

DRAFT

MANAGEMENT PLAN

for the

FOREST CREEK SYSTEM

*incorporating Forest Creek, Eight Mile Creek
and the Forest Anabranh*

STAGE 1.

(to be reviewed after five years)

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FOREWORD

To be inserted in final document

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SUMMARY

Chapter 1. BASIS OF THIS MANAGEMENT PLAN

The development of this Management Plan is primarily a response to concerns regarding the management of the Wanganella Swamp system and long-standing concerns regarding difficulty with the supply of water to the lower reaches of the Forest Creek system. This is one of many projects being undertaken as part of the New South Wales Government's Water Reform Program, and seeks to find a better balance in the sharing of water between the environment and consumptive use, and to involve the community more effectively in water resource management decisions. This project has been funded by the *Water Management Fund* (a \$1.35 environmental management charge on licensed entitlement in 1997) and the Department of Land and Water Conservation (DLWC).

Without a Management Plan, the lower reach of the Forest Creek system is likely to become an increasingly ineffective water carrier, sustaining an increasingly inefficient use of water. This current flow regime is degrading wetland areas that are permanently inundated and has encouraged the extensive growth of cumbungi. Water is taking longer to reach downstream landholders and over time it is likely that problems with water delivery will increasingly affect adjacent, upstream landholders.

Some future consequences are likely to include:

- Maintenance of existing areas of cumbungi with the possibility of continued growth in some places along the creek;
- Ongoing siltation that will ultimately change the shape and gradient of the creek bed;
- Degradation of permanently inundated areas, particularly wetlands, where the life cycles of native species are cued to phases of wetting and drying;
- Maintenance of tanks (dams) in the creek bed in order that sufficient water can be retained for stock watering after the creek has dried;
- Continuation of breakaway flows from the main creek channel encouraged by the expanse of cumbungi and ongoing siltation.

Development of the Forest Creek Management Plan has been a community driven process, with involvement from landholders and representatives from a range of organisations within the wider community. These groups included the:

*Southern Riverina Field Naturalists Club,
NSW Murray Wetlands Working Group,
Deniliquin Aboriginal Land Council,
Windouran and Conargo Shire Councils,
Rural Land Protection Board (RLPB)
Roads & Traffic Authority (RTA)
NSW National Parks and Wildlife Service
NSW Fisheries
DLWC (State Water)
The Yanco Creek and Tributaries Advisory Council*

At the first community meeting in October 1998, landholders and interested stakeholders identified their vision for the future of the Forest Creek system.

They envisaged that future management would:

- Enable the efficient supply and delivery of good quality stock and domestic water all year round;
- Allow for the efficient passage of unregulated flows;
- Maintain and where possible enhance the ecological sustainability of the Forest Creek system;
- Protect areas of cultural heritage;
- Involve landholders and the wider community in the ongoing management of the Forest Creek system.

The Forest Creek Management Plan has been prepared to fulfill the requirements of a Development Control Plan for the two local environment plans (LEPs) – Conargo and Windouran. These requirements are dealt with under Part 3 of the *Environmental Planning and Assessment Act* (1979), and as such, the plan may have legal status under this Act. Management options/actions proposed by this plan may be adopted as part of the MLDCRC flow management plan for the Murray Lower Darling River. If the plan is adopted, it will form part of an implementation plan for the Murray region.

Chapter 2.

DESCRIPTION OF THE FOREST CREEK SYSTEM

The Forest Creek system is located in the south western Riverine Plain in southern New South Wales, and comprises Forest Creek, Eight Mile Creek and the Forest Anabranche. This creek system is an anabranche of Billabong Creek, leaving Billabong Creek approximately 10kms east of Conargo (35°18' S; 145°11' E) and entering Billabong Creek 8.5km upstream of Moulamein (35°5' S; 144°2' E). The creek system is approximately 200km in length. Land adjacent to the Forest Creek system is predominantly freehold, comprising 19 properties. Travelling stock routes (TSRs) (Crown land) cross the Forest Creek near the offtake, and cross Eight Mile Creek near Wanganella Swamp. The Forest Creek system above Warriston Weir is a regulated watercourse under the *Water Act* 1912 and below Warriston Weir it is an unregulated watercourse.

Hydrology

The Forest Creek system is part of the larger Yanco/Billabong Creek System, which includes the Yanco, Colombo and Billabong Creeks. Forest Creek leaves Billabong Creek below the Colombo/Billabong Creek confluence, but above the Yanco/Billabong Creek confluence. The Forest Creek system receives water from several different sources:

Murrumbidgee Catchment

1. *Colombo Creek*
Carries regulated and unregulated flows from the Murrumbidgee River.

Murray Catchment

2. *Billabong Creek*
Carries unregulated flows from the Billabong Creek catchment.
3. *Finley Escape (off Mulwala Canal)*
Since the 1994/95 irrigation season this Escape has been used to carry water from the Murray River to supplement flows in Billabong Creek below Jerilderie and Forest Creek during summer (up to 250Ml/day).

Prior to 1856, under natural conditions, the Yanco/Billabong Creek system would have been a fairly dry intermittent system that only received flood flows. From 1856, works were carried out to increase the flow of water from the Murrumbidgee River into the Yanco Creek. In 1921 the *Yanco, Colombo and Billabong Creeks Water Trust* was established to take

responsibility for the operation and maintenance of works associated with the building of the Yanco Weir on the Murrumbidgee River. The Yanco Weir was completed in 1928, and in conjunction with Burrinjuck Dam (completed in 1928) and Blowering Dam (completed in 1968), facilitated an almost continuous supply of water into the Yanco/Billabong Creek system for stock and domestic purposes.

During the 1970s, granting of irrigation licences and subdivision of riparian holdings along the Yanco/Billabong Creek system greatly increased the overall entitlement to water on the system. In 1982, the Department of Water Resources placed an embargo on the issue of new irrigation licences in the Murrumbidgee Valley, however development continues to occur along the Yanco Creek system. After 1988/89 licensed pumpers along the Yanco/Billabong Creek system were permitted to grow rice. This was accompanied by a large demand for water per hectare, and has changed traditional extraction patterns. Overall demand for water has continued to increase annually as inactive licences are sold or developed, and existing licence holders use more of their annual entitlement.

Under existing regulated flow conditions, a minimum diversion of 500ML/day at the Yanco Creek offtake is provided for stock and domestic requirements in the Yanco/Billabong Creek system all year round. Extra diversions are made in summer and autumn for irrigation. At present, 25GL (25,000ML) is set aside in the Murrumbidgee Resource Assessment for Forest Creek below Warriston Weir (unregulated section). However, the system is operated to supply a volume closer to 36.5GL (approximately 100ML/day) over Warriston Weir.

Physical characteristics

The Riverine Plain is characterised by low relief, sloping gradually to the west, and is dissected by prior streams, ancestral rivers and present day creek and river systems. The Forest Creek system is partially imposed on ancestral river channels. Flows from Forest Creek tend to return to Billabong Creek via small interconnecting creeks and breakaways, because the Forest Creek system is higher in the landscape than Billabong Creek. Soil distribution patterns reflect the depositional characteristics of the prior and ancestral streams, with red-brown earths and grey and brown clays associated with ancestral river deposits and floodplains respectively.

Biological characteristics

The Forest Creek system forms an important riverine corridor of black box *Eucalyptus largiflorens* woodland. Forest and Eight Mile Creeks have been identified as creeks of important conservation value, because they provide:

- valuable habitat for native flora and fauna;
- examples of aspects of the original communities;
- a seed source for future revegetation, and
- corridors for the movement of flora and fauna.

Black box occurs as a discontinuous fringe of both clumps and individual trees along the Forest Creek system. In places it occurs with the occasional stands of cooba *Acacia salicina* and river cooba *A. stenophylla*. Shrubby understorey species include lignum *Muehlenbeckia florulenta*, short-leaved bluebush *Maireana brevifolia* and nitre goosefoot *Chenopodium nitrariaceum*. Cumbungi *Typhus orientalis* forms a narrow fringe along both sides of the creek where the watercourse is well defined. Where the creek is less well defined and the flow is slower, cumbungi grows thickly across the entire watercourse. This is particularly evident in the lower reaches of the Forest Anabranche and in Murgha Creek.

The Forest Creek system supports a number of different wetland types that reflect different flooding regimes. The Wanganella Swamp system is the largest wetland area and its

management has generated the most interest and concern. Sixty-four species of waterbirds have been recorded in the Wanganella Swamp system, of which 29 were breeding records. Five species are listed as 'vulnerable' under the *Threatened Species Conservation Act 1995*: Brolga, Australasian Bittern, Blue-billed Duck, Painted Snipe, and Freckled Duck. Of these vulnerable species the Brolga, Australasian Bittern and Blue-billed Duck have been observed breeding. Forty-five plant species have been recorded in the Wanganella Swamp area. Aquatic herbs and sedges dominate the species list, with only a few introduced species.

Agricultural significance

Rice dominates irrigation in the regulated section of the Forest Creek (above Warriston Weir). Other major crop types grown in this section of the creek include summer and winter pasture and winter crops (wheat and canola). There are 11 irrigation licences and the annual water entitlement is approximately 10, 500ML. In addition, merino sheep and cattle are grazed on properties along this section of the creek. Below Warriston Weir (unregulated), the Forest Creek system provides an important source of water for approximately 55, 000 stock (\approx 4, 500 cattle and \approx 50, 000 sheep). There are five area licences on the Forest Creek system below Warriston Weir.

Cultural significance

Four Aboriginal groups live in the locality of the Forest and Billabong Creeks: the Yota-Yota, Baraba-Baraba, Wamba-Wamba and Wadi-Wadi. In the vicinity of Forest and Billabong Creeks, sites of significance to Aboriginal people are likely to occur in riparian areas. Physical sites are likely to include oven mounds, scarred trees, camp sites, shell middens, burials and tool scatters. As well as physical sites, there are sites of religious and spiritual significance that are not obvious within the landscape, but are still of special importance to local Aboriginal people.

Chapter 3.

MANAGEMENT OPTIONS AND PROPOSED ACTIONS

The issues discussed in this chapter were compiled from information on files held by the DLWC, and discussions with landholders, interested community members and DLWC staff. These issues were confirmed at a community meeting held in October 1998, and each issue was assigned a priority (high, medium or low).

A summary table of management options, proposed actions and intended outcomes is provided at the beginning of chapter 3.

Chapter 4.

IMPLEMENTATION

Water management committees were first established in 1997 to develop flow management rules for rivers and to advise the Minister for Land and Water Conservation on local water management issues. One of the main tasks of these committees is to develop **water management plans** for approval by the Minister for Land and Water Conservation.

Under the proposed Water Management Act, it is the State Government's responsibility through the DLWC (including State Water), to implement the recommendations made in the water management plans. In the Murray region catchment, the DLWC is responsible for preparing **implementation plans** for regulated and unregulated systems within this

catchment. It is intended that the **Forest Creek Management Plan** be endorsed by the Murray Lower Darling Community Reference Committee, and the recommendations included in an implementation plan for the Murray region.

While it is generally the responsibility of government and landholders to implement this management plan, the local community are keen to play a role in overseeing the ongoing implementation through an annual review process.

It has been proposed that the Murray Region of DLWC take responsibility for the implementation of management recommendations on the Forest Creek system. However, input from the Murrumbidgee region through the DLWC and the Murrumbidgee River Management Committee will be important given that regulated flows in the Forest Creek system come from the Murrumbidgee Valley.

Funding options

Actions likely to require funding include:

	Possible source of full or partial funding	Proposed Action
Infrastructure to return flows to Billabong Creek	State Water (capital/river regulation efficiency initiatives) MIL Rice industry	1.3.6a (d)
Establishment of an ecological monitoring program to assess the impact of an environmental allocation on the Wanganella Swamp system	IMEF - Murray region (DLWC, EPA) Wetland Care Australia NSW Wetland Action Group Tertiary Institutions	2.2 (d)
Removal of McCrabb's regulator and adjacent spillway	State Water (capital/river regulation efficiency initiatives) MIL NSW Fisheries	2.4 (a)
Some desilting upstream of McCrabb's regulator and spillway	DLWC MIL	2.4 (c)
Revegetation of sandhills on TSR	Greening Australia DLWC NHT Environmental Trust RLPB SRFNC Local council Local community Industry sponsorship	2.6
Management of wetland areas on <i>Rhyola</i> (repair breached retaining bank)	NSW Wetland Action Group DLWC Environmental Trust Wetland Care Australia	3.1
Investigation of large areas of dead cumbungi in the Wanganella Swamp	NHT Environmental Trust DLWC Tertiary Institutions	4.4
Establishment of a groundwater monitoring program	NHT Environmental Trust Australian Geological Survey Organisation	8.1

	Tertiary Institutions	
Management of Kerribirri Swamp (fencing/modification to block bank)	NSW Wetland Action Group DLWC Greening Australia Environmental Trust Wetland Care Australia	10.2 and 10.3

Review of this management plan

A major review of this management plan, involving DLWC and the local community, should be undertaken after five years.

In chapter 4, proposed actions are grouped in order of priority under the following categories: works, operations, on-farm management, monitoring, investigations, institutional arrangements and education.

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1. BASIS OF THIS MANAGEMENT PLAN

1.1 WHY THIS PLAN?

The development of this management plan for the Forest Creek system is primarily a response to concerns regarding the management of the Wanganella Swamp system and long-standing concerns regarding difficulty with the supply of water to the lower reaches of the Forest Creek system. As long ago as 1973, a Water Conservation and Irrigation Commission report raised awareness of some of the management issues of concern on the Forest Creek system.

The development of this management plan is one of many projects being undertaken as part of the New South Wales Government's Water Reform Program. It seeks to find a better balance in the sharing of water between the environment and consumptive use and to involve the community more effectively in water resource management decisions. Thus, the focus of this plan is water resource management. It is envisaged that some of the ideas presented in this plan could serve as a model for more effective management of streams in other parts of New South Wales faced with similar management issues, for example effluents of the Lachlan River.

1.2 WHAT IF WE DON'T HAVE A PLAN?

If the present flow regime in the unregulated section of the Forest Creek system is maintained, both the environment and landholders in the lower reaches of the system face potentially negative consequences. The lower reach of the Forest Creek system is likely to become an increasingly ineffective water carrier, sustaining an increasingly inefficient use of water. It could be argued that maintaining any inefficient system is inequitable, given current efforts to improve the management of water resources for the environment and water users across New South Wales.

This current water regime is degrading wetland areas that are permanently inundated and has encouraged the extensive growth of cumbungi; water is taking longer to reach downstream landholders and over time it is likely that problems with water delivery will increasingly affect adjacent, upstream landholders.

Some future consequences are likely to include:

- Maintenance of existing areas of cumbungi with the possibility of continued growth in some places along the creek;
- Ongoing siltation that will ultimately change the shape and gradient of the creek bed;
- Degradation of permanently inundated areas, particularly wetlands, where the life cycles of native species are cued to phases of wetting and drying;
- Maintenance of tanks (dams) in the creek bed in order that sufficient water can be retained for stock watering after the creek has dried;
- Continuation of breakaway flows from the main creek channel encouraged by the expanse of cumbungi and ongoing siltation.

Strategic management of the whole creek system is required if we are to achieve the objectives identified by the community, for the Forest Creek system.

1.3 WHO DEVELOPED THE PLAN?

The Forest Creek Management Plan is a community driven plan and reflects the aspirations of the community and government agencies for improved management of the creek system. The project has been funded by the *Water Management Fund* (a \$1.35 environmental management charge on licensed entitlement in 1997) and the Department of Land and Water Conservation (DLWC). DLWC prepared the original funding submission and undertook to manage the project through employment of a project officer.

Landholders and representatives from a range of groups and organisations within the wider community were invited to the first community meeting held in October 1998. These groups included the:

Southern Riverina Field Naturalists Club
NSW Murray Wetlands Working Group
Deniliquin Aboriginal Land Council
Windouran and Conargo Shire Councils
Rural Land Protection Board (RLPB)
Roads & Traffic Authority (RTA)
NSW National Parks and Wildlife Service
NSW Fisheries
DLWC (State Water)
The Yanco Creek and Tributaries Advisory Council

A working group met regularly with the project officer to develop the plan. The working group comprised four landholders (nominated at the first community meeting and representing both the regulated and unregulated sections of the Forest Creek system), and representatives from interested stakeholder groups.

The wider community and several State Government agencies such as NSW National Parks and Wildlife Service and NSW Fisheries, that were unable to attend working group meetings, were invited to oversee the development of the plan through the distribution of working group minutes, community meetings, workshops and field inspections. Technical input was provided by staff from various government agencies and committees within the Murray and Murrumbidgee regions.

1.4 FUTURE VISION FOR THE FOREST CREEK SYSTEM

At the first community meeting in October 1998, landholders and interested stakeholders identified their vision for the future of the Forest Creek system.

They envisaged that future management would:

- Enable the efficient supply and delivery of good quality stock and domestic water all year round;
- Allow for the efficient passage of unregulated flows;
- Maintain and where possible enhance the ecological sustainability of the Forest Creek system;
- Protect areas of cultural heritage;
- Involve landholders and the wider community in the ongoing management of the Forest Creek system.

1.5 LEGISLATIVE AND POLICY FRAMEWORK

To facilitate the implementation of this plan, management recommendations are consistent with the aims of relevant Acts of Parliament and are consistent with local/regional, state and national strategies, and policies. This plan does not mitigate the need for future legislative approvals, but will facilitate the processing of any applications. Any activities with respect to the Forest Creek system must be consistent with this plan.

The most relevant Acts and policies are briefly outlined here, to show how they may be relevant to the implementation of the management plan.

ACTS OF PARLIAMENT

Act	Agency responsible for administration of the Act	Main purpose
<i>Water Act 1912 (currently under review)</i> <i>Water Administration Act 1986</i>	Department of Land and Water Conservation	Sets up the administrative process to allow DLWC to manage surface and sub-surface water, including wetlands. Currently, the Water Act 1912 does not adequately provide for the recognition and preservation of environmental water.
<i>Rivers and Foreshores Improvements Act 1948</i>	Department of Land and Water Conservation	Regulates excavations or earthworks on the bed, banks or within 40m of any watercourse.
<i>National Parks and Wildlife Act 1974</i>	NSW National Parks and Wildlife Service (NPWS)	Provides a framework for managing national parks and reserves as well as providing mechanisms to conserve and manage cultural and natural heritage across NSW.
<i>Environmental Planning and Assessment Act 1979</i>	Department of Urban Affairs and Planning	Establishes processes and requirements for the assessment of development consents, and for the development of environmental planning instruments.
<i>Threatened Species Conservation Act 1995</i>	NSW National Parks and Wildlife Service (NPWS)	Outlines the duties of the NSW NPWS in protecting threatened species, communities and critical habitat in NSW.
<i>Native Vegetation Conservation Act 1997</i>	Department of Land and Water Conservation	Provides a comprehensive system for conserving and managing native vegetation in NSW. The Act provides a framework for government and community to work together, for example through the development of Regional Vegetation Management Plans.

NSW STATE NATURAL RESOURCE MANAGEMENT POLICIES/PROGRAMS

NSW State Rivers and Estuaries Policy	An overarching policy that establishes the framework for the management of rivers and estuaries of NSW and related ecosystems, such as wetlands.
NSW Wetlands Management Policy	This is one of the component policies of the NSW State Rivers and Estuaries Policy. The goal of the Wetlands Management Policy is the ecologically sustainable use, management and conservation of wetlands in NSW for the benefit of present and future generations.

NSW Water Reform Program	In order to better manage our use of water, the DLWC is providing a framework for a partnership between landholders, the community and the NSW Government. The aim is to work together to secure a better balance in the sharing of water between the environment, and consumptive users.
NSW Vegetation Reform Program	The objective of this reform program is to improve the management of native vegetation in NSW. The <i>Native Vegetation Conservation Act 1997</i> provides an important means of achieving this objective.

MURRAY DARLING BASIN NATURAL RESOURCES MANAGEMENT STRATEGY	
This strategy provides a framework for a community/government partnership to develop plans for the integrated management of the Basin's natural resources on a catchment basis. It focuses on the major basin-wide issues such as water quality, water and land salinity and wetland management.	

REGIONAL STRATEGIES

River Management Plans for both the Murray and Murrumbidgee <i>(in preparation)</i>	These plans will provide general water quality and river flow objectives for each Valley, and provide strategies for achieving these objectives.
Western Riverina Regional Vegetation Management Plan <i>(in preparation)</i>	This plan is being developed in consultation with the community to provide strategies for the protection and enhancement of native vegetation in the region.
Murray Regional Environmental Plan No. 2. Riverine Land (REP2)	The REP2 provides for a coordinated and consistent approach to environmental planning and assessment along the River Murray. Although the Forest Creek system does not fall within the boundary of REP2, water from the creek system can ultimately flow into the Murray River. Murray REP2 is endorsed by the NSW Government and the MDBC.

LOCAL POLICIES/PLAN

Strategic Plan for the Yanco and Billabong Creeks System	Developed in 1999, this document sets out a strategic plan for the Yanco/Billabong Creeks system, that aims to assist in attaining the vision of 'an efficient and sustainable creek system, allowing a balance between environmental needs and economic prosperity for the Creeks' rural and urban communities'.
Windouran and Conargo Local Environment Plans (LEPs)	The general aim of these plans is to encourage appropriate management, development and conservation of natural and human resources within these local government areas.

1.6 STATUS OF THE PLAN

The Forest Creek Management Plan has been prepared to fulfill the requirements of a Development Control Plan for the two local environment plans (LEPs) – Conargo and Windouran. These requirements are dealt with under Part 3 of the *Environmental Planning and Assessment Act (1979)* (EP&A Act), and as such, the plan can have legal status under this Act. In addition to a period of public consultation, as required under the EP&A Act, the process of obtaining approval for this Plan has involved:

- Sign-off by Murray and Murrumbidgee Regional Directors - DLWC, and
- Endorsement by the Murray Lower Darling Community Reference Committee (MLDCRC) and the Murrumbidgee River Management Committee

Management options/actions proposed by this plan may be adopted as part of the MLDCRC flow management plan for the Murray Lower Darling River. Once adopted, it will form part of an implementation plan for the Murray region.

2. DESCRIPTION OF THE FOREST CREEK SYSTEM

2.1 LOCATION & LAND TENURE

The Forest Creek system is located in the south western Riverine Plain in southern New South Wales, and comprises Forest Creek, Eight Mile Creek and the Forest Anabranh. This creek system is an anabranh of Billabong Creek, leaving Billabong Creek approximately 10kms east of Conargo (35°18' S; 145°11' E) and entering Billabong Creek 8.5km upstream of Moulamein (35°5' S; 144°2' E) (Figure 2.1). The creek system is approximately 200km in length. Deniliquin is the closest major town centre and is located 40km to the south. While the Murrumbidgee catchment provides an important source of water for Billabong Creek below Jerilderie and the Forest Creek system, both these creeks are located within the Murray DLWC region.

Land adjacent to the Forest Creek system is predominantly freehold, comprising 19 properties. Two travelling stock routes (TSRs) (Crown land) cross sections of the creek. One of these TSRs follows the western side of the Cobb Highway, crossing Eight Mile Creek south of Wanganella. The other TSR crosses Forest Creek along the Conargo-Jerilderie Road, just below the Forest Creek offtake.

2.2 HYDROLOGY

The Forest Creek system is part of the larger Yanco/Billabong Creek System, which includes the Yanco, Colombo and Billabong Creeks (Figure 2.1). Forest Creek is a high level anabranh of the Billabong Creek (White *et al.*, 1985) and flows are directed into Forest Creek via operation of the Hartwood Weir (built around 1929) and the Forest Creek offtake (built in 1930). A regulator was built at the offtake in 1993, which enables additional control over flows into the Forest Creek system. Other important creeks supplied from the Forest Creek system include Piccaninny Creek, Estuary Creek, Clarke's Creek, Murgha Creek and Gum Creek.

