WATER

5. WATER

5.1 Overview

The substantial water resources of the Port Phillip and Western Port region are the lifeblood of the regional economy, and of its society and ecosystems.

There are some 8,000 kilometres of rivers and streams[19] , more than 900 wetlands[20] and more than a dozen estuaries within the region's Werribee, Maribyrnong, Yarra, Dandenong and Western Port catchments. The region also contains numerous large reservoirs that collect and store high-quality water for household, industrial and agricultural use in metropolitan Melbourne and surrounding areas. These surface water supplies are supplemented by significant amounts of groundwater held in the region's aquifers.

The waterways of the five catchments flow to 600 kilometres of spectacular regional coastline and then into the renowned marine systems of Port Phillip Bay, Western Port and Bass Strait. These coastal and marine systems, which include internationally recognised wetlands as well as eight marine protected areas, support myriad recreational activities, underpin commercial initiatives such as ports and commercial fishing, and provide invaluable ecosystem services.

Complex relationships and interactions exist between the region's water resources. Some are obvious, such as the flow of rivers into the bays, or our collection and storage of fresh water in reservoirs for domestic use. Others are less obvious but just as important, such as the contribution of groundwater to base flow levels in streams, and the role of wetlands and estuaries in filtering sediments and nutrients to improve water quality.

Complex relationships and interactions exist between the region's water resources

Important relationships also exist between the activities on land and the health of the region's water resources.

[19] *Draft Port Phillip and Westernport Regional River Health Stategy*
[20] *Current wetlands environment and extent (GIS layer)*

5.2 Policy context for the management of water resources

A range of legislation and supporting policies apply to the management of water resources and support integrated catchment management in the Port Phillip and Western Port region.

State legislation, including the Water Act 1989, the Catchment and Land Protection Act 1994 and the Coastal Management Act 1995, provides for the formation of a number of boards and statutory authorities to plan for, manage and protect water, waterways, floodplains, coasts and marine resources.

Under the Acts, the Victorian water allocation framework establishes several mechanisms that bring together existing water rights and environmental water requirements to establish agreed water allocations. These include Bulk Entitlements for regulated river systems, Stream Flow Management Plans for unregulated river systems and Groundwater Management Plans for groundwater supply protection areas. The recently released Victorian Government Water White Paper Securing Our Water Future Together will generate legislative amendments enabling better integration of activities to achieve improved river health and more sustainable use of surface and ground waters.

The Melbourne Metropolitan Board of Works Act 1958 and the Melbourne Water Corporation Act 1992 are also important elements of the legislative framework, creating the institutional arrangements for waterway and drainage management in much of the region.

The Environment Protection Act 1970 and its subordinate legislation, State environmental protection policies, regulates potential pollution risks to protect the beneficial uses of surface waters and groundwater.

The Catchment and Land Protection Act 1994 also enables declaration of Special Areas (formerly called Proclaimed Water Supply Catchments) for catchments that supply potable water. Special Area Plans can be developed for these areas and be linked to local planning schemes to regulate some land uses.

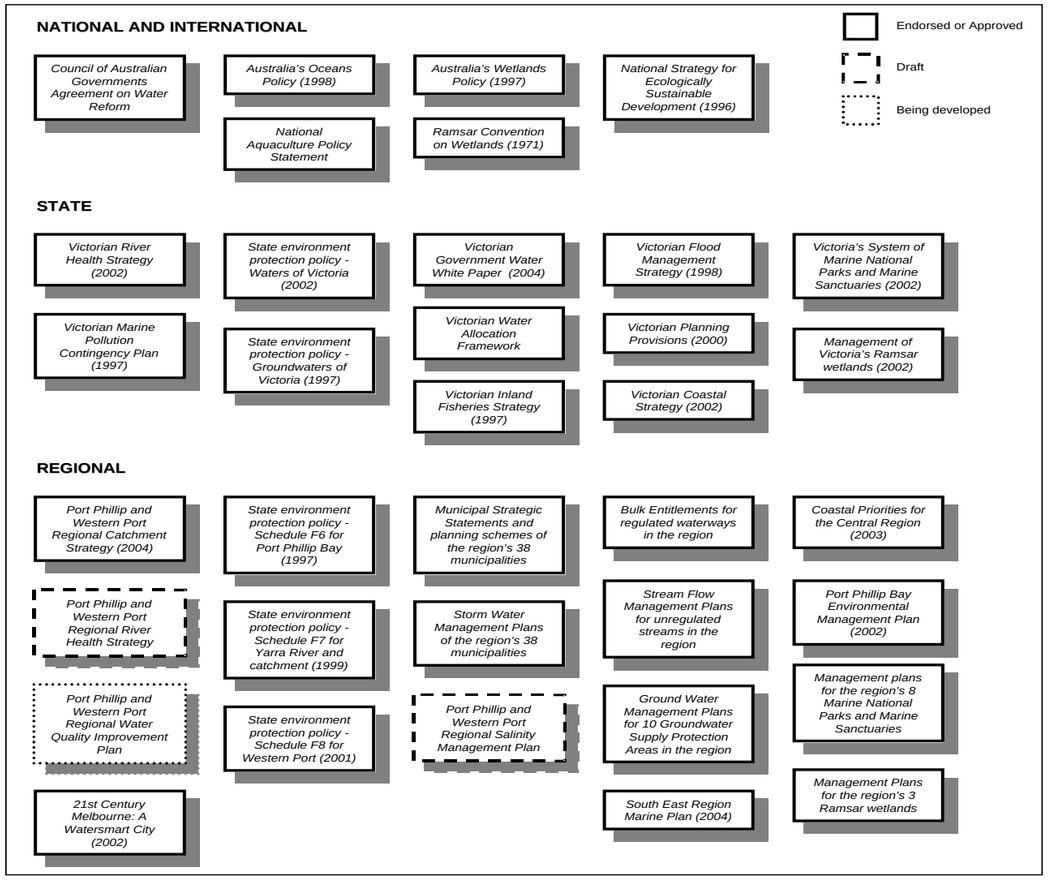
Other legislation relevant to the management of water resources includes:

- The Heritage Rivers Act 1992 - which protects rivers and catchments with environmental, amenity, cultural and historical significance
- The Marine Act 1988 - which prohibits the disposal of dangerous or polluting substances (including ballast water that may contain marine pests) into State controlled waters.

This RCS plays an important role in implementing the intent and provisions for integrated catchment management contained in Federal and State legislation. It provides public agencies and community organisations with common operational goals and incentives to coordinate their activities.

Figure 5 depicts some of the national, State and regional policies, strategies and plans relevant to water resource use and management in the region.

Figure 5: Some of the important policies, strategies and plans relating to the management of water resources.



5.3 Regional goal for water resources

In recognition of the need to keep all components of the water resources healthy and sustainable, including their relationships and interactions, this broad, long-term goal for the region's water resources is established:

Sustainable water use and healthy waterways, wetland estuaries, coasts, bays and seas

This goal embraces the global principles of sustainability and encompasses:

- managing the pressures on the water environment that are inevitable with a large and growing population in the region and an estimated 100 million visits to its waterways annually
- passing waterways onto future generations in a better condition than they have been received
- the management of threatening processes including unsustainable land-use, urban expansion, loss of riparian vegetation, loss of habitat and pest invasion
- protection of Indigenous and other cultural heritage values and provision of water-based assets in a condition fit for recreation and other social and cultural activities
- sustainable water use for residential, commercial, industrial, agricultural, aquacultural and environmental purposes
- management of fresh and marine water systems to protect their fauna and flora and the integrity of ecosystems.

5.4 Objectives

To achieve the goal, the following five Water Objectives (WO1 – WO5) are defined to guide the management of water resources in the region. These objectives are based on and contribute to the principles of sustainability that are outlined in Section 4.1.

Objective		Sustainability Principles
WO1	Ensure efficient management of water resources with minimal new impacts	P2, P3, P4, P5,

Objective WO1 embraces various principles of sustainability because of the inherent dependency on water of our ecosystems and society.

The objective recognises the need to conserve water by using and re-using it as efficiently as possible to minimise the threats posed by diverting surface water and groundwater for necessary and beneficial agricultural, industrial and residential uses. As the level of diversions increases, so too does the risk of damaging ecosystems, decreasing ecological diversity and reducing security of supply for users.

The objective also acknowledges the need to improve our understanding of natural and modified surface water and groundwater processes and their interactions.

Objective		Sustainability Principles
WO2	Protect and improve the environmental health and social and economic values of waterways and wetlands	P2, P3, P4, P5, P6

Objective WO2 has a focus on integrated waterway and wetland rehabilitation consistent with the Victorian River Health Strategy. It acknowledges the need to protect high-value waterways and wetlands and improve the condition of others where there is the highest environmental and community gain for the resources invested. It also acknowledges that, in some streams where threats are high, maintenance of current condition requires considerable effort and resources.

Objective		Sustainability Principles
WO3	Protect and improve the environmental health and social and economic values of estuarine, coastal and marine systems	P2, P3, P4, P5, P6

This objective acknowledges the importance of coasts, estuaries and bays for economic, environmental and social benefits while also recognising that foreshore and marine environments are subject to intense pressures. It seeks to ensure that intra-generational equity occurs, societal values are protected and ecological diversity is maintained. Integrated management of the coastal zone, as part of the catchment as a whole, will strengthen important understanding and partnerships.

Objective		Sustainability Principles
WO4	Improve water quality in waterways, aquifers, wetlands, estuaries, bays and seas	P2, P3, P4, P5, P6

Objective WO4 addresses threats to surface water and groundwater and to aquatic and marine ecosystems from sediments, nutrients, toxicants and other pollutants. It recognises that water quality must be protected to satisfy beneficial uses that provide for economic prosperity, community needs, ecological health and diversity.

Objective		Sustainability Principles
WO5	Ensure the management of water resources minimises risks to natural ecosystems, public land, private assets and public safety	P3, P4, P5, P6

Objective WO5 recognises the inter-relationships between the ways we manage our water resources and the impacts that can have on ecosystems and social and economic values.

It embraces the need to protect and enhance remnant vegetation and to tackle critical threats to our aquatic flora and fauna including bed and bank instability, pollution, environmental weeds and barriers to fish migration, as well as protecting against the introduction of invasive land and aquatic plants, wildlife and aquatic organisms. It also acknowledges critical threats to our foreshore and wetland environments including climate change and shoreline migration.

It also includes recognition of the economic implications of floods and the social dislocations that can result. Natural flooding regimes need not always be modified, but a balance is needed between environmental benefits and asset protection.

The objective reflects sustainability principles relating to the protection of ecosystems and creation of habitat. It recognises that riparian and foreshore vegetation stabilises banks and fragile foreshores, thus contributing to improvement of natural assets for current and future generations.

5.5 Key components of the region's water resources

The region's water resources are made up of five key components:

- surface waters, rivers and streams
- groundwater and aquifers
- wetlands
- coasts
- estuaries, bays and seas.

Because of their extraordinary significance to the region these five components, illustrated in Figure 6, are addressed individually, as Sections 5.6 – 5.10.

Each component is assessed for its values, and the key threats to those values, in order to identify the key areas of risk. The ways in which the overall water objectives (WO1 – WO5, as set out in Section 5.4) relate to these risks are highlighted, and targets and actions are then developed for each component.

Describing the key components of the region's water resources separately is a useful way of presenting a large volume of information, but it must also be recognised that strong linkages exist between the components. The summary table (Section 5.11) shows these inter-relationships.

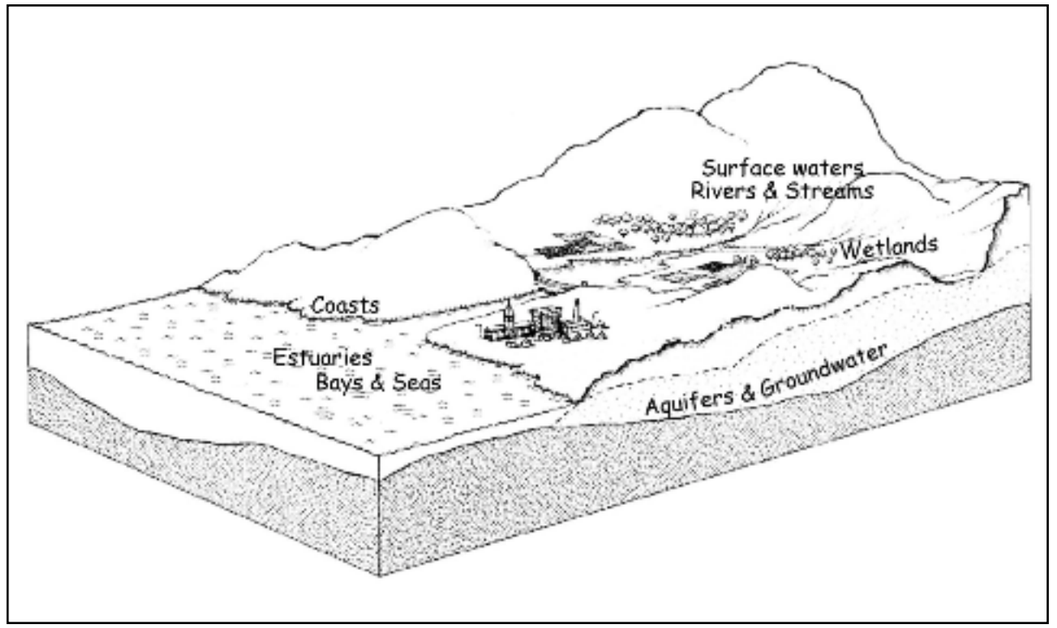


Figure 6: Key components of water resources in a catchment

5.6 Surface waters, rivers and streams

5.6.1 Overview

The surface water flow system in the Port Phillip and Western Port region is complex. It includes the region's natural waterways, some of which incorporate major storages, as well as the stormwater management infrastructure and the water reticulation and sewerage systems.

In the five main catchments - Werribee, Maribyrnong, Yarra, Dandenong and Western Port - there are some 8,000 kilometres of rivers and streams[21].

The stormwater system comprises 25,000 kilometres of street drains and 1,000 kilometres of large drains. They discharge to the waterways and bays from more than 1,000 outfall pipes, nearly 400 of these leading directly into Port Phillip Bay.

The water reticulation systems generally bypass the natural waterways to provide potable water for the region's residents from large and small storages through a network of pipes. The sewerage system utilises separate pipes to remove waste and transport it to treatment plants. Ultimately, some of the treated wastewater is returned to the region's surface or ground waters, bays and the ocean.

Approximately 1,900,000 megalitres of natural surface water flows annually into the region's waterways and water storages[22]. This is supplemented by an additional average 140,000 megalitres per year piped in from the Thomson and Goulburn catchments[23].

Around 550,000 megalitres is used annually for domestic and stock supply, industrial, agricultural and commercial purposes and drinking water for the 3.4 million residents of the region. The bulk of water harvested for potable use in the region comes from closed catchments, which are fully protected. However, water is also harvested from 'open' catchments that can contain multiple land uses. Of the 550,000 megalitres, some 335,000 megalitres enters the sewerage system.

An estimated 650,000 megalitres also enters the region's stormwater system. The volume is increasing as Melbourne and its drainage system expands. In total the region's stormwater and sewerage systems transport almost one million megalitres of water, much of this ending in the waterways or bays. This is more than half of the region's natural flow and there is the potential to reuse much of it.

The remainder evaporates, seeps into the soil and aquifers, is retained in wetlands, lakes and farm dams, or flows through the natural waterways into the bays and seas.

Figure 7 illustrates some of the region's water resource features.

[21] *Draft Port Phillip and Westernport Regional River Health Stategy*
[22] *Australian Natural Resources Atlas (2003)*
[23] *Discussion Starter for developing a water resources strategy for the Greater Melbourne area*

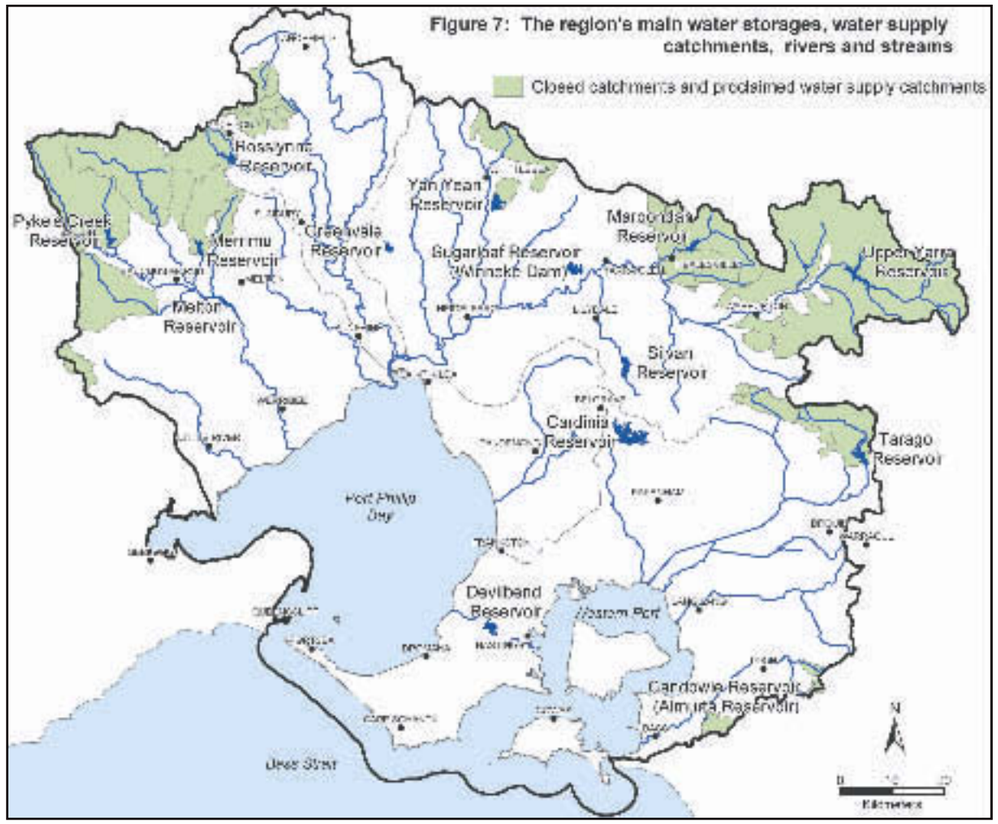


Figure 7: The regions main water storages, water supply catchments rivers and streams

The economic, environmental and social benefits delivered by our rivers and streams depend on their continued health. As part of an assessment of river health, the current condition of rivers can be indicated by the Index of Stream Condition (ISC) which measures flow regimes, water quality, the condition of the river bed and banks, the health of native vegetation in the riparian (riverbank) zones and the invertebrate fauna richness (where richness refers to the type and diversity of native species present) in the waterway. This assessment has been carried out for the region's waterways with the results provided in Table 1 and displayed pictorially in Figure 8.

Catchment	Stream length assessed (km)	Condition rating (% of length)				
		Excellent	Good	Moderate	Poor	Very poor
Dandenong	322	2	-	22	67	9
Maribyrnong	484	-	2	47	45	6
Werribee	825	7	8	51	32	2
Western Port	1,706	6	12	27	39	16
Yarra	3,333	22	15	25	27	11
Overall	6,670	13%	12%	30%	34%	11%

Table 1: Summary of Index of Stream Condition ratings for catchments in the region

As shown in Table 1, only 25% of the region's waterway reaches are in good or excellent condition, and many of these are located in the closed water supply catchments or forested areas. This indicates a pattern of decline in waterway condition from a stream's headwaters to its lowland reaches that is due to the influence of intensive land use and urban development. This is a serious issue for the 20% of the region's waterways that are in existing and future urban areas, though there are examples of water quality in some waterway reaches being improved in recent times, such as the nitrogen and e.coli levels in the Dandenong Creek.

Only 50% of the region's waterway reaches are in good or excellent condition

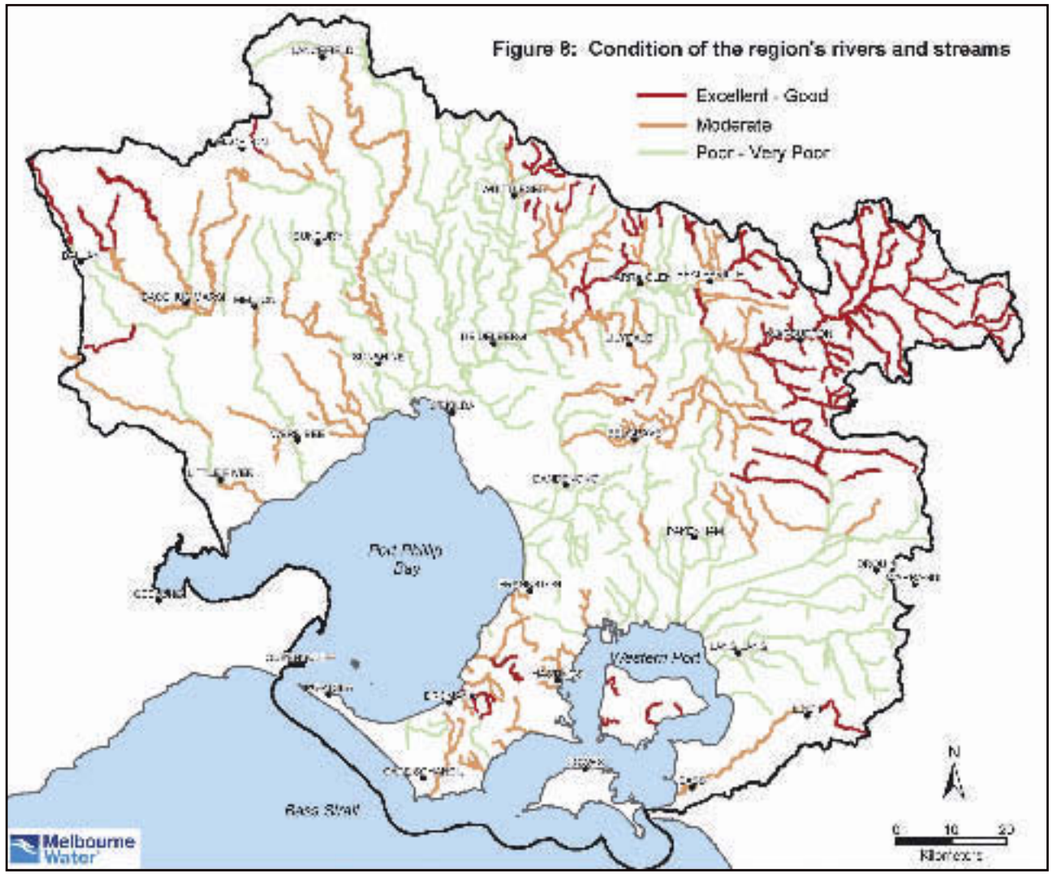


Figure 8: Condition of the region's rivers and streams

The protection of water quality in Victoria is legislated under the State environment protection policy (Waters of Victoria). This is a key government policy that sets environmental quality objectives and the actions needed to achieve them. In addition to the broad objectives of the policy, some areas in the region – Western Port and its catchment, Yarra catchment and Port Phillip Bay – are the subject of localised objectives set out in specific schedules. These are designed to protect the specific values of the areas concerned.

