

1. PLAN CONTEXT AND BACKGROUND.

1.1 BACKGROUND TO THE YANCO CREEK SYSTEM NATURAL RESOURCE MANAGEMENT PLAN (YCS NRMP)

The plan was developed over concern regarding:

- Transmission losses over the Yanco Creek and related tributaries, particularly under high regulated flows.
- The need to be able to deliver more timely flows to system users.
- The impact of introduced trees and other exotic vegetation such as willows and their impact on riparian ecology, channel capacity and over-bank flooding in transfer of high flows.
- Broader issues of creek health including sustainable development and use of the Yanco Creek and its tributaries.
- Timeliness of developing a consolidated view of the management of the creek, given concern over transmission losses raised by the Murrumbidgee River Management Committee; the formation of the Murrumbidgee Catchment Management Board, and the requirement for water savings as part of Government Agreements with 'Snowy Water Savings'

Impetus for the plan grew through an approach from the Yanco Creek and Tributaries Advisory Council (YCATAC) to Department of Infrastructure, Planning and Natural Resources (DIPNR), to form a partnership in the development of the plan. Subsequently the YCATAC Executive Officer and DIPNR officers introduced the concept of the strategic plan to the YCATAC AGM in September 2002, and presented an overview of possible issues that might form the plan basis, and sought feedback at meetings throughout the area in late October 2002. At these meetings potential plan objectives were presented as:

- 1 To maintain and improve the health of the creek and mimic natural flooding events where possible.
- 2 To improve the overall deliverability and efficiency of supply for the entire creek system.
- 3 Maintain and improve the riparian habitat along the creek system.
- 4 Engage all members in decision making.

Details of the community consultation process and a list of key issues nominated by stakeholders are included as Appendix 1.

1.2 RELATIONSHIP TO THE FOREST CREEK MANAGEMENT PLAN

In October 1998, a community meeting was held in the Forest Creek area, where landholders and interested stakeholders identified their vision for the Forest Creek system. This arose as a response to concerns regarding the management of the Wanganella Swamp system and long-standing concerns regarding difficulty of supply of water to the lower reaches of the Forest Creek system.

Without a management plan it was felt that the lower reach of the Forest Creek system was likely to become an increasingly ineffective water carrier, sustaining an increasingly inefficient use of water. This current flow regime was degrading wetland areas that are permanently inundated and had encouraged the extensive growth of Cumbungi (*Typha domingensis*). Water was taking longer to reach downstream landholders and over time it was likely that problems with water delivery would increasingly affect adjacent, upstream landholders.

For various reasons, the Forest Creek Management Plan has not been implemented. In 2001 the YCATAC began discussing the need for an overall Natural Resource Management Plan (NRMP) for the entire creek system which would include the Forest Creek System.

Given the amount of work that has gone into the Forest Creek Management Plan it was decided for the purposes of the YCS NRMP that:

- Issues specific to the Forest Creek system would form a stand-alone part of the YCS NRMP. These are specifically lack of water in the reaches of the Forest Creek Anabranche, Management of the Wanganella Swamp, and Flooding of the Cobb Highway.
- Issues pertaining to the overall Yanco Creek System (including the Forest Creek System) would be included as part of the overall NRMP.
- The Forest Creek part of the NRMP would only include recommended management options and not all options that were considered.

1.3 SCOPE OF THE PLAN

The YCS NRMP encapsulates water delivery and environmental issues surrounding Yanco, Colombo, Billabong and Forest Creeks. It includes the immediate creek surrounds, stock and domestic systems and also the influence irrigation areas. Broader dry land areas are outside the scope of the NRMP.

Figure 1 displays location of Yanco Creek System in NSW and Figure 2 displays location within the Murray/Murrumbidgee River system.

1.4 TARGETED OUTCOMES OF THE PLAN

Implementing the YCS NRMP will help achieve the key interests of YCATAC and other stakeholders by reaching the following outcomes:

- Water delivery losses as defined in this plan will be reduced to an acceptable level of 20% taking into account key factors such as accession losses to the groundwater system, overbank escapes in times of high flow and flood, evaporation and pilfering.
- Through the benefits of all actions undertaken as part of the plan that a net saving of 36 GL's of water will be achieved for alternate purposes such as environmental flows and off sets for funding to undertake on-going maintenance and increased understanding of the system through more extensive scientific and technical investigations.
- That riparian health including native endangered flora and fauna species will improve by 8% by the year 2010.
- That predetermined and measurable water quality parameters at established monitoring sites will improve by 5% by the year 2010.

Achieving these targets will ensure the natural environment ecosystems and agricultural systems are maintained and improved so that future use can be continued and the resource base is not depleted.

1.5 STATUS OF THE PLAN

The YCS NRMP is an advisory plan to influence private and public sector management of the creek. The plan has no regulatory powers. It aims to achieve natural resource management outcomes by awareness and coordinated investment. Using cost-sharing principles with Creek users and stakeholders, it is hoped this document will attract funding from external sources to address issues identified from the planning process.

The Plan is consistent with natural resource targets and associated management actions set out in both the Murrumbidgee and Murray Catchment Blueprints as detailed in the tables below. The plan is set to become a sub-regional plan consistent with objectives in the soon to be compiled Catchment Action Plans which will be required by each Catchment Management Authority. The development of the plan is supported by the Customer Service Committee of State Water, South Area and the Murrumbidgee River Management Committee along with related government agencies.

Summary of integration of the Yanco Creek System Management Plan and the Murray Catchment Blueprint

YCS Management Plan Objectives	Related Blueprint Target	Related Blueprint Action
<p>Maintain and improve the riparian habitat along the creek system.</p> <p>To improve the overall deliverability and efficiency of supply for the entire creek system.</p> <p>To maintain and improve the health of the creek and mimic flooding events where possible.</p>	<p>Interim Water Quality Management Targets – Sedimentation.</p> <p>Progressive reduction from 2002 levels in the average annual quantity of sediment entering rivers from the landscape and being transported between reaches as suspended sediment.</p> <p>A reduction in the loss of soil and nutrients from cropping and grazing systems through improved land management.</p> <p>Undertaking soil erosion management on those sites identified as suffering from accelerated erosion and key contributors to sediment yield.</p> <p>Improving riparian vegetation to stabilise river banks and to trap sediment.</p> <p>Managing the stream and river sediment bed loads.</p> <p>Biodiversity management.</p> <p>Retain and manage for conservation, existing riparian vegetation and restore and manage for conservation 80% of the total land of the riparian zone whilst recognizing and maintaining riparian rights. By 2012 restore and actively manage at least 20% of the total unvegetated area (7000 hectares combined area in total) of the riparian zone in each management unit.</p> <p>Improve the extent and quality of habitat for fish and aquatic species in the Murray through:</p> <p>a) Provision of fish passage on at least 5 additional weirs by 2012 following a weir survey within the region to be undertaken by 2005 to determine priorities and design.</p> <p>b) Provision of fish passage by the removal of redundant weirs identified in a weir survey of the</p>	<p>(Numbers relate to Blueprint Activity Number which are not ranked)</p> <p>A146 870 hectares of riparian zone revegetated and managed for conservation.</p> <p>A143 Actively manage for conservation 32,800 hectares of remnant vegetation.</p> <p>A144 Restore and regenerate 7600 hectares under-represented Broad Vegetation Types.</p> <p>A149 Improve Water Use Efficiency</p> <p>A010 provision of fish passage on 5 additional weirs.</p> <p>A011 Weir Survey and Review</p> <p>A013 Provision of fish passage by the removal of redundant weirs.</p> <p>A014 Establish baseline data for aquatic populations and distribution.</p> <p>A019 Restoration of 10 high conservation wetlands.</p>

<p>Developing community ownership, participation and empowerment for managing the system's natural resources.</p>	<p>region to be undertaken by 2012. c) Restoring by agreement with landholders, 5 high conservation value floodplain wetlands covering an area of not less than 5000 hectares by 2012.</p> <p>Through community cooperation, participation and agreement, develop and implement an effective means of species recovery of at least 10 threatened species listed as occurring in the Murray Catchment by the year 2012.</p> <p>Maintain the population of selected locally threatened birds, mammals, reptiles and where possible increase these populations by 10% by 2022.</p>	<p>A020 Species recovery plans.</p> <p>A021 Paper identifying the research needs of the region being prepared by DIPNR.</p> <p>A022 Develop indicators of riverine health for new river health targets.</p> <p>A023 Analysis of impacts of management actions to achieving targets.</p> <p>A024 Socio-economic research.</p>
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SUMMARY OF INTEGRATION OF THE YANCO CREEK SYSTEM MANAGEMENT PLAN AND THE MURRUMBIGDEE CATCHMENT BLUEPRINT

YCS Management plan objective	RELATED BLUEPRINT TARGET	Related Blueprint action
<ul style="list-style-type: none"> ▪ Maintain and improve the riparian habitat along the creek system ▪ To improve the overall deliverability and efficiency of supply for the entire creek system. ▪ To maintain and improve the health of the creek and mimic natural flooding events where possible 	<p>WATER QUALITY & FLOW</p> <p>WMT1. Protect and enhance 1500 kilometres of stream bank using native riparian vegetation for bank stabilisation and runoff filtration.</p> <p>WMT2. Along those stream reaches, which yield the highest sediment and nutrient loads, control stream bank and gully erosion using structural control works covering a total length of fifty kilometres.</p> <p>Biodiversity</p> <p>Maintain diversity (as described in the NSW Biodiversity Strategy) of indigenous aquatic biota and processes by: A reduction in the species diversity ratio of alien to native fish by 25%. (Note: This</p>	<p>WMA1. Protect, enhance and re-establish existing riparian native vegetation.</p> <p>WMA2. Manage stock access.</p> <p>WMA3. Manage problem weeds (eg black willows)</p> <p>WMA4. Construct stream bank and gully erosion control works.</p> <p>BMA12. Retain, enhance and revegetate riparian and aquatic native vegetation.</p> <p>BMA13. Revegetate the priority riparian and aquatic native vegetation communities</p>

YCS Management plan objective	RELATED BLUEPRINT TARGET	Related Blueprint action
	<p>component of the Management Target does not relate to notified trout waters gazetted under the Fisheries Management Act 1994).</p> <p>A reduction in the abundance ratio of alien to native fish by 50%. A 10% increase in aquatic invertebrate diversity as measured by currently accepted diversity indices (eg SIGNAL scores) and richness; complying with ANZECC guidelines for protecting biodiversity.</p> <p>Establishment and long term maintenance of native aquatic plants for 10 linear kilometres of Murrumbidgee River. Improved river productivity related to natural spatial patterns. Increased extent and duration of floodplain inundation consistent with Water Sharing Plans.</p>	<p>BMA14. Enhance structural habitat for aquatic biota.</p> <p>BMA15. Enhance aquatic connectivity</p> <p>BMA17. Protect sites of relatively intact aquatic biodiversity</p> <p>BMA18. Manage in stream habitat complexity by maintaining and improving channel complexity and in stream vegetation.</p>
<ul style="list-style-type: none"> ▪ Developing community ownership, participation and empowerment for managing the system's natural resources. 	<p>Catchment Target: By 2012 achieve a <i>net gain</i> in the community's capacity to implement natural resource management activities.</p> <p>Net gain refers to a measurable increase over existing capacity in:</p> <p>a) the community's awareness of the social, cultural and economic values of the Murrumbidgee River catchment and;</p> <p>b) The community's effective participation rate in natural resource management activities at the sub-catchment level.</p>	<p>CBMA9. Develop targeted initiatives and strategies to increase the understanding, skills and motivation of the community to take positive action for NRM.</p> <p>CBMA10. Facilitate an increased investment on public and private land through exploring and developing cost sharing mechanisms</p>

1.6 MANAGEMENT ACTIONS

This plan suggests a number of management actions needed to implement the plan. As each recommended Management Action was established, responsibilities for actions, the timeframe needed for completion and the priority of the task was determined. These emerged when YACTAC collected community views on where priority areas along the system existed, when an assessment of the importance of a task to operational needs of the system, and from gauging likely cost benefit of the action in meeting the objectives of the plan. The key management actions are as follows.

