Department of Sustainability and Environment

# Action Statement

Flora and Fauna Guarantee Act 1988 No. 177

## Alteration to the natural flow regimes of rivers and streams

### Description

Under natural conditions in Victoria, seasonal rains cause a cycle of high winter and spring river flows and low summer and autumn river flows. However, industrial and domestic users need a steady supply of water throughout the year, and agricultural users need more water during summer when natural flows are low. The generally dry climate and variable streamflows have resulted in the need for a high degree of river regulation to provide supply with appropriate security at different times of the year (McGuckin and Bennett 1999). River regulation is the most common cause of alterations to the natural flow regime of rivers and streams. River and stream ecosystems (or riverine ecosystems) refer to the whole system from headwaters to the mouth, and so include the channel, the riparian vegetation, any associated floodplain systems and also the estuary or terminal lake.

The effects of regulating and diverting the State's water resources has had a long-term impact on the aquatic ecosystems of our rivers and streams and associated estuaries and floodplains. These ecological impacts are described in a later section of this Action Statement.

As well as ecological effects, alteration to natural flow regimes can have negative impacts on Aboriginal cultural heritage values. Aboriginal cultural heritage values (places, sites and objects and creation stories) are commonly associated with freshwater resources and remnant native vegetation.

#### River Regulation

To cater for agricultural, industrial and domestic demands, reservoirs have been built on many major rivers to store water during high flow periods and release it as required. The Officer for the Commissioner for the Environment (OCE 1988) reported that there are 70 major water storages in Victoria, most of which are committed to irrigation or domestic use. These large dams can have a serious impact on the downstream flows of water by trapping a high proportion of the natural flows.

Changes to flow can occur in rivers without large dams, through smaller diversion weirs, private farm dams or pumping directly from waterways to crops or pastures or for storage in off-stream dams.

Inter-basin transfers can change the amount of water in a river. In the Murray River upstream of Hume Dam, the flows have been increased by 18% due to transfers from the Snowy River basin (Young 2001).

Storage, diversion or transfer of water can change natural flow regimes in a number of ways:

- Large dams can lead to less water overall flowing downstream. For example, until recently the Upper Yarra Reservoir trapped or diverted the entire inflow of the Yarra River. Flows in the Snowy River have been reduced to 1% of its natural flow immediately downstream of Jindabyne.
- Storage or diversion of water in summer, when flows are naturally low, can significantly reduce flows and extend low-flow periods. Exceptionally low flows may occur every summer, rather than only in the occasional drought year.

- Periods of zero flow may occur more frequently, or be extended in duration;
- Large dams can reduce or even eliminate downstream flooding. Floods and high flows are an important part of a river's natural flow pattern.
- Dams or diversions can reduce the frequency of small freshes (flows that produce a substantial rise in river height for a short period, due to short bursts of rain). These are a very important component of riverine ecology.
- The release of water from reservoirs during summer for irrigation can reverse the natural flow regime downstream, with high flows during summer and autumn rather than winter and spring (Cadwallader and Backhouse 1983, Merrick and Schmida 1984, OCE 1988).
- Releases of water from storages for hydroelectricity generation or irrigation can cause abnormally rapid changes in water depth and speed.

Thus, river regulation can have different effects on the flow regime depending on the requirements for water use (eg irrigation, winterfill or urban).

#### Channel changes

Artificial changes to river channels have also altered natural flow patterns. Many rivers have been deepened by dredging, straightened into channels, or had levee banks constructed along their banks with the intent of improving drainage, increasing their water flow and reducing the frequency and severity of flooding.

#### Catchment modification

While reservoirs and diversions can reduce the amount of water flowing in a river, catchment modification such as land clearing and urbanisation actually increases the amount of stormwater run-off reaching rivers and streams (NSW EPA 1997). Clearing land reduces the interception of rainfall on vegetation and the transpiration by plants, leaving more water to travel to the stream. Large areas of hard surfaces (such as roads, house roofs) greatly reduces the amount of water that would naturally infiltrate into the ground, directing it into stormwater drains where it travels more quickly to the stream. Alternatively, decreases in current stream flow may result from plantation development or extensive revegetation.

