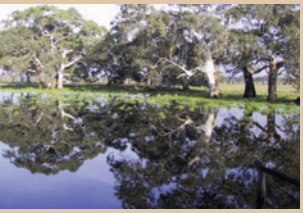
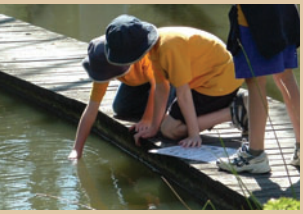
Morambro Creek Water Allocation Plan





Government of South Australia

South East Natural Resources Management Board

Water Allocation Plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area

Prepared by the South East Natural Resources Management Board

January 2006

Government of South Australia
South East Natural Resources Management Board

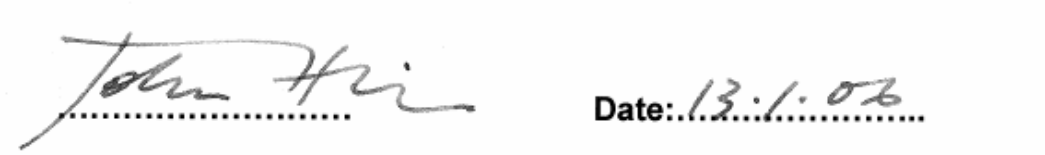
Natural Resources Management Act 2004

Water Allocation Plan

For the

Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area

I, John Hill, Minister for Environment and Conservation, hereby certify that this plan is the Water Allocation Plan for the Morambro Creek Prescribed Water Resources Area adopted by me on 13th January 2006.



Hon John Hill MP
Minister for Environment and Conservation

Prepared by the

South East Natural Resources

Management Board

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1 Morambro Creek Prescribed Area

This document is the Water Allocation Plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area (hereafter Prescribed Area), pursuant to Part 2, Division 2 of the *Natural Resources Management Act 2004*.

The Prescribed Area was prescribed on the 12th April 2001 under the provisions of the *Water Resources Act 1997.* The area of prescription is marked in blue on Government Records Office plan No. 149/2001 (including Cockatoo Lake and Nyroca Channel). It was prescribed in response to an increase in demand for water for aquifer recharge schemes to address the increasing salinity of the adjacent underground water resource in the Padthaway Prescribed Wells Area (PWA).

The Prescribed Area is a significant surface water and watercourse resource in the South East of South Australia, having important ecological and social values, that are likely to be affected by water diversion. The headwaters of Morambro Creek are located in the western part of the Wimmera region of western Victoria. The creek flows from Victoria into the Upper South East of South Australia near Frances, flowing westerly to Cockatoo Lake (approximately 26 kilometres (km) north east of Naracoorte). Cockatoo Lake is one of few permanent inland water bodies in the South East and is an important waterbird refuge. The lake is also an important recreational resource for water skiing and boating. Water then flows along the Nyroca Channel passes through the Harper range via the part of the Nyroca Channel completed in the early 1980s, finally discharging into the Marcollat Watercourse (see Figure 1).

The Prescribed Area covers a catchment area of approximately 22,487 hectares (225 km^2), and includes 30 km of the Nyroca Channel. It intersects parts of the Hundreds of Binnum, Geegeela, Hynam, Lochaber, Glenroy and Marcollat.

The climate in the Prescribed Area is typical of the South East, with hot, dry summers and cool, wet winters. The average annual rainfall recorded at Frances (1889-2002) is 525 millimetres (mm)/year, which compares with other recordings from stations located at Kybybolite and Naracoorte. The average annual evaporation is estimated at 1,480 mm/year (Kybybolite Research Centre).

The majority of existing users divert water from the Morambro Creek or the Nyroca Channel. Others divert water via dams or drainage wells. The diverted water is used for aquifer recharge, stock, domestic, irrigation and recreation purposes. There is no industrial use in the Prescribed Area. Demand for water from the Prescribed Area is expected to increase.

1.1 The Prescribed Resource

Morambro Creek is an ephemeral stream that flows on average 3 in 5 years. The highly variable nature of its flows is typical of South East streams. Analysis of available data indicates that 70-90 percent of the creek's flow originate from the catchment in Victoria. Cross-border mean annual flow estimated from flow records at Frances is 2,500 megalitres (ML) to 3,000 ML. The characteristics of creek flows are influenced by the occurrence of dams, drainage wells and natural runaway holes west of Frances.

The mean annual flow recorded at Frances and the Bordertown-Naracoorte Road Bridge gauging station are similar, which implies that transmission losses between Frances and the

gauging station are almost equal to the catchment contribution to run-off in this area. Trends show that flows greater than 100 ML/ day at the gauging station only occur (on average) two to three times a year, with an average event duration of three days.

Approximately 100 drainage wells and natural runaway holes are scattered throughout the upstream portion of the catchment. It is likely they capture a significant portion of the surface water run-off in the catchment downstream of Frances, especially in the Pretty Gully area.

Watercourse water salinity measured at the Bordertown-Naracoorte Road Bridge gauging station has mostly been below 200 milligrams/ litre (mg/L) (as total dissolved solids) for a range of flows. The salinity levels are significantly below the threshold for adverse impacts on water dependent ecosystems.

For the most part Morambro Creek is in ecological equilibrium, depending on the current hydrological regime and is therefore dependent on the flow it currently receives.

1.2 Cross-jurisdictional issues

As stated above, the headwaters of Morambro Creek are located in western Victoria, it is estimated that between 70% - 90% of the flows in the creek originate from the catchment in Victoria. The health of Morambro Creek, and availability of water for licensed users may be threatened by changed volumes and patterns of flow resulting from potential land use and land management changes from Victoria. The flows will be affected by land use changes and changes to agricultural management practices as fresh surface water becomes more highly valued and sought-after for beneficial use.

At present there are no formal surface water arrangements in place between the South Australian and Victorian governments to ensure a whole-of-catchment approach to management of Morambro Creek, nor for any of the other cross-border creeks in South Australia. The South East Natural Resources Management Plan identifies this issue as a threat to sustainable water resource management. It describes the development of a surface water agreement with Victoria as a key action for implementation. Discussions are underway with relevant Victorian regionally- based bodies with a view to developing a Memorandum of Understanding to enable better engagement on cross-border natural resource management issues and effectively implement a whole of catchment approach to management of the water resources of Morambro Creek and other shared surface waters. The proposed Memorandum of Understanding is the first step in fulfilling the vision of the South East Natural Resources Management Plan.

It is recognised that water requirements in Victoria may need to be taken into account as part of any intergovernmental agreement for the shared catchments between South Australian and Victoria. This may require a review and possible amendment to this Plan.

1.3 Links to other resources

The Prescribed Area overlays portions of the underground water resources of the Padthaway and Lower Limestone Coast PWA (formerly Naracoorte Ranges, Comaum-Caroline and Lacepede Kongorong PWAs). The volume of underground water available for allocation in these areas is generally based on the estimated annual average vertical recharge to the watertable. As water from the Prescribed Area contributes to underground water recharge of PWA, great care is required to prevent double counting of the water when

calculating sustainable limits. The importance of the surface waters to the underlying aquifer may also be significant. Underground water in both the Padthaway PWA and the relevant management areas in the Lower Limestone Coast PWA are fully allocated and controlled through Water Allocation Plans. The relationship between the prescribed surface water resource and the prescribed underground water resources is a function of the runaway holes, drainage wells, the permeable base within the creek, and infiltration through the surface of the catchment.

Downstream and beyond the Prescribed Area, the Marcollat Watercourse is of significant conservation value to the upper South East due to its size and diversity of flora and fauna. It receives water from the Morambro Creek, Naracoorte Creek via Drain E and from its own local catchment. The watercourse extends for approximately 30 km from the south-western edge of the inter-dunal flat between the Harper Range and Stewart Range, flowing north-westerly towards Jip Jip Conservation Park.

It is estimated that Morambro Creek contributes 35 percent of the total flow within the Marcollat Watercourse. The moderate flows from Morambro Creek are more important than Morambro high flows, as the Naracoorte Creek is the main contributor of high flows into the Marcollat Watercourse. Together the flows are important in maintaining the high flow bands and removing salt from the wetland system. Current flows are much lower than historic levels due to the diversion of Mosquito Creek to Drain M.

1.4 History

1.4.1 Pre-European settlement

From the Victoria-South Australian border the creek naturally meandered to the Gap in the Naracoorte Ranges, where it would spill in wet times to the lower-lying land to the west. West of what is now the highway, the water spread out over the land at Dickenson's corner and found its way to the existing Cockatoo Lake, Clay Lake and Salt Lake following no defined path. It eventually found its way to the Marcollat Watercourse many kilometres north of the Nyroca Cutting.

1.4.2 Post Settlement

Soldier settlement, particularly after the Second World War, resulted in extensive native vegetation clearance for agricultural development. Consequently, there is now higher surface water runoff into the creek, and higher rates of underground water recharge through the landscape and via runaway holes and drainage wells.

Flows from Victoria also increased as a result of land clearance.

The area from the Victorian border to the Riddoch highway also saw many small surface drains being constructed.

A channel was constructed to Cockatoo Lake (in the1920's) to limit flooding east to what is now the Riddoch Highway (Dickenson's corner). When Cockatoo Lake filled it would spill onto the plain (the Padthaway Flat) and inundate low lying land including Salt Lake, Clay Lake and areas to the east of the Harper Range. In wet years, very large areas east of the Harper Range were inundated. The water would slowly makes its way north, eventually reaching the Marcollat Watercourse at a low point of the Harper Range west of Padthaway.

In wet years, large volumes of surface water also discharged to the underground water via runaway holes and local areas of transmissive soils and geology.

In the late 1950's an outlet was constructed at the Nyroca Cutting, allowing some flow to reach the Marcollat Watercourse by this route in wet years.

1.4.3 1970's-1980's

The 1970's was a time of very active agricultural development, vegetation clearance and increased drainage, contributing to comparatively higher surface water run-off. The era also experienced above average rainfall.

Higher volumes of in-flow through surface drains to the creek and recharge through runaway holes and drainage wells in the catchment area occurred.

In the area directly west of the Victorian-South Australia border, further development of small surface drains and drainage wells reduced the extent and duration of localised inundation of agricultural land. The Morambro Creek was modified with the construction of a channel at Heralds Lane and levee banks at Lake Cadnite which reduced its capacity by half (original capacity was approximately ~2,260 ML).

In general the creek began to receive larger, higher velocity flows during this time, being attributed to incoming flows from Victoria, modifications to Lake Cadnite and run-off from the catchment into the creek. Channel and creek bed erosion became an issue.

The Riddoch Highway to Cockatoo Lake section of the Morambro Creek was deepened. This resulted in faster filling of Cockatoo Lake and cessation of flows to Clay Lake and Salt Lake.

The Nyroca Channel was extended from Cockatoo Lake to the Nyroca Cutting, reducing the extent and duration of inundation of the Padthaway Flat, east of the Harper Range.

In combination, these changes reduced the extent and duration of inundation, altered the flow path, altered the hydrology of Cockatoo, Clay and Salt Lakes, more quickly directed greater flows to the Marcollat Watercourse via Nyroca Cutting, and reduce the opportunity for point source discharge (runaway holes and drainage wells) and diffuse discharge (through soils and geology) to the underground water.

1.4.4 Current landuse

The last 15 years have been a time of intensification and accelerated sophistication of agriculture. There was a virtual cessation of native vegetation clearance from the early 1980s. There was a significant expansion and refinement of irrigation using underground water, within the framework of the Padthaway Water Allocation Plan. The underground water was prescribed in 1976, and is currently subject to the Padthaway Water Allocation Plan 2001. There was little or no use of watercourse and surface water from the Prescribed Area for irrigation over this time.

The predominant land uses in the Prescribed Area between the Riddoch Highway and Frances are pastures, pasture seed and cropping. A small percentage of the landscape is used for irrigated agriculture.

Further development of surface water drains and drainage bores has occurred in the South Australia and Victoria, with the creek being further deepened or converted into constructed channel.

Following further modifications, the current capacity of Lake Cadnite is now approximately 10 percent (230 ML) of its original size. With less water pooled in the wetlands and lagoons of the Prescribed Area, the potential for higher flows in Morambro Creek and recharge through runaway holes and drainage wells associated with the watercourse has increased.

West of the Riddoch Highway and near the Nyroca Channel, underground water irrigated agriculture is a significant land use. Crops include pastures, vines, pasture seed, lucerne seed and cereals. Land is also used for non-irrigated grazing and cropping. In recent years, there has been increased demand for the watercourse and surface water resources for aquifer recharge schemes to mitigate the trend of increasing underground water salinity in adjacent areas of the Padthaway PWA. The viticultural sector has been active in researching underground water salinity mitigation options.

While, the channel to Cockatoo Lake was deepened due to higher flow rates and erosion, there was little increase in recharge to the underground water through runaway holes and free-draining soils.

1.5 *The Plan*

For the purpose of this Plan the datum for the technical work on this plan is to be the date of prescription. To date the best use of available information has been made and gaps in the information have been identified.

Work programs to improve understanding of the dynamics of the prescribed resource are described in the Companion Document, with a view that the work be completed as far as possible in time for the review of this water allocation which is due to be completed in 2011.

2 Assessment of the needs of dependent ecosystems

Ecosystems within the Prescribed Area vary in their dependency on the local influence of water in the watercourse or run-off from the surface water area. Ecosystems may be entirely dependent, partially dependent, opportunistic or independent of the prescribed water resource.

2.1 Introduction

Consultants from Resource and Environmental Management undertook an assessment of the environmental water needs of the ecosystems within the Prescribed Area (REM 2003). The assessment described the Prescribed Area in eight land units (reaches) based on channel structure and capacity, catchment area, soil types and vegetation. These reaches are:

1. Reach 1- SA/Vic Border to Lake Cadnite
2. Reach 2 – Lake Cadnite to Herald's Lane
3. Reach 3 – Upper Plain,
4. Reach 4- Pretty Gully
5. Reach 5- The Gap
6. Reach 6- Padthaway Flat to Cockatoo Lake
7. Reach 7- Cockatoo Lake
8. Reach 8- Nyroca Channel

Four reaches lie on the Naracoorte Plateau, one in the Naracoorte Range and three on the Coastal Plain of the Padthaway Flat. Within each reach a number of ecosystems have been identified to be dependent on the prescribed surface and watercourse water resource.

Each ecosystem can be described in terms of its vegetation, fauna and physical processes components, and the flow requirements for each of those components. There are no strict boundaries between the ecosystems in this regard, for example fauna will occur in various ecosystems, depending on the flow situation. Processes will often link one part of the watercourse system with another, for example the linking of the floodplain and the in-stream zone during high flow events. Vegetation types are not always strictly limited to a particular ecosystem.

2.2 Ecosystems dependent on water in the Morambro Creek Prescribed Watercourse and Surface Water Area

Twelve ecosystems have been identified as being dependent on water associated with the eight reaches:

1. **Open Water** (Phytoplankton) - Provides hunting habitat for piscivorous (fish eating) birds and hunting habitat for insectivorous birds and bats.
2. **Submerged Aquatic Macrophytes** (*Vallisneria spiralis, Potomogeton spp*. and *Mypriophyllum spp.)* **–** Provides habitat for macro-invertebrate production, grazing and hunting water birds and bats, drought refuge for fish and a water source for terrestrial vertebrates.
3. **Emergent Aquatic Macrophytes** (*Eleocharis gracilis, Triglochin stri*ata and *Bolboschoenus caldwellii*) **–** Provides critical habitat to fish, frogs and macro-invertebrates for shelter, feeding and breeding.
4. **Sedgeland with Red Gum overstory** (*Bolboschoenus caldwellii*, *Eleocharis sephacelata, Schoenoplectus validus*, overstory of *Eucalyptus camaldule*nsis) - Provides nesting material for birds such as grebes and terns, feeding and breeding habitat for Golden-headed Cisticola and egg laying habitat for many birds (Ibis, Bittern, Ducks etc).
5. **Lignum Shrubland** (*Muehlenbeckia florulenta, Gahnia filum*) - Provides nesting and hunting habitat for Black-headed Cisticola and other birds.
6. **Stream Pools** (*Eleocharis acuta, Cotula coronopifolia, Trglochin procera*, and *Dischilis sistichophylla*)- Provides support for macro-invertebrate production, breeding and feeding habitat for fish and frogs, hunting habitat for insectivorous birds and bats, recharge soil moisture for Red Gums and a water source for terrestrial vertebrates.
7. **Stream Bed** (Eleocharis *acuta, Bolboschoenus caldwellii, Distichili distichophylla* and pasture grasses) - Important for the transfer of fish, invertebrates, plant propagates between reaches, grazing habitat for waterfowl and recharge soil moisture for Red Gum.
8. **Flood Dependent Riparian Zone** (*Poa labillardieri* and *Juncus ingens*) **–** Overhanging growth to shade and shelter fish.
9. **Drought Tolerant Riparian Zone** (Juncus australis and J. subsecundus) **–** Provides habitat for frogs and snakes.
10. **Red Gum Riparian Zone** (*Eucalyptus camealdulensis* over *Juncus spp*., *Cyperus gymnocaulos* and *Isolepis nodosa*) - Habitat for frogs, snakes and small mammals. Red Gum roots provide habitat for cryptic fauna including fish, yabbies and substrate for grazing macro-invertebrates.
11. **Red Gum Floodplain** (*Eucalyptus camealdulensis* over *Juncus, Juncus subsecundus, Carex inversa* and *Cyperus gymnocaulos*) - Red Gums provide nesting habitat for Cockatoos, ducks and other birds, roosting habitat for birds and hunting habitat for insectivorous bats and birds.
12. **Buloke Floodplain** (*Allocasarina leuhmanii* over *Juncus subsecundus, J. australis, Carex inversa var. inversa, Lepidosperma congestum* and *Lomandra sororia*) - Provides feeding habitat for Red-tailed Black Cockatoo.

