, 1988, Schedule F7 (draft) - *Waters of the Yarra Catchment*, 1995;
- SEPP W-28 *Waters of Western Port Bay and Catchment*, 1979;
- SEPP W-28A *Waters of the Dandenong Valley*, 1988; and
- SEPP W-29 *Waters of the Yarra River and its Tributaries*, 1984.

SEPP objectives for each StreamWatch indicator monitored in Greater Melbourne's waterways are recorded below.

State Environment Protection Policy Objectives for Greater Melbourne's Waterways

Catchment	DO mg/L min	Turb NTU/FTU Median	SS mg/L Median	TN mg/L max	TP mg/L max	*E.coli* org/100mL Geomean	Pb mg/L max	Zn mg/L max
Waters of the Yarra Catchment								
Rural Eastern Waterways	>6.0	<15	<20	<0.60	<0.05	<200	<0.002	<0.005
Rural Western Waterways	>6.0	<25	<25	<0.60	<0.05	<200	<0.002	<0.005
Yarra Tributaries - Southern	>6.0	<25	<25	<1.00	<0.10	<1000	<0.002	<0.005
Yarra Tributaries - Northern	>6.0	<25	<25	<1.00	<0.10	<1000	<0.002	<0.005
Urban Waterways - Yarra mainstream	>6.0	<25[c]/30[d]	<25[c]/50[d]	<0.90	<0.08	<200	<0.002	<0.005
Waters of the Dandenong Valley								
Dandenong Creek & Major Tributaries	>4.5	<25	<25	<0.75	<0.1	<1000	<0.05	<0.25
Mordialloc & Kananook Creeks	>4.0	<20	<25	<0.75	<0.1	<1000	<0.02	<0.04
Mordialloc & Kananook Creek Tributaries	>4.5	<20*	<25	<0.75	<0.1	<1000	<0.05	<0.25
Waters of Western Port Bay & Catchment								
Western Port Waterways - Peninsula	>6.0	<25*	<25*	<0.75	<0.1	<1000	<0.01	<0.005
Western Port Waterways - Eastern	>6.5	<25*	<25*	<0.75	<0.1	<200	<0.01	<0.005
Waters of Victoria								
Balcombe Creek	>5.0	<25*	<25	<0.75	<0.1	<1000	<0.01	<0.02
Maribyrnong River & Tributaries	>5.0	<25*	<25	<0.75	<0.1	<1000	<0.025	<0.05
Maribyrnong River - Estuarine	>5.0	<25*	<25	<0.75	<0.1	<1000	<0.01	<0.02

Note:
(c) - Yarra mainstream u/s of Diamond Creek confluence & (d) - Yarra mainstream d/s of Diamond Creek confluence.
* - SEPPs do not stipulate an objective, therefore this report has assumed a commonly accepted figure for the catchment. SEPPs for the South Eastern and Western waterways do not stipulate an objective for T-N or T-P. Therefore the ANZECC figures have been used (<0.75 mg/L and <0.1 mg/L respectively).

APPENDIX 2

Methodology

Data Calculation

Eight key water quality indicators (DO, turbidity, SS, T-N, T-P, *E. coli*, Pb and Zn) have been used to describe the water quality for each site. Not all sites are monitored for *E. coli* and heavy metals.

Annual Figures

Annual figures for each site have been calculated one of three ways. Where SEPP objectives state a statistical calculation, that is used (median or geometric mean), otherwise the mean has been calculated.

Mean

For dissolved oxygen (DO), total phosphorus (T-P), total nitrogen (T-N), lead (Pb) and zinc (Zn), the calculated statistic is a yearly mean.

This is calculated by adding all observations for an indicator for the year, then dividing by the total number of observations. Less than (<) results are included as a real number (i.e <0.002 is treated as 0.002).

Median

Suspended solids (SS), turbidity (Turb) and metals are calculated as a median.

This is done by taking all observations for an indicator for the year, and ordering them from lowest to highest. The middle figure is the median. If there is an even number of observations, the middle two figures are added together, then divided by two.

