Amendment date: 28 June 2017

	Title of measure	**Vinifera Floodplain Management Project**
	Proponent undertaking the measure	**Victoria**
	Type of measure	**Supply**
1.	**Confirmation**	
	Date by which the measure entered into or will enter into operation *Must be before 30 June 2024*	This environmental works project will be operational by 30 June 2024.
	Confirmation that the measure is not an 'anticipated measure' *'Anticipated measure' is defined in section 7 02 of the Basin Plan to mean 'a measure that is part of the benchmark conditions of development'.*	Yes
	Confirmation that the proponent state(s) undertaking the measure agree(s) with the notification ***Basin Plan 7.12(3)(c)*** *Joint proposals will need the agreement of all proponents*	Yes.
2.	**Details of the measure**	
	Capacity of the measure to operate as a supply measure *'Supply measure' is defined in section 7.03 of the Basin Plan to mean 'a measure that operates to increase the quantity of water available to be taken in a set of surface water SDL resource units compared with the quantity available under the benchmark conditions of development'*	Yes.
3.	**Description of the works or measure**	
	The Vinifera Floodplain project will water up to 350 hectares of floodplain within Vinifera Forest This represents 55% of the total forest area (638 hectares) and almost all of the flood dependent communities. The works involve construction of four regulators and 1,087 metres of low level track raising to enable control of both flood and pumped flows into and out of Vinifera Creek. Water will be delivered to the site through a combination of natural inflows or temporary pumping when river flows are insufficient. A detailed description of the proposed works package is included in Chapters 3.2 and 12 of the business case **(Attachment B)**.	
4.	**Geographical location of the measure**	
	The Vinifera Floodplain Project is located in the Nyah Vinifera Park on the western bank of the River Murray, 30 km north of Swan Hill.	
5.	**Representation of the project in the MDBA modelling framework**	
	The MDBA will represent the proposed infrastructure, operating strategies and water use in the MSM-BigMod model. A schematic of the model representation is shown at **Attachment A.** Spatial data provided by the proponent (derived using a hydro-dynamic model) describes the areas inundated through the operating of the works. The areas inundated are combined with the timing of modelled operation by the Environmental Outcomes Scoring Tool to quantify the change in environmental outcomes, relative to the Benchmark environmental outcomes. This site has been modelled as a weir pool storage with flow dependant travel times so that backwater impact can be captured depending on the operation of the proposed regulator. The level-volume-area relationship is taken from the hydrodynamic modelling report and the travel time is derived from inflow and volume relationship presented in the same report, these relationships are shown below	

Water pooled by raising the regulator downstream		
Level (mAHD)	Volume (ML)	Area (ha)
63.60	0	0
63.70	813	145
64.30	3392	493
64.49	4680	590
64.50	5000	627
64.51	5210	637

Water pooled without raising the regulator downstream		
inflow (ML/d)	Area (ha)	Travel time (day)
91	145	3.0
544	548	2.6
2091	643	1.0
5350	669	0.6
6902	684	0.4
8455	693	0.4
9616	699	0.4
10568	702	0.4
11714	705	0.4

Interaction between river flows and site inflows

There is no existing representation of this project site in MSM-Bigmod. Therefore there is one new branch relationship developed to describe natural hydrologic characterises to the site depending on river flows downstream of Swan Hill.

DS Swan Hill (ML/d)	Flow to Site (ML/d)
15000	91
17500	544
20000	2091
22500	5350
25000	6902
27500	8455
30000	9616
32500	10568
35000	11714

Return flow from the site to the river

Once inflows to the site are calculated, the model applies hydrologic routing to calculate level, volume and inundation for the floodplain storage area within the site. For a weir storage, given inflow from a branch, flow behaviours are calculated by flow-level relationship at downstream of the weir. Using this information, the model calculates storage volume or water level so that downstream level is lower than or equal to the weir pool level. For this, the following relationships have been drawn, by the MDBA, from the hydrodynamic model report (as submitted by Jacobs for the MCMA) These relationships are shown below.

Flow (ML/d)	Level (mAHD)
91	63.60
544	64.30
2091	64.60
5350	64.90
6902	65.00
8455	65.06
9616	65.10
10568	65.14
11714	65.16

Surface water loss relationships

As part of developing the site based hydraulic model, no seepage loss rate has been applied for the site. However, a constant rate of 2 mm/day has been applied by MSM-Bigmod for consistency with other sites. Evaporation and rainfall are calculated using daily data from Lake Hume climate stations.

6. Representation of each operating strategy in the MDBA modelling framework.

In the case of measures involving floodplain environmental work, Criteria 6 of the notification requires the proponent to outline information on the rate/volume, timing and volume of inflows required to support the proposed operating regimes. Chapter 9 and Chapter 10 of the Business Case (**Attachment B**) outline a series of proposed operating regimes. This information is shown below.

Operating strategy	Flow to start operation (ML/d)	Regulator status	Duration	Optimal frequency	Resilience period (yr)	Equivalent Natural flow (ML/d)
Fresh1	-	All open	-	-	-	-
Intermediate2	15,000	Maintain at 64.4 mAHD	4 months	8 in 10 yrs	3	17,500
Maximum 2	17,500	Maintain at 64.4 mAHD	2 months	1 in 3 yrs	4	20,000

[1] Not included in the model as there is no additional benefit from current regimes.

[2] These operations are always piggybacking on natural overbank events and close regulators at their recession to manage inundation duration. Therefore only one operational mode (advantageous watering) has been modelled so that the works are operated always at the back of overbank flow events. Their frequencies are modelled to operate at every opportunity for the intermediate strategy and every second opportunity for the maximum strategy.

7. Spatial data describing the inundation extent associated with the operation of the measure

The area of inundation associated with the operation of the works has been modelled with the hydrodynamic model. The total area of inundation for each of the operating strategies is given in the table below.

Operation Strategy	**Inundation area (ha)**
Vinifera Fresh (VFF)	20
Vinifera Intermediate (VFI)	264
Vinifera Maximum (VFM)	350

For the purpose of calculating scaling factors for the Ecological Outcomes scoring method, the maps of the inundation areas associated with the works were combined with maps of SFI flow bands and maps representing the ecological elements used in the scoring method. The areas for the resulting hydrological assessment units (HAU) are provided in tables below. In this case the areas for the works represent the inundation area that is additional to the area already inundated by a nested work. If VFM is operated, the inundation areas associated with the operation of VFI are also inundated. Figures in the VFM table below show the additional area the VFM operation would inundate

Inundation area (ha) for VFF	**SFI Flow Bands**				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	20.0	0.0	0.0	0.0
Bitterns, crakes and rails	0.0	19.5	0.1	0.0	0.0
Breeding – Colonial-nesting waterbirds	0.0	20.0	0.0	0.0	0.0
Breeding – other waterbirds	0.0	19.5	0.1	0.0	0.0
Redgum Forest	0.0	17.2	0.1	0.0	0.0
Redgum Woodlands	0.0	0 0	0.0	0.0	0.0
Forests and Woodlands: Black Box	0.0	2.9	0.0	0.0	0.0
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	19.5	0.1	0.0	0.0
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	19.5	0.1	0.0	0.0
Long lived fish	0.0	20.0	0.0	0.0	0 0

Inundation area (ha) for VFI	**SFI Flow Bands**				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	169.0	51.0	5.0	19.0
Bitterns, crakes and rails	0.0	52.9	3.5	0.1	0.6
Breeding – Colonial-nesting waterbirds	0.0	169.0	51.0	5.0	19.0
Breeding – other waterbirds	0.0	52.9	3.5	0.1	0.6
Redgum Forest	0.0	134.9	48.1	4.5	17.8
Redgum Woodlands	0.0	0.0	0.2	0.0	0.1
Forests and Woodlands· Black Box	0 0	18.8	2.6	0.1	0.5
Lignum (Shrublands)	0.0	0.0	0 0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	3.3	1.2	0.0	0.1
Benthic Herblands	0.0	0.0	0.0	0.0	0 0
Short lived fish	0.0	52.9	3.5	0.1	0.6
Long lived fish	0.0	169.0	51.0	5.0	19.0

Inundation area (ha) for VFM	SFI Flow Bands				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	6.0	15.0	4.0	61.0
Bitterns, crakes and rails	0.0	0.8	0.2	0.0	0.6
Breeding – Colonial-nesting waterbirds	0.0	6.0	15.0	4.0	61.0
Breeding – other waterbirds	0.0	0.8	0.2	0.0	0.6
Redgum Forest	0.0	5.3	13.8	3.4	56.1
Redgum Woodlands	0.0	0 0	0.2	0.0	1.8
Forests and Woodlands Black Box	0.0	0.4	1 2	0.2	2.0
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	0.6	0.0	0.0	0.1
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	0.8	0.2	0.0	0.6
Long lived fish	0.0	6.0	15.0	4.0	61.0

8. Surface water SDL resource units affected by the measure

This measure identifies all surface water resource units in the Southern Basin region as affected units for the purposes of notifying supplying measures The identification of affected units does not constitute an agreement between juristictions on apportioning the supply contribution, which will be required in coming months

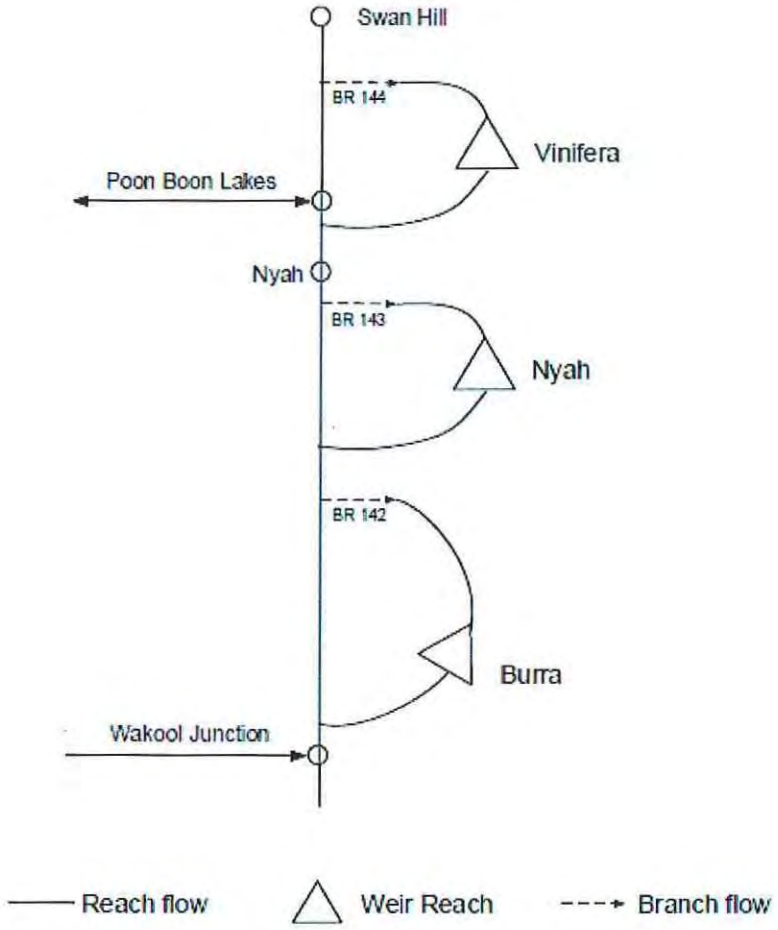
9. Details of relevant constraint measures

Not directly linked to any specific constraint measures but implementing a confirmed package of constraint measures may have implications for the proposed operating strategy.

Attachments:

A	MDBA	Vinifera floodplain management project representation in Murray model
B	Mallee CMA, December 2014	Phase 2 Assessment Supply Measure Business Case. Vinifera Floodplain Management Project

Attachment A: Vinifera floodplain management project representation in Murray model (based on Bigmod Rev. 266)



Sustainable Diversion Limit Adjustment

Phase 2 Assessment

Supply Measure Business Case:

Vinifera Floodplain Management Project

Department of Environment and

mallee

Executive Summary

The *Vinifera Floodplain Management Project* is a proposed supply measure that is designed to off-set water recovery under the Murray-Darling Basin Plan by achieving equivalent or better environmental outcomes on the ground. The Victorian Government's long standing position is that efficient environmental watering is critical to the long-term success of the Basin Plan.

This view is based on the understanding that engineering works like flow control regulators, pipes and pumps can achieve similar environmental benefits to natural inundation, using a smaller volume of water to replenish greater areas. Works also allow for environmental watering in areas where system constraints prevent overbank flows and, due to the smaller volumes required, can be used to maintain critical refuge habitat during droughts.

This project is one of several proposed by the Victorian Government as having the potential to meet the Basin Plan's environmental objectives through smarter and more efficient use of water.

The *Vinifera Floodplain Management Project* is located in the Nyah Vinifera Park on the western bank of the River Murray, 30 km north of Swan Hill in northwest Victoria. This floodplain includes around 638 ha of wetland, forest and woodland areas and includes Vinifera Creek, a seasonal anabranch of the River Murray.

The Vinifera Park features a prominent river red gum forest that is now managed to preserve conservation and heritage values. The Park supports a high diversity of flora and fauna species and ecological communities of national and Victorian conservation significance. Vinifera Park is a network of extensive waterways, wetlands and inundation-dependent woodlands that receive water from the River Murray via Vinifera Creek.

Vinifera is a low-lying floodplain area that was reliably inundated in spring under natural (without regulation) flow conditions. Water commences entering Vinifera Creek at river flows of 12,500 ML/d, inundating low lying watercourses and wetlands on the floodplain. The creek commences spilling at flows above 15,000 ML/d and by 17,500 ML/d most of the forest is flooded. Red gum and black box on the terrestrial fringe of the forest is inundated when river levels exceed 25,000 ML/d.

Most of the forest drains freely as river levels fall. Some water is retained in wetlands between flood events providing some permanency within the landscape. Changes to these natural flow patterns has led to a decline in the condition and productivity of the Park due to the reduced flood frequency and durations.

The project will provide infrastructure to better control the frequency and duration of inundation to reinstate a watering regime matched to the ecological requirements of the significant vegetation and fauna at Vinifera Park. The proposed works involve construction of regulators and track raising to enable control of both flood and pumped flows into and out of Vinifera Creek. This project provides the opportunity to reverse condition decline across the Park and deliver significant benefits to improve habitat for the diversity of species.

The project will provide inundation of up to 350 ha of inundation-dependent habitat with a water level of 64.4 m AHD, requiring a volume of 2,743 ML. Analysis of the inundation flow equivalences (Jacobs, 2014) shows that the proposed works will replicate inundation flows of up to 20,000 ML/d at the site, which is the interface of the floodplain and terrestrial environments. Without the proposed works, inundation of this area requires a more substantial River Murray flooding event (GHD, 2014; Alluvium, 2013a).

