

Water Quality

Environmental indicators reported in this section:

Environmental Indicator	
CO 6.3	Turbidity
CO 6.4	Water nutrients (nitrogen)
CO 7.5	Coastal discharges

Marine and estuarine waters are valued by the community for a range of purposes or environmental values (ANZECC/ARMCANZ 2000). Those environmental values are:

- aquatic ecosystem maintenance,
- primary industry, and
- recreation and aesthetics.

Australia's coastal waters are generally in good condition and support the above environmental values. In the tropical north most coastal waters are in good condition, but where agricultural, urban or industrial development has occurred, coastal waters have been degraded to some extent.

Pollution of coastal waters is derived from both land and marine sources, with land-based sources generally regarded as either point sources (e.g. waste water treatment plants) or as diffuse sources (e.g. urban and agricultural runoff). Marine sources of pollution are associated with harbour dredging, shipping (including fuel and hazardous cargo spills), the use of hull antifouling paints, and aquaculture. The relative contributions of these sources of pollution are poorly defined, but it is widely considered that land-based sources represent the greatest threat to the environmental values of Australia's coastal waters. Only very limited information is available on marine sources of pollution.

Point-source pollution has been well characterised and is regulated through pollution control legislation. Diffuse source pollution from agricultural and urban runoff, however, remains largely unchecked because of:

- the inability or unwillingness of authorities to enforce regulations (where they exist),
- a failure to plan and control the impact of agricultural and urban development on water quality,
- community perceptions that individual actions do not contribute to cumulative impacts, and
- a lack of an integrated management system that recognises environmental values.

There is no comprehensive national coastal water quality monitoring program, and national trends in water quality cannot be reported. However, all States and some other organisations undertake coastal water quality monitoring programs, particularly adjoining large population centres or where there is extensive catchment development and concerns about degraded coastal water quality.

Key pollutants of marine and estuarine waters

Coastal waters can be degraded by a range of pollutants, including nutrients, sediment, pathogens and toxicants (including heavy metals, hydrocarbons and organochlorines). Some coastal waters are also degraded by acidic leachates from coastal acid sulfate soils.

Nutrients [CO Indicators 6.4 and 7.5]

Nitrogen and phosphorus support the growth of plants and phytoplankton in coastal waters. Nitrogen availability generally limits plant growth, and in estuarine systems where nitrogen fixing algae proliferate, phosphorus is often the limiting nutrient (e.g. in Peel Inlet and Harvey Estuary in Western Australia, and the Gippsland Lakes in Victoria).

The National Pollutant Inventory (NPI) provides information on the relative contributions of nitrogen and phosphorus from both point and diffuse source discharges to

Table 5: Total nutrient emissions for selected coastal regions (1000 kg).

Coastal region	Land use	Phosphorus		Nitrogen	
		Point ^A	Diffuse ^B	Point ^A	Diffuse ^B
Peel–Harvey (WA)	Agriculture	na	260	na	1 800
Esk/Tamar (Tas)	Agriculture	150	360	390	1 600
Dawson River (Qld)	Agriculture	20	1 700	28	6 400
Latrobe–Thomson (Vic)	Agriculture	18	410	44	3 800
Richmond River (NSW)	Agriculture	5.8	250	na	1 700
Darwin Harbour (NT)	Mix	68	47	270	590
South-east Queensland (Qld)	Mix	1 300	1 500	3 300	7 000
Water Catchment Adelaide (SA)	Urban/Industrial	210	64	920	550
Port Phillip Bay (Vic)	Urban/Industrial	2 500	190	8 500	2 300
Botany Bay (NSW)	Urban/Industrial	1 300	48	7 600	280
Lake Illawarra (NSW)	Urban/Industrial	190	25	970	170

^A Emissions of Total Phosphorus and Nitrogen from Reporting Facilities 1999–2000.

^B Emissions of Total Phosphorus and Nitrogen to Water from Aggregate Sources 1999–2000. Diffuse source pollution represents aggregated data for which there may be significant error of estimation, ranging up to +/- 50% for data for WA and 3 to 13 times for diffuse source estimates in Tasmania. There are significant qualifications to the National Pollutant Inventory estimates and information on the website should be consulted before quoting and/or interpreting these figures.

na none reported.