Monitoring programs have been established throughout the state and within the region to monitor the achievement of the environmental quality objectives. These sites comprise the Victorian Water Quality Monitoring Network, the Statewide Biological Monitoring Program, the Melbourne Water Waterway Water Quality Monitoring Network and the Melbourne Water Waterway Biological Program.

Our aim is to achieve these environmental quality objectives, including biological and water quality objectives, for all parameters within the next 20-30 years. Given this long-term view, combined with the extensive urban development in the region, it is understandable that the targets may not currently be met at a number of sites and for a number of parameters. A Regional Water Quality Improvement Plan will be prepared to set shorter-term targets across the region. Table 2 summarises data on the attainment of environmental quality objectives for various water quality parameters in 2001, and for biological parameters which were measured for the period 1997-2001.

Environmental quality objectives	No. of sites where objectives were met	No. of sites where objectives were not met	No of sites with insufficient data to determine achievement of objectives	Total no. of sites
Turbidity	37	38	12	87
Total Phosphorus	11	62	13	86
Total Nitrogen	2	72	12	86
Dissolved Oxygen	3	71	13	87
pH range	36	38	13	87
Electrical Conductivity	31	28	8	67
Biological	16	431		447

Table 2: Attainment of key environmental quality objectives for water[24]

Policy objectives for total phosphorus, total nitrogen and biological (macroinvertebrates) parameters are consistently not being met at the majority of sites throughout the region. Elevated nutrient (nitrogen and phosphorus) levels may cause excessive plant growth and/or algal blooms. Of particular concern are cyanobacteria (blue-green algae) blooms. Major sources of elevated nutrient levels in waterbodies include sewage treatment plants, urban stormwater run-off, irrigation drainage, intensive animal industries, soil erosion and agricultural run-off. In addition to the local impacts, downstream water bodies such as wetlands, lakes, estuaries and coastal marine waters are also affected.

The failure to consistently meet the biological objectives may be due to any of, or a combination of, issues.

[24] *EPA Port Phillip and Western Port Rivers and Streams Assessment (2004)*

5.6.2 Values of surface waters, rivers and streams

The draft Regional River Health Strategy outlines a detailed assessment and rating of the economic, social and environmental values of 175 sub-management units of the region.

Economic values

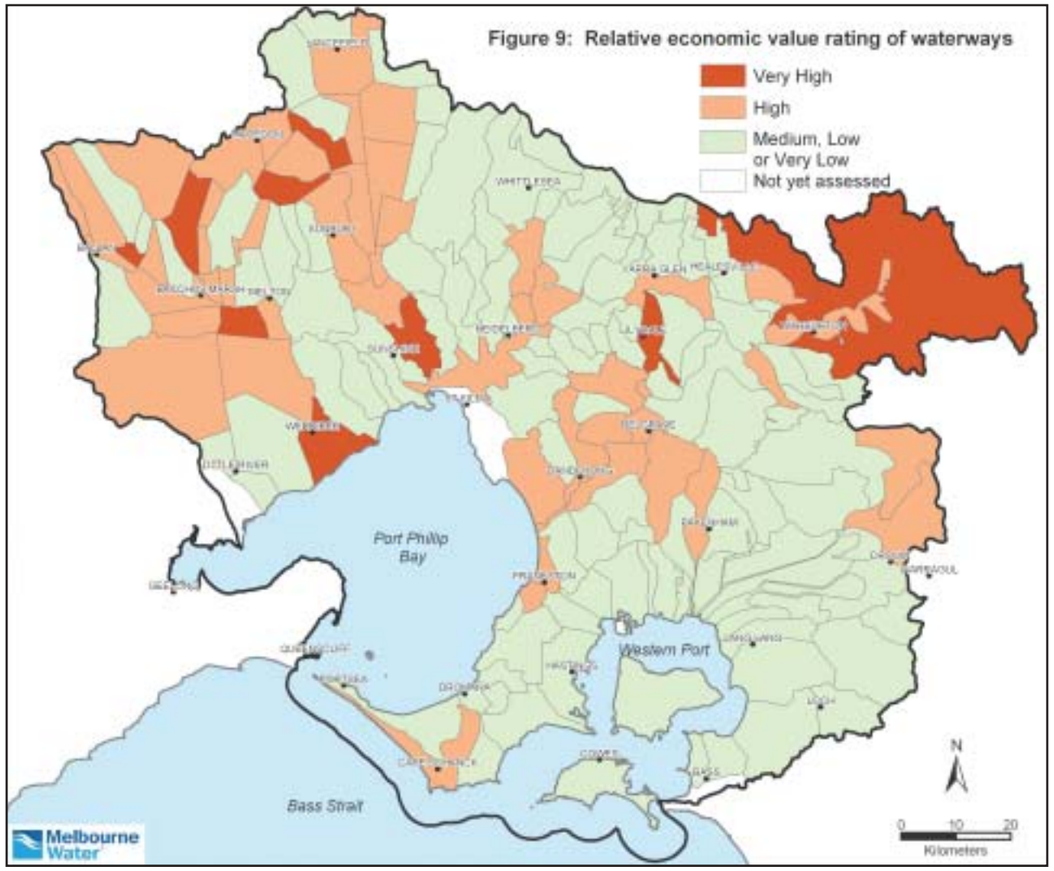
The economic values assessed include infrastructure, water supply for irrigation, proclaimed water supply catchments, land value and tourism. Figure 9 indicates the relative economic value ratings for each of the main rivers and streams.

Figure 9 shows that 37% of the 175 sub-management units have economic values rated as high or very high.

In the most developed part of the region, including the urban areas, high value waterways are clustered around the lower Yarra, and several tributaries including the Plenty and Diamond Rivers, the lower Maribyrnong and Dandenong Creek. These areas display a high rating for infrastructure, land value and in many cases, tourism.

In contrast, in the less developed parts of the region, many waterways are highly valued because they are a primary supply for irrigation water, such as the Werribee River, or where they are proclaimed catchments or supply potable water such as the Upper Yarra.

Areas that rate low for their economic value occur throughout the region. In general many of these areas are not well developed and therefore have a low infrastructure and land value rating.



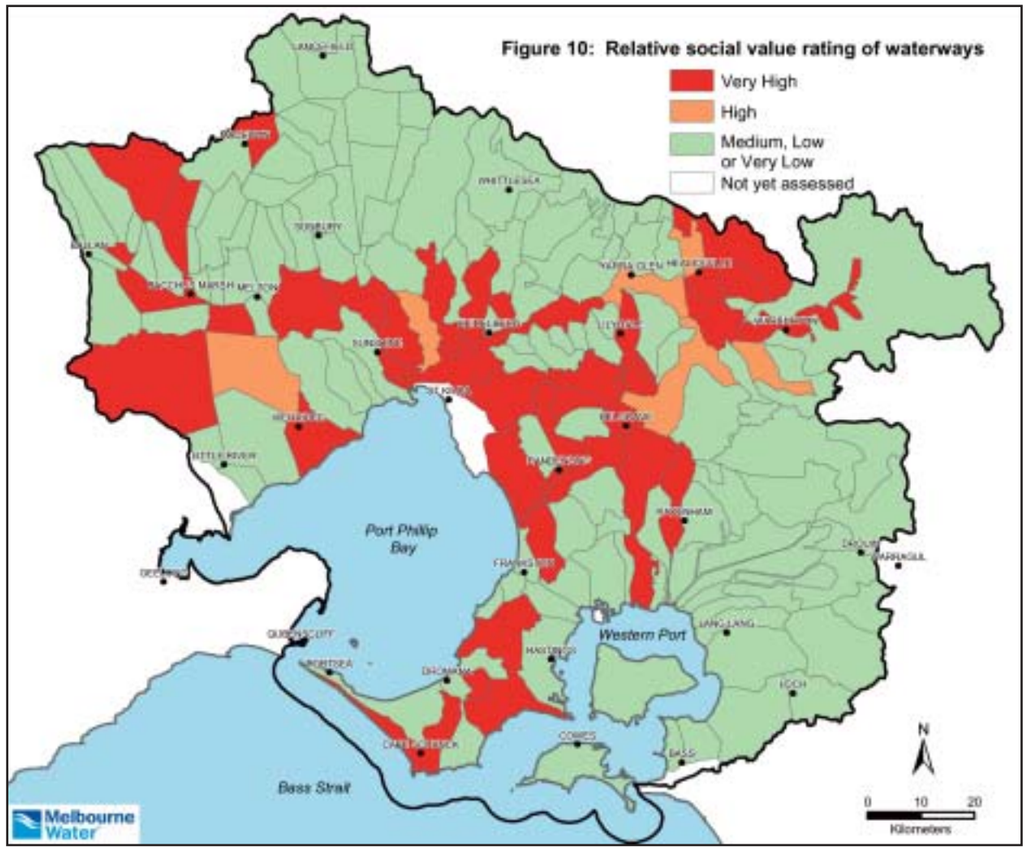
Social values

The social values assessed include recreational values (fishing, boating, camping, swimming and passive recreation) and cultural values (sites of Indigenous and non-Indigenous heritage significance, listed landscapes, geomorphological significance, land tenure and the presence of flagship species).

Figure 10 indicates the relative social values of the region's 175 sub-management units, of which 29% are rated as having high or very high social values, with a high proportion of these areas being in the middle to lower reaches of the region.

Recreational visits to Melbourne's waterways exceed 50 million annually

Most of the highly valued waterways are located in the urban areas where waterways have high visitor numbers and considerable infrastructure including trails, picnic facilities and parks. Recreational visits to Melbourne's waterways exceed 50 million annually[25], indicating their accessibility to the population and perhaps the fact that more than 30% of Melburnians live within one kilometre of a waterway. In addition to recreation, many of these waterways, such as the Lower Yarra, Lower Merri Creek and Maribyrnong River, display other important social values in terms of heritage significance, Indigenous spirituality and sites of geomorphic significance.



[25] *StreamWatch Annual Report 1994.*

Environmental values

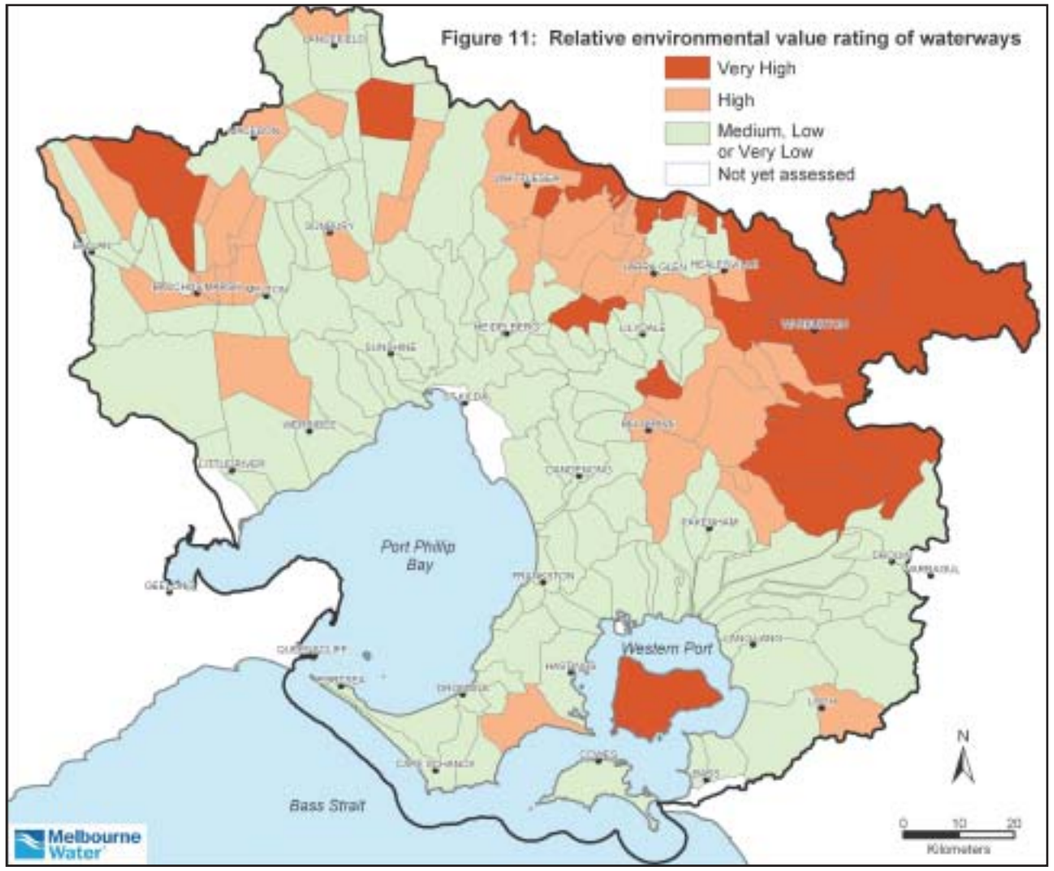
Environmental values include aquatic life, channel form, ecological health, continuity of vegetation, native fish, structural intactness and rare and threatened species and communities.

Our waterways support many rare or threatened species, including fish such as dwarf galaxias, Yarra pygmy perch, the endemic Australian grayling and other aquatic fauna such as the growling grass frog. The Macquarie perch population in the Yarra River is one of the largest remaining in the wild, and the State faunal emblem, the endangered helmeted honeyeater, is known to inhabit the riparian zone of Woori Yallock Creek. Sections of the Yarra and Lerderderg rivers are listed as heritage rivers for their natural and cultural significance.

The Macquarie perch population in the Yarra River is one of the largest remaining in the wild

Figure 11 illustrates the ratings of environmental values of the 175 sub-management units and shows that 34% of these are high or very high.

Rural landscapes show a range of environmental values. Rural waterways of high environmental value are those that have retained significant species and riparian vegetation. In lower value rural waterways threatening processes have influenced one or more of the environmental values. Urban waterways tend to have the lowest environmental value because these are heavily modified.



5.6.3 Key risks to surface waters, rivers and streams

Numerous existing and potential risks must be considered in planning to maintain the health and productivity of the region's surface waters, rivers and streams. Seasonal and intermittent events must be planned for, but the incremental and cumulative impacts of our day-to-day practices are also a serious concern. The draft Regional River Health Strategy identifies the major risks to waterway health and to the delivery of economic, social and environmental benefits.

WR1 – Degradation of the streamside zone

Poor condition of streamside vegetation is a major risk across the region, threatening environmental values in 62% of the region's rivers and streams and social values in 60%.

A poor streamside can lead to a decrease in the quality of habitat, the quality and quantity of food sources to the river, and it can affect access to and enjoyment of recreational experiences. In rural areas, because streamside zones filter runoff, a poor streamside zone can also impact on water quality.

Land use changes, vegetation clearing, stock access and weeds are the main activities that have led to poor streamside zones within the region. A contributing factor has also been the absence of Crown frontages for most of the length of our rivers and streams[26].

WR2 – Land use change

Land use change, in particular urbanisation, poses a considerable risk to waterway health and water quality. An increase in impervious areas and in connections between urban stormwater systems and waterways means that water-borne pollutants can be very efficiently delivered to rivers and streams.

The growth of urban Melbourne over the next 30 years will be concentrated in several key growth corridors including Wyndham, South East, Hume, Melton/Caroline Springs and Plenty/Mernda. The density of some existing urban areas will also increase substantially. This poses a risk to many high value rivers and streams including the Cardinia, Grace Burn, Coranderrk, lower Jacksons, Diamond and upper Djerriwarrh Creeks and the lower Werribee River.

WR3 – Hydrological stress

The diversion of river flows to provide water supplies continues to have significant effects on the ecology of the region's rivers by reducing the level of flows. For example, flows in the Yarra River now represent only 65% of its average natural flow, while the flow in the Werribee River is reduced to 77% [27].

Variations from natural flow levels threaten environmental values in 40% of the region's rivers and streams. Over-allocation can also have a significant economic impact by reducing the security of supply for existing water users, particularly during drought periods.

Victoria's water allocation framework seeks to ensure that all significant water use within a catchment is managed, and enables provision for flow levels and flow regimes that are important for the environment.

WR4 – Pollutants that reduce water quality

Pollutants carried to rivers and streams from stormwater and other diffuse sources reduce water quality and pose a major risk to around 35% of the region's rivers and streams.

Runoff of nutrients, particularly nitrogen and phosphorus, is a problem in some rivers and streams, as are sediments from activities on land. As shown in Table 2, only two of the 86 monitoring sites in the region met the SEPP objectives for nitrogen in 2001 while eleven met the phosphorus objectives.

[26] *Review of Crown Frontages for the Port Phillip and Western Port region*
[27] *National Land and Water Resources Audit (2000).*

Nearly half the monitoring points showed persistent nitrogen and phosphorus concentrations at more than three times the SEPP objectives. This does not include the peak nutrient inputs that occur during high stream flows.

Risks from nutrients are to the bays and to potable water supplies. The Port Phillip Bay Study and Environmental Management Plan recognise nitrogen loads as a key threat to bay health. In waterways and storages, high nutrient loads can lead to algal blooms. This has occurred in several storages

including the Melton, Merrimu, Rosslynne, Yan Yean, Tarago and Candowie reservoirs. Water storages in catchments with multiple land uses are particularly at risk. High nutrient levels in rivers can also lead to problems for stock, native flora and recreational values.

Toxicants such as zinc, lead, copper, nickel, cadmium, petroleum hydrocarbons and pesticides have been detected in many urban streams. The level of other chemicals in the rivers and streams, such as biocides and other synthetic chemicals that may interfere with the human body's hormonal system (endocrine modifiers), needs to be monitored and managed.

Litter is a highly visible symbol of water pollution. It reduces the visual amenity of our waterways and can also have a significant impact on aquatic flora and fauna. Litter travels to waterways and bays mainly through the urban stormwater system. Each year, approximately 230,000 cubic metres or 2 billion items[28] of litter enter the waterways from the urban system. This equates to more than one litter item for every person in the region reaching the waterways each day.

WR5 – Barriers

In-stream barriers such as dams, weirs and road crossings pose a major risk to 56% of the region's rivers and streams. While many barriers have been addressed in recent years, those that remain impede the movement of fish and other aquatic species such as platypus. For example, thirteen of the 20 native fish species recorded in the region are known to have life stages that require migration upstream or downstream.

WR6 – Erosion of bed and banks

Accelerated erosion in many of the region's rivers and streams has been stabilised, but 14% are still threatened by bed and bank erosion leading to an increase in sediment loads in rivers and streams. Land use change that has resulted in vegetation clearance is a major cause of erosion. The erosion can undermine infrastructure, lead to a loss of archaeological sites and reduce available habitat for native fauna. Sediments can also build up in storages, reducing their utility. Because phosphorus and other pollutants can bind to soil particles, increased sediment loads can also result in increased nutrient levels of waterways. Sedimentation is a particular threat to Western Port - this is addressed in more detail in Section 5.10 regarding Estuaries, Bays and Seas.

WR7 – Stock access

Around 20% of the region's rivers and creeks are at serious risk due to the access of stock which can degrade the riparian zone and the quality of the water. This is particularly so in rural areas. Vegetation is reduced, erosion increased and human health threatened through faecal contamination.

WR8 – Introduced species

The streamside zone of waterways is vulnerable to weed invasion. Weeds have colonised many waterways in the region with species like blackberries, willows and arum lily. Introduced fish are present in all regional waterways, with 13% of rivers and streams being particularly at risk from a high level of exotic fish populations. These fish displace native fish populations by either out-competing for food or disturbing habitat.

WR9 – Climate change

Climate change and associated rises in sea level could have significant effects on water resources. Impacts may include incursions of salt water into estuaries and waterways, increased peak flows in rivers and threats to private and public infrastructure. Of great significance are the potential implications of a changed rainfall regime and more frequent and intense fires, droughts and flooding.

[28] *Melbourne Water estimate*

5.6.4 Significant rivers and streams

By combining the analyses of the values and risks, the draft Regional River Health Strategy identifies the rivers and streams that are significant to protect and manage, as shown in Figure 12.

