

# Executive Summary

## Contents

<b>1</b>	<b>INTRODUCTION</b>	<b>2</b>
<b>2</b>	<b>THE ACTION</b>	<b>2</b>
<b>3</b>	<b>MODERNISATION OF THE GMID</b>	<b>2</b>
<b>4</b>	<b>PROJECT CONTEXT</b>	<b>5</b>
<b>5</b>	<b>THE PRE-MODERNISED IRRIGATION SYSTEM AND THE ENVIRONMENT</b>	<b>6</b>
<b>6</b>	<b>DESCRIPTION OF THE ACTION</b>	<b>8</b>
<b>7</b>	<b>APPROACH TO MANAGING POTENTIAL ENVIRONMENTAL IMPACTS</b>	<b>10</b>
<b>7.1</b>	<b>Water Change Management Framework</b>	<b>10</b>
<b>7.2</b>	<b>Environmental assessment approach</b>	<b>10</b>
<b>7.3</b>	<b>Matters of national environmental significance</b>	<b>13</b>
<b>7.4</b>	<b>Results of environmental assessment</b>	<b>13</b>
7.4.1	Localised effects to wetlands and waterways	13
7.4.2	Potential changes to hydrology	15
7.4.3	Potential ecological impacts to MNES	19
7.4.4	Ramsar wetlands in South Australia	24
<b>8</b>	<b>PROJECT BENEFITS</b>	<b>24</b>
<b>9</b>	<b>CONCLUSION</b>	<b>24</b>

## Figures

Figure 1:	Location of the GMID showing the six irrigation areas, water districts, major storages and diversion points	3
Figure 2:	Elements of modernised operation	9
Figure 3:	Location of wetlands and waterways requiring Environmental Watering Plans (river lengths requiring EWP's are indicative only)	14

## Tables

Table 1:	Summary of current effects of the irrigation system on the environment	7
Table 2:	Summary of hydrological and salinity effects to surface water	15
Table 3:	Summary of hydrological effects to groundwater	17
Table 4:	Likelihood of significant impact on MNES	20

## Executive Summary

### 1 Introduction

This Public Environment Report (**PER**) has been prepared for the Commonwealth Department of the Environment, Water, Heritage and the Arts (**DEWHA**) for the assessment and approval of an action that may have an impact upon matters of national environmental significance (**MNES**) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**).

The controlling provisions under the EPBC Act were determined to be:

- wetlands of international importance (sections 16 and 17B)
- listed threatened species and communities (sections 18 and 18A)
- listed migratory species (sections 20 and 20A).

This PER has been prepared in accordance with the Guidelines issued by DEWHA on 24 December 2009.

### 2 The action

The proposed action is the modified operation of the fully modernised Goulburn Murray Irrigation District (**GMID**) in northern Victoria to be delivered by the Northern Victoria Irrigation Renewal Project (**NVIRP**).

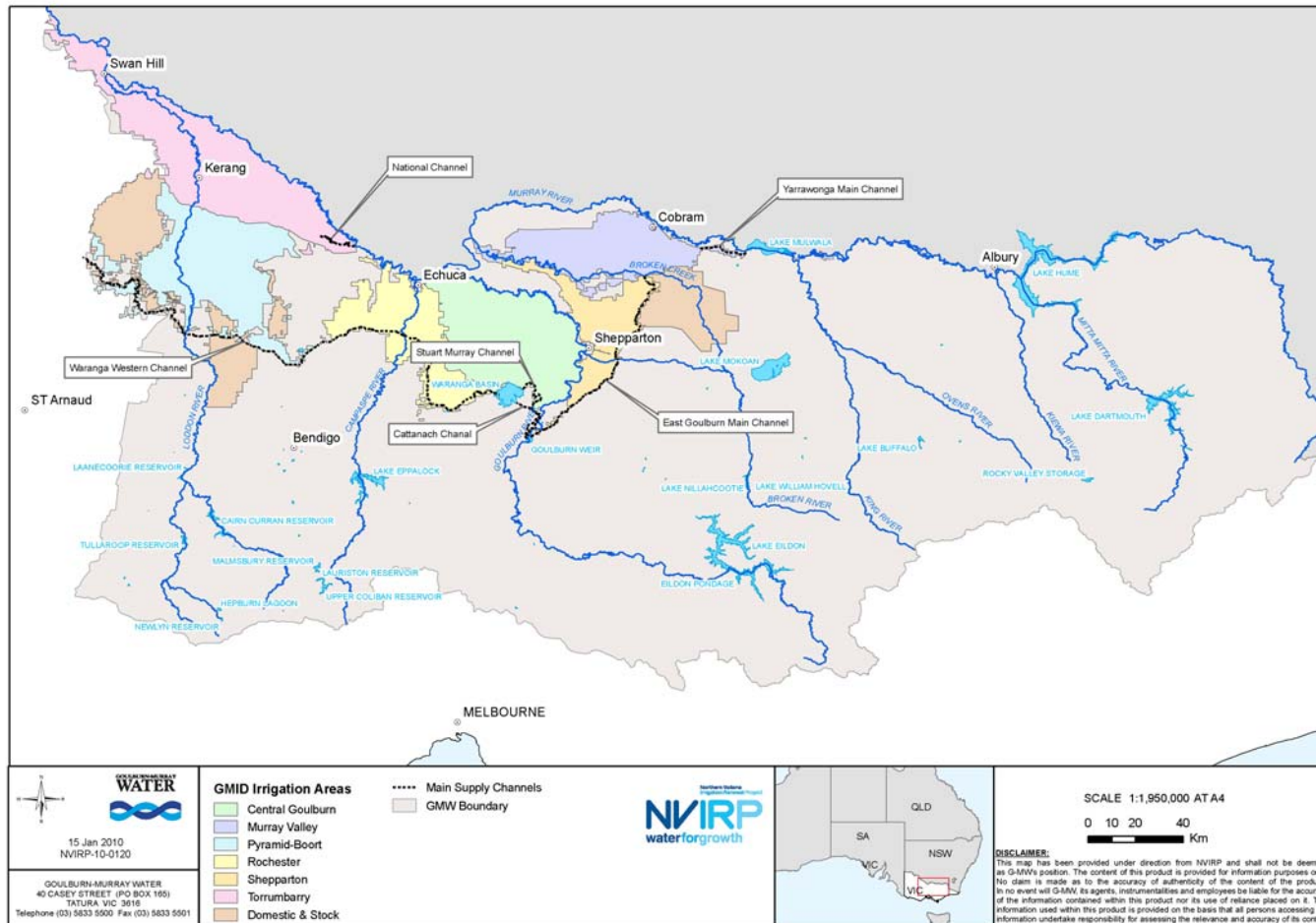
As set out in the Guidelines, the action does not include:

- all construction works
- reconfiguration works within the Kerang Wetlands Ramsar site (Reconfiguration of Kerang Wetlands refers to any reorganisation of how the lakes are connected to or supplied by the irrigation system. Modernised operation of the channel system in the Kerang area is encompassed by the referred action)
- reconfiguration of the Little Murray Weir and modernisation of the irrigation system in the vicinity of the city of Swan Hill
- administrative decisions on the allocation of resulting water savings.