Source: <http://www.environment.gov.au/epg/npi/> (October 2001).

coastal waters. However, it should be noted that the data for diffuse source pollution is likely to be largely an estimate at this early stage of implementation of the NPI.

This early data suggests coastal and marine waters adjacent to:

- heavily urbanised or industrialised areas (e.g. Port Philip Bay, Botany Bay, Adelaide) are likely to receive the majority of their nutrients from point sources, and
- less populated rural and agricultural lands (e.g. Dawson River, Latrobe–Thomson, Richmond River) are likely to receive the majority of their nutrient loads from diffuse sources.

One area that has been well studied is the Great Barrier Reef region, which is particularly susceptible to nutrient enrichment because it is relatively enclosed and shallow (EPA 1999a). A June 1999 workshop discussed the sources, fates and consequences of pollutants within the Great Barrier Reef (Hutchings and Haynes 2000). The reduction of pollution loads from agricultural catchments continues to be the key to the ecological health of the Reef system.

Point sources of nutrient pollution to coastal waters are derived from a number of activities, including wastewater treatment plants, landfills, and industries such as wood product manufacturing and paper production.

Discharges from wastewater treatment plants represent the great majority of phosphorus and nitrogen point source discharges. Table 6 indicates the relative contribution of nutrients from wastewater treatment plants to the total nutrient load from point sources in some coastal regions.

Where urban expansion is planned, there is the potential to increase nutrient loads to already nutrient-rich marine waters. The Western Australian Environment Protection Authority, for example, is concerned that proposed urban expansion along Perth's south-east and north-east corridors could increase nutrient loads to the already highly eutrophic Swan–Canning estuary system. Phosphate inputs from new residential areas in the Southern River catchment could start affecting the Southern River in less than 10 years (Gerritse 1999).

Sediment [CO Indicator 6.3]

Sediment levels in coastal environments are highly variable, depending on climatic and catchment factors. Extreme rainfall events combined with an extensively cleared catchment will result in relatively high sediment losses. Essentially all sediment transported to coastal areas is from diffuse sources, suspended in agricultural and urban runoff. However, building and construction sites can contribute significantly at the local level.

Table 6: Proportion of total point source emissions of nutrients to coastal regions attributable to wastewater treatment plants.

Coastal catchment	Major wastewater treatment plants	%P	%N
Water Catchment Adelaide	Glenelg, Port Adelaide	100	100
Darwin Harbour	Ludmilla, Leanyer Sanderson, Larrakeyah	98	90
Derwent	Macquarie Point, Prince of Wales, Rosny	92	87
Esk/Tamar	Ti-tree Bend, Hoblers Bridge, Newnham, Norwood	87	97
Dawson River	Calliope River	100	100
SE Queensland	Luggage Point, Elanora, Rocklea	92	94
Port Phillip Bay	Werribee, Bangholme	100	99
Botany Bay	Cronulla, Malabar	100	99
Lake Illawarra	Bellambi, Port Kembla, Shellharbour, Wollongong	100	100
Richmond River	Casino	100	na

Source: <http://www.environment.gov.au/epg/npi/> (October 2001).

Most sediment exported during infrequent, intense storms, includes adsorbed phosphorus, organic material and pesticides that may be on suspended clay particles. For example, during Cyclone Sadie in 1994 the Herbert River in Queensland discharged over 100 000 tonnes of suspended sediment, sourced principally from grazing land. This would be sufficient to cover the whole of Sydney in 2 centimetres of soil (Mitchell and Bramley 1997). (For more information refer to the Land Theme Report).

Queensland's State of the Environment Report (EPA 1999a) notes that the increase in catchment sediment yield is considered to be attributable to higher sediment yield from cleared land. In view of continuing vegetation clearing, the natural sediment supply regime can be expected to be affected further in some regions and be particularly evident in more remote regions. Given the already significant impacts of sediment discharges, this should raise major concerns over permitting additional agricultural clearing and coastal development in Queensland and elsewhere, specifically in terms of the potential for further sediment pollution of estuaries and coastal waters.