Geometric Mean

E. coli is the only indicator where this statistic is used. The geometric mean is historically used due to the large variation in bacterial counts, ranging from zero to possibly millions of organisms per 100mL.

The geometric mean is the result of adding the logarithms of all observations, dividing by the number of observations, and converting the quotient to the anti-logarithm.

SEPP objectives require the calculation of a geometric mean using at least five observations taken over the course of no more than 42 days. Aside from some sites which are sampled weekly, most monitoring sites do not meet this strict requirement.

To determine the level of *E. coli* for a year, the geometric mean is taken for all observations in the year and a single figure obtained.

Data Reporting

Yearly "average" results are provided in the tables for each sub-catchment. Consequently, the notion of percentage performance has been used to give an indication of how water quality has measured up against the SEPP objectives.

SEPP objectives are usually maximum allowable figures, except suspended solids and turbidity, which are yearly medians, and *E. coli*,, which is a geometric mean. If these median and geometric mean objectives were strictly applied to the data, it would mean that each site would either pass or fail. This is insufficient information to assess water quality performance against the SEPP.

Percentage (%) Performance

This technique involves assessing each observation for an indicator, over a year, against the SEPP or ANZECC objective. The number of observations that pass is then divided by the total number of observations, to obtain a percentage figure.

This figure represents the percentage performance, or achievement, of the individual observations that meet the statistical (SEPP or ANZECC) objective. Note, this percentage performance is not the same as SEPP compliance.

Percentage performance has been described as excellent (>90%), good (70-90%), moderate (50-70%) and poor (<50%).

APPENDIX 3

Percentage Performance Results - Summary by Indicator

The percentage performance results for all sites are given in Figures 1 through to 7. These figures allow a comparison for each site as to how well they performed against the SEPP (or ANZECC) objective for specific indicators. The numbers 001 to 060 represent the site numbers identified in this report. Not all sites are monitored for all indicators. Those not sampled have been identified. All sites, except 030 (Yarra River downstream Prahran Main Drain, South Yarra) and 060 (Cherry Lake at Altona), have been monitored for the five indicators: DO, turbidity, suspended solids, T-N and T-P. There were 33 sites monitored for *E. coli*. All these sites recorded a percentage performance figure above zero and appear in Figure 6. There were 15 sites monitored for metals. All but one achieved a percentage performance result above zero, as shown in Figure 7. Site 029 (Yarra River at Kew) recorded zero percentage performance for Zn.

Colour Key for Figures 1 to 7

- Good to Excellent Percentage Performance result (>70%)
- Moderate Percentage Performance result (50%-70%)
- Poor Percentage Performance result (<50%)