## Status of threat

Alteration to the natural flow regime of rivers and streams is listed as a potentially threatening process under the **Flora and Fauna Guarantee Act 1988**. In its final recommendation the Scientific Advisory Committee (SAC 1992a) has determined that the alteration to the natural flow regimes of rivers and streams due to human activities is a potentially threatening process, as in the absence of appropriate management it:

- poses, or has the potential to pose, a significant threat to the survival of a range of flora and fauna; and
- poses, or has the potential to pose, a significant threat to the survival of two or more taxa; and
- poses, or has the potential to pose, a significant threat to the evolutionary development of two or more taxa.

The process affects stream biota by reducing flows, altering the seasonality of flows, reducing the frequency and size of flood flows, altering river levels and increasing the rate of rise or fall in river levels (Cadwallader and Lawrence 1990).

The process is widespread across Victoria, though particularly so in areas where agriculture is the dominant land use. There are hundreds of water storages (dams and weirs) on natural waterways in Victoria that alter downstream natural flow regimes. Major storages exist in most catchments, except in East Gippsland and the Mallee. There are also untold thousands of small dams not located on waterways but on drainage lines or off-stream for storage of water pumped from a waterway that all have some impact on flow regimes. The extent of incremental impacts of small dams is not well known in most catchments. Where the impacts have been evaluated, changes to the flow regime have often been significantly higher than expected.

## Management Issues

Impacts on waterways are often the result of a number of threats, so it is generally the case that addressing a single threat will not restore the health of the ecosystem. To achieve Victoria's objective of healthy waterways as identified in the Victorian River Health Strategy (NRE 2002a), integrated action and identification of priorities is required. The mechanism for delivering this is the Regional River Health Strategies. These Strategies will describe priorities for threat management at a regional and local level. The catchment management authorities and Melbourne Water will use a risk-based approach to assist in identifying priority management actions, as described in Victorian River Health Strategy.

#### Ecological issues

Riverine flora and fauna have adapted to natural flow regimes (Koehn and O'Connor 1990a,b). Changes to these flow patterns can affect the survival of the whole river ecosystem, including estuaries and terminal wetlands. The natural flow

regime can be broken down into six flow components, all of which have specific environmental significance (NRE 2002a, NRE 2002b). The impact on biodiversity generally depends on which component of the flow regime is affected, and by how much.

**Zero flows (also called cease to flows)**

Zero flows refers to periods when there is no detectable flow of water (NRE 2002b). However, water can still be maintained in the channel in isolated pools. These pools act as temporary refuges for in-stream biodiversity during cease to flows, with biota restricted to the pools until flows begin again. However, over the dry period, water quality and volume in the pools can decline - the temperature increases, dissolved oxygen decreases and water quality characteristics such as salinity can increase as the water evaporates.

Periods of zero flows as a result of drought are a feature of many Victorian rivers (Boulton et al. 2000). Under natural conditions, these extreme events can cause large reductions in flora and fauna populations and may even make some localised populations extinct (Puckridge et al. 2000). Native species, however, are adapted to drought and have the capacity to recolonise from other refuges after it is over. Many native species go through an upstream migration as part of their life cycle so they are well adapted to recolonise suitable habitats (Koehn and O'Connor 1990b).

When water storage or diversion extends the frequency or duration of zero flows or causes drought conditions to occur every year, there is little chance for species to recolonise and they may be permanently lost. The numerous dams and weirs on Victorian waterways are also a barrier to recolonising migrations (McGuckin and Bennett 1999), further increasing the effect of zero summer flows.

Even if species are not made locally extinct, increased stress due to extending periods of zero flows may reduce population viability.