2.3 Water needs of identified ecosystems dependent on water in each reach along the prescribed watercourse and surface water area.

Water requirements specify the water availability and quality on which ecosystems depend, and must account for the variability inherent in that dependence. The definition of water requirements is complex because the availability and quality of water in the watercourse and surface water area varies spatially and over time. The volume and timing of flow fluctuates seasonally and according to long-term climatic trends. A number of flow bands have been identified to support the different ecosystems in each reach. The processes that occur in each band are summarised below.

Table 2.1: Ecological processes associated with flows

Flow band	Ecological processes	Flow regime
No flow/ cease to flow	No flow in the streambed. Recovery and regeneration of grasses, sedges and Red Gums, growth and regeneration of stream bed vegetation. Sediment drying and nutrient processing. Population control of pests.	Base Flow (B1)
Intermittent pulses	Short duration flow events that fill deep pools in the creek bed and fill depressions in the catchment area. Provides aquatic habitat through summer and low flow periods for yabbies, fish, frogs and waterfowl and sustains grasses, sedges and Red Gums. Freshens water quality in pools.	
Sustained low flows	Water covers the streambed for a reasonable duration and creates connection between pools, causing fauna exchange and colonisation between deep pools. Supports recruitment of fish and invertebrates following triggering flows (high or moderate levels).	
Moderate flows	Flow sufficient to provide flora and fauna exchange with sites in Victoria, along Morambro Creek and watering of the riparian root zone. Contributes low salinity flow to the Marcollat Watercourse.	Moderate Flow (B2)
Bank full flows	Floods stimulates Red Gums and woodlands, promotes Red Gum recruitment, introduces organic matter to Morambro Creek from flora and fauna from pastures and transfer of aquatic biota between reaches. Provides low salinity flooding to the Marcollat Watercourse. Provides a trigger flow for aquatic fauna breeding.	High Flow (B3)
Over bank flows	Very high flows create wetland habitats, sustain floodplain Red Gums, promote Red Gum recruitment, flora and fauna exchange between lower reaches and recharge underground water dependent ecosystems.	

The environmental water requirements were defined for the eight reaches: Lake Cadnite, Herald's Lane, Upper Plain, Pretty Gully, The Gap, Padthaway Flat to Cockatoo Lake, Cockatoo Lake, and the Nyroca Channel. An outline of each reach and required flows are presented on page 9.

2.3.1 Reach 1 –SA/ Vic Border to Lake Cadnite

Lake Cadnite is located at Frances, close to the Victorian Border. Morambro Creek flows in via a small channel that widens into a broad, shallow depression on the Gilgai plain. Small, local drainage lines to the north also contribute runoff to the lake. Originally 226 ha in size (2,260 ML capacity), the lake area has been reduced by over 90 percent (to approximately 230 ML capacity) due to the construction of three metre high levee banks that exclude water from the greater part of the lake. The drained area is now cropped. Water flows out of the lake via a channel. Drainage wells in the area reduce the extent and duration of inundation, reduce flood risk to the Frances township and may contribute to reduced flows in the watercourse.

The reduced storage in Lake Cadnite has important implications downstream. Prior to the construction of the levee banks the lake would have captured initial winter flows, having the effect of buffering flows. There would have been smaller peaks to high flow events, and later commencement of downstream flows. As the lake filled, flow would have been gradually released downstream, resulting in low, persistent flows. Flow now occurs in shorter, more frequent pulses that follow individual rain events.

Four ecosystems occur in Reach 1: Sedgeland with Red Gum over-storey, Lignum shrubland, Red Gum riparian zone and drought tolerant riparian zone.

Table 2.2: Summary of environmental water requirements- Reach 1 Lake Cadnite

Flow band	Flow band description (height above bed level (m))*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
No Flow (cease to flow)	Lake bed dry (0 m)	Regeneration of grasses and sedges Germination of Red Gum	5.3	254	48	Summer/ Autumn
Low Flow	Lake bed waterlogged (0.1 m)	Support aquatic macrophytes growth Wetland habitat for water fowl grazing, frog breeding Trigger growth and reproduction of invertebrates, frogs and birds	9.5	76	8	Winter/ Spring
Moderate Flow	Through-flow to habitats upstream (0.5 m)	Potential for fauna and flora exchange with sites in Victoria	5.6	33	6	Winter/ Spring
High Flow	Through flow to habitats downstream (1.0 m)	Flood and stimulate Red Gum at lake fringes and on levees	1	1	1	Winter/ Spring
Very High Flow	Lake filled to capacity (2 m)	Fish migration from Padthaway Flat	0.1	0.1	1	Winter/ Spring

**Not all flow bands exist in Reach 1
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.2 Reach 2 – Lake Cadnite to Herald's Lane

The streambed and banks of Reach 2 have changed considerably from their original form due to channel realignment, grazing and clearing. The channel has little habitat value. However, it remains an important conduit for migrating fauna during continuous flow between reaches.

Low and moderate flows are critical to enable aquatic habitats to establish in the new channel environment. However establishment of vegetation is limited by grazing compromising the environmental value of low flow.

It is considered that Red Gum woodland associations, as a surface water dependent ecosystem, are subject to water stress as a result of reduced surface water flow, particularly overbank flow. The water table in this area is too deep to sustain these trees and instead they are likely to be dependent on the soil wetting resulting from over-bank inundation and infiltration from persistent standing water. Further investigations are required to establish the degree of stress the ecosystems may be experiencing and to suggest beneficial modifications to the current flooding regime.

Four ecosystem types occur in Reach 2: Stream bed, Red Gum riparian zone, Red Gum floodplain and drought tolerant riparian zone.

Table 2.3: Summary of environmental water requirements- Reach 2 Lake Cadnite to Herald's Lane

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
No Flow	Channel bed dry (0 m)	Colonisation of stream bed by pasture grasses and weeds	5	240	48	Summer/ Autumn
Low Flow	Flow in bottom of constructed channel (0.3m)	Macro-invertebrate regeneration Grazing habitat for waterfowl	9.4	57	6	Winter/ Spring
Moderate Flow	Flow reaches capacity of constructed channel (1 m)	Potential for fauna and flora exchange with sites in Victoria	7	49	7	Winter/ Spring
High Flow	Over-bank flow into Red Gum Woodland (1.5 m)	Flood and stimulate Red Gum at lake fringes and on levees	2	4	2	Winter/ Spring

**Not all flow bands exist in Reach 2
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.3 Reach 3 – Upper Plain

The Naracoorte Plateau between Herald's Lane and the intersection of Morambro Creek and Pretty Gully has a very low relief. The stream morphology on the upper plain provides a wide range of aquatic habitats that have the potential to support a diverse biota with important conservation values. The current diversity of Reach 3 is compromised principally by land management rather than flow. However there are significant threats to water requirements of the ecosystems in Reach 3.

Agricultural development of the area is likely to have increased the duration of dry periods and the frequency of intermittent low flows at the expense of sustained low flows. Agricultural land served by drains shed water more quickly than uncleared catchments. Being downstream, the reduced capacity of Lake Cadnite amplifies the effect for Reach 3. Less persistent flow reduces the opportunities for aquatic invertebrates to reproduce and reach maturity, for frogs to breed and for vegetation to grow and provide habitat.

Drains on the floodplain have also altered the hydrology of the stream. Drains may have increased the magnitude and frequency of high flows at the expense of medium flow duration, as local run-off from major storm events is drained to the stream more quickly. Drains also threaten the quality of floodplain habitat. Prior to development, and in very wet years water would have remained perched on the floodplain in oxbows and shallow wetland depressions. These types of habitats can provide important opportunistic habitat for waterfowl, fish and macro-invertebrates.

Land clearing and livestock grazing has resulted in the loss or degradation of much of the water dependent habitat in the riparian zone and on the floodplain. Protection from grazing and re-establishment of the riparian zone will be important management tools in protecting the resource and for maintaining the health of downstream ecosystems. However, environmental water requirements must be provided if these types of habitats are to recover.

Five ecosystems occur in Reach 3: Stream bed, Red Gum riparian zone, stream pools, drought tolerant riparian zone, and Buloke floodplain.

Table 2.4: Summary of the environmental water requirements- Reach 3 Upper Plain

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
Cease to Flow	Stream bed dry (0 m)	Thatching of Common Spike Rush to provide macro-invertebrate habitat	3.5	263	75	Summer/ Autumn
Intermittent Pulses	Fills deep pools (0.2 m)	Fill deep pools Top-up deep pools to provide semi-permanent aquatic habitat through summer Sustain aquatic fauna including yabbies, fish and frogs Support waterfowl breeding	5.5	28	5	Winter/ Spring
Sustained Low Flow	Continuous flow between pools (0.3 m)	Stimulate aquatic macrophytes on stream bed Fauna exchange and colonisation between deep pools	4.6	14	3	Winter/ Spring
Moderate Flow	Inundate first shelf of stream bed (1 m)	Recharge soil zone for riparian Red Gum Sustained duration supports frog, waterfowl, fish breeding in pools	5	50	10	Winter/ Spring
High Flow (Bank Full)	Inundate upper bank, continuous flows from local catchment (2 m)	Sustain drought tolerant sedges and rushes Runoff from pastures introduces organic matter, flora and fauna Recharge soil zone of riparian Red Gum and Buloke Recruitment of riparian Red Gum	2.2	5	2	Winter / Spring
Very High Flow (Over-bank)	Inundate floodplain (2.5 m)	Overflow from stream introduces flora and fauna to floodplain Recruitment of floodplain Red Gum Fauna and flora exchange with lower reaches	0.5	1	2	Winter/ Spring

**Not all flow bands exist in Reach 3
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.4 Reach 4 – Pretty Gully

Pretty Gully carries water which ponds at a depression upstream of the confluence with Morambro Creek. It is reported that the ponded water can drain quite suddenly down an intermittently effective runaway hole. Pretty Gully is characterised by a flood-prone swale with scattered wetlands depressions that are potentially linked with flood events. The upper sub-catchment includes areas of Red Gum wetlands, and associated Blue Gum and Bottle Brush woodlands. The wetlands are perched above the regional aquifer and are dependent on surface water flows. The lower sub-catchment supports species tolerant to flooding, similar to the floodplain of the Upper Plain Reach 3, particularly Buloke and rushes.

The sub-catchment is drained, cleared and cropped with the watercourse accessed by stock. A significant dam (>5 ML) has been constructed on the gully. It intercepts flows, with the greatest effect on low flows.

Seasonal waterlogging and sub-surface flow is important to the vegetation of Pretty Gully in sustaining Red Gum and Buloke and excluding flood intolerant species. Waterlogging also sustains wetlands by promoting the growth of sedges and rushes, which are important habitat for aquatic fauna. Seasonal waterlogging has been restricted in extent and duration by the construction of shallow drains to assist agricultural production. The swale is not dominated by aquatic vegetation, however, long dry periods (331 days dry per year) is important to sustaining its ecological character.

Low flows link wetlands within Pretty Gully, enabling depleted or disturbed habitats to be recolonised by plant and animal species. This process applies to the rest of Morambro Creek in high flows.

Three ecosystems occur in Reach 4: Red Gum riparian zone, drought tolerant riparian zone, and Buloke floodplain.

Table 2.5: Summary of environmental water requirements- Reach 4 Pretty Gully

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
No Flow	Gully bed dry (0 m)	Regeneration of drought tolerant sedges and rushes Resting stage of frogs	4.2	332	79	All year
Sub-surface Flow	Gully bed waterlogged (0.1 m)	Stimulation of sedges and rushes Grazing habitat for waterfowl Recharge of Buloke root zone	5	15	3	Winter/ Spring
Low Flow	Continuous surface flow (0.2 m)	Frog breeding Recharge of Buloke root zone Stimulation and spread of sedges and rushes	1.6	10	6	Winter/ Spring
High Flow	Sheet flow (0.5 m)	Exchange of fauna and flora with lower reaches	1	10	10	Winter/ Spring

**Not all flow bands exist in Reach 4
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.5 Reach 5 – The Gap

Morambro Creek falls 10 metres (m) over 1,500m through the Naracoorte Range, cutting through outcropping Bridgewater Limestone in a deep gully, called the Gap. The stream channel is 5 to 10 metres wide and 2 to 3 metres deep, with vertical or under-cut (overhanging) banks. The landscape adjacent to the watercourse is relatively undisturbed with limited stock access and intact riparian vegetation, which is contiguous with nearby Heritage Agreement reserves.

The Gap is distinctive in that it is the best-preserved habitat in the Prescribed Area and has the steepest gradient. The riparian zone is well established and the stream has a wide range of intact in-stream and floodplain habitats.

This reach is vulnerable to increased flash flows associated with changes to Lake Cadnite and land clearance and drainage upstream.

Four ecosystems occur in Reach 5: Stream bed, Red Gum riparian zone, stream pools and drought tolerant riparian zone.

Table 2.6: Summary of environmental water requirements- Reach 5 The Gap

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
Cease to Flow	(0 m)	Growth and regeneration of stream bed vegetation	3.5	270	77	Summer/ Autumn
Intermittent Pulses	(0.2 m)	Maintain pools Frog breeding	6.1	55	9	Winter/ Spring
Sustained Low Flow	(0.5 m)	Transfer of aquatic biota between pools	5.2	31	6	Winter/ Spring
Bank Flow	(2.0 m)	Transfer of aquatic biota between reaches	2.4	7	3	Winter/ Spring
Overbank Flow	(2.5 m)	Sustain floodplain macrophytes, Red Gum Water bird breeding and feeding habitat	0.1	0.1	1	Winter/ Spring

**Not all flow bands exist in Reach 5
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.6 Reach 6 – Padthaway Flat to Cockatoo Lake

The grade of the streambed is greatly reduced on the Padthaway Flat where the creek meets the shallow, porous limestone of the Padthaway Formation. The channel meanders, is five to 10m wide and cuts two to four metres into the shallow soil and underlying limestone. This reach is highly modified, grazed and cleared of native vegetation with the exception of scattered riparian Red Gum and rushes. This reach is likely to provide habitat for frog species and aquatic invertebrates and is likely to be a migration zone for fish species between Cockatoo Lake and upstream environments.

Semi-permanent pools form in the creek near the Riddoch Highway, retaining flow from upstream. The pools are believed to be perched above low permeability silts as they are too shallow and the salinity is too low to be a surface expression of the water table. Intermittent pulses are likely to have increased at the expense of sustained low flows, due to reduced storage of Lake Cadnite and land clearance in the upper catchment.

The floodplain has a very low relief and over-bank flows result in widespread inundation. Natural and constructed cavities in the shallow limestone drain floodwater and may support stygofauna. In flood events and prior to prescription, some water was pumped from the creek to a turkey-nest dam upstream of Cockatoo Lake.

Three ecosystems occur in Reach 6: Stream bed, stream pools, and drought tolerant riparian zone.

Table 2.7: Summary of the environmental water requirements- Reach 6 Padthaway Flat to Cockatoo Lake

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
Cease to Flow	(0 m)	Recovery of Red Gum, grasses and sedges	3.7	282	76	Summer/ Autumn
Intermittent Pulses	(0.2 m)	Sustain Red Gum, grasses and sedges Frog breeding	5	20	4	Winter/ Spring
Sustained Flow	(0.5 m)	Provide habitat for aquatic biota within the reach	5.3	37	7	Winter/ Spring
Bank Full	(1.5 m)	Transfer of aquatic biota between reaches	4.1	25	6	Winter/ Spring
Overbank Flow	(2 m)	Drain through karst features Recharge underground water and dependent ecosystems	0.08	0.08	1	Winter/ Spring

**Not all flow bands exist in Reach 6
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.7 Reach 7 – Cockatoo Lake

Cockatoo Lake is a roughly circular aeolian deflation basin with a lunette on the northeast side. The lake receives inflows from Morambro Creek. It can overflow a sill to the Nyroca Channel. The hydrology of the lake underwent a significant change in the 1950s, with the construction of a channel that directed flow from Morambro Creek away from the Clay Lake preventing it from spreading over the land and directing the flows to Cockatoo Lake. Dead Red Gums located on upper floor of the lake, approximately 1.5m below the natural sill, indicate that the lake received significantly less flow prior to the 1950s than is the case now. However the age class of the dead Red Gums and the dynamic nature of the floodplain indicate that the hydrology of the lake may have changed a number of times during its history.

