Koondrook-Perricoota Forest Flood Enhancement Works

NSW Office of Water
and Forests NSW

Environmental Assessment

Volume 1

March 2010

FORESTS NSW

NSW GOVERNMENT | Office of Water

Certification

	Submission of Environmental Assessment Prepared under Part 3A of the Environmental Planning and Assessment Act 1979
Environmental assessment prepared by:	
Name	Peter Carson
Qualifications	BSc (Applied Geography) Hons
Address	GHD Pty Ltd 10 Bond Street Sydney NSW 2000
In respect of:	Koondrook-Perricoota Forest Flood Enhancement Project
Project to which Part 3A applies	
Applicant name	NSW Office of Water and Forests NSW
Applicant address	Forests NSW Locked Bag 21 Orange, NSW, 2800 NSW Office of Water GPO Box 3889 Sydney, NSW, 2001
Land to be developed	As described within the Environmental Assessment
Proposed development	Construction and operation of the Koondrook-Perricoota Forest Flood Enhancement Works
Environmental assessment	An environmental assessment is attached that addresses all matters in accordance with Part 3A of the Act
Certificate	I certify that I have prepared the contents of this document and to the best of my knowledge: ◗ It is in accordance with the requirements of Part 3A; ◗ It contains all available information that is relevant to the environmental assessment of the development to which it relates; and ◗ The information contained in the document is neither false nor misleading.
Signature	
Name	Peter Carson
Date	18 February 2010

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Abbreviations

AADT	Annual Average Daily Traffic
ACT	Australian Capital Territory
AHD	Australian Height Datum
AS	Australian Standard
BS	British Standard
CadnaA	Computer Aided Noise Abatement
CAMBA	China Australia Migratory Birds Agreement
CEMP	Construction Environmental Management Plan
Ch	Chainage
CH_4	Methane
CMA	Catchment Management Authority
CNG	Construction Noise Guidelines
CO_2	Carbon Dioxide
CSIRO	Commonwealth Scientific and Research Organization
dB(A)	Decibel
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEWHA	Commonwealth Department of Environment, Water, Heritage and the Arts
DII	Department of Industry and Investment
DGR	Director-General's Requirements
DNRE	Department of Natural Resources and Environment
DoC	Department of Commerce
DoP	Department of Planning
DWE	Department of Water and Energy
EA	Environmental Assessment
ECRTN	Environmental Criteria for Road Traffic Noise
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMP	Environmental Management Plan

EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
ERA	Environmental Risk Analysis
ESFM	Ecologically Sustainable Forest Management
EWG	Environmental Watering Group
EWMP	Environmental Works and Measures Program.
FDU	Flood Dependent Understorey
FMZ	Forest Management Zoning
FNSW	Forests NSW is a public trading enterprise within NSW Industry and Investment
GHG	Greenhouse Gas
GL	Gigalitre
GL/year	Gigalitre per year
GPS	Global Positioning System
ha	Hectare
HAZMAT	Hazardous Materials
Hz	Hertz
INP	Industrial Noise Policy
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JAMBA	Japan Australia Migratory Birds Agreement
kL	Kilolitre
km	Kilometre
km^2	Square kilometre
km/hr	Kilometres per hour
KTP	Key Threatening Processes
L	Litre
LEP	Local Environment Plan
LGA	Local Government Area
LOS	Level of Service
m^3	Cubic metre
MDB	Murray-Darling Basin

MDBA	Murray-Darling Basin Authority
MDBC	Murray-Darling Basin Commission
MDBMC	Murray-Darling Basin Ministerial Council
ML	Megalitre
ML/d	Megalitres per day
m/s	Metres per second
mm/s	Millimetres per second
MREP	Murray Regional Environment Plan
NEPM	National Environmental Protection Measure
NOW	New South Wales Office of Water
NPW Act	National Parks and Wildlife Act 1974
NSW	New South Wales
OEF	Outcomes Evaluation Framework
OH&S	Occupational Health and Safety
PEA	Preliminary Environmental Assessment
PM10	Particulate <10 micrometres
REP	Regional Environment Plan
RL	Reduced Level
RTA	Roads and Traffic Authority
SEPP	State Environmental Protection Policy
t CO_2-e	Tonnes of Carbon Dioxide Equivalent
TLM	The Living Murray
TSC Act	Threatened Species Conservation Act 1995
ug/m^3	Micrograms per cubic metre
vtpd	Vehicle Trips per Day