### 3 Modernisation of the GMID

The GMID is Australia's largest irrigation community and is a major hub of food production, producing 26% of the nation's milk, nearly 95% of Victoria's tomatoes by weight, 75% of Victoria's stone fruit by weight and 95% of Victoria's grapes.

The GMID covers approximately 9,000 km<sup>2</sup> and is a system of streams, creeks, rivers and 6,300 km of channels that is controlled by Goulburn-Murray Water who store rainfall and/or tributary flows in water storages and release it as required, to provide irrigation water to over 11,000 irrigated holdings (Figure 1).



**Figure 1: Location of the GMID showing the six irrigation areas, water districts, major storages and diversion points**

The GMID accounts for the use of over 70% of water stored in Victoria and nearly 90% of the water used for irrigation across the State. The system has not changed substantially since it was constructed through early and middle parts of the 20<sup>th</sup> century. Approximately 30% of the water diverted for irrigation is not delivered for its intended use, instead being lost in the delivery system through leakage, seepage, outflows within the channel system, meter error and other system inefficiencies. The lost water often evaporates or ends up as non-managed drainage.

NVIRP aims to generate water savings by increasing this currently poor water efficiency to a world class water efficiency of at least 85% through applying modern technology to the delivery of irrigation water, including selectively remodelling and/or lining channels, piping, upgraded metering and automated delivery systems, and rationalisation of redundant channels, channel automation and electronic metering.

Modernisation has two core objectives:

- increased efficiency of water resources delivering up to 425 GL (long term annual average) water savings to provide water for:
  - the environment (up to 175 GL long term annual average)
  - irrigators (up to 175 GL long term annual average)
  - Melbourne (up to 75 GL long term annual average).
- increased viability of northern Victorian irrigators and support for regional development in the context of reduced water availability and climate change.

The benefits of modernisation are:

- increased GMID productivity, profitability and water use efficiency by providing an improved level of water delivery service to irrigators
- a financially viable irrigation system ensuring that the recurrent costs of operating and maintaining the irrigation scheme are affordable
- a sustainable future for the regional irrigation community of the GMID, in the context of reduced water availability and climate change
- improved health of the northern Victorian stressed rivers, floodplains and wetlands through:
  - provision of up to 175 GL of callable, tradeable environmental entitlements
  - reduction in the environmental footprint of the irrigation system
  - retention and, where possible and practical, the enhancement of infrastructure to deliver environmental water
- providing up to 75 GL for Melbourne's water supply.

All water savings arising from the project will be calculated and allocated according to the Water Savings Protocol and Framework issued by the Victorian Minister for Water for this project. All water savings will be independently audited before being allocated against entitlements. All entitlements will have the same reliability and characteristics (i.e. a callable volume in storage that can accrue allocations, temporary trade, carry over provisions and be able to be extracted for use at specific locations).

In summary, the action seeks to achieve enhanced outcomes for irrigators, the environment, urban water consumers and the public at large through more efficient and effective management of the delivery of irrigation water in a context of aged irrigation infrastructure and associated out-of-date operating practices.

The modernisation will be funded by the Commonwealth and Victorian Governments, Melbourne Water and irrigators.

## 4 Project context

Modernisation of the GMID is one of the major infrastructure projects announced in the Victorian Government's *Our Water Our Future – The Next Stage of the Government's Water Plan* (DSE 2007). The Water Plan aims to provide water security for Victoria's growing population, economy and environment through a suite of infrastructure projects comprising the expansion of Victoria's water grid including the Sugarloaf Water Pipeline, NVIRP and the Victorian Desalination Project. Through these it aims to secure urban water supplies, make water available to currently stressed waterways and sustain agricultural productivity.

NVIRP is consistent with and is one of the next major steps in Victoria's long-term direction on water resource management i.e. striving towards greater water efficiency, enhancing water markets, clarifying property rights, recovering water for the environment and addressing over-allocation, managing risks from climate change – all of which are in accordance with the National Water Initiative.

NVIRP has had a long process of development through the work of its predecessor the Food Bowl Modernisation Steering Committee (**FMSC**) who undertook significant public consultation including regional meetings, a public submission process and more than 60 public presentations to community groups.

## **5 The pre-modernised irrigation system and the environment**

The northern plains of Victoria are recognised as being one of the most highly impacted by agriculture in Australia. The landscape of the GMID has been highly modified by the development of water supply and farm irrigation infrastructure. To minimise costs of construction, the irrigation infrastructure used some 800 km of natural waterways to convey water and also made use of natural wetlands to store water. This resulted in irrigation of many areas that are now considered to be unsuitable for irrigated agriculture due to high water tables, poor soils and/or high water delivery losses. It has resulted in significant areas with soil salinisation and salinity problems and has also significantly altered the natural hydrology of the waterways and wetlands.

As a result, the rivers and wetlands in northern Victoria are in poor environmental condition. Many are highly flow-stressed with flow regimes significantly less than required to maintain existing environmental assets. Others connected to the irrigation system can have unseasonal flow regimes and significant water quality problems as a result of salinity or high nutrient levels from drainage outfalls. The impacts of the pre-modernised irrigation system on the environment are outlined in Table 1.