**Low Flows**

These are flows that provide a continuous flow over the bottom of the channel, but do not fill the channel to any great depth (NRE 2002b). The term is most often used in relation to baseflows that occur over drier periods of the year that are sustained for some period (weeks to months), even in the absence of rainfall. In general, these periods of low flows are associated with relatively low amounts of available habitat in the stream. Some parts of the stream bed or other habitat elements (boulders, in-stream debris) may be exposed (thus reducing the potential for algal and invertebrate production). While natural low flows place a certain level of stress on an ecological system, riverine flora and fauna are adapted to this part of the natural flow regime.

Storage or diversion of water can reduce low flows below normal discharges, or increase the duration of naturally low flows, placing additional stress on in-stream biota. Fish that depend on macroinvertebrates for food may not be able to access the food in shallow riffles. Shallow water also increases light penetration to the stream bed which may promote the growth of algae. Shallow water also prevents localised movements of biota, such as platypus which are well known to travel considerable distances in search of food and need to have passage between reaches of the river. Very low summer flows can cause a build-up of nutrients, chemicals or saline water in stagnant pools. These pools of high temperature and low quality water can cause death of resident fish and the vegetation alongside the river bank which helps to maintain the bank and protect it from erosion.

In estuaries a reduced stream flow allows salt water to travel further upstream. This changes the vegetation along the banks and the balance of estuarine and freshwater ecosystems.

Irrigation releases from storages can produce sustained high flows in summer when low flows are normally expected (Doeg 1984, Koehn *et al.* 1995). This, in turn, leads to increased erosion of river banks and changes to natural temperature regimes (SAC 1992b). If the water depth falls rapidly following the release, the water laden banks can collapse under their own weight, causing further bank erosion.

**Freshes**

Freshes are flows that produce a substantial rise in river height for a short period (usually measured in days), due to short bursts of rain (NRE 2002b). They generally occur in spring and summer. They play an important role in maintaining water quality in the stream environment, particularly during zero or low flows by refilling pools and providing inputs of fresher water. Depending on the level of low flows, freshes may allow fish and other biota such as platypus to move locally around the river, possibly gaining access across shallow riffles to new habitats. Small flushes of water also cause macroinvertebrate drift, redistributing animals around the stream, and may move organic material, redistributing food around the stream. During the longer low flow period, the river banks may dry out, so the freshes may replenish soil moisture for riparian plants. Freshes may also dislodge excessive algal growth on rocks, or temporarily move deposited sediment, cleaning the bed habitat (NSW EPA 1997). Storage or diversion

of water can eliminate freshes, reduce their volume or increase the time between freshes, placing additional stress on in-stream biota during low or cease to flows.

**High Flows**

This is a term often used in Victoria to describe the persistent increase in seasonal baseflow that occurs over autumn, winter and spring, but which remain confined in the channel (NRE 2002a, NRE 2002b). These periods usually last for weeks to months (which distinguishes them from freshes which may similarly fill the channel, but for short periods of time). During high flows, practically all habitat in the river (including boulders, logs, some lateral benches) is covered so that the maximum habitat is inundated and production is maximised. In this period the entire length of the channel is connected with relatively deep water, allowing movement of biota freely along the river - in the absence of barriers. Additionally, high flows may scour or redistribute sediment that may build up during low flow periods (some freshes also have this function). Large dams or high levels of winterfill diversions can reduce the size, frequency and duration of high flows.

Some native fish species rely on seasonal high flows during winter and spring as cues to start migration and prepare for spawning. Without these high flows their breeding is severely affected. Murray Cod Maccullochella peelii peelii, for example, migrate in early spring, returning downstream when river levels recede in early summer. Female Tupong Pseudaphritis urvillii migrate downstream to their estuarine or marine spawning grounds only during high flows in late autumn and winter (Koehn and O'Connor 1990b). The Broad-finned Galaxias Galaxias brevipinnis needs a rise in water level for spawning along the edges of streams and then another high flow to cover the exposed eggs before hatching. If the eggs remain exposed they will not hatch (O'Connor and Koehn 1998).