Glossary

Blackwater	Water containing a high concentration of organic matter, often accompanied by an initial depletion of oxygen.
Borrow pit	An excavated structure yielding soil for conditioning and use in construction.
Conditioning	Addition of water to soils at pre-determined rates to ensure it is suitable for levee construction.
dB	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	Frequency weighting filter used to measure ‘A-weighted’ sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
DGR	Director-General’s Requirements. Requirements for an environmental assessment issued by the Director-General of the NSW Department of Planning in accordance with the Environment Planning and Assessment Act 1979.
Emission	The release of material into the surroundings (for example, gas, noise, water).
Environmental flow	The water provision for an ecosystem that is adequate to sustain ecological values.
Environmental Management Plan	A document setting out the management, control and monitoring measures to be implemented during construction and/or operation of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
Environmental watering	Water entitlements legally set aside for the benefit of environmental values.
Environmental Works and Measures Program	The EWMP funds infrastructure to deliver and manage water at the icon sites to achieve The Living Murray First Step environmental objectives. This infrastructure includes regulating structures, water delivery channels and fishways and focuses on achieving environmental outcomes at the six icon sites.
Fishway	A structure placed in or around a constructed barrier to allow migration of fish.
FNSW	Forests NSW is within NSW Department of Industry and Investment.
Hardwood	Generally, one of the botanical groups of trees that have broad leaves, including eucalypts and wattles; also wood produced by such trees regardless of texture.
Icon Site	One of six sites identified under The Living Murray Initiative as having iconic value to the River Murray.
ISO 14001	International Organization for Standardization requirements for environmental management systems.

$L_{Aeq\ (Period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90\ (Period)}$	The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90\ (15\ min)}$.
Level of service	A qualitative measure describing operational conditions within a traffic stream.
Murray Darling Basin	Comprises the catchment of the Murray and Darling Rivers and their many tributaries, extending from north of Roma in Queensland to Goolwa in South Australia.
Murray Darling Basin Authority	The authority responsible for managing the Murray River system in cooperation with state authorities, with the aim of ensuring reliable water supplies for all users.
Murray River	The waters of the main channel of the Murray River and its bed and banks.
Noise Sensitive Place	*Noise sensitive place* means any of the following places— (a) a dwelling. (b) a library, childcare centre, kindergarten, school, college, university or other educational institution. (c) a hospital, surgery or other medical institution. (d) a protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest, under the *Nature Conservation Act 1992*. (e) a marine park under the *Marine Parks Act 1982*. (f) a park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment.
Particulate	Small particles, usually occurring in suspension.
Ramsar listing	A wetland listed under the Ramsar Convention on Wetlands; an intergovernmental treaty providing the framework for national action and international cooperation for the conservation and wise use of wetlands.
River Murray	The Murray River, the waters and the bed and banks of its tributaries and associated water bodies (including related anabranches, creeks, lagoons, lakes, billabongs and wetlands), as shown on the map.
River Red Gum	*Eucalyptus camaldulensis* also known as Red Gum.
River regulation	Control of water flow within a river having the aim of ensuring the health of the river as well as ensuring future water supply.
Softwood	Generally, one of the botanical groups of trees that have needles and bear cones, including pine, cypress and cedar.
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level of 20 micro Pascals.

Threatened species, populations and ecological communities	Species, populations and ecological communities specified in Schedules 1, 1A and 2 of the *Threatened Species Conservation Act 1995*.
Timber harvesting	The commercial cutting and removal of forest products authorised by Forests NSW.
Timber industry	“Forestry’ plus sawmilling and manufacturing / value adding and delivery of the final products to market.
Water year	A period from July to June, seasonally aligned and corresponding to water allocation policy in the River Murray system.

Executive Summary

Introduction

Gunbower-Koondrook-Perricoota Forest is Australia's second largest River Red Gum forest and covers approximately 50,000 hectares. It is listed as a wetland of international importance under the Ramsar convention and is one of six Icon Sites identified under The Living Murray Initiative. The importance of these six Icon Sites is reflected in the 2003 decision to commit $500 million to the first step of The Living Murray Initiative to recover 500 GL of water entitlements to improve environmental flows within these sites.

Gunbower-Koondrook-Perricoota Forest includes the Koondrook-Perricoota Forest (herein referred to as the 'Forest') which is located in NSW and has an area of about 32,000 hectares. It also includes the Gunbower Forest which is located in Victoria and has an area of about 18,000 hectares.

The Forest is of substantial importance to the local and regional community due to its ecological, social, cultural and economic values. However, it has been displaying signs of ecological stress for a number of years, including dead and dying limbs, loss of leaf cover and rigorous epicormic growth, along with a loss of flood dependent understory species, absence of waterbirds, and lack of waterbird breeding. This stress has been particularly evident in River Red Gum communities where there is evidence of tree mortality across large areas of the Forest.

Changes to the flow regime in the Murray River and its tributaries have significantly reduced the ecological health and productivity of the Koondrook-Perricoota Forest. This is primarily due to a reduction in the frequency and magnitude of flooding as a consequence of the long-term effects of river regulation and recent droughts. As a result, the existing flooding regime is inadequate to support flood dependent vegetation communities.

To conserve and enhance the current ecological condition of the Forest, a collective of NSW agencies and the Commonwealth has committed to delivering the Koondrook-Perricoota Forest Flood Enhancement Works (subsequently referred to as the 'project').

The project has been designed to enable controlled discharges of water from the Torrumbarry Weir pool on the Murray River to enhance the flooding regime within the Koondrook-Perricoota Forest. It would involve construction and operation of infrastructure that would have the capacity to divert up to 6,000 ML/d of water from Torrumbarry Weir pool into the Forest. The scheme would be operated to enhance the existing flood regime.

