

THE HEALTH OF THE LITTLE YARRA RIVER CATCHMENT



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PREFACE

Melbourne Water Corporation has waterway management responsibility for approximately 3,974 kilometres of streams. A water quality monitoring network provides the means for measuring how water quality and waterway health changes over time. To complement network monitoring, Melbourne Water began a series of intensive investigations of waterways. These investigations assess waterway health and identify major management issues that need to be addressed to sustain or enhance waterway health.

This discussion paper provides a summary of stream health and key ecological management issues within the Little Yarra River catchment. The assessment includes several measures of waterway health. Aquatic life inhabiting our waterways are sensitive to a range of environmental stresses, including the modification of habitat, poor water quality and alteration to stream flows. So, water quality assessment alone is not being relied upon, but also the physical condition of the waterway, and biological status – such as aquatic invertebrates and fish. Sediment contamination was also measured. Data generated from using these disparate indicators, provide a greater appreciation and understanding of the issues, and a better means of suggesting management actions.

Melbourne Water undertakes waterway management activities under the Healthy Waterways Program. This program aims to:

- reduce sediment levels in the Yarra and south-eastern waterways,
- reduce nitrogen loads to Port Phillip,
- reduce faecal contamination in waterways and at bay beaches,
- reduce litter in waterways and on beaches, and
- enhance the environmental condition of waterways.

Monitoring and assessment programs generate information used to assist in determining priorities for waterway rehabilitation and water quality improvement works, as well as determining the effectiveness of the Healthy Waterways Program. Melbourne Water commits approximately \$17 million annually to the Healthy Waterways Program. Apart from funding waterway investigations, monitoring and research programs, these funds go towards a range of waterway works, including erosion prevention, revegetation, weed control and the construction of wetlands. Barriers to fish movement are also being removed. Together these activities are improving waterways in Greater Melbourne.

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EXECUTIVE SUMMARY

The aim of this report is to assess the ecological health of the Little Yarra River and its tributaries. A number of studies have been commissioned by Melbourne Water to achieve this aim, and this report draws upon them to generate an overall assessment of the system.

A fish survey discovered a rich native fish community within the catchment, including seven native fish and four native crustaceans. Four migratory fish were found upstream of the gauging weir at Yarra Junction, which suggests that this structure is not a complete barrier to fish movement. The absence of native fish above the Britannia Creek weir, in conjunction with the natural rocky incline, indicates this may be a significant obstacle.

Ten platypus were captured over approximately 15 km of the Little Yarra River, with an estimated platypus density of 1.3 animals per kilometre of channel. More than half the animals were rated as being in above average or good condition the rest being average or fair. Nine species of frogs have been recorded in the catchment, including the growling grass frog *Litoria raniformis*, formally recognised as threatened. There are also numerous Vulnerable, Rare or Threatened (VROT) and Regionally Significant Species resident, notably the Powerful Owl *Ninox strenua* and the Great Egret *Ardea alba* – it is acknowledged that these species may not be closely associated with the stream environment.

The catchment wide water quality study determined that during baseflow, conditions are generally good according to ANZECC guidelines and SEPP objectives with the purpose of protecting aquatic ecosystems (EPA 1999). *E. coli* levels, however, were slightly elevated at six of the ten sampling sites. Stock waste is a likely source of this contamination, and as the Little Yarra catchment is not extensively sewered, septic in-flows could also contribute.

Sediment samples were analysed for heavy metals, petroleum hydrocarbons, organochlorine pesticides and total organic carbon. Findings of this study indicate that the sandy sediment poses a low risk to ecosystem health. However, elevated arsenic levels in Saxton Creek and elevated mercury levels in the upper Little Yarra River represent a moderate risk to ecosystem health and warrant further investigation. Elevated concentrations of these contaminants in some locations may be associated with historical gold-mining activity.

Petroleum hydrocarbon analyses returned elevated levels at some sites indicating the likely influence of localised road runoff. Analysis of samples for pesticide residues indicated levels below the detection limit at all sites. Further sampling is recommended to take into account potential seasonal variation.

The dominant invertebrate families in the catchment were Leptoceridae, Leptophlebiidae and Chironomidae. The Little Yarra at Lowes Road site met with all of the SEPP objectives, while the three tributary sites on Britannia, Hackett Creek and Saxons Creeks met none – most probably due to lower stream flows and the absence of riffles to sample. Even so, the ecological condition of waterways in the Little Yarra catchment is still considered good, with a relatively high number of EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa and many of the SEPP objectives failing only marginally.

An assessment of physical stream condition has found the overall condition of the forested portions (60%) of the catchment to be excellent – being stable, well vegetated and containing the full complement of stream habitats expected in undisturbed reaches. Freehold land (19%)

was found to have good tree cover, while agricultural land (20%) lies predominantly on the floodplain and is prone to disturbance. In general, biological and physical condition of Little Yarra system deteriorated with distance downstream.

Considering the relatively good ecological condition of the Little Yarra River and its tributaries, of primary management importance is the protection of this system. Management priorities identified from this integrated stream health assessment are:

- Careful planning to reduce the impact of future urban development
- Continued stream frontage management
 - Weed control – particularly willows
 - Bank stabilisation
 - Replanting riparian vegetation
 - Restricting stock access
- Develop a Stream Flow Management Plan for the Little Yarra River and tributaries
- Investigate opportunities to reintroduce large woody debris into sections of the Little Yarra River that have poor instream habitat (perhaps through the stream frontage management program)
- Investigate opportunities to treat road run-off through involvement of local councils in the Stormwater Management Program
- Further investigation of elevated nutrient and *E. coli* levels, in particular the Slaty Creek catchment

1 INTRODUCTION

This report is a summary of stream health within the Little Yarra River catchment – integrating findings from separate studies that include fish, platypus, water quality, sediment quality and physical stream condition. The aims of this report are to:

- review existing information on the health of waterways within the Little Yarra catchment;
- identify the primary factors influencing the health of those waterways; and
- provide recommendations to maintain and improve stream health within the catchment.

2 STUDY AREA

2.1 Catchment Description

The Little Yarra River rises in the Great Dividing Range above Powelltown about 60 km east of Melbourne (Figure 1), and is the first major tributary to enter the Yarra River below Wesburn. The catchment incorporates an area of around 155 km², with the length of the Little Yarra River being approximately 24 km.

There is only around 1 km² of urban development within the catchment. The rest of the catchment comprises: 93 km² of State forest, 29 km² of grazing and horticulture, and 28 km² of freehold land (Brizga et al. 2000). The main towns within the catchment boundary are Yarra Junction, Wesburn, Gladysdale, Three Bridges, Gilderoy and Powelltown.

Figure 1: Map of the Little Yarra River Catchment



Major tributaries of the Little Yarra River are the Britannia, Learmonth, Mackley, Slatey and Black Sand Creeks. However, there are numerous minor tributaries, which include:

Edwardstown, Hackett, Hearse, Blackwood, Barrier, Tin Mine, Mackley, Morgan, Barker, Condon, Fir Tree, Kobecke, Beer, Saxton, and Moon Gully Creeks.

2.2 Geology

This catchment forms part of the East Victorian Uplands – Dissected Uplands Geomorphic Unit (Land Conservation Council 1991). The dominant Devonian granitic rocks (Warburton Granodiorite and Tynong Granite) of the southern and eastern portions of the catchment form hilly to mountainous terrain. However, Silurian and Devonian sedimentary, and Devonian metamorphic rock occur in the lower north west portion of the catchment with the result that the narrow valley widens in the downstream direction to a broad alluvial floodplain area that eventually merges with the Yarra River floodplain (Brizga and Craigie 1997). Weathering of the granitic rocks that are the dominant geology of the Little Yarra catchment, result in a bedload composed chiefly of sand (Brizga and Craigie 1997).

2.3 Climate

Based on data recorded at Powelltown between 1942 and 2001, average annual rainfall in the catchment is around 1471 millimetres, while the average annual minimum and maximum air temperatures are 6.9°C and 18.3°C respectively (BOM 2002).

2.4 Land Use

This catchment is largely forested, unlike adjacent catchments that have been heavily cleared for agricultural use. Of the area cleared, the steeper slopes of the Little Yarra catchment have been extensively logged since the 1850s and suffered severe damage in the 1939 and 1980s bushfires. The lower slopes and river floodplain area of the eastern region have been cleared for grazing (Brizga et al 2000).