Forest Creek leaves Billabong Creek below the Colombo/Billabong Creek confluence, but above the Yanco/Billabong Creek confluence (Figure 2.1). Yanco Creek is a natural high level effluent of the Murrumbidgee River, leaving the river near Narrandera and flowing south. Thirty-eight kilometres downstream from the Yanco Creek offtake, part of the Yanco Creek flow branches into Colombo Creek which is a low to moderate level effluent of the Yanco Creek. The Yanco/Billabong Creek system is both an effluent system of the Murrumbidgee River and a tributary system of the Murray River. Both the Yanco and Colombo Creeks flow into the Billabong Creek, which flows into the Edward River and eventually into the Murray River.

Insert

Map

Here

The Forest Creek system receives water from several different sources:

Murrumbidgee Catchment

4. *Colombo Creek*

Carries regulated and unregulated flows from the Murrumbidgee River.

Murray Catchment

5. *Billabong Creek*

Carries unregulated flows from the Billabong Creek catchment.

6. *Finley Escape (off Mulwala Canal)*

Since the 1994/95 irrigation season this Escape has been used to carry water from the Murray River to supplement flows in Billabong Creek below Jerilderie and Forest Creek during summer (up to 250Ml/day).

Historical flow information for Billabong Creek

Historical flow data for Billabong Creek at Jerilderie (1919-present) is presented in Figure 2.2.

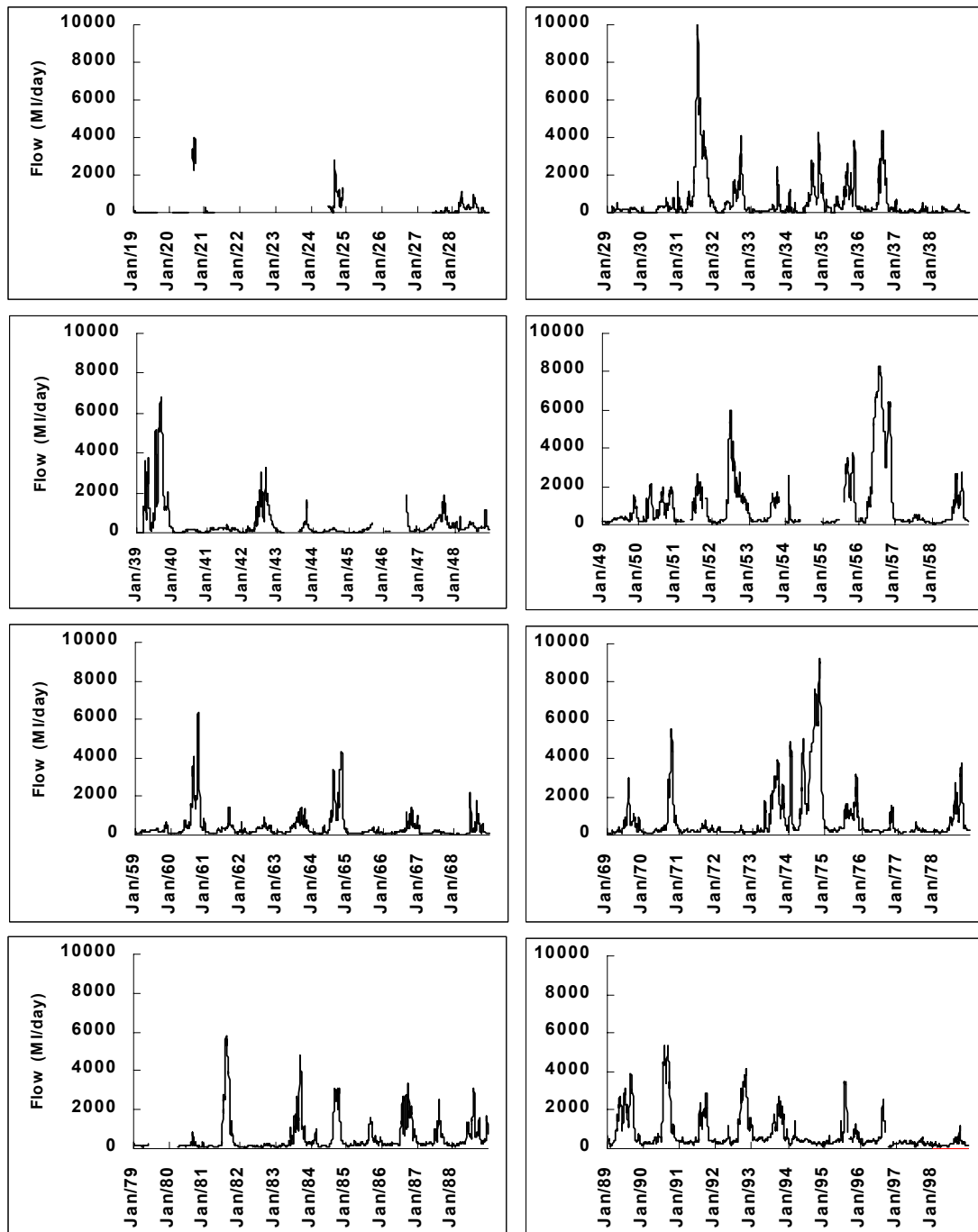


Figure 2.2 *Historical flow data for Billabong Creek at Jerilderie (1919-1998). (Data obtained from Hydsys database, DLWC).*

Historical flow information for Forest Creek

Flow data for Forest Creek at Warriston Weir has been collected since 1980, and is presented in Figure 2.3. A summary of the frequency and accuracy of flow information collected from Warriston Weir is presented in Table 2.1 (*pers. comm.* Brown, 1999).

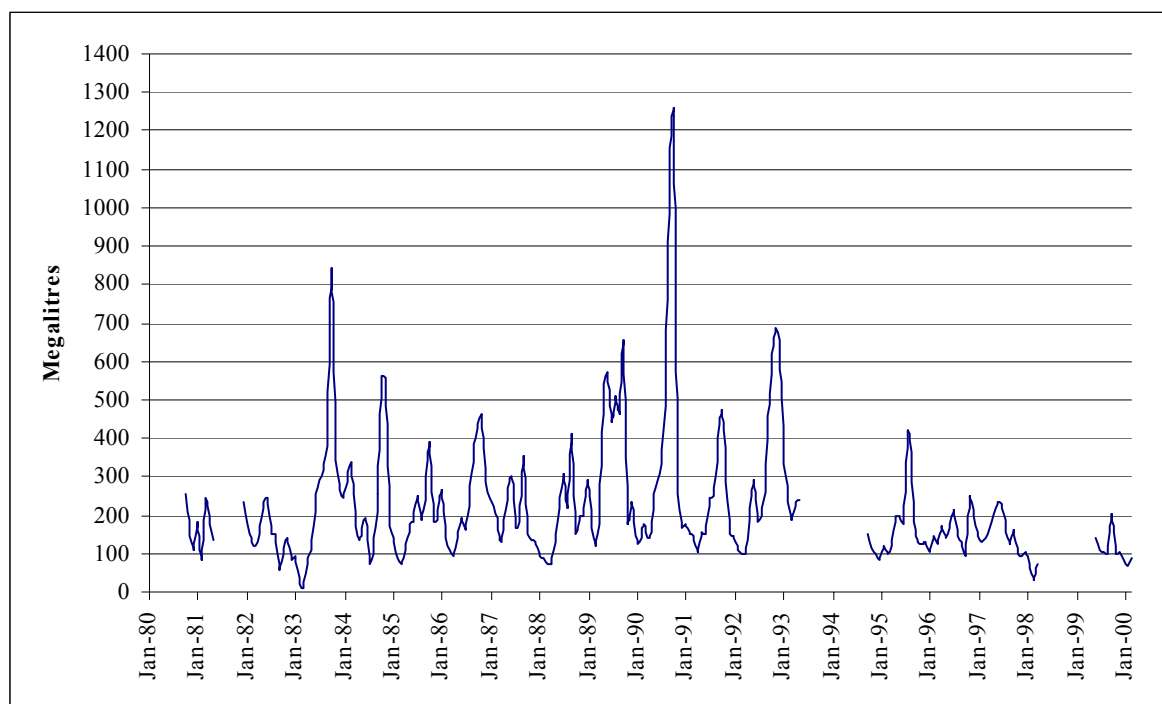


Figure 2.3 Historical flow data for Forest Creek at Warriston Weir (1980 – present). Gaps indicate where no data available. (Data obtained from Hydsys database, DLWC).

Table 2.1 Quality of flow information collected from Warriston Weir (station 410148) between 1980 and the present (*pers. comm.* Brown, 1999).

FREQUENCY AND ACCURACY OF FLOW INFORMATION collected from Warriston Weir (Station 410148)	
1/9/1980 - 31/5/1993	Heights at this site were recorded by a channel attendant approximately 3 days/week. During this time 67 gaugings were recorded in the range of 0.226m to 0.890m. The heights and flows recorded are considered to be reasonably accurate.
31/5/1993 - 26/8/1994	No height or flow data was obtained from this site.
26/8/1994 - 3/4/1998	Some occasional height readings were recorded at this site, however no flow measurements were recorded. This data has been quality coded 36 (time of sample not known – data satisfactory - +/-50mm). This data has a lower quality code but gives an indication of flows during this time.
3/4/1998 - 20/4/1999	No height or flow data was obtained from this site.
20/4/1999 - present	'Greenspan' logger installed to record height, EC and temperature. Gaugings recommenced at this site 16/11/1998.

Given the sparsity of flow data for the Forest Creek system, it has been necessary to collect some hydrological information for the development of this Plan. This data is presented in Appendix 1, and includes:

- Flow and travel time information collected from loggers installed at *Wanganella*, *Avenel*, Kerribirri (*Barratta*) and *Blue Gate*; and
- The location of return flows from Forest Creek to Billabong Creek.

2.3 HYDROLOGICAL DEVELOPMENT OF THE YANCO/BILLABONG CREEK SYSTEM

Prior to 1856, under natural conditions, the Yanco/Billabong Creek system would have been a fairly dry intermittent system that only received flood flows. At the time of European settlement, the Yanco Creek flowed only when flows in the Murrumbidgee River exceeded 40, 000ML/day (4% of the time) (White *et al.*, 1985). In other words, when full carrying capacity of the channel was exceeded (Cummings, 1983).

From 1856, works were carried out to increase the flow of water from the Murrumbidgee River into the Yanco Creek, and by the late 1890s flows were entering the Yanco Creek with 14, 000 to 17, 000ML/day in the Murrumbidgee River (30% of the time). Between 1856 and 1928, high to middle order freshes would have increased, and the system would have flowed more frequently. Records indicate that during this period flows mainly occurred during winter and spring. From 1928 (following completion of the Yanco Weir) there was a tendency for middle order flows to decrease slightly (captured in storage), while low flows were more frequent than before (White *et al.*, 1985).

Despite this early structural work, flow in the creeks was still intermittent, unreliable and failed completely in dry seasons (WRC, undated). It was common practice for landholders to build dams on the creeks to retain water when flow ceased. Many of the dams within the Yanco/Billabong Creek system were fitted with dropboards to provide substantial additional storage capacities. Conditions for the operation of dropboards were introduced to ensure a fairer distribution of water throughout the system during autumn and winter (White *et al.*, 1985).

When construction of Burrinjuck Dam was authorised, landholders along the Yanco/Billabong Creek system feared that flow in the creek system would be even less frequent than previously. They were concerned that the storage of run-off in the dam in years of low rainfall, would reduce the number of freshes in the river. After strenuous representation by landholders, the government of the day agreed to construct a weir at the Yanco offtake, which would provide an assured flow into the Yanco Creek cutting (DLWC file: T110¹).

In 1921 the *Yanco, Colombo and Billabong Creeks Water Trust* was established to take responsibility for the operation and maintenance of works associated with the building of the Yanco Weir on the Murrumbidgee River. The Yanco Weir was completed in 1928, and in conjunction with Burrinjuck Dam (completed in 1928) and Blowering Dam (completed in 1968), facilitated an almost continuous supply of water into the Yanco/Billabong Creek system for stock and domestic purposes (White *et al.*, 1985). Flow records for Billabong Creek at Jerilderie (upstream of Hartwood Weir) indicate that prior to 1928, flow ceased each year for about four to six months prior to June. However, from 1928 to 1983 the flow at Jerilderie had rarely ceased (Cummings, 1983).

In 1930, a cutting approximately 150m long was constructed between Billabong Creek and Forest Creek just below the original Forest Creek offtake (Figure 2.4). This cutting, in conjunction with Hartwood Weir, allowed the Forest Creek to commence flowing with very low flows in Billabong Creek. Prior to construction of the cutting and weir, flow into Forest Creek would have commenced with flows of about 3,000ML/day in Billabong Creek (2% of the time) (Cummings, 1983). Current estimates suggest that with Hartwood Weir boarded up, Forest Creek will commence to flow as long as there is a flow in Billabong Creek. If the boards in the weir are removed, a flow of approximately 50ML/day would be required for Forest Creek to flow. The bed of the Forest Creek cutting is about 2m above the bed of Billabong Creek (White *et al.*, 1985).

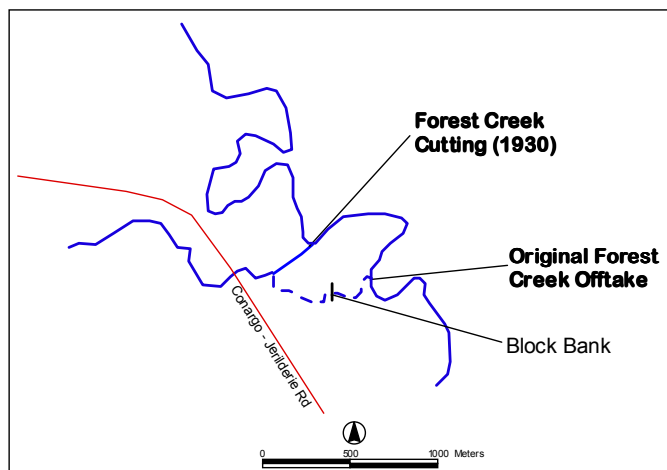


Figure 2.4 Detail of the original Forest Creek offtake and the Forest Creek cutting, constructed in 1930.

River regulation has brought about several major changes to the flow regime in the Yanco/Billabong Creek system. These changes are also common to reaches of the Murrumbidgee and Murray Rivers:

1. **High flows** (occurred less than 5% of the time under natural conditions) remain unchanged under regulated conditions.
 2. **Medium flows** (occurred between approximately 5% and 25% of the time under natural conditions) have diminished.
 3. **Low flows** (occurred more than 25% of the time under natural conditions) have increased.
 4. The occurrence of **zero flows** has diminished.
- (White *et al.*, 1985).

2.4 IRRIGATION DEVELOPMENT ON THE YANCO/BILLABONG CREEK SYSTEM

In 1950, riparian landholders were allowed to irrigate up to 12.5ha by direct pumping from streams, and up to 121.5ha when an off-creek storage was used. Diversions for irrigation were only permitted after stock and domestic needs had been met, and conditions were attached to licences to preclude the extraction of water when flow was less than a prescribed rate (Tolhurst, undated). During the 1970s, granting of irrigation licences and subdivision of riparian holdings along the Yanco/Billabong Creek system greatly increased the overall

entitlement to water on the system (Simpson, 1994). In 1977, subject to all regulator dropboards on the private dams along the Yanco/Billabong Creek system being removed to assist the passage of flow, landholders were permitted to irrigate up to 162ha (400 acres) (White *et al.*, 1985). At about this time, volumetric entitlements on regulated watercourses were introduced by the Department of Water Resources under various sections of the *Water Act 1912* (NSW) (Simpson, 1994). General security entitlements were calculated on the basis of 6ML/ha. Thus, a 162ha area licence was converted to a volumetric allocation of 972ML. In 1982, the Department of Water Resources placed an embargo on the issue of new irrigation licences in the Murrumbidgee Valley and this embargo remains in place today.

Despite this embargo, development continues to occur along the Yanco/Billabong Creek system. After 1988/89 licensed pumpers along the Yanco/Billabong Creek system were permitted to grow rice. This was accompanied by a large demand for water per hectare and has changed traditional extraction patterns. Key times of maximum irrigation demand now occur during October (spring watering and filling rice bays) and from late December to mid-late January (panicle initiation). In 1994, a report stated that the area sown to rice was increasing annually in all sections of the Yanco/Billabong Creek system (Simpson, 1994). Overall demand for water has continued to increase annually, as inactive licences are sold or developed and existing licence holders use more of their annual entitlement. Simpson's report (1994) highlighted the physical constraints of the Yanco/Billabong Creek system, and drew attention to the fact that **demand was at, or near, the system's capacity to supply**. This has become increasingly apparent in recent years, particularly as the peak demand for water is compressed into the summer months.

2.5 MANAGEMENT OF THE FOREST CREEK SYSTEM

During the existence of the *Yanco, Colombo and Billabong Creeks Trust*, water was diverted into Yanco Creek from the Murrumbidgee River to meet stock and domestic requirements. During much of this time landholders benefited from the diversion of additional flows into Yanco Creek because development in the Murrumbidgee Valley was minimal and water requirements for the environment had not been considered.

There were periods of significant drought (1944/45 and 1967/68) when flows into Yanco Creek were restricted, and flows in the lower Forest Creek system were generally confined to the winter/spring months. However, outside these periods there were frequent times when water was plentiful. During the 10 years from about 1947, the Murrumbidgee Valley experienced its wettest 10 years on record and flow into Forest Creek was continuous. Similar flow conditions occurred during the early 1960s and 1970s (Cummings, 1983).

Despite periods of unregulated and rain-rejection flows, supply in the Forest Creek system beyond Zara Dam became increasingly difficult. This was thought to be mainly due to the expansion of the Wanganella Swamp area, and deterioration in the carrying efficiency of the Forest Creek system (Cummings, 1983). In 1973, a report prepared by the Water Conservation and Irrigation Commission (WCIC) stated that:

As a consequence of the difficulties experienced in supplying water through the Wanganella Swamp area, including transmission losses and evaporation, 'it is therefore clear that it is now quite impracticable to attempt to supply the Forest Creek system below Warriston Weir in the summer months'. It was considered that a flow of 19,000 acre feet (23, 427 ML) per year at Warriston Weir should be set aside for supply to the Forest Creek system and that this be made

available over the six months, April to September (WCIC, 1973: 60). This represented approximately 120Ml/day during the six month period.

This operational recommendation of controlled replenishment of the Forest Creek system between April and September, and the diversion of unregulated and rain-rejection flows outside this period, was not strictly employed. In practice, there has been a continuous flow (*pers. comm.* Beck, 1999). In order to meet demand, additional water was passed down the system more than 75% of the time because there was no re-regulatory capacity (*pers. comm.* Simpson, 1999). Until recently, a portion of this additional water could conveniently be passed over Warriston Weir. In addition, structures along the system did not always allow river operations staff to be as accurate as they would have liked with the delivery of flows (*pers. comm.* Harris, 1999). During the 1980s environmental flows were occasionally called on, and this would also have assisted supply to the lower end of the creek system.

There was acknowledgment in the 1973 report that the proposal to provide a replenishment flow between April and September at Warriston Weir could not be expected to provide a long term solution to the water supply problem in the lower Forest Anabranch, because of the possibility that conditions in the creek system would continue to deteriorate (WCIC, 1973).

In 1980, the *Yanco, Colombo and Billabong Creeks Trust* was disbanded and direct control was assumed by the Water Resources Commission (WRC). At this time it declared Forest Creek above Warriston Weir a regulated watercourse under the *Water Act* 1912. The Forest Creek system below Warriston Weir is an unregulated watercourse. There is no knowledge of any formal water supply agreement having been made when the WRC assumed management of the Yanco/Billabong Creek system from the Trust. While the Department is not legally obliged to provide water for users' needs below Warriston Weir, it could be argued that given historical supply arrangements, there is a moral obligation to meet the stock and domestic requirements of these landholders. Part of this management plan aims to address ongoing concerns regarding the supply of stock and domestic water below Warriston Weir.

The Yanco Creek and Tributaries Advisory Council was established following dissolution of the Landholder Trust. It consults closely with DLWC, and continues to actively monitor and advise on the needs of the Yanco/Billabong Creek system.

Existing operational rationale

The channel capacity at the Yanco Creek offtake places a major limitation on supply, and Colombo Creek also presents a supply limitation. A maximum regulated flow of approximately 1, 400Ml/day can be diverted at the Yanco offtake, and the Colombo Creek offtake at Morundah has a bank-full capacity of 600-650Ml/day (*pers. comm.* Jayawickrama, 2000). Under existing regulated flow conditions, a minimum diversion of 500Ml/day at the Yanco Creek offtake is provided for stock and domestic requirements in the Yanco/Billabong Creek system all year round. Extra diversions are made in summer and autumn for irrigation (*pers. comm.* Nicholls, 2000).

Supplementation of flows from Murray Irrigation District (Figure 2.5) and Coleambally Irrigation Area has become critical to the overall operation of the Yanco/Billabong Creek system. Finley Escape (off the Mulwala Escape) is used during the irrigation season to supplement flows in Billabong Creek below Jerilderie and Forest Creek with water from the Murray Valley.

Table 2.2 provides a summary of current licences and entitlement for the Forest Creek system.

Table 2.2 Summary of current active licences and entitlement on the Forest Creek system.

OFFTAKE TO WARRISTON WEIR (REGULATED)	
Active licences	11
Total entitlement	10, 486 MI (10, 104 irrigation /50 stock / 30 domestic / 302 industrial)
Authorised area	1, 684 ha
DOWNSTREAM OF WARRISTON WEIR (UNREGULATED)*	
Forest Creek (2 area licences for stock and irrigation)	69 ha
Forest Anabranh (1 area licence for irrigation)	100 ha
Gum Creek (2 area licences for stock, domestic and irrigation)	222ha
Authorised area	391 ha

* A 980MI licence for stock, domestic and irrigation is located on Billabong Creek, however water can be pumped from the Forest Anabranh if certain flow conditions have been met on the Forest Anabranh.
(DLWC, 1999).

In 1994, following installation of the Forest Creek offtake regulator, a commitment was made to supply 100MI/day over Warriston Weir subject to remedial works being undertaken at McCrabb's regulator, and in other parts of the system. It was stated that this arrangement should then be reviewed (DLWC file: 700161A¹). At present, 25Gl (25, 000MI) is set aside in the Murrumbidgee Resource Assessment for Forest Creek below Warriston Weir (*pers. comm.* Beck, 1999). However, the system is operated to supply a volume closer to 36.5Gl (approximately 100MI/day) over Warriston Weir.

Insert figure from EIS

Figure 2.5 Existing and proposed stormwater escape channels, Berriquin Irrigation District. (won't need this)

2.6 CLIMATE

The general climate of the Deniliquin area is characterised by hot summers, mild winters and winter-dominant rainfall (Table 2.3). The average annual rainfall is about 400mm, and June is generally the wettest month. February is generally the driest month. Dry years are common, and can result in prolonged periods of drought (Porteners, 1993). Approximately 29 drought years were experienced in western New South Wales between 1900 and 1986 (Dalton in Porteners, 1993).

Monthly evaporation in January exceeds rainfall by 10 to 1, whereas in June the ratio of evaporation to rainfall is 0.9 to 1. Average total evaporation for the period October to March inclusive is around 1,400mm, while between April and September it is around 400mm.