Pathogens

Public health may be at risk from high concentrations of faecal coliform and enterococcal bacteria in estuarine and coastal waters, either through contact recreation (especially swimming) or consumption of contaminated seafood. Along some beaches (e.g. in the Sydney Harbour) and under certain conditions (following heavy rains or sewage system overflows), beach users risk a range of illnesses such as carditis, conjunctivitis, hepatitis, and skin and wound infections.

Toxicants

Toxicants are chemical contaminants such as metals, aromatic hydrocarbons, pesticides and herbicides that can potentially have toxic effects at concentrations that might be encountered in the environment. The use of pesticides and herbicides, especially in agricultural production, can result in these compounds being transported by stormwater into estuarine and marine environments where they accumulate in sediments and can affect the communities of invertebrates living in soft sediment habitats.

There is no national overview of the extent and levels of toxicants found in coastal waters and sediments, neither is there nationally available information for the emission of toxicants from diffuse source pollution.

Although concentrations of heavy metals and organochlorine compounds along the Great Barrier Reef coast are generally low, there are hot spots of pollution adjacent to ports and harbours, urban centres and areas adjacent to intensive agricultural activity (Haynes and Johnson 2000).

Although there have been only two reporting periods since the National Pollutant Inventory reporting commenced, there are signs of possible reductions in emissions from some facilities. Most notable in Table 7 are the reductions in emission of:

- various hydrocarbons from the BP refinery at Bulwer Island, Brisbane,

Table 7: Selected emissions from selected reporting facilities for 1998–2000 (kg).
Reporting periods 1 July 1998–30 June 1999 and 1 January 1999–31 December 1999.

Reporting Facility	Substance	1998–1999	1999–2000
Werribee wastewater treatment plant, Melbourne	Arsenic and compounds	—	780
	Chromium VI and compounds	—	1 300
	Lead and compounds	—	520
BHP Steel, Port Kembla	Cadmium and compounds	—	120
	Cyanide	—	3 800
	Lead and compounds	—	520
Caltex refinery, Kurnell	Benzene	—	5 000
	Toluene	—	3 200
	Xylene	—	3 300
BP refinery, Brisbane	Benzene	120	84
	Cadmium and compounds	10	7
	Chromium VI and compounds	10	14
	Lead and compounds	40	40
	Polycyclic aromatic hydrocarbons (PAHs)	220	150
	Toluene (methylbenzene)	130	85
	Xylene and isomers	190	130
Caltex refinery, Brisbane	Arsenic and compounds	15	12
	Cadmium and compounds	7	12
	Chromium VI and compounds	15	9.5
	Cyanide (inorganic) compounds	—	45
Bangholme wastewater treatment plant, Melbourne	Ammonia (total)	3 200 000	3 000 000
	Chromium and compounds	—	900
	Copper and compounds	2 500	2 100
	Lead and compounds	—	900

Source: <http://www.environment.gov.au/epg/npf/> (October 2001).

- ammonia and copper from the Bangholme wastewater treatment plant, Melbourne, and
- arsenic and chromium from the Caltex refinery, Brisbane.

Along with reductions to some emissions there are also increased emissions, for example in:

- cadmium emissions from the Caltex refinery, Brisbane, and
- chromium emissions from the BP refinery, Brisbane.

While information in Table 7 represents known discharges of toxicants from point source pollution, unauthorised and unreported spills may be significant, such as the alleged discharge of 1032 kilograms of arsenic to Cockburn Sound by Wesfarmers CSBP between July and September 1999 (DEPWA 2000).

Tributyl tin (TBT) is used as an antifouling treatment for boats and ships, and has been shown to cause imposex in marine snails at extremely low concentrations. Imposex is the development of male reproductive organs in female snails, making the snails sterile. This phenomenon raises concerns about the ecological impacts of continued TBT use (DEPWA 2000).

In general, toxicant contamination is associated with industry and past effluent management practices. Point-source discharges have, since the 1970s, had to meet increasingly stringent emission limits. However diffuse-source discharges of toxicants, from both agricultural and urban sources, continue effectively unchecked.