Action Number	Action
ACTION 3.1	That YACTAC in conjunction with State Water and NSW Agriculture explore measures to increase information flow to enable landholders to make strategic decisions in terms of what crop or pasture to grow for any year, and enable tactical decisions in terms of specific watering regimes for any given summer irrigation period.
ACTION 3.2(A)	Request appropriate bodies to initiate a comprehensive water balance study of the entire Yanco Creek System to clarify definitions and interpretations of losses occurring in the system. This will improve the overall understanding of water losses and transport of flows within the system and of those which there is little control over in relation to delivery capabilities. i.e. channel capacities, weir distribution volumes and travel times.
ACTION 3.2(B)	Target for reduction of transmission losses to be from the current 43% to 20% over ten years. This equates to 35GL water savings per year.
ACTION 3.3	YACTAC in conjunction with State Water instigate a working party to investigate seasonal delivery policies for the YCS.
ACTION 3.4	YACTAC to consult with DIPNR, NSWF, DEC and State Water on applying an integrated approach for works along the system in order to meet legislative requirements. A holistic approach taking in the needs of both users and the environment for the entire YCS help achieve a streamlined consent process for the project.
ACTION 3.5(A)	That a draft strategic program be developed for willow removal, bank stabilisation and revegetation providing prioritisation and timeframes for any proposed staged development.
ACTION 3.5(B)	That the program of willow removal, bank stabilisation and revegetation be submitted and approved by relevant government agencies.
ACTION 3.6	That the extent of cumbungi in the Yanco Creek system be monitored, with a view to the possible need for future control. This is to involve possible targeted areas where chemical control options would be trialled and monitored to determine efficient and effective control measures.
ACTION 3.7	State Water Asset Management Branch liaise with DIPNR, NSWF and DEC staff where necessary and make provision in a State Water maintenance budget to include remedial works to prevent losses.
ACTION 3.8(A)	That YACTAC be proactive in discussing partnering opportunities with Murray Darling Basin Commission, Pratt Water and Snowy Hydro.
ACTION 3.8(B)	That all engineering options to improve operational and environmental management of the Yanco Creek system be appropriately assessed to determine their feasibility and cost benefit.
ACTION 3.9(A)	That YACTAC DIPNR and State Water undertake a combined information program to increase landholder awareness of weir ownership and/or licence conditions included in relevant legislation.
ACTION 3.9(B)	Following the Weir Review of the YCS, undertaken by State Water, YACTAC review the document with a view to developing a strategic approach to weir removal or retention that is consistent with the outcomes and objectives of this plan.

ACTION 3.9(C)	Where viewed appropriate and in line with operational needs and government policy, that State Water assist with the cost of refurbishment of important in-system flow structures.
ACTION 3.10	That YACTAC seek a meeting with the Murrumbidgee Customer Service Committee to pursue improvements to State Water's water ordering system including information and education of users on its use and the need for compliance.
ACTION 3.11(A)	That YACTAC instigate a demand management strategy be used during water shortages, for future management of supply in the YCS over the irrigation season.
ACTION 3.11(B)	That irrigators continue to order water weekly, with a two week forecast, as part of on-going management of supply in the YCS.
ACTION 3.12	That the YACTAC promote the availability of flow information on the Yanco Creek System to the YCS community in an accessible and easily understood format.
ACTION 3.13(A)	That the current flow regime of YCS be investigated and modified if necessary, to best mimic natural flooding regimes and particularly wetlands.
ACTION 3.13(B)	That a scoping study be undertaken to identify and establish management needs to maintain and enhance key wetlands including natural wetlands and those created by water escapes and weir pools.
ACTION 3.14(A)	That the current water quality monitoring regime in place be assessed with a view to ensuring that it provides timely and accessible information on appropriate water quality parameters.
ACTION 3.14(B)	That a salinity audit of the YCS be undertaken that determines salt sources, its distribution and location in the system, so as to instigate management actions to control its accumulation and impact on the system and to measure export quantities.
ACTION 3.14(C)	That YACTAC meet with Irrigation Companies and the EPA with a view to determining the licence requirements and conditions as they affect YCS and that this be made available to members.
ACTION 3.14(D)	That YACTAC work with the EPA and Local Councils and other bodies such as Fire Brigades and rescue squads to establish emergency management plans to control environmental emergencies. e.g. road accidents/chemical spills.
ACTION 3.14(E)	That a detailed hydrological analysis and modelling for the YCS be undertaken prior to any changes to existing structures or flow management.
ACTION 3.14(F)	That an integrated water quality and ecological monitoring framework be established to assess the effect of plan implementation. This to include riverine environment, in-stream water quality and town water supplies.
ACTION 3.14(G)	That a review be undertaken of flow and water quality recording network to meet current and future requirements, and with particular emphasis on the lower reaches of Colombo Creek to determine end of valley flow and salt load export from the Murrumbidgee valley.
ACTION 3.14(H)	Provision of water quality and monitoring data to ensure landholders are better informed in related decision making.
ACTION 3.15(A)	<ul style="list-style-type: none"> (i) That all land managers including farmers, irrigation companies, government agencies, local councils and regional weed management groups implement and coordinate weed eradication programmes along riparian areas of YCS. (ii) That YACTAC ensure weed identification, reporting and controls are key components in establishing a prioritised works and monitoring programme along the YCS. (iii) That control works programmes are formulated in consultation with government agency staff and comply with relevant legislation and noxious weed protocols. (iv)

ACTION 3.15(B)	That land managers, implement recognised best practice management techniques for the management of stock adjacent to riparian areas. Best management practices may include fencing off areas to exclude grazing stock and allowing natural regeneration.
ACTION 3.15(C)	Those areas of high conservation value riparian areas be identified with a view to developing 'best management practices' and using funding incentives to maintain and improve riparian and wetland habitat. Best management practices may include fencing off areas to exclude grazing stock and allowing natural regeneration.
ACTION 3.15(D)	That DIPNR and CMA's through incentive programs continue to raise community awareness of the value of protecting riparian habitats, and the importance this plays in contributing to ecologically sustainable management.
ACTION 3.16(A)	Community participation programs to promote the control and commercial use of carp be supported and enhanced.
ACTION 3.16(B)	That current research techniques e.g. daughterless carp (induced sterility measures) to control the persistence and spread of carp into inland waterways be supported.
ACTION 3.16(C)	That the YACTAC NRMP strategies and actions are consistent with Murray and Murrumbidgee Catchment Blueprints.
ACTION 3.17	That the YACTAC seek access to vegetation management incentives to facilitate the opportunity to achieve better management outcomes from managing the riparian pathway for conservation purposes.
ACTION 3.19(A)	That any creek works be undertaken following a coordinated and integrated approach involving consent authorities and with regard to whole of system strategy.
ACTION 3.19(B)	That YACTAC investigate the possibility of the YCS NRMP and associated works, be used as a pilot project for trialling improved integrated approvals being developed by government agencies.
ACTION 3.20	That YACTAC set up a funding sub-committee to pursue all funding opportunities for the implementation of the NRMP.
ACTION 3.21	That the YACTAC requests appropriate authority to have a formal and permanent consideration of environmental flow requirements for the YCS.
ACTION 3.22(A)	That YACTAC, DIPNR and State Water develop a Memorandum Of Understanding with Murray Irrigation Limited and Coleambally Irrigation Cooperative Limited which guarantees supply of water from their channel systems to the YCS under agreed conditions.
ACTION 3.22(B)	That the YACTAC, DIPNR and State Water establish formal agreements with irrigation companies for surplus flows entering the system which would place parameters on flow volumes, timing of releases and water quality targets.
ACTION 3.23	That State Water in collaboration with relevant agencies (local government, community etc) establish and make a permanent commitment to an annual system maintenance program based on targeted work priorities to enhance the long term sustainability of the YCS.
ACTION 3.24	YACTAC to make members aware of limited provisions pertaining to compensation contained in the Water Act 2000.
ACTION 3.25(A)	That the YACTAC form an implementation steering group that is tasked with ensuring adequate consultation with stakeholders in the development management and review of the Natural Resource Management Plan.
ACTION 3.25(B)	That YACTAC ensure that works are carried out in accordance with the regulations contained in the National Parks Act 1974 pertaining to Aboriginal sites of cultural significance.
ACTION 3.26	That YACTAC continue to support efforts by groups such as NSW Irrigators Council to improve the public's perception of irrigated agriculture.
ACTION 3.27(A)	That the Landholder proposal currently being drafted be supported and endorsed on completion to expedite its implementation to return 11.5 GL's of water for environmental flows.

ACTION 3.27(B)	That the following revised target flows for Warriston Weir be implemented as soon as possible: Target 1. Unregulated/rain rejection flows <ul style="list-style-type: none"> That unregulated/rain rejection flows be permitted to pass through the Forest Creek system for environmental purposes. (It should be noted that from an operational point of view this is extremely difficult to implement because of the inadequate capacity of the Forest Creek off-take and the Forest Creek Regulated Section to allow those flows to pass through.) Target 2. ‘Summer’ target flow at Warriston Weir <ul style="list-style-type: none"> That a target flow of 80MI/day at Warriston Weir be provided from the beginning of November to end March. Target 3. ‘Winter’ target flow at Warriston Weir <ul style="list-style-type: none"> That a minimum target flow of 60MI/day at Warriston Weir be provided from beginning of April to end October.
ACTION 3.27(C)	That funding be secured for infrastructure to return flows to Billabong Creek.
ACTION 3.27(D)	That proposed changes to the flow regime be monitored annually to assess the social, economic and environmental impact.
ACTION 3.28(A)	That the operation of the Forest Creek off-take regulator and its impact on the Wanganella Swamp be considered in wider YCS assessment of environmental outcomes and related flows.
ACTION 3.28(B)	That McCrabb’s regulator and adjacent spillway be modified and appropriately upgraded.
ACTION 3.28(C)	That the operation of McCrabb’s regulator be monitored as a consequence of the modifications in (B) above.
ACTION 3.29	That flooding of the Cobb Highway at Wanganella be mitigated by redesigning and refurbishing the Estuary Creek Regulator and McCrabb’s regulator.
ACTION 4.1(A)	That YACTAC seek external funding to initiate on-ground works which includes the employment of implementation personnel.
ACTION 4.1(B)	That all water users in the YCS contribute to the NRMA via a levy being \$1.50 per megalitre on entitlement and \$2.00 per megalitre on usage. This is to be charged as part of State Water annual water accounts.