This project will build upon the benefits of Basin Plan flows by improving the frequency of inundation, as well as duration to achieve the environmental water requirements of Vinifera Park. The measure may be used to inundate the Red Gum Swamp Forest community, equivalent to that of a 17,500 ML/d flow event. The water regime of this community will be better matched under the measure, with the frequency of inundation increasing from 6.8 to 9.8 events in 10 years and the duration of inundation from 84 to 110 days, compared to Basin Plan.

Under a restored water regime, the wetland and flooded forest areas will provide dependable refuge and breeding habitat for aquatic fauna. The site's environmental values have been used to inform the development of ecological objectives and targets, allowing the project to measure progress toward its expected outcomes.

A broad level of community support exists for this project, which is the result of working directly with key stakeholders and community members to ensure the integration of local knowledge and advice into the project. Stakeholders materially affected by the Vinifera project such as Parks Victoria, have provided in-principle support for the progression of the project, along with a number of individuals, groups and organisations central to the project's success, including adjacent landholders, Aboriginal stakeholders and community groups.

Further confidence in the success of this project can be taken from the extensive knowledge, skills, experience and adaptive management expertise of the agencies involved in the development of this project. This is evidenced by more than a decade of environmental water delivery and successful construction and operation of environmental infrastructure projects that have delivered measurable ecological benefits across the region.

The *Vinifera Floodplain Management Project* has been developed by the Mallee Catchment Management Authority (CMA), on behalf of the Victorian Government, and in partnership with the Department of Environment and Primary Industries, Parks Victoria and Goulburn-Murray Water, through funding from the Commonwealth Government.

Project risks have been comprehensively analysed and are well known. They can be mitigated through established management controls that have been successfully applied to previous watering projects by the Mallee CMA and partner agencies, as well as the Murray-Darling Basin Authority, Commonwealth and Victorian Environmental Water Holders. As a result, the project has minimised these risks after standard mitigation measures are considered.

Project costs that will be subject to a request for Commonwealth Funding total $9,122,148 in 2014 of project benefits, the value of water savings is not estimated within this business case.

This business case presents the cost to fully deliver the project (i.e. until all infrastructure is constructed, commissioned and operational), including contingencies. Cost estimates for all components in this proposal are based on current costs, with no calculation undertaken of future cost escalations. To ensure sufficient funding will be available to deliver the project in the event that it is approved by the Murray Darling Basin (MDB) Ministerial Council for inclusion in its approved Sustainable Diversion Limits (SDL) Adjustment Package to be submitted to the MDBA by 30 June 2016, cost escalations will be determined in an agreed manner between the proponent and the investor as part of negotiating an investment agreement for this project.

Contents

Acronyms

AEM	Airborne Electromagnetic datasets
AH Act 2006	*Aboriginal Heritage Act 2006* (Vic)
ARG	Aboriginal Reference Group
AS/NZS ISO 31000:2009	Australia and New Zealand Risk Management Standard 2009
BSMS	Basin Salinity Management Strategy
CEMP	Construction Environmental Management Plan
CEWH	Commonwealth Environment Water Holder
CFA	Country Fire Authority
CHMP	Cultural Heritage Management Plan
CMA	Catchment Management Authority
CPI	Consumer Price Index
CRG	The Living Murray Community Reference Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWA	Country Women's Association
DEPI	Department of Environment and Primary Industries
DO	Dissolved Oxygen
DTF	Department of Treasury and Finance
EE Act 1978	*Environmental Effects Act 1978* (Vic)
EMP	Environmental Management Plan
EPBC Act 1999	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EVC	Ecological Vegetation Class
EWMP	Environmental Works and Measures Program
FFG Act 1988	*Flora and Fauna Guarantee Act 1988* (Vic)
G-MW	Goulburn-Murray Water
GST	Goods and Services Tax
IGA	Intergovernmental Agreement on Murray-Darling Basin Water Reform 2014
ISO	International Organisation for Standardisation
LWAC	Land and Water Advisory Committee
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MER	Monitoring, Evaluation and Reporting
MERI	Monitoring, Evaluation, Reporting and Improvement
MLDRIN	Murray Lower Darling Rivers Indigenous Nations
MNES	Matters of National Environmental Significance
NP Act 1975	*National Parks Act 1975* (Vic)
NSW	New South Wales
OPBR	Office of Best Practice Regulation
OH&S	Occupational Health and Safety
O&M	Operations and Maintenance
PCB	Project Control Board
PE Act 1987	*Planning and Environment Act 1987* (Vic)
PMBOK	Project Management Body of Knowledge
PPE	Personal Protective Equipment
RGG	Regulatory Governance Group
SA	South Australia
SDL	Sustainable Diversion Limit
TEV	Total Economic Value
TLM	The Living Murray
TSMP	Threatened Species Management Plan
USBR	United States Bureau of Reclamation

VEAC	Victorian Environmental Assessment Council
VEWH	Victorian Environment Water Holder
WRP	Water Resource Plan
WTP	Willingness to Pay

Abbreviations

Basin	Murray-Darling Basin
Basin Plan	The Murray-Darling Basin Plan adopted by the Commonwealth Minister under section 44 of the *Water Act* 2007 (Cth) on 22nd November 2012
Guidelines	Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases
H	Horizontal
No.	Number
NA	Not applicable
4WD	Four wheel drive

Units

cm/day	Centimetres per day
EC	Electrical conductivity
GL	Gigalitres
ha	Hectares
km	Kilometres
m AHD	Elevation in metres with respect to the Australian Height Datum
m/s	Metres per second
ML	Megalitres
ML/d	Megalitres per day
m	Metres
mm	Millimetres
mS/cm	Millisiemens per centimetre
µS/cm	Microsiemens per centimetre
$M	Million dollars

1. Introduction

1.1. Context

This Business Case for the *Vinifera Floodplain Management Project* has been developed in accordance with the Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases. This project is one nine proposed works-based supply measures within Victoria, and one of seven within the Mallee Catchment Management Authority (CMA) which are listed below:

- Lindsay Island
- Wallpolla Island
- Hattah Lakes North
- Belsar-Yungera Floodplain Complex
- Burra Creek
- Nyah Park, and
- Vinifera Park.

These sites will work in conjunction with proposed altered river operations and existing environmental infrastructure to deliver, using less water, environmental outcomes set under the Basin Plan. Figure 1-1 provides a conceptual overview of the distribution of sites across the Mallee Catchment Management Authority region and the longitudinal connection to the lower Murray region.

1.2. Forest overview

Located between Nyah and Swan Hill, the Vinifera floodplain supports a high diversity of flora and fauna species and ecological communities of national and Victorian conservation significance.

Vinifera Park spans across 638 ha and is an elongate basin aligned parallel to the River Murray. The basin is formed between the terrestrial landscape to the south the natural levee of the river bank to the north. An artificial levee has been constructed at the eastern boundary and reduces private land flooding upstream by isolating it from flooding in the Vinifera system (Ecological Associates, 2014a).

The floodplain is a network of extensive waterways, wetlands and inundation-dependent woodlands that receive water from the River Murray via Vinifera Creek (Ecological Associates, 2014a). Historically the creek was an anabranch of the Murray River however modifications to the upstream end of the creek means it now functions as a separate wetland.

Lying near the western limit of the Murray Fans bioregion, the floodplain is one of the most downstream areas of the central river red gum forests which include Barmah-Millewa, Gunbower-Koondrook-Perricoota, Werai, Cambell Island, Guttrum and Benwell. These communities provide complex physical habitats and are highly productive. The forests support breeding by colonial nesting waterbirds and provide habitat for woodland fauna that require dense and productive understorey (Ecological Associates 2014a).

The floodplain at Vinifera Park evolved in response to the frequent and sustained flooding that occurred under natural flow conditions. Vinifera Creek and its wetlands received flooding almost annually and frequently remained flooded throughout most of the year. Persistent annual flooding would have excluded trees from these areas and supported a community of marshland plants. Frogs, small fish and other aquatic species that depend on permanent aquatic habitat would have expanded from these refuges into the forest overstorey during floods.

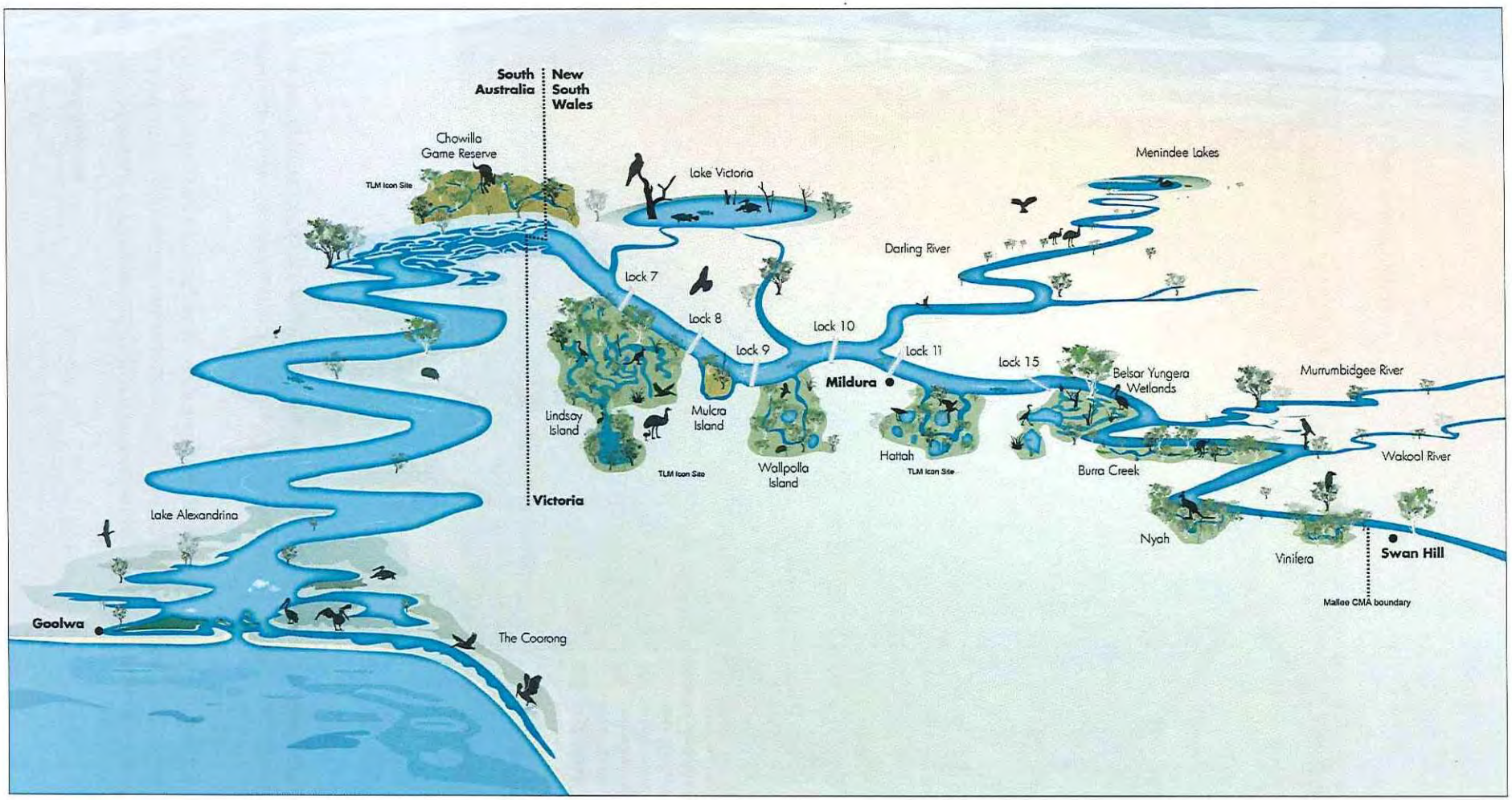


Figure 1-1: Conceptual diagram showing the distribution of sites across the Mallee Catchment Management Authority region and the longitudinal connection to the lower Murray region.

Proposed supply measure sites include Vinifera, Nyah, Burra Creek, Belsar-Yungera, Hattah (North), Wallpolla, Lindsay Island. The Living Murray Environmental Works and Measures sites include Hattah, Mulcra Island, Chowilla Game Reserve, and parts of Lindsay Island. Diagram is not to scale.

1.3. Land tenure

The *Vinifera Floodplain Management Project* is located entirely within Crown Land within the Vinifera Park. The former Vinifera State Forest became part of the Nyah Vinifera (Regional) Park in 2010 in recognition of its conservation values and its outstanding range and concentration of Aboriginal cultural heritage sites (VEAC 2008).

The Park is currently managed by Parks Victoria. It is expected that in future, there will be co-management between the Wadi Wadi community, Parks Victoria and Department of Environment and Primary Industries (DEPI).

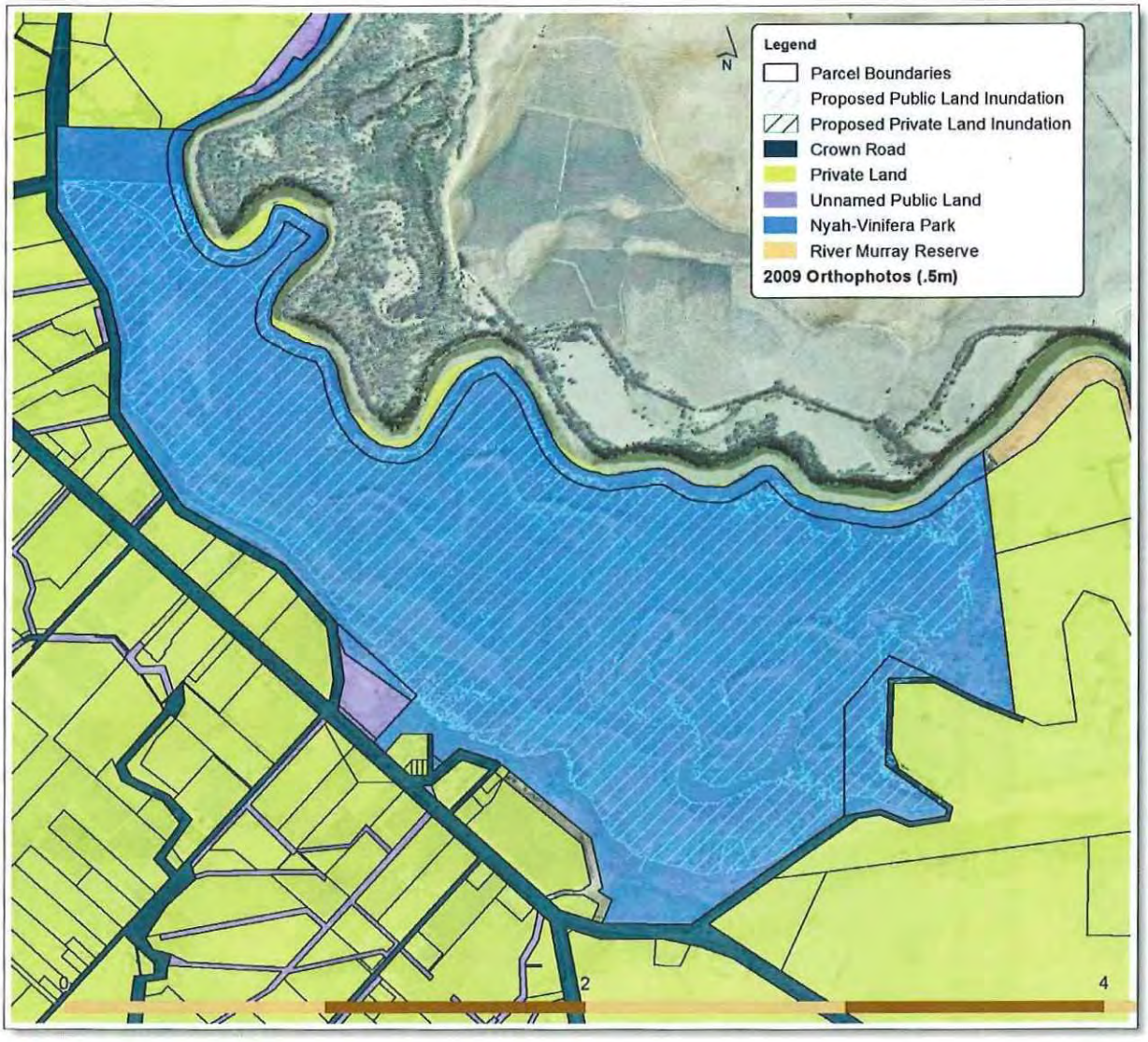


Figure 1-2: Land tenure in Vinifera Park

1.4. The proposal

A range of options have been investigated to address the changes to hydrology to achieve defined ecological objectives. Feasibility, cost-effectiveness and ability to meet objectives have been considered in the analysis of all options. This has resulted in the development of environmental works and measures that optimises costs, achieves the ecological objectives for Vinifera by providing a hydrological regime that meets the requirements of the indigenous fauna and flora.