Winter rainfall in the vicinity of the Forest Creek system does not contribute significantly to runoff and creek flows because of the flat topography and soil types. Summer rainfall can also be largely ineffective due to high temperatures and rates of evaporation at this time of the year (White *et al.*, 1985).

Table 2.3 *Climatic averages for Deniliquin (temperature, rainfall and evaporation data) (Climate and Consultancy Section-Bureau of Meteorology NSW, 2000).*

	MEAN DAILY TEMPERATURES (1858-present)		TOTAL MONTHLY RAINFALL (1858-present) (mm)	TOTAL MONTHLY EVAPORATION (1978-present) (mm)
	Maximum (°C)	Minimum (°C)		
January	32.5	15.7	28.7	290.1
February	32.1	15.7	27.2	245.2
March	28.8	13.3	32.3	191.3
April	23.5	9.5	31.3	112.6
May	18.6	6.6	39.7	60.9
June	15.1	4.5	40.8	37.6
July	14.4	3.4	35.3	40.0
August	16.5	4.4	37.2	60.5
September	19.6	6.2	38.3	93.7
October	23.6	8.8	39.5	158.0
November	27.6	11.8	29.0	220.8
December	30.4	14.1	29.0	271.5

2.7 TOPOGRAPHY / LANDSCAPE

The Riverine Plain is characterised by low relief, sloping gradually to the west, and is dissected by prior streams, ancestral rivers and present day creek and river systems.

Prior streams are indicated by low, winding sandy ridges on the clay floodplain. These are often associated with a winding depression 1-2m deep, which marks the old stream bed. Low, fixed sand dunes formed by the redistribution of the coarse stream-bed deposits may occur near these ridges.

Ancestral rivers are remnants in the landscape of river channels much larger than those of modern rivers such as the Murrumbidgee River. These are represented by belts of sediment,

about 3m below the general level of the adjacent plain. The meander scroll deposition pattern of these old, large rivers is clearly visible on current aerial photographs (Figure 2.6).

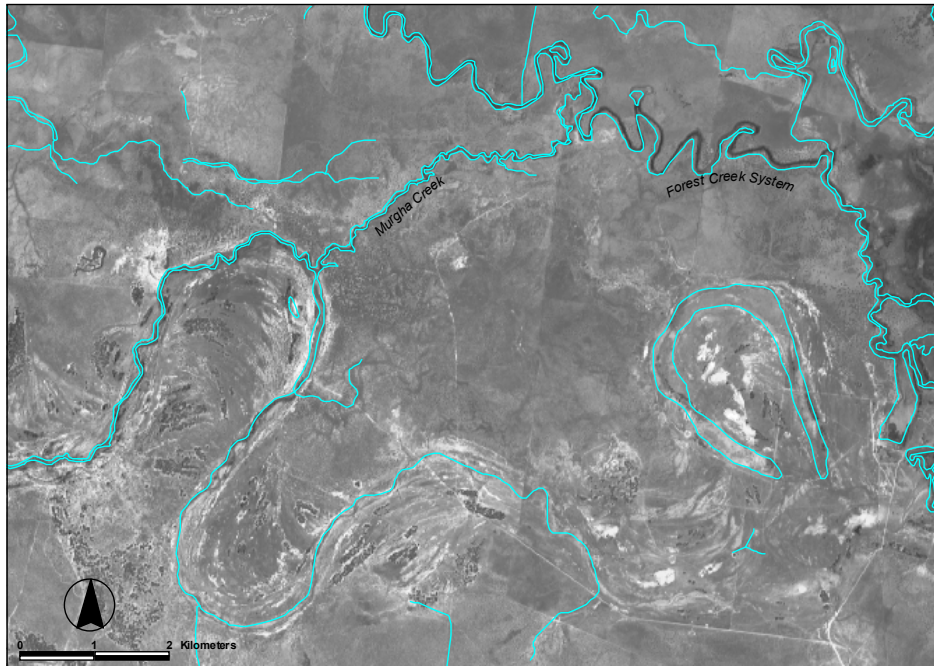


Figure 2.6 *Meander scroll pattern of an ancestral river system. This SPOT Satellite image shows where Murgha Creek, and a flood runner leaving Murgha Creek, overlay part of these ancestral sediments.*

The present Yanco/Billabong Creek system is almost entirely embedded in ancestral sediments, while Colombo and Billabong Creeks are relatively free of these sediments (WCIC, 1973) (Figure 2.7). The present Colombo Creek is thought to follow a similar path to that of a prior stream. Prior streams are generally higher than the surrounding floodplain, and Colombo Creek is a high level effluent of Yanco Creek (White *et al.*, 1985).

The Forest Creek system is partially imposed on ancestral river channels, and this can enable sub-surface diversion of flow away from the present stream to fill ancestral channels. Forest Creek is higher in the landscape than Billabong Creek and consequently flows from Forest Creek tend to return to Billabong Creek via small interconnecting creeks and breakaways. For example, Eight Mile Creek at Wanganella (where the creek flows under the Cobb Highway) is about 3.5m higher than Billabong Creek (*pers. comm.* McCrabb, 2000). Block banks have been constructed along many of these creeks and are an attempt to maintain flow in the Forest Creek system (WCIC, 1973).

Lunettes and dune systems occur throughout the Riverine Plains. Lunettes are ridges that formed when material was blown out of dry lake-beds. They range from 3-50m in height and generally occur immediately to the east of the lake basin. Source-bordering dunes are associated with prior streams and ancestral rivers, and range in height from 3-15m. A major lunette occurs on the eastern margin of the Wanganella Swamp.

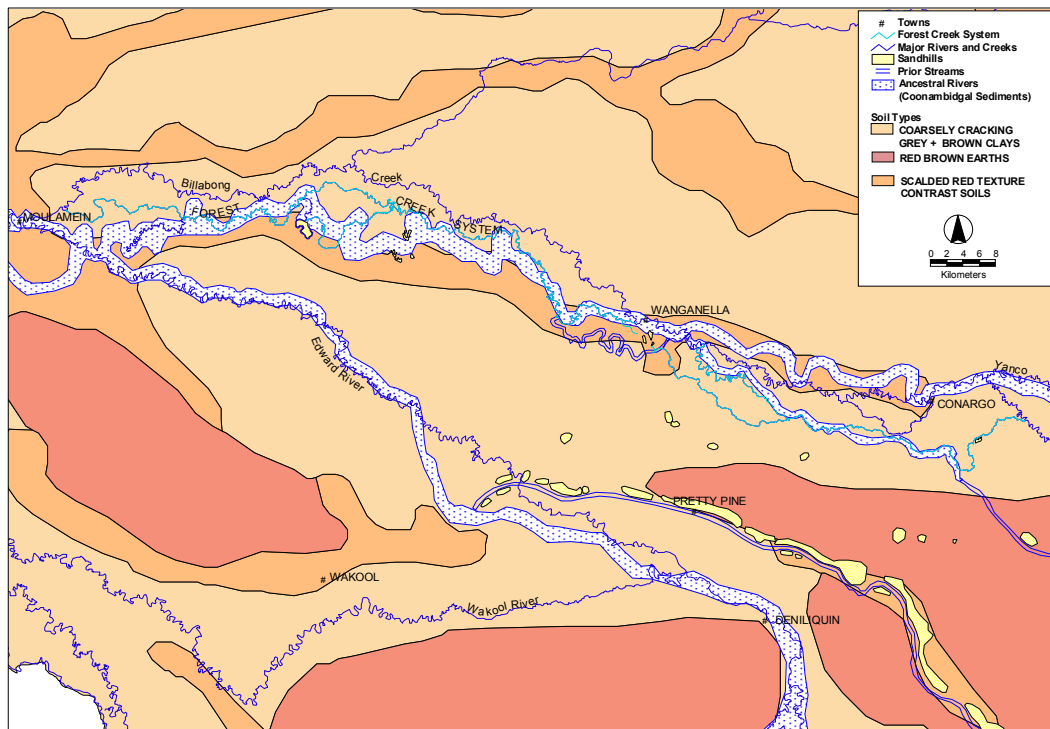


Figure 2.7 Ancestral river system and soil types influencing the Forest Creek system.

2.8 SOILS

Soil distribution patterns of the Riverine Plain reflect the depositional characteristics of the prior and ancestral streams (Figure 2.7).

Red-brown earths are generally associated with ancestral river deposits. These are duplex soils with weakly structured loamy surface horizons overlying well-structured clay material. Wind erosion and scalds are common with this soil type. They are moderately fertile, with hard setting topsoils that are prone to structural breakdown. Infiltration rates are moderate, depending on the surface texture (WRRVC, 1999).

Grey and brown clays occur over extensive areas of western New South Wales. They are associated with the floodplain of the Murrumbidgee River and associated creek systems (White *et al.*, 1985). These clay soils are moderately deep and show little change in texture down the profile. They tend to form deep wide cracks when they dry out, and are less susceptible to erosion than sandy or loamy soils because of their compact nature. Grey clays occur regularly on flooded and poorly drained floodplains, while brown clays are more common on higher, less frequently flooded country (Murphy & Eldridge, 1991).

2.9 VEGETATION

The Forest Creek system forms an important riverine corridor of black box *Eucalyptus largiflorens* woodland, occurring higher in the landscape than the adjacent river red gum *E.*

camaldulensis fringed Billabong Creek. Forest and Eight Mile Creeks have been identified as creeks of important conservation value (Grose, 1993), because they provide:

- valuable habitat for native flora and fauna;
- examples of aspects of the original communities;
- a seed source for future revegetation, and
- corridors for the movement of flora and fauna.

Riparian

Black box occurs as a discontinuous fringe of both clumps and individual trees along the Forest Creek system. In places it occurs with the occasional stands of cooba *Acacia salicina* and river cooba *A. stenophylla*. Shrubby understorey species include lignum *Muehlenbeckia florulenta*, short-leaved bluebush *Maireana brevifolia* and nitre goosefoot *Chenopodium nitrariaceum*.

Cumbungi *Typha orientale* forms a narrow fringe along both sides of the creek where the watercourse is well defined. Where the creek is less well defined and the flow is slower, cumbungi grows thickly across the entire watercourse. This is particularly evident in the lower reaches of the Forest Anabranche and in Murcha Creek. In less well-defined reaches of the creek, which are now more permanently inundated, dead black box trees occur. Burning was used on some properties as a means of controlling cumbungi and is also likely to have contributed to the death of many trees.

Vegetation associated with the Wanganella Swamp system, and several other key wetland areas, is described in this chapter, section 2.11 and in chapter 3, issue 10.

Floodplain

Black box also occurs in stands of open woodland, for example just downstream of the Forest Creek offtake. Here it is found with other woodland species such as river cooba, hooked needlewood *Hakea tephrosperma*, miljee *Acacia oswaldii*, bull oak *Allocasuarina luehmannii* and the occasional river red gum. Grazing has considerably modified the understorey, which comprises a mixture of native and introduced pasture species with few shrubs.

Rangeland

West of the commencement of the Eight Mile Creek, nitre goosefoot, dillon bush *Nitraria billardieri*, and cottonbush *Maireana aphylla*, extend beyond the black box fringed watercourse to form extensive, mainly treeless, shrublands. The distribution of dillon bush has increased markedly with the change in landuse since European settlement. Overgrazing of the original chenopod species has resulted in the establishment of dillon bush in areas once occupied more extensively by bladder saltbush *Atriplex vesicaria* and old man saltbush *A. nummularia* (Noble & Whalley in Porteners, 1993). Groundcover is variable, consisting of perennial and annual grasses and other herbaceous plants (Cunningham *et al.*, 1992).

Threatened species

Several threatened plant species have been identified whose habitat requirements generally match those found in the shrublands and grasslands away from the creek. Two riparian species have also been identified on the threatened species database (Table 2.4).

Table 2.4 List of threatened species identified as likely to occur in the vicinity of the Forest Creek system.

SCIENTIFIC NAME	COMMON NAME
Riparian species	

<i>Eleocharis obicis</i>	-
<i>Eriocaulon australasicum</i>	-
Rangeland species	
<i>Stipa wakoolica</i>	-
<i>Brachyscome papillosa</i>	mossgiel daisy
<i>Lepidium monoplocoides</i>	winged peppergrass
<i>Maireana cheelii</i>	chariot wheels
<i>Swainsona murrayana</i>	slender darling pea
<i>Swainsona sericea</i>	a darling pea

DLWC Threatened Species Database (tSCAB)
(*pers. comm.* Oxley and Webster, 2000).

Introduced species

The main introduced species occurring adjacent to the watercourse are willows *Salix* spp. and African box thorn *Lycium ferocissimum*. *Alisma lanceolatum* was recorded in 1998 on the southern edge of Wanganella Swamp. This is a potentially serious weed (Sainty & Jacobs, 1994) and covers an area of about two hectares.

2.10 FAUNA

Birds

Riparian woodland corridors such as the Forest Creek system provide important habitat for various terrestrial bird species. For example, those species that nest in tree hollows and those that seek cover and roosting sites in wooded areas. Various wetlands along the creek, particularly the Wanganella Swamp system, provide breeding, feeding and roosting habitat for a range of waterbird species, including some migratory and endangered bird species.

- See Appendix 2 for a list of birds observed at Wanganella Swamp, and Box Swamp on *Blue Gate*.

Mammals, reptiles, amphibians and fish

No formal surveys of native fauna have been conducted along the Forest Creek system. Table 2.5 below lists species other than birds that have been observed, or are likely to occur, in the vicinity of the Forest Creek system.

The Forest Creek system supports one of the few remaining populations of native freshwater catfish in the Murray/Murrumbidgee region (DLWC File: 7004471). Local fisheries officers have indicated that the Yanco/Billabong Creek system was likely to be an important passage for fish migration between the Murray and Upper Murrumbidgee Rivers, with fish migrating generally in spring and summer (White *et al.*, 1985).

The Yanco/Billabong Creek system can be frequented by up to 21 professional fishermen who are licensed for most western waters, however it is likely that no more than five fishers would work the Yanco/Billabong Creek system. This system is mainly frequented during holiday periods by recreational fishers. Inland commercial fishers can only fish for carp, yabbies, Murray cod and golden perch. After 1 September 2001, commercial fishers will only be able to target carp and yabbies (restricted fisheries) (*pers. comm.* Angel, 2000).

Table 2.5 Native mammals, reptiles, amphibians and fish that have been observed, or are likely to occur, in the vicinity of the Forest Creek system.

SCIENTIFIC NAME	COMMON NAME	REFERENCE
Mammals		
<i>Macropus giganteus</i>	eastern grey kangaroo	Grose, 1993
<i>Macropus rufus</i>	red kangaroo	Grose, 1993
<i>Ornithorhynchus anatinus</i>	platypus	Grose, 1993
<i>Hydromys chrysogaster</i>	water rat	White <i>et. al.</i> , 1985; DLWC, 1988)
<i>Pseudocheirus peregrinus</i>	common ringtail possum	Grose, 1993
<i>Antechinus flavipes</i>	yellow-footed antechinus	Grose, 1993
<i>Tachyglossus aculeatus</i>	short-beaked echidna	Grose, 1993
<i>Sminthopsis crassicaudata</i>	fat-tailed dunnart	Grose, 1993
<i>Sminthopsis murina</i>	common dunnart	Grose, 1993
-	bat sp.	Grose, 1993
Amphibians		
<i>Emydura macquarii</i>	murray turtle	White <i>et. al.</i> , 1985
<i>Chelodina expansa</i>	broad-shelled river turtle	White <i>et. al.</i> , 1985
<i>Chelodina longicollis</i>	long-necked tortoise	White <i>et. al.</i> , 1985
Reptiles		
<i>Pseudechis porphyriacus</i>	red-bellied black snake	(pers. obs.)
<i>Pseudonaja textilis</i>	eastern brown snake	(pers. obs.)
<i>Notechis scutatus</i>	eastern tiger snake	NPWS, 1995
<i>Morelia sp.</i>	carpet snake	(pers. obs.)
<i>Varanus varius</i>	lace monitor	(pers. obs.)
Fish (Yanco/Billabong Creek system)		
<i>Tandanus tandanus</i>	native freshwater catfish	White <i>et. al.</i> , 1985; DWR, 1988
<i>Maccullochella peelli peellii</i>	murray cod	DWR, 1993; White <i>et. al.</i> , 1985; DWR, 1988
<i>Macquaria ambigua</i>	golden perch	White <i>et. al.</i> , 1985; DWR, 1988
<i>Retropinna semoni</i>	Australian smelt	NSW Fisheries, 2000
<i>Hypseleotris spp.</i>	gudgeon spp.	NSW Fisheries, 2000
<i>Philypnodon grandiceps</i>	flathead gudgeon	NSW Fisheries, 2000
<i>Melanotaenia fluviatilis</i>	crimson-spotted rainbowfish	NSW Fisheries, 2000
Crustaceans and Molluscs		
<i>Cherax destructor</i>	yabbie	DWR, 1993; White <i>et. al.</i> , 1985; DWR, 1988
<i>Corbiculina australia</i>	mussel	DWR, 1993

Table 2.6 lists native species, other than birds, identified under the *Threatened Species Conservation Act 1995 (NSW)* and *Fisheries Management Act 1994 (NSW)* that may occur in the vicinity of the Forest Creek system.

Table 2.6 Native species identified under the *Threatened Species Conservation Act 1995 (NSW)* and *Fisheries Management Act 1994 (NSW)* that may occur in the vicinity of the Forest Creek system.

SCIENTIFIC NAME	COMMON NAME	STATUS
<i>Phascogale tapoatafa</i>	brush-tailed phascogale	<i>Vulnerable</i>
<i>Myotis adversus</i>	large-footed mouse-eared bat	<i>Vulnerable</i>
<i>Nyctophilus timoriensis</i>	greater long-eared bat	<i>Vulnerable</i>
<i>Saccolaimus flaviventris</i>	yellow-bellied sheath-tail-bat	<i>Vulnerable</i>

<i>Litoria raniformis</i>	southern bell frog	<i>Endangered</i>
<i>Maccullochella macquariensis</i>	trout cod	<i>Endangered</i>
<i>Bidyanus bidyanus</i>	silver perch	<i>Vulnerable</i>

Introduced pest species

Carp *Cyprinus carpio* are present in large numbers throughout the creek system, and people have commented on the change in water quality since their introduction. Mosquito fish *Gambusia affinis* have also been observed in the Forest Creek system. This species has been scientifically linked with the decline of a number of species of Australian native fish and frogs. It is to be officially declared ‘a threatening process’ under the *Threatened Species Conservation Act 1995* (NSW). Goldfish *Carassius auratus* and redfin *Perca fluviatilis* are considered likely to occur in the Yanco/Billabong Creek system (*pers. comm.* Angel, 2000). Dense cumbungi has provided cover for large feral pig *Sus scrofa* populations in the past. Their numbers have been controlled to some extent in recent years through helicopter culls, however it is unlikely that this form of control will take place in the future and feral pig numbers could increase again in wet years. **Foxes, rabbits and feral cats** all occur in the vicinity of the Forest Creek system.

2.11 WETLANDS

According to the NSW Wetlands Management Policy (DLWC, 1996), wetlands are defined as land that is:

- inundated with water on a temporary or permanent basis;
- inundated with water that is usually slow moving or stationary;
- inundated with water that is shallow; and
- inundated with water that may be fresh, brackish or saline.

Therefore, wetlands typically contain shallow water, but they may not always be wet. Wetlands are areas that are wet for a long enough period such that the plants and animals living in them are adapted to, and often dependant on, living in wet conditions for at least part of their life cycle (DLWC, 1996).

The Forest Creek system supports a number of different wetland types that reflect different flooding regimes. It is considered important to maintain a mosaic of different wetland types in different stages, as each wetland can support plant and animal populations that have adapted to that particular environment. It is the combination of these different wetland types that enables a diversity of plant and animal life to flourish.

Wetlands are amongst the most naturally productive places on earth. Some of the plants and animals they support can only survive in wetlands, and many migratory birds depend on Australian wetlands for survival. Wetlands also play an important role in protecting the quality of the water in our rivers and streams by filtering sediment and absorbing pollution. They can assist with maintaining some native fish populations by providing breeding and nursery habitats. Wetlands can make an area more visually appealing, and can reduce the impact of floods.

River regulation has altered the natural flow regime of many watercourses in the Murray and Murrumbidgee catchments. Many wetlands are now either permanently flooded, or very rarely flooded. There are far fewer wetlands in the landscape that receive an appropriate wetting and drying cycle. It is this wetting and drying pattern that many wetland rehabilitation projects are attempting to replicate.

Wetlands occurring along the Forest Creek system include:

Insert a couple of photos.

- ❑ Relatively small wetlands that have formed in natural depressions that were once part of an ancestral stream course. One of these wetlands has been disconnected from the Forest Creek, while others form virtually permanent water storages. For example, the Kerribirri storage (off the Forest Anabranch), and the storage on Inverness (off Murgha Creek).
- ❑ A small horseshoe shaped wetland at the far end of the creek system, that the main creek passes through (Box Swamp on Blue Gate). Due to its location on the creek system, this wetland is flooded intermittently.
- ❑ Wetlands of various depths that result from flooding of low-lying areas that contain one, or a series, of flood runners. These generally receive water on a seasonal basis. For example, flood-out areas on Rhyola and Back Nullum.
- ❑ Flood-out areas that only receive water during high flows. For example, flood-out areas associated with Eight Mile Creek and Clarke's Creek.
- ❑ Wanganella Swamp is a large, shallow basin-shaped wetland that contains both permanent and semi-permanent areas of water.

The Wanganella Swamp system (incorporating Eight Mile Creek, part of Clarkes Creek and Wanganella Swamp) is the largest wetland area. Its management has generated the most interest and concern, and it is discussed in more detail below.

Wanganella Swamp System

Being a cumbungi wetland, the Swamps lack the tall grace of river red gums. Rather, much of Wanganella Swamps has an unattractive face: flowpaths lined with dead black box trees; flood-out areas grazed and trampled by cattle. Not very appealing in the heart of summer, but visit in spring of a flood year and you find a riot of color. Introduced yellow-flowered capeweed covers the sandhills. The creek carries rafts of greeny-pink and apricot Azolla. The shallow water holds dense beds of robust red milfoil and vivid new growth of the sedges. Out on the wet muds, patches of nardoo age from young green to old rust (Roberts & Pasma, 1990).

The Wanganella Swamp system is located south of Wanganella township. It comprises the Eight Mile Creek, Wanganella Swamp and part of Clarkes Creek, all of which are hydrologically connected. The Wanganella Swamp system is a flow through system, with Eight Mile Creek flowing under the Cobb Highway into Wanganella Swamp, and then into the Forest Anabranch and on to properties further downstream. The Swamp system is located on both freehold and Crown land (Figure 3.2).

Both Eight Mile Creek and Clarkes Creek have poorly defined channels, and during times of high flow water spreads out extensively across the floodplain to form some 1,700ha of wetlands (White *et al.*, 1985). Flood-out areas form shallow wetlands, though several deeper more extensive wetlands occur within the Eight Mile Creek channel close to the Cobb Highway. These shallow wetlands have provided important breeding areas for many species of waterbirds (*pers. comm.* Maher, 1999). Clarkes Creek supports a small lignum wetland,

regarded as an important feeding area for waterbirds. Wanganella Swamp is a shallow, basin-shaped wetland with sandhills on its eastern margin. The Wanganella Swamp basin is approximately 360ha in size, and water spreads out across this depressional area before returning to the main creek channel.