Figure 1

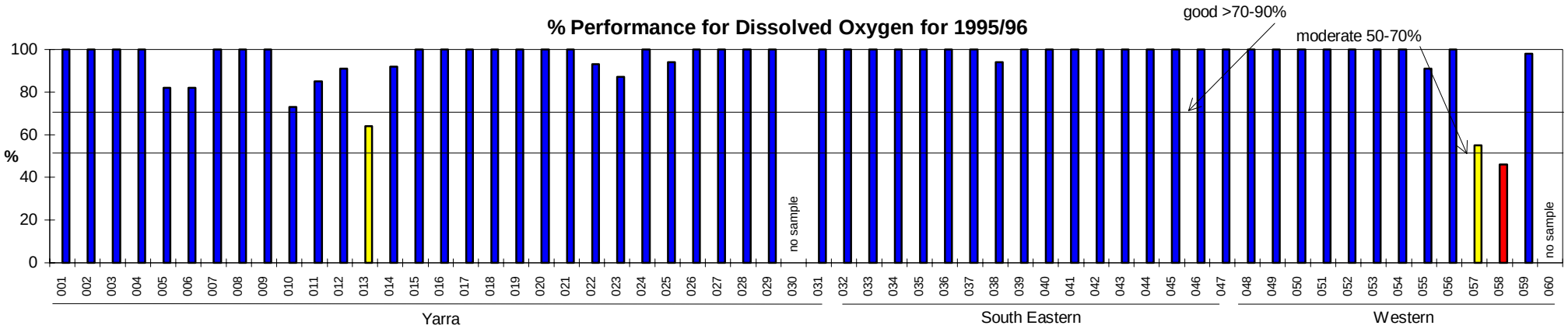


Figure 1 - No site recorded zero percentage performance for DO. The two lowest results were recorded in Skeleton Creek at the Hoppers Crossing and Laverton sites. Of the 58 sites monitored, 44 achieved a 100% performance rating for DO. The South Eastern waterways achieved the best results of the program for DO, almost recording 100% performance. Only one site (038, Kananook Creek, Frankston) fell slightly short, achieving 94%. Tidal conditions and low flows are responsible for these. The Yarra River achieved 100% at all sites, and many of its tributaries.