**Table 1: Summary of current effects of the irrigation system on the environment**

Aspect	Implications of the shared system	Potential effect on wetlands and waterways
Shared delivery	<p>Water is delivered throughout the GMID via man-made channels, natural wetlands and waterways.</p> <p>Once natural wetlands and waterways become conduits and storages in the irrigation system.</p> <p>They may be provided with water that the wetland or waterway would not otherwise receive.</p>	<p>Environmental values of waterways can be impacted through:</p> <ul style="list-style-type: none"> <li>▪ redundancy, straightening and excavation</li> <li>▪ loss of habitat and food sources</li> <li>▪ changes in water chemistry</li> <li>▪ changes in water levels and timing of inundation.</li> </ul>
Natural flood water no longer reaches particular wetlands	<p>River regulation, drainage systems, levee banks, works associated with the irrigation system, other infrastructure and agricultural activities (such as laser grading of terrain).</p>	<p>Reduced frequency and duration of natural flooding.</p> <p>Altered pathways for natural rainfall runoff.</p>
Change in timing of flows	<p>'Reversal' of natural flow regimes as water is stored in reservoirs for summer release.</p>	<p>Waterway summer flows substantially higher than natural and winter/spring flows substantially lower than natural.</p>
Outfall losses from distribution system operating water (Significant water savings will be achieved in this area by NVIRP)	<p>Resulting from manual operation or system shutdown following rainfall, either direct from channel outfalls or from drains.</p> <p>May provide water that the wetland or waterway would not otherwise receive.</p>	<p>Altered water regime and water quality.</p> <p>Increased depth, frequency and duration of wetland inundation.</p> <p>May have a significant influence on flow in smaller waterways, especially during the summer low-flow period.</p>
On-farm application of irrigation water	<p>Elevated groundwater levels.</p>	<p>Increased permanency and water salinity on a number of wetlands.</p> <p>Groundwater intrusion into wetlands and waterways.</p>
On-farm application of irrigation water	<p>Elevated nutrient levels.</p>	<p>Increased risk of episodic events including blue-green algal blooms and fish kills.</p>

Major reaches of the Goulburn River and River Murray suffer from seasonal flow inversion i.e. high flows in summer during irrigation releases and reduced flows during winter/spring. Environmental flow studies for the Goulburn and Murray Rivers have recommended, where possible, reducing unseasonally high summer and autumn flows in the reaches immediately below major storages and increasing the frequency of overbank events which typically occur in spring (Cottingham et al. 2007).

Nevertheless, despite the generally poor environmental condition, some high value environmental assets remain within the GMID, including Ramsar-listed wetlands and waterways of significance for threatened species.

The Victorian Government has developed a number of initiatives over the past decade to address the existing adverse consequences for the environment stemming from the shared irrigation system in the GMID. These include investment in river and wetland environmental improvement, salinity management and water quality improvement and sustainable irrigation to reduce drainage outfalls. More recently, it has also developed an active environmental watering program to water key drought refuges and avoid catastrophic loss during the drought.

Two of the major environmental benefits of the modernisation program are:

- the provision of an additional 175 GL of callable, tradeable environmental entitlements providing much greater capacity for active environmental water management to stressed rivers and wetlands and a better capability to manage these systems in the context of reduced water availability and climate change
- reduction in the environmental footprint of the irrigation area through reduction in groundwater accessions and drainage outfalls and transition for many wetlands and waterways to a more natural flow regime.

In these respects, the potential changes resulting from the modified operation of the system align with the long term environmental directions being pursued by the Victorian Government in northern Victoria and across the state.

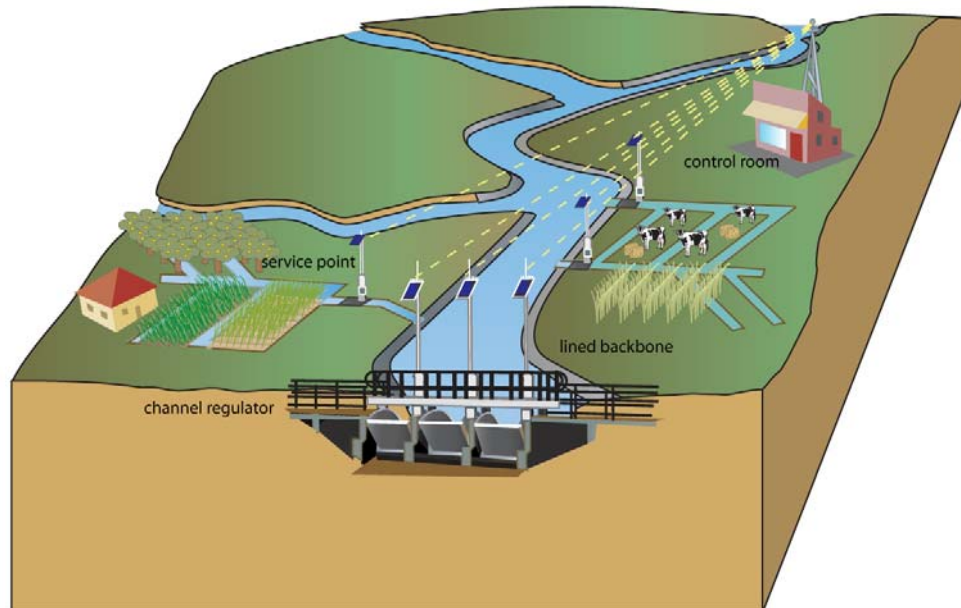
## **6 Description of the action**

Modernised operation will bring irrigation infrastructure into line with best practice and will convert unplanned losses into water savings, which can be put to productive and environmental use as legally recognised entitlements.

These operational outcomes are based on addressing system inefficiencies both technologically, to manage the water resource more responsively, and through physical remediation that addresses system leakage, seepage and evaporation throughout the modernised system.

The key elements of modernised operation (see Figure 2) are:

- automated control system
- increased metering accuracy
- increased channel efficiency
- modernised 'backbone'
- rationalised service points.



**Figure 2: Elements of modernised operation**

The existing channel supply system will be divided into a backbone and smaller spur channels. Approximately 40% of the existing channel system will comprise the backbone along with 85% of all current service points within 2 km of the backbone system. This will be fully automated and some remediation works will occur to improve the level of service and create water savings. All service points on the backbone will be accurately metered. The backbone will be approximately 3,000 km long, compared with approximately 6,300 km of current unmodernised channels.

The balance of the historic channel system will either be transferred to farmers as private delivery channels, remain in situ but not be used for active water delivery or, in some instances, be decommissioned.

Service points providing water to over 11,000 irrigated holdings in the GMID are currently located either on backbone channels or on smaller spur or distribution channels. The connections program focuses on those customers on the spur channels, reconfiguring their connection back onto the backbone. In the modernised system, a higher proportion of customers in the NVIRP area will take their water from a backbone channel rather than from a spur channel, thereby improving customer service delivery through connection to the automated backbone and removing reliance on less efficient spur channels downstream of the backbone.