Location and setting

The Forest lies within the Murray Darling Basin which comprises the catchments of the Murray and Darling Rivers and their many tributaries, extending from north of Roma in Queensland, east to the Snowy Mountains in NSW, and south to Goolwa in South Australia. The Murray Darling Basin covers more than 1 million km^2 which is about one-seventh of mainland Australia.

The Gunbower-Koondrook-Perricoota Forest is located downstream of Torrumbarry Weir, between Moama and Barham on the NSW side of the border. The Murray River flows through the Forest, with Gunbower Forest on the southern side of the river in Victoria and the Koondrook-Perricoota Forest on the northern side of the river in NSW.

The Forest is located approximately 80 km southwest of Deniliquin.

The Living Murray Initiative

The Living Murray Initiative was established in 2002 by the Murray Darling Basin Ministerial Council (MDBMC) in response to concerns about the environmental and economic health of the Murray River System. It is a partnership of the Australian, New South Wales (NSW), Victorian, South Australian and Australian Capital Territory (ACT) governments. The Gunbower-Koondrook-Perricoota Forest was identified as one of six Icon Sites under the Living Murray Initiative due to its high ecological value as well as its cultural significance to Indigenous people and the broader community. It is an important breeding site for waterbirds and provides habitat for native fish, birds and plants.

Under The Living Murray initiative, improvements in health at the Icon Sites are to be achieved by recovering water for use at the sites and by investing in works to allow managed watering of sites and other environmental outcomes such as fishways. The target date for recovery of up to 500 GL (long term cap equivalent) of water entitlements was 2009 (MDBC, 2008) and the Audit of the Living Murray Implementation 2008-09 indicated that this is likely to be achieved by June 2010 (MBDA, 2009).

Project objectives

The project is part of The Living Murray Environmental Works and Measures Program (EWMP) which is implementing projects to water wetland and forest ecosystems by utilise engineering structures to supplement natural high flows or floods. This will enable ecosystems to be watered at the scale, frequency, timing and duration required to achieve environmental objectives developed for The Living Murray Initiative. Works undertaken as part of the EWMP include regulating structures, water delivery channels, and fishways.

The main objective of the project is to provide an adequate water regime to a representative area of River Red Gum forest that has, or historically supported, a flood-dependent understorey. This is consistent with the intent of objectives for the Gunbower-Koondrook-Perricoota Forest set under the First Step Decision of The Living Murray Initiative, and the Environmental Management Plan (MDBA, 2006).

Why enhance flooding in the Koondrook-Perricoota forest?

The ecological health of the Forest is in a state of decline. Annual surveys are undertaken to monitor the health of the Forest and in 2006 the results indicated that of the River Red Gums in the Forest:

- 19% were healthy;
- 59% were unhealthy; and
- 22% were severely stressed or dead.

The key reasons for the Forest being in a state of decline related to water stress due to lack of water supply from local rivers and creeks; low water levels; lack of groundwater re-charge and inadequate water attenuation across the floodplain.

Flooding the Forest would improve the ecological health of the Forest by enhancing the flood regime. These needs are aligned with The Living Murray Environmental Works and Measures Initiative and the objective of enhancing flood events to help achieve wider ecological objectives.

The effects of drought and river regulation

Changes to the flooding regime due to the long term effects of river regulation as well as the recent effects of drought have been identified as the main factors contributing to the water stress that has resulted in the decline in the ecological health of the Forest. The Icon Site Environmental Management Plan (MDBC 2006) identifies inappropriate water management as a threat to achieving the interim objectives for the Forest defined under The Living Murray.

The effect of river regulation has been to significantly reduce the size, frequency and duration of flood events. This has changed vegetation distribution and health, and reduced the abundance and diversity of waterbirds, native fish and many other fauna species.

Analysis of hydrological data for the period 1891 – 2008 shows that river regulation has resulted in an average reduction in magnitude of flows in late winter and early spring. Average flows for September have dropped from approximately 37,000 ML/day to approximately 28,000 ML/day downstream of Torrumbarry Weir. Without the effects of climate change, flows are predicted to fall to approximately 21,000 ML/day as the impact of river regulation takes affect on the long-term average.