Figure 2

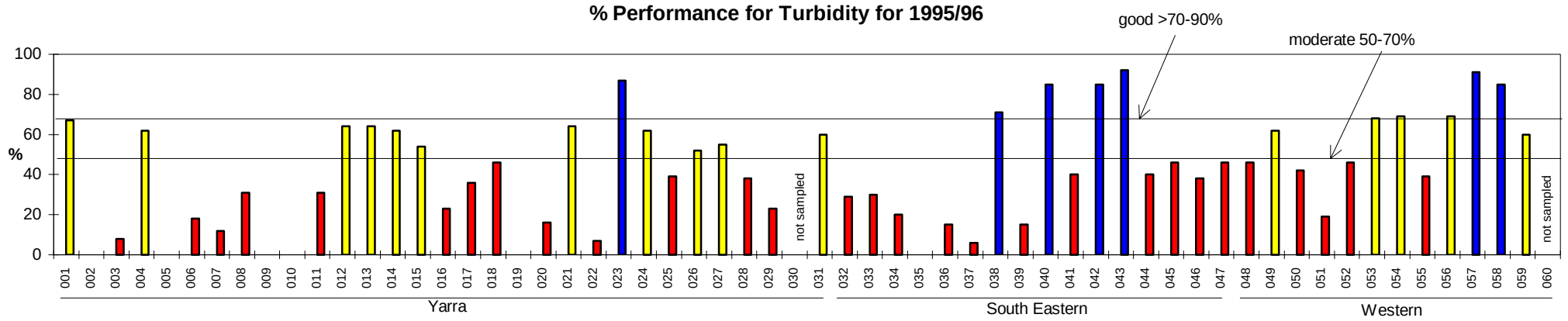


Figure 3

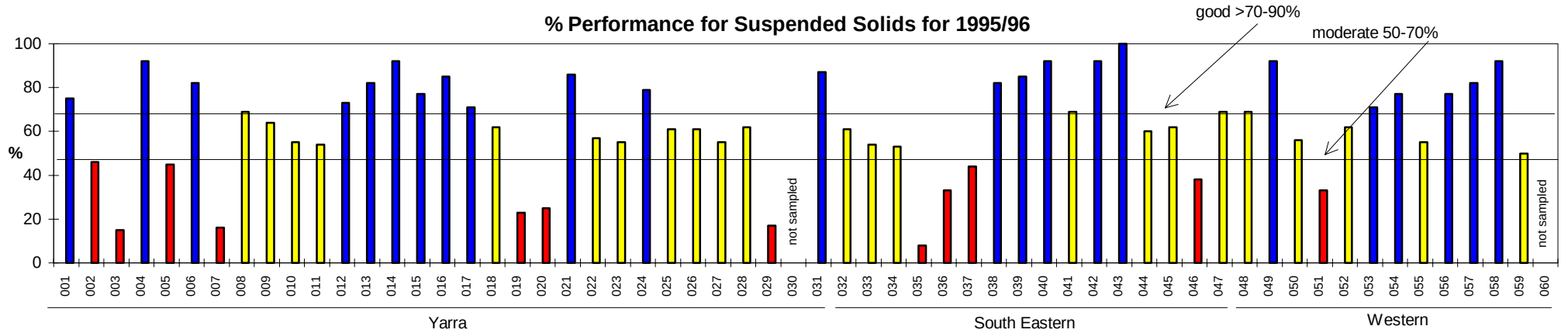


Figure 2 - No site achieved 100% performance for turbidity. Of the 58 sites monitored, six recorded zero percentage performance (five in the Yarra catchment and one in the South Eastern). In the South Eastern waterways, rural sites generally performed better than urban sites. The National Water Sports Centre site in Bangholme (035) is situated at the bottom of the large Dandenong Creek catchment, and receives highly turbid flows following rainfall. Combined with boating activities, catchment disturbances and wind action on a shallow water body, very little settling occurs.

Figure 3 - Only one site recorded a 100% performance rating for suspended solids (043, Cardinia Creek). Unlike results for turbidity, no site recorded zero percentage performance.