Whilst the lake is basically permanent, it dried to a few hundred millimetres deep in the autumn of 2000. Modelling indicates that the lake may undergo infrequent, brief drying phases.

The lake has permanent aquatic habitat with dense fringing sedgeland vegetation. It is surrounded by Red Gum woodland with an understorey of Lignum and Saw Sedge. As one of the few permanent inland freshwater bodies in the South East, the lake is an important waterbird refuge. The system appears to be now ecologically stable and adapted to the new conditions.

The lake dries to about half full once every five years. Fluctuating water levels result in inundation of the littoral (fringing) sedgeland zone and less regular inundation of the surrounding lignum and sword sedge floodplain zone.

Seven ecosystems occur in Reach 7: Open water, submerged aquatic macrophytes, emergent aquatic macrophytes, sedgeland with Red Gum overstory, Lignum shrubland, Red Gum riparian zone and drought tolerant riparian zone.

Table 2.8: Summary of environment water requirements- Reach 7 Cockatoo Lake

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
No Flow (Medium Level)	<1.5 m	Drought refuge for waterbirds, fish Exclude emergent macrophytes	0.2	83	413	All year
Seasonal Fluctuation Zone	1.5 m to Full Supply Level (FSL)	Maintain dense and diverse littoral sedgeland	1.3	209	161	Summer/ Autumn
Above Full Supply	Above FSL	Flood Lignum and Saw Sedge	1.1	63	57	Winter/ Spring

**Not all flow bands exist in Reach 7
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.3.8 Reach 8 – Nyroca Channel

Morambro Creek flows spread out and contributed to widespread inundation of the south western part of Padthaway Flat prior to construction of the Nyroca Channel. Flows across the flat are now usually constrained in the Nyroca Channel, which has two to three metre high banks, 20m apart, that direct flows to the Nyroca Cutting in the Harper Range and to the Marcollat Watercourse immediately north of Jaffrays Swamp.

The Nyroca Channel is grazed and infrequently flooded and differs little ecologically from the surrounding landscape. Riparian vegetation is limited to scattered sedges, rushes and Red Gum.

The Nyroca Channel is an artificial flow path that has developed little ecological value as a stream ecosystem. A history of grazing has prevented the development of any habitat complexity. The channel has potential for ecological improvement through stock exclusion and weed control.

Two ecosystems occur in Reach 8: Streambed and drought tolerant riparian zone.

Table 2.9: Summary of the environmental water requirements- Reach 8 Nyroca Channel

Flow band	Flow band description (height (m) above bed level)*	Key functions within flow band	Frequency (events per year)[1]	Total days per year[2]	Duration (days)[3]	Season
Cease to flow	(0 m)	Recovery of Red Gum Regeneration of grasses and sedges	1.5	299	199	Summer/ Autumn
Intermittent Pulses	(0.2 m)	Recharge underground water and sustain Red Gum	3.5	32	9	Winter/ Spring
Moderate Flow	Continuous flow to Marcollat Watercourse (1.0 m)	Contribute low salinity flow to Marcollat Watercourse	3	24	8	Winter/ Spring
Bank Full	Major flow to Marcollat Watercourse (2.0 m)	Provide low salinity flooding to Marcollat Watercourse	0.5	1	2	Winter/ Spring

**Not all flow bands exist in Reach 8
[1]Number of flow events per year on average
[2]Average total of days per year flow band occurs
[3]Number of days of flow per flow event

2.4 Water needs of dependent fauna species

A variety of frogs, fish and waterbirds exist in all reaches of the watercourse and depend on the varying flow regimes for breeding, food and habitat. Tables 2.10-2.12 detail the requirements of each species and the role of water.

Table 2.10: Water requirements of frogs within Morambro Creek

Frog species	Observations[1]	Role of water
Common Froglet (*Crinia signifera*)	Reach 6 in creek channel	Eggs and tadpoles require still water
Southern Brown Tree Frog (*Litoria ewingii*)	Reach 7-Cockatoo Lake	Flooded grassland or marsh. Insectivorous. Eggs and tadpoles require still water.
Banjo Frog (*Limnodynastes dumerili*)	Reach 7. Near Cockatoo Lake	Burrowing and drought tolerant. Eggs and tadpoles require still water, favour flooded aquatic vegetation.
Mallee Spadefoot Toad (*Neobatrachus pictus*)	Throughout catchment	Burrowing and drought tolerant. Eggs and tadpoles require still water.
Striped Marsh Frog (*Limnodynastes peronii*)	Reach 4. Waterholes in Pretty Gully sub-catchment	Wetlands and permanent water. Favours reeds and debris for shelter. Eggs and tadpoles require still or slow flowing water.
Spotted Marsh Frog *(Limnodynastes tasmaniensis*)	Reach 4. Waterholes in Pretty Gully sub-catchment.	Floodplains and semi-permanent wetlands. Eggs and tadpoles require still water.
Growling Grass Frog (*Litoria reniformis*)	Reach 7. Near Cockatoo Lake	Adults occur close to water and wet areas. Eggs and tadpoles require permanent water.

1. EPA Frogwatch database, South Australian Museum vertebrate fauna database.

Table 2.11: Water requirements of fish in Morambro Creek

Fish species	Habitat	Role of water
Carp Gudgeon (*Hypseleotris sp*.)	All	Flooding of riparian and aquatic vegetation enhances breeding and recruitment. Annual flooding in late spring for 3-5 days. Requires both open water and vegetated habitat to support large populations.
Big-headed Gudgeon (*Philypnodon grandiceps*)	All	Flooding of riparian and aquatic vegetation enhances breeding and recruitment. Flooding every two years in late spring for 5-7 days. Hard surfaces required as a substrate for laying eggs.
Dwarf Galaxias (*Galaxiella pusilla*)	Now likely restricted to lake ecosystems-deep water aquatic vegetation, lake edge zone and sedge lands.	Require inundated or aquatic vegetated habitat to breed. Late-winter-early spring flooding prepares habitat and relatively permanent water is required for survival of juveniles. Trend to high velocity flows of short duration would disadvantage this species most.

Table 2.12: Water requirements of waterbirds in Morambro Creek

Waterbird name[1]	Habitat type[2]				
	Open water	Emergent macrophytes at edge of water	Eleocharis beds in deeper water	Red Gum in or at edges of water	Lignum/ Saw Sedge
Reaches in which habitat types occur	1,7	1,7	1,7	1,2,7	1,7
Great Crested Grebe	F				
Little Black Cormorant, Little Pied Cormorant	F			B	
White-faced Heron, Rufous Night-Heron, Sacred Ibis	F	F	F	B	
Australasia Bittern		F	F		
Black Swan	F	FB	FB		
Freckled Duck	F	F			
Australian Shelduck, Pacific Black Duck, Grey Teal, Chestnut Teal	F	FB		B	
Australasian Shoveler	F	F			
Black-tailed Native Hen		FB			F
Brolga	F	F	FB		
Masked Lapwing		F			
Black-winged Stilt	F	FB	F		
Banded Stilt	F		F		
Eurasian Coot	F	F			
Silver Gull	F	F	F		
Whiskered Tern	F	F	F		
Little Grassbird			FB		FB

(F=feeding habitat, B= potential breeding habitat)

1. Bird sightings reported from Birds Australia bird sighting database (2002), South Australian Ornithological Association submission to tee South Eastern Wetlands Committee (1981) and sources cited by Carpenter (1988).
2. Habitat requirements adapted from Carpenter (1988).

2.5 Threats to water requirements

Excluding Lake Cadnite, the principal threats to the Morambro Creek ecosystem are uncontrolled stock access, vegetation clearance and changes to the hydrology.

The management regime of the plan aims to meet the minimum requirements of dependent ecosystems to prevent further degradation of their condition. Management priority has been attributed to the watercourse and surface water ecosystems at highest risk (outlined in Table 2.13). However it is important to consider that managing the licensed taking and use of water is only one aspect of the overall management of a system such as Morambro Creek. This is particularly the case where declining ecosystem condition is a result of past change in flow regime from channel construction, vegetation clearance and grazing. Management actions beyond the scope of this plan will need to be considered for important ecosystems.

Table 2.13: Summary of threats to Morambro ecosystems

Impact on watercourse and surface water	Significance	Ecosystem Status
Reduced storage in Lake Cadnite	Earlier onset of flow, flow to downstream reaches occurs in shorter, more intermittent pulses	New steady state
Catchment runoff	Land clearance results in earlier onset of flow and flow occurs in shorter, more intermittent pulses.	New steady state
Reduced flooding of Red Gum Reach 2	Channel construction and Lake Cadnite levee banks reduce flooding.	Ongoing decline
Floodplain drainage	Ongoing drainage of floodplain wetlands in Reaches 3 and 4	New steady state change at drained sites, ongoing threat at undrained sites
Cockatoo Lake made permanent	Flow diversion and outlet sill have converted Cockatoo Lake from a temporary wetland to a permanent lake	New steady state change
Constraint of Cockatoo Lake outflows in Nyroca Channel	Water flows directly to Marcollat Watercourse rather than flooding wetlands near Harper Range	New steady state change
Diversion of peak flows	Diversion of water from large flows on Padthaway Flat	Ongoing decline

2.6 Salinity and water quality interactions with ecology-flow relationships

The current salinity range of Morambro Creek is between 50 and 200 mg/L. These salinities easily meet the needs of the major flora and fauna groups that inhabit the system. The effect of increasing salinities is a reduction in the diversity of aquatic and riparian species, often leading to dominance by one or two tolerant species in each group. Fresh water outflows from Morambro Creek are essential to the flow requirements on the Marcollat Watercourse both in terms of flow contribution and in providing fresh water flows to an otherwise predominately brackish system.

Nutrient levels are likely to have increased due to vegetation clearance and agricultural development. Together with light penetration into the watercourse, it is likely that algal growth has increased within these systems. Increasing nutrient levels and increases in turbidity may lead to blue green or other algal blooms in the still waters of pools or lakes. Stream environments are therefore unlikely to develop algal blooms, although filamentous algae can develop on the stream bed which in turn can change the nature of the aquatic habitat available for invertebrates and fish. Algal dominance can lead to low dissolved oxygen levels, which affects the health of all aquatic organisms.

3 Assessment of the effects on other water resources

Introduction

Section 76 (4) (b) of the *Natural Resources Management Act 2004* requires this water allocation plan to include an assessment of whether the taking or use of water from the Prescribed Area and the prescribed water resources will have a detrimental effect on the quality or quantity of water that is available from any other water resource.

The potential detrimental impacts of taking or using water from the Prescribed Area or resource on the quantity or quality of water of another resource and vice versa, were considered in the following situations:

- The impact that taking water from both the watercourse and surface water area may have on the receiving Marcollat Watercourse downstream from the Prescribed Area; and

- The impact that taking water from the watercourse and surface water area may have on the underlying aquifers of the Lower Limestone Coast PWA and Padthaway PWA.

3.1 Marcollat Watercourse

The Marcollat Watercourse is a linear wetland complex comprising more than 20 wetland basins. It receives water from the Morambro Creek, Naracoorte Creek via Drain E and its own local catchment. The watercourse extends for approximately 30km from the south-western edge of the inter-dunal flat between the Harper Range and Stewart Range, flowing north-westerly towards Jip Jip Conservation Park (see Figure 2). The Marcollat Watercourse is of significant conservation value in the upper South East due to its size and the diversity of flora and fauna that depend on the system. The water regimes and salinities of the wetlands vary, providing a system of diverse and complementary habitats.

The Marcollat Watercourse has been modified considerably since settlement. The hydrology of the watercourse has been altered by drainage works in the area. In particular, flow from the south has declined and become more episodic due to the diversion of flow from the Mosquito Creek catchment to Drain M and the channelisation of remaining flow via Drain E. Additional flow has been introduced from the east via the Nyroca Channel.

Flows from Morambro Creek to the Marcollat Watercourse are important both in terms of volume contribution and in providing fresh water (150-200 mg/L) to an otherwise predominantly brackish (2,000 – 6,000 mg/L) system. Moderate flows from Morambro Creek result in the translocation of more salt sensitive organisms to regenerate the wetlands. High band flows are likely to be important in providing surface water flows to the Red Gum woodlands adjacent to the system, whilst low band flows act to dilute the saline runoff from the local catchment.

Morambro Creek flows are important in that they provide flows earlier in the season and more frequently than does the Naracoorte Creek, via Drain E, because of the large storage volume in that system and the intersection of the Marcollat Watercourse with the Nyroca Channel.

It is therefore important that water management in Morambro Creek ensures flows at Nyroca provide:

- No increase in the frequency or duration of no flow;
- No decrease in the frequency or duration of sustained low flow.

A decrease in overbank flows is considered acceptable if it can be demonstrated that no harmful net impact to downstream ecosystems results.

Four flow bands have been identified to describe the environmental requirements of the Marcollat Watercourse (Table 3.1).

Table 3.1: Environmental water requirements of the Marcollat Watercourse

Flow band	Key functions of flow bands
No flow, cease to flow, intermittent pulses	No discharge from Jip Jip Recovery of vegetation intolerant of prolonged flooding (eg Red Gum) Regeneration of grasses and sedges Growth of herbland and halophyte vegetation Wading bird habitat Underground water discharge* Some salinisation of wetland beds*
Sustained low flow	No discharge from Jip Jip Initiation of aquatic plant growth, macroinvertebrate production Provision of some waterbird habitat Wetland water predominantly generated from local runoff Salt load increases Minor underground water recharge and potential contribution to underground water mounding*
Bank full flows	Some discharge from Jip Jip Removal of some salt from system Wetting of fringing vegetation Flows links wetlands, providing dispersal and recolonisation opportunities for aquatic fauna Some freshening of underground water beneath wetlands*
Over bank flows	Major discharge from Jip Jip Flow links wetlands, providing dispersal and recolonisation opportunities for aquatic fauna Extensive aquatic habitat and high temporary aquatic fauna carrying capacity Removal of salt from system

*Where conditions are favourable

Hydrological analysis reported that the reduction of Morambro Creek flow to the Marcollat Watercourse may result in:

- An increased occurrence (days per year) that wetlands spend in no flow; and
- A reduced occurrence (days per year) that wetlands spend in overbank flows.

The reduction of Morambro Creek flows is likely to exacerbate existing salinity trends in the ecosystems of the Marcollat Watercourse. This is likely to result in a reduction in habitat

complexity and reduced abundance of flora and fauna. The reduction in overbank flows will reduce dispersal and migratory opportunities for aquatic fauna such as fish.

The Upper South East Dryland Salinity and Flood Management Program is proposing that the Didicoolum Drain be constructed about 1.5km north-east of and running parallel to the Marcollat Watercourse. Nominal depth of the Didicoolum Drain is likely to be two metres. The drain will affect both the surface water and underground water conditions of the area, which could impact upon the ecology of the wetland.

The construction of the Didicoolum Drain is currently proposed to be a drain that intercepts the saline summer underground water table in the flat. This drain has the potential to decrease surface water flows to the Marcollat Watercourse through:

- Intercepting surface water flows on the eastern side of the drain, meaning a decrease of the local catchment area contributing to the wetlands of approximately 10%; and

- A reduction in the amount of surface run-off by increasing the sub-surface storage capacity allowing more rainfall to infiltrate to the subsoil before run-off occurs.

However, additional features of the Didicoolum Drain design are proposed to address these concerns. Ensuring the surface water on the eastern side of the drain enters the Marcollat Watercourse by constructing a bank along the eastern side of the drain to prevent local run-off entering into the drain and instead directing the surface water along the drain to regularly spaced crossover pipes linked to the watercourse (like road highway culverts). Reducing the subsoil storage can also be achieved by installing weirs in the drain designed to hold groundwater at natural levels over winter and spring. In this way, it is envisaged that the proposed Didicoolum Drain will minimise the reduction in surface water flows to the Marcollat Watercourse.

The current (presently unapproved) proposal for the Didicoolum Drain is;

1. A drain that intercepts the summer underground water table.

2. Located in the flat to best suit landholders interests, but not in the watercourse.

3. Banks on the eastern side of the drain to keep surface water out of the drain. Banks on the western side of the drain to keep watercourse flows contained in the watercourse.

4. Surface water crossover pipes to connect surface water derived from the eastern side of the drain to the Marcollat Watercourse.

5. Reconnection to the excess surface waters derived from the Bool Lagoon/Hacks Lagoon via Drain E.

6. Management agreements over the watercourse country designed to conserve and restore the Marcollat Watercourse values.

7. Restoration of Marcollat wetland sills to key wetland complexes.

8. An operating weir in the drain to achieve a compromise between competing objectives (between landholders, agricultural interests and the environment).

9. Encourage investment in deep rooted pastures and vegetation.

The potential benefits of the Didicoolum drainage proposal will be in terms of improved capacity for water management for the Marcollat Watercourse and to improve the water quality of the watercourse and the wetlands. Construction of the Didicoolum Drain proposal will reduce the reliance on Morambro Creek for freshening flows.