1.7 DURATION OF THE PLAN

This plan is an operational document for a ten-year period to 2014. A mid term review will be conducted after 5 years with an assessment of the implementation of recommendations. Adaptive management principles will be pursued to modify and add to the plan during this period. Principles and recommendations contained in the plan will be subject to on-going review and changes to reflect the changing nature of the current operational environment. An example of this could be changes to funding options or changes to government policy and the like.

1.8 HOW WILL THIS PLAN MAKE A DIFFERENCE?

The YCS adds to the economic and social well being of communities along its reach. These communities also recognise its value to provide environmental services (eg. provision of habitat, diversity for the landscape, refuges for wildlife). Maintenance and improvement of these values requires a co-ordinated effort from communities, stakeholders and Government. Otherwise the isolated action of individuals may not be sufficient to maintain these values.

This plan will assist strategic management of the YCS by documenting the extent of existing problems, nominating specific actions as to a way forward, and guide investment into key creek works. Strategic multi-faceted investment and upgrade to the entire YCS will have a number of advantages to all stakeholders. Examples of these include:

- Facilitate the securing of better environmental conditions in the riparian zone to protect and enhance habitat for the system’s dependant flora and fauna.

- More timely delivery of flows will help to maximise efficient application of irrigation water thus reducing potential yield losses and undermining the agricultural productive capacity of the region.
- Result in a more motivated and empowered community participating in the management of the system that will provide an improved basis for future decision making.
- Assist the achievement of broader river and catchment system management objectives for the greater Murray Darling Basin. Examples of this would include improved water quality and greater attainment of down stream flow targets.
- Additionally, economic saving based on current transmission losses could amount to \$23.4 million based on the assumption of 160,000 ML/yr average use and aiming to reduce losses to 25% is 36,000 ML/yr @ \$650/ ML average price of water based on all user types.

Maps of the Yanco Creek System infestation of cumbungi, willows, large woody debris are contained at the back of this document.



Plate 1: Honourable Minister Craig Knowles signs a copy of “Song of Running Water”, the history book of the Yanco Creek System, at the launch of the Yanco Creek System Natural Resource Management Plan on 1 March 2004 at “Old Coree”, Rice Research Australia Jerilderie – pictured in the foreground, David Harris (DIPNR), Hon. Craig Knowles, Elise Schumacher (Senior Policy Advisor to the Minister), Richard Sleigh (Chairman, YACTAC), Robert Shuttle (State Water).

1.9 CONSULTATION PROCESS

The following outlines the consultation process undertaken thus far by the YCATAC in preparation of the YCS NRMP. The YCATAC believe that a fair and thorough consultation process is necessary to ensure that the NRMP reflects the issues of the landholders along the creek system and that there is general consensus on the way forward to manage the system into the future.

- 1 July 2002 YCATAC convened a meeting of its Executive at Conargo to discuss the issues surrounding a NRMP. At that meeting the Executive drafted four key issues that a NRMP should address.
- 2 The Executive presented the four key issues and the need for a NRMP to its Annual General Meeting held at Jerilderie in September 2002.
- 3 In October 2002, 4 meetings were held along the YCS to discuss the issues associated with a NRMP. Meetings were held at Euroley, Conargo, Jerilderie and Wanganella. Approximately 80 irrigators attended those meetings. Notes of the meetings were recorded and are attached in Appendix 1(A). Irrigators were also invited to record their issues and concerns via telephone and a pre-printed form. The results of this are also contained in Appendix 1(B).
- 4 In February 2003 a meeting was held with the Forest Creek Management Plan Management Committee to look at the issues raised in that plan. Relevant Management actions specific to Forest Creek were identified and amended to account for changed circumstances. It was agreed by the Forest Creek Management Committee to have these issues included in the YCS NRMP along with all other management actions applicable to the whole of the YCS.
- 5 In late September 2003, 200 copies of the draft plan were printed and dispatched to relevant stakeholders. This included all licence holders in the system, NSW Government Agencies, Local Government Shire Offices, and other interested parties.
- 6 In late October 2003 a further round of public meetings were held at the same strategic locations in the system to gain feedback and suggestions on how to improve the plan and what should be considered as part of an implementation plan and the most appropriate way to manage the project. The YCATAC put forward a proposal to fund 40% of the project costs by the licence holders. This would be 20% in cash and 20% in kind. The cash component would take the form of a compulsory levy on all water users being \$1.50 per ML on entitlement and \$2.00 per ML on usage. The levy would be in place for an initial 3 year period after which time it would be reviewed. A proposal was also put forward to form a Project Management Committee to oversee the project. It would be made up of representatives from YCATAC, independent persons and government representatives. Invitations were extended for written submissions and a survey was circulated to all licence holders to gauge interest and support for the proposal put forward by YCATAC. (The results of this are included in Appendix 2.)
- 7 Following the public meetings, feedback and comments were reviewed by the authors and where appropriate were included.
- 8 Due to the complexities surrounding the issues in the Forest Creek, the Forest Creek Working Party was invited to rewrite that part of the document.
- 9 Other sections of the plan were given to other interested parties to gain their thoughts to ensure their comments were fully addressed.
- 10 Several deputations were made including Minister of Infrastructure, Planning and Natural Resource Management, Minister of Utilities, government departments at a state and regional level.
- 11 Work has also commenced to compile the Implementation Plan.

- 12 The Minister of Infrastructure, Planning and Natural Resource Management formally launched the plan at a function at Rice Research Australia, Jerilderie on March 1 2004.
- 13 In May 2004 the final plan was reviewed and endorsed by YCATAC.
- 14 In August 2004 a letter detailing the major changes between the draft and the final was mailed to all license holders along with the final plan.



Plate 2: Landholder Consultation Meeting held at the Conargo Hall, Conargo on 29 October, 2002

DESCRIPTION OF THE YANCO CREEK SYSTEM

2.1 THE PHYSICAL SYSTEM

Water diversion and supply distribution into the YCS forms a major part of the effluent regime of the Murrumbidgee River. Since European settlement of the riverine plains and the construction of irrigation infrastructure over a long history, the Yanco Creek and its tributaries is now a regulated stream providing life giving water critical to the survival of vital ecosystems and to rural communities over a vast track of the Riverina.

With the facility of Yanco Weir in place west of Narrandera, water is distributed down the Yanco Creek flowing south-west to Tarabah Weir located just south of the junction of Yanco Creek and Colombo Creek. Tarabah Weir allows for diversions into the Colombo Creek (Simpson 1994). It takes a mostly southerly flow-path where it joins the Billabong Creek upstream of Jerilderie.

The Billabong Creek, having its origins in the Holbrook/Culcairn region, flows through Jerilderie along to Hartwood Weir where water can be directed into the Forest Creek System. Forest Creek is a high level effluent of Billabong Creek (Simpson 1994), and is a regulated stream of the Murray River until it reaches Warriston Weir, where it becomes an unregulated stream until it flows into Eight Mile Creek providing a domestic and stock water supply. It then passes through Wanganella Swamp into the Forest Creek Anabranch which inturn flows back into the Billabong Creek System downstream of Wanganella Township (Simpson 1994).

The Yanco Creek traverses vast plain country in a south-westerly direction and meets up with the Billabong Creek downstream of Hartwood Weir and upstream of Conargo township. Flows down the Yanco can be supplemented in peak summer demand periods by water that passes through the Coleambally Irrigation Area via the Coleambally Catchment Drain and Drainage Canal (DC800). Flows into the Billabong Creek can be supplemented through Murray Irrigation Limited (MIL) Finley and Berriquin Escapes.

Eventually the Billabong Creek meets the Edward River and finally joins the Murray River downstream of Deniliquin (Simpson 1994).

The Yanco Creek System meanders over a length of approximately 799km of the riverine plain causing the creek to meander considerably. The channel capacities of the creek accommodate relatively low flows and there are significant travel times for water supply deliveries to reach their destinations (Refer Section 2.3).

2.2 HISTORY OF THE SYSTEM

The Edward River was discovered on 3 January 1840 by John Webster and James McLaurin. Two years later Augustus Morris followed the Billabong Creek to its junction with the Edward and then along its banks to the Murray. During this period the NSW Colonial Government had forbidden occupation of land west of Yass. By the early 1840's land seekers were moving west with mobs of sheep and cattle seeking watered country.

Prior to 1856, under natural conditions, the Yanco/Billabong Creek System would have been a mostly dry intermittent system that received flows at certain flood levels. For the Yanco Creek, flows would have only occurred when the Murrumbidgee exceeded daily flow rates greater than 40,000 ML/day (4% of the time) (White *et al.*, 1985).

In 1856, lobbying by Pastoralists allowed the Yanco Creek off-take to be enlarged to provide increased flows into the system. Numerous weirs were constructed by landholders along the system to retain water when flows ceased. By 1858 there were 23 runs along the 230km of the Billabong creek all receiving unimpeded access to its water. In the same year, George Desailly (owner of Coree) built a dam that completely blocked the creek so that settlers below him were waterless except when the dam overflowed.

In 1885 the settlers on the Upper Yanco adopted a plan to finance a cutting that would link the creek with the waters of the Murrumbidgee. A Committee was set up and the following year 100 men completed a cutting about 6 miles long. The sluggish waters however only soaked into the surrounding soil or evaporated. It took another six years to deepen the cutting and install a pump. Once again the result was a failure. It took quite a few more years to dig a deep and properly graded cutting, 8 miles long before settlers were able to watch a free flow of water from the Murrumbidgee into the Yanco. Just before the turn of the century, a joint government-settlers fund financed the new McKinney Cutting.

Due to the importance of flows in the system, *the Yanco Colombo and Billabong Creeks Trust* was established in 1921, to take responsibility for the operation and maintenance of works associated with the building of the Yanco Weir (Simpson 1994). In May 1923 the NSW Government announced that construction work had started. In February 1928 the weir was formally handed over to the Yanco, Colombo and Billabong Creeks Water Trust.

In 1950 limited irrigation of 12.5ha per riparian landholder was permitted. In 1957 the wall height of Burrinjuck was raised to give additional storage capacity and irrigation was extended. Further irrigation expansion was allowed when Blowering Dam on the Tumut River was completed in 1969.