Figure 4

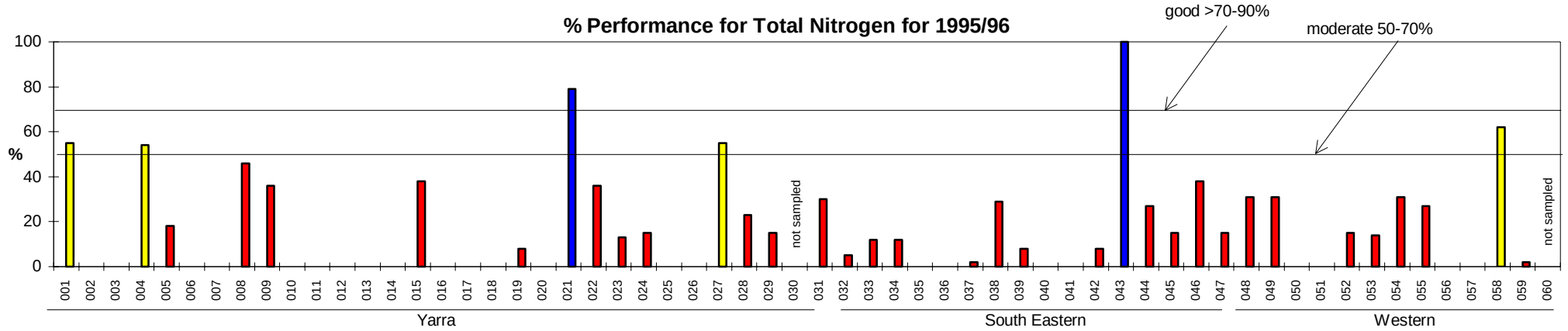


Figure 5

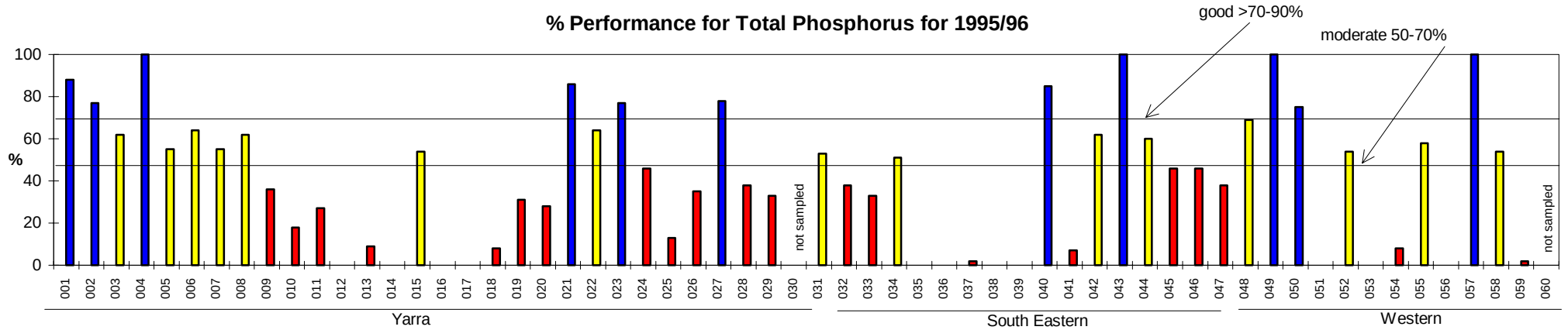


Figure 4 - Total nitrogen had the worst performance of all indicators. Only one site recorded 100% performance and two other sites recorded above 60%. Twenty-three sites recorded zero percentage performance, with most of these in the Yarra catchment (15 of 30 Yarra sites, four of 16 South Eastern sites, and four of 12 Western waterways sites).

Figure 5 - Total phosphorus performed better than T-N, with four sites recording 100% performance, and only 11 sites recording zero. Generally, Melbourne's soils are phosphorus deficient, so that phosphorus in waterways comes from human activities. Nitrogen, however, is produced in large quantities in day to day human activities, as well as being abundant in nature in organic material.