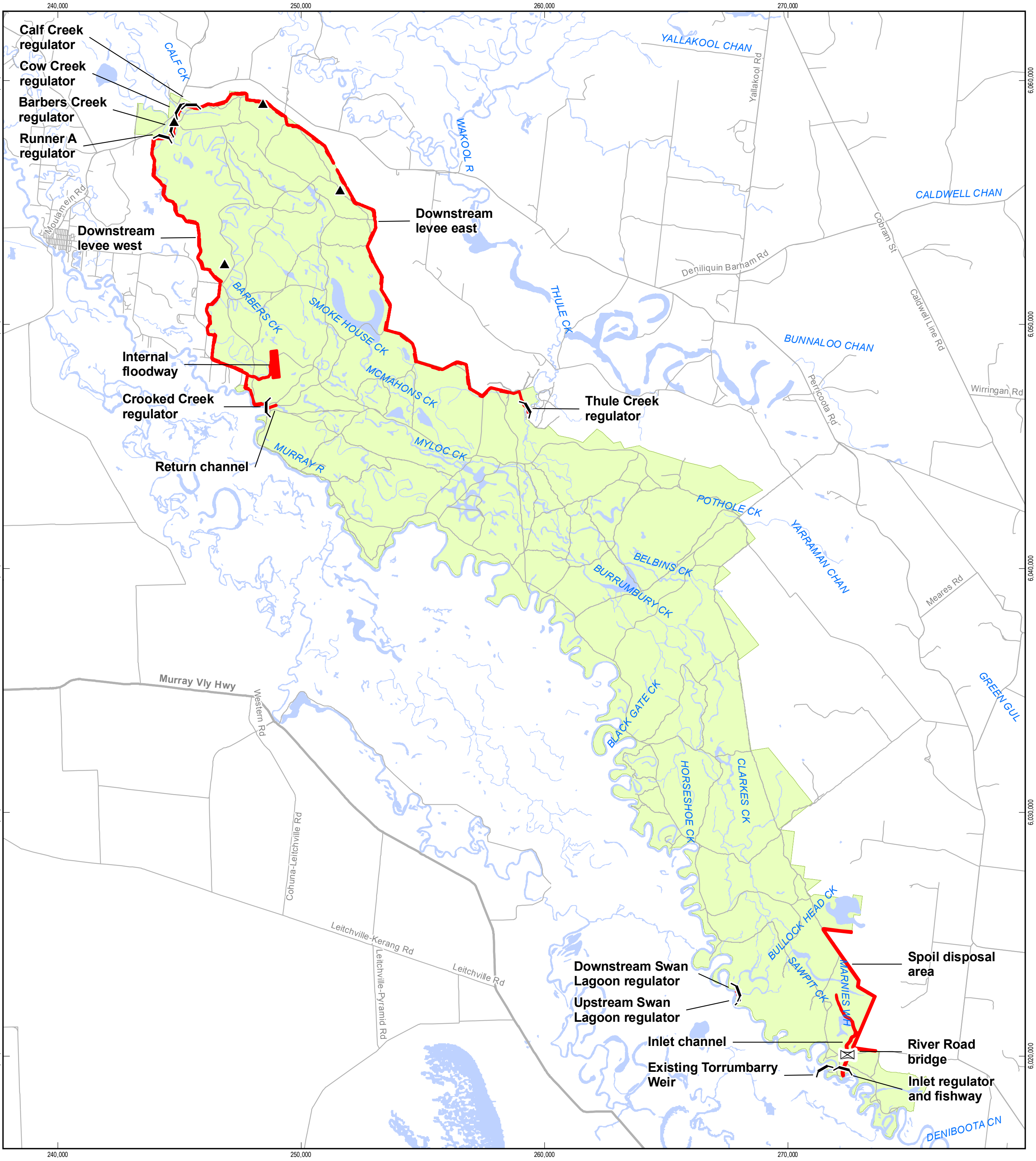
Predicted flows under the CSIRO Median Climate Change scenario have been modelled. Average flows for September are predicted to fall to approximately 12,000 ML/day under the influence of climate change. The frequency of effective, large scale flooding (flows >30,000 ML/day downstream of Torrumbarry Weir) has reduced by 61% and is predicted to occur in only 7% of years under climate change. This means there would be an 87% reduction compared to the natural frequency of flood flows.

To address the effects of river regulation and improve the ecological condition of flood dependent vegetation communities within the Forest, there is a need to enhance the frequency, duration and magnitude of flooding.

How would flooding of the Forest be enhanced?

The project would operate by diverting water into the Forest from the Torrumbarry Weir pool. Water would flow through the Forest and be discharged either directly to the Murray River, or to Barbers Creek. The main structures that would form part of the project are shown in Figure ES-1. The depth and duration of inundation would vary depending on the desired ecological response and water availability.

The project has been designed to enable flexible operations and there is no single way to operate the project. Operating strategies would target the long-term achievement of the interim ecological objectives and respond to water availability, watering history, requirements of the Forest, risks and engineering constraints.



Legend

- ▲ Turkey's nest dam
- ⊠ River Road bridge
- Regulator
- Construction features
- Roads
- Waterway
- Koondrook Perricoota Forest Site

0 1 2 4
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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NSW Office of Water
Koondrook-Perricoota Flood Enhancement Works

Job Number	21-18573
Revision	C
Date	01 FEB 2010

Figure ES 1 Location of the main structures

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Dept of Commerce, Street Map- Navtec, Drawn: Cwilson, cwilson

The overarching objective for the project is to maintain and restore a mosaic of healthy floodplain communities. To achieve this, operations would be in accordance with an Operating Plan (NSW Public Works, 2009) developed specifically for the project. The purpose of the Operating Plan is to provide a framework for the operation of the structures to meet key ecological objectives within the broader context of The Living Murray Initiative and Scheme's governance. It would provide an effective platform for operational decision making based on knowledge development and a strong understanding of what the project should aim to achieve.

An important component of the Operating Plan will be to ensure that the ecological response to watering events is monitored and evaluated against the objectives for the event. In line with adaptive management principles, it is important to be able to alter the operation of the structures, both during events and from one operation to the next, in order to react to the ecological response observed. The ability to plan for, and respond to, varying ecological objectives would be a key function of the Operating Plan.