Of particular importance are the 25% of the region's rivers and streams that are either:
- rivers of special interest including heritage rivers, representative rivers or ecologically healthy rivers
- rivers with very high social, environmental and/or economic values where the risks to these values are also very high.

Many are within forested areas high in the catchments and are therefore in excellent condition, but this category of high value, special interest and high risk also includes the entire main stem of the Yarra River down to Warrandyte.

A further 35% of the region's 175 sub-management units are at the next level of significance for management. These occur across both urban and rural landscapes.

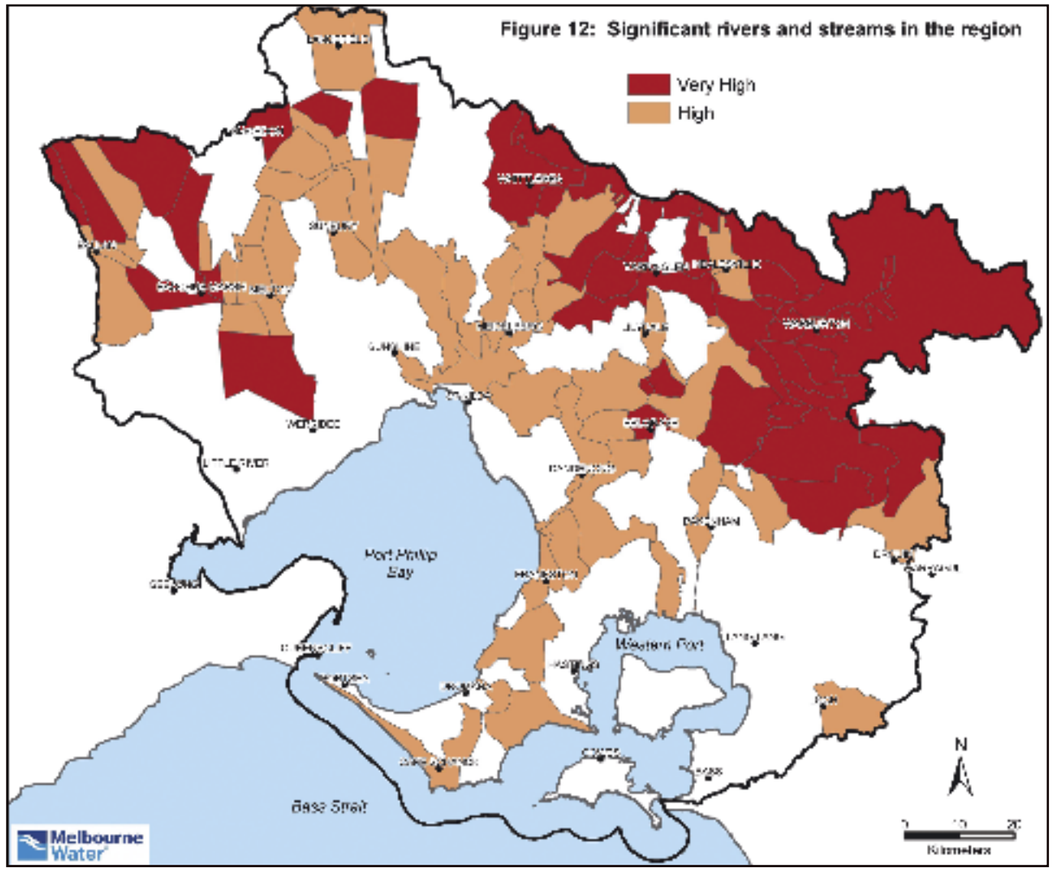


Figure 12: Significant rivers and streams in the region

5.6.5 Objectives for surface waters, rivers and streams

The five Water Objectives (see Section 5.4) have been developed in line with the principles of sustainability and also address the key risks for surface waters, rivers and streams.

Current water use patterns and a growing population place severe stress on the region's waterways. This risk is addressed by ensuring efficient management of water resources with minimal new impacts on natural hydrological processes (Water Objective 1). The risks to our river health caused by pollution, excessive sedimentation and introduced species, are addressed by protecting and improving the health of our waterways and wetlands (Water Objective 2). The water quality and biodiversity effects of these risks are further addressed by progressively improving the water quality in our waterways (Water Objective 4) and ensuring the management of water environments improves the health, diversity and resilience of natural ecosystems (Water Objective 5).

Climate change scenarios suggest the possibility of both less water being delivered to the catchment, and of increased intensity of flood events. The risks thus posed need to be considered when working to achieve all the objectives, and the precautionary principle must be kept in mind.

5.6.6 Targets

This suite of Water Targets (WT1 – WT10) is proposed to meet the elements of the five objectives that are directly relevant to surface waters, rivers and streams.

Efficient management of water resources

Target		Relevant objectives
WT1	Average potable water consumption per person reduced by 15% by 2010	WO1, WO2, WO5

Target		Relevant objectives
WT2	The volume of recycled water used in the region increased to 20% of the total treated volume by 2010	WO1, WO2, WO5

These targets are consistent with the Water Resources Strategy for Melbourne and recognise the need for the conservation of all water sources to meet future needs and maintain the health of rivers. The achievement of WT1 will be pursued through the implementation of various water conservation programs led by the State Government and water authorities including some flagged in the recent Water White Paper Securing Our Water Future Together. One of the important mechanisms to assist water conservation is to increase the availability of recycled water and to use it wisely and appropriately to substitute for the use of potable water.

Target		Relevant objectives
WT3	Diversions from all waterways to be within Sustainable Diversion Limits by 2015	WO1, WO2, WO5

This target recognises that to sustainably produce water to meet the economic, environmental and social needs of the region, our rivers must be healthy with extractions being within sustainable limits.

Target		Relevant objectives
WT4	Improved average value of irrigated agricultural production per megalitre.	WO1

This target recognises the importance of using water efficiently within agricultural industries to achieve optimum value.

Healthy waterways

Target		Relevant objectives
WT5	Maintain the condition of the 13% of the region's rivers that are currently in excellent condition.	WO1, WO2, WO4, WO5
WT6	Improve the condition of the region's waterways so that: - At least 50% of all the natural waterways will be in good or excellent condition by 2015 - All natural waterways will be in good or better condition by 2025	WO1, WO2, WO4, WO5
WT7	Progressive improvement in the condition of water ways across the region, as measured by the Index of Stream Condition, including the bed and banks, streamside zone and aquatic life	WO2, WO4, WO5

These targets, consistent with the Victorian River Health Strategy and the Regional River Health Strategy, aim to maintain waterways that are in excellent condition and improve the overall condition of all other natural waterways. The reporting against these targets is anticipated to occur at five-yearly intervals.

Water quality

Target		Relevant objectives
WT6	Improve water quality in rivers and streams so that: - At least 80% of monitoring sites attain State environment protection policy objectives or regional targets by 2009 - All monitoring sites attain State environment protection policy objectives or regional targets by 2030	WO2, WO4, WO5

The State environment protection policy (Waters of Victoria) and its schedules for the Yarra River, Port Phillip Bay and Western Port, specify long-term environmental objectives for water quality across the region. Shorter-term regional targets will be determined in the near future and outlined in a Regional Water Quality Improvement Plan as interim steps to be achieved.

Note: The management of waterways to reduce inputs of nutrients, sediments and other pollutants to Port Phillip Bay, Western Port and the ocean is also important. Specific targets for reduced inputs from waterways of nitrogen to Port Phillip Bay (WT22) and sediment to Western Port (WT23) are included in Section 5.10 – Estuaries, Bays and Seas.

Floodplains and flooding

Target		Relevant objectives
WT9	No loss of hydraulic capacity and environmental values of floodplains	WO5

Target		Relevant objectives
WT10	Timely flood warnings provided for all major waterways and risks to infrastructure minimised	WO5

Flooding is a natural process that has many benefits. However, these targets also recognise that sound planning and timely warning is required in this region for safety and to protect public and private assets, a notion that is encapsulated, for example in the charter of Melbourne Water.

5.6.7 Actions

This suite of Water Actions (WA1 – WA18) is required to collectively meet the targets. The actions cover various aspects of the management of water resources, including needs for research, planning, education, on-ground works, monitoring and reporting.

Some actions will continue and build on existing programs in the region, while others are new initiatives.

Policy

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA1	Implement the relevant directions of the 'White Paper – Securing our Water Future Together'	WT1 – WT8	2006	MW, CMA	DSE, Local government, Water authorities	Low

A range of State and Commonwealth legislation influences water resource management in the Port Phillip and Western Port region. The legislative framework establishes a range of institutions responsible for managing aspects of water resources and provides these institutions with a range of powers in order to discharge their responsibilities. Of particular importance for this region is the implementation of the recently released Victorian Government Water White Paper Securing Our Water Future Together.

The White Paper establishes Melbourne Water as the "caretaker of river health" for this region, responsible for waterway, drainage, floodplain and environmental water reserve management across the whole of the Port Phillip and Western Port region. In the past, gaps in arrangements for some areas were a major impediment to achieving the region's targets for stream health. It is now important that the rollout of these responsibilities occurs to achieve comprehensive coverage of the region for waterway management.

It is important that the linkages between Melbourne Water and the Port Phillip and Western Port Catchment Management Authority be strengthened. The development of a partnership agreement between the organisations could assist regular interaction between the two Boards, improved coordination of regional grants processes, and the establishment of strong links between the Regional Catchment Strategy priorities and Melbourne Water's annual investment processes and works programs. It will be important to evaluate the effectiveness of this partnership to deliver improved services that integrate waterway health with whole-of-catchment management and enable improved consideration of catchment management principles in urban growth planning, green wedge planning, major landscape change projects, etc.

Planning

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA2	Determine, and ensure compliance with, Sustainable Diversion Limits and Bulk Entitlements for the region	WT1 – WT8	2007	DSE	CMA, MW, SRW, Retail Water Companies	Medium

Water storages and river flows are crucial for the production of water for economic, environmental and social values. It is important to ensure that water quantity is maintained at sustainable levels to deliver these values.

The allocation of surface water is managed by State government agencies under the Victorian water allocation framework. The framework uses a hierarchy of legal entitlements to water, starting with the right of the government to control any water in a waterway. Under this arrangement, bulk entitlements (BEs) are established for urban and rural water authorities to cover water for domestic, commercial, industrial and irrigation use. Outside these entitlements, Sustainable Diversion Limits need to be set for all waterways, and individuals diverting water for commercial or irrigation purposes must be licensed within these limits.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA3	Implement the State Government's policy for the establishment of diversion caps and an environmental water reserve for the region's rivers	WT3	2009	MW	CMA, DSE	Medium

The Victorian Government's Water White Paper Securing Our Water Future Together establishes that the catchments of this region are fully allocated and that diversion caps and an environmental water reserve will be put in place. Included within this action is the need to enhance flows in the Werribee River through the implementation of the Werribee Irrigation District Recycled Water Scheme.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA4	Complete Stream Flow Management Plans for the Plenty, upper Maribyrnong, Watts, Little Yarra, Don and Bunyip Rivers, and Olinda, Stringybark, Pauls, Steels, Dixons, Woori Yallock and Coranderrk (Badger) Creeks, plus additional waterways as required	WT3	2007	MW	CMA, DSE, SRW	Medium

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA5	Develop local stream flow management rules for waterways where Stream Flow Management Plans are not required, eg. Merri Creek, Moonee Ponds Creek and Gardiners Creek	WT3	2009	MW	SRW	Low

Stream Flow Management Plans (SFMP) may be developed in unregulated rivers and streams where changes to the flow regime have been identified as a threat. Other factors considered when determining priorities for development of SFMPs include the ecological values of waterways, any history of management difficulties and any pressures for future development. SFMPs have been developed for Hoddles Creek and Diamond Creek, and need to be developed for many other rivers and streams. For other streams in the region, local management rules are required to ensure equitable and sustainable flow regimes.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA6	Map the land-based sources of nutrients, sediments and other pollutants to waterways, Port Phillip Bay and Western Port, and develop and implement a Regional Water Quality Improvement Plan to address the major sources	WT8, WT21, WT22,WT23	Mapping and plan completed by 2008	EPA	DPI, CMA, MW, DSE	Medium

A Regional Water Quality Improvement Plan is required to strategically identify and address key water quality issues including the management of nutrients, sediments and other pollutants from land-based sources such as leaking septic tanks and poorly managed effluent from some dairy farms. Catchment activities are identified in the Port Phillip Bay Environmental Management Plan as a large contributor to nitrogen loads to Port Phillip Bay. Similarly, recent studies such as the Western Port Sediment Study have indicated that catchment activities are contributing significant loads of suspended solids to Western Port via rivers and streams. The study has identified particular areas contributing high sediment loads to Western Port including the low cliffs of the northern Western Port shoreline and the streams of the Bunyip River, Cardinia Creek and Lang Lang River catchments.

The Australian Government's Coastal Catchments Initiative is an opportunity to bring together various agencies, organisations and communities into this strategic regional planning effort as a basis for coordinated and targeted works and monitoring programs for the future.

Within the development of the plan, appropriate mechanisms are required to estimate the loads of nutrients and other pollutants to waterways and the bays, and the reductions in loads being achieved through various programs and on-ground works.

Works

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA7	Implement the Port Phillip and Westernport Regional River Health Strategy	WT5 – WT8	On-going	MW	CMA, DSE, EPA, SRW, PV, local government, community	High

The Regional River Health Strategy will be an important regional document outlining priorities for the management of waterways as a basis for works programs. It is vital that implementation of the strategy proceeds as quickly as possible and in a manner consistent with integrated investment priorities for the region.

Detailed targets within the Regional River Health Strategy will focus on various elements of river health and the protection of environmental, social and economic values. For example, in regard to native fish, the constructed barriers in our rivers are a particular concern if they affect the viability of native fish populations. Therefore it is proposed that the length of rivers accessible to native fish and platypus will be increased by 1,500 kilometres by 2010.

The continued protection and revegetation of the region's river corridors will also be an important outcome of implementing the Regional River Health Strategy. This will have multiple benefits for waterway health as well as for the quality and amenity of the region's open space and parks networks and offers considerable scope for coordinated and integrated action between Melbourne Water, Parks Victoria, councils, agencies, water authorities and various river management committees.

Other priorities of the Regional River Health Strategy include:

- Improving river and creek vegetation by protection existing remnant vegetation, removing introduced plants, fencing off streamsides to remove stock and replanting with native species
- Improving water quality through the development of a Regional Water Quality Improvement Plan, implementation of best land management practices combined with a comprehensive urban stormwater program of wetlands and implementation of stormwater management plans
- Maintaining an extensive program of fixed site monitoring, waterway investigations, fish surveys and research programs
- Establishing and managing environmental flows through stream flow management plans and the development of local area rules
- Improving beds and banks of waterways
- Protecting heritage values in the waterways and riparian areas
- Enhancing the special social and educational values of waterways in urban areas of this region, including optimising recreation opportunities in line with Parks Victoria's Linking People and Spaces Strategy.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA8	Design and implement schemes for recycling water from the Eastern and Western Sewerage Treatment Plants and smaller plants in the region.	WT2	On-going	MW	SRW, CMA, Retail Water Authorities	High

Sewage and stormwater represent opportunities for the region to recycle water and reduce potable water use. With appropriate treatment, sewage could be reused and be substituted for water extracted from reservoirs and rivers, thus reducing pressure on river flows. Technological innovation that is now taking place could raise the reuse level of treated effluent from the present level of 11% to the Government's target of 20% by the year 2010[29]. EPA endorsement for these schemes will be required.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA9	Complete an audit of stormwater management plan implementation for all municipalities and design and implement a program to address key gaps	WT8	2008	MAV	MW, EPA, local government	High

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA10	Meet best practice standards in urban stormwater discharges in new urban areas	WT8	100% compliance by 2006	Local government	MW, DSE, EPA	High

Historically, urban stormwater management has concentrated on regulating its quantity rather than its quality. But the effect of stormwater on the quality of the waterways and bays is now a major concern as it can be highly contaminated. For example, more than half the nitrogen and phosphorus from the Yarra catchment is sourced from urban areas. Urban stormwater has also been identified as a key source of suspended solids and heavy metals - including zinc, lead and copper - in urban streams[30]. Stormwater inputs to the bays are likely to be increased with continued urban expansion, especially from the identified urban growth areas. The meeting of best practice standards in both redevelopment areas and greenfield development areas will lead to the on-site retention of nitrogen and phosphorus loads. Agreement on cost-sharing arrangements for the implementation of Stormwater Management Plans would trigger accelerated work of these actions.

[29] *Ministerial Statement on implementing 'Water for the Future'*
[30] *Toxicants in Melbourne's streams and wetlands: an emerging threat to healthy waterways*

The application of water sensitive urban design requires a preparedness to challenge conventional methodologies for drainage design of new urban areas. It has significant potential to deliver greater protection of receiving waterways as well as achieving substitution of potable water with site-harvested stormwater.

Planning for, and management of, overland flow paths is also important to enable passage of water during flood events with minimal damage to private property and infrastructure.

The Environment Protection Authority, Melbourne Water and local government have major roles in managing stormwater quantity and quality. The Victorian Government's Water White Paper Securing Our Water Future Together has recognised stormwater as an important asset that is poorly utilised to date. The Government has therefore strongly advocated that stormwater harvesting should have an increased role in the water cycle management for Melbourne and other urban areas, particularly where it can assist with water conservation or enhance regional water quality.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA11	Reduce by 500 the number of properties vulnerable to a one in 100 years flood	WT10	2009	MW	Local government	Medium

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA12	All new developments constructed with floor levels at the required safety margin above one in 100 years flood levels	WT10	On-going	MW	Local government	Low

These actions, included in Melbourne Water's Drainage and Waterway Charter, are key mechanisms for reducing the risks from flooding to infrastructure and safety. Action WA11 deals with some of the existing infrastructure in known flood-prone sites. Action WA12 seeks to ensure that all new development is sited to take account of the likelihood and severity of flood events.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA13	Develop, and incorporate into relevant planning schemes, protocols that contribute to the protection of the environmental values of floodplains	WT9	2008	DSE	MW, Local government, CMA	Low

This action seeks to increase the protection of floodplains by increasing the capability of local government to manage land use in these areas with high environmental values.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA14	Develop and implement Special Area Plans for water supply catchments where appropriate	WT8	2009	DSE	DPI, Water authorities, Local government	Medium

The bulk of water harvested for potable use in the region comes from closed catchments, which are fully protected. However, water is also harvested from 'open' catchments that can contain multiple land uses. These have been proclaimed as Special Water Supply Catchments under the provisions of the Catchment and Land Protection Act 1994. Large areas of these open catchments are used for agriculture, horticulture, residences and infrastructure.

This action recognises that land capability mapping and Special Area Plans may be appropriate mechanisms to determine and define the best ways to manage these open catchments. It also recognises the need to audit the implementation of existing Special Area Plans and to address any situations where land use and management is not adequately protecting the supply and quality of water. The management of special water supply catchments involves many stakeholders, so consultation with local communities and landholders is an essential part of the development, implementation and auditing of Special Area Plans for water supply catchments.

Research and development

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA15	Investigate and quantify the hydrological and ecological relationships between surface waters and groundwater, and develop catchment-based water budgets	WT3, WT5, WT6, WT7, WT8	2009	DSE	CMA, MW, SRW, research organisations universities	Medium

There is an important link between groundwater and surface water flows. Many rivers and streams receive inflows from groundwater that assist in the maintenance of their health. A thorough understanding of these relationships is needed to inform the development of catchment-based water budgets, particularly for the catchments of stressed rivers.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA16	Benchmark rural water use efficiency in major agricultural areas and increase water use efficiency by agricultural industries	WT4	2007	DPI	Agricultural industries, MW, SRW	Medium

We can pursue various actions to minimise the demand for increased diversions and to ensure the water is used to gain the best return. Given that agricultural industries are an important user of water, there is a need to better understand current agricultural practices and opportunities for improved water use. This action requires the strong involvement of primary producers within the region.

Monitoring

Monitoring is of critical importance to the management of surface water resources. The monitoring system needs to be extensive enough to enable trends in water quality and quantity to be determined. The actions that follow are intended to ensure that the region has the best available monitoring network and that the information collected supports decisions by water managers.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA17	Review and implement a surface and ground water quality monitoring system to ensure adequate and coordinated coverage across the region, including reservoirs, high discharge areas, bays and seas, high rainfall events and nutrient loads.	WT8	Review by 2006 Begin to implement by 2007	CMA	EPA, DSE, MW, SRW, PV, CCB, Local Government	High

Water quality monitoring, including the attainment of SEPP objectives, is the basis for trend analysis, planning and priority setting for water quality management actions. This action recognises that substantial fixed-site monitoring occurs now across the region in rivers and streams, but that monitoring efforts are not evenly distributed and miss key sites including the bays and seas. Comprehensive and coordinated coverage is required across the region to remedy existing gaps. This action also recognises that the majority of nutrient and sediment loads are transported in storm events and therefore, to effectively reduce these loads, a better understanding is required.

The reservoir systems are vital for the provision of water for domestic, industrial and rural purposes. Consequently, early detection of any threats to the reservoirs is essential.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA18	Continue regular assessment of the Index of Stream Condition across the region	WT5, WT6, WT7	On-going	MW	DSE, CMA, EPA	Low

The Index of Stream Condition has developed into an important tool for monitoring stream condition and is the basis for some targets in the RCS. A regular monitoring program is essential to test the success of the actions we are putting into place to achieve these targets.

5.7 Aquifers and Groundwater

5.7.1 Values

Aquifers are underground layers of rock, often comprised of ancient sands and gravels that can hold and transport groundwater across geological basins.

Groundwater is an important component of the total water cycle and, where aquifers are close to the surface, groundwater interacts naturally with the flows of rivers and wetlands and contributes to their overall health.