Acid sulfate soils

Coastal acid sulfate soils (CASS) have been recognised as contributing to one of the most important water quality issues in coastal lowlands and estuaries (see Coastal Settlement section on page 44). Acid runoff causes adverse impacts to the environment, in terms of:

- poor water quality with loss of amenity;
- loss of fisheries, wetland biodiversity and aquacultural production;
- additional maintenance of community infrastructure, particularly from acid erosion; and
- the need for rehabilitation of disturbed areas.

Nutrients affecting the Cockburn Sound environment

Cockburn Sound, located south of Fremantle, is the most intensively used marine embayment in Western Australia. Increasing urban and industrial development of the adjacent coast since 1954, and increased inputs of industrial discharges and sewage during the 1960s, led to substantial loss of seagrass.

Management plans put in place in the 1970s had some success in reducing point source discharges. However, water quality has remained at levels found in the 1970s because high winter river flow from the Peel–Harvey and Swan–Canning estuaries carries land-sourced nutrients into the marine environment. The export of nutrients from these catchments to the ocean is estimated to have increased fourfold over the past 50 years (DEPWA 1996).

Seagrass meadows have continued to decline in area, and the species which grows in Cockburn Sound (*Posidonia*), may only recolonise very slowly (if at all), so the losses may be permanent.

The trend in nutrient-related water quality of Cockburn Sound since the 1970s has been initial improvement and subsequent deterioration (Environment Western Australia 1998).

To deal with the issues of coordination and integration in Cockburn Sound, the Cockburn Sound Management Authority was established in 2000 to manage the various uses of the Sound.

Increased acidity in waterways causes fish kills, outbreaks of fungal diseases in fish and leads to the presence of aluminium and iron flocs in the water. The full extent of ecological impacts of acidic waters in estuaries is not yet known.

Impacts on marine and estuarine water quality

The effects of pollution on aquatic ecosystems are dependent on a range of factors, including the nature of the receiving ecosystem, the mixing and dispersion of pollutants, whether floods have transported materials, and on the bioaccumulation of contaminants in sediments, flora and fauna.

Eutrophication

In general, eutrophication of coastal waters occurs where these waters receive significant industrial discharges or urban and agricultural runoff. For example, a 1991 Parliamentary Select Committee report (1991) noted that, of the 22 estuaries in Western Australia's south-west, only seven had low nutrient levels, and these had forested catchments.

The majority of the eutrophic estuaries are fed by agricultural catchments. The situation for Western Australia's south-west estuaries has not improved, and except for the Peel–Harvey coastal catchment, phosphorus levels have not decreased.

The effects of eutrophication are evident Australia-wide; for example:

- in South Australia, at least 250 hectares of mangroves adjacent to the Bolivar sewage outfall have been lost to dieback and smothered by large drifts of sea cabbage. The proliferation of sea cabbage, promoted by nutrient discharges, is also killing seagrasses off the Adelaide metropolitan coastline, where total seagrass loss since 1935 is estimated at 5000 hectares.
- in Western Australia, toxic algal blooms occur annually in the upper reaches of the Canning and Swan Estuaries, and extensive areas of seagrass have been lost to epiphytic algae in Cockburn Sound, Geographe Bay, and Princess Royal and Oyster Harbours. In February 2000, the Western Australian Health Department warned against eating mussels from the Peel–Harvey Estuary following an outbreak of a toxic algal bloom. At the same time, sections of the Swan River were closed to the public following the first recorded major bloom of the toxic blue-green alga *Microcystis aeruginosa*.
- in Victoria, toxic algal blooms have occurred in the Gippsland Lakes, causing extensive fish deaths and affecting fisheries and the local tourism industry.
- in New South Wales, between 1997 and 1999, two algal blooms potentially harmful to marine organisms and seven blooms potentially toxic to humans were recorded. These bloom frequencies were similar to those recorded between 1994 and 1996.

Contaminated edible bivalves in the Ballina and Newcastle areas lead to 59 and 23 cases of gastroenteritis, respectively.

- an algal bloom in the Wagonga Inlet near Narooma in October 1999 caused a temporary halt to oyster harvesting in affected leases. There were also 50 algal blooms between 1997 and 1999—double the number in the previous three years (EPA 2000a).