The overall objective of the connections program is to consolidate connections and ensure as many customers as possible are connected directly to the backbone where they can receive higher levels of water supply service.

The connections program has an active interface with other local, State and Commonwealth programs aimed at improving on-farm practices.

## **7 Approach to managing potential environmental impacts**

From its inception, NVIRP was designed to ensure that, not only would it provide up to 175 GL of callable, tradeable environmental entitlements as a key environmental outcome, but that its implementation would not have a detrimental impact on wetlands and waterways of high environmental value and therefore on the species and communities that depend on these assets.

This Government commitment is brought into effect through the Water Change Management Framework (**WCMF**).

### **7.1 Water Change Management Framework**

The WCMF requires that NVIRP address its impacts through the provision of 'mitigation water' to sites supporting high environmental values (including MNES) that will be impacted by the operation of the modernised GMID. The WCMF is a requirement of the Victorian Minister for Planning and was approved by the Victorian Minister for Water on 14 August 2009.

The WCMF requires that mitigation water is provided through the development and implementation of Environmental Watering Plans (EWPs) for those sites supporting high environmental values where incidental irrigation water currently has beneficial effects. A key Government requirement governing NVIRP is that the water savings resulting from NVIRP are 'net savings'. This means that mitigation water is provided in advance of any calculation of formal water savings from the project and must be provided as an obligation of NVIRP, providing assurance that significant impacts on MNES will be avoided, irrespective of the level of water savings achieved. NVIRP is confident of achieving up to 425 GL of water savings.

In addition, the WCMF also requires NVIRP to identify sites where the modification of irrigation infrastructure could impact on the capacity to deliver environmental water. Where this is the case, there is a requirement on NVIRP to retain or improve the infrastructure.

### **7.2 Environmental assessment approach**

An essential component of the WCMF is an assessment of the species, ecological communities, wetlands and waterways within or related to the GMID to determine which sites are:

- high environmental value including MNES (the basis of this report) and
- likely to be detrimentally affected by the more efficient operation of the modernised irrigation system which includes changes to groundwater levels, changes in surface flows and reduced outfalls and diversions

and therefore require the development of EWPs and where necessary, the provision of mitigation water.

The overall approach to this assessment is outlined below. The details are included in Chapters 4, 5 and 6 in the full report.

The assessment starts from the understanding that any ecological consequences of the project will be related to hydrological changes occurring as a result of the operation of the modernised GMID.

The NVIRP modernisation is expected to have four potential hydrological impacts:

- reduction in gross water diversions to irrigation areas due to reduced need to supply losses
- reduction in channel seepage and bank leakage resulting in reduced recharge to the groundwater system, and consequently reduced watertable levels
- changes in lateral groundwater flows and salt load into waterways
- reduction in channel outfall contributions to drains, wetlands and river flows due to improved technology and system operations.

While many of these hydrological effects are expected to have beneficial effects, there could be some potential adverse impacts on MNES through:

- altered water regimes and salinity levels of Ramsar-listed wetlands
- altered water regimes and salinity levels of wetlands and waterways and subsequent effects on EPBC listed species and ecological communities through habitat loss or degradation.

These potential impacts could occur in the following ways:

- direct localised impact on wetlands and waterways connected to areas of the irrigation system that are being modernised
- direct and indirect effects through changing river flows and/or groundwater and salinity levels on
  - wetlands within the GMID, namely the Kerang Wetlands
  - wetlands and waterways adjacent to/downstream of the GMID. These include the Murray and Goulburn rivers and the Ramsar listed Barmah Forest, Gunbower Forest and NSW Central Murray Forests. Sites further downstream or removed from the GMID include Hattah-Kulkyne Lakes, Banrock Station Wetland Complex, Riverland, the Coorong and Lakes Alexandrina and Lake Albert, Fivebough and Tuckerbil Swamps and Lake Albacutya.

NVIRP undertook a detailed, comprehensive and precautionary approach to this assessment to provide information for the *EPBC Act* assessment and to meet its obligations under the Victorian Minister for Planning's decision. This approach consisted of three key steps:

1. Identification of wetlands and river reaches of high environmental value (including MNES) potentially directly impacted by modernisation. This was based on an initial desktop assessment (SKM 2008) which was then ground truthed to determine a shortlist of wetlands and waterways requiring detailed assessment of potential impacts and, where required, the provision of mitigation water through the preparation of EWPs (Feehan 2009, Hydro Environmental 2009a). This was further validated using more recent data on fauna distribution to determine if there were any additional sites of significance for MNES that required assessment (Brett Lane and Associates 2009).
2. Assessment of the potential changes in hydrology (both surface and groundwater) and salinity levels that are relevant to MNES resulting from the operation of a modernised GMID for:
  - wetlands and waterways within the GMID
  - wetlands and waterways adjacent to/downstream of the GMID.
3. Assessment of the potential ecological impacts due to changes in hydrology and salinity levels against the significant impact criteria set out in the EPBC Act on:
  - Ramsar wetlands within and adjacent to/downstream of the GMID with regard to the ecological character of the sites
  - EPBC listed species and ecological communities that are dependent on the wetlands and waterways within and adjacent to/downstream of the GMID. The assessment of potential impacts to EPBC listed species was undertaken with regard to their habitat requirements and their habitat areas within and adjacent to/downstream of the GMID.

Steps 2 and 3 determined if there were any potentially significant effects on wetlands and waterways within and adjacent to/downstream of the GMID of significance for MNES that should be added to the original shortlisted wetlands and waterways from Step 1.

As stated above, if impacts are considered to be significant, the WCMF requires that these impacts are mitigated through the development of EWPs. In this process, further detailed, local investigations are undertaken which will determine the need, volume and timing for mitigation water and the management arrangements for supplying it.

The outcome of the overall assessment process (Steps 1-3) is to produce a list of waterways and wetlands for which EWPs will be developed.

The information in this report is drawn largely from eight technical reports that were prepared specifically for the project during 2008 and 2009 using the most up-to-date information and methodologies available. These were reviewed by an Expert Review Panel, as required by the Victorian Minister for Planning.