The 1970's saw granting of irrigation licences and subdivision of riparian holdings along the system increase. By 1980 *the Yanco Colombo and Billabong Creeks Trust* was dissolved and control of the system was assumed by the Department of Water Resources, who placed an embargo on the issue of further licences that still prevails today. Following this, much of the system was declared under sections of the Water Act (1912) allowing for greater control of supply obligations and conditions on licence holders. Additionally, the removal of drop boards from the many private weirs constructed was undertaken. The Department of Water Resources also took further action to improve delivery of water by constructing the present day Yanco Creek off-take in 1980 (Simpson 1994). The YCS Advisory Council was also formed in 1980, in response to the restrictions placed on irrigators compared to those applied to the designated Murrumbidgee and Coleambally Irrigation areas (Landale in Tolhurst 2002).

In the late 1980's the Department of Water Resources deregulated rice growing and allowed licensed pumpers on the Yanco Creek system to grow rice, winter/summer cereals, pastures, horticulture and viticulture. Within a short space of time activation of unused ("sleeper") licences throughout the system and the expansion of the current licences to use more of their annual entitlement increased markedly, placed greater demand on supply and delivery of water. In recent years this has become particularly pronounced in the spring-summer months when reliable supplies are needed for filling rice bays and for panicle initiation of rice plants. This increase in demand for water involved a review of the water resource allocation. 155,000 megalitres of water annually at 100% entitlement was deemed sufficient for the system. The growing of winter cereals, pasture, rice and other summer crops accounts for 75-80% of all irrigated land (by area) in the Yanco-Billabong Creeks System (Simpson 1994). In recent years (since 2001), there has been less land area sown to rice.

2.3 HYDROLOGICAL REGIME

The bulk of water entering the Yanco Creek System is supplied by the Yanco off-take, which is situated on the Yanco weir pool on the Murrumbidgee River. From this structure maximum in-stream bank flows are delivered over the majority of the year for irrigation purposes. Supplementary flows are provided by three outfall drains from the Coleambally Irrigation Area and numerous drains and escapes along the Billabong Creek and associated Murray Irrigation Districts. Flows have been regulated from the off-take based on predicted flow requirements provided by State Water for the various sections of the system. Predicted flow requirements are based on planned crop area, past usage and anticipated demand. In most years with the combined effect of inflows from irrigation supplies and natural rainfall, over bank flows do occur throughout the system (Simpson 1994). Statistics detailing volumetric allocation within the YCS are depicted in Table 1.

Table 1 - Yanco/Colombo/Billabong Creek System Volumetric Allocation Summary

	No. Licences	Total Area (Ha)	Irrig. (ML)	Town (ML)	Other (ML)	Total (ML)	Pumping Cap. (ML\Day)
<u>YANCO CREEK</u>							
Off-take - Morundah	14	1,871	11,211		241	11,452	274
Morundah - Catch Drain	4	556	2,916		16	2,932	130
Catch Drain - Bobaroo	41	5,342	27,052		61	27,113	955
Bobaroo - Puckawidgee	15	2,976	12,944		171	13,115	496
Subtotal	60	8,874	42,912	0	248	43,160	1,581
<u>COLOMBO CREEK</u>							
Morundah - Jctn. Billabong	33	2,547	15,292	814	1,019	17,125	458
<u>BILLABONG CREEK</u>							
Jctn. Colombo – Algudgerie	32	3,402	20,289	605	660	21,554	641
Subtotal	65	5,949	35,581	1,419	1,679	38,679	1,099
Algudgerie - Puckawidgee	17	2,589	10,827		197	11,024	480
(FOREST CREEK**)	13	1,441	8,646		379	9,025	234
Subtotal	30	4,030	19,473	0	576	20,049	714
Puckawidgee - Darlot	36	3,813	23,150	18	2,025	25,193	1,014
Darlot - Moulamein	21	2,110	11,686		1,309	12,995	543
(Outfall Drain/Euroly Creek*)	23	2,911					493
Washpan Creek						1,833	
Cuddell Creek						1,326	
TOTAL	249	29,558	144,013	1,437	6,078	154,687	5,718

* Not 22C: No allocation assignment

** Does not include 36.5 GL for Forest Creek Unregulated Section as per the Murrumbidgee Regulated Water Sharing Plan.

River regulation volumes based on previous operational limits are proving unable to cater for the increases in summer cropping for several reasons including:

- An inability to predict an increasing demand in the various sections of the Yanco Creek System because of the long travel time and excessive losses
- Unsatisfactory flow monitoring systems
- Physical constraints- lack of re-regulatory capacity in the system due to things such as overshot weirs.
- Channel capacity restrictions due to infestation of willows, large woody debris (LWD) and cumbungi.

Current Water Flow Travel Times

It takes approximately 5-6 weeks for regulated flows to pass from the Murrumbidgee irrigation dams (Blowering & Burrinjuck) through the YCS to Moulamein.

- | | |
|---|-----------|
| ➤ Dams to Yanco Off take | 7-8 days |
| ➤ Yanco Offtake to Tarabah Weir | 2-3 days |
| ➤ Morundah to DC800 (Yanco) | 7 days |
| ➤ DC800 to Puckawidgee (Yanco) | 7 days |
| ➤ Tarabah to Innes Bridge (Colombo Creek) | 8 days |
| ➤ Innes Bridge to Jerilderie (Billabong) | 2 days |
| ➤ Jerilderie to Hartwood Weir | 4 days |
| ➤ Hartwood to Conargo | 1-2 days |
| ➤ Conargo to Darlot | 7 days |
| ➤ Darlot to Moulamein | 7-10 days |
| ➤ Forest Creek Offtake to Warriston Weir | 5-6 days |

Appendix 3 shows the average daily flow volumes for the system in megalitres.

2.4 FLOW CONSTRAINTS

There are a number of locations along the Yanco Creek to Morundah section where restrictions occur and inhibit the supply and delivery of water. These restrictions are commonly known as in-stream impediments. A maximum 1400 ML/day can be diverted from the Murrumbidgee River. Higher diversion volumes can be diverted; however this tends to cause flooding and increased system losses. Flow rates need to be monitored closely in the Washpan Creek where it leaves the Yanco creek and flows over Spillers Regulator before travelling and returning to the Yanco before Tarabah Weir at Morundah.

Flooding of private property can occur when the bank-full capacity of Colombo Creek exceeds 600-650ML/day. Despite de-snagging works in 1992 that achieved a 15% increase in capacity along this section of Colombo Creek, further removal of strategic obstructions needs to be considered along with a review of operational weirs accompanied by community consultation. This work has to also comply with current legislation including the Fisheries Management Act, 1994, the Threatened Species Conservation Act, 1995, and the Occupational Health & Safety Act, 2000.

Other supply sources such as escapes and drainage channels also have supply limitations. Table 2 depicts creek flow impediments and system losses within the YCS

Table 2: Creek flow impediments, system loses and location of weir structures within the YCS (ML/day)

Section	Off take to Morundah	Morundah to DC 800	DC 800 to Puckawidgee	Conargo to Wanganella	Wanganella to Darlot	Columbo Creek	Junction to Jerilderie	Jerilderie to Algdgerie	Algdgerie to Hartwood	Forest Creek	Hartwood to Conargo	Darlot to Moulamein	Totals
Length of Reach	44 kms	108 kms	106 kms	68 kms	64 kms	148 kms	46 kms	28 kms	61 kms	27 kms	20 kms	79 kms	799 kms
Total No. of Willows	350	>600	>500	>180	>30	>720	>400	>320	100	>220	>75	>15	>3510
Total No. LWD	>500	>600	>4240	>150	>135	>1850	>760	>600	>450	>120	>200	>105	>12980
Total No. Floodrunners and Ox Bows	9	7	7	8	1	11	2	4	5	3	8	1	66
Total No. Wetlands	2				2							1	5
Total No. Cumbungi and other weed Infestations	2	11	13	5	2	5	8	8	4	14	3		75
Weirs – State	2					3	1	1	1	2			10
Weirs – Private		1	4	7	1	5			4	3		1	26
Losses Average ML/day	Off take to Morundah	Morundah to Darlot				Columbo to Conargo						Darlot to Moulamein	
1998/99	16.5	16.8				39.2							
1999/00	35.4	63.7				25.6							
2000/01	48.0	38.7				23.9							
Losses Average ML/day	Off take to Morundah	Morundah to DC800	DC 800 to Puckawidgee	Puckawidgee to Darlot		Columbo Creek	Junction to Jerilderie	Jerilderie to Conargo				Darlot to Moulamein	
2001/02	89.2	27.3	105.3	109.5		61.8	35.5	29.1					
2002/03	57.3	41.7	52.0	57.5		59.7	26.9	38.8					

Note: Losses calculated as averages over the season

2.5 THE BIOPHYSICAL ENVIRONMENT

Climate

The general climate of the YCS is characterised by hot summers and mild winters. Rainfall is winter dominant and averages at 400-450mm per annum. June usually is the wettest month and February the driest. Dry periods and droughts are common with 29 drought years being experienced between 1900-1986 (Dalton in Porteners, 1993). Evaporation rates can be as high as 1,400mm over the spring and summer season and around 400mm in the Autumn-Winter period. Overall, rainfall does not contribute significantly to runoff and creek flows.

Topography

The Riverine Plain is made up of mostly low relief land sloping gradually to the west. It is traversed by numerous prior streams, ancestral rivers and present day creek and river systems.

Prior streams are often depicted by meandering low depressions up to 2m in depth with associated winding sandy ridges. Prior streams are generally higher than the surrounding floodplain. For example Colombo Creek is a high level effluent of Yanco Creek (White *et al.*, 1985). Ancestral rivers are remnants of river channels usually larger than the Murrumbidgee and Murray and can be seen scrolling out below the general floodplain nearby. The present YCS is almost entirely positioned on ancestral sediments. When this occurs, sub surface diversion of flow away from the present stream can take place to fill ancestral channels. Forest Creek is situated higher than Billabong Creek and consequently flows from Forest Creek tend to flow back to the Billabong Creek or the Edward River via small interconnecting creeks and breakaways. To counter this block banks have been installed along many of these creeks to contain the flow in the system.

Soils

Soils of the Riverine Plain are mostly of a depositional nature stemming from the presence of prehistoric water courses. On the more elevated areas, the Red-brown earths prevail and sit adjacent to the paths of ancestral rivers. The duplex soils are weakly structured overlaying a well structured clay base. They are moderately fertile and can be hard setting when structural breakdown occurs affecting infiltration rates.

In the floodplain areas of the Murrumbidgee River and associated creek systems, grey and brown clays prevail. They are moderately deep and show consistent textural development through the profile. They typically form deep wide cracks when dry and are less susceptible to erosion than sandy red clay soils. Grey clays occur on flooded and poorly drained floodplains, while brown clays are frequent on the higher floodplain areas (Murphy & Eldridge, 1991).

Vegetation

The YCS forms a significant riverine corridor of Black Box (*Eucalyptus largiflorens*) woodland occurring higher in the landscape to River Red Gum areas (*Eucalyptus camaldulensis*) on the fringes of the waterways 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.

Vegetation types vary according to key landscape features. Along the riparian zone black box can appear as a discontinuous stand of both individual trees and/or clumps. Other vegetation species having an association with it include Cooba (*Acacia salicina*), River Cooba (*Acacia stenophylla*). Shrub species include Lignum (*Muehlenbeckia florulenta*), Short-leaved Bluebush (*Maireana brevifolia*) and Nitre Goosefoot (*Chenopodium nitrariaceum*).