The Vinifera works consist of four regulators, two on the downstream end of Vinifera Creek and two on the upstream end. Additional works to contain water within the forest include 1,087 m of low level track raising[1], forming a levee at the downstream end of the forest. Minor works to contain water at low spots within existing levels will also be undertaken. A detailed description of the proposed works package is included in Sections 3.2 and 12 of this business case.

Water will be delivered to the site through a combination of natural inflows or temporary pumping when river flows are insufficient. The works enable 349.6 hectares of inundation dependent habitat to have an appropriate water regime reinstated. This represents 55% of the total forest area and almost all of the flood dependent communities found within the forest.

The overall objective of water management at Vinifera Park is:

"to restore the key species, habitat components and functions of the Vinifera Park ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities".

This will be achieved by:

- restoring the vegetation structure of wetland plant communities
- re-establishing resident populations of frogs and small fish
- providing reliable breeding habitat for water birds, including colonial nesting species
- restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler
- contributing to the carbon requirements of the River Murray channel ecosystem.

This project provides the opportunity to reverse condition decline across the floodplain and deliver significant benefits to improve habitat for the diversity of species. Ecological objectives will be achieved by providing ecosystem water requirements of the Vinifera Park floodplain.

A representation of the planned works and inundation at Vinifera is shown in Figure 3.

[1] 'Track raising' is used throughout this business case to refer to the building up of existing tracks to form minor levees to contain water on the floodplain. This method enables duration targets to be met while minimising the construction footprint.

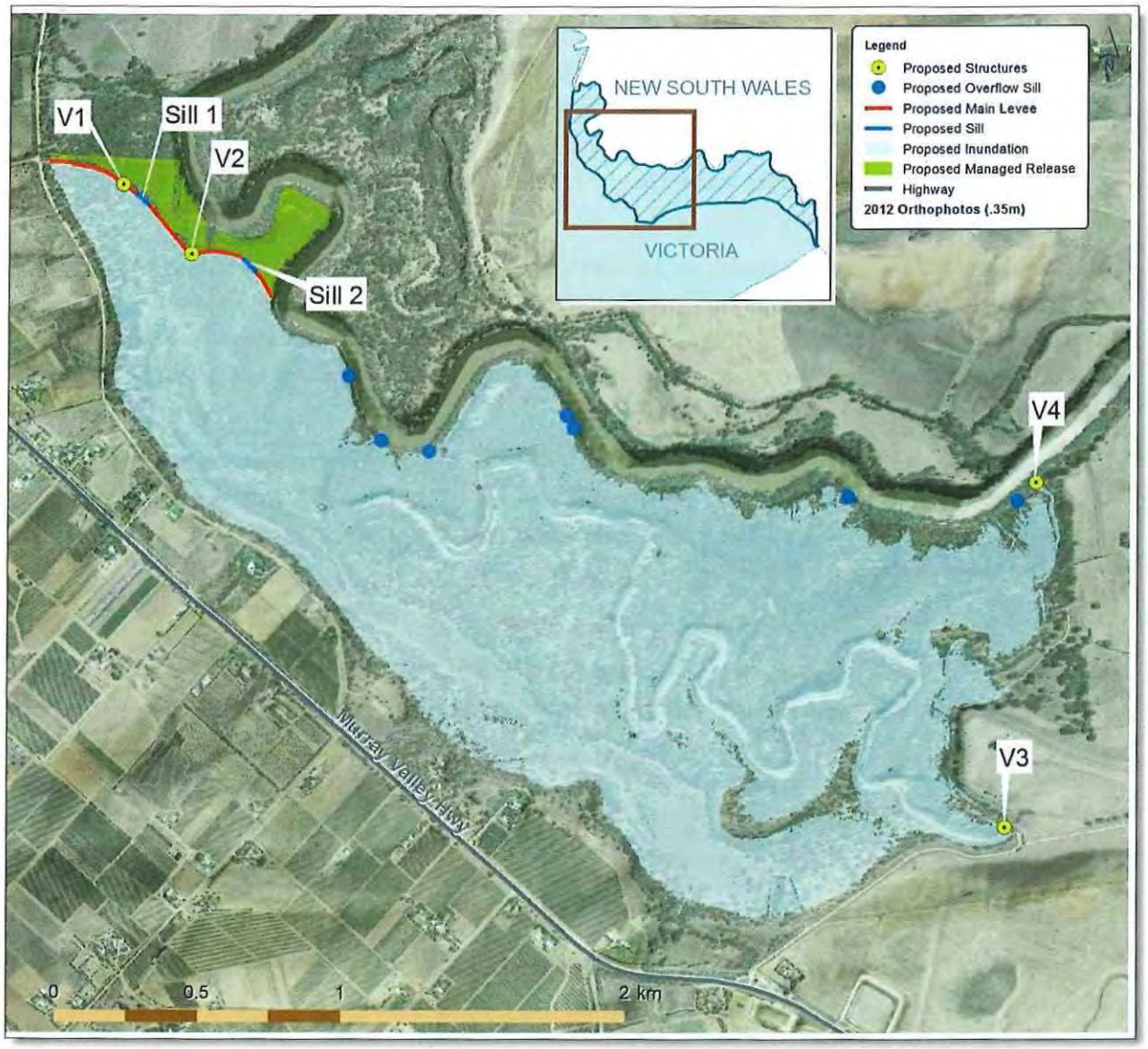


Figure 1-3: Proposed works and inundation extent at Vinifera Park

For ease of reference, a fold-out map of the proposed project has been included as Appendix A to provide a spatial representation of the planned works discussed in this document.

1.5. Project development

The feasibility study and business case for the *Vinifera Floodplain Management Project* has been developed by the Mallee CMA, on behalf of the Victorian Government, and in partnership with the Department of Environment and Primary Industries, Parks Victoria and Goulburn-Murray Water, through funding from the Commonwealth Government.

This proposal draws on a decade of collective experience from all project partners in the construction of large-scale environmental works and measures programs and environmental water delivery in the Mallee region. A recent example of collaborative work successfully delivered by this team includes the $32 million Living Murray environmental infrastructure project at Hattah Lakes. A project that delivered environmental water to more than 6000 hectares of Ramsar lakes and floodplain.

1.6. Project stakeholders

The Mallee CMA has worked with key stakeholders and interested community groups to develop the concept for the Vinifera project over an extended period of time from 2012 to 2014. Consultation has been undertaken with Aboriginal stakeholder groups, land managers, key partner agencies, and targeted community groups. The project has high visibility among adjacent landholders/managers, along with Aboriginal stakeholders and other interested parties.

To ensure the advice and concerns of those involved have been considered and responded to accordingly a detailed Communication and Engagement Strategy has been developed and implemented for this project. This strong commitment to working directly with project partners and the community will be ongoing throughout the construction and implementation phases of the project, further cementing community support for the Vinifera Floodplain project and ensuring it will continue to be a successful project.

Photo point monitoring undertaken during River Murray high flows (2013)

2. Eligibility (Section 3.4)

Victoria considers that this supply measure meets the relevant eligibility criteria for Commonwealth supply measure funding.

In accordance with the requirements of the Murray-Darling Basin Plan, Victoria confirms this is a new supply measure, additional to those already included in the benchmark assumptions under the Plan.

Pending formal confirmation of off-set potential, the operation of this measure is expected to:

- Increase the quantity of water available for consumptive use
- Provide equivalent environmental outcomes with a lower volume of held environmental water than would otherwise be required under the Basin Plan
- Be designed, implemented and operational by 30 June 2024.

This business case demonstrates in detail how each of the criteria (above) is met.

Other than the provision of financial support to develop this business case, this proposal is not a 'pre-existing' Commonwealth funded project, and it has not already been approved for funding by another organisation, either in full or in part.

Vinifera Park in the foreground (2011)

3. Project Details (Section 4.1)

3.1. Description of proposed measure, including locality map

The *Vinifera Floodplain Management Project* is a proposed supply measure project located on the River Murray floodplain, 25km north of Swan Hill in North West Victoria (Figure 3-1).

In accordance with the Phase 2 Assessment Guidelines, this project falls within the category of environmental works and measures at point locations.

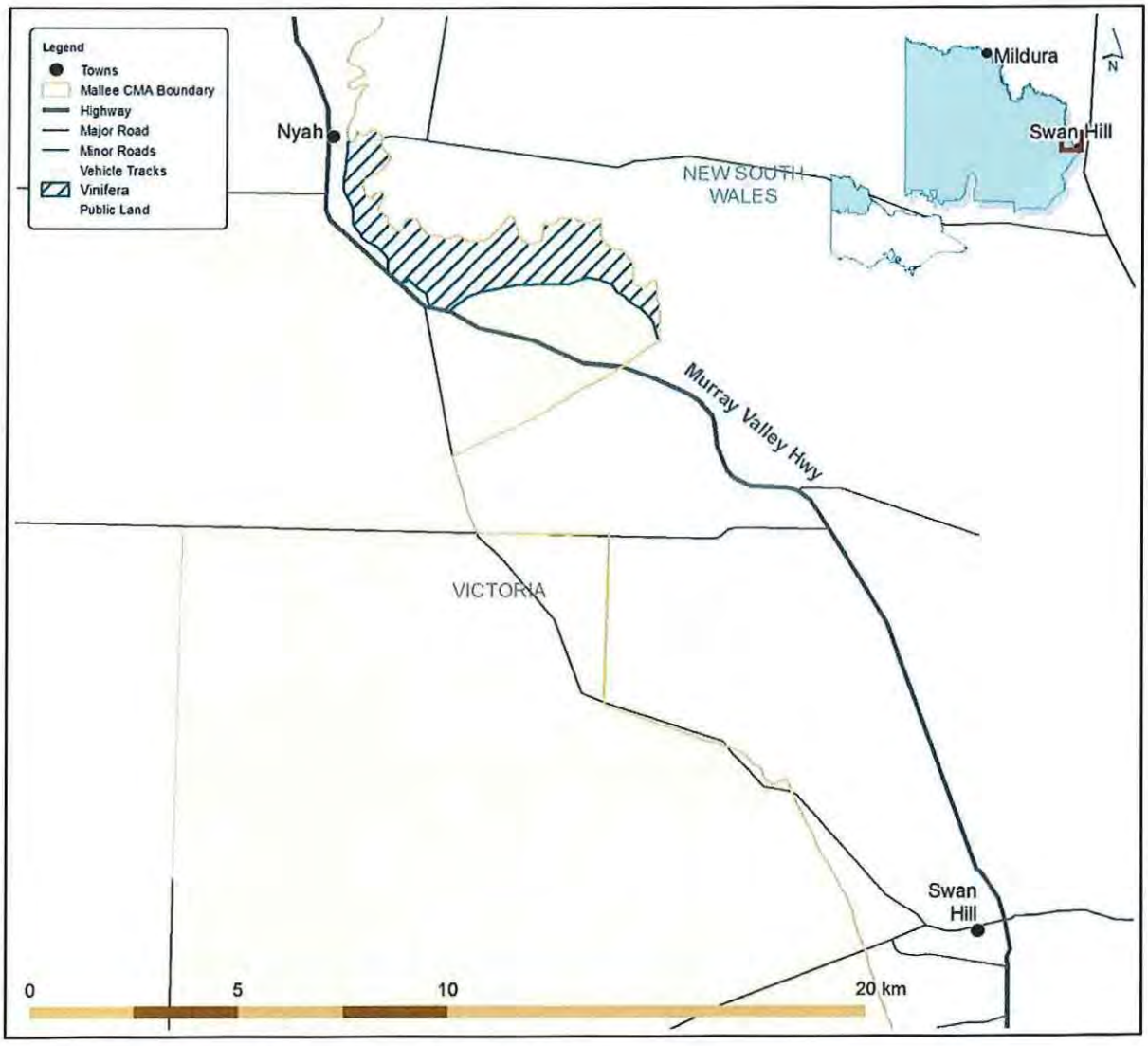
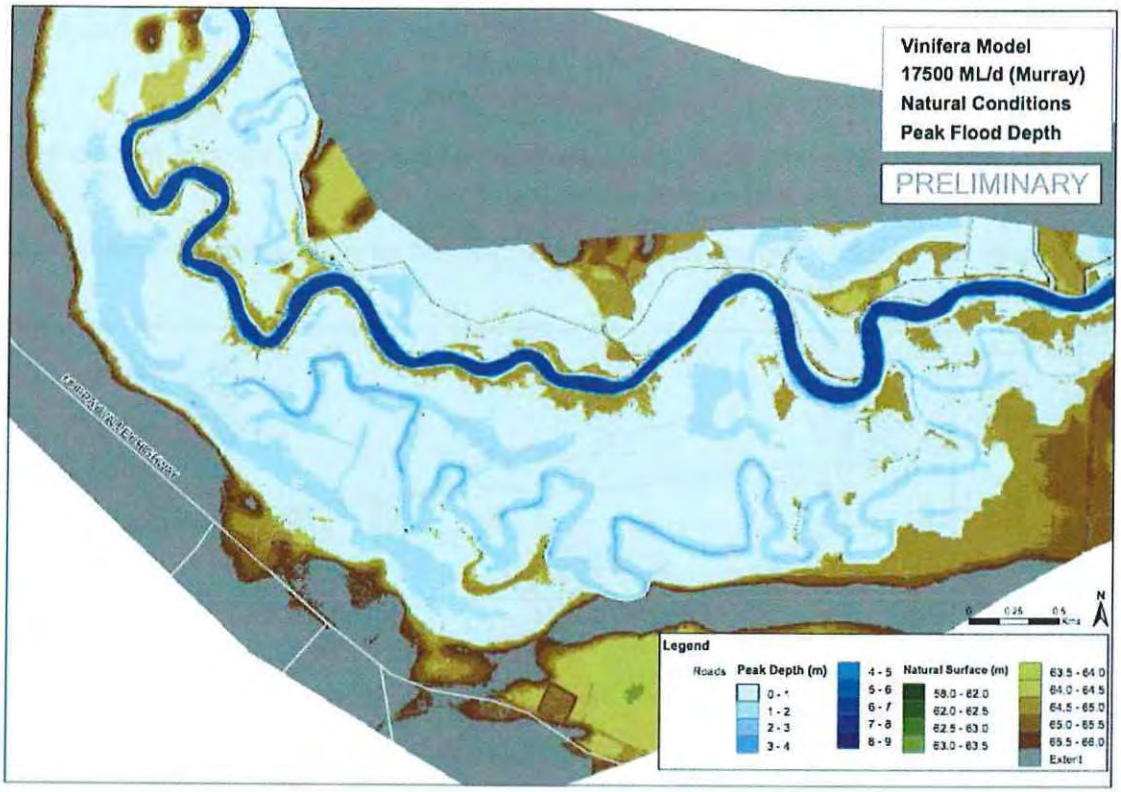