Morambro Creek flows remain important in providing large flows to maintain inter-annual flooding in semi-permanent wetlands and to provide widespread flooding required for the dispersal and migration of aquatic fauna.

3.2 Underlying aquifer

There are three scenarios to consider when evaluating the influence of use of surface water on the underground water system (and the permissible annual volume). These are:

- Diversion and use of surface water that would otherwise have recharged the aquifer via drainage wells, seepage from the base of the channel or recharge via natural runaway holes;

- Drainage of surface water to the aquifer where it is part of an aquifer storage and recovery scheme; and

- Installation of additional drainage wells to control or manage inundation or flooding.

Water drained to point features such as natural runaway holes and drainage wells and loss from the creek bed make up part of the total recharge to the aquifer (around 10 percent, based on work by Herczeg *et al.* 1997). This recharge is included in the calculation of the PAV for the underground water resources of the Lower Limestone Coast PWA and Padthaway PWA. The underground water resource overlain by the Prescribed Area is fully allocated.

Under the first scenario, use of surface water may reduce the rate of recharge. However, the licensed volume to be diverted from the Prescribed Area is likely to be small in comparison with the volume currently recharging the aquifers beneath.

Diversions in many cases are likely to amplify underground water recharge. Under the second scenario, diversion of surface water for aquifer storage and recovery would not have any effect on the PAV for the underground water system, since the operator would be licensed to only extract an amount of water relative to the volume that was discharged to the aquifer.

Under the third scenario, the construction of new drainage wells would potentially divert additional surface water to the aquifer that would have otherwise been part of the flow in the watercourse. This would provide a slight positive benefit to the aquifer (with a larger disadvantage to the watercourse). It is unlikely the benefit to the aquifer would be significant in relation to the district's underground water balance.

4 Assessment of the capacity of the resource to meet demands

4.1 The capacity and status of the resource

The capacity of the water resources of the Prescribed Area to meet demands on a continuing basis will depend on several factors that vary for each management area. They include the rate and timing of diversions from the watercourse and for the surface water area, dam and drainage well development.

Morambro Creek is ephemeral by nature and is characterised by highly variable frequency, duration and magnitude of flows. As a result of this variation, the capacity of the resource to meet demand will vary according to the season and resultant stream flow.

Since European settlement the Prescribed Area has been modified by native vegetation clearance, development of land for farming and local and regional drainage. These changes have resulted in more frequent flows, with larger peaks and shorter duration.

Water from the Morambro Creek and the Nyroca Channel is the main source for diversions for aquifer recharge, irrigation and recreational uses. A number of drainage wells have been constructed in the surface water area to drain surface water to the unconfined aquifer in the Lower Limestone Coast PWA. Farm dams have been constructed in the surface water area to capture the surface water run-off for stock, domestic and recreational use.

The increasing salinity of the adjacent underground water resource in the Padthaway PWA has resulted in an increase in demand for aquifer recharge schemes along the Nyroca Channel and the Morambro Creek. This increase in demand resulted in the prescription of the Prescribed Area in 2001.

The average stream flow passing through the gap in the Naracoorte Ranges has been calculated as 3,470 ML/day (1971-2003). However, recorded stream flows vary between 0ML in a number of years to a maximum of 12,800 ML. The cross-border flow from Victoria has not been quantified, but is estimated as 70-90 percent of the average flow recorded at the Bordertown-Naracoorte Road Bridge.

Salinity levels recorded in the Morambro Creek watercourse over the last 25 years have remained below 200 mg/L, which is considered very fresh.

Diversions from the watercourse have the potential to reduce the frequency, magnitude and duration of stream flow and hence the health of water dependent ecosystems. Farm dam development in the surface water area has the potential to significantly reduce the low flow component of the stream flow of Morambro Creek, Nyroca Channel and downstream, Marcollat Watercourse.

Systems for appropriately allocating water and managing its use are required for the protection of the long-term condition of the water resources and the water dependent ecosystems.

4.2 Volume available for licensed allocation (VLA)

The Prescribed Area has been divided into three management areas (Figure 3). The Herald management area extends from the Victorian Border to the Bordertown-Naracoorte Road Bridge (watercourse and surface area). The Gap management area extends from the Bordertown-Naracoorte Road Bridge to Cockatoo Lake (watercourse and surface area), and the Nyroca Management area extends from Cockatoo Lake to the Marcollat Watercourse (lake and watercourse). The management areas were defined with regard to the locations of existing gauging stations in the watercourse and the different environmental water requirements of the ecosystems depending on water. The management areas also enable limits to allocations in any one part of the Prescribed Area.

A VLA for the resource has been established for the Prescribed Area. The VLA is the average annual volume of water (in megalitres) available for licensed extraction from the Prescribed Area, or specified for management areas.

The Instantaneous Volume for Licensed Allocation (IVLA) for the total resource is the aggregate maximum volume (litres) per second that may be taken from the prescribed resource. In a fully allocated system, this is equivalent to the aggregated individual licensed extraction rates. An IVLA may apply to a management area also.

The VLA for the total resource is calculated as the sum of two components:

1. The VLA for Component A (base) allocation is calculated as 20 percent of the mean flow in the watercourse recorded at the Bordertown-Naracoorte Road Bridge (1985–2003), net of stock and domestic use and drainage wells at the date of adoption. This is calculated to be 730 ML.

2. The VLA for Component B (flood flow) allocation is calculated as 5 percent of the mean annual volume (1985-2003) that can be extracted in addition to Component A extractions. This can only occur once the flood flow taking triggers are met. This is calculated by allocating a maximum diversion rate of 1 cubic metre per second which is equivalent to 86 ML/day. The VLA is limited by the rules for taking water described in section 6.2.

4.3 Morambro Creek Prescribed Water Resource Model

The quality, temporal pattern and spatial distribution of the surface water resource for the Morambro Creek catchment was assessed using a hydrological modelling approach.

The occurrence of flows in Morambro Creek derived from hydrological modelling are presented in Table 10.1.

Using the hydrological modelling the environmental significance of extractions was assessed by referral to the environmental water requirements in section 2 of the Plan. These impacts were assessed against critical water requirements where, due to existing or historic threats, the ecosystem would not tolerate further change.

These were:

- Any further reduction in low persistent flows. As a result of land clearance and reduced storage in Lake Cadnite, low persistent flows have been replaced by longer periods of no flow and briefer, more intermittent flows.

- Any reduction in medium flows to flush wetlands of saline water. The health of the Marcollat Watercourse depends on medium flows for this reason.

- Any further reduction in high flows, where drainage works and levee banks are believed to have already reduced inundation of flood-dependent Red Gum.

- An impact was considered significant where two or more of the indicative variables (frequency, duration or occurrence) both varied upwards or downwards by more than 15 percent.

The sustainable limit to allocation for the whole Prescribed Area has been determined to be 870 ML/year on average. This determination was based on modelling of flows and considerations of the potential change to existing frequency, duration and occurrence of flow bands in the Prescribed Area. Annual average maximum allowable diversions for each management area are indicated in Table 10.3.

The reliability of the assessment is limited by the quality and extent of hydrological and ecological data and the ability of the hydrological model to replicate the real environment. While input data will be improved through further data collection and monitoring (Section 9), existing data is believed to be sufficient to make a reliable assessment of limits to allocation.

4.4 Water demand

The Morambro Creek water resources were prescribed in 2001 following an increase in demand for water for aquifer recharge schemes to reduce the increasing salinity of the adjacent underground water resource in the Padthaway PWA. The South Eastern Water Conservation and Drainage Board (SEWCDB) issued one licence for utilising water from the Nyroca Channel for this purpose prior to the resource being prescribed.

The SEWCDB managed Cockatoo Lake and the Nyroca Channel from 1970. In 1992, the *South-Eastern Drainage Act 1931* and the *Tatiara Drainage Trust Act 1949* were replaced by the *South Eastern Water Conservation and Drainage Act 1992* vesting responsibility for the Morambro Creek watercourse in the SEWCDB. Prior to 1992, there was no management of modifications to or diversions from the Morambro Creek watercourse. There has been no historical management of the Morambro Creek surface water area for the purpose of utilising water. Hence, there are existing users in the Morambro Creek surface water area and diversions from the watercourse that were not issued a licence from the SEWCDB for the utilisation of water.

4.4.1 Historic and present demand

It is difficult to determine the historic or present level of demand from the Prescribed Area as prior to the prescription of the area, there was no formal mechanism for reporting of use (from water users) that could be used to estimate the volume diverted from the watercourse or surface water area. The demand for higher quality Morambro Creek water is expected to increase in the future.

Aquifer Recharge

Aquifer recharge of water diverted from the Prescribed Area represents the largest demand for water. There are currently three aquifer recharge schemes in operation and a large aquifer recharge scheme proposed.

The demand for higher quality water from the Prescribed Area in Nyroca has increased due to the increase in the salinity levels of the unconfined aquifer in the Padthaway PWA.

There is expected to be an increasing demand for water from the Prescribed Area for use in aquifer recharge schemes due to an increase in salinity levels of the unconfined aquifer in the Padthaway PWA and future development.

Existing aquifer recharge schemes in the Padthaway PWA have shown that recharged water from the Prescribed Area can have a local freshening effect on the unconfined aquifer.

Irrigation

There is a small amount of water diverted and captured from the Prescribed Area that is used or could potentially be used for irrigation. Most water used for irrigation is from licensed extractions from the unconfined aquifer and is not the subject of this plan.

The major irrigated crops in management areas Herald and Gap are pasture, pasture seed and lucerne seed. The major irrigated crops in management area Nyroca are pasture, vines, pasture seed, lucerne seed and cereal.

There is limited potential for water diverted or captured from the Prescribed Area to be used for future irrigation developments. This is primarily due to the seasonality of the flows that occur in winter and secondly, due to the low reliability of flows. However, water from the Prescribed Area could be used to supplement water from the prescribed underground water resource.

Recreation

There is a small amount of water diverted from the Prescribed Area that is used for recreational purposes. The recreational use is primarily for amenity dams.

It is likely that there will be increasing demand for water from Prescribed Resources to be used for recreational use. Families are choosing to live on rural properties as a lifestyle choice and envisage a recreational dam as an integral part of this choice.

Stock and Domestic

There are approximately 70 farm dams that divert water from the Prescribed Area that are used for stock and domestic purposes.

In some cases, stock and domestic water from the Prescribed Area can be supplemented with water from the prescribed underground water resource.

While stock numbers will change depending on the season and market conditions, such changes will only have a small effect on the relative magnitude of water use. Consequently, stock and domestic use is not expected to vary much from current levels.

Drainage Wells

Drainage wells discharge water from the Prescribed Area to the unconfined aquifer. There are approximately 100 drainage wells in Herald, equating to a volume of approximately 200 ML/year.

Commercial, Industry and Town Use

There is no commercial, industrial or town use of water from the Morambro prescribed water resources.

Future demand for commercial, industrial or town use of water from the Prescribed Area is unlikely due to the ephemeral nature of the creek.

Ecosystems

As outlined in Sections 2 and 3, the ecosystems in the Prescribed Area and in the downstream Marcollat Watercourse range from partially to fully reliant on the prescribed water resource in terms of various flow bands, frequencies and duration of flows.

It is likely that the requirements of the ecosystems that depend on flows from the Morambro Creek prescribed water resources will increase due to change in extraction regime.

Conclusion

The Morambro Creek system is ephemeral by nature and for the most part the associated ecosystems are in equilibrium with the current flow regime. The environment of Morambro Creek is therefore dependent on the flow it currently receives. Specific rules for diverting water will apply. They will strongly link to actual patterns of flow, meaning that the pattern of licensed diversion (water taking) will also vary year by year and flow event by flow event. It is expected that the rules will minimise any adverse environmental impact from the licensed taking of water. The definition of an unacceptable environmental impact is a change to the hydrologic regime that is not consistent with the Plan's proposed environmental objectives.

A suitable monitoring program is required to objectively measure the impacts of the Plan's diversion, taking and use regime. The information derived from the monitoring program will allow testing of the appropriateness of water provisions in meeting ecological objectives. The review of the plan within five years of adoption provides for review of any provisions within the Plan and the underlying assumptions on ecosystem function. The hydrological model will certainly be improved as further monitoring and licensed diversion information is collected.

5 Definitions

Any terms used in this Plan that are defined in the *Natural Resources Management Act 2004* have the definitions set out in that Act and in addition for the purposes of this Plan the following terms have the definitions set out below except those terms that are defined specifically for the purposes of a section.

"Act" means the *Natural Resources Management Act 2004* and any successor Act.

"**Adjoins"** or **"Adjoining"** means in relation to an allotment or management area that the allotment or management area, or any part of the allotment or management area, is contiguous with another allotment or management area and includes allotments or management areas that are separated only by a road, street, footpath, railway or thoroughfare.

"Allotment" means:

(a) The whole of the land comprised in a certificate of title including a community or development lot or common property within the meaning of the *Community Titles Act 1996* or a unit or common property within the meaning of the *Strata Titles Act 1988*;

(b) The whole of the land comprised in a registered conveyance of land that has not been brought under the provisions of the *Real Property Act 1886*;

(c) A separately defined piece of land that is delineated on a public map and separately identified by a number or letter (not being a piece of land that is identified in a Treasury receipt, certificate or other document or instrument of title as being part only of an allotment);

(d) Two or more separately defined pieces of land that are delineated on a public map and that are identified in a Treasury receipt, certificate or other document or instrument of title as forming one allotment for the purposes of the *Real Property Act 1886*;

(e) A separately defined piece of land delineated on a plan of division for the purpose of enabling the separate ownership in fee simple of that land;

(f) A separately defined piece of land identified as an allotment for the purposes of the *Real Property Act* in a plan prepared by the Registrar-General and accepted for filing in the Lands Titles Registration Office;

(g) Where a primary plan of community division has been cancelled under Part 7 Division 3 of the *Community Titles Act 1996* or a strata plan has been cancelled under Part 2 Division 7 of the *Strata Titles Act 1988* – the land comprising the former community parcel or site shown on the plan.

"Aquaculture" means the propagating or keeping of stocks of any aquatic or marine organism.

"Aquifer recharge" means the process of drainage or discharge of water directly or indirectly to a well for the purposes of refilling or replenishing an aquifer or storing water in an aquifer.

"Buffer zone" means the area of the **prescribed area** within which **catching dams** or **recharge wells** may not be constructed or enlarged, where:

(a) The **buffer zone** for **catching dams** extends 100 metres from the centre of the **prescribed watercourse;** and

(b) The **buffer zone** for **holding dams** and **recharge wells** extends 10 metres from the centre line of the **prescribed watercourse**;

but in any case, no part of the **holding dam** or **recharge well** may be within the banks of the **prescribed watercourse**.

"Catching dam" means a dam, wall, structure or excavation (other than a **Holding dam**) placed or constructed in such a way that it intercepts or collects **surface water** or water flowing in a **watercourse**. It does not include a **diversion structure**.

"Catchment" at a particular point means all of the land from which water would flow to that point if the **surface water** is not diverted or captured by any dam or fully absorbed by vegetation.

"Component A" means the allocation on a water licence relating to the taking of water in other than **flood flow** circumstances.

"Component B" means the allocation on a water licence relating to the taking of water in **flood flow** circumstances.

"Dam" means an excavation, wall or other structure designed to hold water diverted or pumped from a **watercourse**, a drainage path, an aquifer or from another source and includes clay pits.

"Date of adoption" means the date when the Morambro Creek Water Allocation Plan is adopted by the **Minister**.

"Diversion structure" means a wall, sill, weir, other structure or excavation authorised by the **Minister** for the purpose of diverting **prescribed water resources**.

"Domestic use" in relation to the taking of water does not include-

(a) taking water for the purpose of watering or irrigating more than 0.4 of a hectare of land; or

(b) taking water to be used in carrying on a business (except for the personal use of persons employed in the business).

"Drainage well" means a well with its own natural **catchment** that is primarily used for the purpose of draining or discharging **surface water** into the ground.

"Ecological water use" means the non-profit use of water for purposes including, but not limited to, the maintenance or rehabilitation of aquatic ecosystems, riparian ecosystems or **water dependent ecosystems**.

"Ecological processes" All those processes that occur between organisms, and within and between populations and communities, including interactions with the non-living environment, that result in existing ecosystems and bring about changes in ecosystems over time. Important ecological processes are water and nutrient cycling, the flow of energy and evolution by natural selection.

"Endemic" means native to or confined to a certain region; i.e. South East of South Australia.

"Exceptional circumstances" means the death or serious illness of or serious injury to the licensee or, where the licence is held by a company, partnership or incorporated body, the death or serious illness or injury to a director, partner or office holder respectively, that prevents the licensee from using the allocation with the minimum of delay and in any case within 3 years of the date of the granting of the allocation.

"Flood-flow" means the flow in the **prescribed watercourse** above the **threshold flood flow rate**.

"Holding dam" means a dam, wall, structure or excavation that is not constructed across a **watercourse** or drainage path and is designed to hold water diverted or pumped from a **watercourse**, a drainage path, an aquifer or from another source. A holding dam has no natural **catchment** other than the surface area of the dam (eg. a turkey nest dam).