In areas where creeks are less defined and where water movement is slower Cumbungi (*Typha orientale*) infests both the sides of the creek and can extend across the full width of the creek in severe locations. The infestation occurs in areas where the flow is low in volume or restricted and this is evidenced by widespread infestation in numerous parts of the YCS.

On floodplains often co-habiting with Black Box are Hooked Needlewood (*Hakea tephrosperma*), Miljee (*Acacia oswalsii*), and Bull Oak (*Allocasuarina luehmannii*). The understorey contains mostly native and introduced pasture species with few shrubs.

A large part of the Riverine Plain consists of rangeland being mostly treeless. In these areas Nitre Goosefoot, Dillon Bush (*Nitraria billardieri*) and Cottonbush (*Maireana aphylla*) extend beyond the Black Box fringed water-courses. The Dillon Bush has increased markedly corresponding to changes in land use since European settlement mainly brought about by overgrazing. This has removed the Bladder Saltbush (*Atriplex vesicaria*) and Old Man Saltbush (*Atriplex nummularia*) (Noble & Whalley in Porteners, 1993).

The main introduced flora species causing environmental damage in the YCS are Willows (*Sallix spp.*) and African Box Thorn (*Lycium ferocissimum*). The extent and impact of willows will be discussed in depth later in this document. Willows are considered to be one of the major water impediments, causing over-bank flooding and a deterioration of water quality in the entire creek system.

In-stream Ecology and Stream Condition

There is very little information on the ecology and stream health of Yanco Creek. This is an obvious concern for deciding future management of the natural resources in the YCS and is addressed in clear recommendations of improvement for the system as stipulated in Management Action 3.14 (F) and 3.15 (B). However a small amount of aquatic invertebrate data is available from the First National Assessment of River Health (FNARH).

A single sample from Yanco Creek at Morundah illustrates reasonable aquatic richness (as shown in Table 3). A number of invertebrates are strongly associated with snags, including freshwater prawns, riffle beetles and shrimps, where they graze on the algae on the surface of the snags. They are thus an important food source for snag associated fish such as Murray Cod (*Maddullochella peelii*) and Yellowbelly (*Macquaria ambigua*). Another group of grazing invertebrates inhabits aquatic plants, such as cumbungi and common reed (*Phragmites australis*). These include the aquatic moths, caddis flies and shrimp. Many other species inhabit the water body, including the water bugs, while others are associated with the sediment, including the oligochaetes and Chironomids. However, they all directly or indirectly make use of organic material entering the stream from riparian vegetation, LWD/snags and aquatic plants or from phytoplankton (floating algae) in the water column.

Wetlands

River regulation has altered the natural flow regime of many watercourses in the Murray and Murrumbidgee catchments. The YCS contains a number of different wetland types that reflect the water distribution and operational management of flows in the system. The approximate number and collective surface area of wetlands along the Yanco Creek System is currently being determined using satellite imagery from the report River flow/ wetland inundation relationships for the mid-Murrumbidgee River (Frazier, 2001). Wetlands occur in the YCS occur as natural swamps such as Wanganella and in weir pools created by the construction of the weirs. While few have a complete drying phase as would occur in an unregulated system each has developed and adapted to provide an environment for a wide range of flora and fauna habitat. The presence of each wetland area has become an integral part of the YCS and changes to any part of the system, either in the form of infrastructure upgrade or removal in the case of weirs or of flow regime will need to be determined and evaluated from a range of perspectives.

All the wetlands along Yanco Creek can be considered to be “natural”, even if the regulation of the creek has resulted in them being full more often than would have occurred pre-regulation. The only wetlands which would be considered to be man made would be those which were actually constructed (eg. farm dams, banked off creek lines). As a general rule, regulated (irrigation season) flows should be excluded from all the wetlands on the YCS. Environmental flow requirements of wetlands within the YCS need to be determined by DIPNR to ensure the ecological integrity of key wetlands are maximised and to determine flow volumes needed for agricultural productivity and environmental purposes. The YCATAC is cognisant of this requirement and proposes relevant management actions to address this.

YCS and NPWS Nature Reserves

The YCS community is well aware of the unique natural environment that they manage and consequently have established numerous wildlife refuges and nature conservation reserves under National Parks Act (1974). These modify activities to protect native flora and fauna and are voluntarily adopted by landholders.



Plate 3: Artificially created wetland due to high summer flows

2.6 WATER QUALITY AND FLOW MONITORING OF THE YANCO CREEK SYSTEM

Preliminary Environmental Health Status of the YCS – Molino-Stewart Report

Environmental consultants, Molino Stewart, provided a report on the health status of the YCS in 1999. The assessment was conducted on the quality of riparian and in-stream habitat present and the erosional stability of stream banks. The method used was a modified version of assessment used on Victorian streams performed by Mitchell 1990. The assessment was carried out rating the condition of three distinct features. These were:

- Riparian Habitat
- In-stream Habitat
- Streambank Stability

Ratings were based on scoring of health at each site from 1-3 based on criteria contained in Appendix 7, and rankings of the stream condition assessment are listed in Table 4

Table 4 - Stream Condition Assessment of the YCS

Segment	Riparian Habitat Rating	In-stream Habitat Rating	Streambank Stability Rating
Off-take to Morundah	1	1-2	1
Yanco Creek: Morundah to DC 800	1	1-2	1
Yanco Creek: DC 800 to Conargo	1	2	1
Conargo to Darlot	1-2	2	1
Darlot to Moulamein	1-2	2	1
Colombo Creek: Morundah to Billabong Jctn.	3	2-3	2
Billabong Creek: Jctn to Jerilderie	1-2	1-2	1
Billabong Creek: Jerilderie to Hartwood Weir	1-2	1-2	1
Forest Creek: Hartwood Weir to Warriston Weir	2-3	3	1-2

Source: Molino Stewart Report 1999.

Review of Water Quality Data

A brief review of water quality data collected by DIPNR (and its prior organizations) was undertaken during March 2003. This review did not set out to statistically analyse water quality or resultant trends through time, but merely determine the nature of water quality within the Yanco-Colombo system and comment on some apparent patterns in the data. The results reported here should be viewed as the starting point for any water quality analysis rather than the definitive outcome.

Water Quality and Flow Characteristics in the Yanco Colombo System

Water quality records collected at the five currently active water quality stations (Table 5) throughout the Yanco-Colombo system over the last 10 years (1993-2003) were assessed for the following parameters:

- Total suspended sediment and Turbidity
- Total phosphorous,
- pH,
- Dissolved oxygen and
- Electrical conductivity.

Table 5. Water quality stations currently operational within the Yanco-Colombo system.

Station Name	Acronym	Station Number	Location
Yanco Creek at Offtake	YANCKS	410007	upper reaches of Yanco Creek, immediately downstream of Murrumbidgee River
Yanco Creek at Morunda	YANMOR	410015	mid reaches of Yanco Creek downstream of Tarabah Weir
Yanco Creek at Bridge 321	YANCKB	410169	lower reaches of Yanco Creek, downstream of the DC800 drain from CIA.
Colombo Creek at Morunda	COLMOR	410014	upper reaches of Colombo Creek downstream of Tarabah Weir
Colombo Creek at Urana Road	COLURA	410100628	lower reaches of Colombo Creek

Flow Interpretation

The analysis and interpretation of river flow information is a detailed and specialist discipline, beyond the scope of this paper. However, it is difficult to attempt an interpretation of water quality in natural systems without also considering the influence of flows and flooding.

To this end, flow data from 1980 to the present was examined for coarse, unquantified, patterns and trends (Figure 3). It is the interpretation of the author that over the last twenty years flood events in the Yanco-Colombo system have decreased in both frequency and magnitude while there has been a steady but distinct increase in non-event flows, particularly in the upper reaches in the system. This is interpreted as increased flow regulation and is at odds with natural water quality processes associated with the system.

Flow exceedence curves (Figure 4) show the influence of re-regulation and drainage flows from the Coleambally Irrigation Area (Buchan, 1994). Under most flow conditions (approximately 85% of the time) greater volumes of water flow into the upper reaches of Colombo Creek (COLMOR) than continue down Yanco Creek past YANMOR station. These flows in the Yanco are then “topped up” via the Coleambally Catchment Drain and as a result of drainage waters via the DC800 to the extent that greater volumes of water pass YANCKB than YANMOR for up to 85% of the time.

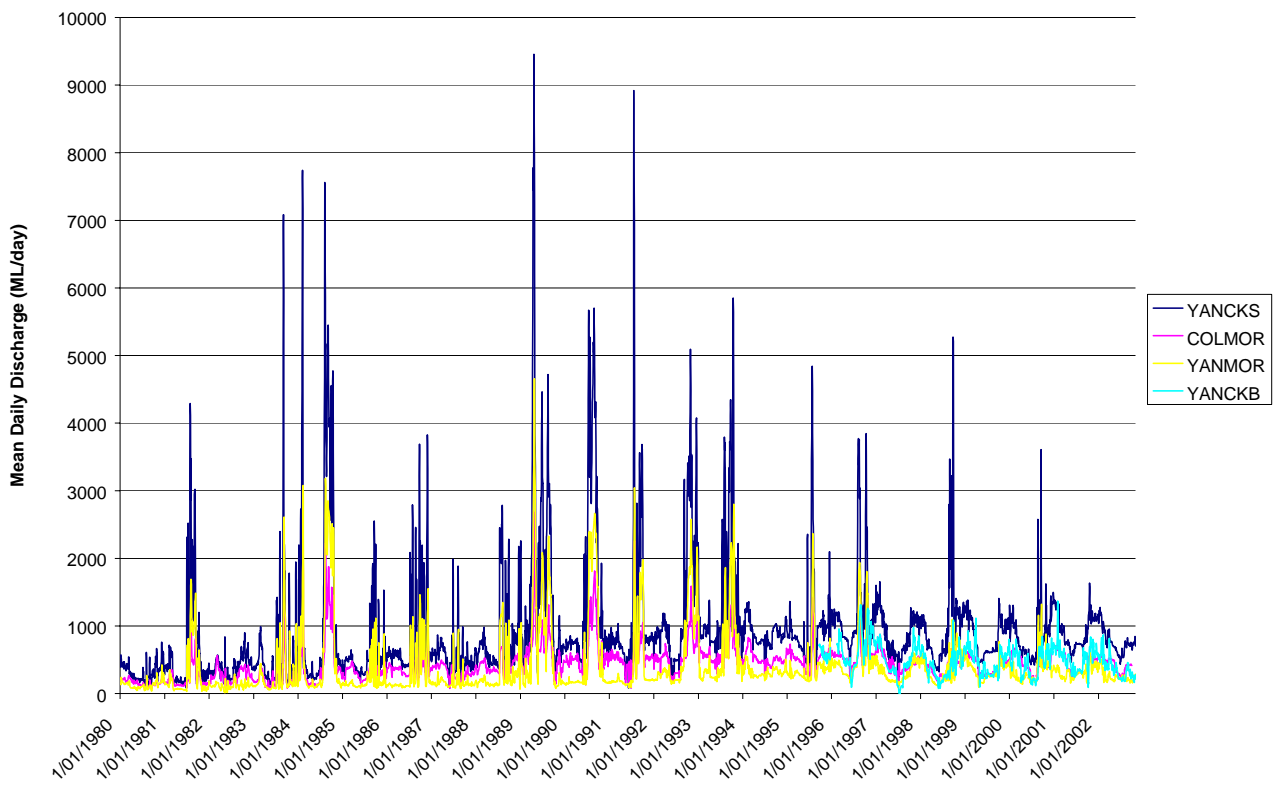


Figure 3. Mean Daily Discharge for Yanco-Colombo system 1980 - present

Time Weighted Stream Discharge Duration Curve.