Figure 3-1: Location of the Vinifera Floodplain Management Project

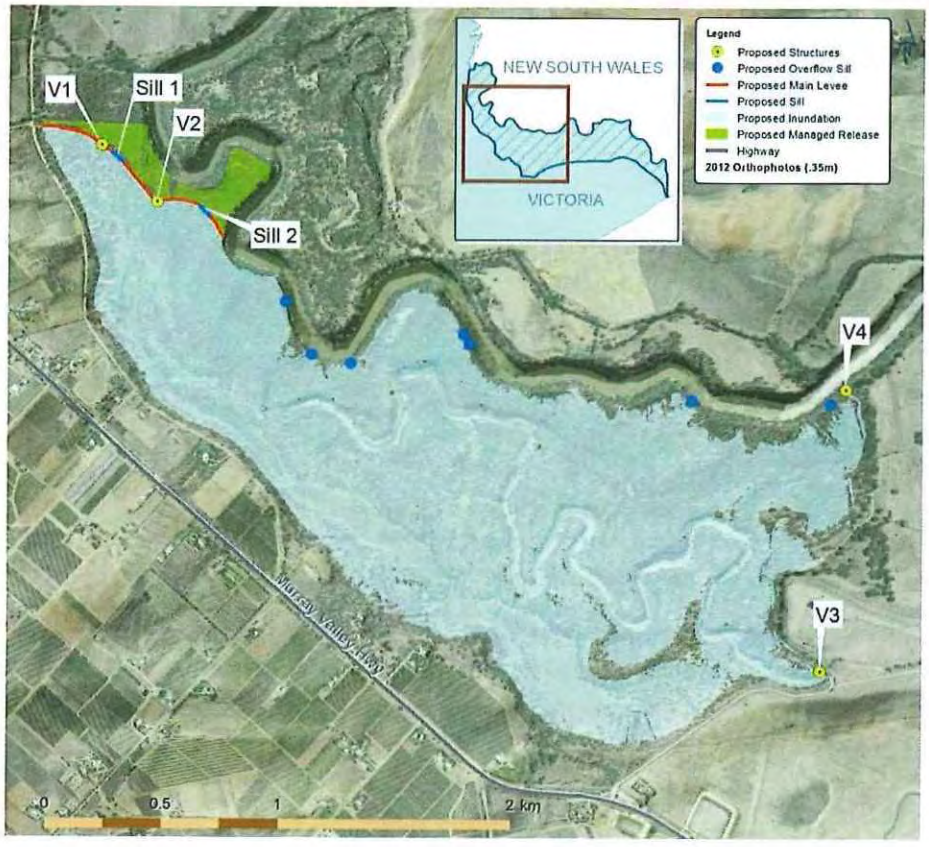
The purpose of this project is to increase the frequency and duration of inundation to reinstate a watering regime matched to the ecological requirements of river red gum and other significant vegetation and fauna on the floodplain. This will require regulating structures and temporary pumping, (in the absence of suitable River Murray flows), to provide a more natural inundation regime.

The project will provide inundation of up to 349.6 ha of inundation-dependent habitat with a water level of 64.4 m AHD, requiring a volume of 2,743 ML. Analysis of the inundation flow equivalences (Jacobs, 2014) shows that the proposed works will replicate inundation flows of 20,000 ML/d at the site (



b)

Figure 3-2). Note that a directly comparable inundation map of 20,000 ML/d per day is not available.



a)

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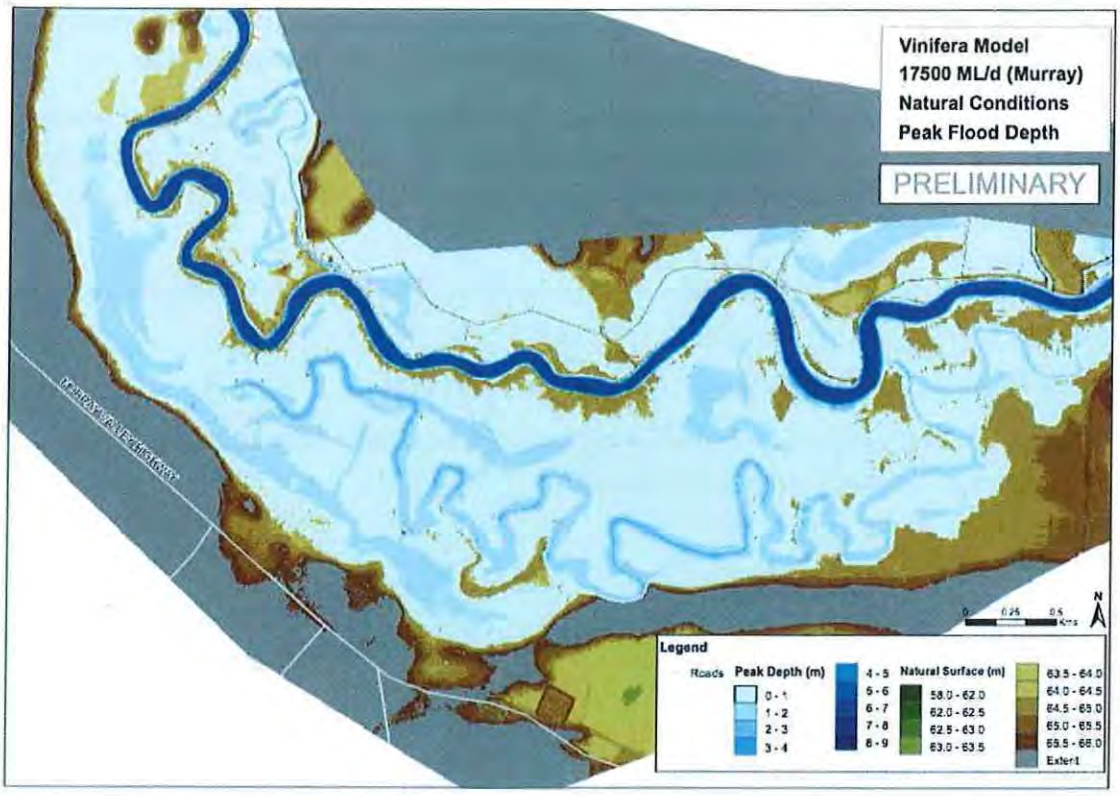


Figure 3-2: Comparison of (a) project flooding footprint against (b) forest inundation at River Murray flow of 17,500 ML/d (from Ecological Associates 2014a).

3.2. Environmental works and measures at point locations

The proposed package of works for Vinifera Park have been designed to:

- allow water movement in and out of Vinifera Park on a natural flow, as well as
- meet targets for flood duration and frequency using flow detention and regulating structures.

Water will be detained in the floodplain basin by a combination of regulating outflows and levees as summarised below. The primary component of the works is two box regulators (V1 and V2) and a stop bank (levee) with overflow sills near the northern (downstream) end of the floodplain.

Regulator V2 is located on the more defined and deeper flow path and is the main regulator for controlling initial flow into and out of the forest. Regulator V1 is located about 330m north-west of V2 and will pass flows through the broad depression leading to the Murray River.

A drop structure and rock work have been included in the channel downstream of structure V2 and near the confluence of the Murray River. The purpose of the drop structure is to protect against erosion when regulator V2 is releasing water to the river at the end of a managed watering event. The specific aim of the structure is to establish a tailwater at the regulator sufficient to prevent sweep out of the hydraulic jump and provide a plunge pool for downstream fish passage.

The regulators will be located in a stop bank (levee) to allow through-flow in the creek and to retain water at a level of up to 64.4 m AHD. The majority of earthen levees will be built on the alignment of existing forest tracks and have been designed to overtop. The levees will provide operator access to the regulators during flooded conditions. Utilising the existing tracks for the alignment of the levees also reduces the footprint of works in undisturbed areas.

Additional works at the upstream end of the forest include two piped regulating culverts and road embankments (V3 and V4). Regulator V3 is designed to pass local drainage flows, pass overland flows in large

events and prevent backflow onto private land during a managed event. Regulator V4 will prevent backflow into the Murray River when retaining water in the forest and allow inflows from the Murray River.

A series of minor works, block banks and overflow sills to secure local low points and contain water within the floodplain have been designed to complement the operation of the regulator structures. The works include a few short lengths of non -trafficable levee at tie in locations where the levee needs to match the natural river levee.

Collectively, these structures will enable inundation of the floodplain to be extended following inflows from natural floods or pumping, and will maintain access during watering events.

The location of these works within the Park are shown in Figure 3-3 below.

An overview of the key elements of the proposed works package is provided in Table 3-1 below. A more detailed description of the works is provided in section 12.

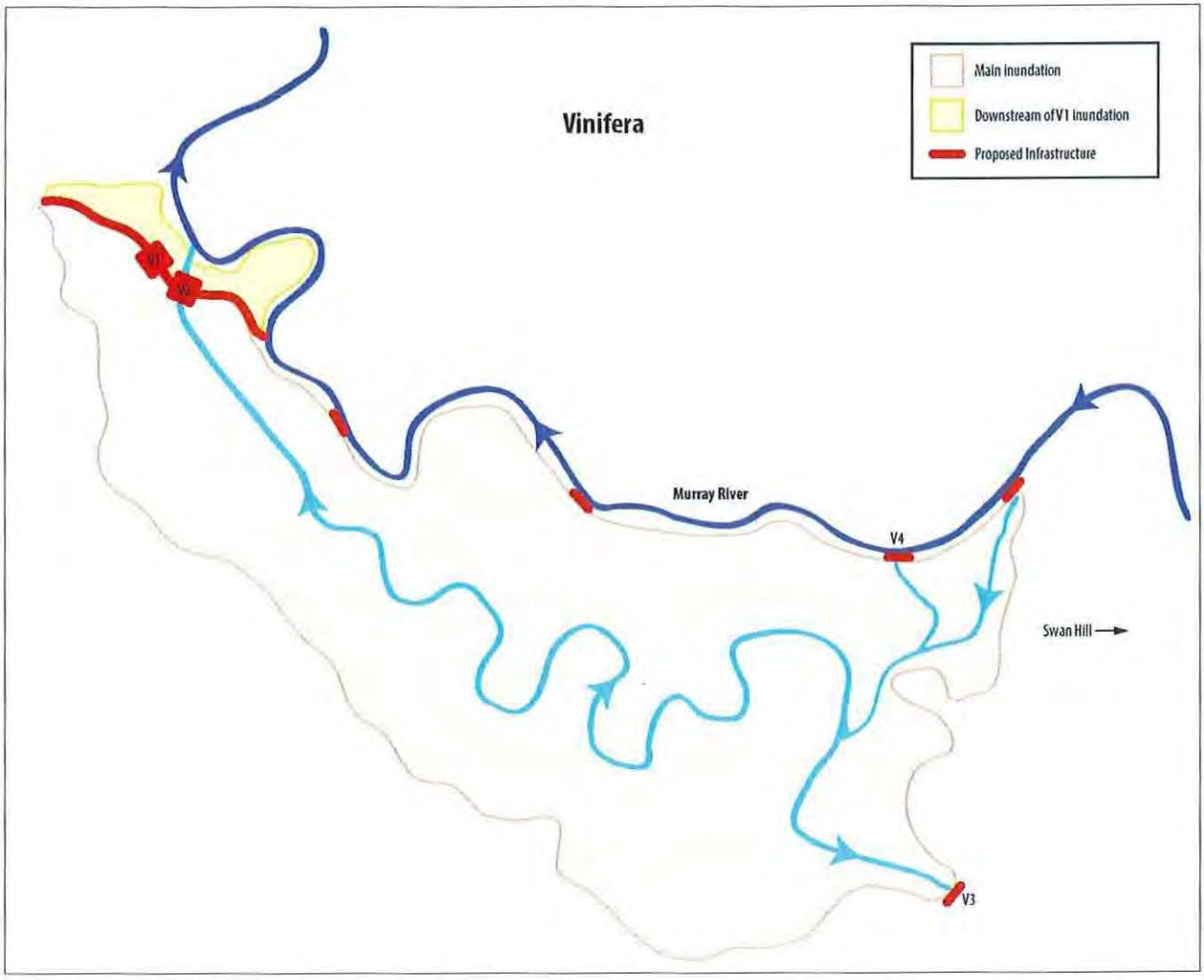


Figure 3-3: Representation of planned works and inundation at the Vinifera floodplain site

Table 3-1: Elements of the Vinifera works (Jacobs, 2014a)

Works	Description
V1 – Regulator	New ten bay regulator to retain water within Vinifera Creek allowing release of gravity controlled water to the very north-western tip of the Vinifera floodplain. 10 box culverts, 4 with dual leaf combination gates and 6 with single leaf gates.
V2 – Regulator	New four bay regulator allowing the release of water into the bend directly adjacent to the River Murray in the northern section of the Vinifera floodplain. 4 box culverts with split leaf combination gates
Main Levee	1087 m long raised track, to a maximum height of 1700 mm, incorporating 2 x 70m long overflow sills.
Drop structure	Rock structure to minimise erosion risk associated with the return of the impounded water to the River Murray.
V3 – Pipe culvert	New pipe culvert regulator on Vinifera creek to pass both local drainage and overland flows in large events. 1,200 mm diameter concrete pipe with penstock gate.
V4 – Pipe culvert	New pipe culvert to allow inflows from the River Murray and prevent backflow to the River Murray when retaining water on the floodplain during a watering event. 1,200 mm diameter concrete pipe with penstock gate.
Raised track sections and overflow sills	Seven overflow sill works, to contain water on the floodplain. The location of overflow sills to align with existing roads where possible, to reduce environmental and cultural heritage impacts. Raise short sections (< 200m in total) of the natural river levee at some sites.