Where the quantity and quality of the water in an aquifer is appropriate, significant amounts of groundwater can be pumped to the surface in bores and used for a range of purposes.

Like surface water, groundwater is recognised as a finite resource and its extraction from aquifers is managed by State Government agencies, in particular Southern Rural Water in the Port Phillip and Western Port region.

Groundwater is commonly used for irrigation, commercial, stock and domestic purposes in this region. Licences exist to extract more than 42,000 megalitres of groundwater each year for commercial and irrigation use in 11 Groundwater Management Areas (GMAs)[31]. Extractions are not limited to GMAs and not all extractions require licences. The total amount of groundwater used annually for stock and domestic purposes is not accurately measured but is likely to be many additional thousands of megalitres. There is potential for the growing use of groundwater in aquaculture. In particular, geo-thermal groundwater has the potential to reduce aquaculture production costs and several operations using this resource are current in the region. The natural salt content of groundwater is variable across different aquifers and is often a limiting factor in the ways that the groundwater can be used. For the protection of various other aspects of groundwater quality, the State Environment Protection Policy (Groundwaters of Victoria) is a key government policy setting standards and performance objectives. This policy assigns roles and responsibilities to relevant agencies and directs actions relating to licensing discharges, pollution abatement and zones of restricted use.

In all of the GMAs in this region, most of the licensed extractions of groundwater are used to supplement surface water supplies for high value agriculture including production of vegetables, fruit, wine grapes, flowers and turf, or for use at golf courses and in industrial processes. It is estimated that the average gross value of production from these agricultural uses is around $6,500 per megalitre[32].

Significant amounts of groundwater can be pumped to the surface and used for a range of purposes, but it is a finite resource

Table 3 shows the estimated sustainable economic value of groundwater from the region's 11 GMAs. Collectively, the GMAs of this region provide an economic value from groundwater use across the region of around $250 million each year. Key contributions to this total come from the Koo Wee Rup, Nepean, Moorabbin and Wandin Yallock GMAs, each of which provide more than $20 million each year.

[31] *Southern Rural Water (2003)*
[32] *Estimates from RM Consulting Group*

5.7.2 Key risks to aquifers and groundwater

WR10 – Extractions exceeding recharge capacity

If extractions from an aquifer exceed its recharge capacity, the long-term viability of the groundwater resource is threatened. While short-term unavailability of water is an issue, prolonged dewatering of aquifers can also contribute to compaction, thereby reducing the future ability of the aquifer to store and transport groundwater.

Excessive extraction can also affect groundwater quality where aquifers are adjacent to the sea and salt water intrusion can occur. This is a particular issue for the Deutgam and Nepean GMAs where the groundwater is drawn from relatively shallow aquifers.

There are also serious environmental impacts from aquifer depletion. As an important component of the water cycle, changes in the hydrological balance of groundwater and surface water can affect ecosystems such as rivers, wetlands and estuaries.

Changes in the hydrological balance of groundwater and surface water can affect ecosystems such as rivers, wetlands and estuaries

An estimated sustainable yield, called a Permissible Annual Volume (PAV), has been established for most GMAs. This is a level beyond which no further groundwater licences should be issued. Comparing the PAV with the actual licensed allocations provides an indication of the threat of extractions exceeding recharge capacity, as shown in Table 3 for the GMAs of this region.

It should also be noted that there are unlicensed uses of groundwater that need to be taken into account, including the use of groundwater in urban areas. In addition, our understanding of complex groundwater dynamics is incomplete and the methods used to calculate PAVs will benefit from continued refinement.

Table 3: Licensed allocations, permissible annual volumes and estimated sustainable gross value of production from groundwater for the region's Groundwater Management Areas.

GMA	Existing licensed allocations (ML/yr)	PAV - Estimated sustainable yield (ML/yr)	Proportion of PAV allocated	Sustainable gross value of production ($million/yr) **
Corinella	791	2,550	31%	5.1
Koo Wee Rup	13,512	14,916*	91%	87.8
Nepean	8,285	5,000	165%	32.5
Frankston	1,564	3,200	49%	10.2
Moorabbin	3,462	4,305	80%	22.5
Wandin Yallock	3,322	3,300	101%	21.5
Kinglake	2,858	3,830	75%	18.6
Lancefield	1,595	1,485	108%	9.6
Cut Paw Paw	515	3,650	14%	3.3
Deutgam	6,050	2,400	252%	15.6
Merrimu	452	450	100%	2.9
TOTAL		42,406		229.6

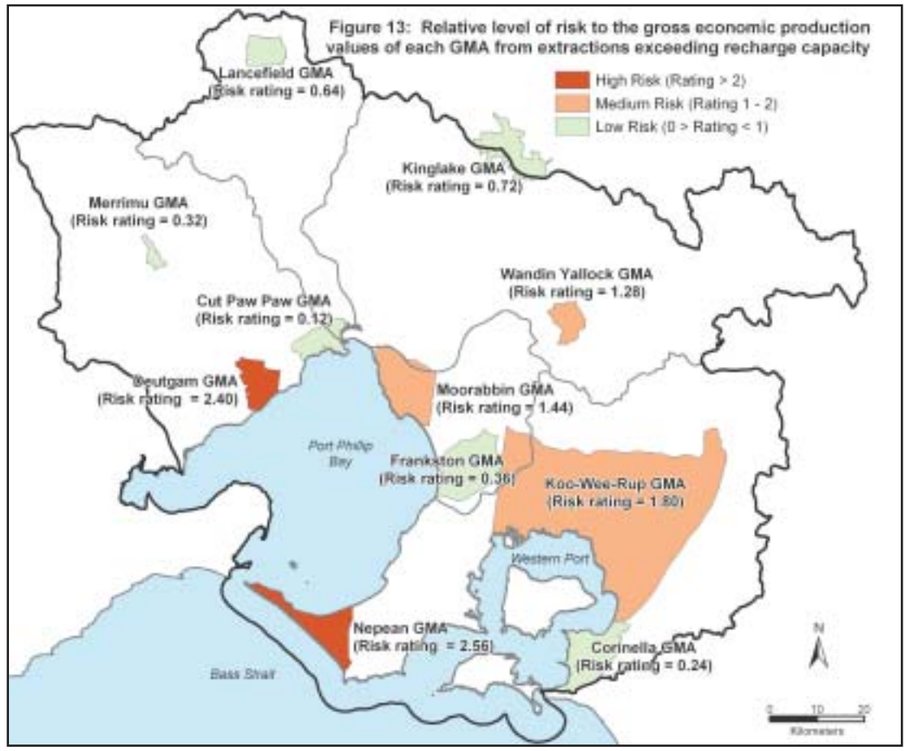
* This is the combined total of draft prescribed volumes from 7 zones in the Koo Wee Rup water supply protection area
** These values are calculated by multiplying the existing allocation (to a maximum of the sustainable yield) by $6,500/ML

The following risk assessment methodology, as explained in Section 4.3, is used to assess the level of risk to the gross economic production values of each GMA from extractions exceeding recharge capacity, with the results shown in Table 4 and Figure 13.

Asset rating Gross value of production of the GMA from groundwater	x	Severity of threat Proportion of PAV allocated	x	Sensitivity Relative impact of the threat on the production value	= Risk
5 >$50 million		1 >200%		0.8 Coastal GMAs	
4 20-50 million		0.8 100-200%		0.6 GMAs	
3 10-20 million		0.6 70-100%		0.4 Other GMAs	
2 5-10 million		0.2 <70%			
1 Up to 5 million					

GMA	Asset rating	x Severity	x Sensitivity	= Risk
Corinella	2	0.2	0.6	0.24
Koo Wee Rup	5	0.6	0.6	1.80
Nepean	4	0.8	0.8	2.56
Frankston	3	0.2	0.6	0.36
Moorabbin	4	0.6	0.6	1.44
Wandin Yallock	4	0.8	0.4	1.28
Kinglake	3	0.6	0.4	0.72
Lancefield	2	0.8	0.4	0.64
Cut Paw Paw	1	0.2	0.6	0.12
Deutgam	3	1.0	0.8	2.40
Merrimu	1	0.8	0.4	0.32

Table 4: Assessment of the relative level of risk to the gross economic production values of each GMA from extractions exceeding recharge capacity



WR11 – Pollution

The protection of groundwater quality is important to ensure the water can be used in a variety of ways. However, this can be a difficult task because the impacts of land-based activities on groundwater quality take a while to show up. It can be decades before contamination of groundwater from a source at the surface becomes apparent. Often, by the time groundwater is obviously degraded, the clean-up measures are technically difficult, costly and ineffective in the short term.

It is therefore important to identify potential threats to groundwater quality and sustainability of supply, and to address them with the precautionary principle in mind.

Known threats to groundwater quality include increasing levels of nitrates, pathogens and pesticides. The main sources of nitrates leaching into groundwater are leaking septic tanks and excessive applications of fertiliser in agricultural activities. The main inputs of pathogens are from leaking septic tanks and inappropriate use of wastewater in irrigation practices. Pesticides leaching from perennial pastures can also contaminate groundwater[33].

Groundwater can also be contaminated by other pollutants. Leaks from petrol stations and landfills may be particularly serious.

A risk is also posed to the uses of groundwater by potential increases in salt concentration of the water caused by inappropriate irrigation processes. Over time, the salt concentration may increase each time water percolates to the aquifer[34].

The risk of pollution degrading the value of aquifers and groundwater is considered important across all of the region's GMAs but is particularly serious in the Nepean GMA due to problems with septic tanks.

5.7.3 Objectives

The five Water Objectives (see Section 5.4) have been developed in line with the principles of sustainability, and also address the key risks for aquifers and groundwater.

The high risk in some GMAs of extractions exceeding recharge capacity and thereby reducing economic values is addressed by ensuring efficient management of water resources with minimal new impacts on natural hydrological processes (Objective 1).

The risk of groundwater quality being degraded by pollution and contaminants, and thereby reducing economic and environmental values, is dealt with by progressively improving water quality in aquifers (Objective 4).

The risks of declining quantity and quality of groundwater impacting on environmental values are dealt with by protecting and improving the health of waterways and wetlands (Objective 2) and ensuring the management of water environments improves the health, diversity and resilience of natural ecosystems (Objective 5).

[33] *A users guide to the groudwater risk management package.*
[34] *Groundwater for the future – Groundwater Notes.*

5.7.4 Targets

These Water Targets (WT11 – WT14) are proposed to meet the elements of the five objectives that are directly relevant to aquifers and groundwater.

Target		Relevant objectives
WT11	Levels of extraction from each GMA in the region to be within the permissible annual volume by 2009	WO1, WO2, WO4, WO5

Target		Relevant objectives
WT12	Groundwater levels in key regional aquifers to be stabilised at sustainable levels by 2025	WO1, WO2, WO4, WO5

As an effectively finite resource, it is important that groundwater is used conservatively. Extractions need to be within set limits so that the groundwater levels in the main aquifers of the region are stabilised and sustainable for the long term. Assessment will be required of all of the uses of groundwater, including unlicensed use in urban areas. The scientific understandings underpinning the definition of PAVs also needs continued development.

Target		Relevant objectives
WT13	Progressively increase the average value of production per megalitre of groundwater extracted	WO1

Groundwater should be used productively to achieve optimum economic, social and environmental benefit. It is a valuable resource that, when applied appropriately to its highest value uses, can sustain farms, businesses, recreation opportunities and local communities. It can also significantly offset the use of other water sources and, in turn, enhance environmental flows in waterways and wetlands. Continual advances in technology and techniques for using and conserving groundwater will be important.

Target		Relevant objectives
WT14	All groundwater monitoring sites to attain State environmental protection policy objectives or regional targets by 2030	WO2, WO4, WO5

The quality of groundwater in this region enables a range of environmental benefits and consumptive uses. Groundwater quality targets for various parameters are outlined in the State environmental protection policy (Groundwater), and specific regional targets will also be developed and included in a regional water quality plan. Inherent in this action is the restoration of groundwater quality in aquifers that are currently polluted.

5.7.5 Actions

The following Water Actions (WA19 – WA27) have been developed to meet the four targets relating to aquifers and groundwater.

Groundwater management arrangements

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA19	Clarify the organisational arrangements for the management of aquifers and groundwater in this region	WT11, WT12, WT14	2006	DSE	SRW, CMA, EPA, MW	Low

There is a need to clarify the organisational arrangements for aquifer and groundwater management in this region, possibly as part of a statewide process.

While the recent Water White Paper Securing Our Water Future Together has established Melbourne Water as the "caretaker of river health" in this region, there would be advantages in designating an organisation with comparative responsibility for our aquifers and the valuable groundwater they contain. That is, an organisation should be designated the role of "caretaker of aquifer health" and be responsible for coordinating planning and actions to protect groundwater quality and ensure sustainable groundwater supply.

In the meantime, a number of the following actions are proposed to be lead by the Department of Sustainability and Environment (DSE) until such time that a caretaker of aquifer health is determined.

Research and knowledge

There is an important link between groundwater and surface water flows. Many rivers and streams receive inflows from groundwater that assist in the maintenance of their health. We must improve our limited understanding of the interaction between groundwater and surface water and the processes that threaten sustainable and beneficial water uses. A thorough understanding of these relationships will enable the development of catchment-based water budgets, particularly for the catchments of stressed rivers.

Note: A specific action (WA15) to investigate and quantify the hydrological and ecological relationships between groundwater and surface waters is included in Section 5.6 – Surface Waters, Rivers and Streams.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA20	Further develop the regional risk assessment model to identify the level of risk facing groundwater assets.	WT11, WT12, WT14	2006	CMA	SRW, DSE, EPA, MW	Low

An enhanced risk assessment model is necessary to assist regional land and water managers identify the most likely circumstances or locations where groundwater quantity and/or quality could be compromised, thereby guiding investment. The risk assessment should also identify gaps in the science and other knowledge used to manage groundwater allocations.

Strategic planning for groundwater use

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA21	Complete Groundwater Management Plans for all GMAs with allocations that approach or exceed their permissible annual volume.	WT11, WT12	2009	DSE and Consultative Committees	SRW, CMA, MW, Ground water user groups	Medium

Currently, the volumes allowed by licenses exceed PAVs in five of the region's 12 GMAs - by a substantial amount at Deutgam.

Groundwater management plans are an appropriate planning mechanism for managing the diversion of water from aquifers when extractions approach or exceed the sustainable limits. For GMAs where the licensed allocations are between 70 - 100% of the PAV, in order to optimise benefits these plans must restrict additional allocations being licensed but enable temporary and permanent trading of individual allocations. For areas where the allocations are already more than 100% of the PAV, the plans must also provide a mechanism for sustainable management. This may include the clawback of licensed allocations, the introduction of restrictions on usage, the development of cost-sharing principles and the identification of alternate supplies such as recycled water. The plans are initiated by the Minister for Water through the Department of Sustainability and Environment, drafted by Ministerially-appointed Consultative Committees, then approved by the Minister.

Associated with the groundwater management planning is the need to develop guidelines for the artificial recharge of aquifers. This process, though largely untried here at present, is nearing reality. There is a need to assess the potential impact of this activity before it occurs and develop appropriate guidelines to ensure the environmental, social and economic benefits of the aquifer are not adversely affected.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA22	Assess the practices and efficiency of groundwater use in GMAs, and develop strategies to achieve higher efficiency and sustainable use of groundwater.	WT13	2006	DPI	SRW, Agricultural industries	Low

To achieve improved conservation of, and productivity from, groundwater, better understanding is needed about who the users of groundwater are, how much water they use, in what ways and why. The data would be used to measure changes in groundwater use over time and to set benchmarks for best practice comparisons. This information should then inform policies and strategies, including regulatory and market mechanisms, that will gradually move groundwater use to higher value practices and achieve increased production from less water.

Strategic planning for groundwater quality

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA23	Develop and implement groundwater quality management plans for GMAs with a high level of risk to groundwater quality	WT14	Develop plan for Nepean GMA by 2006	DSE	SRW, EPA, Local government, DSE, MW, CMA, Retail Water authorities	Medium

The risk to groundwater quality within the Nepean GMA, mainly from failing septic tanks and salt water intrusion, is recognised as being particularly serious[35], and leaking septic tanks are also an issue for groundwater and surface waters in various other parts of the region. In order to protect this important water supply, there is an urgent need to develop and implement a groundwater quality management plan. The plan needs to look at all options for protecting and improving groundwater quality including accelerating, where possible, the backlog sewerage program. This planning process should be undertaken as a pilot study and assessed for its applicability to other GMAs where the level of risk to groundwater quality is high from failing septic tanks (which is a serious issue at various areas across the region), contaminated sites, leaking landfill, etc.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA24	Develop guidelines and codes of practice for the management of risks to groundwater quality, and undertake programs with relevant land and water managers	WT14	2006	DSE	EPA, SRW, DPI, MW, Local government, Water authorities	Medium

There is a great deal of information about activities and situations that are most likely to threaten the region's groundwater, including leaking septic tanks, and about measures for reducing the risk. This information should be consolidated and made readily available to better advise and educate relevant land and water managers.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA25	In the local governments that contain GMAs, develop planning scheme guidelines/regulations to protect groundwater quality.	WT14	2006	DSE	Local government, EPA, SRW, MW	Medium

Local government has an important role in the protection of aquifers and groundwater due to the potential impact of urban development on groundwater. Guidance for local government from groundwater specialists is important to better inform planning and development decisions for effective protection of groundwater quality.

[35] *Nepean Peninsula Groundwater Study Report.*

Monitoring

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA26	Meter all significant existing groundwater extractions used for commercial and irrigation purposes and all new licenses, and monitor groundwater levels within key aquifers to assess trends in relation to sustainable levels.	WT11, WT12	2007	SRW	DSE, MW	Medium

In this region there are in the order of 1,000 commercial and irrigation licences, of which only around 600 are currently metered. To ensure that significant individual licences are not exceeded and that overall management of the total resource is effective, it is important to implement the proposed requirement in Victoria for metering of all significant existing groundwater extractions and all new licences.

The cumulative impacts of the extractions on groundwater levels within aquifers must also be monitored to better understand sustainable yields, review PAVs and guide future policy and management directions.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA27	Develop and implement a comprehensive regional ground water quality monitoring and evaluation program	WT14	2006	EPA	SRW, CMA, DSE	Medium

Groundwater resource managers monitor groundwater quality where it is affected by extraction but overall monitoring and evaluation of groundwater quality in the region is limited. Consequently, little record exists of what is happening to groundwater quality over time and there is no objective process for determining priorities for addressing groundwater quality issues. This also contributes to a relatively low level of awareness of the impacts of land-based activities on groundwater quality. A comprehensive and coordinated regional groundwater quality monitoring program is therefore required.

5.8 Wetlands

5.8.1 Overview

Wetlands are among the world's most ecologically diverse and valuable environments. They support an array of natural ecosystems and species and are key links in processes such as fish and bird breeding, water quality maintenance and flood protection. They also provide recreational opportunities and are important historical and landscape features.

The Port Phillip and Western Port region has more than 900 wetlands greater than one hectare in size, including the tidal flats of Western Port, with a combined area of more than 40,000 hectares. Seven major wetland types are represented in the region (see Table 5).

The region contains wetlands of international importance including sites at Edithvale-Seaford, Western Port and on the western shoreline of Port Phillip Bay that are listed under the Ramsar convention for the international protection of wetlands. In addition, wetlands at Laverton Saltworks and Werribee-Avalon are listed in the National Directory of Important Wetlands.

Wetland type	No:	Original area (ha in 1750)[36]	Current area (ha)[37]	Proportion remaining (%)	Examples
Natural wetlands					
Freshwater meadows	109	880	912	104	Carrum Carrum Swamp
Shallow freshwater marshes	51	5,372	825	15	Boneo Swamp, Jensz Swamp
Deep freshwater marshes	72	51,180	470	1	Rhyll Swamp, Swan Lake
Semi-permanent saline wetlands	57	4452	2,813	86	Truganina Swamp, Corinella Saltmarsh
Permanent saline wetlands	11	24,644	26,701	107	Cheetham Wetlands and Western Port
Sub Total	300	86,528	31,721	37	
Constructed wetlands					
Permanent Open freshwater	597		7,080		Pykes Creek Reservoir
Sewage Ponds	31		1,878		Werribee and Drouin Sewage Treatment Ponds.
Sub Total	628		8,958		

Table 5: Summary analysis of the region's wetlands.

Nearly two thirds of the region's natural wetlands have been lost due to draining, filling and other modification. The extent of the region's deep-water marshes has decreased significantly due to the draining of the Koo Wee Rup Swamp. The draining of the Carrum Carrum Swamp has had a similar effect on the extent of shallow fresh-water marsh wetland systems in the region.

Human activity has also been responsible for new wetland environments created through the construction of reservoirs, storm water treatment ponds and sewerage treatment plants which now provide around 22 per cent of the region's wetland coverage. The Western Treatment Plant at Werribee is recognised for its importance as bird habitat and is part of one of the region's Ramsar sites.

[36] *Wetlands extent pior to European settlement (GIS Layer)*
[37] *Current wetlands environment and extent (GIS Layer)*

5.8.2 Values of wetlands

Environmental values

Wetlands are important as habitat for animal taxa at stages of their life cycle and provide refuge in times of drought. They are vital feeding grounds and nurseries for many land, marine and freshwater animals. They store and supply critical components of the natural food chains for rivers and inshore waters. Hundreds of bird species depend on the region's wetlands for all or part of their annual life cycles. Migratory birds travel to Port Phillip Bay and Western Port wetlands from as far away as Alaska, Siberia, China and Japan. Table 6 identifies the wetlands in the region that have been recognised as wetlands of international and/or national environmental importance.