"Industry" means the carrying on, in the course of a trade or business, of any purposes for, or incidental to:

(a) The making of any article (or part thereof); or

(b) The altering, repairing, ornamenting, finishing, assembling, cleaning, washing, packing, bottling, canning or adapting for sale, or the breaking up or demolition of any article; or

(c) The getting, dressing or treatment of materials, or

(d) Intensive animal production, plant production or dairy washdown.

"Instantaneous volume for licensed allocation (IVLA)" means the maximum aggregate diversion rate on all licences under this **Plan** expressed in litres per second.

"Management area" means for the **watercourse** and **surface water area**, a part of the **prescribed area** as shown in Figure 10.2.

"Minister" means the Minster who is at that time responsible for the administration of the **Act.**

"Plan" means the Morambro Creek and Nyroca Channel **prescribed watercourses** including Cockatoo Lake and the **prescribed surface water area** Water Allocation Plan.

"Pollution" includes any solid, liquid, gas or heat (or any combination thereof) that directly or indirectly causes or has the potential to cause harm to the environment, structures, persons or organisms.

"Prescribed area" means the **prescribed watercourse** and **prescribed surface water area,** as described in GRO Plan No. 149/2001.

"Prescribed surface water area" means the area bounded by the bold black line on GRO Plan No. 149/2001.

"Prescribed watercourse" means the part of Morambro Creek marked in blue on GRO Plan No. 149/2001 (including Cockatoo Lake and Nyroca Channel)

"Prescribed water resources" means the water on or flowing over or in the **prescribed surface water area**, or in the **prescribed watercourse**.

"Recreational use" means the use of water for the irrigation of a park, garden, sports ground or a lake, (whether ornamental or for a sporting activity), and not being used for commercial purposes.

"Recharge well" means a well for the purpose of diverting licensed water to the underground aquifer.

"Runaway hole" means a natural opening in the ground that allows for the free movement of water to the underground water.

"Section 105 allocation" means an allocation of water made to an **eligible existing user** under Section 36 of the *Natural Resources Management Act 2004*.

"Stock use" means the supply of drinking water for animals kept for the purpose of carrying on the business of primary production in which the animals are not confined to a small space or area such as a feedlot or shed and are not usually fed by hand or by mechanical means.

"Surface water" means -

(a) water flowing over land (except in a watercourse) **–**

(i) after having fallen as rain or hail or having precipitated in any other manner; or

(ii) after rising to the surface naturally from underground;

(b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir.

"Threshold flow rate" means the flow rate in the **watercourse** above which water can be diverted at the rate specified for water taking.

"Volume for licensed allocation (VLA)" is the average annual volume of water from the **prescribed water resources** (in megalitres) available for licensed extraction from the **prescribed area**, or separately specified for a **management area**.

"Watercourse" means a river, creek or other natural watercourse (whether modified or not) and includes **–**

(a) a dam or reservoir that collects water flowing in a watercourse; and

(b) a lake through which water flows; and

(c) a channel (but not a channel declared by regulation to be excluded from the ambit of this definition) into which the water of a watercourse has been diverted; and

(d) part of a watercourse.

"Water dependent ecosystems" means those ecosystems whose wellbeing is reliant on certain **surface water** and/or **watercourse** water conditions.

"Water use year" means a period of 12 months commencing on the 1 January in any year and ending on the following 31 December.

"Wild flooding" means irrigation where no adequate system such as land levelling, or irrigation bays is used to ensure a controlled distribution of water.

6 Water allocation criteria

The present and future needs for water by the occupiers of land in the Morambro Creek Prescribed Area are mainly for aquifer recharge, recreation, stock and domestic use and irrigated agriculture.

The capacity of the water resources in the prescribed area to meet demand in the future depends greatly on the frequency of flows, and the flow volume in any one event.

In providing for the allocation of water, the likely effect on the value of land has been considered. While some of the policies contained within this Plan may have potential impacts on land values it is considered that any potential impacts on the value of land are outweighed by the benefits of protecting the condition of the resources in the prescribed area, so they may continue to be used on a sustainable basis. The policies with the potential to impact on land values generally relate to the protection of the resource from degradation through over-allocation, the concentration of water extraction and use, or inappropriate water use and management.

The South East Natural Resources Management Board has taken the above aspects into account in setting policies and criteria within this plan.

6.1 Objectives

1. To manage the allocation and use of the prescribed water resources within the sustainable limits described by the Plan with consideration to local area scale, management area scale and regional scale.

2. To protect the prescribed water resources locally, throughout each management area and the entire prescribed area, by ensuring that the taking and use of water does not have a significant adverse effect on frequency, duration, seasonality and quality of surface water flow.

3. To maintain and protect biodiversity and local and regional ecological processes dependent on the prescribed water resources from significant degradation arising from the taking and use of the prescribed water resources.

4. To maintain and where possible enhance the quality of the water resources of the prescribed area for economic, social and environmental uses.

5. To balance the quantity of water for economic, social and environmental uses.

6. To ensure all available water is fairly shared between all users.

7. To maintain and where possible enhance other water resources that are dependent on the prescribed water resources.

8. To promote the efficient use of water according to industry best practice standards.

6.2 Principles

Basis of allocation

1. Water (taking) allocations shall be allocated as shares or a percentage of the Volume for Licensed Allocation (VLA); and

   (a) Where prescribed watercourse water is taken, the rate of taking shall be limited to a maximum diversion rate in litres per second; and

   (b) Where surface water is being taken, the rate of taking shall be limited to a maximum volume per year in megalitres per year.

2. Water (taking) allocations shall be referenced to a management area.

3. Water shall not be allocated to be taken by:

   (a) a dam located within the buffer zone for catching dams; or

   (b) a recharge well located within the buffer zone for recharge wells.

4. A licence may be endorsed with a component A allocation such that:

   (a) The maximum rate (in litres/second) of diversion of watercourse water endorsed on a licence as a component A allocation shall not significantly adversely affect the potential of other licensees to obtain their share; and

   (b) The allocation of a component A allocation shall not cause the aggregate component A instantaneous volume for licensed allocation (IVLA) (L/second) described in table 10.3 and component A VLA (ML/day) described in table 10.3 to be exceeded.

5. A licence may be endorsed with a component B allocation (flood-flow) such that:

   (a) The maximum rate (in litres/second) of diversion of water from the watercourse endorsed on a licence as a component B allocation shall not significantly adversely affect the potential of other licensees to obtain their share.

   (b) The allocation of a component B allocation shall not cause the aggregate component B IVLA (L/second) described in Table 10.3 or component B VLA (ML/day) described in Table10.3 to be exceeded.

   (c) Component B allocations may not be diverted other than from the prescribed watercourse, excluding Cockatoo Lake.

6. Water may only be taken by an authorised diversion structure authorised by the Minister.

7. Subject to all other provisions of this Plan, there is no limit to the volume of licensed water that may be taken as component A allocations or component B allocations in any one water use year, but the rate (litres/second) of taking endorsed on a licence may not be exceeded.

Limit to total allocation

8. Water shall not be allocated where the allocation would cause the total amount allocated as component A allocations and component B allocations within a management area and the prescribed area to exceed the volume for licensed allocation specified in Table 10.3.

9. Surface water will only be allocated as a component A allocation.

10. Surface water will only be allocated if the allocation does not cause the total volume of catching dams to exceed the maximum dam development limit specified in Table 10.4.

11. Surface water may only be allocated if the water stored in a catching dam does not cause dam capacity, equivalent to 0.05ML/ha of the allotment on which the dam exists or will exist and reduced by the volume of existing catching dams on the allotment, to be exceeded.

Water holding and taking allocations

12. Water may be allocated as a water (holding) or water (taking) allocation.

13. A water allocation may only be endorsed on a licence as follows:

    (a) A percentage or share of the VLA; and

    (b) Either a component A allocation or a component B allocation, and

    (c) If a water (taking) allocation, the point of taking of the allocation is to be referenced to an allotment, with the written permission of the owner of that allotment.

14. A water (taking) allocation on a licence may be converted either in whole or in part, to a water (holding) allocation provided that the allocation is not subject to a condition of a licence requiring 'active and expeditious use' (Principle 6.2: 25-28) and that condition has not been fully complied with.

15. A water (holding) allocation may be converted to a water (taking) allocation where the water is to be taken from the management area specified on the licence, subject to the provisions outlined in section 6.2 of the Plan.

Taking of Water

16. A component A allocation may not be taken from the prescribed watercourse unless:

    (a) Cockatoo Lake has been measured by the Minister to have filled to 80 percent of its capacity in the water use year (WUY) of taking; and

    (b) The threshold flow rate of the water in the prescribed watercourse passing the point at which the allocation is diverted exceeds 230 litres per second (equivalent to 20 ML/day); and

(c) The maximum amount of water taken from the prescribed watercourse at the point at which the allocation is diverted does not at any time exceed 50 percent of the flow exceeding the 230 litres per second passing that point of diversion.

17. A component B allocation may (to be consistent with 16 above) not be taken from the prescribed watercourse unless:

(a) 4,300 ML cumulative flow has passed the Jip Jip weir gauging station in the water use year; and

(b) Cockatoo Lake has been measured by the Minister to have filled to its full capacity in the water use year of taking ; and

(c) The threshold flow rate of the water in the prescribed watercourse passing the point at which the allocation is diverted exceeds 1,200 litres per second (equivalent to 100 ML/day); and

(d) The maximum amount of water taken from the prescribed watercourse at the point at which the allocation is diverted does not at any time exceed 50 percent of the flow exceeding the 1,200 litres per second passing that point of diversion.

Location of taking and measurement

18. Water shall not be taken from Cockatoo Lake.

19. The water taken shall be measured as near as practical to the point of extraction or diversion and in any case shall be measured no more than 100 metres away from the point of taking or diversion.

20. The place and method of measurement shall be approved by the Minister. Before any water can be taken, all measurement devices shall be fitted. The measurement devices shall have the capability of recording parameters including time of taking, duration of taking, rate of taking (litres per second) and volume taken.

Unallocated water

21. Payment will be required for water allocations obtained from the Minister.

22. Where water is available in a management area that is under-allocated at the date of adoption, that water may be allocated in accordance with the criteria outlined in Section 6.2 of the Plan.

Returned water

23. Where water becomes unallocated as a result of licensed allocations being returned to the Minister, part or all of that returned allocation may only be allocated if it does not cause the total volume of existing allocations exceed or further exceed the VLA for the prescribed area and the VLA of the management area from which it is to be allocated.

Water resource condition

24. The allocation of water shall not cause the aggregate taking and use of water to be likely to result in:

    (a) A long-term reduction of flow from the prescribed area to the Marcollat Watercourse of greater than 25 percent of the mean annual flow of Morambro Creek as measured at Nyroca cutting gauging station that would have occurred if there were no licensed extractions; and

    (b) A long-term reduction in the frequency of Cockatoo Lake filling to its full capacity of greater than 15 percent of the frequency that would have occurred if there were no licensed extractions; and

    (c) A long-term reduction of more than 15 percent in the frequency, occurrence and duration of flows in each flow band (Column 2 in tables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 and 2.9, Section 2) for each management area.

For the purpose of this principle 6.2.24 long-term is 15 years.

Active and expeditious use of water

25. All water (taking) allocations excluding water (taking) allocations obtained through transfers of allocation, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation, or have the infrastructure capable of taking the allocation at the maximum lawful diversion rate installed within three years of the granting of the allocation. If no flow occurs for three consecutive years on granting of the allocation the licensee must have infrastructure capable of taking the allocation at the maximum lawful diversion rate.

26. All water (taking) allocations resulting from the conversion of a water (holding) allocation, shall be used with minimum of delay and in any case within 3 years of the conversion of the allocation, or have the infrastructure capable of taking the allocation at the maximum lawful diversion rate installed within three years of the granting of the allocation. If no flow occurs for three consecutive years from the date of conversion of the allocation the licensee must have infrastructure capable of taking the allocation at the maximum lawful diversion rate.

27. For the purpose of principles 6.2.25 and 6.2.26, 'active and expeditious use of water', is the use of an allocation means the development of sufficient facilities, land or equipment that will enable the full water (taking) allocation to be used in accordance with the licence during the water use year.

28. Without in any other way affecting the operation of 'active and expeditious use of water', principle 6.2.27, if exceptional circumstances apply to the licensee, the period specified in principles 6.2.25 and 6.2.26 may be increased to 4 years from the date of endorsement of the allocation on the licence.

Purpose of Use

29. Water shall not be taken or used for wild flooding.

30. Water shall not be taken or used in a way that would cause a significant detrimental impact, including and not limited to increased salinity or pollution on the prescribed water resources or any underground water resources or, water dependent ecosystems or existing users.

31. Water shall not be taken and used for the purpose of irrigation unless:

    (a) The allocation does not exceed the amount that is reasonably required, in accordance with best practice standards current at the time of the assessment of the application, for the proposed purpose;

    (b) There is no detrimental impact including and not limited to increased salinity or pollution on the prescribed water resources or any underground water resources or, water dependent ecosystems or existing users; and

    (c) The proposed location and manner of use has no detrimental impact on the productive capacity of the land and does not cause perched water tables, or water logging.

32. Water shall not be taken or used for the purpose of aquaculture or industry unless:

    (a) The volume of tail water to be disposed of does not exceed an amount that would reasonably be produced according to industry best practice (current at the time of assessment of the application);

    (b) The disposal of tail water does not result in any detrimental impact, (including but not limited to increased salinity or pollution), to the prescribed water resources, underground water resources, water dependent ecosystems or existing users;

    (c) The proposed location and manner of use has no detrimental impact on the productive capacity of the land and does not cause perched water tables, or water logging.

33. Water shall not be taken or used for aquifer recharge unless:

    (a) It will not cause any significant adverse impact (including but not limited to increased salinity or pollution), on the prescribed water resources, underground water resources, water dependent ecosystems and existing users; and

    (b) The proposed location and manner of recharge has no detrimental impact on the productive capacity of the land and does not cause perched water tables, or water logging.

Efficient use of water

34. Water shall only be allocated where the water shall be used or applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used and in accordance with best practice standards (current or expected at the time of assessment of the application).

35. For the purposes of principle 6.2.34 the relevant circumstances for the use of water for irrigation include (but are not limited to):

    (a) The plant type; and

(b) The climate, dominant soil type and topography of the allotment; and

(c) The location of remnant native vegetation and/or other permanent structures such as power lines, that may limit the method of application of water; and

(d) The quality of the water to be used.

36. Where water is to be used for a purpose other than irrigation, the allocation shall not exceed the amount that is reasonable, in accordance with industry best practice standards current at the time of assessment of the application, for the proposed purpose.

Hydrological effects

37. The taking and use of the water shall not cause or be likely to cause:

(a) A decrease in water quality of the prescribed water resources or any other water resource downstream to the Jip Jip gauging station;

(b) A change in water levels that occur for each flow band (Column 2 in Tables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 and 2.9, Section 2) that would result in;

i. long-term reduction of flow from the prescribed area to the Marcollat Watercourse of greater than 25 percent of the mean annual flow of Morambro Creek as measured at Nyroca that would have discharged if there were no licensed extractions, and/ or

ii. long-term reduction, given seasonal conditions in the frequency of Cockatoo Lake filling to its full capacity, of greater than 15 percent of the frequency that would have occurred if there were no licensed extractions, and/ or

iii. long-term reduction of more than 15 percent in the frequency, occurrence and duration of flows in each management area of the prescribed area.

(For the purpose of this principle 6.2.37 (b) long-term is 15 years)

(c) A change in geomorphic structure of the watercourse;

(d) Detrimental impact to other associated water resources within and beyond the prescribed area, downstream to Jip Jip gauging station;

(e) A change to the flow requirements of water dependent ecosystems (principle 6.2.38); and

(f) Detrimental impact to the ecosystems within the watercourse identified as having high ecological value (Reach 5 – The Gap (Section 2.3.5) and reach 7 - Cockatoo Lake (Section 2.3.7)).

Water dependent ecosystems

38. Water shall not be allocated if its taking and/or use would cause a detrimental impact within the prescribed area to:

(a) Endemic ecosystems that are currently stressed; or

(b) Ecosystems that have reached steady-state dependence on the current flow regime; or

(c) Ecosystems that have been degraded by other processes (grazing, salinity and land clearance) and require surface water flows to allow recovery of the ecosystem; or

(d) Threatened species and/or ecological communities; or

(e) Any other water resource.

39. Water may be allocated if its use would have a net beneficial effect on ecosystems within the prescribed area and no significant adverse impact to the prescribed water resources.

Divided allotments

40. Where an allotment is, or two or more adjoining allotments held by the same owner are divided by a management area boundary, but a water allocation is taken from a point in only one of the management areas, the allocation may be taken and used anywhere throughout those allotments, provided that the:

(a) Taking and use of water meets all of the criteria set out in the principles 'Hydrological Effects' principle 6.2.37; and

(b) Point of extraction and/or use is not moved more than 0.5 kilometres into an adjacent management area unless it can be demonstrated that the allocation (or part thereof) was being extracted at the current location in an adjacent management area or prescribed wells area prior to the date of adoption; and

(c) Allocation remains referenced to, and accounted for in the originating management area; and

(d) Allocation will not be available for further transfer within the receiving management area.