Stream Discharge in Megalitres/Day, Instantaneous Values.Interval 1 Days

- Station 410007 YANCO CK AT OFFTAKE 01/01/1980..17/12/2002
- Station 410014 COLOMBO CK @MORUNDAH 01/01/1980..24/02/2003
- Station 410015 YANCO CK @ MORUNDAH 01/01/1980..26/02/2003
- Station 410169 YANCO @ YANCO BRIDGE 18/09/1995..21/11/2002

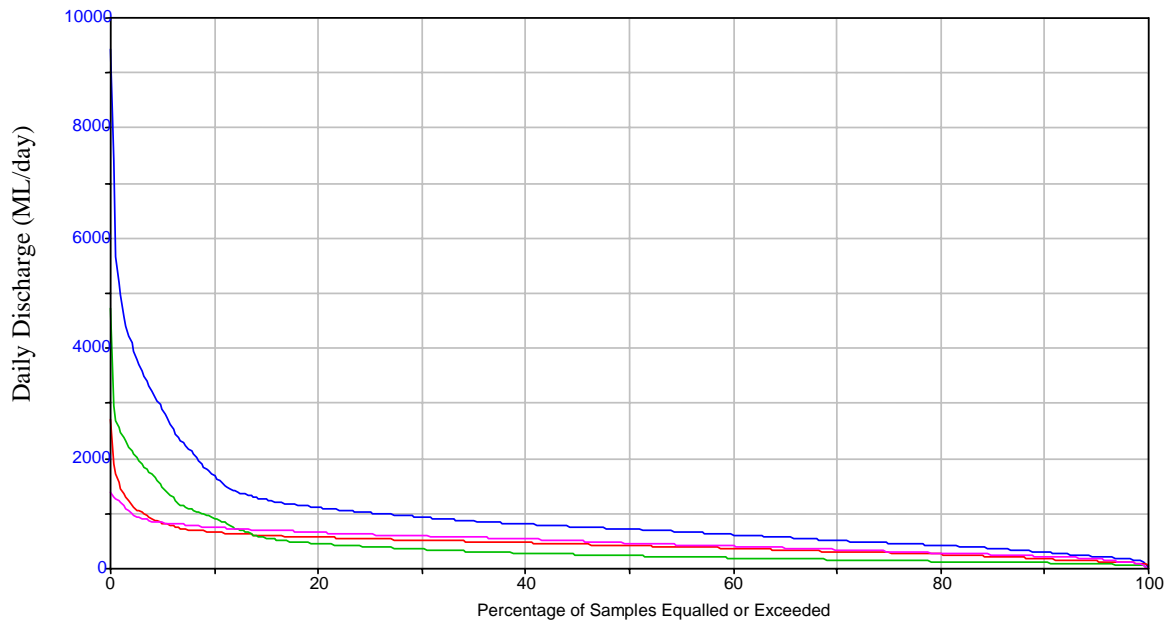


Figure 4. Flow duration curve for Yanco-Colombo system 1980 - present

Suspended Sediment and Turbidity

Suspended sediment concentration is a measure of the mass of particulate matter held in suspension for a given volume of water and is expressed, in this case, as milligrams per litre (mg/L). Turbidity measures the “cloudiness” of water by estimating the light reflectance and scattering properties caused by suspended particulate matter.

Suspended sediment concentrations and turbidity show very similar patterns in terms of variability at each station (Figures 5 and 6). This is expected as turbidity provides a good correlation to suspended sediment concentrations in sediment rich streams. There is a pattern of increasing sediment concentrations as water moves further downstream along Yanco Creek. This pattern is less apparent in the Colombo Creek.

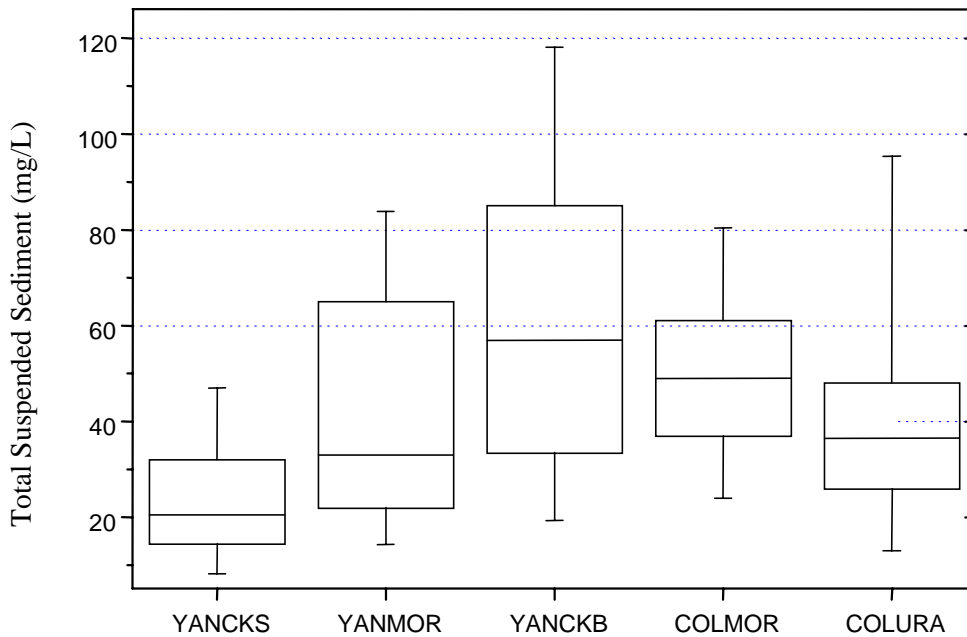


Figure 5. Total suspended sediment data for Yanco-Colombo system 1993-2003

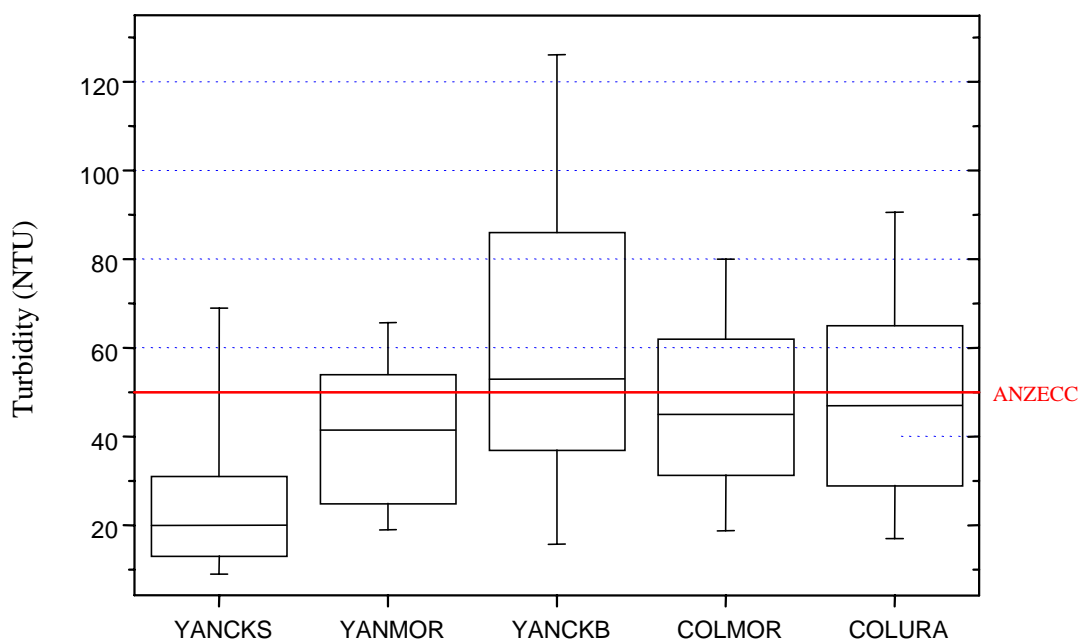


Figure 6. Turbidity data for Yanco-Colombo system 1993-2003.

Likely causes of increasing levels of suspended particulate matter along the Yanco system are stream-bank instability, particularly when subject to altered flow and flooding regimes due to stream regulation, and point source discharges such as irrigation drainage (particularly at YANCKB). There is evidence of sediment deposition in the lower reaches of the Colombo Creek with dense Cumbungi growth and siltation as sediment drops out of suspension at low flow velocities.

ANZECC (2000) guidelines for aquatic ecosystem health suggest a high-end default turbidity trigger value for lowland rivers as 50 NTU. This value is exceeded by more than 50% of observations at YANCKB and more than 25% of observations at YANMOR, COLMOR and COLURA.

High levels of suspended sediment are recognised as a threat to water quality within the Murrumbidgee Catchment Blueprint and the Yanco-Colombo system is showing localised signs of decreasing health in this regard. The situation would be improved by greater flow variability with increased frequency of flood pulses, to help flush the system, and reduced non-flood flows to allow for bank stabilisation through revegetation and settling of suspended sediments. Implementation of the Coleambally Irrigation Area Land and Water Management Plan should result in decreased drainage volumes and sediment concentrations discharged to Yanco Creek.

Total Phosphorous

Total phosphorous concentrations showed a similar rising pattern along with sediment concentrations as water moved further downstream (Figure 7). This is an expected outcome, as a large proportion of total phosphorous is known to bind to suspended sediment particles. ANZECC guidelines for aquatic ecosystem health set a default guideline of 0.05 mg/L. This value is exceeded in more than 50% of all readings at all stations except the most upstream station, YANCKS.