Gold discovery in the 1850s saw the development of the Britannia Goldfield at the confluence of the Little Yarra River and Britannia Creek and included the lower part of the Little Yarra River catchment (Brizga et al 2000).

2.5 Water Harvesting

Comparatively small volumes of water are extracted from the Little Yarra River, or from its tributaries. Of the average annual stream flow of 46,325 ML (based on 1975-1999 data), diverters are only licensed to extract 1,134 ML (2.4%). The majority of water diverted is for domestic and stock watering.

Table 1: Diversion licences in the Little Yarra River catchment

Diversion Category	No. Licences
Powelltown Town Water Supply	1
On-stream Dams	21
Irrigation	22
Industrial	2
Domestic, Stock and Irrigation	7
Domestic and Stock	52
Commercial	3
Total	107

There are no publicly-owned major water harvesting infrastructure (e.g. dams or weirs) in the Little Yarra catchment, but there are many small privately-owned dams, the largest being Lake Muratore (around 2,000 ML) on a minor tributary at Gilderoy (Brizga et al. 2000).

2.6 Sewering

Since 1995, responsibility for the sewer system in the Little Yarra catchment resides with Yarra Valley Water. Prior to 1975, development was permitted to proceed without provision of reticulated sewerage facilities, with the result that by 1995 the Little Yarra catchment had a backlog of 117 unsewered lots (Dawson 1995). These lots are usually serviced by on-site treatment systems such as septic tanks. Effluent is then disposed of via discharge to agricultural drains or the local stormwater drainage systems (Dawson 1995).

SEPP No. W29 for the Yarra River and its tributaries states '*Sewerage shall be provided as soon as possible to all existing subdivisions of land where wastewaters cannot be adequately treated and retained within the boundaries of each allotment*'. Lower density properties, such as those in the Little Yarra catchment however, are considered suited to treating and containing wastewater within the bounds of the property, and thus are unlikely to be included in this program of works.

For properties within the catchment that are connected to sewer, treatment of around 150 kL of wastewater per day was provided by a treatment plant located at Park Road on the Warburton Highway, Yarra Junction, until 10 November 1997, at which point the new Upper Yarra Treatment Plant was made operational (Brian Haymes, YVW Feb 2002, pers. comm.).

The sewerage area in the Little Yarra River catchment principally comprises the town of Yarra Junction. Some properties in Wesburn in the Britannia Creek catchment have also been sewerage, and in general, 1000 m²-lots have been sewerage with the result that there are no longer any areas on the sewerage backlog program in Yarra Junction or Wesburn (Peter Ralph, Yarra Valley Water, personal communication 2002.).

2.7 De-snagging

In the past, large woody debris (or snags) has been removed from several reaches of the Little Yarra River. These works were undertaken primarily due to concern that snags were causing an increased frequency of flooding. State Rivers and Water Supply Commission (later the Rural Water Corporation) carried out snag removal in 1954, 1959, 1962, 1965, 1969/70, 1974, and 1976 and by Melbourne Water Corporation in 1982/83. The latter operation continued until 1987.

Management attitudes to de-snagging have changed in recent times, recognising the negative ecological and stream instability implications typically associated with de-snagging. This change in management attitude has resulted in Melbourne Water re-snagging a roughly 1.5 km reach of the Little Yarra River where snags were removed in spring 1997.

3 INDEX OF STREAM CONDITION

Index of Stream Condition (ISC) endeavours to provide an integrated measure of the environmental condition of streams. The ISC is a standard method developed by the Department of Natural Resources and Environment to be applied across the State of Victoria. The ISC combines information on flow regimes, water quality, condition of the channel, streamside vegetation and aquatic life. It is important to note that the ISC is a broad indicator

of stream health developed to flag issues and identify where more detailed investigations are required. Four of the ten study sites were suitable for calculating the ISC. These sites were adjacent to the urban (more disturbed) areas and, accordingly, the ISC ratings indicated a stream in relatively poor health. ISC ratings for other stream reaches within the Little Yarra River system, where there is less disturbance, are expected to indicate better condition.

A more comprehensive assessment of stream health, including the consideration of additional stream health indicators, is provided in the following sections of this report.

4 FISH

There have been few historical fish surveys conducted in the Little Yarra catchment. Historical survey results, obtained from the Victorian Fish Database, are summarised in Table 2.

Table 2: Historical Fish Survey Results for the Little Yarra River Catchment*

Common Name	Scientific Name	Britannia Creek	Hackett Creek	Saxton Creek
Native Fish				
Short-finned Eel	<i>Anguilla australis</i>	✓		
Mountain Galaxias	<i>Galaxias olidus</i>	✓		
River Blackfish	<i>Gadopsis marmoratus</i>	✓		
Introduced Fish				
Brown Trout	<i>Salmo trutta</i>	✓	✓	✓
Rainbow Trout	<i>Oncorhynchus mykiss</i>	✓		
Last Surveyed		1991	1974	1974
Coverage		Moderate	Poor	Poor

* Source: DNRE Victorian Fish Database, '✓' = present

To improve our understanding of fish communities within the Little Yarra catchment, Melbourne Water commissioned the Arthur Rylah Institute to conduct a qualitative fish survey in May-June 2001. Fish were surveyed using a portable backpack electrofishing unit, with the length of stream survey at each site being generally about 100 m. The exception was site LY02, at the Caulfield Grammar property, where 1500 m of stream was surveyed quantitatively using a two-pass electrofishing technique, with stop nets (5 mm stretched mesh) positioned at upstream and downstream margins of each 100 m sub-reach. This site was sampled differently because it is part of a Melbourne Water study that is investigating ecological response to re-snagging that part of the Little Yarra River. Details regarding recent survey sites are presented in Table 3.

Table 3: Fish Survey Sites in Little Yarra River Catchment 2001*

Date	Site	Waterway	Location	Easting	Northing
29/06/2001	LY01	Little Yarra River	Warburton Highway (0-100m U/S)	379200	5817200
21-30/05/01	LY02	Little Yarra River	Caulfield Grammar School Property	380821	5815426
28/06/2001	LY03	Little Yarra River	Black Sand Creek Road (0-100m U/S)	382900	5811900
28/06/2001	LY04	Little Yarra River	Three Bridges Road (0-100m U/S)	384300	5810600
29/06/2001	LY05	Little Yarra River	Powelltown Footbridge (0-100m U/S)	389700	5808600
29/06/2001	BT06	Brittania Creek	Tarrango Road (0-100m U/S)	379800	5816800
23/05/2001	BT07	Brittania Creek	Justice Track (50m D/S – 53m U/S)	383300	5815800
28/06/2001	BS08	Black Sand Creek	Lot 85 Black Sand Road (0-100m U/S)	383600	5811900
29/06/2001	HC09	Hackett Creek	Yarra Junction-Noojee Road (0-100m U/S)	384700	5809700
29/06/2001	SC10	Saxon Creek	Yarra Junction-Noojee Road (0-100m U/S)	386500	5809300

* Site LY02 was sampled quantitatively over 1,500 m

A total of 10 species of freshwater fish was recorded, of which seven species are native and three exotic (Table 4). These results indicate a relatively rich native fish community. Of the native fish, four species are considered migratory (*Retropinna semoni*, *Anguilla australis*, *Geotria australis* and *Mordacia mordax*). The presence of migratory fish upstream of Lowes Road, Yarra Junction, suggests that the gauging weir at that site is not a complete barrier to fish migration.

Native fish were absent within upper Britannia Creek. This may be due to the relatively small size of the stream and barriers to fish migration, including natural rock outcrops and the Britannia Weir. The more intensive and quantitative sampling at site LY02 at the Caulfield Grammar property is likely to explain the high number of fish recorded at that site.