### 7.3 Matters of national environmental significance

The following matters of MNES were identified as present or potentially present in the GMID and 40 km buffer, and were then included in the assessment process described above. These were identified using the Protected Matters Search Tool (PMST) and other information sources:

- 10 Ramsar wetlands of international importance:
  - 1 within the GMID – the Kerang Wetlands
  - 3 adjacent to/downstream of the GMID. These include the Barmah Forest, Gunbower Forest and NSW Central Murray Forests
  - 6 outside of the GMID i.e. including sites further downstream or removed from the GMID - Hattah-Kulkyne Lakes, Banrock Station Wetland Complex, Riverland, Coorong and Lakes Alexandrina and Lake Albert, Fivebough and Tuckerbil Swamps and Lake Albacutya.
- 61 threatened species and five threatened ecological communities (including one community that has been nominated for listing)
- 54 listed migratory species (all birds) and seven marine overfly species (including 4 migratory species that are also listed as threatened).

### 7.4 Results of environmental assessment

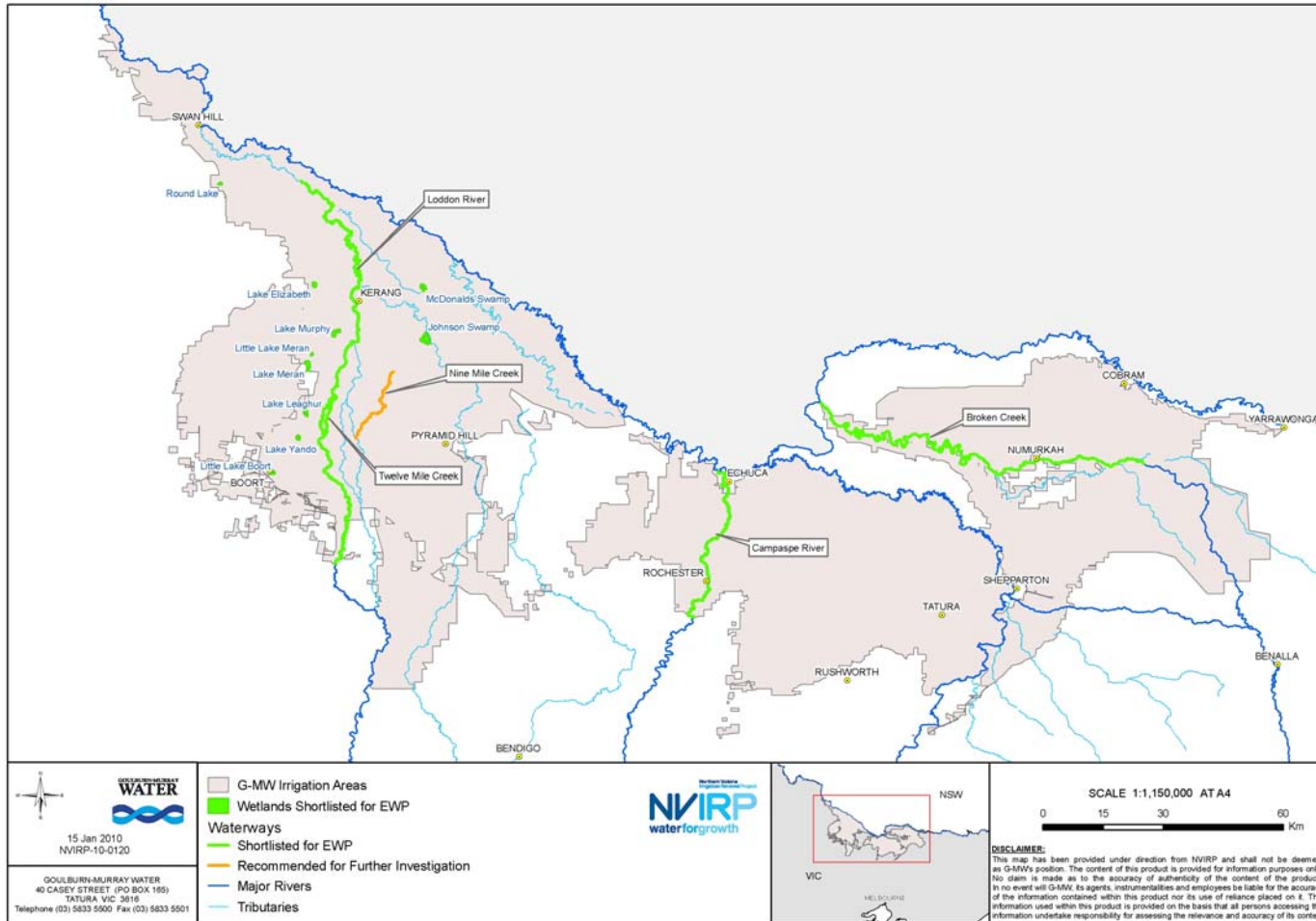
#### 7.4.1 Localised effects to wetlands and waterways

**Step 1** of the assessment outlined above involved the assessment of localised direct impacts. Ten wetlands have been identified for EWPs, together with four waterways, with further consideration to be given to Nine Mile Creek (Figure 3). These are:

**Wetlands** - Johnson Swamp, Lake Elizabeth, Lake Murphy, McDonald Swamp, Lake Leaghur, Lake Yando, Little Lake Boort, Little Lake Meran, Lake Meran, Round Lake

**Waterways** - Loddon River (2 reaches), Campaspe River, Twelve Mile Creek, Broken Creek.

These are subject to detailed assessment of effects and the development of mitigation requirements, with the preparation of an EWP.



**Figure 3: Location of wetlands and waterways requiring Environmental Watering Plans (river lengths requiring EWPs are indicative only)**

## 7.4.2 Potential changes to hydrology

**Step 2** assessed the hydrological effects of the action on surface water and groundwater and changes to river salinity. The effects of each of these parameters is summarised below (Table 2 and Table 3).