Prior to river regulation, the Forest Creek system would only have received water when the Murrumbidgee River was in flood, or when rainfall in the Billabong Creek catchment or local storms were sufficient to generate a flow of more than 1, 500Ml/day at the Forest Creek offtake. This flooding regime would probably have created a series of small ephemeral wetlands along the creek system (White *et al.*, 1985). The Wanganella Swamp system has changed greatly since European settlement, with regulated flows creating a more permanent wetland environment. Continuous flows during the wet periods from the late 1940s to the 1950s, the early 1960s, and 1970s have all played a part in the development of the Wanganella Swamp system (Cummings, 1983).

The Wanganella Swamp system is now recognised by many people as significant for its present ecological values. This wetland system has not been grazed heavily, it has not been cropped or drained, and there are few relatively large, shallow wetlands like the Wanganella Swamp left in this region. A 1990 report suggested that although the wetland area is small compared with extensive shrub and forest wetlands found along the major watercourses of the Riverina, and although considerably altered since European settlement, the Wanganella Swamp system should be considered important at two levels. Locally, it is relatively species rich, and regionally the system represents the ecological changes and biological communities typical of many riverine wetlands (Roberts & Pasma, 1990).

Sixty-four species of waterbirds have been recorded in the Wanganella Swamp system, of which 29 were breeding records. Five species are listed as 'vulnerable' under the *Threatened Species Conservation Act 1995*: Brolga, Australasian Bittern, Blue-billed Duck, Painted Snipe, and Freckled Duck. Of these vulnerable species the Brolga, Australasian Bittern and Blue-billed Duck have been observed breeding (Maher, 1988). Table 2.7 shows the waterbird groups that have been recorded from the Wanganella Swamp system.

Table 2.7 *Waterbird groups recorded from the Wanganella Swamp system between 1978 and 1988 (Phil Maher, unpublished data).*

WATERBIRD GROUPS	NO. OF SPECIES	BREEDING	NON-BREEDING
Colonial nesting	20	6	14
Waterfowl	12	8	4
Crakes and Rails	7	4	3
Raptors	1	1	0
Grebes and Coots	4	4	0
Terns	2	1	1
Small waders	15	3	12
Reed warblers	3	3	0
TOTAL	64	30	34

The number of waterbird species observed here compares favourably with other significant wetland areas of a similar size (Table 2.8), though the number of birds of each species has not been formally recorded.

Table 2.8 Comparison of waterbird observations from the Wanganella Swamp system with observations from other significant wetlands in the Riverina.

	SPECIES OBSERVED	BREEDING RECORDS
Fivebough Swamp , Leeton* (observations 1982-1997)	82	21
Tuckerbil Swamp , Leeton* (observations 1982-1997)	67	13
Wanganella Swamp system (observations 1978-1988)	64	30

* (Hutton & Schultz in Glazebrook & Taylor, 1998)

Forty-five plant species were recorded by Roberts and Pasma (1990) in the Wanganella Swamp area over three visits during different seasons – December 1987, June 1990 and September 1990. A species list is presented in Appendix 3. Aquatic herbs and sedges dominate the species list, with only a few introduced species. The great value of this swamp system is that the vegetation provides a mixture of habitat types suitable for breeding, feeding, roosting and refuge. The vegetation can be grouped into three different zones, based on the water regime: open water, shallow water and the wet/dry zone (Roberts & Pasma, 1990). These are summarised in Table 2.9 below. This information focuses on waterbirds and vegetation because little is known at this stage about other species.

- See Appendix 4 for a summary of Roberts and Pasma’s research:
Roberts, J., Pasma, S. (1993) Wanganella Swamps in Wilson, A. (ed) *River, Plain and Sandhill. Proceedings Southern Riverina Field Naturalists Club Inc.* Vol 1. 1993. Southern Riverina Field Naturalists Club Inc., Deniliquin.

Table 2.9 Ecological zones of Wanganella Swamp, based on simplified water regime and showing associated vegetation characteristics and habitat value (Roberts & Pasma, 1990)

	ZONE 1	ZONE 2	ZONE 3
Name	Open water	Shallow water	Wet-dry zone
Water regime	Permanent	Semi-permanent	Intermittently flooded
Vegetation	None dominant, few submerged: mainly ribbonweed (<i>Vallisneria spiralis</i>), some <i>Azolla</i> sp., duckweed (<i>Spirodela punctata</i>), liverwort (<i>Ricciocarpus natans</i>)	Tall, dense grassland: mainly cumbungi (<i>Typha orientale</i>), some reed (<i>Phragmites australis</i>), giant rush (<i>Juncus ingens</i>)	Herbs, sedges and shrubs in combinations: Milfoil spp., <i>Ranunculus</i> spp., nardoo (<i>Marsilea drummondii</i>) <i>Eleocharis</i> sp., nitregoosefoot (<i>Chenopodium nitrariaceum</i>), lignum (<i>Muehlenbeckia florulenta</i>), <i>Juncus</i> spp., <i>Paspalum</i> sp.

Habitat value

This zone provides habitat for fish feeding and diving birds, and those birds seeking refuge on open water. Dead black box trees provide places for nesting and roosting.

Open water has the potential to provide an important drought refuge.

Provides habitat for nesting and refuge.

Provides an important feeding area for many of the larger waterbirds and waders such as herons, ibis and swans.

Could be expected to show greater productivity than the other zones, with its pulse of post-flooding growth.

Insert photos of the different ecological zones.

2.12 AGRICULTURAL SIGNIFICANCE

Yanco/Billabong Creek system

The Yanco/Billabong Creek system provides stock and domestic water and irrigation supply to 170 landholdings and ≈250 licences, benefiting an area in excess of 400, 000ha. This water supply supports traditional dryland grazing industries, including several major Australian merino sheep studs. Since 1990, the creek system has also supported irrigated agriculture including summer and winter pasture, horticulture and rice. Rice now dominates irrigation on the Yanco/Billabong Creek system above Conargo, with 8-9, 000ha grown in the 1999/00 season.

From the Forest Creek offtake to Warriston Weir (regulated)

Rice dominates irrigation on this section of the Forest Creek. Other major crop types grown on the regulated section of Forest Creek include summer and winter pasture, and winter crops (wheat and canola). There are 11 irrigation licences in this section of the creek, and the annual water entitlement is approximately 10, 500ML. During the 1999/00 irrigation season approximately 660ha of rice was grown, and 7, 400ML of water used (*pers. comm.* Jones, 2000).

In addition, merino sheep and cattle are grazed on properties along this section of the creek.

Below Warriston Weir (unregulated)

The Forest Creek system below Warriston Weir provides an important source of water for approximately 55, 000 stock (≈4, 500 cattle and ≈50, 000 sheep). Table 2.10 provides property size information, and pumping requirements from the Forest Creek system. **These properties run an average of 1.1DSE/ha.**

Table 2.10 *Size of property adjacent to the Forest Creek system, and pumping requirements on properties below Warriston Weir. (Information provided by landholders.)*

PROPERTY	SIZE OF PROPERTY adjacent to the Forest Creek system (ha)*	AVERAGE VOLUME PUMPED (ML/yr)

Wanganella/Peppinella	22, 511	800 (Area licences: 69ha Forest Creek) + filling dams
Avenel	2,391	None
Zara/Barratta	36, 187	450 (fills 6 dams)
Rhyola	7,176	100 (fills 5 dams)
Inverness	2,895	None
Box Green	1,844	None
Murgha	11,752	None
Back Nullum	2,676	None
Mooroolbark	1,223	None
Nullum	2,132	5 (fills 3 dams)
Blue Gate	10,768	None
Woorooma	10,181	950 (Area licences: 100ha Forest Anabranh, 222ha Gum Ck)

* as shown on Figure 3.1

2.13 ABORIGINAL SIGNIFICANCE

Historically, the largest numbers of Aborigines lived along the Murray and Edward Rivers and the major creeks, which provided an available food supply. Aboriginal people depend on the rivers for fish, yabbies, mussels, tortoises and water-fowl. Fish was the principal component of the diet for eight months of the year. On the plains, survival depended on the ability to find water. Soaks and wells were dug to tap underground seepage, rainwater was collected, and often the roots of hakea and mallee species were tapped for their stored water. Active changes were made to the environment, with the burning of shrublands to flush out small animals and other game. Rock fishtraps were also built and creeks were dammed (Beveridge in Porteners, 1993).

Four Aboriginal groups live in the locality of the Forest and Billabong Creeks: the Yota-Yota, Baraba-Baraba, Wamba-Wamba and Wadi-Wadi. In the vicinity of Forest and Billabong Creeks sites of significance to Aboriginal people are likely to occur in riparian areas, including the river bank, floodplain, lagoons and channels. Physical sites are likely to include oven mounds, scarred trees, camp sites, shell middens, burials and tool scatters. As well as physical sites, there are sites of religious and spiritual significance that are not obvious within the landscape, but are still of special importance to local Aboriginal people (*pers. comm.* Crew, 2000).

Eighteen known Aboriginal sites are currently recorded on the NSW National Parks and Wildlife Aboriginal Sites Register within 10km either side of the Forest Creek system. It is important to note that this area may contain sites that are not currently listed on the Aboriginal Sites Register, and that all sites are protected by law under the *National Parks and Wildlife Act 1974*, regardless of their inclusion on the Sites Register and the status of land on which they are located.

2.14 EUROPEAN SIGNIFICANCE

The Register of the National Estate is compiled by the Australian Heritage Commission and is the only nation-wide heritage list for Australia that encompasses natural, indigenous and historic places. No places or items are currently registered on the Register of the National Estate within the Conargo or Windouran Shires.

Heritage places and items of *state significance* in NSW are listed on the NSW State Heritage Register. Heritage items of *local significance* may be identified in local or regional environmental plans prepared by local councils. Items listed in either of these ways are protected in NSW under the *Heritage Act 1977*. A search of the NSW State Heritage Inventory revealed that there are currently no heritage items listed as being of state or local significance in the Conargo or Windouran Shires. However, most local people consider the Wanganella area and the Peppin Merino Stud to be of local historical significance.

2.15 OTHER VALUES

The south western plains region of New South Wales lacks local topographic relief, and therefore forested areas, remnant dune formations, and watercourses provide important areas of aesthetic interest.

Much of the Forest Creek system flows through private property, and public access to the riverine environment is limited. However, the creek environment provides a natural setting enjoyed by local landowners, landmanagers and their families for camping, fishing and birdwatching.

The creek is considered to be a significant property asset.

3. MANAGEMENT OPTIONS AND PROPOSED ACTIONS

The issues discussed in this chapter were compiled from information on files held by DLWC, and discussions with landholders, interested community members and DLWC staff. These issues were confirmed at a community meeting held in October 1998 and each issue was assigned a priority (high, medium or low). At this meeting participants also brainstormed some of the ways in which these issues could be addressed, and over the next two years these ideas were discussed and further developed, or in some instances discarded, by the working group. These issues have provided the basis for the development of this management plan, and this chapter is formatted against these issues.

A six page summary of management options and proposed actions is followed by a detailed discussion, and the rationale behind, each option and action.

Management issues are presented in order of priority from highest to lowest, as determined by the community at the meeting held in October 1998.

Proposed actions are also listed in order of priority. The priority assigned each action was determined on the basis of criteria such as the:

- ease with which the action could be undertaken;
- benefits of undertaking the action;
- cost;
- urgency.

The proposed actions are numbered according to the management option they relate to. For example:

- Proposed Action 2.1 relates to Management Option 2.1;
- Proposed Actions 2.2a through to 2.2e relate to Management Option 2.2; and
- Proposed Actions 1.1.6a(a) through to 1.1.6a(h) relate to Management Option 1.1.6a.

SUMMARY OF MANAGEMENT OPTIONS, PROPOSED ACTIONS AND INTENDED OUTCOMES

ISSUE 1. LACK OF WATER IN THE LOWER REACHES OF THE FOREST ANABRANCH Management Objectives:			
<ul style="list-style-type: none"> To enable the efficient supply and delivery of good quality stock and domestic water all year round To allow for the efficient passage of unregulated flows To maintain and where possible enhance the ecological sustainability of the Forest Creek system 			
MANAGEMENT OPTIONS	SUB-OPTIONS		PROPOSED ACTIONS
Management Option 1.1 Changing the flow regime	1.1.1 Continue with the current flow regime (36.5Gl) 1.1.2 Limit the replenishment flow to 25Gl below Warriston Weir (currently set aside in Murrumbidgee Resource Assessment) 1.1.3 Deliver a replenishment flow below Warriston Weir via a parallel channel 1.1.4 Alternate the supply of water between Murgha Creek and a parallel section of the Forest Anabranh 1.1.5 Provide an alternate water supply below Wanganella Swamp or below Warriston Weir 1.1.6 Provide an alternate water supply below <i>Rhyola</i>	1.1.6a Twelve month access to alternate water supply/stock and irrigation entitlement (Preferred Option) 1.1.6b Six month access to alternate water supply/stock and irrigation entitlement	Proposed Action 1.1.6a (a) <ul style="list-style-type: none"> That water savings, and the sharing of those savings between the environment and consumptive users, be clarified.

		<p>1.1.6c Twelve month access to alternate water supply/stock entitlement only/financial assistance to develop infrastructure</p> <p>1.1.6d Six month access to alternate water supply/stock entitlement only/financial assistance to develop infrastructure</p> <p>1.1.6e Twelve month access to alternate supply/stock entitlement only/no financial assistance</p>	<p>Proposed Action 1.1.6a (b)</p> <ul style="list-style-type: none"> That landholders and DLWC clarify the apportioning of water savings amongst landholders accessing an alternate water supply. <p>Proposed Action 1.1.6a (c)</p> <ul style="list-style-type: none"> That the following revised target flows for Warriston Weir be implemented, if Management Option 1.1.6a (a) receives approval: <ul style="list-style-type: none"> <i>Target 1. Unregulated/rain rejection flows</i> That unregulated/rain rejection flows be permitted to pass through the Forest Creek system for environmental purposes. <i>Target 2. 'Summer' target flow at Warriston Weir</i> That a target flow of 80ML/day at Warriston Weir be provided from the beginning of November to end March. <i>Target 3. Summer contingency</i> That a contingency of 400ML be used if necessary to offset the effects of very high evaporative losses during summer. (This flexibility is required in order to accommodate evaporative losses.) <i>Target 4. 'Winter' target flow at Warriston Weir</i> That a minimum target flow of 60ML/day at Warriston Weir be provided from beginning of April to
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end October.

Proposed Action 1.1.6a (d)

- That investigations be carried out to assess the structural requirements, appropriate location and cost of returning replenishment flows to Billabong Creek upstream of those properties accessing an alternate water supply.

Proposed Action 1.1.6a (e)

- That funding be secured for infrastructure to return flows to Billabong Creek.

Proposed Action 1.1.6a (f)

- That proposed changes to the flow regime be monitored annually to assess the social, economic and environmental impact.

Proposed Action 1.1.6a (g)

- That landholders above Warriston Weir instigate a rostering system during the irrigation season, with assistance from State Water.

Proposed Action 1.1.6a (h)

- That riparian pumpers below Warriston Weir instigate a rostering system during water shortages, to modify the impact on flows that can occur when several people are pumping together.

			<p>OUTCOME: IMPROVEMENT IN THE ECOLOGICAL SUSTAINABILITY OF THE LOWER FOREST ANABRANCH, AND ACCESS TO A MORE RELIABLE SUPPLY OF WATER FOR LANDHOLDERS IN THIS SECTION OF THE CREEK.</p>
<p>Management Option 1.2 Cumbungi control</p>			<p>Proposed Action</p> <ul style="list-style-type: none"> • None – not the preferred management option
<p>Management Option 1.3 Willow removal</p>			<p>Proposed Action 1.3</p> <ul style="list-style-type: none"> • That landholders, with assistance from DLWC and Greening Australia, include the removal of willow trees in their farm management plans, and prioritise sites on the basis of impact on the passage of flow. <p>OUTCOME: IMPROVEMENT IN FLOW EFFICIENCY, AND ENHANCEMENT OF THE ECOLOGICAL SUSTAINABILITY OF THE FOREST CREEK SYSTEM.</p>

<p>ISSUE 2. MANAGEMENT OF THE WANGANELLA SWAMP SYSTEM Management Objectives:</p> <ul style="list-style-type: none"> • To maintain and where possible enhance the ecological sustainability of the Forest Creek system • To allow for the efficient passage of unregulated flows • To enable the efficient supply and delivery of good quality stock and domestic water 	
<p>Management Option 2.1 Revised operation of the Forest Creek offtake regulator</p>	<p>Proposed Action 2.1 (a)</p> <ul style="list-style-type: none"> • That the Forest Creek offtake regulator be operated according to the following rules, outside the irrigation season: <p><i>Rule 1.</i> The Forest Creek offtake regulator be operated to allow an equitable proportion of the flow in Billabong Creek at Jerilderie (≈25%) to enter the Forest Creek system</p> <p><i>Rule 2.</i> The Forest Creek offtake regulator be fully opened during large floods, which are beyond the control of regulatory structures.</p> <p>Proposed Action 2.1 (b)</p> <ul style="list-style-type: none"> • That State Water program their control software (CITECT) to automatically remind operations staff of the change in operation of the Forest Creek offtake regulator at the end of the irrigation season (see operation rules at 2.1 (a)). <p>Proposed Action 2.1 (c)</p> <ul style="list-style-type: none"> • That several flow measurements be taken at the Forest Creek offtake to improve the accuracy of the discharge coefficient used in the equation to determine discharge at the Forest Creek offtake. <p>OUTCOME: PASSAGE OF AN EQUITABLE PORTION OF UNREGULATED AND RAIN REJECTION FLOWS DOWN THE FOREST CREEK SYSTEM.</p>
<p>Management Option 2.2 Access to an environmental allocation</p>	<p>Proposed Action 2.2 (a)</p> <ul style="list-style-type: none"> • That an environmental allocation for the Wanganella Swamp system be set aside in the form of a specific allocation. <p>Proposed Action 2.2 (b)</p> <ul style="list-style-type: none"> • That an environmental allocation be provided to the Wanganella Swamp system according to the following rules:

	<p><i>Rule 1. Trigger level</i> The trigger has been met if flows ≥ 400MI/day at Warriston Weir (or $\geq 1, 400$MI/day at Jerilderie) occur over a period of 40 consecutive days between mid-August and mid-October.</p> <p><i>Rule 2. Trigger deadline</i> If the trigger is not met by mid-October, the allocation to be made available for other purposes. Murrumbidgee region to determine distribution.</p> <p><i>Rule 3. Flow requirement</i> The following estimated target flows be provided at Warriston Weir if an environmental flow is required. (The environmental flow is in addition to the stock and domestic supply).</p> <table data-bbox="757 531 1590 654"> <tr> <td>October:</td> <td>100MI/day environmental flow + stock and domestic supply</td> </tr> <tr> <td>November:</td> <td>80MI/day environmental flow + stock and domestic supply</td> </tr> <tr> <td>December:</td> <td>60MI/day environmental flow + stock and domestic supply</td> </tr> <tr> <td>January:</td> <td>20MI/day environmental flow + stock and domestic supply</td> </tr> </table> <p><i>Rule 4. End of breeding season</i> Flows be gradually tapered off after birds have fledged (around late January).</p> <p><i>Rule 5. Pumping</i> Water users are not permitted to pump water from an environmental allocation.</p> <p>Proposed Action 2.2 (c) Monitoring program</p> <ul style="list-style-type: none"> • That flows be monitored during winter and spring to ensure that the offtake regulator allows freshes to pass down the system. • That the Wanganella Swamp system be monitored after the trigger has been met, to assess whether waterbirds have commenced breeding activities or other environmental needs exist, and a recommendation made regarding the requirement for an environmental allocation. • That waterbird activity be monitored during the breeding season, and State Water advised when waterbirds have fledged. • That an ecological monitoring program be established and maintained by DLWC to assess the impact of an environmental allocation on the Wanganella Swamp system, consistent with current water reform requirements. This monitoring program should include a reporting mechanism. <p>Proposed Action 2.2 (d)</p> <ul style="list-style-type: none"> • That DLWC seek advice from the following sources, regarding the management of an environmental allocation, should the trigger be achieved: <ul style="list-style-type: none"> - Local expertise and interest: eg. Phil Maher, Rick Webster 	October:	100MI/day environmental flow + stock and domestic supply	November:	80MI/day environmental flow + stock and domestic supply	December:	60MI/day environmental flow + stock and domestic supply	January:	20MI/day environmental flow + stock and domestic supply
October:	100MI/day environmental flow + stock and domestic supply								
November:	80MI/day environmental flow + stock and domestic supply								
December:	60MI/day environmental flow + stock and domestic supply								
January:	20MI/day environmental flow + stock and domestic supply								

	<ul style="list-style-type: none"> - Project Officer, NSW Murray Wetlands Working Group - NSW National Parks and Wildlife Service, Griffith Office. <p>Proposed Action 2.2 (e)</p> <ul style="list-style-type: none"> • That DLWC commit to an annual review process where relevant agency representatives meet to review environmental requirements for the Forest Creek system, and the most appropriate means of delivering flows to meet these requirements. For example, whether an environmental allocation for the Wanganella Swamp system could be shared between the Murrumbidgee and Murray catchments, via Colombo Creek and the Finley Escape. <p>Proposed Action 2.2 (f)</p> <ul style="list-style-type: none"> • That State Water program their control software (CITECT) to automatically identify when the trigger on Billabong Creek has been met, so that management staff in Deniliquin can be notified. <p>Proposed Action 2.2 (g)</p> <ul style="list-style-type: none"> • That logging probes installed on either side of Wanganella Swamp (Woolshed Bridge on Wanganella, and McCrabb’s Bridge on Avenel) be retained, and flows continue to be monitored to determine the proportion of an environmental flow that could be returned to Billabong Creek, and re-credited for use further downstream. <p>OUTCOME: ENHANCEMENT OF WETLAND PROCESSES THAT DEPEND ON SUSTAINED MODERATE SIZED FLOODS, INCLUDING THE REGENERATION/REPRODUCTION OF A RANGE OF NATIVE PLANTS AND ANIMALS, PARTICULARLY WATERBIRDS.</p>
<p>Management Option 2.3 Drying phase</p>	<p>Proposed Action None – addressed by other actions</p>
<p>Management Option 2.4 Removal/replacement of McCrabb’s regulator and adjacent spillway</p>	<p>Proposed Action 2.4 (a)</p> <ul style="list-style-type: none"> • That McCrabb’s regulator and adjacent spillway be removed. Silt and rubble to be stockpiled adjacent to the site for later use if required. <p>Proposed Action 2.4 (b)</p> <ul style="list-style-type: none"> • That several weeks after the removal of McCrabb’s regulator and spillway, an assessment be made to determine whether some desilting and removal of cumbungi in the Eight Mile Creek channel upstream of the regulator is required to facilitate the passage of flows.