3.3. Name of proponent and proposed implementing entity

As the project owner, DEPI will have oversight responsibility for project implementation, pending confirmation of construction funding. Further information regarding the proposed governance and project management arrangements for implementation is provided in Section 17.

3.4. Summary of estimated costs and proposed schedule

The total cost of the *Vinifera Floodplain Management Project* is $9,122,148.

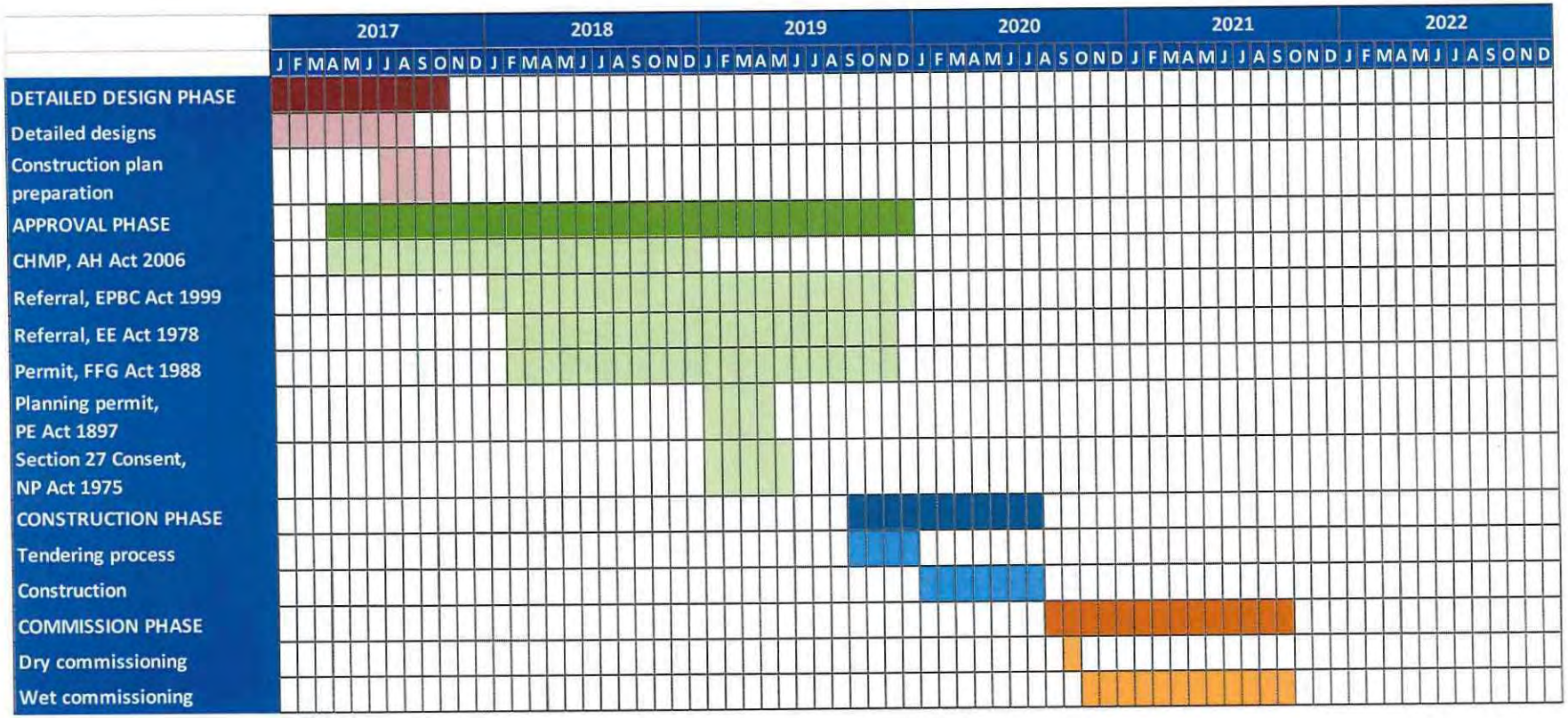
Further details on project costs are provided in Section 14.

This business case presents the cost to fully deliver the project (i.e. until all infrastructure is constructed, commissioned and operational), including contingencies. Cost estimates for all components in this proposal are based on current costs, with no calculation undertaken of future cost escalations. To ensure sufficient funding will be available to deliver the project in the event that it is approved by the MDB Ministerial Council for inclusion in its approved SDL Adjustment Package to be submitted to the MDBA by 30 June 2016, cost escalations will be determined in an agreed manner between the proponent and the investor as part of negotiating an investment agreement for this project.

Table 3-2 outlines a high-level program schedule for the project. The program does not include durations for hold points at project gateways, as these are yet to be confirmed. The works are planned to be fully operational prior to 2024.

Vinifera Forest in flood

Table 3-2: Proposed project delivery schedule



note: timelines are indicative only and will depend on finalisation of funding agreements

4. Ecological values of the site (Section 4.2)

4.1. Fauna values

Vinifera Park is one of the most downstream areas of the central river red gum forests, lying near the western limit of the Murray Fans bioregion. It provides a unique ecological community where the semi-arid Mallee landscape and River Murray and its floodplain connect, providing an essential biodiversity corridor for fauna to move between environments vital to their life-cycles.

Recent flora and fauna surveys from Nyah-Vinifera Park indicate that the Vinifera project site contains or is expected to contain the following species of conservation significance (Brown et al, 2013; Cook 2012; Davies et al, 2008; DSE, 2005; Ecological Associates, 2014a; GHD, 2013), as summarised below.

The Park contains, or is expected to contain, the following numbers of animal species of conservation significance:

- 21 species of fauna on the DEPI advisory list of rare or threatened fauna
- 14 species listed under FFG Act including fish, bushbirds, waterbirds and bats
- Of the 14 species listed above, the regent parrot (*Polytelis anthopeplus monarchoides*) and Murray cod (*Maccullochella peelii peelii*) are considered Vulnerable under the EPBC Act.

Significant and listed species recorded during recent and past surveys are listed in full in Appendix B.

Regent parrot feed in nearby Mallee woodlands, but depend on the large, healthy red gum near the river to provide nesting hollows. The forest, creek and wetlands also provide essential resources for a vast array of flora and fauna, including waterbirds, woodland birds, mammals and reptiles as well as small- and large-bodied fish. The sugar-glider and black wallaby are common in the park and use the highly productive and complex habitat available, even though they are at the downstream limit of their range.

There is diverse bird fauna at Nyah-Vinifera Park with over 140 species recorded from the site and local vicinity (Brown, Byant and Horrocks, 2013, in Ecological Associates, 2014a). Of these, 20 species are of conservation significance in Victoria. Whilst not reported from Vinifera Park, the floodplain potentially provides habitat for the EPBC listed regent parrot (Ecological Associates, 2014a). The state listed eastern great egret (*Ardea modesta*) and white-bellied sea eagle (*Haliaeetus leucogaster*) are also subject to the China-Australia and Japan-Australia migratory bird agreements. Wetlands provide habitat for dabbling, diving and filter feeding ducks, piscivorous waterbirds and wading birds (Ecological Associates, 2014a). A significant population of grey-crowned babbler (*Pomatostomus temporalis*) inhabit the floodplain, with their favoured habitat being black box and red gum woodland where they forage both on the ground and on the trunks and branches of trees and shrubs (Ecological Associates 2014a).

The woodlands and understory of Vinifera Park also support a diverse bat population. A recent survey recorded 11 species of bats, including the state listed little broad-nosed bat (*Scotorepens greyii*) (Brown, Bryant and Horrocks, 2013). Other mammals recorded include black wallaby (*Wallabia bicolor*), common brushtail possum (*Trichosurus vulpecula*) and eastern grey kangaroo (*Macropus giganteus*) (Brown, Bryant and Horrocks, 2013).

Vinifera Park also provides habitat for reptiles and frogs. A recent survey recorded the presence of five reptile and three amphibian species, with a further two reptiles recorded as occurring in the Victorian database (Brown, Bryant and Horrocks, 2013 in Ecological Associates, 2014a). High levels of forest productivity are required to provide the refuge habitat and vertebrate and invertebrate prey on which reptiles and amphibians depend (Ecological Associates, 2014a).

The site provides seasonal wetlands and flowing creek habitat expected to be suitable for seven of ten fish species regularly encountered in the River Murray near Vinifera (Davies, et al. 2008 in Ecological Associates, 2014a). The Vinifera Creek and surrounding wetlands provides resources such as submerged aquatic vegetation, woody debris and plant and invertebrate food sources, considered suitable for a range of small fish, including potential populations of the state listed Murray-Darling rainbowfish (*Melanotaenia fluviatilis*) and freshwater catfish (*Tandanus tandanus*) as well as carp gudgeon (*Hypseleotris klunzingeri*), flathead gudgeon (*Phylipnodon grandiceps*) and Australian smelt (*Retropinna semoni*) (Ecological Associates, 2014a).

Male mulga parrot at Vinifera Park (2013)

4.2. Vegetation values

Vinifera Park has a diverse flora assemblage and supports numerous species of conservation significance. More than 270 indigenous plant species were observed in the Nyah Vinifera Park during a flora survey in 2012 (Cook, 2012) and 15 rare or threatened flora species have been recorded within or close to the forest complex (Cook, 2012; GHD, 2013; Ecological Associates, 2014a).

Recent flora and fauna surveys from Nyah-Vinifera Park indicate that the Vinifera project site contains or is expected to contain the following species of conservation significance (Brown et al, 2013; Cook 2012; Davies et al, 2008; DSE, 2005; Ecological Associates, 2014a; GHD, 2013), as summarised below.

The Park contains, or is expected to contain, the following numbers of plant species of conservation significance:

- 24 species on the DEPI advisory list of rare or threatened flora species in Victoria
- One species listed under the FFG Act - wavy marshwort (*Nymphoides crenata*)

- One endangered EVC (103 Riverine Chenopod Woodland), and two vulnerable EVC's (295 Riverine Grassy Woodland, 819 Spike-sedge Wetlands)

Significant and listed species recorded during recent and past surveys are listed in full in Appendix B.

The vegetation of Vinifera Park is dominated by red gum forest, with areas of open canopy and shrubby understory that include pale-fruit ballart (*Exocarpus strictus*), as well as areas with a dense canopy and only a sparse ground layer. The wetland areas of the floodplain, where the canopy is more open, supports aquatic macrophytes including *Ludwigia peploides, Eleocharis acuta* and *Marsilea drummondii*. The high terrace along the western edge of the park supports terrestrial species, including a greater proportion of grasses and chenopods (Ecological Associates, 2014a).

Ecological Vegetation Class

The vegetation communities of the Vinifera site are distributed across the floodplain according to hydrological conditions, soils type and groundwater quality. In Victoria vegetation mapping units known as Ecological Vegetation Classes (EVCs) are the standard unit for classifying vegetation types. EVCs are described through a combination of floristics, lifeforms and ecological characteristics, and preferred environmental attributes (DSE, 2014). The EVC classifications provide a suitable basis to inform water management planning at the site.

A total of 9 EVCs have been mapped at Vinifera Park, all are water dependent (Figure 4-1). The EVCs are:

- Riverine Chenopod Woodland
- Grassy Riverine Forest
- Riverine Grassy Woodland
- Floodway Pond Herbland
- Grassy Riverine Forest / Floodway Pond Herbland Complex
- Riverine Swamp Forest
- Sedgy Riverine Forest
- Spike-sedge Wetlands
- Tall Marsh.

Of the 9 floodplain EVCs present at Vinifera, one EVC (Riverine Chenopod Woodland) is endangered in the Murray Fans bioregion and two EVCs (Riverine Grassy Woodland and Spike-sedge Wetlands) are vulnerable (Ecological Associates, 2014a). The remaining EVCs, except for Tall Marsh, are regionally depleted (Ecological Associates, 2014a).

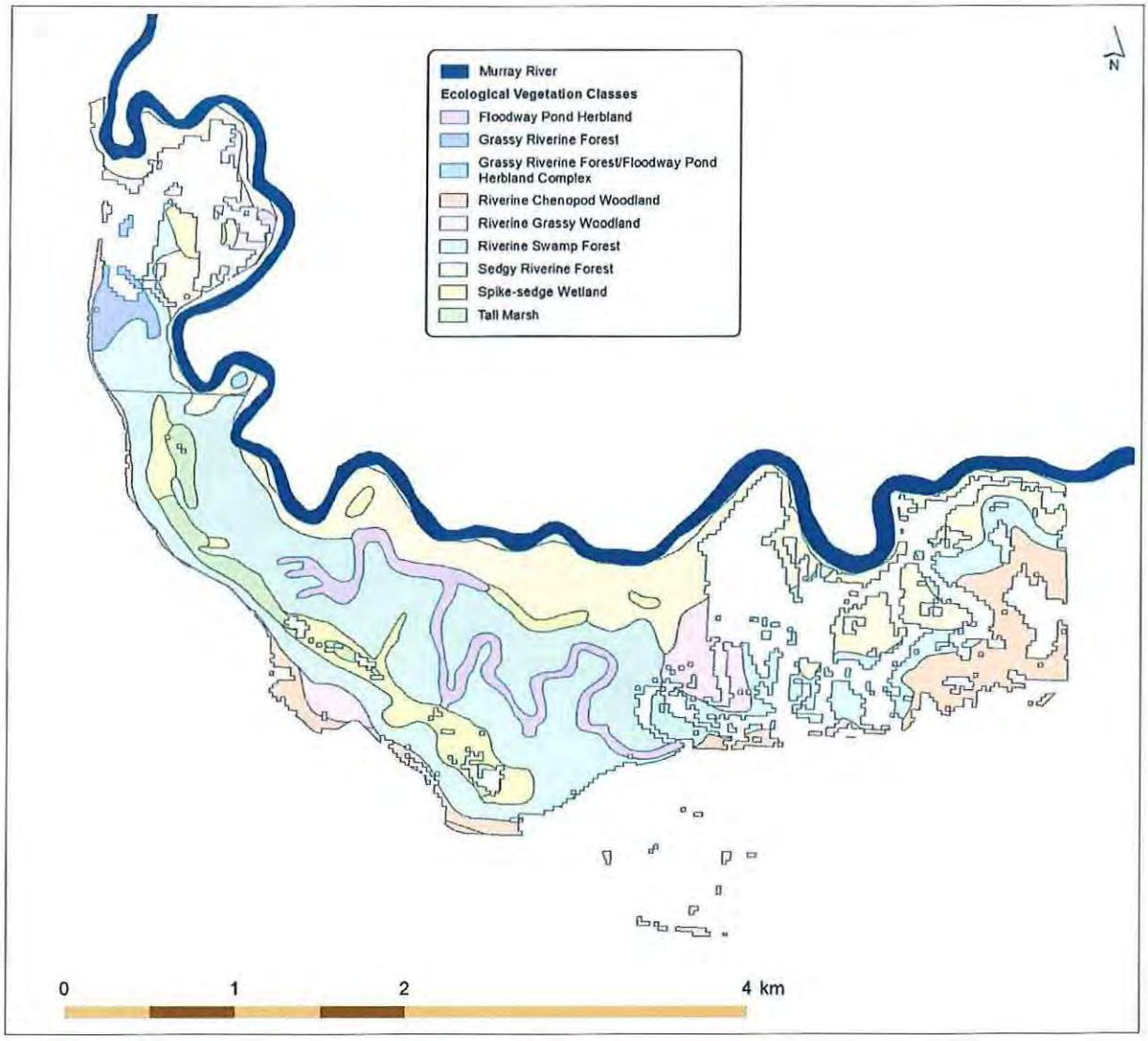


Figure 4-1: Ecological Vegetation Classes present at Vinifera Park

Water Regime Class

Floodplain ecology is influenced by the duration, depth, frequency and timing of inundation events. Therefore, it is useful to define water regime classes to establish objectives for the location, extent and condition of components of the floodplain ecosystem.