**Table 2: Summary of hydrological and salinity effects to surface water**

Scale of potential effect	Sites likely to be affected	Outcome of assessment
Local	Individual sites	Ten wetlands requiring Environmental Watering Plans, together with four waterways, with further consideration to be given to an additional site.
Within GMID	Kerang Lakes	<p>There will be no impact on wetland extent, hydrology, water quality or species for the majority of the wetlands.</p> <p>Johnson Swamp was shortlisted through the localised assessment process as being potentially impacted by reduced surface water. However the EWP concluded that mitigation water was not required to maintain the ecological character of Ramsar site as incidental irrigation outfalls are not contributing significantly to supporting high environmental values at the wetland.</p>
Adjacent / downstream – direct effects	River Murray	<p><i>between Hume Reservoir and Yarrawonga Weir</i></p> <ul style="list-style-type: none"> <li>predicted to have a slight reduction in flow (and level) over the summer and autumn of 12-14 mm but no change in flow (or level) over the winter and spring.</li> </ul> <p><i>between Yarrawonga Weir and Torrumbarry Weir</i></p> <ul style="list-style-type: none"> <li>predicted to undergo a small reduction in flow and river level during parts of summer/autumn and winter/spring. However the total magnitude is very small (average difference of 0-7 mm) compared to average water level in the river of 1.2-1.5 m.</li> <li>as the part of this reach upstream of Torrumbarry Weir is influenced by backwater effects of the weir pool, levels in this section of the river are not expected to be affected by NVIRP.</li> </ul> <p><i>downstream of Torrumbarry Weir</i></p> <ul style="list-style-type: none"> <li>predicted to experience a slight reduction in flow and river level over the winter/spring period (average difference of 0-9 mm) but no change in flow (or level) over the summer/autumn period.</li> </ul> <p><b>Salinity</b> The output of the modelling indicates that at Torrumbarry the salinity change in most months is zero and at most 1 <math>\mu\text{S}/\text{cm}</math>. At points downstream, in most months the effect is a reduction in river salinity in the order of 1-3 <math>\mu\text{S}/\text{cm}</math>. This compares to background salinity levels along the River Murray of 100-400 <math>\mu\text{S}/\text{cm}</math>.</p>

Scale of potential effect	Sites likely to affected	Outcome of assessment
	Goulburn River	<p><i>upstream of Goulburn Weir</i></p> <ul style="list-style-type: none"> <li>predicted to undergo a reduction in river level of up to 67 mm compared to an average river level depth of 1.42 m. Despite this being a relatively small change, it is in the direction of the environmental flow recommendations which recognise high summer flows in the Goulburn River as a threat to the health of the river.</li> </ul> <p><i>downstream of Goulburn Weir</i></p> <ul style="list-style-type: none"> <li>predicted to incur a slight reduction in flow (and level) over the summer/autumn period (average difference 0-45 mm) compared to an average river level depth of 1.56 m. No change in flow (or level) over the winter/spring period is expected.</li> </ul> <p><i>Salinity</i> Salinity is expected to decrease by approximately 7 or 8 µS/cm and is attributed to the reservoir releases increasing to supply downstream demands and minimum passing flows.</p>
Adjacent / downstream – indirect effects	Barmah Forest	<p>There will be no direct impact to wetland extent or loss of wetland area.</p> <p>Hydrological changes will be minimal and most likely be too small to be measurable i.e. Barmah Forest will experience less than a 1 mm change in the flood peak height and average level.</p> <p>Effect on salinities is considered negligible and is most likely to be a reduction.</p>
	Gunbower Forest	<p>There will be no direct impact to wetland extent or loss of wetland area.</p> <p>Hydrological changes will be minimal and most likely be too small to be measurable i.e. a 3 mm reduction in the flood peak height and an average reduction of 3 mm in average level.</p> <p>Effect on salinities is considered negligible and is most likely to be a reduction.</p>
	NSW Central Murray Forests	<p>There will be no direct impact to wetland extent or loss of wetland area.</p> <p>Will experience similar changes to Barmah Forest and Gunbower Forest. The Werai Forest will not be affected.</p> <p>Effect on salinities is considered negligible and is most likely to be a reduction.</p>

Scale of potential effect	Sites likely to affected	Outcome of assessment
	Hattah-Kulkyne Lakes	There will be no direct impact to wetland extent or loss of wetland area.  Hydrological changes will be minimal and most likely be too small to be measurable i.e. experience a 23 mm reduction in the flood peak height with an average reduction of 1 mm.  Effect on salinities is considered negligible and is most likely to be a reduction.
	Riverland, Banrock Station Wetland Complex, The Coorong, Lakes Alexandrina and Albert	Located at a distance downstream, such that there are numerous river locks and Lake Victoria in between, which will regulate flows and levels in the River Murray to the extent that there is expected to be no observable impact due to NVIRP at each of these sites.
	Fivebough and Tuckerbil Swamps	Located on the Murrumbidgee River and will not be affected by NVIRP.
	Lake Albacutya	Located in the Wimmera Basin and not hydraulically connected to the GMID; therefore will not be affected.

**Table 3: Summary of hydrological effects to groundwater**

Scale of potential effect	Sites likely to affected	Outcome of assessment
Local near channel unit effects	Individual sites	Highly unlikely that channel seepage would provide meaningful volumes of water (>25 ML/year) to support wetlands within 200 m of the channel.  In highly unlikely cases where this is not the case, a method is recommended for NVIRP to investigate whether channel recharge groundwater is significant to MNES associated with the wetland.
Within GMID	East of the Terrick Terrick Hills	Watertable reduction modelled to decrease by less than 1 m in the vast majority of the GMID. A drop of more than 5 m is predicted to occur in the Murray Valley Irrigation Area. However, this may be due to modelling assumptions that the current levels of intensive groundwater pumping in the Murray Valley Irrigation Area will continue. This may give over-estimates of the drawdown in localised areas where pumping is concentrated. The reduction in watertables more widely in this area is considered representative of the likely effects of the NVIRP modernisation.  Given the threat posed by the highly saline groundwater, a reduction in the water table is likely to be beneficial and will mean less intrusion of saline groundwater into the wetlands and waterways.