Table 4: Fish Collected in the Little Yarra River Catchment 2001

Common Name	Scientific Name	LY01	LY02	LY03	LY04	LY05	BT06	BT07	BS08	HC09	SC10
Native Fish											
Australian Smelt	<i>Retropinna semoni</i>	✓	✓	✓							
Short-finned Eel	<i>Anguilla australis</i>	✓	✓	✓		✓	✓			✓	✓
Mountain Galaxias	<i>Galaxias olidus</i>	✓	✓	✓		✓	✓		✓		✓
Pouched Lamprey	<i>Geotria australis</i>		✓	✓							
River Blackfish	<i>Gadopsis marmoratus</i>	✓	✓	✓	✓	✓	✓		✓	✓	✓
Short-headed Lamprey	<i>Mordacia mordax</i>		✓	✓							
Southern Pygmy Perch	<i>Nannoperca australis</i>		✓		✓						
Native Crustaceans											
Burrowing Cray	<i>Engaeus sp.</i>		✓								
Gippsland Spiny Cray	<i>Euastacus kershawi</i>		✓			✓					
Central Highlands Spiny Cray	<i>Euastacus woiwuru</i>							✓			
Yarra Spiny Cray	<i>Euastacus yarraensis</i>		✓	✓	✓						
Introduced Fish											
Brown Trout	<i>Salmo trutta</i>	✓	✓		✓		✓				✓
Rainbow Trout	<i>Oncorhynchus mykiss</i>		✓					✓			
Roach	<i>Rutilus rutilus</i>		✓		✓						

5 PLATYPUS

The Australian Platypus Conservancy (APC) conducted platypus surveys on behalf of Melbourne Water within the Little Yarra River in November 2000 and February 2001 (Serena et al. 2001). Results from these surveys are summarised below and in Table 5.

A total of ten platypus were captured, including three adult males (>23 months old), two sub-adult males (11-23 months old), four adult or sub-adult females (>10 months old), and one juvenile female (≤10 months old). More than half of animals were rated as being in above average or good condition (tail fat index = 2), with the remaining four individuals rated as being in average or fair condition (tail fat index = 3).

Platypus were captured at eight of the ten survey sites along the Little Yarra River – with platypus present between Corduroy Road, Yarra Junction to Three Bridges Road, Three Bridges. No platypus were captured at the Britannia Creek site – thought to be possibly due to the relatively small size of the waterway (Serena et al. 2001).

Serena et al. (2001) estimated that the Little Yarra River currently supports 1.3 platypus per km of channel. This platypus density is similar to estimates obtained for Olinda Creek upstream of Lilydale Lake and the Watts River downstream of Maroondah Reservoir (Serena et al. 2001) – streams considered in relatively good stream health.

Table 5: Platypus Survey Sites and Platypus Captures 2000/2001

Location	Distance From Yarra (km)	Platypus Captured
Corduoy Road, Yarra Junction	2.0	1 adult or sub-adult female
Lowes Road, Yarra Junction	4.0	1 adult male
1.2 km downstream of Caulfield Grammar School bridge, Yarra Junction	6.8	None
0.5km downstream of Caulfield Grammar School bridge, Yarra Junction	7.5	1 adult male, 1 adult or sub-adult female
Caulfield Grammar School bridge, Yarra Junction	8.0	1 adult male (same individual captured 0.5km downstream), 1 juvenile female
0.5km upstream of Caulfield Grammar School bridge, Yarra Junction	8.5	1 sub-adult male, 1 adult or sub-adult female
McMasters Road, Gladysdale	12.0	1 sub-adult male
Coles Road/Black Sand Road, Gladysdale	13.5	1 adult or sub-adult female
Coles Road/Three Bridges Road, Three Bridges	15.5	1 adult male
McConachys Road, Gilderoy	17.5	None
		Total individual platypus captured = 10

6 FROGS

Nine species of frogs have been recorded, or presumed to occur within the Little Yarra catchment (Table 6). These records were summarised from a report for Melbourne Water regarding the significance of Melbourne Water works on frog populations (Tyler and Watson 2000). Of particular note is the presence of *Litoria raniformis* (growling grass frog), which is formally listed as threatened under the *Flora and Fauna Guarantee Act 1988* and considered nationally significant under the *Environment Protection and Biodiversity Conservation Act 1999*.

Table 6: Frog Distribution within the Little Yarra River Catchment (Tyler & Watson 2000)

Species	Common Name	pre-1980 records	Presumed distribution
<i>Litoria ewingi</i>	Southern brown tree frog	Present throughout catchment	Throughout catchment
<i>Litoria raniformis</i>	Growling grass frog	Upper Little Yarra River and upper Britannia Creek	Throughout catchment
<i>Litoria verreauxi</i>	Whistling tree frog	Mid to lower catchment	Mid to lower catchment
<i>Crinia signifera</i>	Common froglet	Throughout catchment	Throughout catchment
<i>Geocrinia victoriana</i>	Victorian smooth froglet	Throughout catchment	Throughout catchment
<i>Limnodynastes dumerili</i>	Pobblebonk frog	Mid to lower catchment	Throughout catchment
<i>Limnodynastes peronii</i>	Striped marsh frog	Upper Britannia Creek	Mid to lower catchment
<i>Limnodynastes tasmaniensis</i>	Spotted marsh frog	Upper catchment	Throughout catchment
<i>Pseudophryne semimarmorata</i>	Southern toadlet		Throughout catchment

7 OTHER SIGNIFICANT SPECIES

Table 7 lists Victorian Rare or Threatened (VROT) species known to reside in the Little Yarra catchment (Viridans Biological Databases 2000), as well as a number of other resident species that are regionally significant (Craig et al. 1995).

Table 7: VROT and Regionally Significant Fauna of the Little Yarra catchment.

VROT Species	
Common Name	Scientific Name
Broad-toothed Rat	<i>Mastacomys fuscus</i>
Great Egret	<i>Ardea alba</i>
Grey Goshawk	<i>Accipiter novaehollandiae</i>
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>
Leadbeater's Possum	<i>Gymnobelideus leadbeateri</i>
Powerful Owl	<i>Ninox strenua</i>
Regent Honeyeater	<i>Xanthomyza phrygia</i>
Sooty Owl	<i>Tyto tenebricosa</i>
Southern Myotis	<i>Myotis macropus</i>
Tree Goanna	<i>Varanus varius</i>
Regionally Significant Species	
Common Name	Scientific Name
Yellowtailed Black Cockatoo	<i>Calyptorhynchus lathami</i>
Australian King Parrot	<i>Alisterus scapularis</i>
Superb Lyrebird,	<i>Menura novaehollandiae</i>
Eastern Whipbird	<i>Psophodes olivaceus</i>
Whites Thrush	<i>Zoothera lunulata</i>
Large Billed Scrubwren	<i>Sericornis magnirostris</i>
Lewin's Honeyeater	<i>Meliphaga lewinii</i>
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>
Dusky Antechinus	<i>Antechinus swainsonii</i>
Yellow-bellied Glider	<i>Petaurus australis</i>
Greater Glider	<i>Petauroides volans</i>
Feathertail Glider	<i>Acrobates pygmaeus</i>
Swamp Wallaby	<i>Wallabia bicolor</i>
Swamp Rat	<i>Rattus lutreolus</i>
Long-nosed Bandicoot	<i>Perameles nasuta</i>

There are two sites of State significance and eleven sites of regional significance within the Little Yarra catchment. Black Sand Creek and adjoining Yarra State Forest site are of zoological value due to the range of habitat types present. This sub-catchment supports a high diversity of native vertebrate fauna including the threatened Large-footed Myotis, Sooty Owl and Broad-toothed Rat.

Within this sub catchment there are also seventeen regionally significant species. There are seven species of birds: Yellowtailed Black Cockatoo, Australian King Parrot, Superb Lyrebird, Eastern Whipbird, Whites Thrush, Large Billed Scrubwren, and Lewin's Honeyeater; and ten species of mammals: Platypus, Short-beaked Echidna, Dusky Antechinus, Yellow-bellied Glider, Greater Glider, Feathertail Glider, Swamp Wallaby, Swamp Rat and Long-nosed Bandicoot (Craig et al. 1995).

8 WATER QUALITY

Melbourne Water funded a water quality survey in the Little Yarra River catchment during April and May 2001. Samples were collected from 10 sites (Table 8), on seven occasions, with an approximate sampling frequency of 14 days. Samples were collected primarily during base flows.

In situ field measurements were performed for the following parameters: pH, electrical Conductivity (EC), Dissolved Oxygen (DO) and turbidity. Samples were analysed in the laboratory for: fluoride, suspended solids, reactive phosphorus, total phosphorus, nitrate and nitrite, ammonia and total nitrogen, total organic carbon and *E. coli*.

McGuckin (2001) presents a detailed report of these water quality data, along with an analysis of historical data. Historical data was available for the Little Yarra River at Lowes Road, and the Little Yarra River at Corduroy Road, UY35 and UY36 respectively. The former is monitored as part of the Victorian Water Quality Monitoring Network (VWQMN), and the latter as part of the Melbourne Water Water Quality Monitoring Network (MWWQMN).

During baseflow, the water quality of the Little Yarra River catchment was generally found to be acceptable according to SEPP objectives (EPA 1999), with major findings of McGuckin (2001) report summarised below.