Plant communities present at Vinifera Park have been described and mapped in detail as EVCs. Possible relationships between EVCs and water regimes were assessed. Using topographic data and information on the known spread of water on a rising hydrograph, EVCs were arranged in the order in which they are likely to be flooded and likely frequency and relative durations of flooding. This environmental gradient was refined by reviewing the EVC descriptions, which set out the species present during flooded and dry phases, their relative abundance and their habitat. Species with known relationships to flooding could be used to rank EVCs from most-likely to least likely to be flooded (Ecological Associates 2007).

EVCs were amalgamated into five water regime classes (Figure 4-2).

Table 4-1 provides a brief description of the water regime classes at Vinifera Park. A more detailed description of the characteristics of these water regime classes is provided in Appendix B.

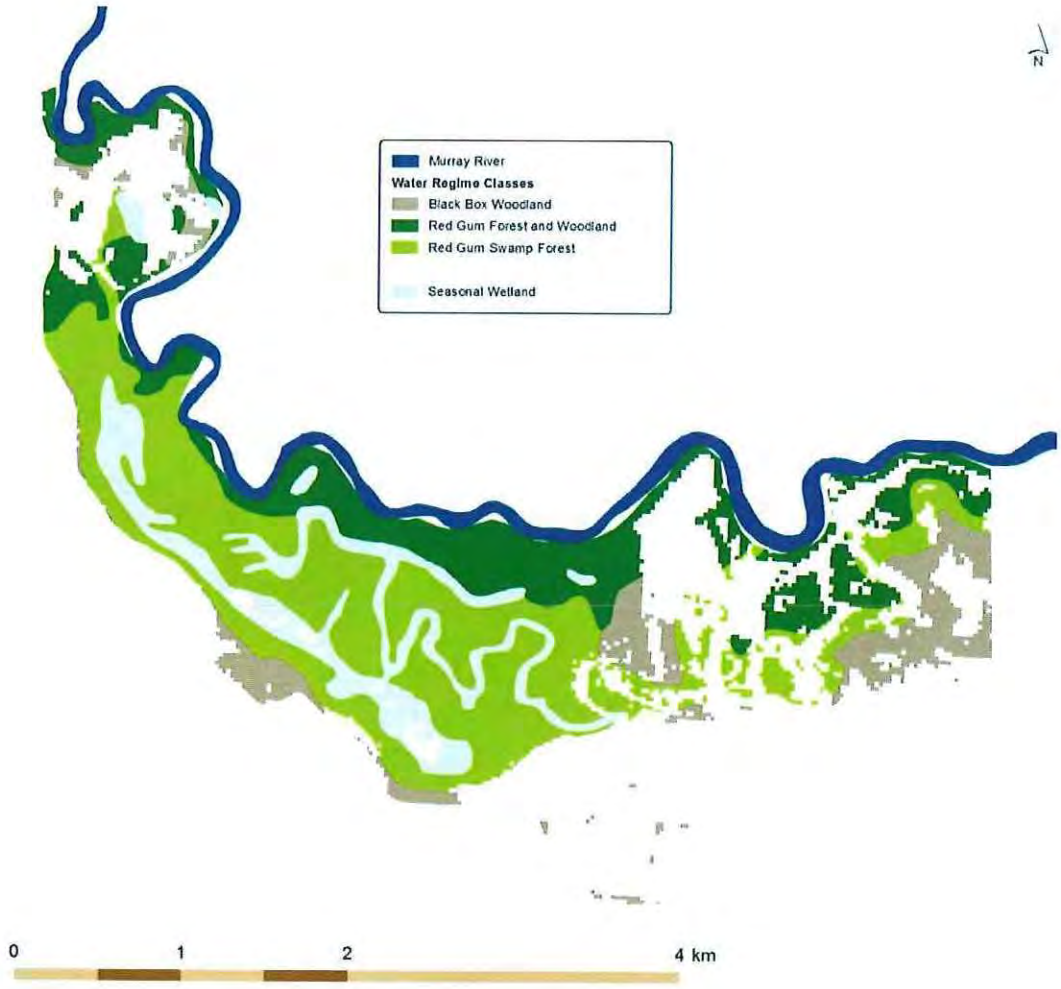


Figure 4-2: Vinifera Park Water Regime Classes

Table 4-1: Vinifera Park Water Regime Classes (Ecological Associates, 2014a)

Water Regime Class[1]	Area (ha)	Area to be watered within this project (ha)	Ecological Vegetation Class
Seasonal Wetland	98	92	819 Spike-sedge Wetlands 821 Tall Marsh 810 Floodway Pond Herbland
Red Gum Swamp Forest	278	189	814 Riverine Swamp Forest
Red Gum Forest and Woodland	161	59	106 Grassy Riverine Forest 811 Grassy Riverine Forest / Floodway Pond Herbland Complex 816 Sedgy Riverine Forest
Black Box Woodland	87	2	295 Riverine Grassy Woodland 103 Riverine Chenopod Woodland
Un-mapped EVC[2]	7	7	
Total	**637**	**350**	

1 Riverine Grassy Woodlands or Forests (shown in Figure 4-2) is not included in Table 4-1 as it is outside the project inundation area

[2] There is a small area on Vinifera where EVCs have not been mapped due to gaps in spatial data.

Table 4-1 shows that:

- The project predominantly manages inundation in three of the water regime classes identified
- the Black Box Woodland water regime class (which occurs at higher elevations of the floodplain) is largely outside the project footprint.

4.3. Current Condition

The forests and woodlands of the River Murray floodplain have been declining rapidly in condition over the past two decades. The decline is associated with increasing regulation of the River Murray and extended periods of drought (Cunningham et al, 2011).

Vinifera Park has a sparse understory and reduced diversity and habitat value due to the alteration in the sites water regime (Ecological Associates, 2014a). Structural habitat and food resource availability for species such as carpet python, swamp wallaby, grey-crowned babbler and other woodland species has also reduced (Ecological Associates, 2014a). In addition, forest productivity has declined, causing a decrease in tree density and canopy cover (Ecological Associates 2014a).

Vinifera features broad wetland depressions that retain water following flood recession. Persistent inundation is required to sustain the rich ecological values of Vinifera Park. The inundation is important as it supports marshland communities including spiny mudgrass, frogs and small fish that depend on permanent aquatic habitat; however inundation durations are now too short to sustain perennial aquatic macrophytes, to prevent encroachment of red gum on swamp and wetland areas, and to significantly contribute to the breeding requirements of native fish or waterbirds (Ecological Associates 2014a).

As a result, areas of seasonal wetland have been lost from the site due to hydrological change. Wetlands with open canopies have been encroached upon by river red gum, resulting in site now able to provide habitat for aquatic fauna only opportunistically. Flood duration in the Vinifera Creek is also too brief to meet the habitat requirements of channel specialist fish species and Murray crayfish (Ecological Associates, 2014a).

Further discussion on the current condition of the Vinifera floodplain is provided in section 6.

4.4. Past Management Activities and Actions

Historically the Vinifera Park was managed under pastoral leases and then as a timber reserve. The area has been managed as state forest since the 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989), primarily with a focus on timber harvesting and cattle grazing. These activities ceased in 1990 and 1998 respectively (P Kelly, 2014, pers comm).

Since the Victorian Environmental Assessment Council (VEAC) recommendations in 2008, Nyah Vinifera forest has been proclaimed as a regional park. Land management is now focused on the protection of conservation and aboriginal heritage values, while still permitting recreational use. The management activities for regional parks include, but are not limited to, management of pest species, managing fire, preserving natural values and providing recreational opportunities.

An Environmental Water Management Plan (Mallee CMA, 2012) was developed for Nyah-Vinifera Park in 2012. The plan identified ecological objectives and hydrological targets for the Park and recognised the requirement for infrastructure to better manage the inundation regime. The same ecological objectives and targets have been adopted for the *Vinifera Floodplain Management Project*.

To prevent ecosystem collapse of the River Murray floodplain system, an emergency environmental watering program was initiated at Nyah Park in 2004-05 as an immediate response to the poor condition of the floodplain. Where temporary works and portable pumps were able to partially facilitate the necessary

inundation depth, duration and extent, condition of red gum stands improved. This is shown in the photographs below.

The environmental watering program was unable to be applied at Vinifera as it required works to manage the inundation at a cost beyond that of the program. However, the responses observed at Nyah are expected to occur at Vinifera subject to the reinstatement of a more favourable flow regime.

Nyah Park before (left) (2010) and after environmental watering (right) (2011)

4.5. Other values

In addition to its environmental values, the VInifera Floodplain is recognised for its many social and cultural values.

Cultural and Historical values

The Vinifera floodplain occurs within the Nyah-Vinifera Park and is known to have a large number of culturally significant sites. The park is an important cultural site for the Wadi Wadi Aboriginal people and there are numerous burial sites, middens, and scarred trees throughout the park (VEAC, 2008). Under the *Aboriginal Heritage Act 2006* the Nyah-Vinifera area, including the Vinifera floodplain is specified as an area of cultural heritage sensitivity in accordance with several categories.

Since European settlement, the Vinifera floodplain has had many uses including grazing, forestry and local firewood collection. A European Heritage due diligence assessment has been undertaken and there were no sites identified that will have a material impact on this project.

Social and Recreational Values

Since the Victorian Environmental Assessment Council (VEAC) recommendations in 2008, management of the area is more focused on protecting conservation and aboriginal heritage values, at the same time permitting recreational use.

The Nyah–Vinifera Park is managed for multi-use values, including conservation, recreation, apiary and indigenous values. Recreational uses include dispersed camping, fishing, boating, four-wheel driving and walking. The Nyah District Pony Club is currently licensed to use 13 hectares of Vinifera forest for equestrian activities and this is expected to continue (VEAC, 2008).

There are also active community groups, including Friends, Field Naturalists, residents and the indigenous community advocating to protect and restore the ecology of the Vinifera floodplain system. (Mallee CMA, 2012).

Aboriginal cultural artefacts at Vinifera Park

5. Ecological objectives and targets (Section 4.3)

Ecological objectives have been developed for the Vinifera floodplain site, drawing on a range of approaches and recommended lines of enquiry including, but not limited to:

- The overarching objectives in Schedule 7 of the Murray-Darling Basin Plan (MDBA, 2014)
- The Basin-wide Environmental Watering Strategy (MDBA, 2014)
- A review of relevant literature including monitoring data from the TLM initiative (2010; Henderson et al, 2012; Henderson et al, 2013; Henderson et al, 2014)
- Desktop and field based flora and fauna surveys (GHD, 2013; Brown, Byant and Horrocks, 2013)
- Site visits
- An ecological objectives workshop with an expert panel comprised of aquatic, wildlife and restoration ecologists and key project stakeholders from DEPI and the Mallee CMA (Ecological Associates, 2014a)
- Site Environmental Water Management Plan (Mallee CMA, 2012).

The ecological objectives for the Vinifera Park project were developed with a view to enhance the conservation values of the site with the proposed works inform the detailed design and operation of the work and guide monitoring and evaluation.

5.1. Overarching ecological objectives

The overarching objective of water management at Vinifera Park is:

*"to **protect and restore** the key species, habitat components and functions of the Vinifera Park ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities"* (Ecological Associates, 2014a).

This will be achieved by using infrastructure to better meet the water requirements of Vinifera Park. The proposed works will enable wide spread inundation of Vinifera Creek and adjoining wetlands and floodplain. The works have been designed to operate under low River Murray flows (5,000 ML/d) and will therefore protect the Park through droughts.

5.2. Specific objectives and targets

Specific ecological objectives and targets have been developed for the proposed supply measure based on the key water-dependent values of Vinifera Park. The objectives are consistent with those of the Nyah Vinifera Environmental Water Management Plan (Mallee CMA, 2012) and will contribute achieving the environmental objectives set by the Basin Plan. The Basin Plan objectives have been summarised as follows:

1. *to protect and restore a subset of all water-dependent ecosystems in the Murray-Darling Basin ensuring that:*
   (a) declared Ramsar wetlands that depend on Basin water resources maintain their ecological character;
   (b) water-dependent ecosystems that depend on Basin water resources and support the lifecycles of species listed under the Bonn Convention, CAMBA, JAMBA or ROKAMBA continue to support those species; and
   (c) water-dependent ecosystems are able to support episodically high ecological productivity and its ecological dispersal.
2. *to protect and restore biodiversity that is dependent on Basin water resources, by ensuring that:*
   (a) water-dependent ecosystems that support the lifecycles of a listed threatened species or listed threatened ecological community, or species treated as threatened or endangered in State law, are protected and, if necessary, restored so that they continue to support those life cycles;
   (b) representative populations and communities of native biota are protected and if necessary restored;
   (c) representative populations and communities of native biota are protected and if necessary restored.
3. *that the water quality of Basin water resources does not adversely affect water-dependent ecosystems and is consistent with the water quality and salinity management plan.*
4. *to protect and restore connectivity within and between water-dependent ecosystems including by ensuring that:*
   (a) the diversity and dynamics of geomorphic structures, habitats, species and genes are protected and restored;
   (b) ecological processes depend on hydrologic connectivity longitudinally along rivers, and laterally, between rivers and their floodplains (and associated wetlands) are protected and restored;
   (c) the Murray Mouth remains open at frequencies, for durations and with passing flows, sufficient to enable the conveyance of salt, nutrients and sediment from the Murray-Darling Basin to the ocean;
   (d) the Murray Mouth remains open at frequencies, and for durations, sufficient to ensure that the tidal exchanges maintain the Coorong's water quality within the tolerance of the Coorong ecosystems' resilience and
   (e) barriers to the passage of biological resources (including biota, carbon and nutrients) through the Murray Darling Basin are overcome or minimised.
5. *that natural processes that shape landforms (for example, the formation and maintenance of soils) are protected and restored.*
6. *to provide habitat diversity for biota at a range of scales (including, for example, the Murray–Darling Basin, riverine landscape, river reach and asset class).*
7. *to protect and restore food webs that sustain water-dependent ecosystems, including by ensuring that energy, carbon and nutrient dynamics (including primary production and respiration) are protected and restored.*
8. *to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (for example recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that;*
   (a) flow sequences, and inundation and recession events, meet ecological requirements (for example, cues for migration, germination and breeding); and
   (b) habitat diversity that supports the life cycles of biota of water dependent ecosystems (for example habitats that protect juveniles from predation) is maintained.
9. *to protect and restore ecological community structure and species interactions.*
10. *that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (for example, drought and fire)*
11. *to protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna, including during drought to allow for subsequent re-colonisation beyond the refugia.*
12. *to provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible changes.*
13. *to mitigate human-induced threats (for example, the impact of alien species, water management activities and degraded water quality).*
14. *to minimise habitat fragmentation.*

The contribution of the proposed project's specific objectives to the Basin Plan objectives is demonstrated in Table 5-1.