Scale of potential effect	Sites likely to affected	Outcome of assessment
	West of the Terrick Terrick Hills	<p>Water table modelling shows a reduction in level between 0.2 -1.3 m. West of the Terrick Terrick Hills, groundwater salinity in the Upper Shepparton Formation is almost universally saline, up to 50,000 µS/cm.</p> <p>Reductions in the saline water table are likely to be beneficial, and will reduce intrusion of saline groundwater into the wetlands.</p>
	Kerang Wetlands	<p>Water table modelling shows a decrease in level between 0.2 - 1.3 m. Not considered significant as seasonal fluctuations of this magnitude are common. Groundwater salinity in this area is almost universally saline, up to 50,000 µS/cm.</p> <p>Reductions in the saline water table are likely to be beneficial, and will reduce intrusion of saline groundwater into the wetlands.</p>
Downstream/ adjacent effects on the floodplain unit	Barmah Forest	<p>No change in watertable depth below the Barmah Forest except at the margin of the forest, which may decrease by 0.9 m in the Upper Shepparton formation. This is likely to be beneficial, and will reduce intrusion of saline groundwater into the wetlands.</p> <p>The reduction of salt load flow towards the site is about 8% and is likely to reduce the threat of a high water table increasing groundwater salinity levels.</p>
	Gunbower Forest	<p>No change is expected in the watertable under the Gunbower Forest.</p> <p>The reduction of salt load flow towards the site is about 8% and is likely to reduce the threat of a high water table increasing groundwater salinity levels.</p>
	NSW Central Murray Forests	<p>These sites are down gradient to the Barmah and Gunbower Forests. As there are no effects to the watertable under the Barmah and Gunbower Forests, it is considered improbable that there will be any effects to these sites.</p> <p>The reduction of salt load flow towards the site is about 8% and is likely to reduce the threat of a high water table increasing groundwater salinity levels.</p>
	Hattah-Kulkynne Lakes	<p>The site is down gradient to the Gunbower Forest. As there are no effects to Gunbower Forest, it is considered improbable that there will be any effects to this site.</p>
	Riverland, Banrock Station Wetland Complex, the Coorong, Lakes Alexandrina and Albert	<p>These sites are more than 300 km downstream of the project area, and downstream of Lake Victoria (regulated off-stream storage). This is beyond the boundary of where hydrological effects can be reasonably expected to be detected.</p>
	Fivebough and Tuckerbil Swamps	<p>Located on the Murrumbidgee Floodplain upstream of the project area. There is no plausible impact pathway linking NVIRP to this site.</p>

Scale of potential effect	Sites likely to affected	Outcome of assessment
	Lake Albacutya	Located the Wimmera basin and is not hydraulically connected to the GMID; therefore will not be affected. There is no plausible impact pathway linking NVIRP to this site.

### 7.4.3 Potential ecological impacts to MNES

Step 3 of the assessment determined the likely effects of hydrological changes on Ramsar sites, listed threatened species and communities (including flora and ecological communities, terrestrial fauna and aquatic fauna) and migratory species. A number of species were screened out of the assessment, with no further assessment conducted, because the species were:

- unlikely to occur regularly or in significant numbers and the GMID is therefore unimportant to the maintenance of their overall populations, or
- not wetland dependent and therefore not susceptible to the changes that modernised operations will cause.

The potential effects were assessed against the significant impact criteria set out in the *EPBC Act* Policy Statement 1.1 Significant Impact Guidelines (DEWHA 2009a). The results assessing the likelihood of a significant impact on the 10 Ramsar sites, 33 listed species and communities and 19 migratory species (noting that two species are both listed and migratory) are outlined in Table 4 below.

The assessment showed that:

- no significant impacts were predicted for any Ramsar wetlands
- no significant impacts are expected for listed threatened flora species or ecological communities
- no significant impacts are expected for listed frog species
- no significant impacts are expected to the listed fish species, Trout cod and Macquarie perch. There could be impacts to the listed Murray Cod and Murray Hardyhead but these occur at wetlands and waterways for which an EWP will be developed and these will ensure that these species are not negatively affected by the modified operation of modernised GMID
- 20 EPBC Act listed threatened and migratory bird species were found to be susceptible to operational impacts from NVIRP through potential habitat loss and degradation at the ten short-listed wetlands as a result of Step 1. To mitigate potential impacts, EWPs will be developed for these wetlands which will prevent habitat loss and degradation at affected wetlands and ensure that modernised operations do not result in a significant impact on MNES.

The full assessment indicates that, subject to the implementation of EWPs for the wetlands and waterways listed above, the action is not expected to have a significant impact on MNES.

The assessment also identified a number of potential benefits of modernisation, including lower watertables resulting from the action, providing an ecological benefit to many areas in the GMID.

The assessment also noted that, as a consequence of NVIRP, up to 75 GL (long term annual average) of savings will be converted to Victorian environmental entitlements and up to 100 GL (long term annual average) of savings will be held by the Commonwealth Environmental Water Holder. These will be callable, tradable environmental entitlements which will be used, amongst other environmental uses, to provide environmental water to Ramsar wetlands of international importance and to support MNES, particularly in the face of reduced water availability and climate change.

**Table 4: Likelihood of significant impact on MNES**

Species	EPBC listing	Likelihood of significant impact	Recommended management and mitigation measures (if relevant)
<b>Ramsar Wetlands</b>			
Kerang Wetlands	R	<i>NO</i>	<i>NA</i>
Barmah Forest	R	<i>NO</i>	<i>NA</i>
Gunbower Forest	R	<i>NO</i>	<i>NA</i>
NSW Central Murray Forests	R	<i>NO</i>	<i>NA</i>
Hattah-Kulkyne Lakes	R	<i>NO</i>	<i>NA</i>
Riverland	R	<i>NO</i>	<i>NA</i>
Banrock Station Wetland Complex	R	<i>NO</i>	<i>NA</i>
The Coorong, Lakes Alexandrina & Lake Albert	R	<i>NO</i>	<i>NA</i>
Fivebough and Tuckerbil Swamps	R	<i>NO</i>	<i>NA</i>
Lake Albacutya	R	<i>NO</i>	<i>NA</i>
<b>Flora</b>			
River Swamp Wallaby-grass ( <i>Amphibromus fluitans</i> )	V	<i>NO</i>	<i>NA</i>
Mueller Daisy ( <i>Brachyscome muelleroides</i> )	V	<i>NO</i>	<i>NA</i>