Table 8: Little Yarra River catchment study sites and ES Map reference

Code	Waterway	Location	ES Map Reference
LYR01	Little Yarra River	Monett Road, Powelltown	714 B7
LYR02	Little Yarra River	Yarra Junction - Noojee Road, Powelltown	713 J7
LYR03	Little Yarra River	Coles Road, Three Bridges	713 D4
LYR04	Little Yarra River	Tarrango Road, Gladysdale	713 B3
LYR05	Little Yarra River	Lowes Road, Yarra Junction	684 I11
LYR06	Little Yarra River	Corduroy Road, Yarra Junction	684 H11
SXC07	Saxton Creek	Yarra Junction - Noojee Road, Gilderoy	713 H6
HCC08	Hackett Creek	Yarra Junction - Noojee Road, Three Bridges	713 E6
BSC09	Black Sand Creek	Black Sand Road, Three Bridges	713 D4
BTC10	Brittania Creek	Tarrango Road, Yarra Junction	684 J12
UY35 229214	Little Yarra River	Little Yarra River at Lowes Road	916 I11
UY 36	Little Yarra River	Little Yarra River at Corduroy Road	916 H11

8.1 Surface Water Temperatures

Historical surface water temperature data for the Little Yarra River indicate a typical range between 8.1°C and 17.6°C. During the study, surface water temperatures were between 10°C to 15°C. Water temperatures varied by less than 2°C at all sites over the sampling period, meeting the SEPP objective (EPA 1999). The level of temperature variation for all sites was generally considered acceptable for aquatic biota.

8.2 pH

During the time of the study, pH levels ranged between 5.8 and 7.1, with lowest readings associated with highest stream flows. Apart from one extreme flow event, pH readings for all sites fell within the SEPP objective of 6.0 - 8.5 (EPA 1999).

Low pH levels noted in the Little Yarra River catchment appear to be a natural characteristic noted in headwater streams of other Yarra River sub-catchments (McGuckin 1998, 1999). pH values measured in this catchment are considered acceptable for aquatic communities (EPA 1999).

8.3 Conductivity

The SEPP objective for conductivity within this catchment is 800 $\mu\text{S}/\text{cm}$ (500 mg/L). Measurements at all sites during the study period were remarkably similar, ranging between 21 and 90 $\mu\text{S}/\text{cm}$ with elevated flows coinciding with lower conductivity levels. Headwater conductivity levels were found to be lowest, with conductivity gradually rising with distance travelled downstream.

Historical conductivity data for the Little Yarra River are consistent with those collected during this study. Low salinity levels in the Little Yarra River system would be acceptable for the protection the aquatic ecosystem (EPA 1999).

8.4 Dissolved Oxygen

The majority of dissolved oxygen concentrations recorded in this study were above the minimum SEPP requirement of 80% saturation -- typically between 80% and 105%. An exception to this observation occurred following weather on April 2001, when concentrations ranged between 60% and 90% saturation.

Oxygen concentrations in Saxton Creek (SXC07) were less than other tributaries of the Little Yarra River and may be related to lower stream flows. However, at all sites, median dissolved oxygen levels were above the SEPP limit and 6 mg/L, the value considered critical for fish and invertebrates (ANZECC 1992; Koehn & O'Connor 1990).

8.5 Water Clarity

With the exception of the April 2001 sampling date, suspended solid concentrations at all sites were remarkably consistent between sampling events and were below the 50th percentile of the SEPP annual objective of 20 mg/L. During April 2001, elevated flows contributed to higher suspended solids concentrations. Results were generally between 40 and 80 mg/L, however, at Yarra Junction (LYR06) a concentration of 152 mg/L was recorded.

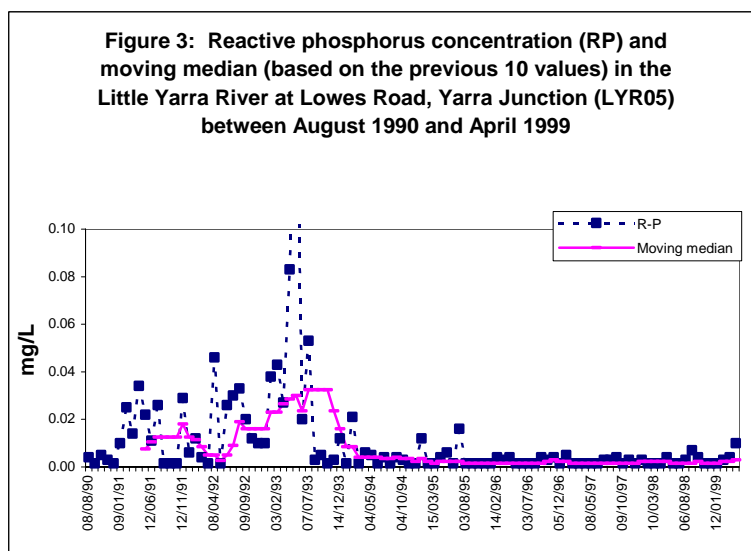
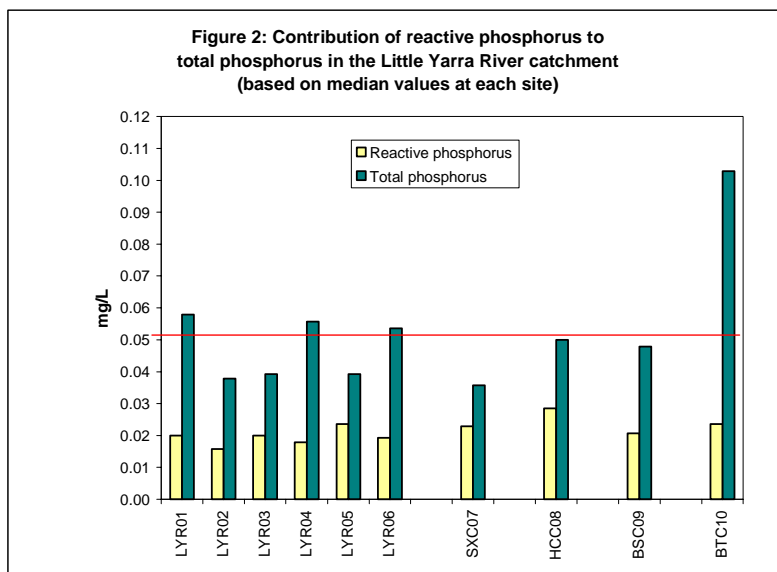
On a majority of occasions during the study, turbidity levels recorded at all sites were lower than the SEPP 50th percentile of 25 NTU. As observed for suspended solids, elevated flows contributed to high turbidity readings during April 2001. Tributaries recording the highest turbidity levels, were Saxton (SXC07) and Black Sand Creeks (BSC09), with around 40 NTU during the elevated flows. Turbidity generally increases with distance downstream, with median turbidity in the Little Yarra River at Powelltown (LYR01) and Yarra Junction (LYR06) being 2.4 and 8.7 NTU, respectively.

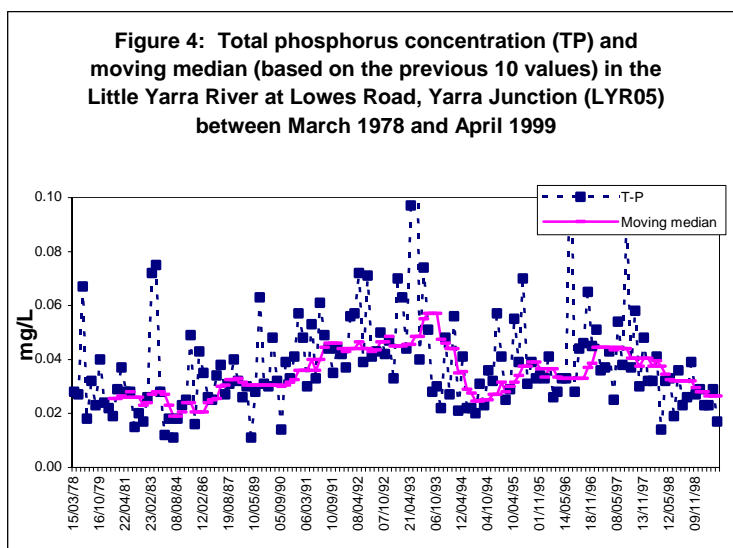
8.6 Phosphorus

Most sites recorded total phosphorus concentrations below the SEPP objective of 0.05 mg/L on the majority of sampling occasions. Highest concentrations occurred during the high-flow event during April 2001, when levels exceeded the SEPP objective. On this occasion, a peak concentration of 0.20 mg/L was recorded at Corduroy Road, Yarra Junction (LYR06).