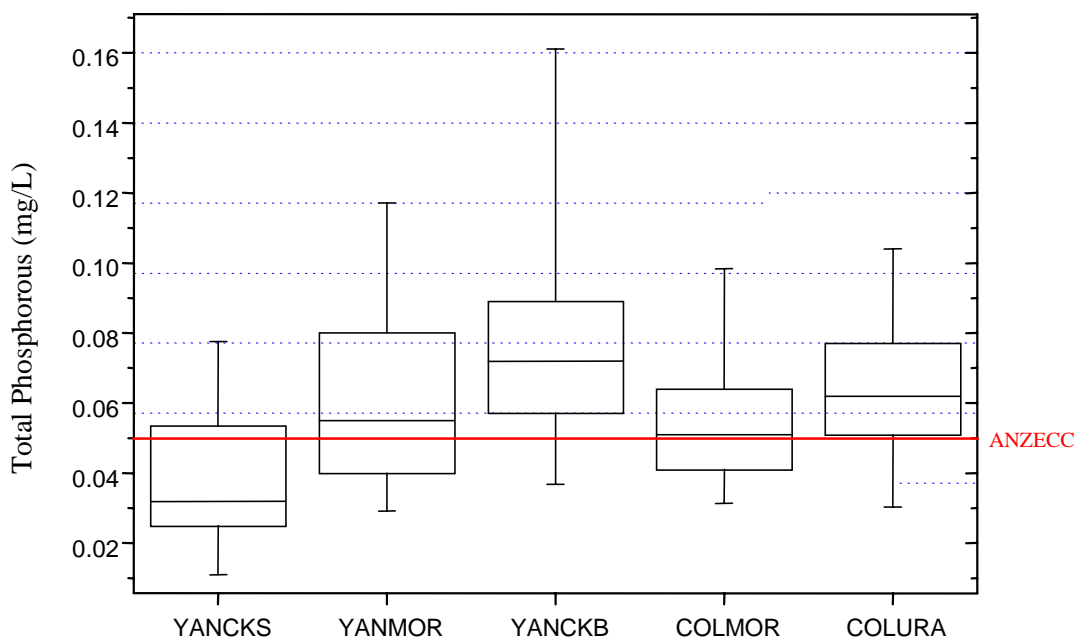


Figure 7. Total Phosphorous for Yanco-Colombo system 1993-2003

It is anticipated that phosphorous concentrations are directly related to elevated suspended sediment concentrations and, are best addressed through the same processes of flow management, bank stabilisation and reduced point source discharge.

pH

Water pH in the Yanco-Colombo system is generally neutral to slightly alkaline (Figure 8). However, samples were occasionally neutral to mildly acidic, particularly at the more downstream stations, perhaps indicating increased biological influences. All samples fell within ANZECC guidelines for ecosystem health (6.5-8.0).

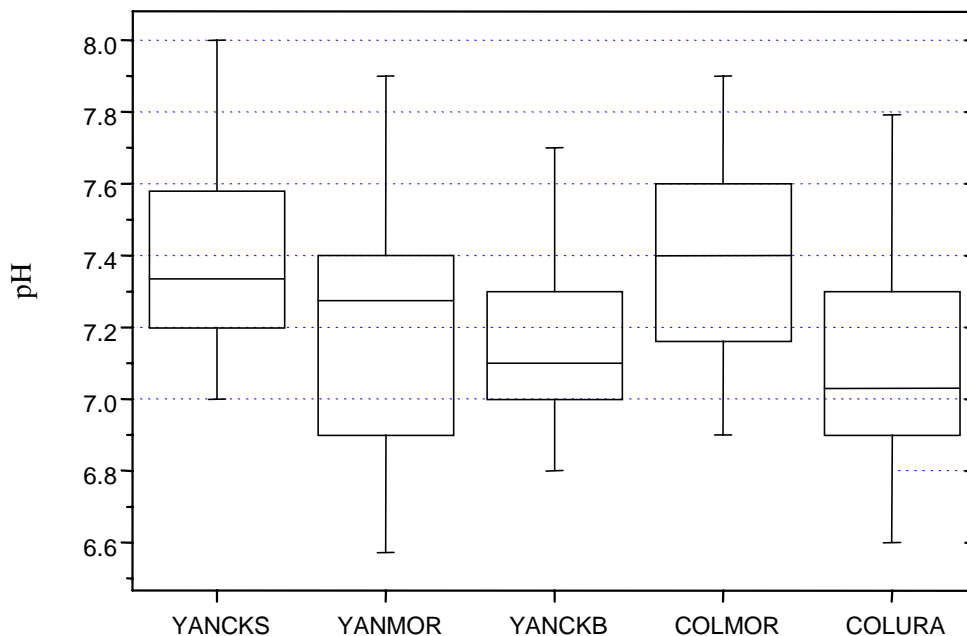


Figure 8. pH for Yanco-Colombo system 1993-2003

Dissolved Oxygen

Dissolved oxygen concentrations tend to decrease from upstream to downstream (Figure 9). It is suspected this is due to eutrophication processes associated with the input of nutrient rich water combined with reduced flow velocities and elevated water temperatures experienced in the lower reaches of each creek system. Under eutrophic conditions the rapid growth and multiplication of bacteria depletes the oxygen from the water, reducing the amount of saturated oxygen available for other organisms. Under extreme cases this may cause fish kills and mass mortality among other aquatic biota.

ANZECC guidelines recommend a lower threshold of 85% saturation for ecosystem health in lowland streams. Median dissolved oxygen concentrations at both COLURA and YANCKB are below this value, as are 25% of readings at COLMOR.

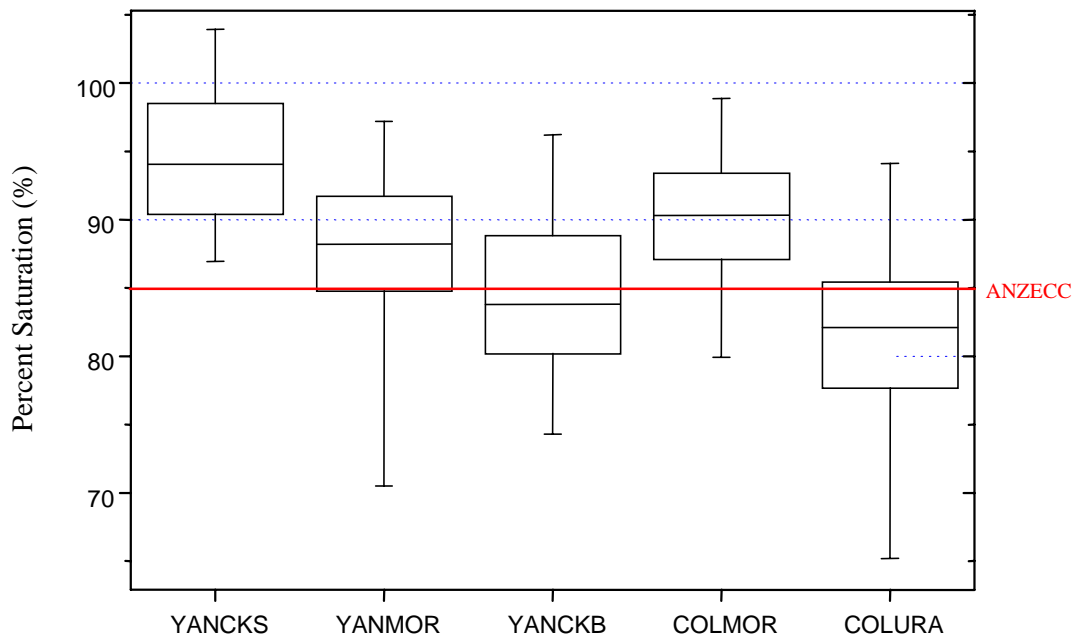


Figure 9. Dissolved Oxygen concentration for Yanco-Colombo system 1993-2003.

Electrical Conductivity

Salinity as electrical conductivity (EC) is highly variable throughout the system ranging from below 50 $\mu\text{S}/\text{cm}$ to 350 $\mu\text{S}/\text{cm}$. This variability is apparent at all sites indicating the influence of source waters from the Murrumbidgee River (Figure 10). Median EC at YANCKB is elevated relative to other sites perhaps indicating the influence of irrigation drainage from the Coleambally Irrigation Area. Low volume winter drainage is known to be highly saline due to groundwater interception between irrigation channels and a perched shallow groundwater lens.

ANZECC guidelines are quite variable for EC and the values obtained are not considered likely to have a significant impact on aquatic ecosystems, nor any agricultural, domestic or cultural uses of the water. The vast majority of readings fall below the median end-of-valley target of 245 $\mu\text{S}/\text{cm}$ specified in the Murrumbidgee Catchment Blueprint.

The results suggest that stream salinity is not currently a major issue within the Yanco-Colombo system. This may change if there is a significant increase in stream salinity in the Murrumbidgee River downstream of Narrandera, however this seems unlikely in the short term. Furthermore, actions implemented under the Murrumbidgee Catchment Blueprint, should lead to reductions in stream salinity and Irrigation Area discharge volumes.

One issue that needs to be addressed is the lack of continuous salinity and flow metering at the end of the Colombo system. This does not allow for end-of-valley discharge to be accurately determined. This is considered important, particularly if further water resource development in the region is likely.

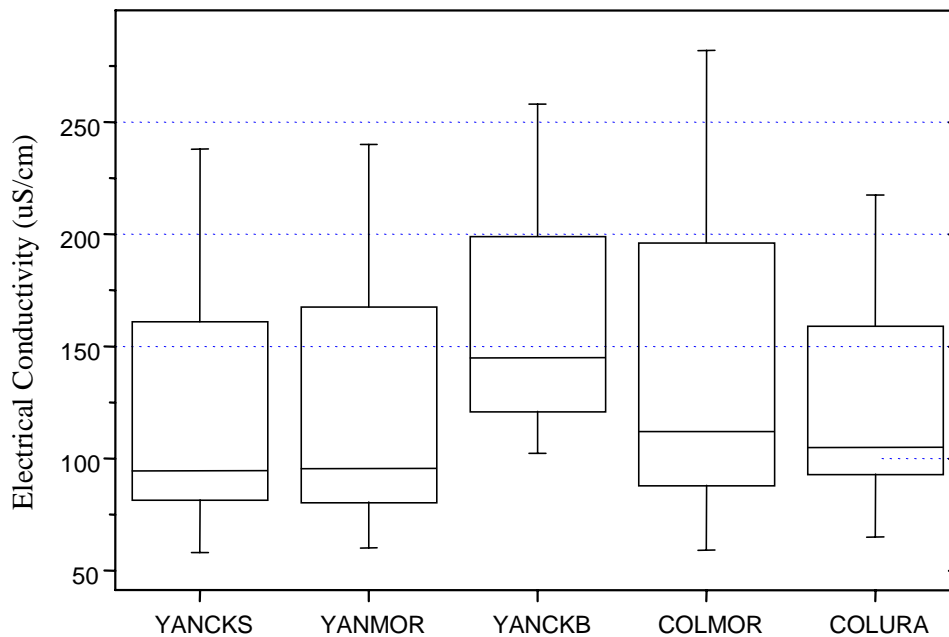


Figure 10. Electrical Conductivity Yanco-Colombo system 1993-2003

Summary of Water Quality

Water samples were collected and analysed by DIPNR from a total of 16 sites along the Yanco/Billabong Creek System. These included eight sites along the regulated portions of the Creeks System, seven sites on the drains from the Murray and Coleambally Irrigation Areas, and one site on the main tributary, being the Upper Billabong Creek. The parameters measured included salinity, nutrients, turbidity, dissolved oxygen, pesticides and biological indicators.