Hundreds of bird species depend on the region's wetlands for all or part of their annual life cycles

The ability of wetlands to capture nutrient and sediment loads in urban stormwater and the need to protect their biological functions has made them an important part of the work to protect water quality in Port Phillip Bay and Western Port. Among actions to improve the quality of stormwater discharging from Melbourne's south-eastern growth corridor is the construction of 10 wetlands to treat stormwater run-off in the cities of Casey, Greater Dandenong and Kingston. Constructed wetlands are also planned or have been completed in other parts of Melbourne and in the Western Port catchment. Wetlands also have important functions as groundwater discharge and recharge areas. Their potential benefits in both improving surface run-off quality for surface and ground water storage and later re-use has not yet been explored at any significant scale in the region.

Status	Sites in Port Phillip and Western Port region
Wetlands of international importance (Ramsar sites) listed under the Convention on Wetlands (Ramsar, 1971)	Western Port Ramsar site Edithvale-Seaford Wetlands Ramsar site Components of the Port Phillip (Western Shoreline) and Bellarine Peninsula Ramsar site at Point Cook Werribee, The Spit and Mud Islands
Sites included on the East Asian-Australian Shorebird Network	Western Port Shorebird site Components of the Port Phillip (Western Shoreline) and Bellarine Peninsula Shorebird site at Point Cook Werribee, The Spit and Mud Islands.
Areas of International and National Importance for Shorebirds identified in a National Plan for Shorebird Conservation in Australia[38]	Western Port, Seaford Swamp, Werribee, Altona, Laverton (Cheetham) Saltworks, Mud Islands,
A Directory of Wetlands of National Importance in Australia	Western Port, Edithvale-Seaford, Mud Islands, Werribee, Altona, Laverton (Cheetham) Saltworks, Point Cook, Lerderderg River (heritage component),Yarra River (heritage component)

Table 6: Wetlands status in the Port Phillip and Western Port Region

[38] *A national Plan for Shorebird Conservation in Australia*

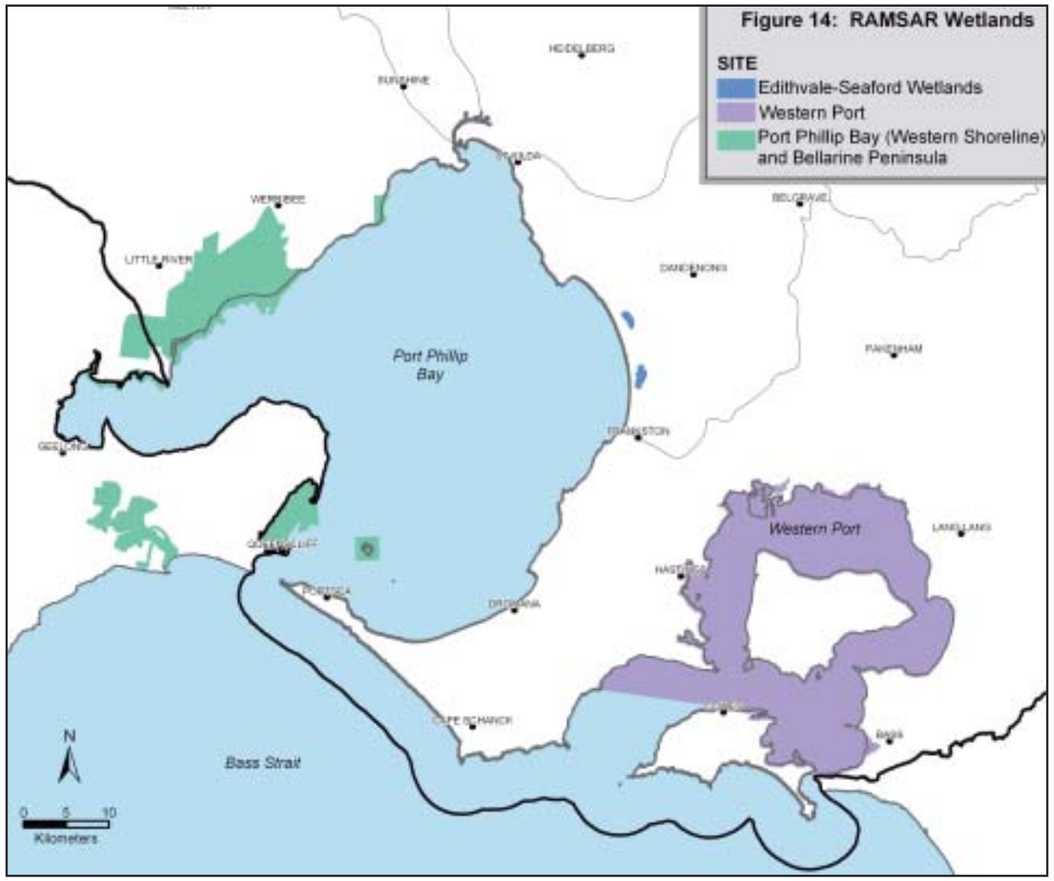


Figure 14: RAMSAR Wetlands

Economic values

Wetlands have important economic values in urban and rural areas in reducing flood damage by storing floodwaters and retarding peak flows. For example, the remaining parts of the Edithvale-Seaford wetlands are critical parts of Melbourne's flood management schemes for the south and south-eastern suburbs. Some of Melbourne's existing network of flood retarding basins have also been earmarked for redevelopment as constructed wetlands to add environmental and social values to their flood management functions. Wetlands serve as nurseries for recreational and commercial fish species and the associated species that support them.

Social values

Wetlands have many cultural and social values. Natural wetlands are an important component of Aboriginal cultural heritage and are regarded as sites of spiritual importance. Social values of both constructed and natural wetlands include landscape and aesthetics, recreational (such as water sports, fishing) and educational (nature observation). Due to an increasing recognition of the values provided by wetlands, many new housing estates are including construction of wetlands as integral parts of developments for their landscape, recreation and environmental benefits, and these have become important parts of the region's network of parks and recreation areas.

5.8.3 Risks to wetlands

The following risks are incrementally diminishing the number, size and quality of the region's wetlands.

WR12 – Loss of wetlands from changes in land use

High protection status is provided for Ramsar wetlands and those in State and regional parks or areas dedicated to water supply or effluent treatment. However, these represent only a small number of the region's wetlands and little emphasis is currently placed on monitoring and protecting wetlands on private land, particularly shallow wetlands.

Remnant wetlands on private land, often already degraded by land clearing and partial drainage, are often drained and filled in when urban development occurs or when rural land that is permanently or intermittently waterlogged is used for more intensive agricultural production.

WR13 – Changes to water regimes

The conversion of the region's catchments to agricultural and urban land use with high and rapid runoff rates has also changed the volumes, timing and frequency of flows to wetlands, altered their wetting and drying duration and seasons and, for coastal wetlands, altered their cycles of salt and fresh water flows.

The health of floodplain wetlands is intrinsically tied to the floods and droughts on their adjacent rivers and streams. These wetting and drying cycles have been significantly altered by river regulation and the loss of large and medium river floods due to dams and storages.

WR14 – Sediments and toxicants

The input of sediments and toxicants from inflows is a major issue for natural and constructed wetlands. The capacity and quality of reservoirs in the north west of the catchment (such as Melton and Rosslynne reservoirs) are threatened by sediment inflows while around one-third of sampled metropolitan wetlands show elevated levels of heavy metals in sediments[39].

While constructed wetlands are partly designed to capture sediments and pollutants, their biological functions and other social and environmental values need to be protected by capturing pollutants at their source.

[39] *Toxicants in Melbourne's streams and wetlands: an emerging threat to healthy waterways.*

5.8.4 Objectives for wetlands

The five Water Objectives (see Section 5.4) have been developed in line with the principles of sustainability and also address the most important risks for wetlands.

The high risk to wetlands posed by land use change is addressed by protecting and improving the health of wetlands (Objective WO2). The risks posed by changes to water regimes is addressed by ensuring efficient management of water resources with minimal new impacts on natural hydrological processes (Objective WO1). The risk of wetlands being degraded by pollution and contaminants, and thereby reducing economic and environmental values, is dealt with by progressively improving water quality in the regions waterways, which includes the management of stormwater (Objective WO4).

5.8.5 Targets for wetlands

These Water Targets (WT15 – WT16) are proposed to meet the elements of the five objectives that are directly relevant to wetlands. Wetlands will also greatly benefit from management actions to address the key risks that face surface water, bays and coasts.

Target		Relevant objectives
WT15	No net loss in the extent and health of wetlands of each existing type	WO2, WO5

Target		Relevant objectives
WT16	Progressively improve the overall health and social value of natural wetlands, including those that are nationally and internationally recognised	WO2, WO4, WO5

As indicated, natural wetlands in the region have generally decreased in number, extent and health. We need to protect and enhance the extent and diversity of what is left. To do this, we need to understand the elements of wetland ecology that make the wetlands healthy, including the volumes and frequency of flows, water quality, vegetation cover and diversity of species. And we must seek to put in place programs to address these elements.

The region retains some valuable and significant wetlands including some that are internationally recognised, and it is particularly important to protect and maintain these. As well as ensuring no net loss in the extent and health of wetlands in the region, there is a need to protect and enhance depleted ecological vegetation classes that exist in wetland environments.

Measuring achievement of this target will require development of an Index of Wetland Condition (see Action WA 28). This would likely be similar in concept to the Index of Stream Condition that is now applied across Victoria as a consistent approach to measuring the condition of waterways.

5.8.6 Actions for wetlands

These Water Actions for wetlands (WA28 – WA32) focus on implementing existing Strategic Wetland Management Plans for Ramsar wetlands. They aim to develop a greater understanding of wetland ecosystems and to incorporate the principle of wetland protection into land management policies and activities in the region.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA28	Develop and apply an Index of Wetland Condition method to determine the overall health of wetlands in the region and establish a benchmark to measure change into the future	WT15, WT16	2006	DSE	Parks Victoria, CMA, MW, EPA, Local government	Medium

A critical issue for managing complex ecosystems such as wetlands is to have in place a robust and nationally accepted method of assessing the condition of wetlands. Such a methodology is being developed by the Commonwealth and State Governments and is expected to be available in 2005.

Some wetlands, including those listed under the Ramsar convention or in the National directory of important wetlands, have been assessed and prioritised for their values and protection needs. However, most of the region's 900 wetlands have been mapped but not categorised to determine their relative importance or what the aims of conserving them might be. This makes it difficult to effectively prioritise actions, allocate funding or appropriately share the cost of works with private landholders.

Establishing the existing condition of the region's wetlands will enable risk assessment, and will underpin the development of a regional Wetland Plan identifying priorities for on-ground action.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA29	Consolidate and distribute data on regional wetlands to relevant stakeholders including local government, landholders and Kulin people.	WT15, WT16	2006	DSE	Local government MW, CMA, landholders	Low

Some data on the location, type, vegetation and native fauna of wetlands in the region is available but is not consolidated or readily available. As well as important environmental and water quality benefits, natural wetlands often contain Indigenous heritage sites. A region-wide inventory of wetlands on private and public land with information on condition and trends would therefore be useful. The consolidation and distribution of wetland information would enable local government, landholders and others to better plan for and manage these assets. Information on appropriate management techniques and assistance programs would also be valuable.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA30	Develop a Regional Wetland Plan to establish and implement priorities for investment.	WT15, WT16	2007	CMA	Parks Victoria, DSE, MW	Medium

Our activities often have an impact on the health of wetlands, especially activities including vegetation clearing, recreational boating and fishing, introducing pest plants and animals and fire. People's lack of awareness of wetlands and their susceptibility to our activities are often contributing factors to decline in wetland health.

A regional wetland plan is required that addresses the values of wetlands and the risks to them. It should also include consideration of flow requirements and natural flooding. It should also consider the current level of community awareness of, and attitudes to wetlands, opportunities for enhancing values and reducing threats, opportunities for building new wetlands and cost sharing arrangements including possible incentive programs for the management of wetlands on private land. Incorporating this into major, landscape-scale projects in the Western Port and Dandenong catchments should be explored as a way of generating new funding for this work, as discussed in Action PA10 in Chapter 8 on People and Organisations.

New, constructed wetlands can play important roles as silt traps and water retarding basins. However, an increased emphasis should also be placed on creating native vegetation at these new environmental assets to create refuge and habitat for native fish and other fauna. The monitoring of water quality at constructed wetlands, including in urban areas, will require consideration.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA31	Develop planning policy and protocols that contribute to the protection of wetlands, and incorporate them in relevant planning schemes	WT15, WT16	2007	DSE	Local government, MW, CMA, EPA	Low

Protecting the remaining wetlands within the urban areas of the region and those in the designated urban growth corridors requires strong partnerships with local governments. This will ensure that stormwater management and design of new urban areas take account of the needs of wetlands and the value that these wetlands can provide to residents.

The development of management practices that will incorporate wetlands into urban design will be important to manage the risk posed by urban development to environmental values and downstream water quality. Other tools for protection include placing conservation covenants on them, or purchase through the National Reserve System via Trust For Nature's revolving fund.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA32	Implement existing Wetland Management Plans for all three Ramsar wetland areas in the region (Port Phillip – Western Shoreline, Western Port and Edithvale-Seaford)	WT16	2008	MW, Parks Victoria	DSE	High

Strategic management plans [40,41], exist for nationally and internationally significant wetlands, including Ramsar plans, and should be implemented to protect and enhance these valuable catchment assets. Discussions between agencies including Parks Victoria and Melbourne Water will be important to identify catchment-based threats to these wetlands and determine how these threats can be cooperatively managed.

[40] *Western Port Ramsar: Startegic Management Plan*
[41] *Port Phillip Bay (Western Shorline) and Bellarine Peninsula Rumsar Site: Strategic Management Plan*

5.9 Coasts

5.9.1 Overview

The Port Phillip and Western Port region has 600 kilometres of outstanding coastal landscapes bordering the two iconic bays and Bass Strait. Port Phillip Heads, Point Nepean, the bay beaches and foreshores, Bass Strait surf beaches, French Island and Phillip Island provide a wide range of natural and cultural assets and are the most accessible parts of the region's coasts.

The proximity of these areas to metropolitan Melbourne ensures they are popular for visits and are highly used. The emerging popularity of a "seachange" lifestyle is bringing more people to the coast as permanent residents. This high and growing demand on our coasts will increase the pressures on the coastal resources and amenity.

The coast, in its strictest definition, is the interface of the land and sea including foreshore and beach areas. Though this is often a narrow strip of land, coasts are dynamic ecosystems influenced by marine processes and by various aspects of the natural and built environment above the high water mark.

The region's coasts encompasses a diverse range of vegetation communities and geological landforms, built environments and managed open space, providing substantial environmental, economic and social benefits to the region and to Victoria.

The emerging popularity of a "seachange" lifestyle is bringing more people to the coast as permanent residents.

5.9.2 Values of coasts

Environmental values

The biological and geological elements of the coastal environments of the Port Phillip and Western Port region are a feature of these populous and popular areas. The region's coasts support a range of flora and fauna, with some of the region's most fragile and threatened flora and fauna found along the coastal strips. More than 50 of the region's ecological vegetation classes occur within two kilometres of the coast, with 27 of these listed as endangered in at least one of the three coastal bioregions[42] (Gippsland, Otway and Victorian Volcanic Plains). Among these EVCs is the 'Coastal Moonah Woodland', a floristic community listed as threatened under the Flora and Fauna Guarantee Act 1988. However, little of the original vegetation that once occupied the foreshore remains.

The environmental significance of the coast has been recognised through the creation of reserves such as National Parks, the declaration of Ramsar wetlands and more recently the recognition of the Mornington Peninsula and Western Port Biosphere Reserve. The coastal areas contain examples of all eight of Victoria's wetland types and provide important habitat for 14 nationally and internationally recognised shorebird species[43]. The inter-tidal zone contains reef systems that provide many important habitat and marine nursery areas.

Social values

Highly valued for their contributions to our lifestyles and industries, the coasts are sought for residential living as well as underpinning much of the region's recreation and tourism activity.

The coasts provide significant recreational values, with the Victorian Coastal Council's survey of coastal use in 2001 finding that the Victorian coast sustains more than 70 million visits annually[44] (this figure does not include trips under two hours duration), many of which occur in the region. The range of recreational activities includes swimming, surfing, sailing, fishing and walking. Figure 15 illustrates the spatial distribution of the recreational value of coasts.

[42] *Draft Port Phillip and Western Port Native Vegetation Plan*
[43] *A National Plan of Shorebird Conservation in Australia*
[44] *Market Research Report: Victorian Coastal and Marine Research, Wave 2*

Utilisation by the region's Indigenous people of the coast's productivity and abundance of wildlife resulted in many important cultural values, particularly relating to coastal landscapes and biodiversity[45]. Indigenous relationships with coastal and marine environments stretch back many thousands of years and are reflected in the cultural sites present along Victoria's coast and in this region. These sites, which include shell middens and camping places, date back as far as 6,000 years which is when the sea rose to its present level. Access for Indigenous people to these resources for cultural purposes remains a key challenge given the impacts of development on the coast.

Economic values

The region's coasts provide substantial economic value, particularly in and around Melbourne. Both bays support commercial fisheries and both are home to operating ports of international significance. The region's excellent coastal amenity and resulting recreation and tourism operations depend on natural coastal assets such as beaches, biodiversity, water quality and aesthetic values. The economic value of the coasts in terms of recreation was estimated in 1997 at $140 million per year[46].

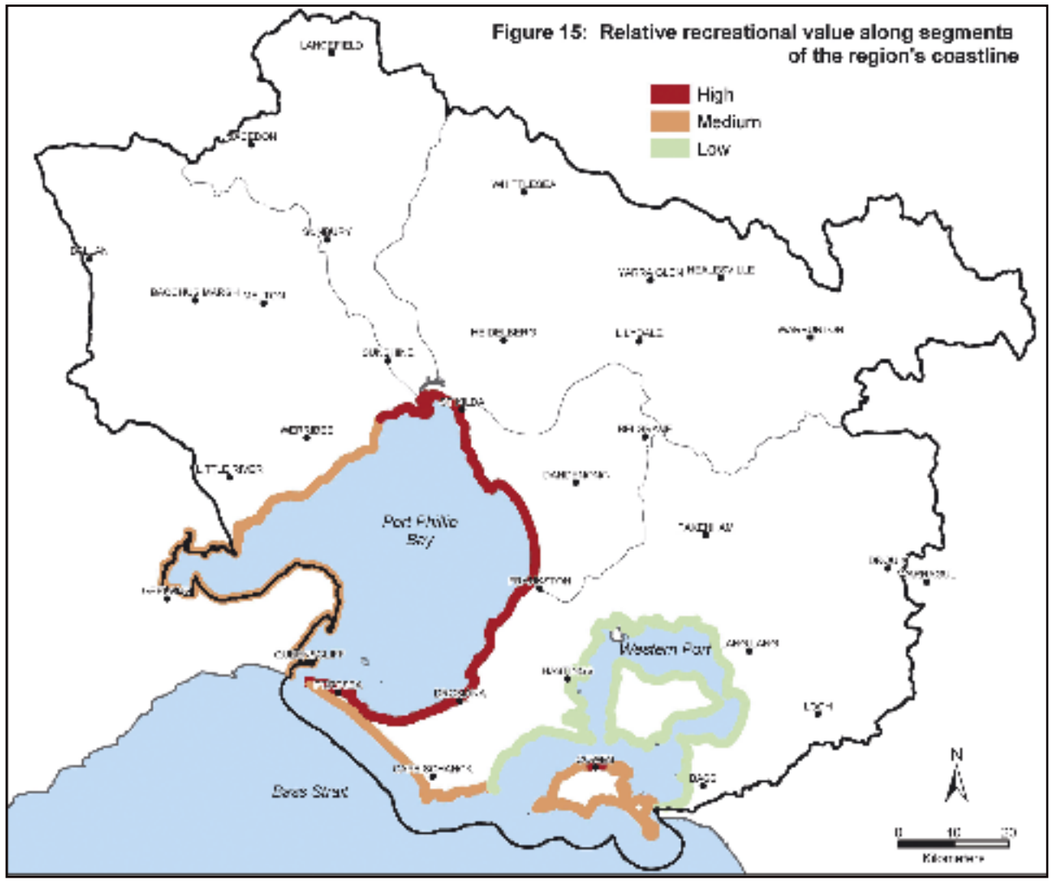


Figure 15: Relative recreational value along segments of the region's coastline

[45] *Aboriginal occupation of the Melbourne Area, District 2A*
[46] *Risk assessment framework and outputs for Port Phillip and Western Port Region*

5.9.3 Key risks to coastal values

In terms of coastal values, the popularity of the coastal zone provides both risks and opportunities. Often, increasing the value that one use bestows on coasts (for example, urban and residential development) decreases other values (for example, coastal areas for recreation and habitat). Achieving a balance between these values requires triple bottom line decision-making processes, and involves some significant risks.

WR15 – Coastal uses that compromise other values

The popularity of coasts continues to increase, with opportunities for both development and recreation on the coastal fringe being highly sought after. The very high demand for coastal living and recreation opportunities, and the resulting scale of development and use, threatens the ability of some coastal systems to adapt and respond. There is increasing pressure for residential, access, boating, car parking, tourism and uses in highly sensitive coastal settings. Development poses particular threats to landscape, biodiversity and amenity values. Inappropriate development also impacts on other values such as water quality, notably through stormwater and urban run-off.

Inappropriate access by vehicle and pedestrian traffic also threatens many coastal values. Impacts include erosion, degraded habitat and displacement of the associated native animal species.