The proportion of phosphorus that is readily available for uptake by aquatic biota can be represented by the ratio of reactive phosphorus to total phosphorus. Figure 2 shows that reactive phosphorus concentration at most sites was about half the total phosphorus concentration – suggesting moderate levels of bioavailable phosphorus.

Data collected during the study were within the range of historical data. Historically, although maximum values exceed the SEPP objective, median total phosphorus concentrations from the study were below 0.05 mg/L. Although a decline in the moving median of reactive phosphorus is evident since 1994, there appears to be no apparent long-term trend in total phosphorus concentrations since 1978 (Figures 3 & 4).

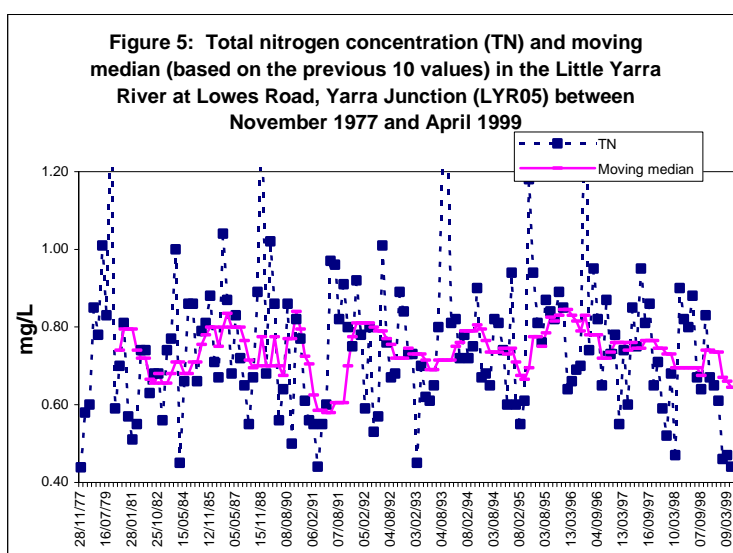


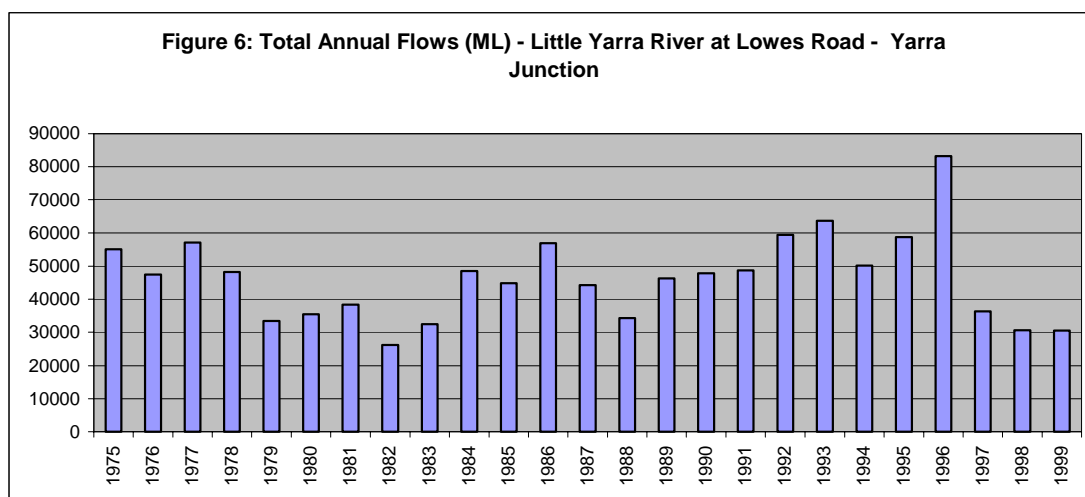


8.7 Nitrogen

Total Kjeldahl nitrogen (TKN) levels in the Little Yarra catchment are generally low to moderate, but due to the April 2001 high-flow event, all but one site (Saxton Creek, SXC07) exceeded the (TN) SEPP objective of 0.6 mg/L on at least one occasion. Saxton Creek was the only site that did not exceed the total nitrogen (TN) SEPP objective during the sampling period. The elevated TKN reading of 1.8 mg/L at Corduroy Road, Yarra Junction (LYR06) in May 2001 cannot be explained. Median TKN levels at all sites were below 0.3 mg/L or about half the TN SEPP limit.

There is no long-term trend in TN concentrations over the period 1996 to 2001, although TN concentrations seemed to have reduced slightly since 1996 - possibly due to prevailing dry conditions (Figures 5 & 6).





8.8 Ammonia

Elevated levels of ammonia can be acutely toxic to organisms (particularly fish). The guideline for total ammonia concentrations for the protection of aquatic ecosystems is 2.2 mg/L for conditions during the study, i.e. water temperatures between 10°C and 15°C and pH between 5.8 and 7.1 (ANZECC 1992). During the study period, ammonia levels were low in the Little Yarra River catchment, with most sites recording levels below the detection limit of 0.01 mg/L. Saxton Creek was the exception, with ammonia levels that ranged between 0.05 and 0.24 mg/L. Although these levels appear high relative to all other sites, they are unlikely to be of significance to the health of aquatic biota in this stream.

8.9 *E. coli*

E. coli densities provide a measure of faecal pollution from warm-blooded animals. The SEPP objective for *E. coli* is specified as a geometric mean of 200 organisms/100 mL based on at least five samples over six weeks (EPA 1999). Geometric means of *E. coli* from the study results, although not complying with the SEPP sampling frequency requirements, were compared with the SEPP as a benchmark.

Geometric means ranged between 9 to 418 organisms/100 mL. Headwater sites of the Little Yarra River, Saxton Creek and Black Sands Creek were the only sites that compared favourably with the SEPP objective (all geometric means below 50 organisms/100 mL). The remaining four Little Yarra River sites between Three Bridges and Yarra Junction, plus Hackett and Britannia Creeks all recorded geometric means between 271 and 418 organisms/100 mL. Potential sources of *E. coli* in the Little Yarra River catchment include septic in-flows, stock and wildlife. Historical *E. coli* levels are similar to those found during the 2001 study, therefore, little improvement in faecal pollution appears to have occurred over the past decade.

9 SEDIMENT QUALITY

On 5 November 2001, Melbourne Water collected sediment samples from ten sites within the Little Yarra River catchment. These sediment sampling sites replicated the water quality sites (Table 9). Sediments were analysed by Australian Laboratory Services for selected metals (all sites) and organics (Little Yarra River sites only).

Sediment samples for metal analyses were sieved through a 64 µm nylon-mesh net at the time of sampling. The metal analyses – arsenic, copper, chromium, cadmium, lead, mercury, nickel and zinc – were conducted on the <64 µm particle-size fraction. Whole sediment samples were analysed for total petroleum hydrocarbons, organochlorine pesticides and total organic carbon.

While metal analyses were standardised based on the <64 µm fraction, the organic concentrations can be standardised based on the percentage of total organic carbon (ANZECC 2000). At all sites where metals were sampled, an additional whole sample was collected for sediment size-fraction analysis. Fractions were defined as >2 mm, 63 µm to 2 mm and <63 µm. Because the majority of metal contaminants tend to be bound to the <63 µm fraction, knowledge of the sediment size-fraction enables some estimate of whole-sediment concentrations.

Metals data were compared to ANZECC Interim Sediment Quality Guidelines (ISQGs) in Table 10. This table also includes the sediment size fractions. In general, sediment in the Little Yarra River catchment is dominated by sand and sediment quality appears to be good, or a low risk to ecosystem health. Of note, however, were elevated arsenic in Saxton Creek (SXC07) and elevated mercury in the upper Little Yarra River (LYR01 and LYR02) – both representing a moderate risk to ecosystem health. Elevated arsenic and mercury at these locations may be associated with historical gold-mining activity (Pettigrove, V (1998).