Salinity

The salinities generally increase with distance downstream, probably due to the combined effects of higher salinity inflows from tributaries, evaporation and groundwater inflows. This is presented in Appendix 8.

The salinities of inflows to the Creeks System from tributaries is quite variable and can be of poor quality for both human use and the environment (>1500uS/cm). In the Upper Billabong Creek the highest salinity flows from its headwaters occur in summer periods and are the result of dryland salinity. The creek flows will generally be low during these periods and the Upper Billabong Creek inflows will be substantially diluted by the regulated flows in Conargo Creek.

The salinity of flows in the drains from the irrigation areas is lower during the irrigation season than in winter because of the diluting effects of escapes and regulated releases from the channel systems. The higher salinity flows in the winter are due to saline groundwater discharges from the irrigation areas.

Stream salinity trends of streams in the Murray-Darling Basin have been calculated by Walker et al. (1998). These show that stream salinity in the Upper Billabong Creek is increasing by 5% per year, and by 3% per year in the lower reaches of the Billabong Creek. While this increase is one of the highest in the state, it appears that it is not causing high salinity increases in the lower portion as the salinity in the Murrumbidgee River at the Yanco Off-take is 3% per year increase also. The salinity threshold for various salinity classes of irrigation water have been specified for the National Water Quality Management Strategy (ANZECC, 1992) and are presented in Appendix 9.

In summary, the salinity of flows in the Yanco-Billabong Creeks Systems is generally low and most users would have little risk of salinity problems occurring. At worst, flows in the YCS are of medium salinity level, which may cause some yield reduction in low salt tolerant plant species. Salinity impacts on the aquatic ecosystem would be slight.

Nutrients

The total phosphorus (TP) concentrations of the Murrumbidgee River at the Yanco Off-take are similar to the concentrations that could be expected in undisturbed streams in the central plains zone (DIPNR, 1995), using the criteria developed for Preliminary Guidelines for Victorian Inland Streams (EPA, 1995).

Total Phosphorus concentrations of flows in the Yanco-Billabong Creeks System are significantly higher than those of the Murrumbidgee River and are generally above the threshold at which damage to the ecological community will occur (EPA, 1995). These elevated TP concentrations will increase the risk of algal blooms occurring in off-stream storages or in portions of the streams that are stagnant.

The maximum TP concentrations recorded in the Creeks System would provide very low phosphorus loadings on irrigation soils and there is no risk of the water being detrimental for irrigation supply due to nutrient concentrations.

Turbidity

In the regulated portions of the Yanco-Billabong Creeks System turbidity generally increases with distance downstream. Using the criteria developed for the State of the Rivers Report (DIPNR, 1995), the turbidity is good at the Yanco Off-take, poor in the upper reaches of the Creeks System and declines to very poor in the lower reaches.

By comparison with inland rivers, the Yanco-Billabong Creeks System is relatively turbid and is more turbid than the River Murray at the confluence with the Murrumbidgee (Mackay and Eastburn, 1990). This is possibly a reflection of bank erosion that is occurring at high flows that are maintained for extended periods in the Creek's System, but it is more likely attributable to the impact of common carp (*Cyprinus carpio*).

Test results showed that the Yanco-Billabong Creeks System flows would be unsatisfactory for domestic use, and would restrict growth of aquatic plants and the abundance of aquatic animals. The high turbidity flows possible would also cause clogging of irrigation pipes.

Dissolved Oxygen

The Dissolved Oxygen levels in the Yanco-Billabong Creeks System are generally within the healthy range and are fairly uniform throughout. The number of drain samples taken indicate that these flows are healthy.

Pesticides

A limited amount of pesticide sampling has been carried out in the Yanco-Billabong Creeks Systems, mainly at sites along the drains of the Murray and Coleambally Irrigation Areas.

On most sampling occasions in the Murray Irrigation Area, concentrations of pesticides were below the detection limits.

Molinate was the only chemical that exceeded the environmental guideline by at least one unit at five sites. These recordings are often due to rainfall events causing drainage waters to escape from rice bays.

Biological Indicators

Limited surveys conducted in the Yanco-Billabong Creeks System indicate that invertebrate fauna are in a healthy state.

Fish population data is collected at only one site in the regulated section of the Yanco-Billabong Creeks System on Colombo Creek. At this site approximately equal numbers of introduced and native fish species have been recorded in recent years. However, the introduced species were significantly larger in body weight compared to the native fish recorded.

Anecdotal reports have indicated that Golden Perch, Macquarie Perch and Murray Cod are species under significant stress in recent years. Common carp and Redfin to a lesser degree are considered to be the most common species (O'Connell, 1997).

Algae

Monitoring for algae in the Yanco-Billabong Creeks System has been carried out at 5 sites. These results show that no blooms of blue-green algae were recorded and that at most sites the algal count was at or below the Low Alert level. Compared to the River Murray, the Yanco-Billabong Creeks System has a relatively low abundance of algae, which may be related to the high turbidity of the Creeks system (O'Connell, 1997).

Pathogenic Micro-organisms

The measure of this is based on the suitability of water for drinking after measuring the concentration of bacteria, viruses, and protozoa. Guidelines for the maximum concentration of faecal coliforms have been prepared by ANZECC (1992) as follows:

Drinking water supplies	No faecal coliforms
Recreational water	150 faecal coliforms/100 ml
Irrigation and livestock water	1000 faecal coliforms/100 ml

Testing in the Yanco-Billabong Creeks System has been carried out at 15 sites. No samples exceeded the guidelines for irrigation and livestock watering. Overall, around 50% of the 96 samples taken through out the Yanco-Billabong Creeks System passed the guidelines for primary contact recreation (swimming) and there were no apparent trends of water quality decline through the Creeks System.



Plate 4: Diversion of flow by LWD, resulting in erosion and turbidity.

2.7 AGRICULTURAL IMPORTANCE

Irrigation has delivered substantial benefits to regional communities and the nation as a whole. In 1997, irrigated agricultural production in Australia was valued at almost \$9.4 billion with NSW contributing approximately \$2.7 billion of the total. According to the ABS, irrigated agriculture uses just 1.5% of agricultural land in NSW but accounts for nearly 35% of production.

The Murrumbidgee Valley is the major rice-growing valley in Australia and is renowned for its horticultural produce and wines. Irrigated agriculture covers just 4% of the area of the catchment but contributes 41.6% of the total production. Across the valley, agriculture is the second largest employer after retail, providing jobs for nearly 12% of the working population.

Agricultural production is the lynch pin of the economic prosperity enjoyed by many residents of the area. There are no statistics, which enable us to place a value on the agricultural production of the Yanco Creek and its Tributaries. We do know, however, that the YCS divert 2.57% of the water available for irrigation in New South Wales.

The area is the base of some of Australia's most famous Merino Studs. Tolhurst (1991) author of "Song of Running Water" describes YCS as "nurturing possibly the single most diverse strip of agricultural experiment and development in Australia". The establishment of irrigation into this area has enabled production of mixed cropping, irrigated pastures, rice farming, horticulture and viticulture.



Plate 5: Agriculture on the Yanco Creek System

Table 6 describes the approximate value of agricultural production on the Yanco Creek system based on the percent irrigated. The values are based on the Agricultural Census at 31 March 1999 and can be found on the website of the New South Wales Irrigators Council, (www.nswirrigators.org.au).

Table 6: Approximate Value of Irrigated Agriculture in the YCS

Crop	Total Value of Production in NSW	Percent Irrigated	Irrigated Value	YCS Approximate Production Value
Grapes	249,322,394	83.3%	207,733,027	5,338,738
Livestock Slaughtering	1,795,543,812	3.1%	55,985,520	1,438,827
Livestock Products	1,432,808,478	19.3%	275,909,357	7,090,870
Fruit (Excluding Grapes)	411,351,135	77.5%	318,885,796	8,195,364
Vegetables	251,120,019	82.5%	207,193,188	5,324,864
Pasture and Grasses	150,230,881	51.4%	77,200,936	1,984,064
Crops for Hay	47,549,115	24%	11,411,787	293,282
Cereals for Grain	1,888,005,143	23.2%	437,685,063	11,248,506
Other Crops	1,437,795,924	71.6%	1,055,364,696	27,122,872
Total Agriculture	7,699,726,901	34.4%	2,647,369,375	68,037,387

(NB: This has been calculated by taking 2.57% of the Agricultural Census figures for Total Value of Production in NSW as at 31 March 1999. 2.57% is the amount of water diversions. It is designed to give an indication of the likely value only.)

In economic terms, the value of that production to the communities along the creek system could be anywhere between \$204,000,000 and \$340,000,000.



Plate 6: The YCS provides water for vital agriculture and unique riparian ecosystems along its 800 km length.

2.8 INDIGENOUS SIGNIFICANCE

The major waterways of the Murray and Murrumbidgee River systems were the main source of food to the various tribal groups known to have lived in the area. The five main groups were Wiradjuri, Yota-Yota, Baraba-Baraba, Wamba-Wamba and Wadi-Wadi. Fish was the principal component of their diets for eight months of the year. As YCS was known to be an ephemeral stream prior to regulation, indigenous habitation was likely to be sporadic. These tribal groups may have exerted changes to the environment in the YCS as a result of burning shrub lands to flush out animals for hunting. Because of the Aboriginal people's dependence on the waterways for food, the riparian environment including the river bank, floodplains and lagoons along with nearby sand-hills, may contain culturally significant sites.

A significant piece of evidence of Aboriginal habitation in the YCS and associated tributaries was discovered in December 1989 when a human skull, that of a woman, was found in an excavation by Urana Shire Council in the lake bed of Lake Urana. In high flood events such as 1974 the Billabong can flood to the north and enter Lake Urana, which in turn spills into Lake Cockatoo before it enters the Colombo Creek. The thermoluminescence dating method used to date the human skull found it to be between 20,000-30,000 years old. This compares to ages of Aboriginal habitation found in Lake Mungo. (Page K Dare-Edwards T 1994) The NSW National Parks & Wildlife Service holds a data base to register and conserve known sites. The National Parks and Wildlife Act 1974 encapsulates all sites of Aboriginal significance registered or not, through legal requirement, to notify the discovery of any sites. Any consent process for works as a result of actions contained in the plan will adhere to existing protocols with regard to cultural significance.

In research of significance of the YCS had to Aboriginal communities and consultation with key indigenous contacts revealed no known information. Additionally, no recordings were available from a check of the NSW National Parks & Wildlife Service significant sites data base.

2.9 EUROPEAN SIGNIFICANCE

The Australian Heritage Commission has established a Register of National Estate. Heritage sites and items of State significance in NSW are listed on the NSW State Heritage Register. Local Councils can also identify and include locally significant sites and items on their Local Environment Plans. Although there is scant information on sites of European significance, it is imperative that they are considered in the implementation of this plan. Additionally, the significance of the YCS and its presence in the landscape along with the community's dependence on it for the past wealth and future sustainability of the region, makes it a "prized jewel" to local people.



Plate 7: "Old Coree" Homestead