	<p>Proposed Action 2.4 (c)</p> <ul style="list-style-type: none"> • That an assessment of the impact of the removal of McCrabb’s regulator and spillway on the wetland environment be conducted over the next five years, and if necessary a recommendation made regarding future structural requirements. <p>OUTCOME: IMPROVEMENT IN THE ECOLOGICAL SUSTAINABILITY OF THE WANGANELLA SWAMP, INCLUDING RESTORATION OF WATER LEVEL FLUCTUATIONS, AND IMPROVEMENT IN FLOWS EFFICIENCY THROUGH THE WANGANELLA SWAMP.</p>
<p>Management Option 2.5 Grazing management</p>	<p>Proposed Action 2.5 (a)</p> <ul style="list-style-type: none"> • That landmanagers, with assistance from DLWC, implement best practice management techniques for the management of stock adjacent to wetland areas. <p>Proposed Action 2.5 (b)</p> <ul style="list-style-type: none"> • That the western portion of the Wanganella Swamp system (ie. west of the Cobb Highway) be fenced off from TSR100 to allow for better management of travelling stock. <p>Proposed Action 2.5 (c)</p> <ul style="list-style-type: none"> • That funding requirements and funding sources be investigated for a project to fence off Wanganella Swamp from TSR100. <p>OUTCOME: IMPROVEMENT IN THE ECOLOGICAL SUSTAINABILITY OF THE WANGANELLA SWAMP SYSTEM THROUGH SUSTAINABLE AND APPROPRIATE MANAGEMENT OF GRAZING.</p>
<p>Management Option 2.6 Revegetation of sandhills on the travelling stock reserve (TSR100)</p>	<p>Proposed Action 2.6</p> <ul style="list-style-type: none"> • That funding requirements and funding sources be investigated, for a project to revegetate the sandhills on TSR100, either side of Eight Mile Creek, with local indigenous species. <p>OUTCOME: INCREASE IN THE BIOLOGICAL DIVERSITY, AND HABITAT VALUE, OF THE SANDHILLS ON THE TSR ADJACENT TO THE WANGANELLA SWAMP.</p>
<p>Management Option 2.7 Maintenance of a flowpath through Wanganella Swamp</p>	<p>Proposed Action 2.7</p> <ul style="list-style-type: none"> • That an assessment of Eight Mile Creek through Wanganella Swamp be made each year, on the basis of field inspections and community advice, to gauge whether maintenance (desilting or cumbungi management) of sections of the flowpath is

	<p>required to assist the passage of flow through the Wanganella Swamp.</p> <p>OUTCOME: IMPROVEMENT IN FLOW EFFICIENCY THROUGH THE WANGANELLA SWAMP.</p>
<p>Management Option 2.8 Bypass channel</p>	<p>Proposed Action None.</p>

<p>ISSUE 3. BREAKAWAY FLOWS AND EXCESS STORAGE OF WATER ON RHYOLA Management Objectives:</p> <ul style="list-style-type: none"> To allow for the efficient passage of unregulated flows To maintain and where possible enhance the ecological sustainability of the system and adjacent wetlands 	
<p>Management Option 3.1 Repair the breached retaining bank</p>	<p>Proposed Action 3.1</p> <ul style="list-style-type: none"> That the breached retaining bank on <i>Rhyola</i> be repaired, with assistance from DLWC, to enable winter/spring freshes to reach the end of the Forest Creek system without breaking back to Billabong Creek. <p>OUTCOME: IMPROVEMENT IN THE EFFICIENCY OF UNREGULATED AND RAIN-REJECTION FLOWS TO THE LOWER REACHES OF THE FOREST CREEK SYSTEM.</p>

<p>ISSUE 4. EXCESSIVE GROWTH OF CUMBUNGI IN THE FOREST CREEK SYSTEM Management Objectives:</p> <ul style="list-style-type: none"> To allow for the efficient passage of unregulated flows To enhance the ecological sustainability of the Forest Creek system 	
<p>Management Option 4.1 Spraying cumbungi</p>	<p>Proposed Action None – not the preferred management option</p>

Management Option 4.2 Dredging to remove silt and cumbungi	Proposed Action None – not the preferred management option
Management Option 4.3 Cutting cumbungi	Proposed Action None – not the preferred management option
Management Option 4.4 A period of drying	Proposed Action None – addressed by other actions (1.1.6a)
Management Option 4.5 Ongoing monitoring	Proposed Action 4.5 <ul style="list-style-type: none"> • That the extent of cumbungi in the upper reaches of the Forest Creek system be monitored, with a view to the possible need for future control. OUTCOME: INCREASED AWARENESS OF CHANGES IN THE EXTENT OF CUMBUNGI GROWTH AND BASIS FOR POSSIBLE FUTURE CONTROL.

ISSUE 5. SILTATION Management Objectives: <ul style="list-style-type: none"> • To enable the efficient supply and delivery of good quality stock and domestic water all year round • To allow for the efficient passage of unregulated flows • To maintain and where possible enhance the ecological sustainability of the Forest Creek system 	
Management Option Research	Proposed Action 5.1 <ul style="list-style-type: none"> • That investigations be undertaken to determine the cause of large areas of cumbungi dying in the Wanganella Swamp. OUTCOME: IMPROVED MANAGEMENT OF THE FOREST CREEK SYSTEM, BASED ON A BETTER UNDERSTANDING OF THE PHYSIOLOGY OF CUMBUNGI.

ISSUE 6. INADEQUATE KNOWLEDGE OF SURFACE WATER QUALITY Management Objectives: <ul style="list-style-type: none"> To enable the efficient supply of good quality stock and domestic water To maintain and where possible enhance the ecological sustainability of the Forest Creek system To improve understanding of surface water quality in the Forest Creek system 	
Management Option 6.1 Establish a community water quality monitoring project	Proposed Action None – not considered a long-term option given changing levels of community commitment.
Management Option 6.2 Continue with the existing water quality monitoring	Proposed Action 6.2 <ul style="list-style-type: none"> That the monthly and continuous water quality monitoring that commenced on the Forest Creek in 1999 be continued by DLWC. OUTCOME: GREATER UNDERSTANDING OF WATER QUALITY IN THE FOREST CREEK SYSTEM.

ISSUE 7. POTENTIAL IMPACT OF THE BERRIQUIN SURFACE DRAINAGE PROGRAM ON WATER QUALITY AND WATER QUANTITY Management Objectives: <ul style="list-style-type: none"> To enable the efficient supply and delivery of good quality stock and domestic water To maintain and where possible enhance the ecological sustainability of the Forest Creek system 	
Management Option 7.1 Proposed surface drainage developments	Proposed Action 7.1 <ul style="list-style-type: none"> That all proposals for drain developments likely to influence the Forest Creek environment consider the principles and objectives of the Forest Creek Management Plan. OUTCOME: RECOGNITION AND PROTECTION OF THE ENVIRONMENTAL VALUES OF THE FOREST CREEK SYSTEM.

<p>Management Option 7.2 Use of Wollamai West Stormwater Escape to deliver supplementary freshwater to the Forest Creek</p>	<p>Proposed Action 7.2</p> <ul style="list-style-type: none"> • That the potential to use Wollamai West Stormwater Escape for the delivery of supplementary freshwater to Forest Creek be investigated. <p>OUTCOME: MORE EFFICIENT DELIVERY OF BETTER QUALITY WATER TO THE FOREST CREEK SYSTEM.</p>
<p>Management Option 7.3 Improved communication/education</p>	<p>Proposed Action 7.3 (a)</p> <ul style="list-style-type: none"> • That MIL and DLWC take responsibility for notifying the community of the nature, extent and outcome of any water quality concerns that arise. <p>Proposed Action 7.3 (b)</p> <ul style="list-style-type: none"> • That Murray Irrigation inform BID landholders of the potential impact of poor drainage management on the downstream environment and landholders, and that MIL discourage pumping from deep bores in the BID because of the potential for increased salinity in escape water, and ultimately in the receiving waters of the creek systems. <p>OUTCOME: RECOGNITION AND PROTECTION OF THE ENVIRONMENTAL VALUES OF THE FOREST CREEK SYSTEM</p>

<p>ISSUE 8. INADEQUATE KNOWLEDGE OF GROUNDWATER MOVEMENT AND GROUNDWATER QUALITY Management Objectives:</p> <ul style="list-style-type: none"> • To involve landholders and the wider community in the ongoing management of the Forest Creek system • To increase awareness of groundwater trends, and enable early action at the local or regional level if disturbing trends develop 	
<p>Management Option 8.1 Establish a groundwater monitoring program</p>	<p>Proposed Action 8.1</p> <ul style="list-style-type: none"> • That a groundwater monitoring program be established <p>OUTCOME: IMPROVED UNDERSTANDING OF GROUNDWATER SYSTEMS INFLUENCING THE FOREST CREEK.</p>

ISSUE 9. WATER SUPPLY ADMINISTRATION Management Objective: <ul style="list-style-type: none"> To enable the efficient supply and delivery of stock and domestic water all year round 	
Management Option 9.1 Binding agreement for supply through MIL escapes	Proposed Action None – in progress
Management Option 9.2 Raising landholder awareness of supply constraints	Proposed Action None – in progress
Management Option 9.3 Demand management during the irrigation season	Proposed Action 9.3 <ul style="list-style-type: none"> That a demand management strategy be used during water shortages, for future management of supply in the Yanco/Billabong Creek system over the irrigation season. Proposed Action 9.3 (b) <ul style="list-style-type: none"> That irrigators continue to order water weekly, with a two week forecast, as part of on-going management of supply in the Yanco/Billabong Creek system. OUTCOME: MORE EQUITABLE DISTRIBUTION OF SUPPLY DURING PERIODS OF WATER SHORTAGE.
Management Option 9.4 Improve the provision of flow information	Proposed Action None – improvements have been achieved and work in this area is ongoing
Management Option 9.5 Improve local understanding of Finley Escape operation	Proposed Action 9.5 (a) <ul style="list-style-type: none"> That State Water develop stronger links with MIL operations staff. Proposed Action 9.5 (b) <ul style="list-style-type: none"> That consideration be given to extending the area of responsibility of the State Water metering inspector (Deniliquin) to include Billabong Creek from Finley Escape Channel downstream.

	<p>Proposed Action 9.5 (c)</p> <ul style="list-style-type: none"> • That a gauge be installed at Algdgerie Weir to assist MIL and State Water with management of the Finley Escape. <p>OUTCOME: IMPROVED MANAGEMENT OF WATER RESOURCES IN THE YANCO/BILLABONG CREEK SYSTEM.</p>
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<p>ISSUE 10. PROTECTION OF WETLANDS OTHER THAN THE WANGANELLA SWAMP SYSTEM, AND PROTECTION OF RIPARIAN LAND Management Objectives:</p> <ul style="list-style-type: none"> • To maintain and where possible enhance the ecological sustainability of the Forest Creek system • To manage wetland areas and the riparian zone to support a diversity of native plant and animals species • To increase community awareness of the value of wetlands and the riparian zone 	
<p><i>Kerribirri</i> Management Option 10.1 Continue with present management</p>	<p>Proposed Action None – will not provide the greatest environmental benefits</p>
<p>Management Option 10.2 Fence around Kerribirri Swamp</p>	<p>Proposed Action 10.2 That Kirribirri Swamp be fenced to enable controlled management of grazing.</p> <p>OUTCOME: INCREASE IN THE BIOLOGICAL DIVERSITY, AND HABITAT VALUE, OF THE KERRIBIRRI SWAMP.</p>
<p>Management Option 10.3 Modify the block bank</p>	<p>Proposed Action 10.3 That the block bank between Kerribirri Swamp and Forest Anabanch be modified, with assistance from DLWC, to enable a more frequent filling and draining regime.</p> <p>OUTCOME: INCREASE IN THE BIOLOGICAL DIVERSITY, AND HABITAT VALUE, OF THE KERRIBIRRI SWAMP.</p>
<p><i>Rhyola</i></p>	

<p>Management Option 10.4 Continue with present management</p>	<p>Proposed Action None – present management is contributing to ongoing degradation of permanently inundated areas Addressed by proposed action 10.5.</p>
<p>Management Option 10.5 Repair the breached retaining bank</p>	<p>Proposed Action 10.5 That the breached retaining bank on <i>Rhyola</i> be repaired, with assistance from DLWC, to enable the control of small to moderate winter/spring freshes to low-lying depressions and flood runners. DLWC to set rules for the operation of a new structure in the retaining bank.</p> <p>OUTCOME: INCREASE IN THE BIOLOGICAL DIVERSITY, AND HABITAT VALUE, OF LOW-LYING AREAS ON <i>RHYOLA</i>.</p>
<p>Back Nullum Management Option 10.6 Continue with present management</p>	<p>Proposed Action None – no change to present management</p>
<p>Blue Gate Management Option 10.7 Continue with present management</p>	<p>Proposed Action None – no change to present management</p>
<p>Management Option 10.8 Ongoing education</p>	<p>Proposed Action 10.8 (a)</p> <ul style="list-style-type: none"> • That DLWC continue to raise community awareness of the value of protecting riparian habitats, and the importance this plays in contributing to ecologically sustainable management. <p>Proposed Action 10.8 (b)</p> <ul style="list-style-type: none"> • That the Whiporie Park project be used as a local demonstration site to show how riparian vegetation changes with controlled grazing management. <p>OUTCOME: IMPROVED MANAGEMENT OF RIPARIAN LAND.</p>

ISSUE 11.
STRUCTURES ON THE FOREST CREEK SYSTEM
Management Objectives:

- To maintain and where possible enhance the ecological sustainability of the Forest Creek system
- To allow for the efficient passage of unregulated flows
- To enable the efficient supply and delivery of good quality water.

<p>Management Option 11.1 Assessment of the Yanco/Billabong Creek system</p>	<p>Proposed Action 11.1</p> <ul style="list-style-type: none"> • That State Water identify and investigate opportunities for improving the supply and delivery of water throughout the Yanco/Billabong Creek system. <p>OUTCOME: IMPROVED MANAGEMENT OF WATER RESOURCES IN THE YANCO/BILLABONG CREEK SYSTEM.</p>
<p>Management Option 11.2 Upgrade of Hartwood Weir</p>	<p>Proposed Action 11.2</p> <ul style="list-style-type: none"> • That State Water pursue the urgent refurbishment of Hartwood Weir on Billabong Creek. <p>OUTCOME: IMPROVED MANAGEMENT OF WATER RESOURCES IN THE YANCO/BILLABONG CREEK SYSTEM.</p>

ISSUE 12.
IMPACT OF THE BLOCK BANK ACROSS THE ORIGINAL FOREST CREEK OFFTAKE
Management Objectives:

- To allow for the efficient passage of unregulated flows
- To maintain and where possible enhance the ecological sustainability of the Forest Creek system

<p>Management Option 12.1 Investigate the impact of the block bank and negotiate changes if necessary</p>	<p>Proposed Action 12.1 (a)</p> <ul style="list-style-type: none"> • That the height at which flows overtop the block bank on the original Forest Creek offtake, during a moderate to large flood event, be investigated. <p>Proposed Action 12.1 (b)</p>
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	<ul style="list-style-type: none"> • That if necessary, modifications be made to the block bank so that small to moderate freshes are not prevented from passing down the Forest Creek system. <p>OUTCOME: IMPROVEMENT IN THE PASSAGE OF UNREGULATED AND RAIN-REJECTION FLOWS, AND ENHANCEMENT OF THE ECOLOGICAL SUSTAINABILITY OF THE FOREST CREEK SYSTEM</p>
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ISSUE 13. FLOODING OF THE COBB HIGHWAY, WANGANELLA Management Objectives: <ul style="list-style-type: none"> • To allow for the efficient passage of unregulated flows • To ensure that where possible, flows in Eight Mile Creek are managed to minimise the impact of flooding on the Cobb Highway Wanganella 	
Management Option 13.1 Management of flow through Wanganella Swamp	Proposed Action None – addressed by other actions
Management Option 13.2 Operation of Estuary Creek regulator	Proposed Action 13.2 <ul style="list-style-type: none"> • That Estuary Creek regulator be operated when necessary, to enable floodwaters to pass down Estuary Creek to Billabong Creek, before reaching the Cobb Highway at Wanganella. <p>OUTCOME: MINIMISE FLOODING OF THE COBB HIGHWAY AT WANGANELLA.</p>

ISSUE 1.

LACK OF WATER IN THE LOWER REACHES OF THE FOREST ANABRANCH

This issue has implications for the landholders of seven properties downstream of *Rhyola* (Figure 3.1), and has implications for the natural environment.

Currently, landholders at the furthest end of the creek system are most effected by this situation – particularly *Woorooma* and *Blue Gate*; and to a lesser extent *Nullum*, *Mooroolbark* and *Back Nullum* – with smaller volumes of water taking longer to reach these landholders as each year passes. There is general agreement that over time, problems with water delivery are likely to increasingly affect adjacent upstream properties, particularly where the cumbungi growth is now most extensive.

From an environmental perspective, the provision of a virtually constant supply of water has altered the creek environment. Prior to regulation, the system would have supported a range of native plant and animal species that were adapted to an ephemeral flow regime. It is now dominated by cumbungi (which provides one type of habitat), and a range of species that have adapted to a virtually permanent flow regime. Flow management changes will alter the existing aquatic populations. Changes that attempt to mimic natural flow patterns are likely to favour a greater diversity of habitats, that will support a greater diversity of plant and animal species.

Although the Forest Anabranh is an unregulated watercourse and there is no *legal obligation* to supply water, a Department of Water Resources report in 1994 stated that ‘it could be argued that there is a *moral obligation* to supply stock and domestic requirements ...’ (Simpson, 1994). This argument is based on the history of supply and history of landholder expectation generated as ratepayers of the Trust that administered the system between 1921 and 1980. Reliable delivery of water for stock and domestic purposes below Zara Dam has been an issue for landholders at various times since the 1930s.

‘Prior to 1928, flow in Box Creek (Forest Anabranh) at Rhyola may only have occurred for a few weeks in most spring periods of the year. From 1928 onwards flow in Box Creek at Rhyola would have occurred during each winter/spring and for longer durations. Except for 1940, 1943, 1944, 1945, 1946, 1967, 1968 and 1983 flow at Rhyola should have continued for about six months of the year. During wet sequences, flow may have been continuous for a number of years, possibly for three years in 1933-1936, 10 years in 1947-1957, three years in 1960-1963 and four years in 1973-1977’ (Cumplings, 1983).

On average during the last decade, properties below *Back Nullum* have received a flow in the creek from May/June until October/November, and relied on tanks in the creek to hold water as the creek dried up over summer. There has not been a flow in the Forest Anabranh through *Blue Gate* and *Woorooma* since 1997. The lack of protocols for operation of the Forest Creek offtake regulator (installed 1993) has compounded this problem in recent years, as winter/spring flushes were prevented from entering the creek system (addressed at management option 2.1).

Between 1982 and 1986, DLWC undertook investigations of the Forest Creek to determine why freshes were taking so long to reach downstream landholders. A report stated that of the measured flows over Warriston Weir only 32-35% was recorded at the Kirribirri gauge on *Barratta* and 8-10% was recorded at a gauge located at *Blue Gate* (DLWC File:

700161A²). Flow information collected during this project also showed that on average 30% of Warriston Weir flow was recorded at Kerribirri. During this period, no flows were recorded on *Blue Gate* (see Appendix 1).

Probable factors contributing to this issue

This issue appears to be the result of a combination of factors:

- ❑ Summer flows have led to the extensive invasion of cumbungi in the creek channel, particularly below *Rhyola*;
- ❑ This build up of vegetation has slowed the flow of water and provided ideal conditions for deposition of sediments and organic material. This has in turn compounded the flow problem;
- ❑ Breakaway flows to Billabong Creek. Despite construction of block banks, breakaway flows still occur in several key places where structures, excessive growth of cumbungi and low creek banks allow backed-up water to move out of the creek channel. This occurs at the Wanganella Swamp and on *Rhyola*;
- ❑ After the summer months, extensive wetland areas on *Rhyola* fill, before water flows further downstream. In addition, Forest Anabranh sometimes backs up into Murgha Creek where Murgha Creek re-enters the Forest Anabranh. This tends to occur after a particularly dry summer when the Forest Anabranh begins to flow again, and Murgha Creek is virtually dry. These flow patterns delay the passage of water to properties further downstream on the Anabranh;
- ❑ Increased regulation upstream;
- ❑ Increased demand for water upstream, for irrigated agriculture;
- ❑ Seepage to prior streams reduces the end-of-system flow;
- ❑ Willow trees planted at various locations along the creek (generally at crossings) have suckered and spread, and in some places are restricting the flow of water.

Management objectives

- ❑ To enable the efficient supply and delivery of good quality stock and domestic water all year round;
- ❑ To allow for the efficient passage of unregulated flows;
- ❑ To maintain and where possible enhance the ecological sustainability of the Forest Creek system.

MANAGEMENT OPTION 1.1

CHANGING THE FLOW REGIME

The following options are presented in this section:

- 1.1.1 Continue with the current flow regime (36.5Gl)
- 1.1.2 Limit the replenishment flow to 25Gl below Warriston Weir (currently set aside in Murrumbidgee Resource Assessment)
- 1.1.3 Deliver a replenishment flow below Warriston Weir via a parallel channel
- 1.1.4 Alternate the supply of water between Murgha Creek and a parallel section of the Forest Anabranh
- 1.1.5 Provide an alternate water supply below Wanganella Swamp or below Warriston Weir
- 1.1.6 Provide an alternate water supply below *Rhyola*
 - 1.1.6a – 1.1.6e
- 1.1.7 Preferred option (1.1.6a)**

1.1.1 Continue with the current flow regime (36.5GI)

- Continue to provide a replenishment flow of 36.5GI over Warriston Weir (\approx 100MI/day)
- Allow unregulated winter/spring freshes that mimic natural flow patterns, to pass through the Forest Creek system

This option does not meet any of the management objectives sought by addressing this issue. This is primarily because a permanent flow regime (particularly summer flows) perpetuates the growth of cumbungi, particularly in the lower Forest Anabranh. Some form of cumbungi control in association with this option, may improve transmission efficiency in the creek below *Rhyola*. However, this is likely to be inconsistent with the objective of enhancing the ecological sustainability of the creek system because of the potentially negative impact that an ongoing maintenance program, for example spraying or dredging, could have on the environment. This option is not an efficient use of water.

ADVANTAGES	DISADVANTAGES
	Environmental <ul style="list-style-type: none"> • Negative ecological consequences associated with a regulated flow regime • Continual growth and expansion of cumbungi • Siltation associated with cumbungi growth
	Economic <ul style="list-style-type: none"> • Considerable ongoing expense associated with maintaining transmission efficiency in the lower Forest Anabranh, eg. cumbungi control, desilting of tanks (dams) in the creek • Inefficient use of an increasingly valuable resource
	Accountability <ul style="list-style-type: none"> • State Water South lack accountability for the delivery and use of flows over Warriston Weir
	Security of supply <ul style="list-style-type: none"> • Security of supply is likely to deteriorate over time

1.1.2 Limit the replenishment flow to 25GI below Warriston Weir (currently set aside in Murrumbidgee Resource Assessment)

- Provide a replenishment flow of 25GI over Warriston Weir between April and September (inclusive) (\approx 120MI/day)
- Allow unregulated winter/spring freshes that mimic natural flow patterns, to pass through the Forest Creek system

This option was first proposed in a 1973 report prepared by the Water Conservation and Irrigation Commission, on the basis that it was no longer practical to supply the Forest Creek system below Warriston Weir in the summer months (WCIC, 1973) (see discussion in section 2.5). This option would help to improve transmission efficiency in the lower Forest Anabranh through a reduction in summer flows, and would provide a flow regime that

mimics more closely the natural flow regime. However, it would not meet the objective of providing an efficient supply of good quality stock and domestic water all year round.

It was also acknowledged in the 1973 report that the proposal could not be expected to provide a long-term solution to the water supply problem in the lower Forest Anabranche, because of the possibility that conditions in the creek system would continue to deteriorate (WCIC, 1973).