7 Transfer criteria

The following objectives and principles apply to the transfer of water allocations in the Morambro Creek and Nyroca Channel prescribed watercourses including Cockatoo Lake and the prescribed surface water area (hereafter the prescribed area).

7.1 Objectives

1. To maintain and where possible protect the quality and quantity of the water resource from any adverse impacts of transfers.

2. To ensure that the management, taking and use of the water resources in the prescribed area protects the local and regional environments and prevents and/or addresses significant degradation of any other resource including soil, water and vegetation.

3. To prevent loss of biodiversity and protect local and regional ecological processes, that are dependent on the water resources, from significant degradation arising from the taking and use of the water from the prescribed area.

4. To encourage the active and efficient use of the water according to best practice standards.

5. To manage the water in the prescribed area in a cautious manner so that it may continue to be utilised by future generations and is available for stock use and domestic use supply.

6. To provide flexibility and equity in access to the water resources in the prescribed area.

7. To enable a water market to develop so that water allocations are readily available for future economic development.

7.2 Principles

Limit to total allocation

1. Water shall not be transferred where the transfer would cause the total amount allocated as component A allocations and component B allocations within a management area and the prescribed area to exceed the volume for licensed allocation specified in Table 10.3.

2. An allocation of surface water shall not be transferred unless:

   (a) There is no change in location of the point of taking; or

   (b) The infrastructure to take the water from the original point of taking has been modified so that it cannot take water.

Transfers of water (holding) allocations

3. A water (holding) allocation may be transferred in whole or in part within a management area or to another management area and converted to a water (taking) allocation provided the VLA for the receiving management area is not exceeded, subject to the provisions of this Plan relevant to the transfer of a water(taking) allocation.

Applications to transfer water (taking) allocations - Purpose of use

4. Water shall only be transferred as a water (taking) allocation where the proposed location and manner of use of the water will not have a significant detrimental impact on the prescribed water resource, water dependent ecosystems or existing water users as specified in 6.2.37 (Hydrological Effects), 6.2.38 (water dependent ecosystems).

5. Water shall not be transferred where the water is to be taken or used for wild flooding.

6. Where the transfer of a water allocation will require the establishment of a water affecting activity, that water allocation shall not be transferred until the water affecting activity has been authorised by a permit (Section 8 Permits).

7. Water shall not be transferred where the water is to be taken and used for the purpose of irrigation unless:

   (a) The allocation does not exceed the amount that is reasonably required, in accordance with industry best practice standards current at the time of the assessment of the application, for the proposed purpose;

   (b) There is no detrimental impact including and not limited to increased salinity or pollution in the prescribed water resources or any underground water resources or, water dependent ecosystems or existing users;

   (c) The proposed location and manner of use has no detrimental impact on the productive capacity of the land and does not cause perched water tables, or water logging.

8. Water shall not be transferred where the water is to be taken and used for the purpose of aquaculture or industry unless:

   (a) The volume of tail water to be disposed of does not exceed an amount that would reasonably be produced according to industry best practice (current at the time of assessment of the application); and

   (b) The disposal of tail water does not result in any detrimental impact (including but not limited to increased salinity or pollution), to prescribed water resources and underground water resources, water dependent ecosystems or existing users; and

   (c) The proposed location and manner of use has no detrimental impact on the productive capacity of the land and does not cause perched water tables, or water logging.

9. Water shall not be transferred where the water is to be taken and used for aquifer recharge unless:

   (a) It will not cause any significant adverse impact (including but not limited to increased salinity or pollution), on the prescribed water resources, underground water resources, water dependent ecosystems or existing users; and

   (b) The proposed location and manner of recharge has no detrimental impact on the productive capacity of the land and does not cause perched water tables or water logging.

Applications to transfer water (taking) allocations – development of allocation before transfer

10. A licence endorsed with a water allocation granted subject to a condition or conditions requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time) (Principle 25-28 Section 6.2) may only be transferred on the following terms:

   (a) Where the condition or conditions have been fully complied with, the allocation or part of the allocation and the licence may be transferred;

   (b) Where the condition or conditions have not been fully complied with, only the portion of the allocation that could be used in accordance with the extent of development at the date of receipt by the Minister of the application to transfer may be transferred; or,

   (c) Where the licence or allocation is to be transferred in its entirety, and the point of the taking will not change, it may be transferred whether or not the land or equipment has been fully developed in accordance with the condition(s), provided the new landowner fully develops the land and equipment to allow use of the allocation at its maximum lawful rate, in accordance with the original condition(s).

Applications to transfer water (taking) allocations – Destinations

11. Water may be transferred between management areas provided the VLA for the receiving management area is not exceeded.

12. The taking and use of water at the destination shall be consistent with the provisions of Section 6.2 in the Plan,

13. An allocation shall not be transferred with a diversion rate that exceeds the diversion rate endorsed on the transferor's licence.

Applications to transfer water (taking) allocations - efficient use of water

14. Water may only be transferred where the water shall be used or applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used and in accordance with

industry best practice standards (current or expected at the time of assessment of the application).

15. For the purpose of principle 7.2.14 the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

    (a) The plant type;

    (b) The climate, dominant soil type and topography of the point of application;

    (c) The location of remnant native vegetation and/or other permanent structures such as power lines, that may limit the method of application of water; and

    (d) The quality of the water to be used.

16. Where the transferred water is to be used for a purpose other than irrigation, the allocation shall not exceed the amount that is reasonable, in accordance with industry best practice standards current at the time of assessment of the application, for the proposed purpose.

Applications to transfer water allocations – Hydrological effects

17. The taking and use of the water at the transfer destination of an allocation shall not cause or be likely to cause:

    (a) A decrease in water quality of the prescribed water resources or any other water resource downstream to Jip Jip gauging station;

    (b) A change in water levels that occur for each flow band (Column 2 in Tables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 and 2.9, Section 2) to ensure there is no;

        i. long-term reduction of flow from the prescribed area to the Marcollat Watercourse of greater than 25 percent of the mean annual flow of Morambro Creek as measured at Nyroca that would have discharged if there were no licensed extractions, and/ or

        ii. long-term reduction, given seasonal conditions in the frequency of Cockatoo Lake filling to its full capacity, of greater than 15 percent of the frequency that would have occurred if there were no licensed extractions, and/ or

        iii. long-term reduction of more than 15 percent in the frequency, occurrence and duration of flows in each management area of the prescribed area.

    (For the purpose of this principle 7.2.17 (b) long-term is 15 years.)

    (c) A change in geomorphic structure of the watercourse;

    (d) Detrimental impact to other associated water resources within and beyond the prescribed area, downstream to Jip Jip gauging station;

    (e) A change in the flow requirements of water dependent ecosystems (principle 6.2.38), and

(f) Detrimental impact to the ecosystems within the watercourse identified to have high ecological value (Reach 5 – The Gap (Section 2.3.5) and Reach 7 - Cockatoo Lake (Section 2.3.7)).

18. The transfer of water shall be deemed to have complied with the principles in 7.2.1 without further assessment where, after transfer:

    (a) The water would continue to be taken from the same diversion point; or

    (b) The transferee is renewing a temporary transfer for the same amount of water, to be taken from the same point of extraction, for the same duration as the original transfer and the transferee applies for this transfer before that temporary transfer has expired.

19. Relocation of a diversion point on the same allotment shall be subject to hydrological assessment (Section 6.2).

Metering

20. The water taken shall be measured as near as practical to the point of extraction or diversion and in any case shall be measured no more than 100 m away from the point of taking.

21. The place and method of measurement shall be approved by the Minister. Before any water can be taken all measurement devices shall be fitted. The measurement devices shall include the capability of recording parameters including time of taking, duration of taking, rate of taking (litres per second) and volume taken.

8 Permits

The water affecting activities described in table 8.1 are activities for which a permit is required under Section 127 of the *Natural Resources Management Act 2004*.

In some cases a permit may not be required for the activities below because the provisions of Section 129 of the *Natural Resources Management Act 2004* remove the requirement.

Table 8.1: Water affecting activities

Water-affecting activity	Example activities	Relevant Authority
Section 127 (5)		
(a) the erection, construction or enlargement of a dam, wall or other structure that will collect or divert water flowing in a watercourse that is not in the Mount Lofty Ranges Watershed and that is not prescribed or flowing over any other land that is not in a surface water prescribed area or in the Mount Lofty Ranges Watershed;	**Dam** construction	The Minister
(b) the erection, construction or placement of any building or structure in a watercourse or lake or on the floodplain of a watercourse;	Weirs Wetland management works Bridge construction	The Minister
(f) depositing or placing an object or solid material on the floodplain of a watercourse or near the bank or shore of a lake to control flooding from the watercourse or lake;	Levees	The Minister
(g) destroying vegetation growing in a watercourse or lake or growing on the floodplain of a watercourse	Clearing reeds	The Minister
(h) excavating or removing rock, sand or soil from- (i) a watercourse or lake or the floodplain of a watercourse; or (ii) an area near to the banks of a lake so as to damage, or create the likelihood of damage to, the banks of the lake;	Drain excavation	The Minister
(i) using water in the course of carrying on a business in a catchment area at a rate that exceeds the rate of 0.5ML/year prescribed by the Plan if the water has been brought into the catchment area by means of a pipe or other channel;	Importation of water from a Prescribed Wells Area	The Minister
(j) using effluent in the course of carrying on a business (which includes intensive animal keeping) in a catchment area at a rate that exceeds 100 kg of nitrogen/hectare/year.	Effluent spreading	The Minister
Section 127 (3)		
(a) the drilling, plugging, backfilling or sealing of a well;	Drainage well construction	The Minister
(b) repairing, replacing or altering the casing, lining or screen of a well;	Drainage well maintenance	The Minister
(c) draining or discharging water directly or indirectly into a well;	Disposal of drainage waters to a drainage well	The Minister
(d) the erection, construction or enlargement of a dam, wall or other structure that will collect or divert- (i) Water flowing in a watercourse in the Morambro Creek prescribed water resources area; or (ii) Surface water flowing over land in the Morambro Creek prescribed water resources area.	Dam construction	The Minister

Note: The Minister designated as the relevant authority is the Minister responsible for the *Natural Resources Management Act 2004.*

8.1 Catchment Wide Provisions

To address the potential impacts of activities across the Morambro Creek Prescribed Area, objectives and principles are outlined in this Plan for the relevant authority to use when assessing an application for a permit.

The objectives and principles in the South East Natural Resources Management Plan apply throughout the Prescribed Area. They provide general guidance on the basic requirements that must be met for a permit to be granted.

The objectives and principles in the Morambro Creek Prescribed Area Provisions are additional to those expressed as catchment wide provisions applicable to the whole of the catchment area.

8.1.1 Regional water balance

Objective

1. To sustainably manage the quantity and quality of the water of the region to optimise productive use, while providing for the needs of ecosystems.

Principles

1.1 Activities should not compromise the use of prescribed water resources, the quality of water resources or capacity for natural systems such as a watercourse, a wetland or an area subject to inundation to restore or maintain water quality.

1.2 Activities should not adversely affect water dependent ecosystems.

1.3 Activities should not adversely affect underground water recharge and discharge processes.

8.1.2 Aquatic Biota

Objective

2. To protect the health and condition of native aquatic biota and its capacity for migratory behaviour within and into the region.

Principle

2.1 Activities should not adversely affect the capacity for the migration of native aquatic biota or their environmental water requirements.

8.1.3 Environmental water requirements

Objective

3. To protect and enhance the provision of water for environmental purposes.

Principle

3.1 Activities should not adversely affect the quality, quantity, duration or in any other way, the supply of water to water dependent ecosystems.

8.1.4 Water quality

Objective

4. To protect and enhance the quality of surface and underground water.

Principles

4.1 The discharge of waters to receiving surface waters or underground water should not cause the quality of the receiving waters to change detrimentally.

4.2 The quality of discharge water should not have an adverse effect on the quality of receiving waters to the extent that the capacity of those receiving waters to support current environmental, economic or social uses is affected.

8.1.5 Flood risk

Objective

5. To protect against the risk of harm to public and private assets and to the public from flooding.

Principle

5.1 Activities should not cause or increase the flood risk to public and private assets, communities or individuals.

8.1.6 Character of lakes, wetlands and areas subject to inundation

Objective

6. To protect and enhance the ecological and natural features of a lake, wetland, watercourse, or the floodplain of a watercourse.

Principle

6.1 Activities should occur in a manner that protects the ecological values of ecosystems and natural features of a lake, a wetland, a watercourse or the floodplain of a watercourse.

8.1.7 Erosion and soil conservation

Objective

7. To protect watercourses and regional drainage infrastructure from erosion.

Principle

7.1 Activities should provide for the protection against degradation of watercourses or drainage infrastructure from wind or water erosion arising from the activity.

8.1.8 Water storage and diversion

Objective

8. To prevent temporary works impeding surface water or drainage flows from becoming permanent structures.

Principle

8.1 A dam constructed to allow maintenance work, construction of drainage management structures or to allow construction of regional or on-property transportation structures may only be constructed across a watercourse on a temporary basis.

8.1.9 Drainage works

Objective

9. To provide for the drainage of land subject to inundation for flood management, agricultural productivity and salinity mitigation while balancing the water needs of water dependent ecosystems.

Principle

9.1 Drains should be designed and constructed to enable the preservation and enhancement of ecological functions of ecosystems reliant on underground and/or surface water.

Objective

10. To protect the capacity and the structural integrity of the government drainage infrastructure and provide access for maintenance.

Principles

10.1 Private drainage works should be designed and maintained so as to prevent siltation of the government drainage system.

10.2 Construction of private drainage works shall not interfere with access along the drainage reserve of the government drainage system.

10.3 The capacity of private drainage works shall not cause the capacity of government drainage infrastructure to be exceeded.

8.1.10 Wetland management works

Objective

11. To minimise adverse off site impacts from the construction and operation of wetland management works.

Principle

11.1 Wetland management works should be designed and operated to incorporate the provision of environmental water needs of the wetland and downstream dependent ecosystems and have regard for the requirements for regional or localised landscape drainage.

Objective

12. To minimise adverse localised impacts from ponding of water in wetlands.

Principle

12.1 Ponding of water for wetland management should not cause waterlogging, unacceptable underground water mounding or cause or exacerbate dryland salinity.

8.1.11 Obstructions to surface water flows

Objective

13. To prevent adverse changes of surface water flow from the construction of structures.

Principle

13.1 Culvert and bridge design and construction shall include provisions to ensure that fixed sill levels, created as a result of the structure, do not adversely impede the flow of water in a watercourse, across the floodplain of a watercourse, a lake or a wetland.

Objective

14. To minimise the potential for erosion and the restriction of surface water flows arising from construction of transport and drainage infrastructure.

Principles

14.1 Construction of roads that span a watercourse, the floodplain of a watercourse, a lake, a wetland or an area subject to inundation shall be designed to minimise the risk of erosion resulting from the construction and location of the structure.

14.2 The placement of a road that spans a watercourse, the floodplain of a watercourse, a lake, a wetland or area subject to inundation should not adversely affect the provision of environmental water requirements of those areas.

8.2 Morambro Creek Prescribed Water Resources Provisions

The following objectives and principles apply to all water affecting activities within the Morambro Creek Prescribed Area. They are in addition to those expressed for the catchment wide provisions in the South East Natural Resources Management Board Plan.

The relevant authority for all water affecting activities in the Morambro Creek Prescribed Area is the Minister.

8.2.1 Draining or discharging water into wells

Objective

1. To maintain and protect surface water flows across the landscape and into the watercourse and prevent adverse impacts from the construction of wells.

Principle

1.1 No new wells shall be constructed apart for the replacement of existing ones.

Note: The location of new wells needs to be assessed against the placement of the existing one.

1.2 No new wells shall be constructed on the watercourse or tributaries to the watercourse.

1.3 New wells shall not be constructed within the buffer zone for the prescribed area.

1.4 Wells shall only be constructed in such a manner that surface water flows from the catchment into the watercourse are not obstructed in any way during construction of the well, to avoid contamination and reduced flows to the watercourse.

1.5 Wells will need to be constructed with a sill set at a level so that the criteria within section 6.2 are satisfied and to prevent degradation to water dependent ecosystems.

Objective

2. To protect the quality of the surface water and underground water resources from the construction and maintenance of a well.

Principle

2.1 The equipment, materials and method used in the drilling, plugging, backfilling or sealing of a well or the replacement or alteration of the casing, lining or screen of a well, shall have no adverse impact on the quality of surface water flow into the watercourse.

Objective

3. To protect the surface water and underground water resources from pollution, deterioration and undue depletion.

Principles

3.1 Draining or discharging water directly or indirectly into a well shall occur in a manner that does not adversely affect the water quality of the underground or surface water resource or any ecosystem that depends on that water.