Species	EPBC listing	Likelihood of significant impact	Recommended management and mitigation measures (if relevant)
Mclvor Spider-orchid ( <i>Caladenia audasii</i> )	E	NO	NA
Crimson Spider-orchid ( <i>Caladenia concolor</i> )	V	NO	NA
Rigid Spider-orchid ( <i>Caladenia tensa</i> )	E	NO	NA
Yellow-lip Spider-orchid ( <i>Caladenia xanthochila</i> )	E	NO	NA
Western Water-starwort ( <i>Callitriche cyclocarpa</i> )	V	NO	NA
Bald-tip Beard-orchid ( <i>Calochilus richiae</i> )	E	NO	NA
Clover Glycine ( <i>Glycine latrobeana</i> )	V	NO	NA
Euroa Guinea-flower ( <i>Hibbertia humifusa</i> subsp. <i>erigens</i> )	V	NO	NA
Winged Pepper-cress ( <i>Lepidium monoplacoides</i> )	E	NO	Develop and implement site-specific Environmental Watering Plans for specific saline waterways wetlands at risk.
Erect Pepper-cress ( <i>Lepidium pseudopapillosum</i> )	V	NO	NA.
Hoary Sunray ( <i>Leucochrysum albicans</i> subsp. <i>albicans</i> var. <i>tricolor</i> )	E	NO	NA
Chariot Wheels ( <i>Maireana cheelii</i> )	V	NO	Develop and implement site-specific Environmental Watering Plans for specific saline wetlands at risk.
Ridged Water-milfoil ( <i>Myriophyllum porcatum</i> )	V <sup>1</sup>	NO	NA
Spiny Rice-flower ( <i>Pimelea spinescens</i> subsp. <i>spinescens</i> )	C	NO	NA
Turnip Copperbur ( <i>Sclerolaena napiformis</i> )	E	NO	NA

<sup>1</sup> C = Critically Endangered, E = Endangered, M = Migratory, N = Nominated, R = Ramsar wetland of international importance, V = Vulnerable, O = Marine Overfly

Species	EPBC listing	Likelihood of significant impact	Recommended management and mitigation measures (if relevant)
Stiff Groundsel ( <i>Senecio behrianus</i> )	E	NO	NA
Slender Darling-pea ( <i>Swainsona murrayana</i> )	V	NO	NA
Red Swainson-pea ( <i>Swainsona plagiotropis</i> )	V	NO	NA
Yellow Swainson-pea ( <i>Swainsona pyrophila</i> )	V	NO	NA
Mountain Swainson-pea ( <i>Swainsona recta</i> )	E	NO	NA
<b>Communities</b>			
<i>Buloke Woodland</i>	E	NO	NA
<i>White Box Woodland</i>	C	NO	NA
<i>Inland Grey Box Woodland</i>	N	NO	NA
<b>Frogs</b>			
Growling Grass Frog ( <i>Litorina raniformis</i> )	V	NO	NA
<b>Fish</b>			
Murray Hardyhead ( <i>Craterocephalus fluviatilis</i> )	V	Potential risk	Develop and implement site-specific Environmental Watering Plans for specific waterways at risk.
Murray Cod ( <i>Maccullochella peelii peelii</i> )	V	Potential risk	Develop and implement site-specific Environmental Watering Plans for specific waterways at risk.
Trout Cod ( <i>Maccullochella macquariensis</i> )	E	NO	NA
Macquarie Perch ( <i>Macquaria australasica</i> )	E	NO	NA
<b>Birds</b>			
Australian Painted Snipe ( <i>Rostratula australis</i> )	M V	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Black-winged Stilt ( <i>Himantopus himantopus</i> )	O	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Caspian Tern ( <i>Hydrogogne caspia</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Cattle Egret	M	NO	Develop and implement site-specific

Species	EPBC listing	Likelihood of significant impact	Recommended management and mitigation measures (if relevant)
<i>(Ardea ibis)</i>			Environmental Watering Plans for specific wetlands at risk.
Common Greenshank ( <i>Tringa nebularia</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Curlew Sandpiper ( <i>Calidris ferruginea</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Double-banded Plover ( <i>Charadrius bicinctus</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Eastern Great Egret (previously Great Egret) ( <i>Ardea modesta</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Glossy Ibis ( <i>Plegadis falcinellus</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Latham's Snipe ( <i>Gallinago hardwickii</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Marsh Sandpiper ( <i>Tringa stagnatilis</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Red-necked Avocet ( <i>Recurvirostra novaehollandiae</i> )	O	NO	Develop and implement site-specific Environmental Watering Plans for specific waterways and wetlands at risk.
Red-capped Plover ( <i>Charadrius ruficapillus</i> )	O	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Red-necked Stint ( <i>Calidris ruficollis</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Sharp-tailed Sandpiper ( <i>Calidris acuminata</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Superb Parrot ( <i>Polytelis swainsonii</i> )	V	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Swift Parrot ( <i>Lathamus discolor</i> )	E O	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Whiskered Tern ( <i>Chlidonias hybridus</i> )	O	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
White-bellied Sea-Eagle ( <i>Haliaeetus leucogaster</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.
Wood Sandpiper ( <i>Tringa nebularia</i> )	M	NO	Develop and implement site-specific Environmental Watering Plans for specific wetlands at risk.

#### 7.4.4 Ramsar wetlands in South Australia

The assessment of potential impacts to Ramsar sites in South Australia indicate that for floodplain sites (Riverland and Banrock Station) the effects of NVIRP will be negligible. For the Coorong and the Lower Lakes, the nature of outfalls and the operation of the River Murray are such that very little, if any, of the estimated outfalls will reach the South Australian border let alone the Lower Lakes. Finally, the use of the 175 GL for the environment is expected to overwhelm any reductions in outfalls and will significantly enhance the health of Ramsar sites in South Australia.

## 8 Project benefits

NVIRP will generate up to 425 GL (long term annual average) water savings which will be used to:

- provide water for the environment (up to 175 GL long term annual average), improving the ability to maintain and enhance environmental values
- enhance water availability to support improved productivity in Victoria's Food Bowl region (up to 175 GL long term annual average), adding to the productivity improvements achieved through irrigation modernisation
- provide water to Melbourne (up to 75 GL long term annual average), increasing the security of supply.

Economically, the project is expected to result in improvements in agricultural production and increases in regional economic activity as a result of greater activity in the local agricultural industry.

Over recent years, drought and fluctuating commodity prices have had negative impacts on the GMID community and its social sustainability. The major social benefit of NVIRP is that, in the long term, it secures the future of the GMID community by providing enhanced water security, facilitating employment growth and largely equitably distributing benefits through the community.

Environmentally, NVIRP will help secure the future of rivers and wetlands in northern Victoria through:

- providing up to 175 GL of callable, tradeable environmental entitlements - one of the most effective tools for managing stressed river and wetland systems in the context of water scarcity and climate change
- moving the water regimes of wetlands and waterways towards more beneficial pre-irrigation conditions.

## 9 Conclusion

This assessment shows that NVIRP will have no significant adverse impacts on MNES and will have substantial economic, social and environmental benefits for northern Victoria. Through the efficient use of available water, the action of NVIRP will safeguard the productivity of the GMID, lessen the overall environmental footprint of irrigation in the region and secure the future of northern Victoria's communities and environments.