This risk of further loss of value is high, due to the increasing popularity of the coast and a recognised need for additional infrastructure. The areas of greatest risk are those zones where ecosystems are largely undisturbed, predominantly around the Mornington Peninsula and Bass Coast.

WR16 – Increased rates of coastal erosion

Changing rates of coastal processes, such as erosion and deposition, also pose significant threats to coastal values. Erosion and sedimentation caused by both natural and human activities threatens the ongoing viability of recreation and tourism by diminishing access to beaches and threatening safety, indigenous relics and infrastructure.

There is increasing pressure for residential, access, boating, car parking, tourism and other development in highly sensitive coastal settings

Increased erosion and the presence of hard structures can also have a direct impact on biodiversity values through habitat fragmentation, with impacts also occurring as a result of sediment smothering aquatic habitat. Particular examples in the region include clay cliff erosion on Western Port's eastern shore and beach erosion in Port Phillip Bay which have been outlined in a Beaches at Risk report.

This risk is expected to increase if climate change forecasts are realised.

WR17 – Pest plants and animals

Pest plants and animals pose a major risk to coastal remnant vegetation and associated biodiversity values. There are few areas of the coastal zone unaffected by pests. Garden escapees threaten indigenous vegetation in many areas while foxes, dogs and cats threaten a range of coastal flora and fauna through predation and displacement. The impact of pests on biodiversity values also affects tourism and recreation values.

WR18 – Inundation

Global climate change predictions suggest a rise in sea levels, which will threaten many coastal values in low-lying areas including infrastructure, remnants of indigenous habitat and recreational amenity through increased erosion. Impacts from storm surges and increased intensity and/or frequency of storm events may be a key concern. Habitat fragmentation is also likely to occur with the area available for habitats being reduced because of the existence of hard structures such as roads. The risk of inundation is high in several areas, particularly saltmarsh habitats in Western Port.

WR19 – Litter

Litter is a highly visible pollutant that finds its way to beaches largely through waterways, but also from shipping. Litter threatens recreational and tourism values through its impact on amenity, and places a significant financial burden on local government to maintain substantial beach cleaning programs for key recreational beaches. It also poses many risks to wildlife such as discarded fishing line entangling birds and fauna being entrapped in plastic mesh. The risk of litter being transported to the coast is exacerbated during storm events, when volumes of run-off increase.

WR20 – Nutrients and other pollutants

Nutrient threats generally originate in the catchments and have predominantly marine impacts, however these can also threaten coastal values. Similarly, toxicants, suspended solids and seepage from septic systems can threaten particular areas of coasts

WR21 – Oil spills

There is a high volume of shipping in this region and although programs are in place to prevent oil spills, there remains a risk of oil pollution. While oil spills will generally occur in the marine environment they have coastal impacts when oil contacts the shoreline adversely, affecting tourism and recreation values, and on biodiversity. Depending on spill scenarios, clean-up can be very costly, so the economic impacts can also be significant.

The physical characteristics of Western Port mean an oil spill may not be effectively contained in some common tidal conditions and oil would be quickly dispersed throughout the marine and coastal environment.

WR22 – Coastal acid sulphate soils

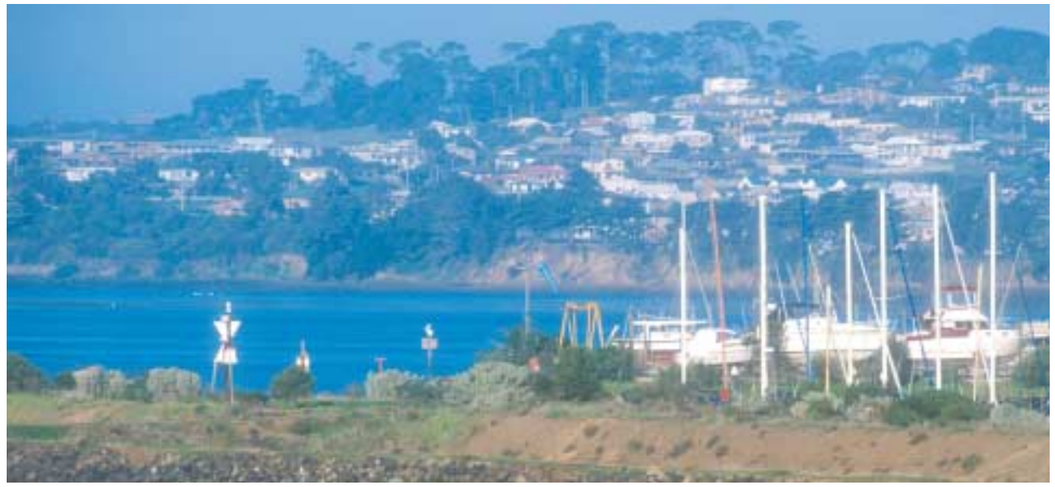
The region contains the majority of Victoria's coastal acid sulphate soils (CASS) [47]. Disturbing these soils and exposing them to air can cause the production of sulphuric acid affecting land, biodiversity and water values. Future urban and infrastructure development needs to recognise the constraints associated with CASS, as the future costs of ameliorating impacts would be significant. The risk posed by CASS is high due to a general lack of awareness of their presence and potential impacts.

WR23– Deliberate loss of coastal vegetation

Coastal vegetation provides important habitat and aesthetic values, and exists primarily on coastal Crown land. Historically, there has been a cumulative loss of native vegetation along the coast, mainly for residential, industrial, tourism and recreational opportunities. In recent years, some areas of coastal vegetation have been subject to deliberate clearing and damage, often for maintaining or creating views and for convenient coastal access. The deliberate loss of coastal vegetation provides a significant risk to coastal values, and is particularly important where the remnant vegetation occurs in small or fragmented areas and where the vegetation comprises ecologically significant systems such as saltmarsh and mangroves.

WR24 – Threats to inter-tidal areas

The region contains an array of inter-tidal areas that provide important habitat, fishing and recreational opportunities. While some of these areas are protected, others are subject to intense pedestrian traffic and harvesting activities. The risks to these systems can be magnified when water circulation is limited or when they are in close proximity to urban influences such as stormwater.



[47] *Acid Sulphate Soil Hazard Maps: guidelines for coastal Victoria*

5.9.4 Objectives for coasts

The five objectives (see Section 5.4) for the region's water-based assets have been developed in line with the principles of sustainability, but also address the key risks for coasts.

The risk to coastal values posed by land use change is addressed by ensuring that the management of coasts improves the health, diversity and resilience of natural ecosystems (Water Objective 5).

The risks posed by acid sulphate soils, erosion, pest plants and animals and inundation are addressed by protecting and improving the health of coastal systems (Water Objective 3).

The risks posed to coasts by pollutants such as oil, litter and excess nutrients are addressed by protecting and improving the health of coastal systems (Water Objective 3) and by progressively improving water quality (Water Objective 4).

5.9.5 Targets

Water Targets (WT17 – WT20) are proposed to meet the elements of the six objectives that are directly relevant to coasts. The targets are a way of measuring both the protection of the key environmental, economic and social values of coasts, and the management of the major risks to those values. Environmental values will be enhanced through achievement of the targets relating to native vegetation, litter reduction and beach health. Social values will be enhanced through achievement of the targets relating to Indigenous cultural heritage, public accessibility and beach health targets. Achievement of the environmental and social targets underpins the capability of coasts to provide economic values.

Target		Relevant objectives
WT17	**Reduce the proportion of coast in the region where environmental values, recreational beaches, Indigenous cultural values and public infrastructure are at high risk from accelerated coastal erosion and other degrading**	**WO1, WO3, WO5**

Erosion is an integral part of the normal biological and physical processes for the region's dynamic coastal environments. However, accelerated coastal erosion is an important issue for a number of coastal sites and beaches here, with major threats to social and recreational values along with public risk issues being identified at 20 of our major recreational beaches [48]. Coastal biological diversity, heritage and Indigenous cultural values are also at risk at some of these sites.

There is a need to broaden the assessment of coasts to cover the whole region, assess their current state as a benchmark, determine the level of risk to the coast's values from various processes, and then revise Target WT17 to quantify it and make it timebound.

[48] *Beaches at risk report*

Target		Relevant objectives
WT18	A net gain in the extent and quality of native coastal vegetation, as measured by habitat hectares	WO3, WO5

Coastal vegetation is very important due to its role in protecting the environmental, social and economic values that occur at this dynamic land-sea interface. The protection of coastal ecological vegetation classes therefore makes an important contribution to maintaining coasts in good condition. While native coastal vegetation provides multiple benefits, non-indigenous vegetation can also be valuable in protecting highly-visited coastal areas.

Target WT18 focuses on increasing the extent and quality of native vegetation on coasts and recognises that the coastal fringe in this region contains some of our most sensitive and degraded native vegetation types. The Regional Native Vegetation Plan will specify targets for each of the region's ecological vegetation classes, including those that occur along our coasts. Meeting these targets will require protecting some areas plus revegetating others. Ongoing assessment will be required to assess the habitat hectares of our coastal vegetation, which is a combined measure of both its extent and quality, with a view to progressively increasing the total habitat hectares in the coastal areas.

Target		Relevant objectives
WT19	Public access to the region's beaches and bays maintained	WO5

One of the main reasons for coasts being highly valued is their accessibility to the public. This target seeks to maintain the ability of the public to access and enjoy many areas of beach and bay in this region where other values are not diminished or compromised. An associated issue is managing the sites of access so that coastal values are protected.

Target		Relevant objectives
WT20	The number of days that beaches are classified unsuitable for swimming reduced to zero by 2010	WO4

Personal contact with the waters of the bays is the basis of many social and economic activities. Achieving standards of water and beach quality that ensure beaches are suitable for swimming will support these values and is an indicator of how well we are managing our catchments.

5.9.6 Actions

These Water Actions (WA33 – WA40) have been developed to meet the coastal targets.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA33	Investigate, assess and manage accelerated coastal erosion and other degrading processes at high value sites where recreational, heritage, Indigenous culture, environmental values and public infrastructure are at risk	WT17	Risk assessment by 2006 Begin to implement	DSE	CCB, local government, Committees of Management	High

Addressing coastal issues at priority sites, including beaches at risk from accelerated coastal erosion, is a key component of protecting and maintaining the values of the region's coasts.

Building on the work undertaken to prepare the Beaches at Risk report, this action requires further identification of sites across the region where environmental, social, Indigenous culture and public infrastructure values are at risk from coastal erosion, longer-term climate change and other degrading processes.

Programs then need to be developed and implemented to maintain normal biological and physical processes, whilst recognising the dynamic nature of coasts and beaches and accommodating the needs for public infrastructure, use and access.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA34	Communicate the requirements of contingency plans for oil spills to all relevant stakeholders	WT17, WT20	On-going	Marine Safety Victoria	Port authorities, EPA	Low

Oil spills are a major risk to coastal values, and demand an on-going and vigilant effort by appropriate authorities, including communication with relevant stakeholders, is required.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA35	Map areas susceptible to inundation in Port Phillip Bay and Western Port	WT17, WT18	2006	DSE	CCB, MW, Port authorities, local government	Medium

Not enough is known or understood about the threat of inundation addressed in this action, though it is recognised that climate change and the subsequent inundation represent a major risk to all coastal values.

While managing the threat of climate change requires coordinated national and international efforts, it is possible for the Port Phillip and Western Port region to mitigate some of the potential impacts. To do this, we need to understand where inundation might occur and to develop strategies for adaptation. To a lesser extent, changes to the Port Phillip Bay's shipping channels could also affect the region's susceptibility to inundation, and we need to understand the potential impact.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA36	Map the occurrence of coastal acid sulphate soils and develop overlays for inclusion in relevant planning schemes	WT17, WT18	2009	DSE	CCB, Local Government, DPI, EPA	Low

Not enough is known or understood about the threat of acid sulphate soils addressed in this action. Disturbance of coastal acid sulphate soils is an emerging but manageable risk. We particularly need to understand the distribution of the soils and ensure that the information is available to local government planners for inclusion in planning schemes.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA37	Develop and implement plans to increase the extent and quality of coastal ecological vegetation classes	WT18	2009	DSE	DPI, CMA, CCB, Parks Victoria, Local Government, Committees of Management	Medium

The protection and enhancement of native vegetation is crucial in maintaining the overall health of the region's coasts. This includes the management of impacts from weed infestations, pest animals, erosion and vandalism. Particular attention is required for the coastal ecological vegetation classes that have been depleted below 10 per cent of their original extent and remnant vegetation in urban areas which provide particular educational and social value in addition to their inherent environmental value. This action will contribute to implementation of the State environment protection policies.

Aligning coastal development and social value

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA38	Ensure planning schemes in coastal areas reflect the Victorian Coastal Strategy and Coastal Action Plans	WT17 – WT21	2005	DSE	Local government, CCB	Medium

Protection of our coastal values requires a strong land use planning framework in which the unique characteristics of the coasts are understood and the risks to the values are mitigated. The provision of appropriately located and designed infrastructure can enhance the benefits we derive from coasts while minimising the impacts on its values. However, inappropriate development can result from inadequate detail in local planning schemes and/or the interpretation of planning controls. As a key initial action, the content of the Victorian Coastal Strategy and Coastal Action Plans needs to be reflected in relevant planning schemes. The 3-yearly reviews of all Municipal Strategic Statements provide opportunities to progress this action. As the links between coastal management and planning schemes develops further, key outcomes may also include buffer zones for habitat and waterway protection and the protection of coastal open space. The establishment of minimum sizes for coastal reserves should also be considered to protect coastal areas when land use change or subdivision occurs in these sensitive areas.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA39	Audit coastal public facilities and develop guidelines for coastal infrastructure that reflect environmental and social values and provide for public access and use	WT17 – WT21	2008	DSE	Parks Victoria, CCB, Local government, Marine Safety Victoria	Medium

This action recognises the importance of integrating coastal protection with tourism and recreational values. It seeks to ensure that infrastructure including toilets, paths, buildings, boat ramps, etc. are designed, constructed and managed in ways that provide social benefits whilst also protecting landscape and ecosystem values. The guidelines for this task may be appropriately developed under the provisions of the Coastal Management Act.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA40	Identify coastal areas with significant discharge of stormwater and sewage effluent directly to the bays and implement programs to manage the quantity and quality of these discharges	WT17, WT20	2008	MW, Local government	DSE, CCB, EPA	High

The design and management of stormwater systems in rapidly developing coastal towns is a very important issue for this region due to the high level of urban development around the bays. Townships such as Corinella are experiencing rapid development and there is a need to ensure stormwater and sewage management systems are adequate to deal with the increased populations and visitor numbers. This action will make an important contribution to meeting water quality objectives to be determined in a Regional Water Quality Improvement Plan.

5.10 Estuaries, bays and seas

5.10.1 Overview

The Port Phillip and Western Port region has significant estuaries, two renowned bays and important marine areas (with a nominal regional boundary to three nautical miles offshore) that provide substantial economic, environmental and social benefits for the region and Victoria.

Estuaries

Estuaries are situated at the end of every river and stream that reaches the sea and provide a unique environment for species that rely on a mixture of marine and fresh water to survive. They are important habitats and nursery grounds for many fish and a wide array of aquatic plants and animals. They often support wetlands and provide ideal habitats for migratory birds.

Larger estuaries in Port Phillip Bay are located at the entrance of the Kororoit, Skeleton and Laverton creeks, and the Yarra, Werribee, Maribyrnong and Patterson rivers. In Western Port the larger estuaries occur at the entrances of the Bunyip, Bass, Lang Lang, Cardinia and Tarago rivers.

All estuaries have been modified since European settlement due to urban, industrial and agricultural activities [49], with a number of them also modified by port operations and the development of boating facilities. Many smaller estuaries in urban areas have been converted to stormwater drains. Other estuaries and wetlands surrounding Port Phillip Bay have been converted to sandy beaches, which require regular, ongoing maintenance.

Port Phillip Bay

Port Phillip Bay is one of the largest examples in the world of a shallow embayment in which the benthic or sea floor ecosystem is crucial to the overall health of the bay. It covers 1,930 square kilometres and is 24 metres deep at its deepest central point [50]. Its narrow entrance, 'the Rip', is three km wide and reaches depths up to 94 metres. Substantial sand deposits located just inside the entrance restrict the tidal exchange for the entire Bay with only four per cent of its contents exchanged in each tidal period [51]. However, the narrow entrance creates significant tidal currents within the lower part of the Bay that help to sustain environmental values such as sponge communities.

The average residence time of water in Port Phillip Bay is about one year. This, combined with the fact that the Bay is surrounded by a populated region with urban and agricultural activity, makes it particularly susceptible to catchment based inputs

Drainage from the Bay's catchments, which cover 9,790 square kilometres, is predominantly from the Yarra River, with other inputs from the Maribyrnong, Werribee, Patterson and Little rivers, from Kananook, Mordialloc and Kororoit creeks and from a multitude of stormwater drains.

Western Port

Western Port is 680 square kilometres in area and is highly valued for its environmental benefits, recently highlighted by the establishment of three marine protected areas. It contains numerous sea-grass, mudflat, mangrove, saltmarsh and deep-water communities with high habitat values. French Island lies in the centre and Phillip Island at the entrance, providing shelter from Bass Strait seas. While Western Port is generally shallow with 40 per cent of its northern area exposed as mud flats at low tide, the south western part is known for its deeper channels of around 14.3 metres in depth [52,53].

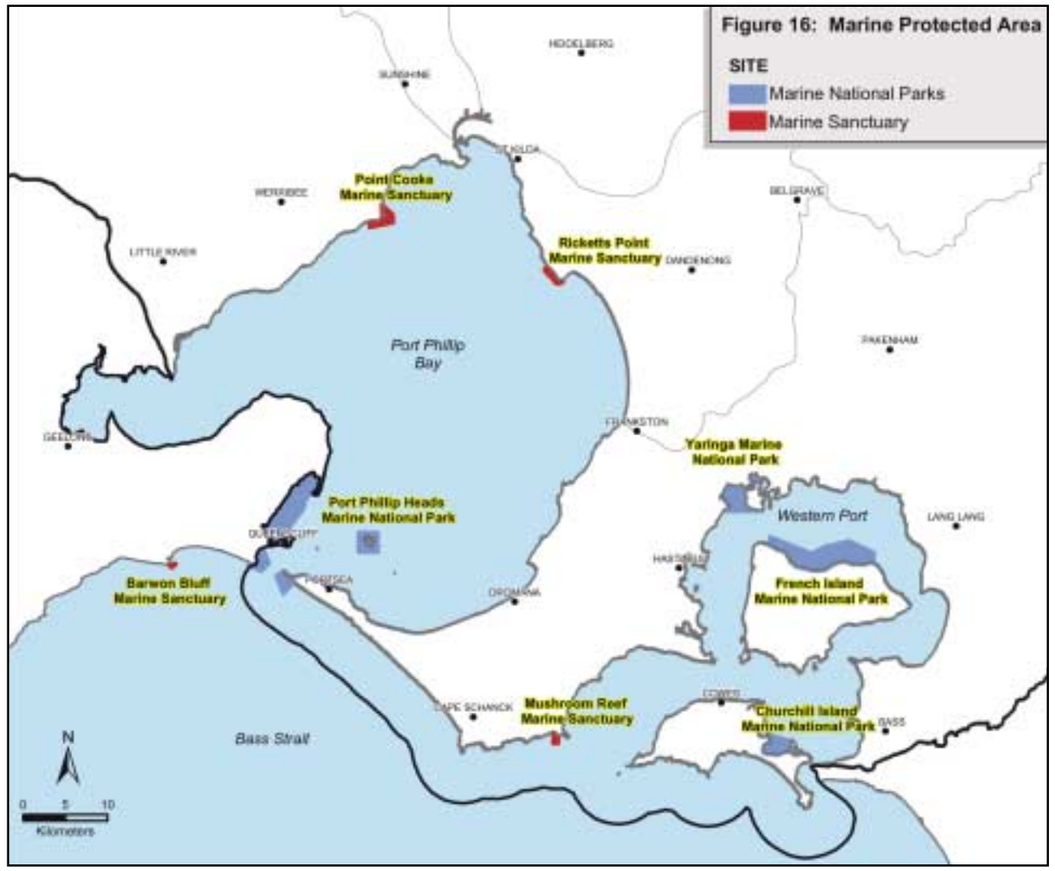
[49] *National Land and Water Resources Audit – Estuaries Assessment*
[50] *Port Phillip Bay Environment Study Final Report.*
[51] *Port Phillip Bay Environment Study Final Report.*
[52] *State environment protection policy – Western Port and catchment*

The watersheds of the Mornington Peninsula to the west, the Strzelecki Ranges to the east and the southern fringes of the Yarra Ranges to the north define the Western Port catchment area, which totals some 3,000 square kilometres. The majority of streams flow from the catchment to the East Arm of Western Port by way of the Bunyip, Bass, Lang Lang, Cardinia and Tarago systems. While waters in the western area exchange with Bass Strait over a period of days, it can take months for this exchange to occur in the East Arm.

Near-shore Bass Strait

The scope of this Regional Catchment Strategy extends offshore to the limit of State waters (3 nautical miles or approximately 5.5 kilometres). Like the region's terrestrial environment, the offshore marine environment is diverse.

Dominated by ocean swells and currents, the offshore component of the region is a high energy environment and Bass Strait is influenced by large-scale tidal movements of water. On an incoming tide, waters enter Bass Strait from both the east and west almost simultaneously, although in the area near our two Bays the waters are more influenced by the cool sub-Antarctic waters moving in from the south-west.