3.2 Draining or discharging water directly or indirectly into a well shall occur in a manner that does not adversely increase the concentrations, levels or amounts of the substances, materials or characteristics of the receiving water, and shall not be sufficient to degrade the ecosystems dependent upon underground water within the prescribed area or the adjoining underground water prescribed wells areas or reduce the suitability of the underground water for other purposes for which it might reasonably be used.

3.3 For the purposes of principles 3.2 and 3.5, the list of substances, materials and characteristics comprises substances, materials and characteristics that may reasonably be expected to be present in the water from the prescribed area to be drained or discharged and have the potential to degrade the native underground water and the ecosystems that depend upon the native underground water, including where relevant (but not limited to):

(a) pH, TDS, turbidity, ammonia, nitrate, nitrite, total phosphorus, sodium, chloride, sulphate, calcium, total chromium, total lead, total manganese, total zinc, total coliform and faecal coliform; and

(b) Pesticides, Giardia, Cryptosporidium, volatile organic compounds and petroleum hydrocarbons (including but not limited to water from land used for intensive agriculture or industrial purposes), those substances, materials and characteristics likely to be present in the source of the water; and

(c) Trihalomethanes where the water to be drained or discharged has been treated by chlorination.

3.4 For the purpose of principles 3.2 and 3.3 the relevant concentrations, levels or amounts shall be measured by sufficient representative samples as determined by the Minister from:

(a) The water to be drained or discharged, collected either from an existing dam or directly from the source; and

(b) Native underground water collected from the proposed point of injection, and from the same aquifer as that in which storage is proposed.

3.5 The draining or discharging of water directly or indirectly into a well may not be granted (despite principle 3.2) where the cumulative effects of the discharge of water to the aquifer are considered sufficient to degrade the ecosystems dependent upon underground water within the underground water prescribed wells areas, or to reduce

the suitability of the underground water for other purposes for which it might reasonably be used.

Objective

4. To protect surface water environmental flows from adverse impacts from discharge to wells.

Principle

4.1 Construction and siting of wells for the drainage or disposal of surface water shall not compromise surface water flows to surface water dependent ecosystems in the prescribed area, and upstream of Nyroca Cutting.

Objective

5. To provide for the measured recharge of water to the aquifer.

Principle

5.1 Draining or discharging of water allocated (extracted) from the prescribed water resource down a well for recharge purposes may only occur where the water is measured, and information recorded includes volume, timing, duration and rate of discharge.

8.2.2 Water storage and diversions (dams)

Objective

6. To protect the access of licensed and stock and domestic use downstream water users of surface water resources from the impacts of the construction and management of dams.

Principles

6.1 All new dams for licensed extraction commissioned for that purpose after the adoption date shall be constructed outside the 100 m buffer zone.

6.2 The capacity of all dams other than holding dams within the prescribed area shall not exceed the maximum dam development limit.

6.3 After the date of adoption where a dam (the new dam) is to be constructed on an allotment created by a land division or series of divisions of a larger allotment (the original allotment) the combined capacity of the new dam (or dams) and any existing dam (or dams) shall not exceed 30 percent of the median run-off of the original allotment.

6.4 Infrastructure to enable diversion of water from a watercourse, or the floodplain of a watercourse, shall incorporate a low flow bypass mechanism so that no more than 50

percent of the available flow, above the threshold flow rate, can be diverted at any time.

6.5 An on-stream dam, wall or other structure shall include a device that regulates the diversion of any flow at the threshold flow rate away from the dam and returning it back to the same watercourse or drainage path below the dam, wall or structure and be of similar quality.

Objective

7. To protect against adverse impacts on environmental flows and ecological processes.

Principle

7.1 Collection or diversion of water flowing in a watercourse or over land shall not adversely affect downstream water dependent ecosystems by causing significantly reduced stream flow duration, lengthened periods of no or low flow, or other such impacts.

7.2 Dams shall not be situated in ecologically sensitive areas or in areas prone to erosion.

Objective

8. To protect against underground water mounding as a result of water storage in dams.

Principle

8.1 Dams shall be constructed and managed to prevent seepage resulting in underground water mounding in the vicinity of the dam and near neighbouring properties.

Objective

9. To prevent temporary works in the catchment area impeding permanent surface water or drainage flows in the watercourse.

Principle

9.1 A temporary dam (coffer dam) constructed to allow for maintenance work, construction of drainage management structures or to allow construction of regional or on-property transportation structures, may only be constructed across a watercourse on a temporary basis. A low flow bypass must be installed to ensure continued flow to downstream users.

8.2.3 Building or structure in a watercourse, lake or floodplain

Objective

10. To prevent any adverse changes to surface water flow and to protect the ecology of a watercourse or lake.

Principles

10.1 The construction of a building or structure should not lead to rising water tables and salinity.

10.2 Structures that impede the flow of water, such as weirs, should be designed to provide low flow by-pass mechanisms.

10.3 Buildings and structures should be maintained in an appropriate condition to perform their intended function.

8.2.4 Depositing or placing an object or solid material on the floodplain of a watercourse or lake to control flooding

Objective

11. Ensure that the objects or solid material placed on the floodplain to provide flood protection are appropriate.

Principle

11.1 Depositing or placing an object or solid material in a watercourse or lake to control flooding should not:

(a) Adversely impact upon the natural flow of a watercourse;

(b) Increase the risk of flooding (including up and downstream); or

(c) Result in watercourse erosion.

Objective

12. Ensure the natural flows of watercourses are retained.

Principles

12.1 The design, construction and location of levees should:

(a) Provide for the needs of ecosystem processes, including the migration of aquatic biota;

(b) Minimise the impact or risk of flooding on human communities; or

(c) Not cause or increase watercourse erosion.

8.2.5 Destroying vegetation

Objective

13 To protect vegetation in a watercourse, lake or floodplain of a watercourse to maintain bed and bank stability, protect biodiversity and maintain water quality.

Principles

13.1 Vegetation shall only be destroyed in such a manner that would not cause or increase erosion or sedimentation.

13.2 Vegetation should not be destroyed if it:

(a) has significance as a habitat for wildlife; or

(b) is native, has a high level of diversity of plant species or has rare or endangered plant species or plant association(s).

13.3 Vegetation should not be destroyed if the destruction is likely to lead to the deterioration in the quality of underground water or water in watercourses or surface water run-off.

8.2.6 Excavation or removal of rock, sand or soil

Objective

14. To preserve the geomorphic characteristics of a watercourse or floodplain.

Principles

14.1 Alteration to the alignment of a watercourse may only occur where it is for the protection of existing buildings, structures and infrastructure or rehabilitation of a watercourse and the realignment does not result in any of the following:

(a) Increased erosion;

(b) Increased flooding;

(c) Bed and bank instability;

(d) Downstream sedimentation;

(e) Loss of riparian vegetation;

(f) Reduction in water quality; or

(g) Alteration to the natural flow regime of a watercourse.

Objective

15. To protect the natural state of runaway holes in the catchment area.

Principle

15.1 Modifications to natural runaway holes shall not be permitted. Maintenance work may occur, including the removal of silt and debris blocking the free flow of water down the holes.

8.2.7 Importation of water

Objective

16. To protect the quantity and quality of water resources in the prescribed water resources area and avoid the detrimental effects of flooding arising from the importation of water.

Principles

16.1 Water shall only be imported where it causes no detrimental effects, either directly or indirectly, on the quality and quantity of the receiving water resources.

16.2 Any necessary facilities for storage of imported water shall be constructed and operated in a manner that does not cause any significant detrimental impact on the quality of surface water or the health of water dependent ecosystems.

16.3 Imported water that is chlorinated shall not be discharged into the prescribed water resource.

16.5 Where imported water is stored in a dam, the dam shall be a holding dam (turkey nest dam).

Objective

17. To prevent detrimental impacts on the productive capacity of land or water dependent ecosystems from the taking and use of imported water.

Principles

17.1 The importation of water shall have no detrimental effect on the productive capacity of the land, including, but not limited to, creating perched water tables less than 2 metres from the surface, or waterlogging.

17.2 The importation of water shall have no adverse effects on those qualities of any receiving water upon which ecosystems rely.

9 Monitoring

Section 76 (4) d of the *Natural Resources Management Act 2004* requires the Plan to assess the capacity of the resource to meet demands for water on a continuing basis and provide for regular monitoring of the capacity of the resource to meet those demands.

9.1 Historic monitoring and management

During the 1970s the South Eastern Water Conservation and Drainage Board (SEWCDB) managed Cockatoo Lake and the Nyroca Channel, while the Tatiara Drainage Council managed Morambro Creek. In 1992, the *South Eastern Drainage Act 1932* and the *Taitiara Drainage Trust Act 1949* were replaced by the *South Eastern Water Conservation and Drainage Act 1992*, leaving the responsibility of Morambro Creek Watercourse to the SEWCDB. Prior to 1992, there was no management of modifications or diversions from the Morambro Creek Watercourse.

Historic flow events have been recorded in Morambro Creek and in the downstream Marcollat system at: The Gap (1971–continuing); Frances (June 1987-Feb 1990); and Marcollat Watercourse at Jip Jip (April 1985-continuing).

A number of studies have assessed varying aspects of the hydrology of Morambro Creek and nearby catchments. Included is work related to the drainage, wetland and flood management. The investigations were undertaken by groups such as the SEWCDB, Department of Environment and Heritage, the former Engineering and Water Supply and former Department of Water Resources, as well as specific flood investigations for road bridge design purposes undertaken by Transport SA.

Salinity data has also been collected at: Jip Jip gauge (1992 to 1997); from the lakes and wetlands on the Marcollat system (2000-2001); Morambro Creek at the Gap (1972 to 1996); and for Frances (over a more limited time period).

The number of drainage wells and farm dams was determined by a field survey conducted by the DWLBC in October 2002. Consultants to the South East Catchment Water Management Board, Resource and Environmental Management, estimated the water usage and recharge at the time of prescription.

9.2 Monitoring the capacity of the watercourse and surface water resource- water use, flows and surface water/ underground water interactions.

An ecological and hydrological monitoring program is recommended for the Morambro Creek Prescribed Area to compare desired management outcomes with actual outcomes and to evaluate the effectiveness and efficiency of water provisions.

Table 9.1 stipulates the location and data to be recorded from gauging stations required along the watercourse to enable the efficient management of the prescribed water resources**.**

Table 9.1: Surface water monitoring

What	Where	When
Contribution of flows into Morambro Creek from Victoria (level, duration frequency, seasonality, rates of rise and fall of flow events)	Readings from gauging station located downstream from Lake Cadnite	Throughout the year and continuously from the commencement of each flow event until its conclusion.
Flows and water quality at the Naracoorte Rd -Bordertown Rd gauging station (A2390531) (level, duration frequency, seasonality, rates of rise and fall of flow events, salinity)	Readings from gauging station located at the Naracoorte/ Bordertown Bridge	Throughout the year and continuously from the commencement of each flow event until its conclusion.
Water level at Cockatoo Lake	Cockatoo Lake	Throughout the year
Flows and water quality at the Jip Jip weir (Level, duration, frequency, seasonality, rates of rise and fall of flow events and salinity)	Down stream from the Jip Jip weir	Throughout the year and for each flow event.
Turbidity, salinity, pH, nutrients and pollutants	Key locations in the watercourse (to be determined)	During flow events.

9.3 Strategy for regular monitoring of demands placed on the watercourse and surface water resource.

The strategy for regular monitoring of the demands placed on the surface water and watercourse resources is provided below. The monitoring program will include:

9.3.1 Water resource condition

Regular monitoring of flows in the watercourse should ensure that the aggregate taking and use of water shall not cause or be likely to cause:

(a) A long-term reduction of flow from the prescribed area to the Marcollat Watercourse of greater than 25 percent of the mean annual flow of Morambro Creek as measured at Nyroca that would have discharged if there were no licensed extractions, or

(b) A long-term reduction, given seasonal conditions in the frequency of Cockatoo Lake filling to its full capacity, of greater than 15 percent of the frequency that would have occurred if there were no licensed extractions, and

(c) A long-term reduction of more than 15 percent in the frequency, occurrence and duration of flows in each management area of the prescribed area.

(For the purpose of this principle (c) long-term is 15 years.)

9.3.2 Annual Water Use Report

An annual water use report is to be prepared by each licensee and submitted to the Department of Water, Land and Biodiversity Conservation (DWLBC), Mount Gambier Office, on or by 5 pm, 31 January each year. Each licensee will provide the following information in the Annual Water Use Report for the water use year:

(a) The rate at which water was diverted from the watercourse;

(b) The volume of water actually taken by the licensee and recorded on each meter during the water use year (i.e. opening and closing meter readings);

(c) The period of extraction for each meter (eg. From 10 July to 16 July);

(d) The purpose for which water has been taken;

(e) Where water is taken by the licensee is used for irrigation:

i. The area of each crop type irrigated;

ii. A sketch plan showing location of each area irrigated, a description of the equipment type used, and area and location of each irrigation method or equipment type;

iii. The number of irrigations on each crop;

iv. The nature of services used to schedule when irrigation is required (eg. Neutron probes, external irrigation scheduling service, tensiometer, etc.);

v. The yield of any crops grown (non-compulsory).

9.4 Monitoring of the water needs of water dependent ecosystems.

The water needs of the ecosystems dependent on the surface water are described in column two of Tables 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 and 2.9, Section 2. Monitoring arrangements must be established to evaluate whether the policies in the Plan protect the water needs that have been identified.

This requires monitoring of critical hydrological and ecosystem parameters that can be used for this evaluation. These parameters include:

- Water levels during flow events;
- Frequency and duration of flows;
- Seasonal fluctuations;
- Water salinity;

- Species composition and abundance;
- Species recruitment; and
- Specific vegetation health measures such as death of Red Gums in the wetlands or disease in trees.

A detailed program to monitor the parameters listed above will be formulated and implemented through the investigations program detailed in the South East Natural Resources Management Plan.

10 Miscellaneous

In preparing this Water Allocation Plan, the Board has had regard to the issues set out in section 7 (2) of the *Natural Resources Management Act 2004,* the *South Eastern Water Conservation and Drainage Act 1992* and the *Upper South East Dryland Salinity and Flood Management Act 2002.*

The Plan shows consistency with the following plans and policies:

(a) Relevant Development Plans under the *Development Act, 1993*;

(b) Relevant environment protection policies under the *Environment Protection Act, 1993*;

(c) Relevant plans of management under the *National Parks and Wildlife Act, 1972*;

(d) Guidelines relating to the management of native vegetation adopted by the Native Vegetation Council under the *Native Vegetation Act, 1991*;

(e) State Water Plan;

(f) National Water Initiative.

Tables

Table 10.1: Annual and mean flow recordings and modelled flows for Morambro Creek (1985–2003), potential maximum extraction from the creek for Component A and B allocations and modelled flows from Morambro following extraction of Component A and B volumes

Year	Morambro Measured Flow (ML)	Morambro Measured Flow and Catchment runoff (ML)	Maximum possible extraction for Component A Licence (ML)	Maximum possible extraction for Component B Licence (ML)	Morambro Flow after Component A extraction (ML)	Morambro Flow after Component A & B extraction (ML)
1985	308	318	0	0	318	318
1986	2,775	3,134	1,041	0	2,093	2,093
1987	8,769	8,868	1,968	0	6,900	6,900
1988	12,220	12,680	2,754	572	9,926	9,354
1989	1,847	2,006	522	0	1,484	1,484
1990	372	513	0	0	513	513
1991	7,670	8,459	1,754	684	6,704	6,020
1992	6,430	6,518	2,034	8	4,484	4,476
1993	367	368	0	0	368	368
1994	0	4	0	0	4	4
1995	12,857	13,304	1,589	714	11,715	11,000
1996	7,997	9,113	1,437	612	7,676	7,064
1997	0	1	0	0	1	1
1998	459	476	0	0	476	476
1999	0	1	0	0	1	1
2000	987	1,119	150	0	968	968
2001	1,520	1,584	316	0	1,268	1,268
2002	0	0	0	0	0	0
2003	1,320	1,655	255	0	1,400	1,400
Mean	**3,468**	**3,691**	**727**	**136**	**2,963**	**2,827**

Table 10.2: Historic values for extraction based on the extraction criteria flows as a percentage of the resource leaving Morambro Creek and Jip Jip

Year	Proposed Extraction for Component A (ML)	Extraction as a percentage of the resource	
		Morambro Flow	Flow Entering Jip Jip
1985	0	0	0
1986	1,041	33	37
1987	1,968	22	23
1988	2,754	22	7
1989	522	26	7
1990	0	0	0
1991	1,754	21	5
1992	2,034	31	9
1993	0	0	0
1994	0	0	0
1995	1,589	12	6
1996	1,437	16	6
1997	0	0	0
1998	0	0	0
1999	0	0	0
2000	150	13	38
2001	316	20	25
2002	0	0	0
2003	255	15	24
	ML	**%**	**%**
Average	**727**	**20**	**8**

Table 10.3: Volume for Licensed Allocation (VLA) for the management areas in Morambro Creek Prescribed Area

A	B		C	D	
Management Area	VLA (ML/year)		Total VLA (ML/year)*	IVLA (litres/second)	
	A	B	A+B	A	B
Herald	300	140	440	210	1,000
Gap	730	140	870	510	1,000
Nyroca	730	140	870	510	1,000
Total Allocation	**730**	**140**	**870**	**510**	**1,000**

*Note: The VLA for the entire prescribed area (management areas 1 + 2 + 3) should not exceed 730 ML per year for Component A allocations or 140 ML per year for Component B allocations. A total VLA of 870 ML per year for both components may be allocated.