With reference to hydrologic conditions in the Murray River downstream of Torrumbarry Weir, operation of the project during individual events would occur in one of three general ways:

- For flow events <18,000 ML/day, water can be delivered to the Forest through the inlet channel. This is referred to as an 'entirely managed' event, as flows in the Murray River would not be of sufficient magnitude to naturally enter the Forest;
- For flow events >18,000 ML/day, water can enter the Forest through natural watercourses/effluents and potentially be supplemented with water delivered through the inlet channel. This is referred to as one of many 'hybrid' events, as water would enter the Forest via natural low points in the landscape, as well as via the structures that form part of the project; and
- For larger flood events >35,000 ML/day water enters the Forest via overbank flow and the flood enhancement project infrastructure would not be operated. As the infrastructure would not be operated during these events, they are referred to as 'uncontrolled' events.

The natural flow regime at the site provides a guide to the water requirements of the existing ecological processes and communities. The flow regime is highly variable and comprises floods of various magnitudes and durations that occur at a range of frequencies. In general, small floods are more frequent than larger floods.

The project has been specifically designed to achieve the project objectives by providing the flexibility to operate over a range of flows. Allowing the project to operate at varying magnitude, duration and timing would ensure effective and measurable environmental outcomes are delivered across a broad range of available water demand scenarios.

The structures have been designed to simulate flood events of variable size. It is intended that large flood events would occur every three to four years and that smaller events would occur more frequently. Some of the flooding scenarios that are proposed are:

- Frequent low flows to maintain the wetland habitats occurring in lagoons, depressions and flood runners;
- Less frequent floods of medium magnitude to maintain the extent of the River Red Gum communities, with larger floods maintaining the extremities, and smaller floods supporting the core areas with flood dependent understorey communities; and

- Flood events of long duration to initiate and facilitate bird breeding.

This Environmental Assessment assesses the impacts of one possible operating scenario which is an entirely managed flood event involving the maximum possible in-flows of 6,000 ML/day via the inlet channel. The large flood events would be capable of inundating of up to 52% of the Forest. The maximum maintainable inundation would be approximately 41% of the Forest (approximately 16,000 ha) for a period of about 100 days.

This event would have a total cycle of flooding and recession of approximately 235 days and is expected to require approximately 466 GL of water. It is predicted that the requirements of the Forest would account for 225 GL (evaporation and infiltration), and 222 GL would be returned to the Murray River. The flooding is expected to result in numerous ecological benefits, such as improved forest health and encouraging bird and fish breeding.

This operating scenario was selected as the basis for the Environmental Assessment as it would be the largest operate the infrastructure at its design limit. This would achieve the maximum extent and duration of inundation which is required to meet the project objectives. This event would be between the 1991 flood event which had an annual recurrence interval of less than two years, and the 1993 flood event which had an annual recurrence interval of about 1 in 10 years.

Various combinations of managed, hybrid and uncontrolled events would be possible; however the fully managed maximum inundation upon which this Environmental Assessment is based is the event of maximum controlled manipulation.

As the project would be within a regulated river system that is operated for multiple outcomes, there are a range of risks and trade-offs that need to be managed. These risks would be managed by implementing a design that enables highly varied and flexible operations which provide the opportunity to implement adaptive management principles in response to factors such as:

- Differing water availability and river conditions;
- Risk management requirements; and
- The targeting of specific environmental outcomes (e.g. vegetation response, bird or fish breeding events) that may be required from time-to-time to achieve long term objectives.

What are the statutory requirements?

The project is subject to approval under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This Environmental Assessment has been prepared in accordance with the requirements of Part 3A of the EP&A Act and supports an application to the NSW Minister for Planning for project approval to construct and operate the project.

The Environmental Assessment addresses the requirements of the Director-General of the NSW Department of Planning (the Director-General's Requirements), issued under Section 75(F) of the EP&A Act, dated 22nd of May 2009.

How were key issues for the Environmental Assessment identified?

The Director-General's requirements identified key environmental issues that would require detailed impact assessment under Part 3A of the EP&A Act. During preparation of the Environmental Assessment, a risk workshop was held to assess the key issues and assign a level of risk against each issue. Risks were also identified through other processes prior to gaining Director-General's requirements, such as development of the Investment Proposal (DWE, 2008), and the ecological risk assessment for the Murray Darling Basin Authority (MDBA).

Key environmental issues

Ecology

The Koondrook-Perricoota Forest is considered to be in poor ecological health due to the effects of river regulation and drought. By enhancing flooding to the Forest, approximately 16,000 ha would be inundated during large flood events that would occur every three to four years, interspersed with smaller events. This would improve the health of River Red Gums, Black Box and associated understory species. It would also improve the health of floodplain marshes and growth and reproduction opportunities for associated wetland biota, and increase migration and breeding opportunities for waterbirds, frogs and other floodplain and aquatic biota. Overall, the project would improve habitat resources for floodplain biota, including many terrestrial fauna, due to a general increase in floodplain health and productivity.