Sedimentation

Increased sediment loads are affecting almost all of Australia's coastal waters. Even in the sparsely populated north-west of Western Australia, sedimentation is severe and is directly linked to pastoral activities and over-grazing. Though not a coastal water, Lake Argyle provides an opportunity to evaluate sediment transport from the pastoral areas. Sediment has accumulated in Lake Argyle (since it was created by the Ord River Dam in 1971) at an average rate of 24 million cubic metres per year, which by 1998 represented a little over 10% of the original volume (Environment Western Australia 1998). Rehabilitation of the areas of the Ord River catchment degraded by pastoral activities has been ineffective.

Turbidity from suspended sediment can have serious physical impacts on aquatic ecosystems, including clogging and damaging the gills of fish, and loss of shellfish and other invertebrates from sediment ingestion. Along with the direct physical impacts on marine organisms, sediment contributes nutrient and toxicant loads to coastal waters in both urban and agricultural catchments, and so is a major concern for coastal water quality.

The 1992 Western Australia State of the Environment Report observes that:

- a single summer flood (date unknown) delivered 100 000 tonnes of soil to Beaufort Inlet and reduced its depth by 25 millimetres,
- the depth of Stokes Inlet has been reduced by 20–25 cm in 30 years,
- sediment almost filled the Irwin Inlet in a flood event (date unknown),
- many other south-western estuaries have become shallower since clearing for agriculture began, and
- sediment loads to south-western estuaries are a major source of nutrients, with those estuaries demonstrating eutrophic conditions.

In its studies of Port Phillip Bay, the CSIRO (Harris et al. 1996) has shown that sediments are the primary factor affecting water quality in the Bay. The study uncovered the basic features of nitrogen cycling in the Bay, where biogeochemical processes in the sediments assimilate and release nutrient loads.

Faecal contamination

Faecal contamination is a major concern where it affects recreational or aquacultural environmental values.

Monitoring of Sydney's ocean beaches shows that ocean beach water quality has improved very substantially since the commissioning of the deep ocean sewage outfalls in the early 1990s (see <http://www.epa.nsw.gov.au/beach/snapshot.htm> [accessed 5 September 2001]), and most of Sydney's beaches are now suitable for swimming most of the time. The New South Wales EPA's Beachwatch and Harbourwatch programs operate throughout the Sydney metropolitan area and in the Hunter and Illawarra regions, and reports to the community on the risks of sewage and stormwater pollution at swimming areas (<http://www.epa.nsw.gov.au/beach/index.asp> [accessed 5 September 2001]).

Faecal contamination by stormwater and sewage overflows following heavy rains is still causing some beach closures in Sydney's harbour and estuarine beaches, the Derwent Estuary in Tasmania, and Port Phillip Bay in Victoria.

Faecal contamination can also affect aquaculture activities. For example, in February 1997 an outbreak of hepatitis A was linked to oysters grown in Wallis Lake in central New South Wales, where the contamination was caused by poorly treated sewage entering the lake.

Toxicants

Toxicant concentrations are known for some coastal lakes and estuarine areas, but their effects on biota are poorly understood. Reports on toxicant monitoring indicate some 'hotspots' of contamination, for example:

- the presence of hydrocarbon 'biomarkers' in fish sampled in Cockburn Sound, Western Australia. Sampling adjacent to the Fremantle Fishing Boat Harbour had the highest levels of these biomarkers (DEPWA 2000).
- in the Port River estuary, Adelaide, monitoring during 1995–96 showed that sediment heavy metal concentrations (especially of copper and lead) at all sites exceeded guideline concentrations, and found high levels at some sites (copper, lead, zinc, mercury and cadmium).
- heavy metal contamination of Macquarie Harbour in Tasmania continues to be of concern, with the continued drainage of acidic mine water containing heavy metals into the Harbour (see 'The condition of an estuary' box on page 22).
- tests on fish, crustaceans and cephalopods taken from Moreton Bay in Queensland in 1995 found that lead, inorganic arsenic, chromium and nickel concentrations were, in most cases, below the level of detection. No sample contained a concentration of zinc, mercury, selenium or cadmium in excess of the maximum permitted concentration (MPC), but more than half the crustaceans tested for copper exceeded the MPC (EPA 1999a).