**Bankfull Flows**

These are flows that completely fill the channel, but do not break the banks. Bankfull flows are generally thought to have the function of determining and maintaining the shape of the channel, the so-called 'channel forming flows' or 'channel maintenance flows' (Gordon et al. 1992). Naturally occurring bankfull floods are important for maintaining river profiles. During floods sediment is moved and deposited. Reduced flooding causes a build-up of sediments, reducing water depth, filling in pools and smothering habitat. Without natural flooding the river channel can decrease in size, becoming incapable of containing the increased flows which may occur in very wet years.

**Overbank Flows**

Flows higher than bankfull spill out of the channel onto the floodplain. They are vital for the health of floodplain wetlands associated with a river system. Overbank floods that link rivers to their floodplains are thought to be an important mechanism in supplying organic inputs to the river from the floodplain.

Reducing the frequency and/or duration of overbank floods has impacts on fish, waterbirds, reptiles and amphibians. These groups rely on sufficient water to cover streamside and floodplain areas which provide their habitat. With reduced flooding, many floodplains, wetland and swamp areas have insufficient water supplies, while others dry up permanently.

The environmental impact of alterations to the natural flow regime of rivers and streams ultimately depends on the impact on these individual flow components. Thus, managing this threatening process depends on the provision or restoration of one or more of these natural flow components.

### Wider conservation issues

The release of the Victorian River Health Strategy (NRE 2002a) provides a solid basis for improving water management, for implementing this Action Statement, and for meeting the conservation objectives.

The Victorian Government recognises the importance of improving water management in catchment areas for a range of ecological, economic and social reasons. Protection, maintenance and enhancement of the natural resource is seen as a key requirement for economic and social health of the community. A primary goal of catchment management authorities, Melbourne Water, the Department of Sustainability and Environment and other bodies such as the Environment Protection Authority is to protect the water resource through targeted activities. It is through such programs that the objectives of this Action Statement will be realised.

Management of this threatening process will have an influence on the success of managing a number of other threatening processes listed under the **Flora and Fauna Guarantee Act 1988**, specifically

- Degradation of native riparian vegetation along Victorian rivers and streams (Nomination No. **354**).
- Alteration to the natural temperature regimes of rivers and streams (Nomination No. **230**);
- Prevention of passage of aquatic biota as a result of the presence of instream structures (Nomination No. **292**).

Management of this threatening process is an integral part of achieving quality catchment management and ecologically sustainable development.