Adverse impacts would focus on disturbance of native biota within a construction corridor of approximately 206 ha. This would involve removal of native vegetation, including permanent removal of 8 ha of Inland Grey Box Woodland which is listed as an endangered ecological community under the *Threatened Species Conservation Act 1995*. Impacts on this community would be offset as it would not benefit from the enhanced flood regime. The biodiversity offset strategy has been developed in consultation with Department of Environment, Climate Change and Water (DECCW). This would include a 149 ha offset site within the former Toorangabby property in the Perricoota State Forest that contains 'like for like' vegetation communities to those that would be disturbed, including 94 ha of Inland Grey Box Woodland. In addition, the offset strategy would provide habitat for terrestrial fauna and River Red Gum communities.

Hydrological modelling indicates that approximately 190 hectares of Inland Grey Box Woodland, a listed endangered ecological community, would be inundated out of approximately 951 ha at the Forest. Under natural conditions, large floods inundate this community but it generally occurs on higher, less frequently flooded levees and terraces. The duration of inundation arising from the project is unlikely to result in significant or irreversible impacts on local populations of Inland Grey Box Woodland.

There is the potential for adverse impacts on water quality due to blackwater events that have the potential to lead to mortality of aquatic organisms. Blackwater events would occur at the end of watering events and adverse impacts would need to be balanced against the substantial positive impacts that would result from enhancing the flood regime to improve the ecological health of a Forest. The Operating Plan would include measures to ensure that watering events are managed to minimise the potential for blackwater events to occur. This would involve ensuring that large flood events are initiated during winter and spring when blackwater conditions are less likely to develop.

Hydrology

The Murray River defines the hydrology of the Forest via flow into overflow streams across the Forest and overbank flow onto the floodplain during large flood events. Flooding restores soil moisture reserves necessary for tree growth and sustains wetland habitats.

Floods occur as two main types of flow pattern: channel flow, and broad-area flooding. Flow of floodwater through the Forest is dominated by the Burrumbury-Barbers Creek system and water sourced naturally from the Swan Lagoon on the Murray River.

Murray River flow, as it relates to the hydrology of the Forest, is measured at the MDBA gauging station downstream of Torrumbarry Weir and is expressed in mega litres per day (ML/day). Flows at Torrumbarry Weir have been significantly lower since January 1997 than those observed over the previous 20 years. The lack of high, flooding flows (defined as mean monthly flow > 30,000 ML/day) during the last 10 years has been significant.

The project would deliver positive hydrological impacts within the Forest by allowing a flood regime to be implemented that is more representative of natural conditions.

The key potential impacts to hydrology arising from this project include:

- Changes to Murray River flows and levels downstream of the Forest due to the diversion of water into the Forest and return of water directly to the Murray River;
- Changes to the extent of flooding and potential impacts to surrounding land use due to the proposed flooding regime; and
- Impacts on the Barbers Creek system and the hydrological regime outside the Forest due to the operation of the downstream regulators.

Management measures have been developed during design of the project to minimise risks during construction and operation. These measures include ensuring that the project has the flexibility to operate over a wide range of hydrological conditions to maximise benefits associated with the timing, duration, extent and frequency of inundation. This flexibility would also allow the project to be operated to minimise adverse impacts. The return channel would allow water to circulate within the Forest to assist aerating the water and help prevent the symptoms of blackwater or green algal blooms, which lead to poor water quality.

Water would be sourced from existing entitlements within a regulated system to ensure that allocations of other licensees would not be affected.

The project has been designed to minimise the impacts on the Murray River flow conditions downstream of the Forest boundary. Water would be returned directly to the Murray River via the return channel from Crooked Creek to improve system efficiency and provide greater flexibility to control the level and duration of inundation of the Forest area without having to pass large flows into Barbers Creek.

The project would enhance flooding conditions and has been designed to minimise changes to the spatial extent of flooding relative to a comparable natural event. The position of the downstream levee was selected to maximise the area of forest that would be inundated, and minimise the area of private property affected and reduce the area of vegetation required to be cleared. The western portion of the levee would be located in the vicinity of an existing licensed levee that protects the town of Barham from floodwaters. As such, Barham would be provided with an improved level of flood protection as the downstream levee would have a higher standard of construction and maintenance relative to the existing levee.

Impacts on the hydrological regime of Barbers Creek would be managed by restricting the release rate of water into the system during the event assessed in the Environmental Assessment to a maximum of 250 ML/day. This would minimise the risk of damage to downstream infrastructure such as block banks. Flows in excess of 250 ML/day may pass down Barbers Creek during hybrid or uncontrolled events.

The project has been specifically designed to provide the flexibility to operate over a range of flows to ensure that effective and measurable environmental outcomes are delivered using a broad range of available water. This flexibility is detailed in the Operating Plan and would ensure that adaptive management principles are implemented to effectively minimise potential impacts.

Water quality

The Environmental Assessment identified four key issues that have the potential to result in negative impacts on water quality during construction and operation of the project. These are:

- Turbidity - arising from the erosion of sediments during construction and operation which would be released into creeks and rivers;
- Salinity arising from saline groundwater or soils;
- Blooms of potentially toxic blue-green algae (Cyanobacteria); and
- Blackwater events - A blackwater event could be triggered by leaching of organic material from plant litter accumulated on the Forest floor and shallow warm water temperatures.