Acid sulfate soils

Coastal acid sulfate soils (CASS) disturbance has been linked to major fish kills and outbreaks of red spot disease in fish, and to the increased incidence of acid-tolerant, disease-carrying mosquitoes. The products of acid leachate from these soils have also been implicated in the increasingly severe *Lyngbya* blooms experienced in Deception Bay and Pumicestone Passage, Moreton Bay (although the blooms are also triggered by high phosphorus loads (Watkinson et al. 2000)).

In April 2001, acid plumes with a pH as low as 3 have been detected in the Richmond and Macleay Rivers in northern New South Wales (Collins, pers comm.). Although recent acid flows and effects are not as great as in the 1994 floods, frequent low-level acidic discharges will continue to kill benthic organisms and affect estuarine ecosystems. The annual loss of fish catch in New South Wales as a result of disturbed acid sulfate soils is estimated to be \$1 million, and a similar figure is estimated for the oyster industry (Department of Natural Resources 1999).

Responses to marine and estuarine water pollution

Society's response to the condition of our coastal waters and its capacity to support the waters' environmental values has taken many forms. The following list is not exhaustive, but intended to give examples of the various approaches adopted, with the focus on actions taken since SoE 1996.

Institutional

- A major revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality was released in 2001. These provide a risk-based framework for setting water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources. Each jurisdiction must develop water quality objectives based on the guideline values.
- In 1998, the National Environment Protection Council (NEPC) established a National Environment Protection Measure (NEPM) as the statutory basis for the National Pollutant Inventory. The NPI provides the community and other stakeholders with information on the discharge of pollutants to the environment.
- Australia's Oceans Policy (1998) recognised the continued degradation of Australia's coastal waters. Through this policy the Commonwealth Government is pursuing consistent water quality standards.
- All Australian States except New South Wales and the Northern Territory have finalised or are developing statutory environmental protection and/or planning policies for marine and estuarine water quality.
- In 2001, the Great Barrier Reef Marine Park Authority released a Water Quality Action Plan for the Great Barrier Reef with 10 year targets to reduce discharges from the entire Great Barrier Reef catchment (GBRMPA 2001).
- The Cockburn Sound Management Authority was established in Western Australia in 2000.

Management

- Within the last five years a number of local authorities or corporations have announced or implemented plans to upgrade the level of wastewater treatment. For example:
 - Environment Improvement Plans are in place for four wastewater treatment plants near Adelaide, and include nutrient reduction, additional treatment, greater reuse and improved dispersion from outfalls,
 - Western Australia's Water Corporation is committed to reducing suspended solids, bacteria, nutrient and heavy metals discharged from one of Perth's wastewater treatment plants, and
 - In September 1997, the New South Wales Government announced funding of \$60 million to assist councils with preparing stormwater management plans and for a stormwater education program (see <http://www.epa.nsw.gov.au/stormwater/usp.htm> [accessed 5 September 2001]).
- In April 1998 the New South Wales EPA issued a legal direction requiring councils to prepare stormwater management plans. More than 80 plans were received by July 2000.
- Melbourne Water and local councils have developed a Stormwater Agreement, and 23 metropolitan councils have prepared Stormwater Management Plans.
- The Commonwealth Government has allocated \$6.8 million to the Urban Stormwater Initiative, aimed at enhancing water quality in the waterways of major coastal cities through improved stormwater management.
- Sewage, stormwater and industrial discharges are now being viewed as a valuable resource. Wastewater is being treated and redirected away from ocean discharge to productive uses in agriculture and horticulture. Examples of recent programs funded through the Coasts and Clean Seas Initiatives include:
 - The redirection of stormwater and treated sewage from Brighton Council's wastewater treatment plant at Green Point in Tasmania for reuse on land. The redirection started in late December 1999. The outcome was the cessation of treated sewage discharges by the following year.
 - The construction of stormwater detention basins to treat the increased sewage and urban runoff from Hervey Bay's rapidly increasing population in Queensland. Treated water will be pumped into existing sewer and wastewater irrigation infrastructure to provide reuse water for crops such as sugar cane.
- In South Australia, construction of the Virginia Pipeline Scheme, delivering treated effluent from the Bolivar Wastewater Treatment Plant to the Virginia Plains horticultural areas, will reduce by up to 70% Bolivar's nitrogen discharges to the Gulf St Vincent.