## Previous Management Action

- In 1994 the Council of Australian Governments (COAG) agreed that the environment must be provided with enough water to meet its seasonal needs. Governments must now report regularly on their progress in providing environmental flows. Victoria is a signatory to this agreement.
- In 1994, the Murray-Darling Basin Ministerial Council instituted a cap on all diversions within the Murray-Darling Basin, which includes all north-flowing Victorian rivers and streams.
- Catchment Management Authorities have been established under the **Catchment and Land Management Act 1994**, replacing the Catchment and Land Protection Boards (Catchment Management Structures Working Party 1997). The role of the catchment management authorities is to ensure the sustainable development of natural resource based industries, the protection of land and water resources and the conservation of natural and cultural heritage. Catchment Management Authorities co-ordinate the development of Regional Catchment Strategies, which detail action plans and priorities for land and water resource management, including flows.
- The Victorian River Health Strategy (NRE 2002a) outlines a Water Allocation Framework to provide all users of water (including the environment) with entitlements that are explicit, exclusive, enforceable and tradeable, enabling water users and managers to make informed choices about water use to allow for certainty in long term planning. The Framework builds on many previous actions which were carried out in an uncoordinated manner. The key planks of the framework are:
  - Bulk Entitlements (BEs) which specify property rights to water held by Water Authorities which specify volume, rate of extraction, security and environmental conditions to be met;
  - Streamflow Management Plans (SFMPs) on unregulated rivers, which manage diversion licences by establishing environmental objectives, environmental flow provisions, mechanisms to achieve long term environmental flow objectives, rostering and trading rules, and rules covering the granting of new licences;
  - Stressed River Plans, which are produced for rivers where recommended environmental flow requirements have not been met though the water allocation process (which provides for environmental water needs within constraints of protecting existing rights). Victoria's River Restoration Program for Flow Stressed Rivers identifies ways and means to improve flows in priority flow stressed rivers to those required for maintenance of an ecologically healthy river.
  - A winter/spring Sustainable Diversion Limit (SDL - NRE 2002c), which specifies a minimum passing flow, a maximum extraction volume and a maximum rate of extraction for each catchment and subcatchment over the high flow period (June to October). The SDL is based on a conservative hydrological analysis and is designed as a rapid first approximation of how much water can be extracted over the June to October period without putting environmental values at risk. When licensed diversions approach the SDL volume, more detailed plans which include an environmental flow assessment (such as an SFMP) will to be developed.
  - Permissible Annual Volumes (PAV) have been developed for 64 groundwater management areas within the State. The PAV is a first cut estimate of the sustainable yield that can be licensed for extraction from groundwater.
  - Groundwater Management Plans (GMPs) are developed when the groundwater commitments reach 70% of the PAV. GMPs conduct more extensive studies into the groundwater availability, in order to identify the extent of groundwater use and opportunities for additional usage where the resource is available.
- A consistent method for identifying environmental flow requirements for Victorian rivers and streams was developed – the 'Statewide method for determining environmental water requirements in Victoria', referred to as the FLOWS method (NRE 2002b). FLOWS was developed for use in Stream Flow Management Plans and small to mid sized Bulk Water Entitlement conversions projects.
- A consistent approach for assessing impacts of farm dams on streamflows was developed – the Tool for Estimating Dam Impact (TEDI – Neal *et al.* 2000).
- A hydrological deviation index was included in the Index of Stream Condition as a method to evaluate flow stress when reporting on stream condition (Ladson and White 1999). This index will be revised in 2003-4 by DSE.

- The Farm Dam Review recommended that all commercial dams within a catchment should be licensed. Legislation implementing the recommendations of the Farm Dam Review has passed through Parliament.
- A Resource Manual for Environmental Flows (NRE 2002d) has been developed and has been used as a training and resource tool for those involved in identifying and providing environmental flows through the water allocation processes.

## Major Conservation Objectives

### Long term objectives:

1. To reduce the impact of changed flow regimes in rivers and streams to levels which do not compromise the viability of riverine biota;
2. To achieve a balance between the environmental and consumptive uses of water that maintains the ecological sustainability of riverine ecosystems;
3. To reverse declines in the conservation status of many individual species or ecological communities affected by changed water regimes.

### Short term objectives:

1. To reduce the impact of changed flow regimes in rivers and streams to levels which do not compromise the viability of riverine biota in priority catchments through the Bulk Entitlement, Streamflow Management Plans and Stressed Rivers Program;
2. To achieve a balance between the environmental and consumptive uses of water that maintains the sustainability of riverine ecosystems in priority catchments through the Bulk Entitlement, Streamflow Management Plans and Stressed Rivers Program;
3. To increase awareness amongst land and water managers and the community of the threat posed by changed flow regimes to biodiversity, and the most effective management responses.

## Intended Management Action

*The intended management actions listed below are further elaborated in DSE's Actions for Biodiversity Conservation database. Detailed information about the actions and locations, including priorities, is held in this system* and *will be provided annually to land managers and other authorities.*

### Water Allocation

1. Complete Bulk Entitlement Conversions for all urban and rural water authorities across Victoria.

   *Responsibility: Urban and Rural Water Authorities*

2. Establish and apply Statewide Rules for management of unregulated rivers as outlined in the Victorian River Health Strategy (NRE 2002b).

   *Responsibility: DSE (Catchment and Water Services)*

3. Complete Streamflow Management Plans in all identified priority catchments.

   *Responsibility: Urban and Rural Water Authorities*

4. Complete Stressed Rivers Plans in all priority catchments identified as flow stressed.

   *Responsibility: Catchment Management Authorities, Melbourne Water*

5. Apply winterfill Sustainable Diversion Limits in all catchments and subcatchments across Victoria.

   *Responsibility: DSE (Catchment and Water Services), Water Authorities*

6. Ensure groundwater and surface water allocations are integrated and that all Groundwater Management Plans address impacts on surface water flows.