ADVANTAGES	DISADVANTAGES
<p>Accountability</p> <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston Weir 	
<p>Environmental</p> <ul style="list-style-type: none"> • Restriction of summer flows will help to contain the growth of cumbungi, and in combination with grazing, is likely to improve transmission efficiency 	<p>Environmental</p> <ul style="list-style-type: none"> • Would still maintain some cumbungi growth and siltation
	<p>Security of supply</p> <ul style="list-style-type: none"> • Insufficient volume to meet stock water requirements in the lower Forest Anabranche during summer
	<p>Economic</p> <ul style="list-style-type: none"> • Some ongoing expense associated with maintaining transmission efficiency in the lower Forest Anabranche, eg. cumbungi control, desilting of tanks (dams) in the creek • Productivity losses associated with lack of water in the lower Forest Anabranche during summer • Reduction in property value associated with lack of water in the lower Forest Anabranche during summer

1.1.3 Deliver a replenishment flow below Warriston Weir via a parallel channel

- Deliver sufficient water via a channel to meet the stock and domestic requirements of landholders below Warriston Weir
- Establish a regular maintenance program to control cumbungi growth in the channel
- Return flows in the Forest Creek system below Warriston Weir to unregulated winter/spring freshes, that mimic natural flow patterns
- Enhance the biological diversity of the Forest Creek system by mimicing natural flow patterns

This option is included as a record that it has been considered, however it is not considered to be economically viable, given the substantial construction costs and the ongoing costs associated with channel maintenance. It is also likely that an Environmental Impact Statement (EIS) would be required, as the channel would probably pass through environmentally sensitive areas.

ADVANTAGES	DISADVANTAGES
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	<p>Economic</p> <ul style="list-style-type: none"> • Significant initial cost of constructing the channel • Potential devaluation of property associated with the channel • Considerable ongoing expense associated with maintaining transmission efficiency in the channel, eg. cumbungi control • Considerable expense associated with the construction of fences and crossings
<p>Accountability</p> <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows beyond Warriston Weir 	
<p>Environmental</p> <ul style="list-style-type: none"> • Reduction in the spread of cumbungi in the creek system associated with restriction of summer flows through the creek • Reduction in feral pig habitat and therefore feral pig numbers • Improved health of black box communities in areas that have been permanently inundated • Enhanced biological diversity through the creation of new habitat 	<p>Environmental</p> <ul style="list-style-type: none"> • Likely to obstruct flood flows • Potential groundwater implications • Would dramatically change the hydrology of the Wanganella Swamp system
<p>Security of Supply</p> <ul style="list-style-type: none"> • Increased security of supply 	

1.1.4 Alternate the supply of water between Murgha Creek and a parallel section of the Forest Anabranh

- Continue to supply a sufficient replenishment flow at Warriston Weir for the Forest Creek system
- In some years contain the supply to Murgha Creek, while allowing the parallel section of the Forest Anabranh to dry
- In other years contain the supply to the Forest Anabranh, while allowing the parallel section of Murgha Creek to dry

This option may assist with improving transmission efficiency and enhancing the ecological sustainability of sections of the creek system where the growth of cumbungi is extensive, and these objectives are consistent with the vision statement. However, this strategy only deals with a limited section of the creek system, and is not considered to be the most effective long-term solution. As long as summer flows are provided through these sections of the creek, even every couple of years, the cumbungi problem will persist. This option would not permanently tackle the cause of the problem, which is the permanent flow regime.

ADVANTAGES	DISADVANTAGES
<p>Environmental</p> <ul style="list-style-type: none"> • Some reduction in the spread of cumbungi through periods of drying • Some reduction in feral pig habitat and feral pig population • Improved health of black box communities in areas that have been permanently 	<p>Environmental</p> <ul style="list-style-type: none"> • Would not enable the Forest Anabranh to dry below Murgha Creek • Potential negative impact of an ongoing cumbungi maintenance program below Murgha Creek

inundated	
Water savings <ul style="list-style-type: none"> • Possible generation of some water savings through more efficient transmission in a section of the creek system 	
	Economic <ul style="list-style-type: none"> • Murgha Creek offtake regulator would require considerable refurbishment

1.1.5 Provide an alternate water supply below Wanganella Swamp or below Warriston Weir

- Return flows below Wanganella Swamp, or below Warriston Weir, to unregulated winter/spring freshes that mimic natural flow patterns
- Provide landholders with access to an alternate water supply from Billabong Creek or the Edward River
- Allow landholders to use the alternate water supply for both stock and irrigation purposes
- Provide landholders with the financial ability (through irrigation revenue) to develop appropriate re-watering infrastructure

The option of all properties below Wanganella Swamp accessing water from an alternate source was canvassed. However, there was strong opposition to this proposal from landholders/managers with properties between the Wanganella Swamp and *Rhyola*, on the basis that the Forest Creek is a relatively well-defined watercourse through these properties, and the water supply (in all but the driest of years) has always been reliable. This argument also applies to the creek further upstream between, Warriston Weir and Wanganella Swamp.

ADVANTAGES	DISADVANTAGES
Environmental <ul style="list-style-type: none"> • Reduction in the spread of cumbungi through restriction of summer flows • Enhanced biological diversity through the creation of new habitat • Opportunity for the Wanganella Swamp system to experience a more complete drying cycle • Reduction in feral pig habitat and feral pig population • Improved health of black box communities in areas that have been permanently inundated 	
Water savings <ul style="list-style-type: none"> • Generation of water savings 	
Economic <ul style="list-style-type: none"> • Landholders have the ability to finance their own infrastructure development through irrigation revenue • Additional government revenue from charges associated with alternate water entitlement 	Economic <ul style="list-style-type: none"> • Ongoing cost of maintaining infrastructure to access alternate supply • Property devaluation associated with loss of replenishment flow in Forest Creek system
Accountability <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston 	

Weir

Security of supply

- Greater security of supply through year-round access to a regulated watercourse

1.1.6 Provide an alternate water supply below *Rhyola*

Landholders have put forward the option of an alternate water supply for properties below *Rhyola*. They propose that replenishment flows no longer be supplied for stock and domestic requirements below *Rhyola*, and that this flow be returned to Billabong Creek via a channel on the western boundary of *Rhyola*. They have proposed that a portion of the water savings generated by this changed flow regime be transferred to existing licences on Billabong Creek or the Edward River, as all landholders below *Rhyola* have frontage to either, or both, these watercourses.

Several options for providing this alternate water supply have been identified and ranked by landholders. These are presented below in order of preference.

1.1.6 a

***Twelve month access to alternate water supply
Stock and irrigation entitlement***

- Return flows below *Rhyola* to unregulated winter/spring freshes that mimic natural flow patterns
- Provide landholders with access to an alternate water supply from either Billabong Creek or the Edward River
- Allow landholders to use the alternate water supply for both stock and irrigation purposes
- Provide landholders with the financial ability (through irrigation revenue) to develop appropriate re-watering infrastructure
- Enhanced biological diversity in the lower Forest Anabranche through the creation of new habitat

ADVANTAGES	DISADVANTAGES
<p>Environmental</p> <ul style="list-style-type: none"> • Enhanced biological diversity through the creation of new habitat • Reduction in the spread of cumbungi through restriction of summer flows • Reduction in feral pig habitat and feral pig population • Improved health of black box communities in areas that have been permanently inundated 	<p>Environmental</p> <ul style="list-style-type: none"> • Ecological benefits may be potentially reduced by the environmental problems that irrigation can cause, however the nett benefit would be positive.
<p>Water savings</p> <ul style="list-style-type: none"> • Generation of water savings 	
<p>Economic</p> <ul style="list-style-type: none"> • Landholders have the ability to finance their own infrastructure development • Additional government revenue from charges associated with alternate water entitlement 	<p>Economic</p> <ul style="list-style-type: none"> • Funding required to return replenishment flows to Billabong Creek • Ongoing cost of maintaining infrastructure to access alternate supply • Property devaluation associated with loss of regulated flow

Accountability <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston Weir 	
Security of supply <ul style="list-style-type: none"> • Greater security of supply through year-round access to a regulated watercourse 	

1.1.6 b

*Six month access to alternate water supply
Stock and irrigation entitlement*

- Provide a replenishment flow below *Rhyola* during the months April to September (inclusive)
- Provide landholders with access to an alternate water supply from either Billabong Creek or the Edward River during the months October to March (inclusive)
- Allow unregulated winter/spring freshes that mimic natural flow patterns to pass through the Forest Creek system
- Allow landholders to use the alternate water supply for both stock and irrigation purposes
- Provide landholders with the financial ability (through irrigation revenue) to develop appropriate re-watering infrastructure
- Establish a cumbungi maintenance program to improve transmission efficiency in the creek below *Rhyola*

ADVANTAGES	DISADVANTAGES
Environmental <ul style="list-style-type: none"> • Some enhanced biological diversity through the creation of new habitat (depending on the extent to which flows dry up during summer) • Reduction in cumbungi resulting from maintenance program and reduction in summer flows • Some reduction in feral pig habitat and feral pig population • Some improved health of black box communities in areas that have been permanently inundated 	Environmental <ul style="list-style-type: none"> • Potential negative impact of an ongoing cumbungi maintenance program • Ecological benefits may be potentially reduced by the environmental problems that irrigation can cause, however the nett benefit would be positive.
Water savings <ul style="list-style-type: none"> • Generation of water savings 	
Economic <ul style="list-style-type: none"> • Landholders have the ability to finance their own infrastructure development • Additional government revenue from charges associated with alternate water entitlement 	Economic <ul style="list-style-type: none"> • Funding required to return replenishment flows to Billabong Creek between October and March • Ongoing cost of maintaining infrastructure to access alternate supply • Considerable ongoing expense associated with cumbungi maintenance program • Property devaluation
Accountability <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston Weir 	
Security of supply	

- Greater security of supply through access to a regulated watercourse between October and March through a permanent entitlement

1.1.6 c

Twelve month access to alternate water supply

Stock entitlement only

Financial assistance to develop infrastructure

- Return flows below *Rhyola* to unregulated winter/spring freshes that mimic natural flow patterns
- Provide landholders with access to an alternate water supply from either Billabong Creek or the Edward River
- Allow landholders to use the alternate water supply for stock watering only
- Provide landholders with financial assistance to develop appropriate re-watering infrastructure
- Enhanced biological diversity of the lower Forest Anabranche through the creation of new habitat

ADVANTAGES	DISADVANTAGES
Environmental <ul style="list-style-type: none"> • Enhanced biological diversity through the creation of new habitat • Reduction in the spread of cumbungi through restriction of summer flows • Reduction in feral pig habitat and feral pig population • Improved health of black box communities in areas that have been permanently inundated 	
Water savings <ul style="list-style-type: none"> • Generation of water savings 	
Economic <ul style="list-style-type: none"> • Additional government revenue from charges associated with alternate water entitlement 	Economic <ul style="list-style-type: none"> • Funding required for infrastructure development on individual properties, and to return flows to Billabong Creek • Ongoing cost of maintaining infrastructure to access alternate supply • Property devaluation
Accountability <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston Weir 	
Security of supply <ul style="list-style-type: none"> • Greater security of supply through year-round access to a regulated supply of water through a permanent allocation 	

1.1.6 d

Six month access to alternate water supply

Stock entitlement only

Financial assistance to develop infrastructure

- Provide a regulated flow below *Rhyola* during the months April to September (inclusive)

- Provide landholders with access to an alternate water supply from either Billabong Creek or the Edward River during the months October to March (inclusive)
- Allow unregulated winter/spring freshes that mimic natural flow patterns to pass through the Forest Creek system
- Allow landholders to use the alternate water supply for stock purposes only
- Establish a cumbungi maintenance program to improve transmission efficiency in the creek below *Rhyola*
- Provide landholders with financial assistance to develop appropriate re-watering infrastructure

ADVANTAGES	DISADVANTAGES
<p>Environmental</p> <ul style="list-style-type: none"> • Some enhanced biological diversity through the creation of new habitat (depending on the extent to which flows dry up during summer) • Reduction in cumbungi resulting from maintenance program and reduction in summer flows • Some reduction in feral pig habitat and feral pig population • Some improved health of black box communities in areas that have been permanently inundated 	<p>Environmental</p> <ul style="list-style-type: none"> • Potential negative impact of an ongoing cumbungi maintenance program
<p>Water savings</p> <ul style="list-style-type: none"> • Generation of water savings 	
<p>Economic</p> <ul style="list-style-type: none"> • Additional government revenue from charges associated with alternate water entitlement 	<p>Economic</p> <ul style="list-style-type: none"> • Funding required for infrastructure development on individual properties and to return replenishment flows to Billabong Creek between October and March • Ongoing cost of maintaining infrastructure to access alternate supply • Considerable ongoing expense associated with cumbungi maintenance program • Property devaluation
<p>Accountability</p> <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston Weir 	
<p>Security of supply</p> <ul style="list-style-type: none"> • Greater security of supply through access to a regulated watercourse between October and March through a permanent entitlement 	

1.1.6 e

Twelve month access to alternate supply

Stock entitlement only

No financial assistance

- Return flows below *Rhyola* to unregulated winter/spring freshes that mimic natural flow patterns
- Provide landholders with access to an alternate water supply from either Billabong Creek or the Edward River

ADVANTAGES	DISADVANTAGES
Environmental <ul style="list-style-type: none"> • Enhanced biological diversity through the creation of new habitat • Reduction in the spread of cumbungi through restriction of summer flows • Reduction in feral pig habitat and feral pig population • Improved health of black box communities in areas that have been permanently inundated 	
Water savings <ul style="list-style-type: none"> • Generation of water savings 	
Economic <ul style="list-style-type: none"> • Additional government revenue from charges associated with alternate water entitlement 	Economic <ul style="list-style-type: none"> • Landholders unable to finance their own infrastructure development • Funding required for infrastructure to return flows to Billabong Creek • Ongoing cost of maintaining infrastructure to access alternate supply • Property devaluation
Accountability <ul style="list-style-type: none"> • State Water South more accountable for the delivery and use of flows over Warriston Weir 	
Security of supply <ul style="list-style-type: none"> • Greater security of supply through year-round access to a regulated watercourse through a permanent entitlement 	

1.1.7 Preferred option (1.1.6a)

From an ecological, economic and social perspective, Option 1.1.6a has been selected by all interest groups as the most appropriate way to deal with this management issue. This option is consistent with the vision statement, in that it would:

- *Enable the efficient supply and delivery of good quality stock and domestic water to landholders in the lower reaches of the Forest Anabranche all year round (via an alternate supply);*
- *Allow for the efficient passage of unregulated flows;*
- *Maintain, and where possible enhance, the ecological sustainability of the Forest Creek system.*

Importantly, this option would improve the overall operational efficiency of the Yanco/Billabong Creek system, and generate water savings in the Murrumbidgee Valley that could be shared between the environment and consumptive users.

Water savings have been identified through the development of options to reduce the replenishment flow at Warriston Weir below 36.5Gl. The following revised target flows for Warriston Weir have been proposed:

Target 1. Unregulated/rain rejection flows

- That unregulated/rain rejection flows be permitted to pass through the Forest Creek system for environmental purposes.
- Target 2. ‘Summer’ target flow at Warriston Weir**
- That a target flow of 80Ml/day at Warriston Weir be provided from the beginning of November to end March.
- Target 3. Summer contingency**
- That a contingency of 400Ml be used if necessary to offset the effects of very high evaporative losses during summer. (This flexibility is required in order to accommodate evaporative losses).
- Target 4. ‘Winter’ target flow at Warriston Weir**
- That a minimum target flow of 60Ml/day at Warriston Weir be provided from beginning of April to end October.

➡ More details regarding the *calculation of water savings* are presented in Appendix 5.

Based on these revised target flows, the annual requirement from Warriston Weir to those properties accessing an alternate water supply is 25Gl. This leaves a volume of 11.5Gl (36.5 – 25Gl), that may be shared between the environment and consumptive users.

It has been proposed that the water savings generated by this changed flow regime be distributed between users and the government to meet consumptive requirements and to provide environmental benefits respectively.

<p>1. Provision of environmental flow An environmental allocation for the Wanganella Swamp system (1 in every 3-4 years on average) (See Issue 2).</p>	4Gl
<p>2. Provision of alternate water supply An alternate water supply from Billabong Creek or the Edward River for stock and irrigation purposes below <i>Rhyola</i> (see below)</p>	5.75Gl
<p>3. Other Additional water available for environmental or consumptive purposes elsewhere in the Murrumbidgee Valley. It should be noted that up to 5.75Gl (4Gl + 1.75Gl) would be available when an environmental flow was not required for the Wanganella Swamp system.</p>	1.75Gl

MANAGEMENT CONSIDERATIONS

Distribution of water savings between the environment and consumptive users

It is critical that landholders clearly justify their claim to a share of water savings. It has been proposed that the following information be provided by landholders below *Rhyola*:

- independent costings for the establishment of re-watering infrastructure on each property,
- independent assessment of the value of land on each property, with and without the Forest/Murgha Creek system. This will indicate the potential property devaluation.

Distribution of water savings amongst landholders below Rhyola

Landholders have put forward a proposal for sharing a portion of the water savings according to a buffer through each property that delineates the influence of the Forest Anabranh on the surrounding country.

Provide more detail about the buffer, eg. the area of buffer on each property. Perhaps include a map showing the buffer.

Three area licences (total of 322ha) are located on Woorooma, at the end of the Forest Anabranh: one licence on the Forest Anabranh (100ha), and two licences on Gum Creek (60ha and 162ha). It has been proposed that these licences are also transferred to Billabong Creek or the Edward River, and allocated an entitlement equivalent to half their volumetric entitlement (from the volumetric conversion process), on the basis that they are being upgraded from opportunistic to regulated, general security licences. This entitlement would also come from the water savings allocated for consumptive use.

Table 3.1 provides a summary of property and licence information, for the properties below *Rhyola*.

Table 3.1 Summary of property and licence information for properties below Rhyola.

PROPERTY	SIZE of property adjacent to the Forest Creek system (ha)*	AVERAGE PUMPING	CREEK FRONTAGE (km)	LICENCE TYPE
INVERNESS	2,895	None	10.8	Riparian
BOX GREEN	1,844	None	4.9	Riparian
MURGHA	11,752	None	14.3	Riparian
BACK NULLUM	2,676	None	15.0	Riparian
MOOROOLBARK	1,223	None	7.5	Riparian
NULLUM	2,132	5MI (fills 3 dams)	7.6	Riparian
BLUE GATE	10,768	None	15.6	Riparian
WOOROOMA	10,181	950MI (3 area licences)	28.2	Riparian and three area licences

* See property boundaries shown on Figure 3.1

SUMMARY OF LICENCE INFORMATION

Riparian Right:

Section 7 of the *Water Administration Act* 1986 details the rights of occupiers of riparian land (Appendix 6). Essentially, the occupier of land which forms the bank of a river or a lake has the right, without the need to obtain a license -

(a) to take and use the water then being in the river or lake -

- (i) for domestic purposes;
- (ii) for the purpose of watering stock;
- (iii) for the purpose of irrigating gardens, not exceeding 2 hectares in area in the aggregate, which are cultivated in connection with the use of not more than one dwelling-house and of which the produce is not sold, bartered or exchanged or exposed or offered for sale, barter or exchange; and
- (iv) for the purpose of irrigating land, not exceeding 2 hectares in area, which is used for the growing of crops or pastures to produce fodder for animals kept solely in connection with the use of not more than one dwelling-house.

Area Licences:

57SL047328: Forest Anabranck 100ha, for the purpose of irrigation.

50SL047540: Gum Creek 60ha, for the purpose of irrigation

50SL048530: Gum Creek 162ha, for the purpose of stock, domestic and irrigation

Summary of licence conditions:

The licence holder must be able to measure the quantity of water diverted, if required by the DLWC; must obtain permission from DLWC prior to irrigating for rice; must manage drainage water appropriately; must observe restrictions for the size of excavations for a pump and must not obstruct the passage of floodwaters or streamflow.

Use of an alternate water supply

Landholders believe it is critical that they can use a portion of their alternate water supply for irrigation to generate revenue to fund the develop of re-watering infrastructure, and to off-set other economic and social costs associated with the move to an alternate water supply. For example, property devaluation that they believe would result from the changed flow regime.

Several considerations have been flagged by the wider community in relation to the use of an alternate water supply:

- That social and economic costs will be off-set in part by an increase in the security of an alternate water supply on Billabong Creek or the Edward River, and this will become an increasingly valuable property asset with time;
- The ecological benefits of this proposal may potentially be reduced by the environmental problems that irrigation can cause;
- Under the new Water Act, riparian rights are to be re-defined as stock and domestic. This is a basic water right that will not require a licence and is non-tradeable. What will be the transferability and security of the alternate water supply?;
- Use of the water savings for irrigation indefinitely may be considered inequitable. A 'sunset' option has been suggested, where for example, the water savings could be traded on a temporary basis until the outlay associated with establishing re-watering infrastructure is recouped.
- An embargo is currently in place on the application for irrigation entitlements in the Murrumbidgee and Murray basins. Stock and domestic entitlements are currently exempt from this embargo. This embargo would have to be lifted to include new irrigation entitlements.

MDBC Cap implications

The Murray-Darling Basin Ministerial Council (MDBMC) Cap is an agreement between the State and Territory Governments of the basin and the Commonwealth Government to place a ceiling on diversions for consumptive use within the Murray-Darling basin. The Cap has been set at the level of diversions which would have occurred given the same infrastructure and management rules as those in place during 1993/94.

In order to maintain equity within the regulated Murrumbidgee system, the volume of any alternate water entitlement offered to landholders, combined with the replenishment flow requirement still required over Warriston Weir, must be kept within the 36.5Gl currently supplied.

To ensure a Cap neutral outcome, any entitlements offered to landholders within the regulated system should only facilitate the level of diversions assessed to have been occurring up to 1993/94 within the Forest Creek system. This would represent a shift from the (as yet undetermined) unregulated Murrumbidgee Cap to the regulated Murrumbidgee Cap, but maintain the overall Murrumbidgee Cap.

However, NSW has introduced a suite of management rules in the Murrumbidgee regulated system, including environmental flow rules, that are currently expected to maintain diversions below Cap in the long-term. As a consequence, there may exist some scope for provision of alternate entitlements that result in diversions in excess of those expected to have occurred under Cap conditions. Should any alternate entitlements facilitate diversions in excess of those expected to have occurred under Cap, the potential impacts will need to be assessed to ascertain whether there is a significant erosion of the impacts of the Murrumbidgee environmental flow rules in maintaining diversions below Cap in the long-term.

Consequently, any additional water savings from the 36.5Gl that are not used for alternate entitlements could also be made available for either consumptive or environmental purposes. However, any water savings to be used for consumptive purposes would also require assessment to ensure that the impact of environmental flow rules, in maintaining diversion below Cap, was maintained.

Implications of supplying alternate water from Billabong Creek or Edward River

Provision of an alternate supply from Billabong Creek is only likely to be affected by water shortages and the physical capacity of the Yanco/Billabong Creek system. During times of water shortage the principle of capacity sharing provides each licence with a daily share of water, based on the entitlement for that licence (see the table below for an example). This principle was agreed to by the *Yanco Creek and Tributaries Advisory Council* and the DLWC.

	Original allocation	Daily share
License 1	972	19%
License 2	2,000	39%
License 3	250	5%
License 4	972	19%
License 5	972	19%
TOTAL	5,166	100%

It is thought that irrigators on the Yanco/Billabong Creek system are unlikely to support the inclusion of the alternate water in the capacity share determination. This is consistent with the principle and understanding that transfers into the Yanco/Billabong Creek system will not result in an increased share of the available capacity. That is, any increase in an irrigator’s allocation, either by permanent or temporary transfer or the granting of additional water (alternate supply), should not change their daily share percentage. The same principle should apply to the Edward River, although capacity on this system is not such an issue at present (*pers. comm.* Nicholls, 2000).

Impact of this proposal on landholders above Rhyola

Considerable concern has been expressed regarding the impact of rapid and unexpected fluctuations in water levels below Warriston Weir resulting from supply error or extractions upstream in excess of water orders (see Appendix 5). This exposes mudflats and has implications for the safety of stock. While it is recognised that the Yanco/Billabong Creek system is a very complex system to manage, landholders believe that greater control of flow (particularly below Warriston Weir during summer) needs to be achieved. In the future, State Water will be able to meet water orders with increasing accuracy. It is the responsibility of landholders to ensure that water orders match water use (see Issue 9).