Table 5-1: Relationship between the site based objectives and targets and the Basin Plan objectives

Specific Objective	Ecological Target	Water Regime Classes	Associated Basin Plan Objectives
Restore the vegetation structure of wetland plant communities	The projected red gum canopy cover in seasonal wetlands decreases by 50% from 2015 levels by 2030 The projected aquatic macrophyte plant cover in December in seasonal wetlands exceeds 50% by 2030.	Seasonal Wetlands Red Gum Swamp Forest Red Gum Forest and Woodland	1,2,4,6,7,8,9, 10,11,12,13,14
Re-establish resident populations of frogs and small fish	At least four native fish species are present in seasonal wetlands every spring between 2025 and 2035. At least three frog species are present in seasonal wetlands every spring between 2025 and 2035.	Seasonal Wetlands Red Gum Swamp Forest Red Gum Forest and Woodland	1,2,4,6,7,8,9, 10,11,12,13,14
Provide reliable breeding habitat for waterbirds, including colonial nesting species	Any species of waterfowl, crake, rail, waterhen or coot breeds every year between 2025 and 2035 at Vinifera. Cormorants and/or nankeen night heron breed at Vinifera on at least six occasions between 2025 and 2035	Seasonal Wetlands Red Gum Swamp Forest Red Gum Forest and Woodland Black Box Woodland	1,2,4,6,7,8,9, 10,11,12,13,14
Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler	All red gum stands within the project area achieve a health score of moderate or better under Cunningham (2011) tree health monitoring for all years between 2025 and 2035. Total bat abundance increases by 25% from 2015 levels by 2030	Red Gum Forest and Woodland Black Box Woodland	1,2,4,6,7,8,9, 10,11,12,13,14
Contribute to the carbon requirements of the River Murray channel ecosystem	The average annual carbon load (dissolved and particulate) to the River Murray from Vinifera Park for the period 2025 to 2035 is double 2015 to 2020 levels.	Red Gum Swamp Forest Red Gum Forest and Woodland Black Box Woodland	1,2,4,6,7,8,9, 10,11,12,13,14

Ecological targets have also been developed to measure progress towards the specific ecological objectives. It is anticipated that these targets will be tested and refined once the proposed supply measure is operational. The targets describe an ecological outcome or process and are:

- Quantitative and measurable
- Time-bound
- Justified by existing site data or scientific knowledge

The ecological targets compare the current state of the ecosystem (i.e. using 2015 as a baseline) with a future state after the recommended water regimes have been applied, assuming that the proposed works are commissioned in 2020. It will take some time to realise ecological outcomes due to the time required for vegetation to adapt to the new inundation conditions, for floodplain productivity to increase (e.g. for additional energy and nutrients to be distributed through the food web) and for fauna populations to respond. Targets

based on relatively stable variables are evaluated in 2030. Targets based on the frequency of an event occurring are evaluated over the period from 2025 to 2035.

Photo point monitoring shows river red gum tree condition improvements at Nyah Park as a result of environmental watering (Above left: 2010; Above right: 2012)

5.3. Environmental water requirements

The works will provide flexibility to deliver a wide range of environmental watering events to meet the ecological objectives described in Section 5-2.

Table 5-2 provides a comparison of the water regime that can be provided by the proposed measure with the following water regimes:

- Natural;
- Baseline Condition (Current Condition); and
- Basin Plan (2750) without the measure.

Basin Plan flows will contribute toward achieving the environmental water requirement of Vinifera Park compared to baseline conditions. The proposed measure is required to bridge the gap between Basin Plan flows and the environmental water requirements of Vinifera Park. Table 5-2 also shows shows that the proposed works can be operated to meet shortfalls in the water requirements for frequency and duration across all of the water regime classes. This has been used to inform the proposed operating regime, as discussed in sections 8.3 and 9. Detailed ecological justification and the water requirements of each water regime class is provided in Appendix B.

Table 5-2: Comparison of water regimes provided by natural, baseline, Basin Plan (2750) and the Vinifera measure

Threshold (ML/d)	WRC	Scenario	Frequency Mean (/100 yrs)	Interval Median (days)	Duration Median (days)	Event start date Median (day of year, 1 Jan = 1)	Prevalence yrs with event %
15,000	Seasonal Wetland	With Measure[1]	100	190	150	152	100
		Natural	100.9	172	174	170	95
		Baseline	80.7	274	82	196	74
		Basin Plan without measure	86	230	133	179	82
17,500	Red Gum Swamp Forest	With Measure[1]	90	210	120	152	90
		Natural	98.2	191	157	181	94
		Baseline	68.4	290	84	198	65
		Basin Plan without measure	85.1	344	110	185	81
20,000	Red Gum Forest and Woodland	With Measure[1]	90	220	120	182	90
		Natural	100	205	143	190	92
		Baseline	61.4	307	72	201	59
		Basin Plan without measure	78.9	259	93	192	72

[1] With Measures figures based upon interpretation of the preliminary operations plan adapted from (Ecological Associates 2014c)

Source: Gippel (2014).

The links between the water regime classes and the site's ecological objectives are shown in Table 5-3 and illustrate that all of the water regime classes need to be inundated in order to realise the project's ecological objectives. This has informed the selection of proposed works for the *Vinifera Floodplain Management Project.*

Table 5-3: Links between water regime classes and the ecological objectives for Vinifera Park

Ecological objective	Seasonal Wetland	Red gum swamp forest	Red gum forest and woodland	Black box woodland
Restore the vegetation structure of wetland plant communities	✓	✓	✓	
Re-establish resident populations of frogs and small fish	✓	✓	✓	
Provide seasonal feeding and reproductive opportunities for riverine fish species	✓	✓	✓	
Provide reliable breeding habitat for waterbirds, including colonial nesting species	✓	✓	✓	✓
Restoring floodplain productivity to maintain resident populations of vertebrate fauna			✓	✓
Contribute to the carbon requirements of the River Murray channel ecosystem		✓	✓	✓

6. Anticipated ecological benefits (Section 4.4.1)

The creek, wetlands and floodplain system of Vinifera Park support a variety of ecological communities, including forest, woodlands and swamps (Section 4). The condition of ecological values at Vinifera Park and past management activities and actions are outlined in sections 4.3 and 4.4 respectively.

A summary of the current condition of each of the water regime classes targeted by the *Vinifera Floodplain Management Project* is provided in Table 6-1 below.

Table 6-1: Summary of the current condition of the main water regime classes at Nyah Park (Ecological Associates, 2014)

Water regime classs	Current condition
Seasonal wetland	Seasonal wetland habitat has been lost from Vinifera Park through a reduction in the duration of spring flow peaks. There has been encroachment of river red gums and a shift from aquatic marshland vegetation to an understorey dominated by grasses and herbs. There has been a loss of waterbird habitat and wetlands now only provide opportunistic habitat for aquatic fauna that colonise the system when water is available.
Red gum swamp forest	Red gum swamp forest has been severely degraded due to a reduction in flood duration allowing higher tree density and increased shading of the understorey. Perennial aquatic plants have largely been replaced by more drought tolerant species and flooding is too brief to contribute significantly to the breeding requirements of native fish or waterbirds.
Red gum forest and woodland	Red gum forest and woodland is also severely degraded at Vinifera Park. The same decline observed in the health and ecosystem functioning of the red gum swamp forest is observed in this water regime class also. The food resources and structural habitat for carpet python, swamp wallaby, grey-crowned babbler and other woodland species have reduced.

6.1. Ecological benefits of inundation

The proposed Vinifera Park supply measure will restore flooding frequency and duration and to improve productivity to areas of creek, wetlands, swamp and red gum forest. Inundation maintains the integrity and productivity of waterway and floodplain habitats. It promotes germination of aquatic plants, which provide understorey habitat for a range of aquatic fauna species including fish, invertebrates and frogs (Ecological Associates, 2014a; Mallee CMA, 2013). Inundation also helps to maintain the health of woodlands that provide important habitat like nesting sites and hollows for regent parrot and carpet python (*Morelia spilota metcalfei*) (Mallee CMA, 2013) and promotes the growth of trees and triggers flowering.

Increased rates of tree growth provide organic matter to the floodplain system, which promotes productivity and as floodwaters recede this material also enters the River Murray contributing to the energy requirements of the broader river system. Flowering attracts nectar-eating insects and birds and provides abundant insect prey for bats and the insectivorous birds (Ecological Associates, 2014a).

Drawing upon the ecological response monitoring outcomes associated with Nyah Park and large scale watering of the Hattah Lakes through the TLM works, it is expected the observed trend of improved ecological condition (Henderson, 2014) would also occur at Vinifera once permanent works can facilitate an appropriate

water regime. These results provide a high level of confidence that the implementation of the proposed supply measure and its associated watering regime will provide the expected benefits.

An overview of the expected benefits of reinstating more appropriate flooding patterns is summarised for each of the water regime classes influenced by the *Vinifera Floodplain Management Project* below.

Once the duration requirement of these vegetation communities has been met, water will be released from the floodplain back into the River Murray system. Increased rates of tree growth provide organic matter to the floodplain system, which promotes productivity and as floodwaters recede this material also enters the River Murray contributing to the energy requirements of the broader river system.

Seasonal wetland

Seasonal inundation is important to wetland productivity. The plant matter that is exposed on the drying wetland bed in summer and autumn is readily mineralised when reflooded in winter. This supports a productive food web of algae and zooplankton and bacterial biofilms (Young 2001) which in turn provides prey for larger fauna including fish and waterbirds.

Dense aquatic vegetation, algae and biofilms are a productive food source and provide physical habitat for zooplankton, macroinvertebrates and small fish such as gudgeon, smelt and hardyhead. Tree-less, open water habitat is an important habitat component for waterfowl, fish-eating birds and bats. The wetlands provide food for dabbling and grazing ducks such as grey teal and reliable breeding habitat for waterfowl which use reedy vegetation to build nests. Wading birds such as royal spoonbill and intermediate egret will prey on invertebrates and small fish.

Reeds will provide terrestrial frogs with abundant aquatic invertebrates and flying insects, a substrate for eggs and shelter from predators. The wetlands are a refuge habitat for frogs such as southern bullfrog and spotted marsh frog. Reliable flooding in the wetlands maintains the population, which expands to flooded red gum understorey during floods.

Dense reedy vegetation near the wetlands provides shelter for black wallaby.

Red gum swamp forest

Frequent and sustained inundation In the low-lying areas where the Red Gum Swamp Forest water regime class occurs limits tree density to an open forest structure. The understorey comprises obligate wetland plant species which require regular spring and summer flooding (Ecological Associates, 2014a). The swamp forest represents an extension of the seasonal wetland habitat with a similar understorey and similar habitat values for aquatic fauna (Ecological Associates, 2014a).

Inundation of this water regime class provides temporary habitat for aquatic fauna, particularly vegetation-dependent fish such as gudgeon complex, rainbow fish and hardyhead. The habitat for terrestrial frogs, which is normally limited to the reeds fringing wetlands, will expand to the red gum understorey. Burrowing frogs, which aestivate in the floodplain soil, will become active. Other wetland species that will extend into the flooded woodland will include yabby, tortoises and water rat (Ecological Associates, 2014a).

Flooding events will support waterbird breeding. The trees provide nesting sites for waterbirds that breed over water such as little egret, white-necked heron, white-faced heron, great cormorant and little black cormorant. A range of other waterbird guilds will breed including waterfowl, large waders and small waders (Ecological Associates, 2014a).

These habitat values of red gum forest can be restored by increasing the duration of flooding events while maintaining a high flooding frequency. Longer events will contribute to the breeding requirements of waterbirds while shorter events will provide foraging habitat and breeding opportunities for resident aquatic fauna. A higher density of vegetation on the forest floor will contribute to the habitat requirements of terrestrial fauna. It will provide forage and shelter for swamp wallaby and a source of prey and physical habitat

for carpet python. High levels of insect productivity will sustain local bat populations (Ecological Associates, 2014a).

Red gum forest and woodland

Red gum woodland is present on higher ground near the terrestrial boundary of the floodplain and on local rises within the forest. Red gum trees forms an open woodland canopy while the understorey is dominated by tussock grasses that respond to winter and spring rain but do not depend on flooding (Ecological Associates, 2014a). The ground layer is grassy with a sparse scattering of low shrubs (Ecological Associates, 2014a).

Red gum trees and their understorey have an important role in providing structural habitat for floodplain fauna, particularly hollows for nesting wood duck, carpet python, bats and brush-tailed possum. Red gum growing close to water provide nesting habitat for some birds which feed in adjacent Mallee including regent parrot and Major Mitchell cockatoo. Dense understorey vegetation provides habitat for grey-crowned babbler, swamp wallaby and carpet python (Ecological Associates, 2014a).

The grassy understorey provides seeds and forage for granivores such as finches, cockatoos, galah, lorikeet and budgerigar, the frugivorous emu and large herbivores including western grey kangaroo and swamp wallaby (Ecological Associates, 2014a). The trees directly support insectivorous and omnivorous birds such as honeyeaters and wattlebird. Both overstorey and understorey vegetation support insect production on which a wide range of insectivorous birds and bats depend (Ecological Associates, 2014a).

The ecological values of woodland can be restored by increasing the frequency of floods to support tree and the growth of trees and understorey grasses and shrubs over late spring and summer.

6.2. Proposed ecological benefits

The proposed supply measure will restore flooding frequency and duration to improve productivity of the creek, wetlands, swamp and red gum forest. It will contribute significantly to the feeding and breeding requirements of colonial nesting waterbirds. Frequent flooding of wetlands will maintain wetland sedgelands and support populations of small-bodied fish. Larger wetland areas will provide habitat for benthic herblands which in turn contribute to the habitat requirements of small-bodied fish and a wide variety of waterbirds (Ecological Associates, 2014a).