Figure 6

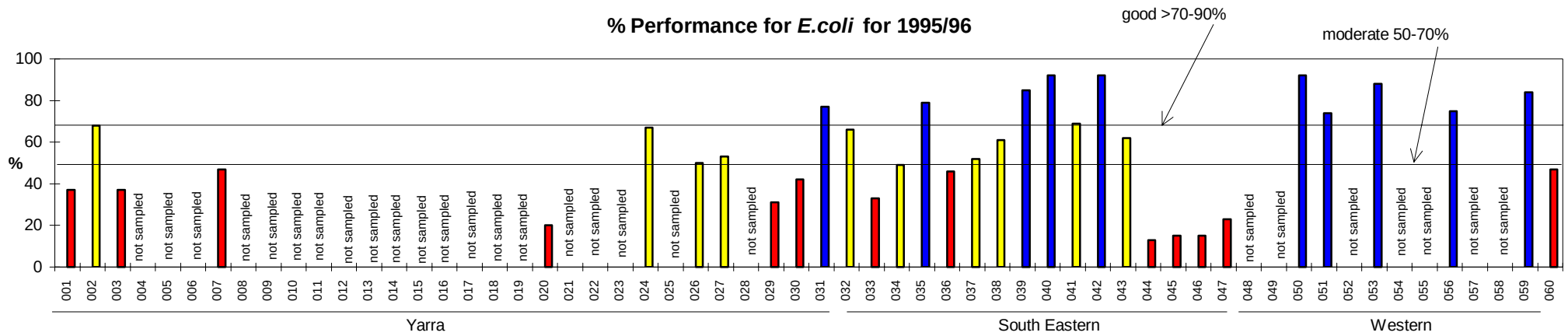


Figure 7

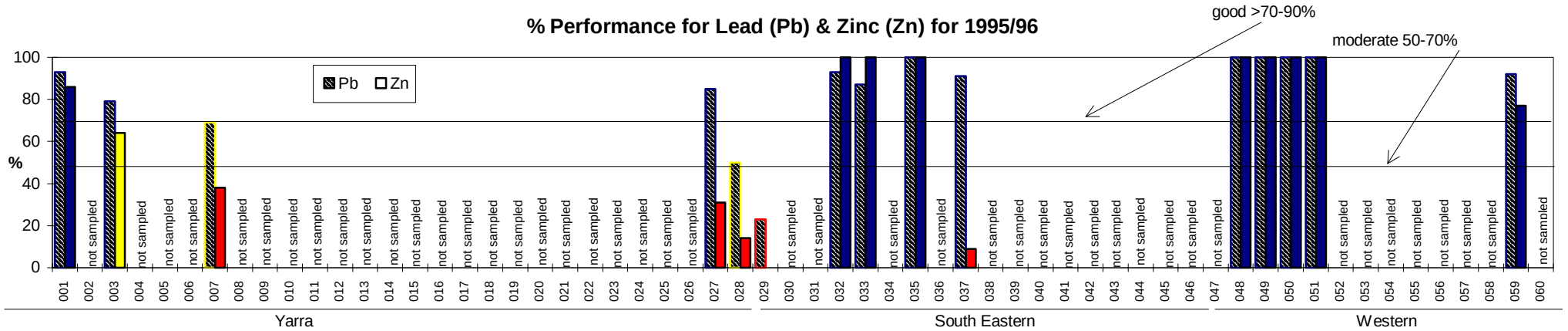


Figure 6 - No site recorded zero or 100% performance for *E. coli* . The four lowest percentage performances were recorded in the rural sites of the South Eastern waterways, which are all in the Western Port-Peninsula catchment, and have the lower SEPP objective of <200 org/100mL. Sites with a SEPP objective of <1000 org/100mL tended to record a higher percentage performance (average 66%) than those with an objective of <200 org/100mL (average 37%).

Figure 7 - Five sites recorded 100% performance for both metals, while two sites recorded 100% for Zn only. Except for Zn at site 037 (Mordialloc Creek - more stringent objective applies), percentage performances in the South Eastern and Western waterways were high. The Yarra catchment had the worst percentage performance, however, SEPP objectives for this area are more stringent.

APPENDIX 4

Biological Results

WQ SITE NO. #	WATERWAY	ECOSYSTEM HEALTH RATING	KEY FACTORS INFLUENCING ECOSYSTEM HEALTH
	Back Ck, Dawson Dve, Glen Iris	1	Stream habitat, general water quality
040	Balcombe Ck, "The Briars", Balcombe	3	Conductivities
	Balcombe Ck, Two Bays Rd, Mt Eliza	2	Metals
043	Cardinia Ck, Boundary-Manestar Rd, Harkaway	4	Nil
	Cockatoo Ck, Tschampions Rd, Nangana	4	Nutrients
	Dandenong Ck, Boronia Rd, Wantirna	1	Very poor stream habitat
	Dandenong Ck, Brady Rd, Endeavour Hills	2	Stream habitat
	Dandenong Ck, Doongala State Forest, Kilsyth Sth	4	Nil
	Dandenong Ck, High St, Glen Waverley	2	Stream habitat
034	Dandenong Ck, Pillars Crossing, Dandenong Sth	2	Stream habitat
049	Deep Ck, Trap St, Bulla	3	Salinity
	Eumemmerring Ck, Belgrave-Hallam Rd, Narre Warren	3	Nutrients
	Eumemmerring Ck, Progress St, Dandenong	2	Stream habitat, nutrients, metals
036	Eumemmerring Ck, Worsley Rd, Bangholme	2	Stream habitat, nutrients, metals
	Gardiners Ck, Blackburn Lake, Blackburn	2	Stream habitat, nutrients, metals
	Gardiners Ck, Eric Raven Reserve, Glen Iris	2	Stream habitat, nutrients, metals
	Gardiners Ck, Station St, Box Hill	2	Stream habitat, nutrients, metals
	Gardiners Ck, Toorak Rd, Kooyong	1	Stream habitat, sedimentation
	Gardiners Ck, Warrigal Rd, Chadstone	2	Stream habitat, nutrients, metals
048	Jacksons Ck, Sunbury	3	Stream condition
059	Kororoit Ck, Racecourse Rd, Altona	1	Toxicants in sediments, nutrients
	Kororoit Ck, Sinclairs Rd, Melton East	3	Salinity, stream habitat
	Kororoit Ck, Warmington Rd, Sunshine	2	Stream habitat, salinity
	Lang Lang River, Drouin-Poowong Rd, Poowong	2	Stream habitat, nutrients
047	Lang Lang River, South Gippsland Hwy, Lang Lang	2	Stream habitat, suspended solids
	Maribyrnong River, Sydenham	3	Nutrients, metals
051	Maribyrnong River, Canning St Ford, Avondale Heights	3	Nutrients, metals
	Maribyrnong River, Calder Hwy, Keilor	3	Nutrients, metals
	McCrae Ck, Healesville-Koo Wee Rup Rd, Yellingbo	4	Nil
	Scotchmans Ck, Warrigal Rd, Oakleigh	2	Stream habitat, nutrients, metals
	Shepherd Ck, Beenak Reserve, Beenak	4	Nil
	Skeleton Ck, Point Cook Rd, Laverton	2	Nutrients, salinity
057	Skeleton Ck, Sayers Rd, Hoppers Crossing	3	Stream habitat, salinity
	Wandin Yallock Ck, Sunnyside Rd, Gruyere	3	Stream habitat
	Woori Yallock Ck, Kylie Lane, Woori Yallock	3	Stream habitat, nutrients
	Woori Yallock Ck, Woori Yallock Rd, Macclesfield	4	Nil
	Woori Yallock Ck, Parslows Rd, Yellingbo	4	Nil
029	Yarra River, Chandler Hwy, Kew	2	Stream habitat, turbidities, metals
	Yarra River, Dights Falls, Abbotsford	1	Stream habitat, metals, turbidities
	Yarra River, downstream of Armstrong Ck, Reefton	4	Nil
003	Yarra River, Everard Park, Maroondah Hwy, Healesville	3	Stream habitat
	Yarra River, Fitzsimons Lane, Templestowe	3	Turbidities, nutrients
	Yarra River, Healesville-Koo Wee Rup Rd, Woori Yallock	4	Nil
007	Yarra River, Spadonis Reserve, Coldstream	3	Stream habitat
027	Yarra River, Warrandyte Rd bridge, Warrandyte	3	Turbidities, nutrients