Turbidity

Within floodplain river systems, water movement over the floodplain is often slow and sediment tends to be deposited rather than eroded. While the project has the potential to lead to elevated turbidity levels during both construction and operational phases, in general, risks to water quality from sediment are considered of low consequence. This is because much of the transported sediment would be deposited within the Forest during the period while the water is retained and thus would have little impact on the river downstream.

The Forest would be a net sediment trap rather than a sediment source. The impact of erosion from construction sites is likely to be short term and only contribute to downstream turbidity where the source is near the discharge point.

Salinity

The risk of the project increasing river salinity is considered to be low because the Electrical Conductivity (EC) impact is less than 0.1 µS/cm. Previous assessments of the risk of salinisation from groundwater have concluded that the Forest appears to be primarily a groundwater recharge area rather than a discharge area. Consequently, there is little risk of the seepage of saline groundwater from the area entering either the Murray River or other streams in the area.

Construction of infrastructure would not involve excavations deeper than 5m below ground level. As typical groundwater depths in the Forest are between 7 - 12m below ground level, groundwater is unlikely to be affected during construction.

Blue-green algae

Water quality parameters that would be important in influencing algal growth include nutrient concentrations, which would influence the size of the algal standing crop, and the ratio of phosphorus to nitrogen, with higher relative phosphorus levels tending to favour cyanobacteria many of which can fix atmospheric nitrogen. Light penetration into the water would be influenced by the colour and turbidity level of the water.

During the initial stages of flooding, there is likely to be some discolouration of water as organic matter is disturbed by flood waters. As the organic matter slowly breaks down it would release nitrogen into the water column that would lead to discolouration. If these conditions prevailed and the water contained elevated levels of total nitrogen and phosphorus, the risk of algal blooms would increase. Based on the nutrient values in the Torrumbarry Weir pool, existing water quality is unlikely to lead to blue-green algal blooms forming in the Forest during operation of the project.

Blackwater events

Blackwater events were modelled for the project using a model adapted from the one developed by Howitt et al. (2007) to predict the occurrence of blackwater events at Barmah-Millewa Forest. The model was adjusted so the hydrological inputs reflect the operational scenario for the Koondrook-Perricoota Forest.

The key output parameter of the blackwater model is the dissolved oxygen concentration, which can trigger fish kills if it drops below about 2 mg/L. For most of the modelled scenarios, dissolved oxygen dropped below this level either in January or February as water temperatures rose, or where there had been no prior flood for two years, so there were higher amounts of accumulated organic material on the floodplain to leach dissolved organic carbon. As a result, the seasonality of flood events is considered to be the main factor determining whether a blackwater event is likely to occur.

Blackwater events may arise both on the inundated floodplain and in downstream channels. The extent to which they occur in downstream channels would depend on the dilution of the released blackwater in the receiving channel, and the concentration of dissolved oxygen in the receiving water, which depends on water temperature.

Whether the return of water to the Murray River, Barbers Creek or other channels causes an environmental issue would also depend on the season and river conditions at the time of release. For the Murray River, the release is least likely to create an issue if it occurs when river water levels are high because this would maximise the dilution potential and river turbulence which enhances re-aeration.

Releasing the floodwater when water temperatures are cold would also lessen the risk of impacts associated with blackwater events because dissolved oxygen concentrations in both the released water and the river would be maximised. However, if the floodplain water is released when water temperatures are high and river flows are low, impacts such as fish kills are more likely.

The blackwater model did not allow predictions of downstream impacts on the Murray River from releases via the return channel or Barber Creek/Wakool system. When the return channel is operating at maximum flow rates of 1,850 ML/day, flows in the Murray River downstream of the Torrumbarry Weir are likely to be at least 5,000 - 6,000 ML/day. As a result, blackwater would be diluted by flows in the Murray River.

If blackwater is released down Barbers Creek at the maximum rate of 250 ML/day, it would flow approximately 58 km downstream before being diluted by the Wakool River, which is likely to have flows in the order of 500 – 600 ML/day at the time of year the project is likely to operate. If flows from the Merran Creek system are entering Barbers Creek upstream of the confluence with the Wakool River, this would assist in diluting blackwater.

The project would be operated in accordance with an Operating Plan. A fundamental component of the Operating Plan is to plan for events such that the benefits are maximised and adverse impacts are minimised. As detailed in the preliminary Operating Plan, flood events would be targeted towards winter and spring events to minimise the likelihood of blackwater events occurring. Controlling the seasonality of flood events is considered to be the most effective method of mitigating the impact of blackwater events.

The Operating Plan would include a comprehensive monitoring program that would provide input to a blackwater model developed specifically for the project. The model would be continuously refined to enable it to function as an operational tool to predict the timing, duration and extent of blackwater events. The outputs of the model would be used to refine watering events to minimise the potential for blackwater to occur.

The Operational Plan would include a procedure to be implemented in the event that blackwater conditions are observed. This would lead to involve a multi-agency coordinated response using the best available scientific information.

Soils

Soils in the Forest are generally classified as medium to heavy clays from the surface to 3-3.5m below ground level. These overlay coarser grained materials. Soil layers vary greatly in depth and extent, reflecting the complicated and often indistinct drainage pattern.

The majority of soil units within the Forest have a slight to high erosion hazard potential but no significant erosion was observed.