Table 9: Concentration of metals and the particle size fraction in the sediments of the Little Yarra River catchment (metals results in mg/kg)* (See Table 8 for site descriptions)

Site	As	Cd	Cr	Cu	Ni	Pb	Zn	Hg	<63µm %	63-200µm %	>200µm %
LYR01	2.5	<0.5	8.9	7.0	5.0	15.6	42.2	0.20	6.9	91.9	1.2
LYR02	3.8	<0.5	14.7	10.0	7.9	19.4	60.1	0.50	1.7	86.1	12.2
LYR03	1.2	<0.5	10.9	3.4	4.5	8.0	26.5	0.10	11.5	83.1	5.4
LYR04	1.3	<0.5	13.2	4.0	5.3	7.9	26.3	0.05	10.1	88.6	1.3
LYR05	1.5	<0.5	15.3	5.0	6.2	8.1	27.2	0.05	17.6	76.0	6.4
LYR06	3.1	<0.5	24.4	9.6	10.4	17.3	59.4	0.05	11.2	88.1	0.7
SXC07	46.7	<0.5	11.8	3.6	4.0	9.1	14.5	0.05	17.6	61.5	20.9
HCC08	3.2	<0.5	12.2	4.8	5.6	9.8	29.6	0.12	10.9	84.7	4.4
BSC09	3.7	<0.5	27.7	9.2	10.0	9.2	25.7	<0.05	4.1	92.3	3.6
BTC10	3.2	<0.5	22.3	7.4	8.8	8.1	25.1	0.10	0.5	99.3	0.2
ISQGLow	20	1.5	80	65	21	50	200	0.15			
ISQGHigh	70	10	370	270	52	220	410	1			

*Metals results are based on the <63 µm fraction. Red shading indicates a high probability, yellow shading indicates a moderate probability, and no shading indicates a low probability of impacting the aquatic ecosystem (ANZECC 2000).

Table 10 contains results for petroleum hydrocarbon analyses for six sites in the Little Yarra River. Currently no suitable guidelines exist for petroleum hydrocarbons, but results indicate elevated levels at some sites. Elevated petroleum hydrocarbons are probably reflecting the influence of localised road run-off.

Table 10: Concentration of petroleum hydrocarbons in whole sediments from the Little Yarra River (results in mg/kg) (See Table 8 for site descriptions)

	C6 - C9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	Total*	%TOC**
LYR01	34	32	154	378	598	7.81
LYR02	17	<25	<50	68	123	6.48
LYR03	<10	34	111	169	319	4.38
LYR04	<10	<25	<50	78	121	4.53
LYR05	<10	<25	76	144	238	3.95
LYR06	<10	32	118	148	303	3.4

* Total assumes that concentrations below the detection limit, are half the detection limit

**TOC = total organic carbon

At sites sampled for organochlorine pesticides, concentrations were all below detection limits (Appendix 1). While no samples had results above the method detection limit, it is possible that this is snapshot of sediment quality is not a true indication of pesticide-residue status. To be more confident about organochlorine levels, the sediment-sampling regime could be improved and extended to take into account seasonal variation, storm events and key application times.

10 AQUATIC MACROINVERTEBRATES

Ten sites were surveyed for aquatic by AWT in 1998-1999 (Hardwick and Waller 1999). Locations of sites sampled and their EPA (1999) segment classification are presented in Table 11. One site (BSC01) was sampled in December 1998 only due to insufficient water in March 1999. Surveys were conducted according to the EPA Victoria rapid bio-assessment methods (EPA 1998).

Table 11: Macroinvertebrate survey sites in the Little Yarra River Catchment 1998/1999

CODE	Sampling Locality	ESMAP (1991)	EPA Segment*
LRR01	Little Yarra River at Monett Road	714B7	PF
LRR02	Little Yarra River at Yarra Junction Noojee Road	713J7	REW
LRR03	Little Yarra River at Coles (Black Sand) Road	713D4	REW
LRR04	Little Yarra River at Tarrango Road	713B3	REW
LRR05	Little Yarra River at Lowes Road	684I11	REW
LRR06	Little Yarra River at Corduroy Road	684G11	REW
BTC01	Britannia Creek at Tarrango Road	684J12	REW
BSC01	Black Sand Creek at Black Sand Road	713D4	REW
HCC01	Hackett Creek at Yarra Junction Noojee Road	713E6	REW
SXC01	Saxons Creek at Yarra Junction Noojee Road	713H6	REW

* 'PF'= Parks and Forest segment, 'REW' = Rural Eastern Waterways segment (EPA 1999)

A total of 898 macroinvertebrates from 42 families was collected over the two seasons of sampling. Dominant families in the catchment in decreasing order of abundance were Leptoceridae (Trichoptera), Leptophlebiidae (Ephemeroptera) and the Chironomidae (Diptera) sub-family Chironominae.

Information regarding aquatic macroinvertebrate compliance with EPA (1999, 2001) guidelines and number of habitats sampled is presented in Table 12. One site met all of the SEPP objectives (LRR05). Three of the tributary sites did not comply with any SEPP objectives (BTC01, HCC01 and SXC01).

SIGNAL scores ranged between 6.1 (SXC01 and HCC01) and 7.1 (BSC01) – with scores greater than 6 indicative of clean to excellent water quality (EPA 1999). Values for key

families ranged from 9 (SXC01) to 18 (LLR01). Minimum number of key families ranged between 18 (BSC01) and 35 (LLR01 and LLR06) and those families present at each site are listed in Tables 13 & 14.

The number of EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa recorded at each site ranged between 6 (HCC01 and SXC01) and 17 (LLR01) – where higher scores tending to indicate less disturbance (EPA 2001). Leptophlebiidae (Ephemeroptera), Gripopterygidae (Plecoptera) and Leptoceridae (Trichoptera) were recorded at every site (Table 15). EPT scores compared well to the draft SEPP (Waters of Victoria) objectives, with only the Saxton Creek site scoring unsatisfactorily.

Although some SEPP objectives for aquatic macroinvertebrates were not met, the ecological condition of waterways in the Little Yarra River catchment is still considered good as there was a relatively high number of EPT taxa and many of the SEPP objectives failed only marginally. Tributaries of the Little Yarra River did not rate as well as the mainstream. This may be due to various reasons, including the absence of riffle for kick sampling (a number of key families are known to prefer riffles (Hardwick & Waller 1999)) or lower stream flows (ie. lower dissolved oxygen).

Table 12: Summary aquatic macroinvertebrate results for the Little Yarra River catchment (based on pooled habitat and season data)

Site	EPA Segment	Number of Habitats	SIGNAL score and Number of families used ()	Minimum Number of Families	Total Number of Key Families	Number of EPT Families* (Riffle)	Number of EPT Families* (Edge)
LLR01	PF	2	6.8 (34)	35	18	12	13
LLR02	REW	1	6.5 (25)	27	13	NA	11
LLR03	REW	2 ^b	6.7 (32)	33	15	10	11
LLR04	REW	1	6.5 (26)	26	15	NA	11
LLR05	REW	2	6.6 (31)	32	17	10	11
LLR06	REW	2	6.2 (33)	35	17	9	13
BTC01	REW	1	6.3 (20)	20	11	NA	9
BSC01	REW	1	7.1(16)	18	11	NA	9
HCC01	REW	1	6.1 (21)	22	11	NA	8
SXC01	REW	2 ^b	6.1 (19)	19	9	2	6

^a Sampled in December 1998 only

^b Only sweep sampled in March 1999

Does not meet SEPP objective (EPA 1999)

NA = not NA – not applicable

* - Based on draft SEPP (Waters of Victoria) objectives for EPT Families in the Forests – B Segment (EPA 2001)

Table 13: Key families present at Little Yarra River catchment sites within the ‘Parks and Forests’ segment of the SEPP, based on pooled habitat and season data (EPA 1999)

Site	Stoneflies			Mayflies		Dragonflies		True flies		Caddis flies							Beetles		Amphipods						
	Gripopterygidae	Austroperlidae	Eustheniidae	Notonemouridae	Leptophlebiidae	Baetidae	Coloburiscidae	Aeshnidae	Atheriidae	Blephariceridae	Leptoceridae	Philocheitridae	Helicopsychidae	Glossosomatidae	Hydrobiosidae	Philopotamidae	Hydropsychidae	Calocidae	Helicophidae	Conoesucidae	Elmidae	Ptilodactylidae	Scirtidae	Eusiridae	
LLR01	✓	✓	✓		✓	✓	✓	✓			✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓

✓ = Present at site

Table 14: Key families present at Little Yarra River catchment sites within the ‘Rural Eastern Waterways’ segment of the SEPP, based on pooled habitat and season data (EPA 1999)