Funding arrangements

Landholders would be expected to fund the development of their own re-watering infrastructure. If the alternate water supply was used for irrigation this would offset the costs of establishing re-watering infrastructure and, in fact, provide the incentive to change existing water management arrangements.

Government funds may be required for a regulatory structure and channel to return replenishment flows to Billabong Creek upstream of those properties accessing an alternate water supply. Operation of this structure must prevent replenishment flows from passing

beyond *Rhyola*, but allow unregulated winter/spring freshes to pass down the Forest Creek system.

PROPOSED ACTION 1.1.6A (A)

That water savings, and the sharing of those savings between the environment and consumptive users, be clarified.

Responsibility: DLWC

Timeframe: ongoing

Priority: high (this is the key to resolving several major issues)

PROPOSED ACTION 1.1.6A (B)

That landholders and DLWC clarify the apportioning of water savings amongst landholders accessing an alternate water supply.

Responsibility: landholders and DLWC

Timeframe: ongoing

Priority: high (linked to 1.1.6a (a))

PROPOSED ACTION 1.1.6A (C)

That the following revised target flows for Warriston Weir be implemented, if Management Option 1.1.6a (a) receives approval:

Target 1. Unregulated/rain rejection flows

- That unregulated/rain rejection flows be permitted to pass through the Forest Creek system for environmental purposes.

Target 2. 'Summer' target flow at Warriston Weir

- That a target flow of 80Ml/day at Warriston Weir be provided from the beginning of November to end March.

Target 3. Summer contingency

- That a contingency of 400Ml be used if necessary to offset the effects of very high evaporative losses during summer. (This flexibility is required in order to accommodate evaporative losses).

Target 4. 'Winter' target flow at Warriston Weir

- That a minimum target flow of 60Ml/day at Warriston Weir be provided from beginning of April to end October.

Responsibility: DLWC (State Water)

Timeframe: dependent on approval of 1.1.6a (a)

Priority: high (linked to 1.1.6a (a))

PROPOSED ACTION 1.1.6A (D)

That investigations be carried out to assess the structural requirements, appropriate location and cost of returning replenishment flows to Billabong Creek upstream of those properties accessing an alternate water supply.

Responsibility: DLWC (State Water)

Timeframe: commence 2000 – end 2000

Priority: high (linked to action 1.1.6a (a))

PROPOSED ACTION 1.1.6A (E)

That funding be secured for infrastructure to return flows to Billabong Creek.

Responsibility: DLWC

Timeframe: commence 2000 – end 2002

Priority: high (linked to action 1.1.6a (d))

PROPOSED ACTION 1.1.6A (F)

That proposed changes to the flow regime be monitored annually to assess the social, economic and environmental impact.

Responsibility: DLWC and interest groups

Timeframe: commence 2000 – end 2005

Priority: high (fundamental to efficient operation of the Forest Creek system)

PROPOSED ACTION 1.1.6A (G)

That landholders above Warriston Weir instigate a rostering system during the irrigation season, with assistance from State Water.

Responsibility: landholders above Warriston Weir, with assistance from State Water

Timeframe: ongoing

Priority: high (fundamental to efficient operation of the Forest Creek system)

PROPOSED ACTION 1.1.6A (H)

That riparian pumpers below Warriston Weir instigate a rostering system during water shortages, to modify the impact on flows that can occur when several people are pumping together.

Responsibility: riparian pumpers below Warriston Weir

Timeframe: ongoing

Priority: medium (important for effective/equitable management of water supply)

MANAGEMENT OPTION 1.2

CUMBUNGI CONTROL

The option of cumbungi control was initially considered as a means of addressing this issue. However, this option would only tackle the symptom, rather than the cause of the problem, which is the regulated flow regime (summer flows).

Details regarding the advantages and disadvantages of alternatives available for controlling cumbungi are discussed at Issue 4.

PROPOSED ACTION

None – not the preferred management option.

MANAGEMENT OPTION 1.3

WILLOW REMOVAL

Willow trees have been planted at various places along the Forest Creek system, particularly at sites where bridges cross the creek. These trees have suckered and spread, and in some places are now restricting the flow of water. Areas where willow trees are not currently a problem, may lead to flow restrictions in the future.

Willows also provide a totally different, and much poorer living environment for native plants and animals, than the local natural system. The strong fibrous roots of willows and their ability to grow in continually wet soil enables them to exert a strong influence on

stream behaviour. Fibrous willow roots and dense willow foliage trap large amounts of silt and build up the streambed, which can decrease channel capacity, exacerbate flooding and change flood patterns. Willows can also reproduce prolifically from seed, creating seedlings from cross-pollination between different willow types. Willows can germinate in massive numbers and form islands in watercourses.

In managing willows along watercourses it is important to consider the creek system further downstream. Willows, like many land management issues, have consequences beyond the local environment.

Advice is available from DLWC on best management practice for willows. It is recommended that sites are revegetated with native species, and that grazing is managed to allow native seedlings to successfully establish. For example, on the Forest Creek system, the cooba (or native willow) *Acacia salicina* is a native species that could be used to replace the introduced willow, and would also provide the shade that willows are currently providing at some house sites.

As with many watercourses throughout NSW, the Forest Creek system is State Protected Land, and approval is therefore required from DLWC before willow trees can be removed.

PROPOSED ACTION 1.3

That landholders, with assistance from DLWC and Greening Australia, include the removal of willow trees in their farm management plans, and prioritise sites on the basis of impact on the passage of flow.

Responsibility: landholders

Timeframe: commence 2000 – end 2002

Priority: medium (ongoing growth will continue to impede flows)

ISSUE 2.

MANAGEMENT OF THE WANGANELLA SWAMP SYSTEM

Management of water within and through the Wanganella Swamp system is regarded as an issue from both an environmental and a supply perspective.

From an environmental perspective, the wetland system supports a relatively rich diversity of plant species (Roberts and Pasma, 1990) and is considered to be of regional significance for waterbirds (*pers. comm.* Maher, 1999) (see Section 2.11). According to historical reports and anecdotal evidence, the Wanganella Swamp system has supported large numbers of waterbirds in the past. See Appendix 2 for a list of bird species recorded from the Wanganella Swamp system. During the floods of the mid 1950s, the Ibis rookery at Wanganella was described as follows:

'The rookery was situated at a point where the Forest Creek widened into a small lake, some three feet deep, and extensively overgrown with thick reeds or cumbungi except for a small area in the centre. It was in this bare centre that the colony had apparently originated and many young birds of both species (Straw-necked Ibis and Australian White Ibis) were occupying large nests on lignum'... 'An area of about six acres of the reed bed had been completely flattened to form thousands of "rafts"' (Hobbs, 1956: 351).

The wetland system also provides other important ecological and social benefits including improved water quality, flood mitigation, opportunities for scientific research, recreation, education, and aesthetic values.

From a supply perspective, the Wanganella Swamp and McCrabb's regulator are regarded as restrictions to flow (Figure 3.2). Water slows down as it passes through cumbungi and disperses through inundated low-lying areas, before finally passing through the regulator (600mm pipe) (or flowing over the adjacent spillway if the water level is high enough) and into the Forest Anabranch.

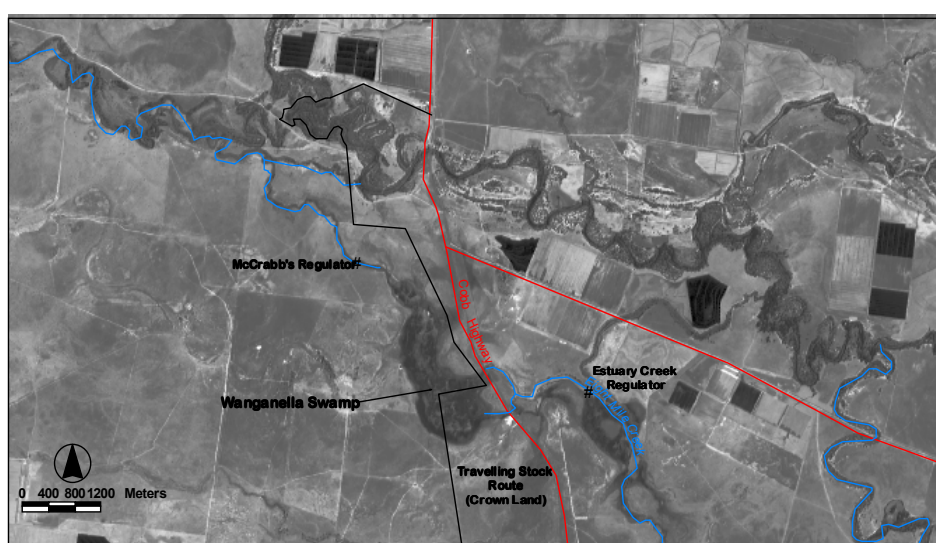


Figure 3.2 Location of McCrabb's Regulator, Estuary Creek Regulator and the travelling stock route adjacent to Wanganella Swamp.

In addition, during times of high flow return flows to Billabong Creek reduce the potential flow-through to downstream users. Water breaks away from the Wanganella Swamp to the north in three locations, and these three breakaways converge to flow under the Zara Road and into Billabong Creek. These flows are not controlled by structures, and vary significantly with the size of the flow entering Wanganella Swamp under the Cobb Highway. Water used to escape from the wetland only during flood flows, however since construction of McCrabb's regulator (1987) and the creation of a weir pool, breakaway flows have generally occurred every year between May and December (*pers. comm.* McCrabb, 1999).

As well as its ecological significance, the Wanganella Swamp system provides good grazing and watering for local and travelling stock, particularly during spring and summer.

Current situation

In addition to the major impacts which have increasingly altered the flow regime in rivers and streams since European settlement (see Section 2.3), there have been several more recent, local changes that are affecting flows to the Wanganella Swamp system. These include:

1. The **commencement of rice growing** in the Yanco/Billabong Creek system during the 1988/89 season, and the additional demand this has placed on water supply; and
2. The construction (1993) and **operation of the Forest Creek offtake regulator** which has excluded small to moderate freshes from the system during the winter/spring months (Figure 3.3). While large floods will find their way into the system via the original offtake and around the regulator, small to moderate freshes will probably be prevented from passing down the Forest Creek system if the regulator is not opened (*pers. comm.* Holden, 1999).

These changes have affected several wetlands along the creek system, where natural ecological cycles are cued to seasonal variations in flow. Attention has focused on the impact of these changes on waterbirds because more is known about these species, however the intention is to manage the wetland system for a range of native flora and fauna, and to sustain important wetland processes.

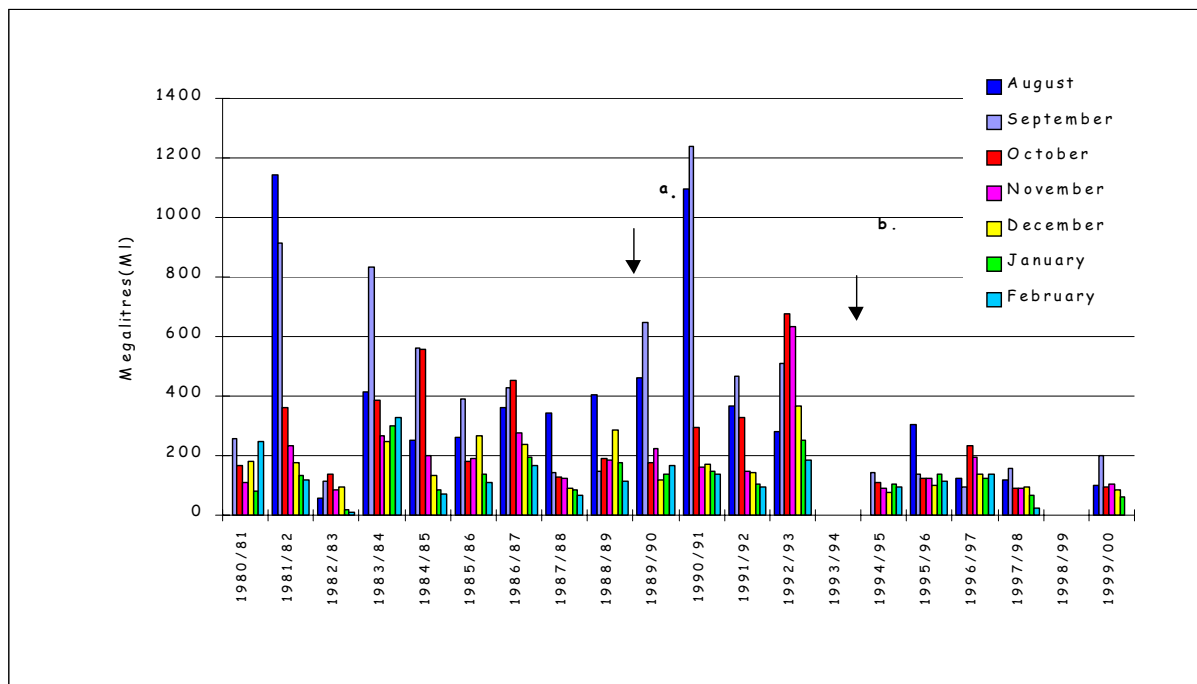


Figure 3.3 Average daily flows at Warriston Weir between August and February, 1980-2000. Gaps indicate where no data is available. (a. commencement of rice growing, b. installation of Forest Creek offtake regulator)

A local ornithologist has observed a decline in waterbird numbers since 1983/84 and believes this is due to the sudden fall in water levels after a peak flow, and more recently the effect of the Forest Creek offtake regulator on restricting the passage of winter/spring freshes (*pers. comm.* Maher, 1998). Ideal breeding conditions for a wide range of waterbirds occur when water levels remain fairly stable around their nesting areas from the time a good flood passes through the wetland system, until the end of January. This provides waterbirds with a food source and protection from predators while they complete their breeding cycle. Water levels sometimes remain high naturally, particularly if the flood peak originates in the Murrumbidgee catchment (these peaks tend to be of longer duration than those arising in the Billabong Creek catchment). However, with increasing regulation and extractions, there is an increasing tendency for water levels to recede from nesting and feeding areas before waterbirds have had a chance to complete their breeding cycle. Some examples from relatively recent records of birds using the Wanganella Swamp show that:

- Little Bitterns only bred in years when water levels remained high, such as 1981/82 and 1983/84;
- Australasian Bitterns and Blue-billed Ducks were recorded in good numbers in October 1986, but a sudden drop in water levels caused these species to leave the area before they had time to breed;
- Royal Spoonbills and Straw-necked Ibis bred in years when the water levels remained high (Maher, 1988).

Some people may have noticed that Australian White Ibis continue to breed in the Wanganella Swamp, despite the changes that have been mentioned above. However, this species is not generally considered to be a good indicator of the health of a wetland, as its reproductive and habitat requirements appear to be either less stringent, or less affected by hydrological changes, than other colonial waterbirds (Leslie, 1999).

During the 1980s, when the Department of Water Resources began to manage the creek system, there was a focus on protecting waterbird requirements. The Department, in liaison with the National Parks and Wildlife Service and local ornithologists, deliberately diverted water into Wanganella Swamp to extend natural high flows to successfully support waterbird rookeries. Some works were constructed in 1987 to assist in achieving this objective (DWR, 1988). During the 1990s, management focused more on the protection of wetland processes and functions.

Probable factors contributing to this issue

From an environmental perspective:

- Regulated flows have led to permanent inundation of some areas of Wanganella Swamp;
- Increasing extraction and regulation has reduced the frequency and duration of flooding. This has increased the likelihood of water levels falling rapidly after a natural flood event.

From a supply perspective:

- The combination of regulated flows and the depressional nature of the Wanganella Swamp has encouraged the extensive growth of cumbungi, siltation and the spread of water beyond the flowpath;
- McCrabb's regulator has encouraged the spread of water to the north-east of Wanganella Swamp. Some of this water flows into three existing flood runners, which converge before carrying water north under Zara Road and into Billabong Creek.

Management objectives

- To maintain and where possible enhance the ecological sustainability of the Forest Creek system;
- To allow for the efficient passage of unregulated flows;
- To enable the efficient supply and delivery of good quality stock and domestic water.

MANAGEMENT CONSIDERATIONS

Although the Wanganella Swamp system has been considerably modified, much of its current conservation value is the result of these changes. Returning the system to a fully natural state would be virtually impossible, and would also result in the loss of these values. River regulation and landuse changes within both the Murray and Murrumbidgee catchments have contributed to the degradation of many natural wetlands. Consequently active management of some remaining areas such as the Wanganella Swamp system may be the only way to conserve significant numbers of native plants and animals (particularly those identified as threatened or endangered); and the only way to conserve important wetland functions such as water quality improvement, biological productivity and nutrient recycling. It is felt that by meeting the water requirements of Wanganella Swamp to the west of the Cobb Highway, the conservation values of Eight Mile Creek and Clarkes Creek will also be protected.

Waterbirds generally commence breeding in response to sustained winter/spring freshes and the onset of warmer weather, which promotes biological activity such as the growth and flowering of aquatic plants (Pressey in Green, 1994). Figure 3.3 indicates that peak flows are most likely to occur in the Forest Creek during August/September.

In addition to floods of extended duration, it is also considered important that every couple of years parts of the Wanganella Swamp system have an opportunity to dry out. Allowing some

parts of the swamp system to dry will ensure that important ecological processes that sustain the health and productivity of the wetland are maintained.

A drying phase allows for the decomposition of plants and the release of nutrients upon re-flooding, which provide a critical food source for wetland plants and animals. Many water plants set seed during this dry period, while other plants require a period of drying for survival. The re-flooding of a dry wetland triggers prolific growth and breeding of insects as well as the germination of native wetland plants. These insects and plants provide an abundant food source for native fish, large numbers of different kinds of waterbirds, and other animals. A period of drying can also allow sediments to consolidate, which can help to reduce turbidity upon re-flooding. Clear water provides better conditions for seedling re-establishment, and is important for waterbirds that rely on clear water to find food.

Research undertaken by Roberts and Pasma in 1990 led to the development of some general guidelines for the management of Wanganella Swamp. They recommended maintaining the three ecological zones (described in Section 2.11) in approximately the same proportions and dimensions as of winter 1990. They emphasised the importance of retaining the characteristics of a 'natural' water regime as far as possible, within the framework of present water resource demands and future developments. More specifically, they recommended that:

Zone I

The open water zone should be kept permanently wet and deep enough (>2m) in the main channels to prevent expansion of cumbungi.

Zone III

The wet-dry zone should be flooded over winter for close to 6 months - on average every 2-3 years. *(This has been re-assessed as being required every 3-4 years.)*

Zone II

Any action that could result in expansion of cumbungi from Zone II (the shallow water zone) into Zone I (open water) or Zone III (the wet-dry zone) should be avoided.

It is worth noting that since 1980, construction of several structures has given DLWC greater control of supply to the Forest Creek and the wetland system, and an increased ability to manipulate water levels within Wanganella Swamp. These structures include McCrabb's regulator (1987), Estuary Creek regulator (1987) and the Forest Creek offtake regulator (1993). Until the offtake regulator was installed, alteration of flows into Forest Creek had been largely dependent on the manipulation of boards in Hartwood Weir on Billabong Creek. This is a very difficult structure to operate, and there was a time delay of approximately two weeks before the impact of the operation of the weir was experienced in Wanganella Swamp. Consequently, it was not always possible to be very accurate with the delivery of water. These works have improved DLWC's ability to manage flows (for wetting or drying) to the wetland system in response to management requirements. Installation of telemetric equipment at the Forest Creek offtake and Warriston Weir in 1998 has further increased operational efficiency.

Several options have been identified for improving the management of this wetland system. The combination of these options will protect, and hopefully enhance, the environmental values of this wetland system, while enabling the provision of a sufficient stock and domestic supply to downstream users.

MANAGEMENT OPTION 2.1

REVISED OPERATION OF THE FOREST CREEK OFFTAKE REGULATOR

The Forest Creek offtake was altered in the 1930s by the construction of a channel between Billabong Creek and the original offtake (Figure 2.4). In 1993 the Forest Creek offtake regulator was constructed at the commencement of this channel, on the basis that a management plan would be prepared for the Forest Creek system, and that operational requirements would be outlined in that plan.

Since the installation of the Forest Creek offtake regulator in October 1993, winter/spring freshes have been excluded from the Forest Creek system. Figure 3.3 reveals the lack of a seasonal flow pattern since 1993. This is partly the result of a sequence of relatively dry years, but is also due to operation of the regulator. It is critical that freshes are allowed to enter the creek system, as native plants and animals in-stream and within adjacent wetlands, are cued to respond to seasonal events such as high flows.

Distribution of peak flows between Billabong Creek and Forest Creek

Management of the distribution of peak flows between Billabong Creek and Forest Creek is important. Hartwood Weir is currently a difficult and dangerous structure to operate (see Issue 11) and as a consequence, it is not always possible to alter Hartwood Weir in response to peak flows coming down Billabong Creek. Therefore, the Forest Creek offtake regulator needs to be actively manipulated during peak flows, to reflect an equitable distribution of flows between the two creeks. It will not always be appropriate to fully open the Forest Creek offtake regulator, as the bulk of a peak flow may be drawn down Forest Creek at the expense of Billabong Creek. When the Hartwood Weir is re-furbished it should be possible to open both structures fully in response to a peak flow.

An assessment of the relationship between peak flows in Billabong Creek at Jerilderie, and in the Forest Creek at Warriston Weir indicates that on average, approximately 25% of a peak flow at Jerilderie reaches Warriston Weir (Figure 3.4). Obviously it will not be possible to control the distribution of very large flows, however the recommendation to distribute flows according to the above proportion should be useful when managing small to moderate freshes.

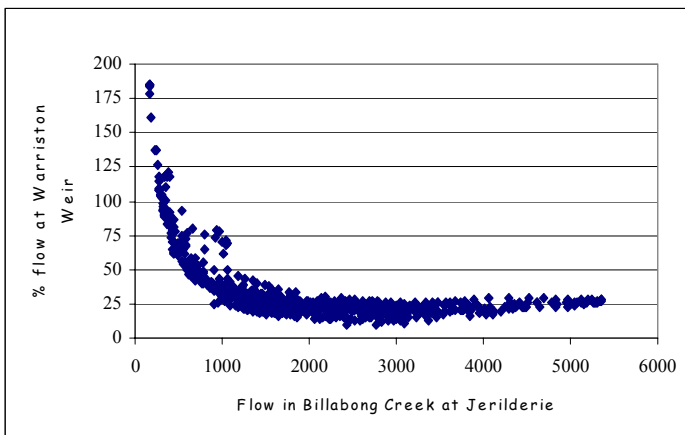


Figure 3.4 Relationship between flow in Billabong Creek at Jerilderie and flow in Forest Creek at Warriston Weir. (Instances where the proportion of flow at Warriston Weir is high, relative to the Jerilderie flow, is probably the result of inflows from Finley Escape.)

Accurate operation of the Forest Creek offtake regulator

Accurate operation of the Forest Creek offtake regulator is fundamental to the management of the Wanganella Swamp system, particularly when waterbirds are breeding. Accurate calculation of discharge at the offtake has been difficult in the past, as there was no means of recording flow information prior to the construction of the Forest Creek offtake regulator. In addition, it has not been possible to establish a rating table for this site because the gauge immediately downstream of the regulator appears to be influenced by water backing up, perhaps from the original offtake. It has been suggested that the downstream gauge is influenced by backwater from the first dam downstream (Parry Dam), however this is not possible given the height of the crest of Parry Dam, the distance from the downstream gauge to the dam, and the gradient of the creek.