- where a corresponding water quality site exists that number is used.

Key to Ecosystem Health	
Very good to excellent condition	4
Mild signs of stress	3
Moderate stress	2
Severe stress	1

APPENDIX 5

Toxicant Results

WQ SITE NO.#	LOCATION	LAND USE	METALS						
			Arsenic	Cadmium	Chromium	Copper	Mercury	Lead	Zinc
040	Balcombe Ck, "The Briars", Balcombe	OU							
	Balcombe Ck, Two Bays Rd, Mt Eliza	OU							
043	Cardinia Ck, Boundary-Manestar Rd, Harkaway	A							
	Cockatoo Ck, Tschampions Rd, Nangana	A							
	Dandenong Ck, Boronia Rd, Wantirna	U							
	Dandenong Ck, Brady Rd, Endeavour Hills	U							
034	Dandenong Ck, Pillars Crossing, Dandenong	U							
	Dandenong Ck, Doongala State Forest	F							
049	Deep Ck, Trap St, Bulla	A							
036	Eumemmerring Ck, Worsley Rd, Dandenong	U							
	Eumemmerring Ck, Belgrave-Hallam Rd, Narre Warren Nth	A							
	Gardiners Ck, Blackburn Lake, Blackburn	U							
	Gardiners Ck, Eric Raven Reserve, Glen Iris	U							
	Gardiners Ck, Station St, Box Hill	U							
	Gardiners Ck, Toorak Rd, Kooyong	U							
	Gardiners Ck, Warrigal Rd, Chadstone	U							
	Jacksons Ck, Sinclairs Rd, Melton East	A							
048	Jacksons Ck, Sunbury	A							
059	Kororoit Ck, Racecourse Rd, Altona	I							
	Lang Lang River, Drouin-Poowong Rd, Poowong	A							
047	Lang Lang River, South Gippsland Hwy, Lang Lang	A							
	Maribyrnong River, Calder Hwy, Keilor	OU							
051	Maribyrnong River, Canning St Ford, Avondale Heights	OU							
	McCrae Ck, Healesville-Koo Wee Rup Rd, Yellingbo	F							
	Shepherd Ck, Beenak Rd, Pakenham	F							
	Skeleton Ck, Point Cook Rd, Laverton	U							
	Wandin Yallock Ck, Sunnyside Rd, Gruyere	A							
	Woori Yallock Ck, Kylie Lane, Woori Yallock	A							
	Woori Yallock Ck, Woori Yallock Rd, Macclesfield	A							
	Woori Yallock Ck, Parslows Rd, Yellingbo	A							
	Yarra River, Dights Falls, Abbotsford	U							
029	Yarra River, Chandler Hwy, Fairfield	OU							
	Yarra River, Fitzsimons Lane, Templestowe	OU							
	Yarra River, Healesville-Koo Wee Rup Rd, Woori Yallock	A							
003	Yarra River, Maroondah Hwy, Healesville	A							
007	Yarra River, Spadonis Reserve, Coldstream	A							
027	Yarra River, Warrandyte Rd bridge, Warrandyte	A							
	Yarra River, downstream of Armstrong Ck, Reefton	F							