Community

- In October 2000 the community-based Fitzroy Basin Association released its Central Queensland Strategy for Sustainability. The Strategy, which covers an area of 200 000 km², seeks amongst other matters to 'develop water quality and river health targets . . . and maintain the values of instream, riverine, estuarine and marine ecosystems' and to 'improve the management of landscapes and land uses which contribute excessively per unit area . . . to nutrient and sediment runoff into streams'.
- Introduced in 1998, the Commonwealth Government's Industry Partnership Program provides more than \$1.5 million to industry to undertake works that improve the quality, amenity and health of urban coastal waterways by reducing pollution from industrial sources.
- The Natural Heritage Trust's Coasts and Clean Seas Initiative, introduced in 1996, supports sustainable wastewater management in coastal areas. The program also aims to reduce marine pollution from other sources such as shipping, boating activities and aquaculture.

Conclusions and Implications

Many of Australia's coastal waters continue to receive ecologically unsustainable levels of pollutants. Algal blooms, triggered by excess nutrients, are causing massive ecological damage, threatening aquaculture production, and prejudicing the recreational amenity of many highly

valued coastal waters. Meanwhile, sewage overflows and untreated urban stormwater threaten aquaculture production (e.g. oyster farming) and cause authorities to close swimming beaches. Extreme rainfall events cause massive soil erosion and sediment discharges to coastal systems, carrying with it nutrients and other contaminants, and smothering benthic communities.

Over the last 20–30 years, increasingly stringent limits have been placed on point-source emissions, so that in many areas (e.g. Port Phillip Bay in Victoria, Cockburn Sound in Western Australia, Botany Bay in New South Wales, and Lake Illawarra in New South Wales) sediment pollutant concentrations have declined. However, there is still considerable potential for further reducing industrial discharges.

Of the point sources of pollution, wastewater treatment plant effluent remains the most intractable. The discharges from large treatment plants are orders of magnitude greater than other point source discharges and in some areas, the discharges are into relatively protected, poorly flushed coastal water systems where concentrations of pollutants and sediment loads can be high. Sydney Water and Western Australia's Water Corporation, for example, have constructed deep ocean outfalls to discharge large volumes of waste to areas where currents dilute and disperse the pollutants. Monitoring to date suggests there are no unacceptable environmental impacts from this practice, but the long-term sustainability is yet to be demonstrated because the indirect and possibly accumulating effects of various subtle-acting substances (such as hormone mimics) has yet to be assessed.

Wastewater discharges to estuaries and embayments (such as the Derwent River in Tasmania and Moreton Bay in Queensland) continue to contribute substantial loads of nutrients and toxicants to these poorly flushed systems, enhancing the accumulation of these substances in sediment and biota.

To date, the pursuit of estuarine and marine water quality objectives has been through waste management technologies treating point-source pollution, with the current major focus on reducing discharges from wastewater treatment plants. However, it is clear that estuarine and marine water quality will not be protected through point source controls alone. Emissions information in the National Pollutant Inventory indicates that diffuse source pollution is the major contributor to water quality degradation, whether derived from agricultural or urban stormwater.

All of society faces a major challenge to reduce pollution, and all levels of government must show leadership in this regard. There is a pressing need for governments to implement the National Water Quality Management Strategy, identify the environmental values and water quality objectives of our coastal waters, and estimate and pursue the pollutant load reductions needed to protect those environmental values. Once load reductions are established, economically efficient and equitable strategies must be formulated to address point and diffuse sources of the major pollutants of concern.

Also, suitable benchmarks for environmental values, including targets for species and habitats, must be established and incorporated into environmental quality objectives as part of an integrated approach to the management of pollutant loads.

A cooperative reporting and standardisation of methods for water quality assessment will be a key part of building a shared understanding of the problems and potential solutions.