Currently, State Water use a theoretical equation to calculate discharge at the Forest Creek offtake. This equation has a discharge coefficient for a regulatory structure with a submerged orifice. Some 'trial and error' adjustment of this coefficient has recently been made on the basis of flow downstream at Warriston Weir, where there is an accurate rating table. However, to further improve the accuracy of this equation it has been suggested that flow measurements be taken immediately downstream of the Forest Creek offtake, and that these measurements be related to parameters such as the upstream and downstream water levels and the size of the gate opening in the Forest Creek offtake regulator. Several flow measurements would be required at different flows, as the coefficient would vary with discharge.

It is anticipated that future assessment and management of flows at the Forest Creek offtake will be greatly facilitated by the SCADA equipment and remote control of this structure, and will be further improved with adjustment of the discharge coefficient.

PROPOSED ACTION 2.1 (A)

That the Forest Creek offtake regulator be operated according to the following rules, outside the irrigation season:

Rule 1.

- The Forest Creek offtake regulator be operated to allow an equitable proportion of the flow in Billabong Creek at Jerilderie ($\approx 25\%$) to enter the Forest Creek system

Rule 2.

- The Forest Creek offtake regulator be fully opened during large floods, which are beyond the control of regulatory structures.

Responsibility: DLWC (State Water)

Timeframe: immediate

Priority: high (critical for maintenance of ecological processes)

PROPOSED ACTION 2.1 (B)

That State Water program their control software (CITECT) to automatically remind operations staff of the change in operation of the Forest Creek offtake regulator at the end of the irrigation season (see operation rules at 2.1 (a)).

Responsibility: DLWC (State Water)

Timeframe: commence 2000 - end 2002

Priority: high (critical for management of flows in the Forest Creek system)

PROPOSED ACTION 2.1 (C)

That several flow measurements be taken at the Forest Creek offtake to improve the accuracy of the discharge coefficient used in the equation to determine discharge at the Forest Creek offtake.

Responsibility: DLWC (State Water)

Timeframe: commence 2000 - end 2002

Priority: medium (important for accurate operation of the Forest Creek system)

MANAGEMENT OPTION 2.2

ACCESS TO AN ENVIRONMENTAL ALLOCATION

The Southern Riverina Field Naturalists Club have stated that ‘this wetland system is one of the best wetlands left in the Southern Riverina, and could easily be managed with a relatively small amount of water’ (SRFNC, 1996).

Objective of accessing an environmental allocation

An environmental allocation would provide water to the Wanganella Swamp system after a natural flood has occurred and the trigger on Billabong Creek has been met. The main objectives of accessing an environmental allocation are to:

- offset changes that have occurred with regulation, particularly the reduction in moderate sized floods; and
- to offset the tendency for water levels to fall dramatically, by enabling water levels to recede gradually over the summer months (as would have occurred naturally with floods of this size).

This will sustain wetland processes that depend on moderate sized floods, and create an environment that will favour the regeneration/reproduction of a range of native plants and animals, including waterbirds.

Large floods will provide the best breeding conditions for the greatest diversity of waterbirds, as water levels in the wetland system are likely to remain stable right through until the end of January (as opposed to a slow tapering off that is more likely to occur following a moderate flood). These floods still occur as frequently as they did prior to regulation, because they are generally beyond the control of regulatory structures.

Consideration was given to the option of using an environmental allocation to **initiate** a flood in the wetland system. However, when the Forest Creek offtake regulator is operated to allow unregulated and rain-rejection flows through the Forest Creek system this should not be necessary (see Management Option 2.1). It must also be recognised that some high level ‘peaky’ flows that pass through the system in one or two weeks are not sufficient to sustain a number of wetland functions, including waterbird breeding and plant regeneration. It is not considered appropriate to use an environmental allocation to artificially extend these type of flows.

Characteristics of the environmental allocation

It has been estimated that an environmental allocation of up to 4,000MI at Warriston Weir is required between October and January (inclusive), 1 in every 3-4 years on average. This would provide a flow in addition to the stock and domestic replenishment flow, of 100MI/day (Oct), 80MI/day (Nov), 60MI/day (Dec), and 20MI/day (Jan). The modelled average requirement for an environmental allocation is 33 days.

In years when the environmental allocation is not required, the water would be available for use elsewhere in the Murrumbidgee Valley.

- More details regarding the calculation of the environmental allocation are provided in Appendix 7.

It is anticipated that the environmental allocation would not be an additional water requirement, but would come from the water savings achieved through changes to flow management in Forest Creek (see Management Option 1.1.6).

This is a flow-through system, and it is estimated that up to half of the environmental allocation could potentially be returned to Billabong Creek and re-credited for downstream use. This estimate is based on the size of the wetland and evaporative losses. Studies conducted for a report published in 1973 also showed that about 50% of the inflow to Wanganella Swamps passed through the wetland (WCIC, 1973: 20). Flow information collected during this study appears to support these estimates (Appendix 1), however ongoing assessment of flows is required to confirm the accuracy of these estimates.

Whether an environmental flow is returned to Billabong Creek downstream of Wanganella Swamp should depend on the environmental needs in the Forest Creek system further downstream, in that year.

Options for the provision of an environmental allocation

Two options were identified for the provision of an environmental allocation:

1. 4, 000MI with no carry-over provision if the water is not used (preferred option)
2. 1, 000MI with the provision to carry-over up to 4, 000 MI

Provision of an annual allocation of 4, 000MI is the preferred option, because it ensures that an adequate environmental flow is available for the wetland system when required. This flow *is not required each year, but 1 in every 3-4 years on average*. Therefore, there may be two consecutive years when the water is needed, and then a period of four or five years when the water is not required. An annual allocation of 1, 000MI with the provision to carry-over does not, for example, cover the needs of the wetland system should an environmental allocation be required two years in a row, as only 1, 000MI would be available in the second year. In addition, carry-over provisions for environmental water in the Murrumbidgee are such that a pro-rata quantity is lost from all water carried over, when the storages spill.

There is a strong preference for the environmental water to be set aside as a **specific allocation** for the Wanganella Swamp system, rather than for the water to come from the Murrumbidgee Environmental Contingency Allowance (ECA). A specific allocation is a more secure arrangement, and means that the wetland system does not have to compete with other wetlands in decisions regarding distribution of the Murrumbidgee ECA. It means that water is available (when the trigger on Billabong Creek has been met), regardless of triggers having been met in the Murrumbidgee Valley.

Should water savings ultimately be inadequate to meet environmental requirements, the Murrumbidgee River Management Committee is willing to consider meeting the requirements from their ECA (Appendix 8).

Ownership and management of the environmental allocation

Ownership and management of water savings from the Moira Lake rehabilitation in the Millewa Forest, NSW can serve as a model for the management of other water savings. These water savings are owned by the NSW Government through the Water Administration Ministerial Corporation and are managed by DLWC, with advice from the Murray Wetland

Working Group. It may be appropriate that similar arrangement be made for the management of water savings generated by changed management of the Forest Creek system.

Advice from the following sources should be sought regarding management of the environmental allocation:

- Local knowledge: Phil Maher, Rick Webster
- Project Officer, NSW Murray Wetlands Working Group
- NSW National Parks and Wildlife Service, Griffith Office.

Delivery of an environmental allocation

It has been proposed that the delivery of an environmental allocation could be shared between the Murrumbidgee and Murray catchments (via Colombo Creek and the Murray Irrigation channel system – Finley Escape/Wollamai Escape Channel). Sharing the delivery of an environmental allocation could provide a more rapid response to environmental requirements, and may help to relieve delivery constraints.

Since 1994/95 delivery of water via the Finley Escape has been used to supplement flows in Billabong Creek and Forest Creek during the irrigation season. Finley Escape is a far more efficient carrier of water than Colombo Creek (average summer losses of 35% in Colombo Creek compared with 10% in Finley Escape) (*pers. comm.* Nicholls, 1999), and the travel time from Finley Escape outfall to Wanganella Swamp is approximately three weeks, compared with six weeks from the Yanco Creek offtake on the Murrumbidgee River.

The demand for an environmental allocation will overlap with the demand for irrigation water and the difficulties this presents will vary according to seasonal conditions. As a guide, key times of maximum irrigation demand in both the Yanco/Billabong Creek system and the channel system are generally the first three weeks of October (spring watering and filling rice bays), and from the end of December to mid-late January (pannicle initiation) (*pers. comm.* MacLeod, 1999; Nicholls, 1999).

- More details regarding this proposal, including potential operational issues are presented in Appendix 9.

Monitoring changes to the flow regime

It is essential that the environmental allocation is monitored to assess the impact it has on the wetland system; to determine whether it is achieving the desired objectives; and to enable necessary changes to be made to ensure successful long-term management. This environmental allocation was estimated according to the best available information, however future monitoring will improve our understanding of the system and provide us with the information needed to fine-tune the environmental requirements if necessary.

The following references regarding monitoring programs are on file (DLWC file: 7004471). The report by Reid identifies the key physico-chemical and biological indicators of wetland health that should be included in all monitoring programs, and the manual edited by Chessman details methods for monitoring a range of parameters likely to be influenced by environmental flows including vegetation, macroinvertebrates and changes in the extent of wetland inundation.

Reid, M., Brooks, J. (1998) *Measuring the effectiveness of environmental water allocations: recommendations for the implementation of monitoring programs for adaptive hydrological management of floodplain wetlands in the Murray-Darling Basin*. Department of Biological Sciences, Monash University, Melbourne.

In addition to monitoring the environmental allocation, it is important to monitor flows during winter and spring to ensure that the offtake regulator allows freshes to pass down the system.

PROPOSED ACTION 2.2 (A)

That an environmental allocation for the Wanganella Swamp system be set aside in the form of a specific allocation.

Responsibility: DLWC, Murrumbidgee River Management Committee

Timeframe: commence 2000 – end 2001

Priority: high (linked to action 1.1.6a (a))

PROPOSED ACTION 2.2 (B)

That an environmental allocation be provided to the Wanganella Swamp system according to the following rules:

Rule 1. Trigger level

- The trigger has been met if flows ≥ 400 MI/day at Warriston Weir (or $\geq 1, 400$ MI/day at Jerilderie) occur over a period of 40 consecutive days between mid-August and mid-October.

Rule 2. Trigger deadline

- If the trigger is not met by mid-October, the allocation to be made available for other purposes. Murrumbidgee region to determine distribution.

Rule 3. Flow requirement

- The following estimated target flows be provided at Warriston Weir if an environmental flow is required. (The environmental flow is **in addition to** the stock and domestic supply).

October: 100MI/day environmental flow + stock and domestic supply

November: 80MI/day environmental flow + stock and domestic supply

December: 60MI/day environmental flow + stock and domestic supply

January: 20MI/day environmental flow + stock and domestic supply

Rule 4. End of breeding season

- Flows be gradually tapered off after birds have fledged (around late January).

Rule 5. Pumping

- Water users are not permitted to pump water from an environmental allocation.

Responsibility: DLWC

Timeframe: commence 2000 - ongoing

Priority: high (linked to action 1.1.6a (a))

PROPOSED ACTION 2.2 (C)

Monitoring program

- That flows be monitored **during winter and spring** to ensure that the offtake regulator allows freshes to pass down the system.
- That the Wanganella Swamp system be monitored **after the trigger has been met**, to assess whether waterbirds have commenced breeding activities or other environmental needs exist, and a recommendation made regarding the requirement for an environmental allocation.
- That waterbird activity be monitored **during the breeding season**, and State Water advised when waterbirds have fledged.

- That an ecological monitoring program be established and maintained by DLWC to **assess the impact of an environmental allocation** on the Wanganella Swamp system, consistent with current water reform requirements. This monitoring program should include a reporting mechanism.

Responsibility: DLWC

Timeframe: ongoing

Priority: high (linked to action 2.2a)

PROPOSED ACTION 2.2 (D)

That DLWC seek advice from the following sources, regarding the management of an environmental allocation, should the trigger be achieved:

- Local expertise and interest: eg. Phil Maher, Rick Webster
- Project Officer, NSW Murray Wetlands Working Group
- NSW National Parks and Wildlife Service, Griffith Office.

Responsibility: DLWC

Timeframe: commence 2000 - ongoing

Priority: high (valuable exchange of information and expertise)

PROPOSED ACTION 2.2 (E)

That DLWC commit to an annual review process where relevant agency representatives meet to review environmental requirements for the Forest Creek system, and the most appropriate means of delivering flows to meet these requirements. For example, whether an environmental allocation for the Wanganella Swamp system could be shared between the Murrumbidgee and Murray catchments, via Colombo Creek and the Finley Escape.

Responsibility: DLWC

Timeframe: commence 2000 - ongoing

Priority: high (linked to action 2.2 (a))

PROPOSED ACTION 2.2 (F)

That State Water program their control software (CITECT) to automatically identify when the trigger on Billabong Creek has been met, so that management staff in Deniliquin can be notified.

Responsibility: DLWC (State Water)

Timeframe: commence 2000 – end 2000

Priority: medium (efficient means of determining environmental flow requirement)

PROPOSED ACTION 2.2 (G)

That logging probes installed on either side of Wanganella Swamp (Woolshed Bridge on Wanganella, and McCrabb's Bridge on Avenel) be retained, and flows continue to be monitored to determine the proportion of an environmental flow that could be returned to Billabong Creek, and re-credited for use further downstream.

Responsibility: DLWC

Timeframe: ongoing

Priority: high (linked to action 1.1.6a (a))

MANAGEMENT OPTION 2.3

DRYING PHASE

A period of drying during summer and autumn can help to sustain the health and productivity of wetlands such as the Wanganella Swamp system.

A constant stock and domestic replenishment flow passes through Eight Mile Creek and Wanganella Swamp, keeping some areas permanently inundated during summer. Water is also held back behind McCrabb's regulator and spillway. Proposals put forward in this management plan, include a reduction in summer replenishment flows (Management Option 1.1.6a) and removal of McCrabb's regulator and spillway (Management Option 2.4). These options will enable more of the Wanganella Swamp to dry over summer.

PROPOSED ACTION

None – addressed by other actions.

MANAGEMENT OPTION 2.4

REMOVAL/REPLACEMENT OF McCRABB'S REGULATOR AND ADJACENT SPILLWAY

McCrabb's regulator and adjacent spillway were installed on the western edge of Wanganella Swamp in 1987 (see Figure 3.2). The purpose of these structures was to maintain a relatively stable water level in Wanganella Swamp after a natural flood event had initiated waterbird breeding. A number of concerns have been raised regarding the design, location, operation, and overall impact of these structures.

Design

The regulator comprises dropboards and a steel gate that can be manipulated to control the flow of water through a 600mm pipe. Experience suggests that the size of this pipe can be insufficient to meet downstream requirements, particularly during summer (*pers. comm.* Holden, 2000).

Location

The location of the regulator creates a weir pool that extends approximately 1, 200m upstream. This is a smaller pool than had originally been intended. For example, most Ibis breed beyond the extent of the weir pool, just downstream of the Cobb Highway. Due to the gradient of land through Wanganella Swamp it is not possible to extend the influence of the weir pool any further.

Operation

McCrabb's regulator has not been operated since 1990 due to staffing changes within DLWC (*pers. comm.* Holden, 2000), and the structure has remained open since this time. This is thought to have contributed to a considerable build-up of silt within the weir pool, as water has remained backed up at a constant shallow level without the ability for higher velocity freshes to carry silt through the wetland. There has also been less opportunity for seasonal fluctuations in water level, which are important for maintaining natural ecological processes within the wetland.

The combination of these factors has led to the conclusion that the existing regulator and spillway do not serve a useful purpose within Wanganella Swamp.

It has been proposed that the regulator and spillway be removed and that an assessment be made to determine the impact of these works, and whether a new structure is required. It has also been identified that some initial desilting upstream of the regulator may be required to facilitate the passage of flows. This may not be necessary as the silt is very soft, and the flow of water may carve a path through the silt very easily. Any work would need to be undertaken with regard to the local topography, as a natural levee here is responsible for pooling water where waterbirds breed (*pers. comm.* Maher, 2000). The natural topography

of the site should not be disturbed, and work would also need to be consistent with environmental legislation.

If a new regulatory structure is required, it has been suggested that Murray Irrigation Limited (MIL) be approached for assistance, as they have previously expressed interest in developing a joint venture for the management of Wanganella Swamp (Molino Stewart, 1999).

PROPOSED ACTION 2.4 (A)

That McCrabb's regulator and adjacent spillway be removed. Silt and rubble to be stockpiled adjacent to the site for later use if required.

Responsibility: DLWC

Timeframe: immediate

Priority: high (rehabilitation of Wanganella Swamp)

PROPOSED ACTION 2.4 (B)

That several weeks after the removal of McCrabb's regulator and spillway, an assessment be made to determine whether some desilting and removal of cumbungi in the Eight Mile Creek channel upstream of the regulator is required to facilitate the passage of flows.

Responsibility: DLWC

Timeframe: immediate

Priority: high (linked to action 2.4 (a))

PROPOSED ACTION 2.4 (C)

That an assessment of the impact of the removal of McCrabb's regulator and spillway on the wetland environment be conducted over the next five years, and if necessary a recommendation made regarding future structural requirements.

Responsibility: DLWC

Timeframe: commence 2000 – end 2005

Priority: high (linked to action 2.4 (a))

MANAGEMENT OPTION 2.5

GRAZING MANAGEMENT

As efforts are being directed towards protecting the environmental values of this wetland system through more appropriate flow management, it is important that grazing management is also addressed.

Stock moving along the travelling stock route affect only a part of the whole wetland system. A study conducted in 1990 suggested that travelling stock did not appear to be adversely affecting aquatic herb diversity at the time of the study, although the abundance and vigour of some species was being reduced. This was apparent when comparing the flood-out areas on the travelling stock route with similar areas on private properties fringing the swamps along Eight Mile Creek, where extensive stands of palatable sedges and fragile herbs could still be found (Roberts & Pasma, 1990).

This study stated that an increase in grazing pressure, especially over summer as stock move in for water and green pick, could result in localised elimination of palatable and soft-stemmed wetland species and an expansion of flood-loving weedy species. This would destroy the value of the Wanganella Swamp system.

Currently stock on private land tend to be moved away from Wanganella Swamp (and Eight Mile Creek? check with Michael Elmes) during winter. The swamp paddocks are grazed during spring and then de-stocked as the wetland areas dry back in late summer, to prevent stock bogging in exposed mudflats (*pers. comm.* McCrabb, 2000). The TSR adjacent to the Wanganella Swamp is the most heavily grazed area on this stock route because it provides the best feed. On average, a mob of 600-800 stock is moved along the stock route 8-10 times a year. They are likely to spend around 7-10 days at the Wanganella Swamp, depending on seasonal conditions (*pers. comm.* Mullins, 2000).

It is important that stock on private and Crown land are managed to minimise the impact of grazing on the Wanganella Swamp system.

PROPOSED ACTION 2.5 (A)

That landmanagers, with assistance from DLWC, implement best practice management techniques for the management of stock adjacent to wetland areas.

Responsibility: landmanagers (private and RLPB), with assistance from DLWC

Timeframe: ongoing

Priority: high (fundamental to management of the wetland ecosystem)

PROPOSED ACTION 2.5 (B)

That the western portion of the Wanganella Swamp system (ie. west of the Cobb Highway) be fenced off from TSR100 to allow for better management of travelling stock.

Responsibility: RLPB with assistance from other organisations

Timeframe: ongoing

Priority: high (fundamental to management of the wetland ecosystem)

PROPOSED ACTION 2.5 (C)

That funding requirements and funding sources be investigated for a project to fence off Wanganella Swamp from TSR100.

Responsibility: RLPB, DLWC, SRFNC, Greening Australia, local council, local community

Timeframe: 2001 - 2003

Priority: high (linked to proposed action 2.5 (b))

MANAGEMENT OPTION 2.6

REVEGETATION OF SANDHILLS ON THE TRAVELLING STOCK RESERVE (TSR100)

Sandhills adjacent to the Wanganella Swamp would once have supported vegetation similar to remnant vegetation on sandhills to the east of the Cobb Highway on *Wanganella*, and to the north west of the Wanganella township on *Zara*. The sandhills either side of the northern arm of the Eight Mile Creek are heavily grazed by travelling stock and vegetation here is now dominated by introduced species, eg. capeweed *Arctotheca calendula*, paterson's curse *Echium plantagineum* and ryegrass *Lolium perenne*. Only one emu bush and a few spiny saltbush remain on the southern-most sandhill.

Vegetation and habitat assessments have recently been conducted to determine the condition and composition of native vegetation on TSRs in the Riverina RLPB area (Webster, 2000). Webster (2000) recommended that the sandhills adjacent to Wanganella Swamp be revegetated with local indigenous species, and this is consistent with Proposed Action 2.6 below.

PROPOSED ACTION 2.6

That funding requirements and funding sources be investigated for a project to revegetate the sandhills on TSR100 (either side of Eight Mile Creek) with local indigenous species.

Responsibility: RLPB, DLWC, SRFNC, Greening Australia, local council, local community

Timeframe: 2001 - 2003

Priority: medium (important means of improving the biological diversity of the area)

MANAGEMENT OPTION 2.7

MAINTENANCE OF A FLOWPATH THROUGH WANGANELLA SWAMP

According to Roberts and Pasma (1990), siltation was still occurring through the Wanganella Swamp system (particularly Wanganella Swamp), but was probably most severe in the weir pool above McCrabb's regulator. Their study showed that the flowpath through Wanganella Swamp was consistently less than 0.5m. In contrast, the main channel in Eight Mile Creek was generally 1.5-1.85m deep, except for one 'hole' of about 2.4m just upstream of the Cobb Highway. Recent observations have shown that a channel does still exist through Wanganella Swamp, but that a considerable quantity of very fine organic material and silt has settled in the channel and on the bed of the wetland, particularly in the vicinity of the channel.

The previous option of removing McCrabb's regulator is accompanied by a proposal that desilting and removal of some cumbungi in the Eight Mile Creek channel just upstream of the regulator may be required to facilitate the passage of flows. The condition of the flowpath should be assessed each year to determine the extent of siltation and whether changes in the growth pattern of cumbungi are dramatically affecting the passage of flow. Any work must be consistent with environmental legislation.

PROPOSED ACTION 2.7

That an assessment of Eight Mile Creek through Wanganella Swamp be made each year, on the basis of field inspections and community advice, to gauge whether maintenance (desilting or cumbungi management) of sections of the flowpath is required to assist the passage of flow through the Wanganella Swamp.

Responsibility: DLWC

Timeframe: commence 2001 - ongoing

Priority: medium (not urgent)

MANAGEMENT OPTION 2.8

BYPASS CHANNEL

The option to construct a bypass channel around Wanganella Swamp was first proposed in 1949, as a means of facilitating the supply of water to downstream water users. This bypass channel was to effectively replace the existing flowpath through the swamp. In a Water Conservation and Irrigation Commission minute (1953), it was stated that 'the work involved a cutting to bypass a cumbungi infested swamp, which is progressively silting up, and in recent years causing water to spill over into the Billabong Creek downstream from Wanganella'. 'The increasing restriction of the get-away west of the Hay Road causes water to back up and endanger that road and also the Wanganella-Conargo Road upstream, and causes spreading of water, which in turn causes further spreading of cumbungi'. (DLWC file: T111).

In recent years, the focus of management has shifted towards protecting the environmental values of wetland areas such as the Wanganella Swamp system. There are also more

options available now for managing flows through Wanganella Swamp, and to downstream users.

Given these circumstances, the working group concluded that the option of a bypass channel should no longer be pursued.

PROPOSED ACTION

None.