Site	Stoneflies		Mayflies				Dragonflies		True flies	Caddis flies										Beetles		Amphipods	Shrimps	Snails/Bivalv			
	Austropterygidae	Gripopterygidae	Baetidae	Leptophlebiidae	Austropterygidae	Leptophlebiidae	Coloburiscidae	Aeshnidae	Leptidae/Synlestidae/Cordulidae	Athericidae	Leptoceridae	Philotheithridae	Glossosomatidae	Hydrobiosidae	Calamoceratidae	Hydropsychidae	Calocidae	Ecnomidae	Atriplectididae	Conoesucidae	Elmidae	Philoctactyidae	Hydrophilidae	Hydrochidae	Ceinae/Eusiridae	Atyidae	Hydrobiidae/Corbiculidae
LLR02	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓			✓			
LLR03	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓			
LLR04	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓						
LLR05	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓				
LLR06	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓					✓
BTC01	✓		✓	✓		✓	✓	✓		✓				✓	✓				✓	✓	✓						
BSC01	✓		✓	✓		✓		✓		✓					✓	✓			✓	✓	✓			✓			
HCC01	✓		✓	✓				✓		✓	✓			✓	✓				✓	✓	✓						✓
SXC01	✓		✓	✓			✓	✓		✓	✓			✓	✓				✓	✓	✓						✓

✓ = Present at site

Table 15: EPT (Ephemeroptera, Plecoptera, and Trichoptera) families recorded at each site within the Little Yarra River catchment (based on pooled habitat and season data)

Site	Ephemeroptera				Plecoptera				Trichoptera											
	Baetidae	Oniscigastriidae	Coloburiscidae	Leptophlebiidae	Caenidae	Austropterygidae	Eustheniidae	Notonemouridae	Gripopterygidae	Atriplectidae	Hydrobiosidae	Ecnomidae	Philoptamidae	Hydropsychidae	Conoesucidae	Calocidae	Philotheithridae	Calamoceratidae	Limmiphidae	Leptoceridae
LLR01	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
LLR02	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
LLR03	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
LLR04	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
LLR05	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
LLR06	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BTC01	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
BSC01 ^a	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
HCC01	✓			✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
SXC01				✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓

^a Sampled in December 1998 only

✓ = Present at site

11 PHYSICAL STREAM CONDITION

Melbourne Water funded a physical form and streamside zone survey during 2000 (Brizga et al. 2000). Surveys were undertaken along twelve reaches of the Little Yarra and nominated tributaries. Table 16 lists these locations and gives a brief description of the sites. Brizga et al. (2000) presents a detailed report on the physical form and streamside zone – the major

findings are summarised below. Management actions proposed by Brizga et al. (2000) have been summarised in Appendix 2

Table 16: Index of Stream Condition Sites (from Brizga et al. 2000)

Stream	Location	Condition Comment
Learmonth Creek	U/S of Learmonth Road, Powelltown	Excellent condition, high environmental values
Britannia Creek	U/S of Tarrango Road, Gladysdale	Significant loss of riparian vegetation, weed invasion and stock access
Slaty Creek	U/S of Railway, Gladysdale	Disturbed waterway subject to weed invasion and inputs of septic tank effluent
Black Sand Creek	U/S of Portas Road, Gladysdale	Natural waterway in good condition, largely undisturbed riparian vegetation
Hackett Creek	D/S of Hackett Creek Road, Three Bridges	Physically disturbed in D/S reaches, subject to weed invasion
Blackwood Creek	U/S of Yarra Junction-Noojee Road	Diverse remnant vegetation, good environmental condition
Mackley Creek	U/S of Mackley Road, Powelltown	Diverse remnant vegetation, good environmental condition
Little Yarra River	U/S of Mackley Road, Powelltown	Attractive rocky stream in excellent condition
Little Yarra River	U/S of Three Bridges Road, Three Bridges	Condition deteriorates with clearing of riparian zone and increasing numbers of willows
Little Yarra River	U/S of Tributary at Doon Road, Yarra Junction	Poor riparian vegetation, increasing weed invasion and stock access → reduced environmental values
Little Yarra River	D/S of Tarrango Road, Gladysdale	Poor riparian vegetation, increasing weed invasion and stock access → reduced environmental values
Little Yarra River	U/S of Howell Road, Gilderoy	Lack of stream-side vegetation, limited bank erosion

The overall physical condition of the river and its tributaries flowing in forested areas (60% of catchment) is excellent, being stable, well vegetated and containing the full complement of stream habitats expected in undisturbed, forested reaches. A further 19% of the catchment is freehold land with good tree cover. Of the 20% of land devoted to grazing and horticulture, the majority lies on river floodplain. These predominantly pasture areas are prone to disturbance with the result that biological and physical condition deteriorates with distance downstream. The remaining 1% of the catchment area is represented by the more disturbed, urban sections.

11.1 Sand Slugs

Historically, sand slugs were seen to reduce channel capacity, causing flooding and impacts to habitat, resulting in the perceived need for de-snagging and sand removal from the streambed (Brizga et al. 2000). Brizga et al (2000) found that the Little Yarra and many of its tributaries naturally carry sandy sediment loads as a result of their granitic geology. Localised deposition of sediment loads, however, has probably increased due to bushfires and human activities within the catchment – particularly those involving vegetation disturbance e.g. logging (Brizga et al. 2000). The catchment has been extensively logged in the past and most of the present forest is regrowth following timber harvesting and extensive bushfires of 1939 and 1983 (Brizga et al. 2000). The road network is quite extensive and exposed unsealed surfaces could be a substantial source of sediment to waterways during storm events (OCE 1998).

The Britannia Goldfield included the lower part of the Little Yarra catchment and alluvial and reef gold-mining took place after gold was discovered in the area in 1859 (Brizga et al. 2000). This caused major environmental disturbance, mobilising sediments and creating new sediments by crushing quartz and clearing forest to provide timber for mines (Brizga et al. 2000).

There is no evidence that specific tributaries are supplying elevated sand loads to the river. Deposition rates are likely to be related to hydraulic controls such as stream gradient and valley shape (Brizga et al. 2000).

Sand-bed rivers are fundamentally different from other stream types, and need to be managed accordingly. Major deposits tend to build up in areas with conducive hydraulic conditions such as low flow velocities and stream power. Extraction of these deposits is not without risk, however as erosion at the extraction site (as well as up and downstream) could eventuate, with associated damage to the riparian zone and in-stream habitat.

11.2 Instream & Riparian Habitat

Instream and riparian habitat is in excellent condition in forested stream reaches within the Little Yarra catchment. Elsewhere there is degradation occurring due to loss of riparian vegetation, de-snagging and uncontrolled stock access.

Remnant riparian vegetation on the river and tributaries support a high diversity of native fauna, provide a range of breeding and feeding habitats and forms major wildlife corridors. Large woody debris plays a critical role in providing stable substrate and hydraulic diversity in sand-bed rivers. There is now much less LWD in the Little Yarra River than there would have been under natural conditions, with a resulting loss of stable surface, hydraulic habitat diversity, and organic carbon source. Desnagging was typically carried out in response to concern regarding the frequency of localised floods.

Uncontrolled stock access to the Little Yarra River system is widespread. It is of particular concern because it may result in physical disturbance to the bed and banks and loss of regeneration of riparian vegetation.

12 DISCUSSION

The Little Yarra River catchment supports a rich aquatic ecosystem, including fish, platypus, frogs, and several pollution-sensitive aquatic macroinvertebrates. Water and sediment quality are generally good and stream flows are relatively intact compared to adjacent streams within the upper Yarra catchment. In particular, the headwater areas of the Little Yarra are in excellent physical and biological condition, with a diversity of in-stream and riparian habitat within undisturbed, forested areas. Accordingly, management of the Little Yarra River and its tributaries should focus on protecting waterways from any decline in condition.

12.1 In-stream Habitat

Historical activities within the Little Yarra River catchment, especially land clearing and the removal of large woody debris from streams have impacted the aquatic ecosystem. Large woody debris plays an important role in sand-bed streams, both in terms of stabilising stream bed and banks, and providing habitat for many aquatic organisms. Brizga et al. (2000) identified that, although once a prominent natural feature of this catchment, LWD has been reduced by decreases in the rate of replenishment due to tree falls and also by de-snagging operations. In addition the quality of LWD has degraded. This is because the presence of willows along some reaches – willow wood tends to be less enduring than indigenous hardwood timber.