   *Responsibility: DSE (Catchment and Water Services)*

7. Improve environmental water flows through implementation of the government's Water for the Future policy initiative.

   *Responsibility: DSE (Water Sector Development)*

### Planning

8. Ensure stormwater is adequately managed in new and existing urban development programs through Stormwater Management Plans by the provision of, for example, stormwater retention basins.

   *Responsibility: Local government*

9. Ensure that Regional River Health Strategies identify priority river reaches where environmental flows are inadequate and recommend strategies to improve them.

   *Responsibility: Catchment Management Authorities, Melbourne Water*

10. Encourage involvement of local Aboriginal people in water allocation planning, consistent with the commitment of the Indigenous Partnership Strategy, to recognise the fundamental role Aboriginal indigenous

communities have in natural resource management.

*Responsibility: DSE (Regions), Water Authorities, Catchment Management Authorities*

11. Participate in development of national approaches to management and monitoring of flow regimes through fora such as the Natural Resource Management Ministerial Council and Murray-Darling Basin Ministerial Council.

    *Responsibility: DSE (Water Sector Development), EPA*

12. Develop a consistent approach to setting environmental flow objectives for Bulk Entitlement conversions and Streamflow Management Plans.

    *Responsibility: DSE (Catchment and Water Services, Biodiversity & Natural Resources Division)*

13. Complete documentation of the Streamflow Management Plans process and guidelines.

    *Responsibility: DSE (Catchment and Water Services)*

14. Develop a summer hydrological stress index that can be used to identify priority stressed catchments, assist in flow restoration planning, and be incorporated into an upgraded Index of Stream Condition.

    *Responsibility: DSE (Catchment and Water Services)*

15. Develop principles and guidelines for protecting environmental values when water allocations are traded.

    *Responsibility: DSE (Catchment and Water Services)*

16. Further refine the FLOWS method for determining environmental water requirements to take account of wetlands and estuaries.

    *Responsibility: DSE (Catchment and Water Services, Biodiversity & Natural Resources Division)*

#### Education and extension

17. Implement a training program for regional staff and community project groups involved in water allocation and environmental flow programs.

    *Responsibility: DSE (Catchment and Water Services, Biodiversity & Natural Resources Division)*

#### Research

18. Undertake, as funding becomes available, technical research in priority areas:
    - Further investigate causal links between changes to flow regimes and biota or ecological processes;
    - Make improvements to hydrological modelling techniques to allow daily flow series to be constructed;
    - Develop engineering solutions allowing passing flows to be provided from new and existing farm dams;
    - Develop and refine on-farm and supply based water efficiency measures.

    *Responsibility: DSE (Catchment and Water Services, Biodiversity & Natural Resources) DPI (Agriculture)*

#### Resource assessment and monitoring

19. Conduct farm dam assessments using the Tool for Estimating Dam Impacts in all priority catchments.

    *Responsibility: Catchment Management Authorities, Water Authorities*

20. Develop a monitoring framework to assess environmental change following the implementation of environmental flows.

    *Responsibility: DSE (Catchment and Water Services, Biodiversity & Natural Resources Division)*

21. Develop appropriate performance indicators for this threatening process to assist land and water management authorities in environmental audit and condition of catchment requirements.

    *Responsibility: DSE (Catchment and Water Services, Biodiversity & Natural Resources Division)*

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**Compiled by Tim Doeg, Environmental Consultant, and Shelley Heron, Heron Environmental Consulting.**

**Further information can be obtained from Department of Sustainability and Environment Customer Service Centre on 136 186.**

**Flora and Fauna Guarantee Action Statements are available from the Department of Sustainability and Environment website: http://www.dse.vic.gov.au**

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