All soils within the Forest have an element of total dissolved salts, although these levels are not considered to be elevated. The washing of salts during flood events is considered to be the most influential process in the potential delivery of salt to the Murray River via flooding of the Forest. Average soil salinity for soils at 10 cm below the surface was 100 µSm/cm, or approximately 100 kg/ha. The wash off of salt from soils in the Forest during operation of the project would not deliver all the stored salt back to the river as much stays stored and/ or moves downward through the soil profile.

Although acid sulphate soils are known to occur in the region, they are not known to occur within the Forest. Management measures would be developed to ensure that any acid sulphate soils encountered during construction are appropriately managed.

Spoil and waste management

Construction would generate waste including spoil, timber, water and other miscellaneous construction waste. Approximately 800,000 m^3 of material would be required to construct the downstream levee, the majority of which would be sourced from borrow pits adjacent to the levee alignment. Approximately 123,000 m^3 of material excavated for the internal floodway would be reused in construction of the downstream levee.

Approximately 250,000 m^3 of spoil would be generated by construction of the inlet channel and this is likely to be deposited adjacent to an existing levee.

Construction would require removal of vegetation within the construction corridor. Management measures would be implemented as part of the Construction Environmental Management Plan to minimise the area of vegetation impacted by construction. Details of how the residual green waste would be used would be determined during construction planning. Where possible, recoverable timber would be sold commercially and residues may be used for purposes such as use in resnagging projects. Burning off would not be undertaken as part of the project.

Indigenous heritage

Known items of Indigenous heritage identified and recorded as part of field surveys include evidence of long-term Indigenous occupation (scarred trees, middens, burial sites). Construction is not expected to damage any items of indigenous heritage significance.

Representatives of Indigenous groups would be present on site during construction to monitor excavations and advise of the presence of any items of significance to the Aboriginal community.

Project justification and conclusions

The project is needed at a regional level because unless action is taken to restore extensive flooding to the Forest, the ecological condition of the NSW component of the Gunbower-Koondrook-Perricoota Forest Icon Site would continue to decline. Although low to medium size floods would occur in the absence of the project, these are unlikely to provide the frequency, volume or duration of flows needed to meet the water requirements of significant areas of the forest. Maintaining the ecological health of the forest is essential for retaining the cultural, social and economic values for which Gunbower-Koondrook-Perricoota Forest Icon Site is recognised (DWE, 2009).

The project has been designed to achieve the requirements of the interim objectives set by the MDBMC as part of First Step for the Living Murray. The overarching objective for the Gunbower-Koondrook-Perricoota Icon Site is to "Maintain and restore a mosaic of healthy floodplain communities." The interim ecological objectives for the Forest are:

- 30% of River Red Gum forest in healthy condition and 80% of permanent and semi-permanent wetlands in healthy condition;

- Successful breeding of thousands of colonial waterbirds in at least three years out of ten; and
- Healthy populations of resident native fish in wetlands.

The project is considered to be the most effective mechanism to achieve these objectives as it would have the flexibility to operate over a wide range of flows to enhance the existing flow regime. It would be capable of managing a large flood event that would inundate approximately 52% of the forest every three or four years to meet the interim objective of 30% of River Red Gum forest in healthy condition. These large flood events would be of sufficient duration to trigger colonial waterbird and fish breeding events. The project would also be able to convey small flood events on a more frequent basis to assist in maintaining wetlands in a healthy condition. It would deliver water in a manner that would support recruitment and long term survival of wetland dependent flora and fauna across the Icon Site. It would also provide habitat for species that use the site as a refuge.

The design would enable flexible operation to respond to the following conditions and issues:

- Changes in water availability that may enable the watering activity to be extended or varied to achieve additional or different environmental outcomes;
- Monitoring environmental outcomes;
- Monitoring and response to environmental risks; and
- Monitoring impacts on third-parties (e.g. impacts on downstream landholders or other communities) (MDBA 2009).

Operation of individual events would target specific environmental outcomes and different events would target different outcomes. For example, short duration events would target maintenance flows to vegetation, while longer duration events would provide conditions for successful bird breeding. To achieve long term objectives, planning for future watering events would give careful consideration to the environmental outcomes of previous events.

The next steps

The NSW Office of Water and Forests NSW are seeking approval from the Minister for Planning for the construction and operation of the Koondrook-Perricoota Forest Flood Enhancement Works. The next steps of the process are:

- **Exhibition of the Environmental Assessment** for a minimum of 30 days and invitation to the community and interested stakeholders to make submissions.
- **Consideration of submissions** that are received by the Director-General of the Department of Planning. The proponents may then be required to prepare and submit:
  - A Submissions Report, which contains responses to issues raised in the submissions, and/or further design development.
  - A Preferred Project Report, outlining any proposed changes to the project to minimise its environmental impacts.
  - A revised Statement of Commitments.

- **Determination of the Environmental Assessment**. The Director-General of the Department of Planning provides an assessment report on the Environmental Assessment to the Minister for Planning, who then makes a decision on the project and, if approved, can set Conditions of Approval.

Consultation with the community and stakeholders would continue throughout the construction phase and operational phase of the project.