- where a corresponding water quality site exists that number is used.

Key		Predominant Land Use	
	passed both criteria: LEL and Aust. Level B	A - agriculture	OU - outer urban
	Failed LEL criteria: Moderate contamination for aquatic sediments	F - forest	U - urban
	Failed Australian Level B criteria (therefore LEL): Higher contamination for soils	I - industry	LEL - lowest effect level each metal has on benthic invertebrates based on overt toxicity tests (Ontario Ministry of the Environment)

FURTHER INFORMATION

The Environment Protection Authority (EPA) conducts a Beachwatch program over the summer months. This program monitors Melbourne's key swimming beaches for microbiological contamination (*E. coli*) and other factors that may affect human health. This coincides with Melbourne Water's summer *E. coli* program, which monitors numerous key primary recreational waterways between December and March, on a weekly basis.

As Greater Melbourne's waterway manager, Melbourne Water also has a responsibility for monitoring algal blooms. This involves following an Emergency Management Plan to identify and respond to a bloom. Some blooms occur in waterways that do not come under Melbourne Water's responsibility. Nonetheless, Melbourne Water, as 'convening agency', co-ordinates the reporting of such blooms.

For More Information Contact:

Melbourne Water
Waterways & Drainage
630 Church Street
Richmond VIC 3121
Phone (03) 9235 2100
Fax (03) 9429 7174

Or Write To:

Melbourne Water
Waterways & Drainage
Locked Bag 4280
East Richmond VIC 3121

Fact Sheets Available

- Cherry Lake and Truganina Swamp
- Drainage Rate
- Drains to the Bay Stencilling Program
- Flood Plain Management
- Green Waste and Waterway Pollution
- List of Teaching Resources
- Litter in Waterways
- Maribyrnong Area Major Works for 1995/96
- Melbourne Platypus Study
- Oil and Water Don't Mix
- Painting and Stormwater Pollution
- Profile of the Waterways & Drainage Business, Melbourne Water
- South East Area Major Works for 1995/96
- Stormwater Pollution
  Stormwater Pollution at Construction Sites
- Water Quality of Mordialloc Creek
- Waterway Management in Rural Areas
- Wetlands - Kidneys of the Catchment
- Willow Removal Program
- Yallock Drainage and Rivers Improvement Rates Advisory Committee
- Yarra Area Major Works for 1995/96
- Yarra River

Other StreamWatch Reports

- StreamWatch Biological Monitoring Program - Annual Report, 1997
- StreamWatch Toxicant Monitoring Program - Annual Report, 1997

Other Reports Available*

- Biological Condition and Sediment Contamination in Melbourne's Waterways
- Community Perceptions of Melbourne's Waterways
- 18 Week Monitoring Program of *Escherichia coli* - Summer 94/95.
- Environmental Condition of Melbourne's Waterways
- Recreation Amenity of Melbourne's Urban Waterways
- Stream Condition Inventory: Yarra and Maribyrnong Catchments Data Report
- StreamWatch Annual Report 1994
- StreamWatch Annual Report 1995
- StreamWatch Biological Monitoring Program
- StreamWatch Toxicant Monitoring Program
- StreamWatch 1993/94 *E. coli* Monitoring Program
- Turbidity in the Yarra River
- Water Quality in The Yarra River, 1975-1994

[* Contact Parks Victoria, Ph: (03) 9 816 7000]

NOTES

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CONTACTS