[53] *The Bays Asset Assessment Study*

5.10.2 Values of estuaries, bays and seas

The estuarine and marine environments are valuable for environmental reasons and they also support substantial economic activity and are a focal point for social and recreational activity. They are important from a national perspective as around one-fifth of the entire Australian population live within the catchments of Port Phillip Bay and Western Port.

Environmental values

The estuarine and marine waters of the region support unique ecosystems that have significant intrinsic value and provide a range of ecosystem services. Port Phillip Bay supports a diverse range of aquatic flora and fauna, including plankton, seagrass, seaweeds, numerous species of invertebrates, fish, shellfish, marine mammals and aquatic birds. It is of considerable importance for providing critical nursery habitat for juvenile fish and important feeding grounds for aquatic birds, particularly those associated with the Bay's internationally significant wetlands.

The southern part of Port Phillip Bay is one of Victoria's most significant marine areas. The interplay of currents and coastal landscape in the tidal bottleneck known as The Rip has given rise to a unique concentration of marine ecosystems including sponge gardens, kelp forests, seagrass meadows, sandy plains and mudflats. Over 78% of the invertebrate species found within the Bay are found in its southern reaches. The Point Lonsdale intertidal platform also supports some of the highest diversity of any sandstone reef in Victoria.

The ecosystem is unique and areas of environmental and scientific significance have been recognised with the establishment of representative marine national parks and sanctuaries within its boundaries. The nitrogen cycling processes that occur across the Bay are critical to the health of its ecosystem. The animals and plants living in the sediments on the Bay's floor play an important part in these processes, which are crucial for converting much of the nitrogen input from the catchment to nitrogen gas.

Western Port has a highly diverse variety of habitat types. In its northern part, are unique and highly productive communities of seagrass, mangrove and saltmarsh habitat. This habitat provides food and shelter for invertebrates, insects, crabs, reptiles, fish and birds, and critical nursery habitats for a range of commercial and recreational fish species. This habitat is also critical to the survival of many internationally protected migratory birds and the whole area is an internationally recognised Ramsar wetland site.

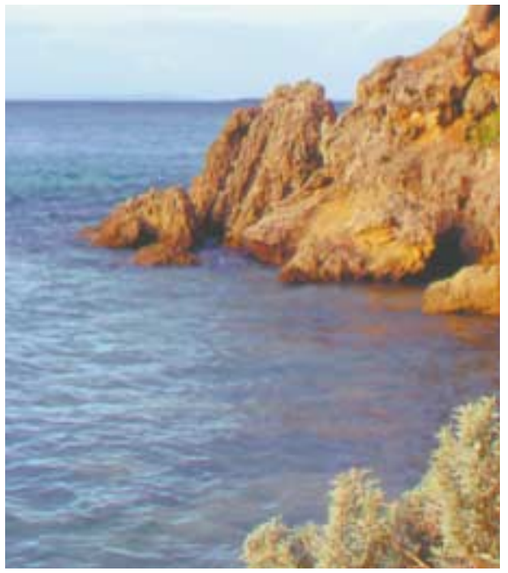
The southern parts of Western Port also support diverse habitats including intertidal rock platforms and deeper waters. The ecosystem is unique and areas of environmental and scientific significance have been recognised with the establishment of representative marine national parks and sanctuaries, as shown in Figure 16.

In Bass Strait, the unvegetated subtidal carbonate sands and muddy habitats that exist offshore are rich in faunal species. Closer to shore, these sandy and muddy areas are broken by low limestone and basalt reefs. Shallow, sandy areas also hold important stands of Amphibolis seagrass communities. Rock platforms and shallow subtidal reefs are dominated by kelps such as the Macrocystis species and other algae, while deeper reefs are covered by an array of sessile invertebrates including sponges, hydroids and soft corals. The marine waters also support true pelagic species that are not commonly found within the bays including barracouta, Australian salmon, southern right whales, Australian fur seals and bottlenose dolphins.

Economic values

The region's estuarine and marine waters are particularly important for their economic value. These values rely heavily on clean waters and a healthy ecosystem. Together, Port Phillip Bay and Western Port make a significant contribution to Victoria's economy, estimated in 1997 at $7.7 billion annually or 7.4 per cent of the gross state product [54].

Together, Port Phillip Bay and Western Port make a significant contribution to Victoria's economy



[54] *The Bays Asset Assessment Study*

Port Phillip Bay underpins some of the State's most important shipping activity. Major international shipping ports are located at Melbourne and Geelong, with around 3,000 ships docking annually and handling some 25 per cent of Australia's sea cargo. Western Port is also of vital economic importance to Victoria. As a deep water port, it supports shipping trade primarily related to oil and gas extractions and metal production, together valued at over $200 million to the State[55].

Fisheries are highly valued in the region, with the annual landed value being around $20 million, mostly from abalone. The ocean fishery between Cape Woolamai and Point Nepean accounts for around $11 million, and Port Phillip Bay $9 million while the average Western Port catch is valued at approximately $220,000 [56]. The aquaculture industry is growing and becoming increasingly important. Around 320 hectares of the bays are being farmed for mussels and abalone, with current production valued at $3.6 million[57]. The region's fisheries support snapper, the most important recreational fish in Victoria, which is not only of economic value to the State as a whole, but provides substantial economic and employment benefits to the local communities. Western Port's most important recreational fish is the King George Whiting. In 1997, the recreational fisheries were valued between $430 million and $680 million [58].

The variety of open ocean and sheltered waters within the region provides excellent opportunities for a wide range of recreational pursuits, in turn supporting a significant tourism industry. These waters are visited by many Victorians, but are also a key destination for Australian and overseas visitors. Activities in the region include sight-seeing, swimming, angling, sailing, boating and surfing.

Revenue from ecotourism operations is also very significant although few studies have clearly articulated the dollars generated by these activities. Over 90% of all scuba diving in Victoria occurs in southern Port Phillip Bay, generating an estimated $48 million annually[59] and providing significant economic and employment benefits to local communities on the Mornington and Bellarine Peninsulas. Marine tourism based on seals and dolphins is also significant within southern Port Phillip Bay.

A significant degradation of these waters would result in severe economic consequences to the range of industries that operate within or around the Bays. In addition there would be economic flow-on effects to activity on the surrounding land that is indirectly linked to the adjacent seascape, for example residential activities.

Social values

Port Phillip Bay is the most significant water body in Victoria due to the siting of the city of Melbourne around its edges. It is the most intensively used and plays a crucial role in providing a recreational resource for more than three million residents living within its catchment, as well as for visitors to the region. It is estimated that there are 40 million visits to the bay each year.

The waters of Western Port and Bass Strait are becoming increasingly popular for water-based recreation activities, as residents and visitors travel further seeking more space and fewer crowds. The region's marine and estuarine waters are also important for their cultural values. Indigenous people have an ongoing and intimate relationship with coastal and marine environments stretching back thousands of years. Contemporary Indigenous people see the sea as a natural extension of country, and continue to have a cultural affiliation with these environments.

The region is also valued for its European cultural significance. Victoria's earliest European exploration and settlement was heavily reliant on coastal shipping and from the early 1800s, whalers and sealers established stations in Victoria, exporting seal pelts, whalebone and whale oil. Throughout the 19th century as settlement and trade increased ships were the most reliable means of transport for local produce and passengers. Shipwrecks were a regular occurrence, and over fifty rest at the entrance to Port Phillip Bay. This underwater heritage includes a range of sailing, steam, wooden and iron ships.

[55] *The Bays Asset Assessment Study*
[56] *S McCormack pers. comm.*
[57] *S Boreham, pers. comm.*
[58] *The Bays Asset Assessment Study*
[59] *based on estimates in Marine and Coastal Special Investigation, Land Conservational Concil, 1995*

5.10.3 Risks for estuaries, bays and seas

The health of our estuaries, bays and seas is threatened by land-based activities taking place in the region, including unsealed roads and road construction. These activities result in inputs that drain into rivers and streams, through estuaries and ultimately to the marine waters. Atmospheric inputs, such as vehicle emissions, can also enter marine waters directly. The inputs are particularly significant where large populations in high densities live within the catchments, along the foreshore and in areas of intensive land use. Human activities, including recreational and commercial uses, and natural processes taking place in the ocean also affect these waters.

Numerous reports have identified the risks posed to the region's marine and estuarine environments. The more recent reports include the Port Phillip Bay Study, the Port Phillip Bay Habitat Assessment, the Western Port Habitat Assessment, the Western Port Sediment Study, Victoria's Biodiversity Strategy and State of Environment Protection Policy (Waters of Victoria) schedules.

A specific risk assessment was prepared for Port Phillip Bay during the development of the Port Phillip Bay Environmental Management Plan (EMP). The assessment considered the threats that could result in potential ecological impacts that could become irreversible, with have significant adverse long-term implications for the region's social and economic benefits. The EMP listed nutrient inputs and exotic marine organisms as the two highest ranked current threats to the Bay. While other threats may also have the potential to cause significant impacts on the Bay, these two require immediate attention. A similar approach to that used for Port Phillip Bay will be used for assessing other marine and estuarine environments in the region.

While the recent Western Port Sediment Study has added to our knowledge of threats to Western Port, further research is required to identify key threats to the sensitive Western Port ecosystems and to determine specific targets and the actions required to achieve them.

The key risks to marine and estuarine waters in the region include (but not in priority order):

WR25 – Algal blooms from increased nutrient loading and detrimental changes to nutrient cycling

Since European settlement, changes to the environment have significantly altered water quality. Catchment activities in the region continue to affect the quality of its coastal waters. Nutrient inputs draining into coastal waters remain a key threat to the marine and estuarine environments, while potential new sources of nutrients, through activities such as intensive marine farming, need to be carefully managed..

Benthic (sea floor) organisms help to maintain the water quality by recycling nutrients that naturally drain from catchments. An increased supply of nutrients from catchment-based activities may overload the recycling capacity of these organisms, potentially leading to eutrophication and algal blooms. There would be serious environmental, social and economic repercussions if widespread eutrophication and prolonged, persistent algal blooms were to occur in Port Phillip Bay or Western Port.

The protection of nutrient cycling processes, largely through limiting nitrogen loads, is a key issue for Port Phillip Bay. The Bay Study emphasised the links between eutrophication risk to the bay and both nitrogen-input levels and adverse effects on cycling processes. Key nitrogen sources for the bay include urban stormwater, agricultural run-off entering the rivers and streams in the catchments and the discharge from the Western Treatment Plant that treats most of Melbourne's sewage.

In 2001, only eleven of the 86 waterway monitoring sites in the region fully met the State environment protection policy (SEPP) objectives for phosphorus and two met the nitrogen objectives. Numerous monitoring points showed persistent nitrogen and phosphorus concentrations at more than three times the objectives, figures that excluded the peak nutrient inputs that occur during high stream flows. These objectives are largely designed to protect the waterways themselves. For Port Phillip Bay it is the nitrogen loads that these waterways deliver, particularly from high flows occurring during storms, that pose a major threat to nutrient cycling processes. Storm-event monitoring is now in progress. In the long term this will allow the nitrogen load reduction targets to be assessed.

Nutrient inputs draining into coastal waters remain a key threat to the marine and estuarine environments

WR26 – Toxicant inputs

Toxicants have the potential to kill, or adversely affect living organisms. This can lead to changes in the abundance of species and the composition of ecological communities. Toxicants can also accumulate in the tissues of biota, potentially making them unsafe for human consumption. The risks of these effects vary with the toxicants involved, their levels and many other factors including toxicant form, exposure duration and various environmental conditions.

Different toxicants may interact with each other, creating different effects on organisms. The sensitivity of a species to a given toxicant can also vary. Toxicants stem from a wide range of sources and enter coastal waters through rivers, drains, licensed discharges, groundwater, the atmosphere and activities such as shipping and boating. They can then accumulate in sediments, for example sediments in the lower reaches of the Yarra River are known to contain elevated levels of toxicants. Sediments near marinas can also contain elevated levels of organotins such as tributyl tin. These sediments and the toxicants they contain can be re-suspended through disturbances such as dredging [60].

WR27 – High sediment loads and increased suspended solid levels

Catchment-based activities have significantly increased the sediment inputs to the estuaries and bays. This is particularly important in Western Port where sediment inputs have increased because of land-clearing and increased catchment runoff, and because of modifications to the natural catchment drainage system.

The drainage and channelisation of the Koo-Wee-Rup Swamp district in the 1800's particularly affected the sediment delivery into Western Port. The Cardinia Creek system, Lang Lang, Bunyip and Bass rivers, and Deep, Toomuc, Cardinia and Red Bluff creeks were also significantly altered.

Increased sediment inputs can result in unnaturally high levels of suspended solids. Light penetration is reduced and natural processes, like photosynthesis in light sensitive biota such as seagrass, are impeded. Sedimentation is thought to have made a key contribution to the loss of more than 70 per cent of Western Port's seagrass cover since the 1970s.

Suspended solids can also smother biota, affect oxygen transfers through gills and can carry nutrients, toxicants and pathogens. Such solids include fine particles of soil from erosion, organic matter from plants and animals including sewage, dust and particles in urban runoff and bacteria and other micro-organisms.

The recent Western Port Sediment Study has indicated that catchment activities and coastal processes are contributing significant loads of suspended solids to Western Port via rivers and streams. Particular areas have been identified as making major contributions of sediment, including the low cliffs on the northern Western Port shoreline and the streams of the Bunyip River, Cardinia Creek and Lang Lang catchments.

WR28 – Oil spills

Oil spills, although rare, can cause significant impacts to marine and estuarine environments. Oil coats the water surface and any animals that come to the surface to breathe, as well as rocks and beaches where the oil slick is washed ashore. Cleaning oil spills is a major logistical exercise that needs to be undertaken rapidly to be effective. Cleaning spills may not be possible at all in many areas of Western Port.

[60] *Determinants of TBT absorption and desorption in esturine sediments, 1995*

WR29 – Changes in freshwater quantity

Natural flows of freshwater are important to estuarine ecosystems. These flows can trigger breeding and recruitment in fish stocks and other marine species. Increased urban water use and irrigation for agriculture can reduce the amount and change the timing of water reaching the marine and estuarine environments.

Conversely, too much freshwater can have a deleterious effect on marine ecosystems. This has been shown to be the case around Boag's Rocks where the output from the Eastern Treatment Plant enters the ocean [61].

WR30 – Presence of pathogens

Pathogens can cause health problems in plants, animals and humans. Pathogens originate from septic tanks, sewage overflows, damaged sewers, and animal faeces (from dogs, cats, horses, cows, pigs, birds, rats and other wildlife). They enter coastal waterways through sewage treatment plants, rivers, drains – and potentially through direct sewage discharges from vessels. They can also be remobilised from sediments by dredging. Escherichia coli or E. coli is often used as an indicator of faecal contamination and the SEPP sets quantitative E. coli objectives.

WR31 – Presence of litter

Litter is a hazard to public health and to some marine life. Given the large population resident at its edges, Port Phillip Bay is particularly susceptible to litter which travels through waterways to the bay mainly by way of the urban stormwater system. Each year, approximately 230,000 cubic metres or two billion items of litter enter the waterways from the urban system. This equates to more than one litter item for every person in the region reaching the waterways each day. Around 95 per cent of litter polluting the bay and its beaches comes from the metropolitan area, costing bayside Councils more than $2 million a year to remove. The remaining five per cent is dumped by beach goers or from ships and boats.

WR32 – Exotic marine organisms

Exotic organisms are a key threat to marine and estuarine ecosystems. Their impacts include feeding on native wildlife or out-competing it for food and shelter. They threaten biodiversity, aquaculture, commercial and recreational fishing, recreation and tourism. Unless well-managed, shipping can introduce organisms that are carried on fouled hulls or are present in ballast water. This is also the case for the multitude of small vessels using the marine waters and for the movement of aquaculture equipment.

As an international shipping port, Port Phillip Bay is particularly susceptible to introductions. It currently hosts more than 100 introduced species and, on average, 2 or 3 new species establish each year. Not all of these introduced species become pests, but those that do, such as the Northern Pacific seastar, Japanese kelp and European fan worm, have the potential to affect the ecosystems and marine industries. This highlights the importance of preventing further introductions to Australia. It is also essential that any introduced species already found in the marine waters, particularly those contained within embayments, are not spread to new locations.

While the other marine waters in the region are susceptible to pest introductions and spread, they have not had such a history of high introduction rates.

WR33 – Physical disturbance of habitats

Sources of direct physical disturbance include harvesting techniques that involve contact with the sea floor, dredging, spoil disposal and engineering works that change water, and sediment movement patterns. Some fishing techniques, such as widespread scallop dredging, have now ceased in Port Phillip Bay. However dredging continues and involves, removal and disposal of large quantities of material each year at Queenscliff, South Channel, the Port of Melbourne, the Yarra and small boat harbours and creeks. This is expected to increase should the channel deepening project proceed.

From time to time, capital works, such as construction of marinas, ports and shipping channels as well as beach renourishment activities, involve movement of large volumes of material.

[61] *Environmental Impact Assessment and Review of Effluent Disposal Options for Eastern Treatment Plant.*

WR34– Harvesting activities

Harvesting activities such as commercial and recreational fishing have direct effects on the abundance of marine species in the region and there is evidence of significant pressure on species such as tiger flathead, southern rock lobster and greenlip abalone. The impacts on marine ecosystems from prolonged fishing have not been well studied in the region, although removing certain age classes, size classes, gender classes and overall abundance of particular species is well known as having impacts on food webs and ecosystem functioning. Harvesting activities also have impacts on species that are accidentally caught in equipment or gear including non-target fish species and birdlife.

The cumulative impact of recreational harvesting of intertidal invertebrate populations over many decades has lead to seriously depleted populations of marine life on many intertidal reefs within the region. In response to this practice, the taking of marine invertebrates in the Bay from the high water mark to two metres water depth was prohibited in 1998. In addition, illegal harvesting is placing significant pressure on species such as abalone and other intertidal gastropods in the region.

Close management of the region's fisheries needs to continue in order to minimise its detrimental impacts on the abundance of target and by-catch species and on wider marine ecologies.

WR35 – Climate change

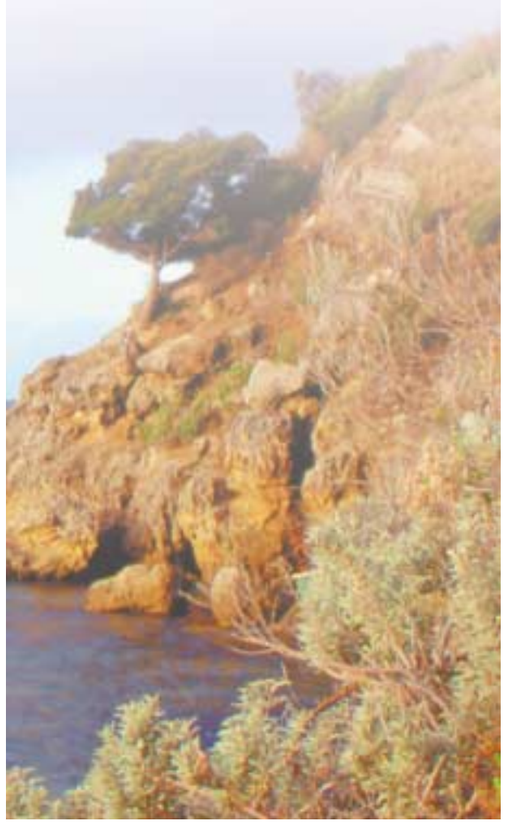
Long-term, slowly changing characteristics of the marine and estuarine environment have been related to climate change. Of particular note are increased sea temperatures and rising sea level. Even minor increases in temperatures have the potential to cause significant changes to the entire ecosystem such as sea level rises affecting the mangrove and estuarine environments.

5.10.4 Objectives for estuaries, bays and seas

The five Water Objectives (see Section 5.4) for the region have been developed in line with the principles of sustainability, and also address the key risks for estuaries, bays and seas.

The first seven risks relate to inputs to the marine environment generated by humans that threaten a wide range of values. These risks will be managed by improving water quality (Water Objective 4) and protecting the health of the marine systems (Water Objective 3).

The management of disturbance, exotic organisms and over-harvesting will be dealt with by protecting the health of the marine systems (Water Objective 3) and ensuring that the management of our water environments improves the health, diversity and resilience of natural ecosystems (Water Objective 5). Climate change can also be managed by these objectives.



5.10.5 Targets

These Water Targets (WT21 – WT24) are proposed to meet the elements of the objectives that are directly relevant to water quality issues for estuaries, bays and seas. Additional targets related to marine and estuarine biodiversity are contained in Chapter 7 – Biodiversity.

Target		Relevant objectives
WT21	**Improve water quality in estuaries, bays and seas so that all monitoring sites attain State environment protection policy objectives or regional targets by 2030.**	**WO2, WO3, WO4, WO5**

The State environment protection policy (Waters of Victoria) specifies long-term objectives for water quality. It contains generic objectives for open coasts and estuaries and inlets, with specific objectives for Port Phillip Bay, the Yarra River and Western Port being in schedules F6, F7 and F8 respectively. The objectives are currently being met in most of these waters. Shorter-term regional targets, specific to estuaries and marine waters, need to be determined in the near future, particularly where the objectives are not being met. These targets will be outlined in a Regional Water Quality Improvement Plan as interim steps to be achieved. This Target WT21 supports the attainment of those more specific water quality objectives and targets. Estuaries may require separate evaluation and investigation.