Conversion

1litre/second = 1.43 ML/ year

Percentage Share (%) = Volume of Allocation / VLA x 100

Diversion Rate (l/s) = IVLA/ Percentage Share x 100

Table 10.4 Limit to dam development for the prescribed surface water area and management areas

Management Areas	Surface water area (ha)	Maximum dam development limit (ML/ Management area)
Herald	18,096	905
Gap	4,342	217
Nyroca	Not applicable	0
Total	**22,438**	**1,122**

"Maximum Dam Development Limit" for the prescribed surface water area, a management area or an allotment is calculated by:

Area of the prescribed surface water area, management area, or allotment x maximum dam capacity factor (0.05 ML/ha).

Figures

Figure 1: Morambro Creek prescribed surface water area and watercourse location plan

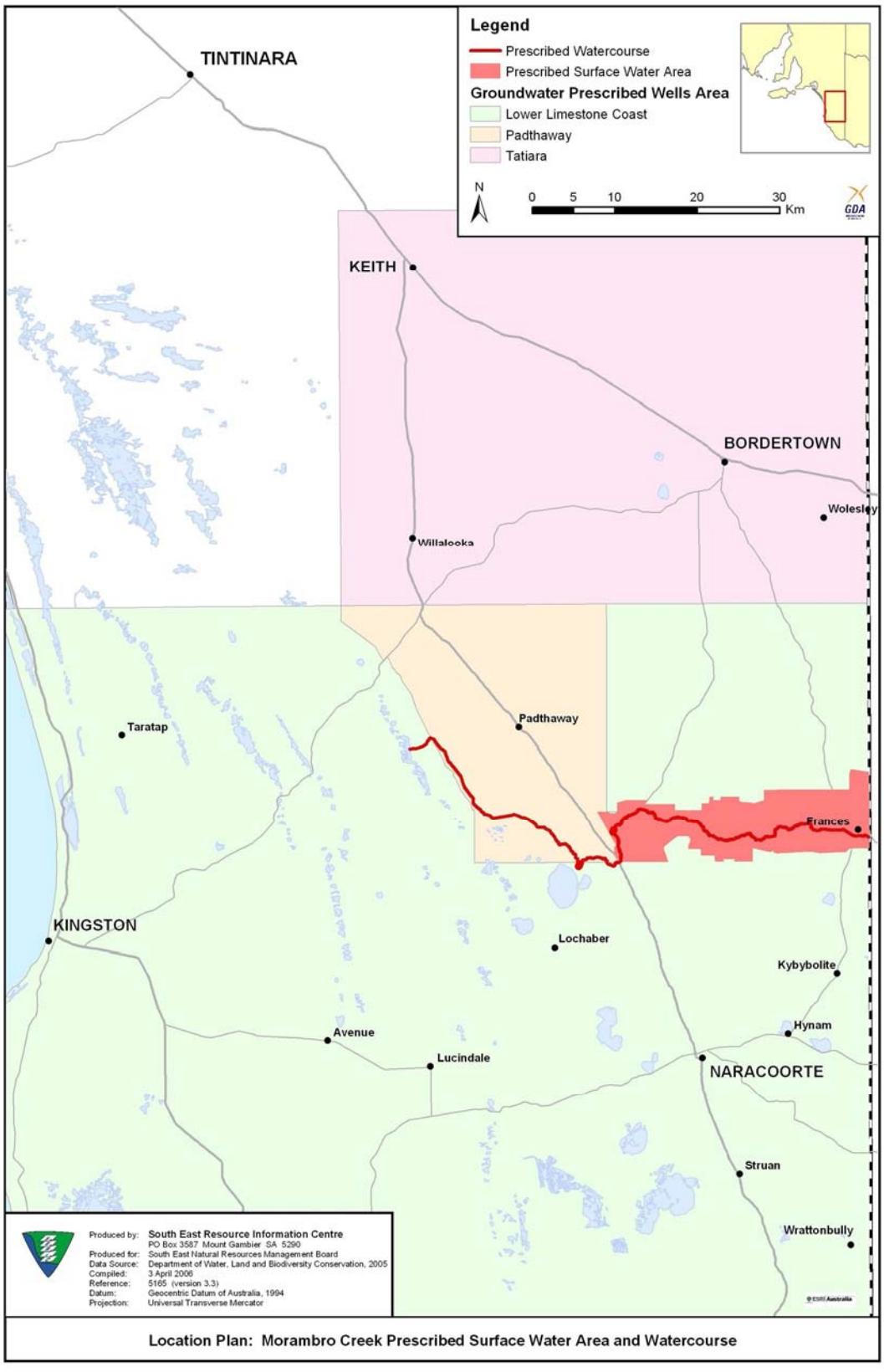


Figure 2: Morambro Creek prescribed area land units (reaches) based on channel structure and capacity, catchment area, soil types and vegetation

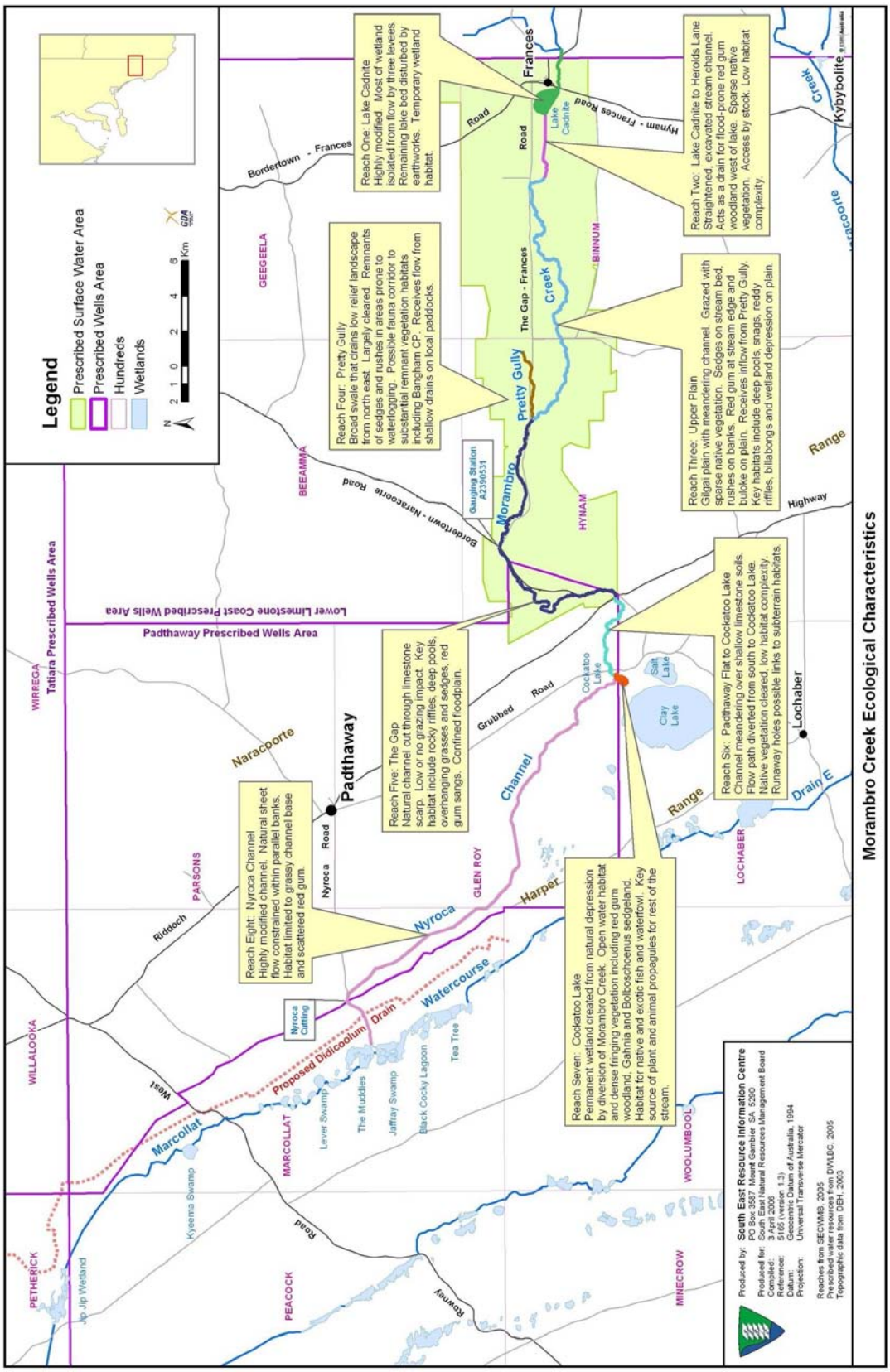


Figure 3: Morambro Creek prescribed area management areas

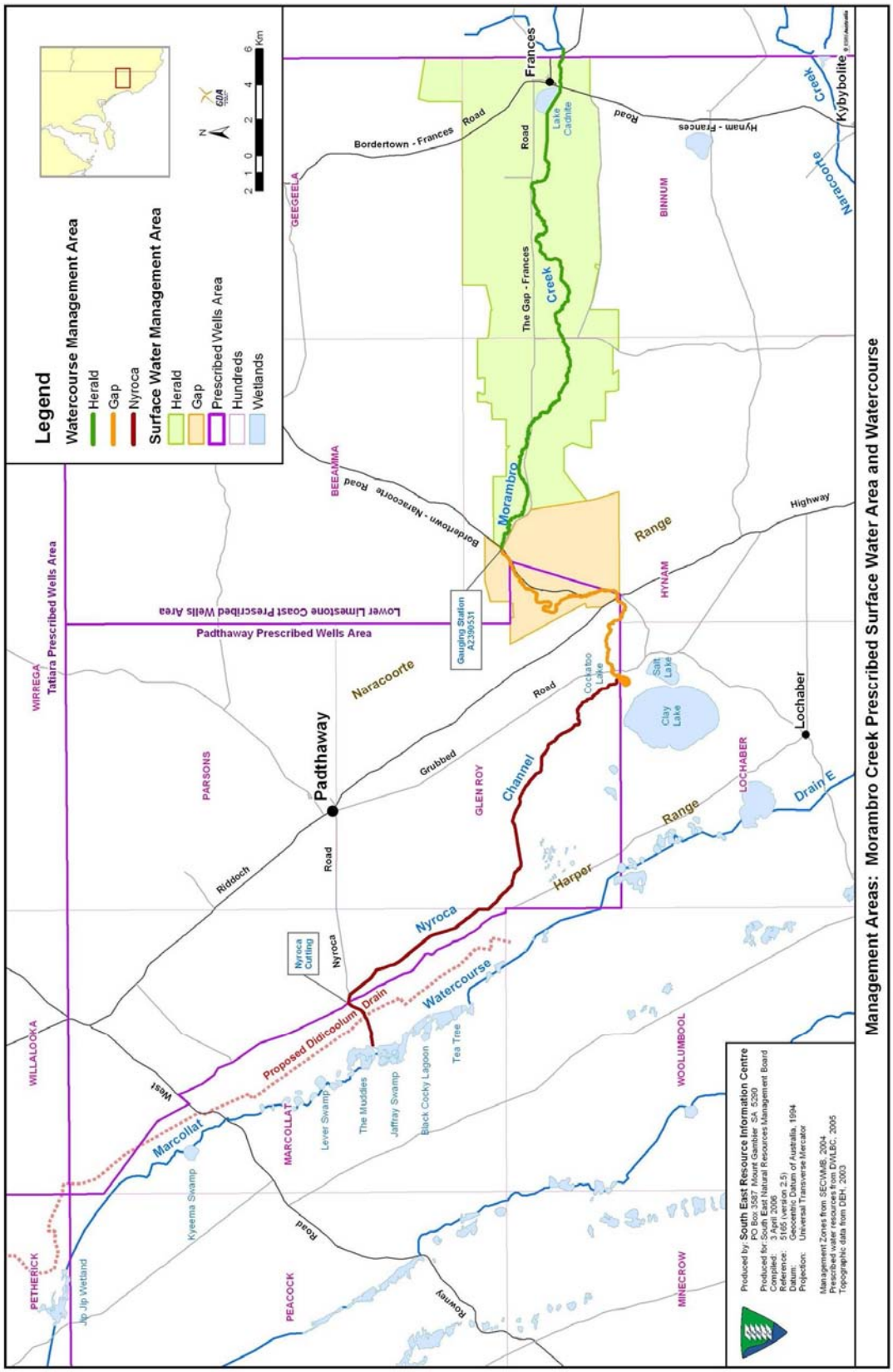
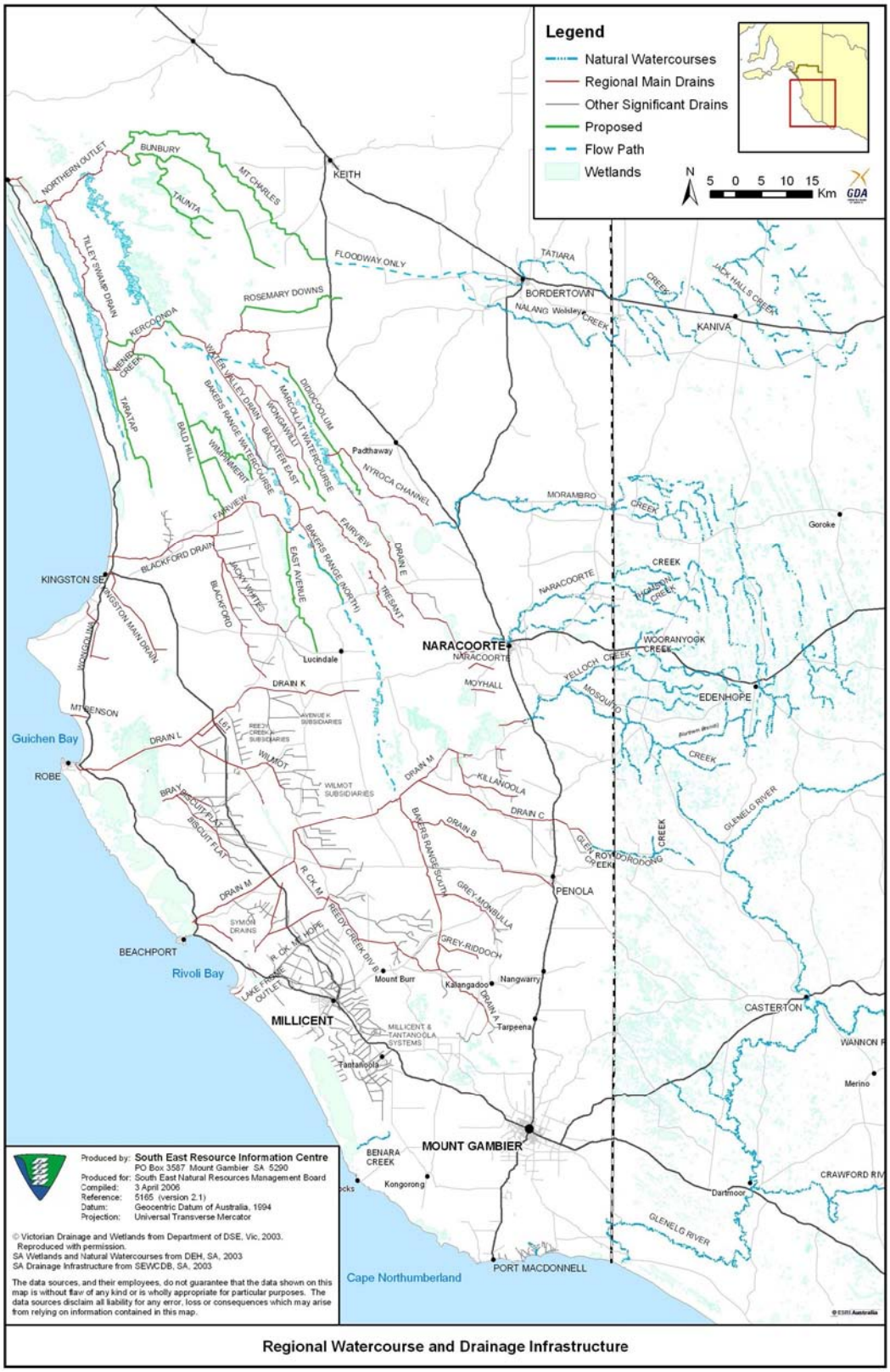


Figure 4: Regional watercourse and drainage infrastructure



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Government of South Australia

South East Natural Resources Management Board

South East Natural Resources Management Board

PO Box 30 (9 Wehl Street), Mt Gambier SA 5290
T: (08) 8724 6000 F: (08) 8723 2965
www.senrmb.com.au