During January 2002, Melbourne Water re-snagged a 1.5 km reach of the Little Yarra River along the Caulfield Grammar Property, Yarra Junction. This project is expected to help stabilise the stream bed, but also improve instream habitat. As part of this work, Melbourne Water initiated a study to measure the ecological benefits of re-snagging. Several physical and biological aspects are being studied before and after large woody debris reintroduction; physical habitat, aquatic macroinvertebrates, platypus and fish. This study is expected to improve understanding regarding large woody debris reintroduction techniques and responses of certain biota. Opportunities to reintroduce large woody debris into other reaches of the Little Yarra River should be investigated particularly where instream habitat is poor. This is a high to moderate priority and could possibly be incorporated into the stream frontage management program.

12.2 Urbanisation

There is approximately 1 km² of urban development within the catchment, with only half a dozen townships within the catchment boundary.

Impacts associated with urbanisation include degraded water and sediment quality (e.g. through contaminated run-off from buildings and roads), change in flow regime (leading to more intense and shorter high-flow events that can scour out habitat and aquatic organisms), and increased litter.

To protect the aquatic ecosystem within the catchment, potential urban development needs to carefully consider how to reduce environmental impacts. Environmental protection initiatives could include the expansion of the sewer system and the incorporation of water sensitive urban design concepts and technologies into urban developments (e.g. CSIRO 1999).

12.3 Riparian Management

Important functions of a healthy riparian zone include providing terrestrial and aquatic (from large woody debris falling into the stream) habitat, food supply, shade (to lower water temperature and restrict algal growth) and buffering run-off quality and velocity to the stream. A healthy riparian zone can also provide a habitat corridor for many terrestrial biota, can restrict stock access, and protect stream banks from erosion.

Waterway issues along the Little Yarra River system, such as riparian weeds, stock access to streams, bank erosion and loss of large woody debris, can be addressed through the Melbourne Water Stream Frontage Management Program. This program assists land-owners to implement rehabilitation on private freehold and leased stream frontage by providing grant subsidies, technical assistance and educational opportunities to participants. The program commenced in the Little Yarra River catchment in 1996-1997 and became a focus for grants in 2001-2002. Continuation of the program in the Little Yarra River catchment is of high importance for the protection and enhancement of the stream system.

Weeds, particularly willows, may degrade riparian zones. Problems associated with willows include:

- greater variation in shade between summer and winter;
- a discontinuous supply of leaf litter (with large autumn drop);
- increased breakdown rates of leaf litter (may lead to large pulses of nutrients and periods of low dissolved oxygen) and large woody debris (poor in-stream habitat);
- poor habitat value for many aquatic and terrestrial organisms; and

- choking of stream channel (causing potential fish barriers, increasing potential for flooding, and possibly diverting flows into unprotected banks resulting in erosion problems).

Willow infestations within the system are a significant threat to river ecosystems. Among commonly listed detrimental impacts associated with willow infestation in waterways listed above, willow may reduce summer flows and considerably lower dissolved oxygen levels. Recent studies on a small Tasmanian stream infested with willows showed how very low dissolved oxygen concentrations developed within willow stands during low summer flows, compared to an upstream site with a healthy native riparian strip (Bobbi 1999). It was suggested that bacterial breakdown of organic material trapped by the willow roots was the primary cause of reduced oxygen (Bobbi 1999).

Willow removal has been conducted and will continue in sections of the Little Yarra River in 2001-2002 (i.e. lower Little Yarra River below Yarra Junction and some minor works at Three Bridges) and similar works should continue along other infested reaches.

12.4 Roads

Unsealed roads can be a substantial source of sediment to waterways during storm events (OCE 1988) and therefore, the large unsealed road network within the catchment has the possibility to be a significant source of suspended solids to the Little Yarra River. In terms of reducing sediment loads to streams, road management should firstly focus on protecting those reaches where in-stream values are greatest, that is, the upper forest reaches.

As well as being a source of sediment, during storm events roads can also be a significant source of contaminants such as heavy metals and oils that are associated with road vehicles (OCE 1988, Brockbank & Batley 1996, Pettigrove 1998).

While water quality of the Little Yarra is reasonably good, there is little or no treatment of road run-off, including toxicants from sealed roads. Opportunities exist to investigate treatment opportunities through involvement of local councils in the Stormwater Management Program.

12.5 Sediment Contamination

Although a low priority, elevated levels of arsenic and mercury could be investigated further. Sediment samples were taken from ten sites on one occasion with arsenic levels at the site on Saxon Creek and mercury levels at two sites on the Little Yarra River found to represent a moderate risk to ecosystem health. This sampling regime could probably be extended to other sites within the catchment, particularly to those areas known to have been sites of mining activity, to form a better understanding of the extent of heavy metal pollution in the catchment. The Department of Natural Resources and Environment has GIS maps showing locations of mining sites that could be useful in determining the spatial extent of contamination.

12.6 Significant Species

Historically, growling grass frogs (*Litoria raniformis*) have been recorded within the Little Yarra catchment. Considering the conservation status of this species, it would be beneficial to determine the current distribution of this, and other frog species within the catchment. Frog surveys could be encouraged through the Melbourne Water Frog Census initiative – a community-based monitoring program run in conjunction with Melbourne Waterwatch.

12.7 Septic Tank Systems

McGuckin (2001) suggested that poorly-functioning septic tank systems may be responsible for instances of elevated nutrients and *E. coli* (although it should be noted these parameters are not excessive). Stock waste and wildlife are also potential sources of these contaminants. In order to continue to protect the health of the Little Yarra system, local government could assist by ensuring that locals have a clear understanding of the requirement for periodic maintenance of their tanks, particularly if backed up by comprehensive information made available to residents when moving into the district, or when installing or upgrading their systems.

Additionally, an investigation should occur to determine the extent (and sources) of nutrient and *E. coli* contamination that was identified as an issue in the Slaty Creek catchment by Brizga et al. (2000). This is a moderate priority.

12.8 Environmental Flows

The relatively preserved flow regime within the Little Yarra River is an essential component of the aquatic ecosystem that needs to be carefully managed. Of particular importance, therefore, is the development of a Stream Flow Management Plan by Melbourne Water – where rules are established for the use of current and future water extraction licenses.

12.9 Influence on the Yarra River

The Little Yarra River system plays an important role in maintaining the ecological health of the upper Yarra River. This important role would include providing the Yarra River with steady stream flows and of good water quality and also providing additional corridor/refuge for aquatic organisms that are sensitive to disturbance (e.g. highly modified flow regime, pollution, habitat loss).

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APPENDICES

Appendix 1: Concentration of organochlorines within whole sediments from the Little Yarra River

	alpha-BHC	HCB	beta-BHC & gamma-BHC	delta-BHC	Heptachlor	Aldrin	Heptachlor epoxide	Chlordane - trans	Endosulfan 1	Chlordane - cis	Dieldrin	DDE	Endrin	Endosulfan 2	DDD	Endrin aldehyde	Endosulfan sulfate	DDT	Endrin ketone	Methoxychlor
LYR01	<0.1	<0.1	>0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.4	<0.1	>0.4
LYR02	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.4	<0.1	<0.4
LYR03	<0.025	<0.025	<0.05	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.1	<0.025	<0.1
LYR04	<0.025	<0.025	<0.05	>0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.1	<0.025	>0.1
LYR05	<0.025	<0.025	<0.05	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.1	<0.025	<0.1
LYR06	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.2

Appendix 2: Summary of Management Options proposed by Brizga et al. (2000)

Reach	Strategy	Priority
U/S of Powelltown	<ul style="list-style-type: none"> • Weed control 	2
Powelltown to Black Sand Creek	<ul style="list-style-type: none"> • Willow control • Channel capacity assessment • Revegetation 	1 - 2 1 2
Black Sand to Britannia Creek	<ul style="list-style-type: none"> • Channel capacity assessment • Trial for impact of past desnagging • Willow control • Revegetation 	1 1 3 2
Britannia Creek to Yarra River	<ul style="list-style-type: none"> • Revegetation • Willow control • Weed control • Modification of weir (fishway) • Reconstruction of rock chutes 	2 3 2 2 2
Tributaries	<ul style="list-style-type: none"> • Weed management • Revegetation 	2 3
Entire catchment	<ul style="list-style-type: none"> • Annual monitoring & maintenance • Annual willow & weed control • Annual weed control in tributaries. 	

Priorities are allocated by extent of observed problems and relative environmental, social and economic benefits to be accrued from works implementation. Priorities vary from 1 (highest) to 3 (lowest).