Target		Relevant objectives
WT22	**Reduce the average annual nitrogen load entering Port Phillip Bay by 1000 tonnes by 2006**	**WO2, WO3, WO4**

Nitrogen levels have been identified as a critical threat to the health of Port Phillip Bay. The need for reduction of the annual nitrogen load was identified in the Port Phillip Bay Study. The target reduction of 1000 tonnes from an annual baseline by 2006 is consistent with the targets outlined in the Port Phillip Bay Environmental Management Plan and State environment protection policy, and will also be referred to in the future Regional Water Quality Improvement Plan. Within this target, it is proposed that 500 tonnes/year be reduced from the region's sewerage treatment plant inputs and that the other 500 tonnes/year be reduced from the catchment inputs that enter the bay via the waterways. It should be noted that it may be five to 10 years before reductions become apparent and the effectiveness of actions can be specifically measured.

Target		Relevant objectives
WT23	**Reduce the total sediment load annually entering Western Port by 2015, measured against existing benchmarks**	**WO2, WO3, WO4**

High sediment loads have been identified as a critical threat to the health of Western Port. Initial studies recently commissioned by EPA and Melbourne Water, and undertaken by the CSIRO [62], have identified key sediment sources in the catchment and established estimates of the annual sediment load from various waterways. In the coming years, there will be increasing pressure on the health of Western Port as a result of urbanisation and infrastructure development within the catchment.

[62] *Western Port Sediment Study*

This target recognises the need to immediately substantially reduce the sediment load that is annually entering Western Port via the waterways. However, it is acknowledged that further studies are also required in order to better quantify benchmarks and include specific targets in the Regional Water Quality Improvement Plan that is to be developed.

Target		Relevant objectives
WT24	Reduce the amount of litter and other gross pollutants entering Port Phillip Bay and Western Port by 70% by 2015	WO2, WO3, WO4, WO5

Litter and other gross pollutants are a major problem affecting the environmental and social values of all water, but in particular the bay and marine waters. A great proportion of these pollutants enter the waterways and bays through our stormwater system. This target is consistent with the objective from the Victorian Stormwater Strategy and Action Plan for litter.

5.10.6 Actions

These Water Actions (WA41 – WA53) has been developed to meet the four targets relevant to waters quality of our estuaries, bays and seas. Additional actions related to marine and estuarine biodiversity are contained in Chapter 7 – Biodiversity.

Research and coordination

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA41	Continue to investigate marine ecosystems and the links with key threatening processes, and identify an appropriate set of indicators and targets	WT21-WT24	Set of indicators and targets developed by 2006	DSE	EPA, DPI Fisheries, MW, Parks Victoria, CCB, CMA, Local government, Water authorities	High

Past research regarding the ecosystem processes of Port Phillip Bay, Western Port and the open ocean has highlighted key issues associated with maintaining their health. Some of the region's marine and estuarine waters have been the focus of significant research projects, such as the Port Phillip Bay Environmental Study, while others have had much less research attention.

The dynamics of marine ecosystems and the high number of threatening processes make the prioritisation of actions a complex task. This emphasises the need to progressively improve our understanding of these environments, the links with processes that threaten them (such as the relationship between seagrass health and turbidity) and the setting of targets to manage risks.

Outputs need to include an appropriate set of indicators and targets that assist monitoring of the marine environment and the associated threats.

Action WA41 generally reinforces the importance of continuing to improve our understanding of the key risks to the region's marine and estuarine ecosystems, and continuing to improve our management of these risks taking into account any relevant new understanding as well as reviews of progress. This target will assist in priority setting for filling key information gaps and developing programs to address risks.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA42	Research the health of, and risks to, estuaries in the region	WT21-WT24	2005	DSE	EPA, DPI, MW, CCB	Medium

There are significant gaps in knowledge about the region's estuarine environments. Targeted research is needed to improve our understanding of these environments and assist planning for their protection and enhancement. In the future, a robust method for measuring estuarine health, similar to the Index of Stream Condition method used to monitor the condition of waterways across Victoria, would be useful

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA43	Establish coordination forums for Port Phillip Bay and Western Port to identify priorities for research, planning and implementation programs	WT21-WT24	2005	CMA	CCB, EPA, MW, Parks Victoria, DSE, DPI, Local government	Medium

Action WA43 recognises the need to establish coordinated forums bringing together key stakeholders for Port Phillip Bay and Western Port to determine agreed future research, planning and implementation programs that build on the long history of research and management. The potential for working with existing multi-stakeholder forums, such as the Mornington Peninsula and Western Port Biosphere Reserve Foundation, should be explored as an efficient way of establishing these forums. The forums should invite the involvement of Kulin people and other groups with interests in heritage and other social values.

Addressing marine water quality issues

There is an important link between the health of our estuaries, bays, seas and the activities that take place in the catchments. A specific action (WA6) to map the land-based sources of nutrients, sediments and other pollutants across the region, and develop and implement a Regional Water Quality Improvement Plan to address the major sources is included in Section 5.6 – Surface Waters, Rivers and Streams. This action will make an important contribution to meeting Targets WT21, WT22 and WT23.

While this is occurring, the reduction of nitrogen into Port Phillip Bay is already recognised as a priority. Similarly, the reduction of sediment entering Western Port from the catchments and waterways is recognised as a priority requiring immediate action. The following actions are included to specifically address these and other marine water quality issues.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA44	Implement the Port Phillip Bay Environmental Management Plan to reduce the average annual nitrogen input into Port Phillip Bay by 1,000 tonnes, and review and extend the plan to address additional risks to the Bay	WT22	Nitrogen target achieved by 2006 Review and extension of the EMP initiated in 2006	DSE, CCB	MW, EPA, CMA, DPI, Local government	High

The Port Phillip Bay Environmental Management Plan outlines reduction targets for key sources of input from the following three areas; the Western Treatment plant, the Yarra/Maribyrnong Rivers and Patterson River. The overall target was established in the Port Phillip Bay SEPP. As the target applies to a baseline which has been based on 1991-95 Bay inputs, further efforts will be required to reduce or compensate for the increasing loads expected from continued urbanisation of the catchment and the increasing intensive agriculture. The targets for waterway nitrogen loads will therefore be particularly challenging.

The Port Phillip Bay Environmental Management Plan is scheduled for review in 2006. The review of the Environmental Management Plan should consider possible mechanisms to provide a strengthened framework for all bay-related plans with a view to facilitating strong integration between all organisations, their plans and work programs. This will assist with the review of the Port Phillip Bay State environment protection policy scheduled for 2007.

The programs outlined in the current Port Phillip Bay Environmental Management Plan focus on mitigating two risks recognised as critical to the Bay's environment - nutrients and marine pests. However, the plan also emphasises that other key Bay risks require ongoing consideration. The review of the plan is an opportunity to identify and assess other risks to the Bay and to develop appropriate targets and actions to deal with these risks.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA45	Investigate and pilot ways for new nitrogen inputs to Port Phillip Bay to be offset by reduced inputs from elsewhere	WT22	Pilot programs initiated by 2009	DSE	MW, CMA, CCB, EPA, DPI	Medium

This action recognises that some bay uses, such as an expansion of permitted aquaculture, could result in additions to nitrogen load. In order to maintain ecologically acceptable levels of nitrogen, mechanisms such as an offsetting process may enable reductions made elsewhere in the region to offset these new loads.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA46	Initiate research and major integrated programs to identify the specific sources, and reduce the inputs of, sediment and other pollutants to Western Port	WT23	Programs initiated by 2006	EPA, CMA	MW, CCB, DPI, DSE, Local government	High

An improved understanding of the Western Port ecosystem and the threats to its health is vital to improve our management in the catchment and the bay and to ensure that major impacts on the substantial Western Port values are avoided. This will be progressed through Actions WA6 and WA41.

Contributing to our overall understanding, recent studies including the Western Port Sediment Study have indicated that catchment activities and coastal processes are contributing significant loads of suspended solids to Western Port via rivers and streams. Particular areas have been identified as making major contributions of sediment, including the low cliffs on the northern Western Port shoreline and the streams of the Bunyip River, Cardinia Creek and Lang Lang catchments.

Major programs are needed to immediately begin dealing with the identified major sources of sediments and other pollutants to Western Port. This will make a key contribution to the implementation of the State environment protection policy for Western Port. For best effect, these programs should be integrated so they simultaneously address other catchment management issues in these locations.

An improved science-based understanding of the links between some land uses and water quality in waterways and Western Port is also required. For example, intensive animal industries are widely established in the Western Port catchment and spirited community debate is occurring regarding the impacts of chemical use, waste management and other practices on local environmental values. The expansion of intensive animal industries is a complex issue as economic benefits must be accompanied by management practices that enable SEPP objectives for Western Port to be met. As an initial step to progress the debate and to assist future planning and decision-making, a detailed study of intensive animal industries in the Western Port catchment is required to research, assess and report on:

- The current extent of these land uses and the likely expansion of the industries in the Western Port catchment
- The management practices that are generally in use
- Any impacts on groundwater, surface water and other catchment assets.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA47	Refine and implement key actions in municipal Stormwater Management Plans to reduce inputs of sediments, nutrients, toxicants and litter to the bays	WT21-WT24	2009	Local Government	EPA, MW	High

The implementation of stormwater management plans will play a key role in reducing the level of pollutants entering our marine waters. In refining the Stormwater Management Plan actions, the potential for using stormwater as a valuable resource should also be considered and opportunities identified for recycling some of it to reduce the use of high quality water and subsequently benefitting the region's waterways.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA48	Implement ammonia reduction work at the Eastern Treatment Plant	WT21	2007	MW	EPA	High

This action addresses the effects on the environment at Boags Rocks, near Gunnamatta, of the levels of ammonia and fresh water entering the ocean from the outfall from the Eastern Treatment Plant at Carrum. This action is linked to Environment Protection Authority works approvals and licensing requirements.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA49	Implement priority litter management programs that include installation of gross pollutant traps at key sites on drainage systems	WT24	2009	Local government	MW, EPA	Medium

Litter entering the bays from urban areas affects coastal values, especially in highly visited areas. This action aims to reduce litter at its source or as it is carried to waterways. Priority sites have already been identified in municipal Stormwater Action Plans. The reduction of litter once it has reached the beaches is also important and the Association of Bayside Municipalities has developed beach-cleaning guidelines that could be adopted.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA50	Develop and implement environmental management plans for the region's ports and marinas	WT21	2010	EPA	Parks Victoria, Port and Marina managers	High

These management plans are required to effectively address risks to water quality such as oil, toxicants, litter and exotic pests. All these risks can be exacerbated by the disposal of waste and ballast water from ships and boats that use the local marine waters. Plans will include appropriate behaviour for boat owners, the provision of facilities to assist with waste management and the management and provision of other facilities to reduce impacts on the environment. Specific plans for improving the manageent of marinas will be developed from 2006 onwards.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA51	Ensure adoption of best practice guidelines for all marine dredging	WT21	Ongoing	EPA	DSE, Parks Victoria, Port managers, Marine Safety Victoria	Medium

Dredging is a necessary activity for the maintenance of shipping channels and boat harbours. However, how this is done and what is done with the spoil affects the quality of the environment at both the sites of extraction and deposition. Continued adoption of best management practices will reduce the affect on other values.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA52	Regularly review the marine pollution contingency plans to ensure world's best practice procedures are incorporated	WT21	Ongoing	Marine Safety Victoria	EPA, Port managers	Medium

The likelihood of major oil spills is small, however the potential impact on marine and estuarine environments is significant. On-going and vigilant management practices are required.

Action		Relevant targets	Completion date	Lead role	Key partners	Level of investment
WA53	Develop and implement a coordinated monitoring, evaluation and reporting framework regarding the condition of the region's marine environment, risks and the effectiveness of actions	WT21-WT24, BT5, BT7-BT10	Framework in place by 2008	DSE, EPA, DPI	CCB, Parks Victoria, CMA, Local government, Melbourne Ports	Low

The overall processes for managing the marine environment will be enhanced if a coordinated monitoring, evaluation and reporting framework is put in place to gauge the health and extent of the region's marine habitats, assess key risks, assess the effectiveness of current actions and determine priorities for future investment. This would enable reporting and would be the basis for review of actions and the development of future initiatives.

This would build on current regional monitoring and reporting processes and will link with state and national reporting on marine condition.

Current monitoring processes include monitoring of:

- long term water quality trends by the EPA at sites across the bay
- water quality monitoring at key recreational beaches by the EPA
- fish populations
- fish catches
- condition of habitat
- key nutrient cycling indicators by Melbourne Water and DSE
- nutrient levels from waterways during storm events
- nutrient inputs from the Western Treatment Plant.

However, there is variation in the extent and regularity to which the monitoring occurs and how widely the results are reported. In addition, other elements of marine health are not extensively monitored such as the quantitative assessment of nitrogen input to the bays and the extent of marine pest species. Further investment in monitoring activities may therefore be required.

5.11 Summary table

The following table summarises the translation of the goal for all of the components of the region's water resources through the steps of objectives and targets to actions.

Goal

Sustainable water use and healthy waterways, wetlands, estuaries, coasts, bays and seas

Objectives

WO1. Ensure efficient management of water resources with minimal new impacts on natural hydrological processes

WO2. Protect and improve the environmental health and social and economic values of waterways and wetlands

WO3. Protect and improve the environmental health and social and economic values of estuarine, coastal and marine systems

WO4. Improve water quality in waterways, aquifers, wetlands, estuaries, bays and seas

WO5. Ensure the management of water resources minimises risks to natural ecosystems, public land, private assets and public safety

Targets (pre-existing targets in Bold)

WT1. **Average potable water consumption per person reduced by 15% by 2010**

WT2. **The volume of recycled water used in the region increased to 20% of the total treated volume by 2010**

WT3. **Diversions from all waterways to be within Sustainable Diversion Limits by 2015**

WT4. Improved average value of irrigated agricultural production per megalitre

WT11 Levels of extraction from each GMA in the region to be within the permissible annual volume by 2025

WT12. Groundwater levels in key regional aquifers to be stabilised at sustainable levels by 2025

WT13. Progressively increase the average value of groundwater extracted

WT5. **Maintain the condition of the 13% of region's rivers that are currently in excellent condition**

WT6. **Improve the condition of the region's waterways so that:**
- **At least 50% of all natural waterways will be in good or excellent condition by 2015**
- **All natural waterways will be in good or better condition by 2025**

WT7. Progressive improvement in the condition of waterways across the region as measured by the Index of Stream Condition, including beds and banks, streamside zone and aquatic life

WT15 No net loss in the extent and health of wetlands of each existing type

WT16. Progressively improve the overall health and social value of natural wetlands, including those that are nationally and internationally recognised

WT17 Reduce the proportion of coast in the region where environmental values, recreational beaches, Indigenous cultural values and public infrastructure are at high risk from accelerated coastal erosion and other degrading processes.

WT18 A net gain in the extent and quality of native coastal vegetation as measured by habitat hectares.

WT19 Public access to the region's beaches and bays maintained

WT20. The number of days that beaches are classified unsuitable for swimming reduced to zero by 2010

WT24. **Reduce the amount of litter and other gross pollutants entering Port Phillip Bay and Western Port by 70% by 2015**

WT8. **Improve water quality in rivers and streams so that:**
- **At least 80% of monitoring sites attain SEPP objectives or regional targets by 2009**
- **All monitoring sites attain SEPP objectives or regional targets by 2030**

WT14 All groundwater monitoring sites to attain SEPP objectives or regional targets by 2030

WT21 Improve water quality in estuaries, bays and seas so that all monitoring sites attain State environment protection policy objectives or regional targets by 2030

WT22. **Reduce the average annual nitrogen levels entering Port Phillip Bay by 1000 tonnes by 2006**

WT23. Reduce, by 2015, the total sediment load annually entering Western Port, as measured against existing benchmarks.

WT9 No loss of hydraulic capacity and environmental values of flood plains

WT10. Timely flood warnings provided for all major waterways and risks to infrastructure minimised

Actions (pre-existing actions in Bold)

WA2. **Determine, and ensure compliance with Sustainable Diversion Limits and Bulk Water Entitlements for the region.**

WA3. **Implement the State Government's policy for the establishment of diversion caps and an environmental reserve for the region's rivers**

WA4. **Complete Stream Flow Management Plans for the Plenty, Upper Maribyrnong, Watts, Little Yarra, Don and Bunyip Rivers and Olinda, Stringybark, Pauls, Steels, Dixons, Woori Yallock and Coranderrk Creeks plus additional waterways as required**

WA5. **Develop local stream flow management rules for waterways where Stream Flow Management Plans are not required; eg. Merri, Moonee Ponds and Gardiners Creeks.**

WA8. **Design and implement schemes for recycling water from the Eastern and Western Sewerage Treatment Plants and smaller plants in the region.**

WA15. Investigate the hydrological and ecological relationships between surface waters and groundwater and develop catchment-based water budgets

WA16. Benchmark rural water use efficiency in major agricultural areas and increase water use efficiency by agricultural industries

WA19 Clarify the organisational arrangements for the management of aquifers and groundwater in this region

WA20 Further develop the regional risk assessment model to identify the level of risk facing groundwater assets

WA21 Complete Groundwater Management Plans for all GMAs with allocations that approach or exceed their permissible annual volume.

WA22 Assess the practices and efficiency of groundwater use in GMAs and develop strategies to achieve higher efficiency and sustainable use of groundwater.

WA1. **Implement the relevant directions of the 'White Paper – Securing Our Water Future Together'.**

WA7. **Implement the Port Phillip and Westernport Regional River Health Strategy.**

WA28 Develop and apply an Index of Wetland Condition method to determine the overall health of wetlands in the region and establish a benchmark to measure change into the future.

WA29 Consolidate and distribute data on regional wetlands to relevant stakeholders, including local government, landholders and Kulin people.

WA30 Develop a Regional Wetland Plan to establish and implement priorities for investment.

WA31 Develop planning policy and protocols that contribute to the protection of wetlands, and incorporate them in relevant planning schemes.

WA32 Implement Wetland Management Plans for all three Ramsar wetland areas in the region (Port Phillip – Western Shoreline, Western Port and Edithvale-Seaford)

WA33 Investigate, assess and manage accelerated coastal erosion and other degrading processes at high value sites where recreation, heritage, Indigenous culture, environmental values and public infrastructure are at risk.

WA34 Communicate the requirements of contingency plans for oil spills to all relevant stakeholders

WA36 Map the occurrence of coastal acid sulphate soils and develop overlays for inclusion in relevant planning schemes

WA38 Ensure planning schemes in coastal areas reflect the content of the Victorian Coastal Strategy.

WA39 Audit coastal public facilities and develop guidelines for coastal infrastructure that reflect environmental and social values and provide for public access and use.

WA41. Continue to investigate marine ecosystems and the links with key threatening processes and identify an appropriate set of indicators and targets.

WA42. Research the health of and risks to estuaries in the region.

WA49 **Implement priority litter management programs that include installation of gross pollutant traps at key sites on drainage systems**

WA50 Develop and implement environmental management plans for the region's ports and marinas

WA51 Ensure adoption of best management practices for marine dredging

WA52. Regularly review the marine pollution contingency plans to ensure world's best practice procedures are incorporated

WA53. Develop and implement a coordinated monitoring, evaluation and reporting framework regarding the condition of the region's marine environment, risk and effectiveness of actions.

WA6. Map the land-based sources of nutrients, sediments and other pollutants to waterways, Port Phillip Bay and Western Port and develop and implement a Regional Water Quality Improvement Plan to address the major sources.

WA10. **Meet best practice standards in urban stormwater discharges in new urban areas.**

WA17 Review and implement a surface and ground water quality monitoring system to ensure adequate and coordinated coverage across the region, including reservoirs, high discharge areas, bays and seas, high rainfall events and nutrient loads

WA18 **Continue regular assessment of the Index of Stream Condition [ISC] across the region.**

WA23. Develop and implement groundwater quality management plans for GMAs with a high level of risk to groundwater quality

WA24 Develop guidelines and codes of practice for the management of risks to groundwater quality, and undertake programs with relevant land and water managers

WA25 In the local governments that contain GMAs, develop planning scheme guidelines/regulations to protect groundwater quality.

WA27 Develop and implement a comprehensive regional ground water quality monitoring and evaluation program.

WA44 **Implement the Port Phillip Bay Environmental Management Plan with a focus on reducing the annual nitrogen input into Port Phillip Bay by 1,000 tonnes per year and review and extend the plan to address additional risks to the Bay.**

WA46 **Initiate research and major integrated programs to identify the specific sources and reduce the inputs of sediments, nutrients and other pollutants to Western Port.**

WA47. **Refine and implement key actions in municipal Stormwater Management Plans to reduce inputs of sediments, nutrients, toxicants and litter to the bays**

WA48. **Implement ammonia reduction work at the Eastern Treatment Plant by 2007**

WA9. Complete an audit of stormwater management plan implementation for all municipalities and design and implement a program to address key gaps

WA11. Reduce by 500 the number of properties vulnerable to a one in 100 years flood

WA12. All new developments constructed with floor levels at the required safety margin above one in 100 years flood levels

WA13. Develop and incorporate into relevant planning schemes, protocols that contribute to the protection of the environmental values of floodplains

WA14. Develop and implement Special Area Plans for water supply catchments where appropriate.

WA26 Meter all significant existing groundwater extractions used for commercial and irrigation purposes and all new licenses and monitor groundwater levels within key aquifers to assess trends in relation to sustainable levels.

WA35 Map areas susceptible to inundation in Port Phillip Bay, and Western Port.

WA37 Develop and implement plans to increase the extent and quality of coastal ecological vegetation classes

WA40 Identify coastal areas with significant stormwater and sewage effluent discharge directly to the bays and implement programs to manage the quantity and quality of these discharges.

WA43. Establish coordination forums for Port Phillip Bay and Western Port to identify priorities for research, planning and implementation programs.

WA45 Investigate and pilot ways for new nitrogen inputs to Port Phillip Bay to be offset by reduced inputs from elsewhere.