Nine ecological targets have been developed to provide some quantification on the degree of environmental benefit expected by the measure (Table 5-1).

The expected ecological benefits for each water regime class, as a result of the supply measure are outlined in Table 6-2.

Table 6-2: Water regime class, strategy and ecological benefits at Vinifera (Ecological Associates 2014a; Alluvium, 2013a)

Water Regime Class	Strategy	Ecological benefit (including site targets)
Seasonal Wetlands	Capture peaks in river flow by closing regulators on the flood recession Pump water into forest if peaks in river flow are too infrequent	Watering will provide regular breeding habitat for waterbirds and will support the seasonal requirements of aquatic wetland fauna including native fish. Water levels should fall over summer and autumn to promote macrophyte growth over broad areas of the wetland bed and to promote mineralisation of organic matter. Adjacent trees will potentially demonstrate increased vigour, recruitment, therefore leading to an overall improvement in wetland health, maintenance of wetland buffers and maintenance of fauna habitats. Riparian shrubs will potentially demonstrate increased vigour in species such as lignum, and possibly also exhibit an increase in abundance and diversity. Understorey forbs and herbs will likely display an increase in diversity and abundance as inundation cycles promote regeneration and germination from the seed bank. In-channel macrophytes; flows convey seeds and propagules from water source into the wetland resulting in an increase in diversity and abundance of aquatic species. Water quality may also improve. Bank and channel edge macrophytes; flows convey seeds and propagules from water source into the wetland resulting in an increase in diversity and abundance of emergent species. Water quality may improve, wetland banks will be stabilised and habitats for fauna will be provided.
Red Gum Swamp Forest	Capture peaks in river flow by closing regulators on the flood recession Pump water into forest if peaks in river flow are too infrequent	Inundation of red gum forest and woodland provides temporary habitat for aquatic fauna, particularly vegetation-dependent fish. The habitat for terrestrial frogs, which is normally limited to the reeds fringing wetlands, will expand to the red gum understory. Burrowing frogs, which aestivate in the floodplain soil, will become active. Other wetland species that will extend into the flooded woodland will include yabby, tortoises and water rat. Flooding events will support waterbird breeding. The trees provide nesting sites for waterbirds that breed over water. A range of other waterbird guilds will also breed.
Red Gum Forest and Woodland	Capture peaks in river flow by closing regulators on the flood recession Pump water into forest if peaks in river flow are too infrequent	Increasing the duration of inundation events while maintaining a high inundation frequency can restore the habitat values of red gum forest. Longer events will contribute to the breeding requirements of waterbirds while shorter events will provide foraging habitat and breeding opportunities for resident aquatic fauna. A higher density of vegetation on the forest floor will contribute to the habitat requirements of terrestrial fauna. It will provide forage and shelter for swamp wallaby and a source of prey and physical habitat for carpet python. High levels of insect productivity will sustain local bat populations.
Black Box Woodland	Although not inundated by the	High levels of productivity will follow inundation as elevated soil moisture promotes the growth and flowering of understorey

	proposed works, Black Box woodlands benefit from having flooding in nearby areas.	grasses, shrubs and trees. The abundant food, including forage, insects, nectar and seeds will support breeding by many floodplain fauna. Inundation also maintains the propagules of water-dependent plants, such as *Eleocharis acuta,* which grows from drought-tolerant rhizomes when inundated and *Marselia drummondii* which grows from drought-tolerant spores.

6.3. Monitoring and evaluation plans (Section 4.4.1)

The effectiveness of the proposed supply measure and its operation will primarily be monitored and reported on through the Mallee CMA's well-established monitoring, evaluation and reporting (MER) strategies and protocols. These strategies and protocols will build upon experience and lessons learned though the ongoing, long-term Living Murray ecological monitoring programs, which include condition and intervention monitoring across several sites in the Mallee. The Mallee CMA has been implementing and coordinating the local Living Murray annual MER process since 2006.

The MER strategies and protocols are linked to overarching State and Victorian Environmental Water Holder frameworks to provide a routine process to:

- Establish a robust program logic to define the correlation between works and other inputs and identified outputs and ecosystem outcomes. This provides the basis for a suite of quantifiable ecological targets that are relevant to the specific site
- Monitor progress against those targets on a regular basis
- Evaluate the implications of the results for the operational parameters of the scheme
- Amend and adjust the operational arrangements to optimise performance and outcomes

Monitoring data is required to plan watering events, to optimise water delivery, to manage risks and to refine ecological objectives. The evaluation process involves analysing collected data and improving operations.

A detailed monitoring and evaluation plan has been prepared for the Vinifera site by Ecological Associates (2014b). Monitoring and evaluation will focus on the effects of local watering actions and includes:

- Evaluating water use
- Measuring ecological outcomes against ecological targets
- Refining conceptual models and improving knowledge
- Managing risk

The Vinifera floodplain monitoring and evaluation plan identifies the agencies responsible for commissioning, reviewing and acting on monitoring data. The linkages back to decision-making are described in the detailed plan.

Initial monitoring will provide a baseline of the existing status of the ecological objectives and outcome monitoring will measure progress towards these objectives. This information will inform the ongoing operations at the site. Over time the results of the outcome monitoring will test assumptions and monitoring data will assist with refining conceptual models and ecological objectives. Parameters for monitoring each ecological objective of the supply measure for Nyah Park are detailed in Appendix C (Ecological Associates 2014b).

The environmental risks from implementing the proposed water regime are detailed in Section 11 - Operational Risks. Monitoring data will identify emerging hazards and enable operational decisions to minimise risk.

This MER approach will be formalised once funding for this supply measure has been confirmed.

The final MER approach for this supply measure will be informed by broader intergovernmental arrangements for Basin-wide monitoring and evaluation under the Basin Plan. This measure is expected to contribute to the achievement of outcomes under two key Chapters of the Plan, namely: (i) the delivery of ecological outcomes under Chapter 8; and (ii) under Chapter 10, meeting the relevant sustainable diversion limit/s (SDLs), which must be complied with under the state's relevant water resource plan/s (WRPs) from 1 July 2019.

Both Chapter 8 and Chapter 10 of the Basin Plan are captured under the MDBA's own monitoring and evaluation framework. Once specific Basin Plan Chapters commence within a state, the state must report to the MDBA on relevant matters. This will include five yearly reporting on the achievement of environmental

outcomes at an asset scale in relation to Chapter 8, and annually reporting on WRP compliance in relation to Chapter 10.

The proponent is satisfied that its participation in the MDBA's reporting and evaluation framework will effectively allow for progress in relation to this supply measure to be monitored, and for success in meeting associated ecological objectives and targets to be assessed.

This approach closely aligns with agreed arrangements under the Basin Plan *Implementation Agreement*, where implementation tasks are to be as streamlined and cost-efficient as possible.

Photopoint monitoring undertaken at Vinifera Park during high River Murray flows (2013)

7. Potential adverse ecological impacts (Section 4.4.2)

This business case has taken into consideration potential adverse ecological impacts of this proposal. It is acknowledged that works that alter floodplain hydraulics and hydrology may threaten the ecological values of the Lindsay Island site, and potentially those of surrounding areas. In order to identify and assess these risks during project development, a comprehensive and rigorous risk assessment was completed (Lloyd Environmental, 2014). This involved identifying potential undesirable outcomes, determining their root causes, assessing likely consequences and significance; and developing relevant mitigation measures to reduce any residual risk to an acceptable level (very low to moderate). Experience gained from previous works and measures, and environmental watering projects of similar scale and complexity, including The Living Murray Program, informed this process.

The methodology described in Section 7.2 was applied to assess the threats to successful project development, delivery and operation, and the potential adverse ecological impacts of the proposed supply measure. It is therefore also relevant to Sections 11 and 17.

The comprehensive approach undertaken to assess potential adverse ecological impacts of the Lindsay Island project ensures risk management strategies can be implemented to ensure management and mitigation of:

- Adverse salinity impacts or water quality outcomes at the site;
- The potential to increase pest species;
- The potential to favour certain species to the detriment of others or to adversely affect certain species; and
- Adverse impacts on ecological function and connectivity.

The nature of any downstream salinity and/or water quality impacts, and any potential cumulative impacts with other measures, cannot be formally ascertained at this time. This is because such impacts will be influenced by other measures that may be operating upstream of this site, including other supply/efficiency/constraints measures under the SDL adjustment mechanism, and the associated total volume of water that is recovered for the environment.

It is expected that likely or potential downstream/cumulative impacts will become better understood as the full package of adjustment measures is modelled by the MDBA and a final package is agreed to by Basin governments.

7.1. Risk assessment methodology

A risk assessment was completed in line with the requirements of AS/NZS ISO 31000:2009 (Lloyd Environmental 2014). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and prioritised mitigation strategies and measures. Table 7-1 and Table 7-2 show, respectively, the definitions used for assigning levels of the consequences of threats, and definitions used for assigning levels of the likelihood of threats. Tables 7-3 and 7-4 show, respectively, the risk matrix and definitions used in this risk assessment.

A thorough review of existing literature and a cross-disciplinary expert workshop with the Mallee CMA and key stakeholders was undertaken to complete the risk assessment for the project site (Lloyd Environmental, 2014). In summary, the process included:

- Identification of values, threats to those values and the significance of these threats
- Assessment of the likelihood and consequences of potential impacts for each threat

- Identification of mitigation options
- Assessment of the residual risk after mitigation options were identified.

Further work to consolidate the risk assessment was undertaken as the project developed and incorporated into Table 7-5.

Table 7-1. Definitions used for assigning levels of the consequences of threats

	Level	Description
Consequence	Minor (1)	The effects are limited in extent or duration and do not significantly impact on the site values
	Moderate (2)	The effects are moderate in extent or duration and are in conflict with site values or will have minor impacts on offsite values
	Severe (3)	The event significantly undermines site values or moderately impacts on offsite values
	Catastrophic (4)	The event is in significant conflict with the site values or severely impacts offsite values and will result in a serious deterioration of the system

Table 7-2. Definitions used for assigning levels of the likelihood of threats

	Level	Description
Likelihood	Remote (1)	An event which is not expected to occur but may occur under rare, exceptional circumstances
	Unlikely (2)	An event which is not expected to occur as a result of normal activities but may occur
	Possible (3)	An event which is possible and will occasionally occur as a result of normal activities
	Likely (4)	An event which is expected to occur as part of normal activities
	Certain (5)	An event which is expected to occur as a result of the action

Table 7-3. ISO Risk Matrix

	Consequence			
Likelihood	Minor	Moderate	Severe	Catastrophic
Remote	1	2	3	4
Unlikely	2	4	6	8
Possible	3	6	9	12
Likely	4	8	12	16
Certain	5	10	15	20

Table 7-4. Definitions of the levels of risk

	Scores	Risk	Definitions
Risk	1-2	Very Low	There is no reasonable prospect the project objectives will be affected by the event
	3-4	Low	The event is a low priority for management but risk management measures should be considered
	5-8	Moderate	The risk is a moderate priority for management. Risk management measures should be undertaken.
	9-12	High	The risk is a high priority for management. There is a reasonable likelihood it will occur and will have harmful consequences. Risk management is essential.
	15-20	Very High	The risk is a very high priority for management. It is likely to occur and will have very harmful consequences. Risk management is essential.

7.2. Risk assessment outcomes

A summary of the risk assessment and subsequent work undertaken are presented in Table 7-5, including the mitigation measures developed and an assessment of the residual risk after these are applied. Where a residual risk is given a range of ratings, the highest risk category is listed. It is important to note that the majority of the risks identified in this table exist in both an "existing conditions" or "Basin Plan without works" scenario, but are included because the proposed works provide mitigation opportunities.

Table 7-5. Risk assessment - potential adverse ecological impacts without mitigation and residual risk rating with mitigation, adapted from Lloyd Environmental (2014)

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
Adverse salinity impacts or water quality outcomes						
Low dissolved oxygen (DO) levels	Low dissolved oxygen (DO) concentrations can occur through a variety of processes, including blackwater events, algal and cyanobacterial blooms, high organic matter loadings and stratification. Low DO can cause the death of aquatic fauna and have negative impacts on the health of wetland communities in general. More frequent inundation (i.e. through managed watering events) will reduce the accumulation of organic matter on the floodplain between inundation events.	Likely	Severe	High	Planning phase: • Monitor antecedent floodplain conditions (i.e. organic matter loads) to assess risk of a hypoxic event occurring. • Consider seasonal conditions (e.g. temperature, algae) prior to watering Operations phase: • Commence watering as early as possible to move organic matter off the floodplain while temperatures are low • Maintain through-flow where possible in other areas to maximise exchange rates and movement of organic material. • Monitor DO and water temperature to identify hypoxic areas to inform consequence management (see below). Managing consequences: • Ensure dilution of low DO water by managing outflow rates and river flows • Delay outflows if river flows are too low. • Dispose of hypoxic water by pumping to higher wetlands where possible. • Agitate water using infrastructure to increase aeration.	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
Poor water quality	Water manipulations may lead to suspension of sediments and/or organic matter causing elevated nutrients, high turbidity and/or low dissolved oxygen (DO) levels. This may impact reduce food sources and possibly toxic algal blooms upon wetland community health, threatened species, fish and other aquatic fauna communities, and waterbird communities (via impacts). The risk assessment for low DO water is presented above.	Possible	Moderate	Moderate	As above.	Low
Inability to discharge poor quality water	Inability to discharge water of poor water quality during a managed flow event, due to downstream impacts (e.g. increases in instream salinity), could result in impacts on floodplain vegetation (due to extended inundation) or formation of blackwater/algal blooms.	Likely	Severe	High	Schedule watering events to make use of dilution flows where possible. Maintain good relationships with other water managers. Integrate water management with other sites in seasonal water planning process. Continue to undertake water quality monitoring before, during and after watering events to inform adaptive management strategies and real-time operational decision making.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
Development of saline mounds under wetlands and displacement of saline groundwater	An increase in groundwater levels may occur in response to project inundation events. Shallow saline groundwater can impact on the health of floodplain vegetation and wetland communities, both at Lindsay Island and downstream. Further details on the salinity impact assessment and mitigation strategies for this proposed supply measure is provided in Section 11.4.	Likely	Severe	Moderate	Avoid watering salinity hot spots identified through the use of AEM datasets (Munday et al. 2008), instream nanoTEM (Telfer et al. 2005a and 2005b, 2007) and other salinity investigations. Monitor the salinity of ground and surface water salinity before, during and after watering events to inform management and ensure sufficient volumes are available for mitigation such as: • Diluting saline groundwater discharge with sufficient river flows. • Diluting saline water on the floodplain by delivering more fresh water to these areas. Reduce the frequency and/or extent of planned watering events if sufficient volumes not available.	Low
The potential to increase pest species						
Increased carp populations	Carp will breed in response to both natural and managed floods. High numbers of carp can threaten the health and diversity of wetland vegetation, affecting native fish and other aquatic fauna. This has potential impacts both within the project site and at the reach scale.	Certain	Severe	Very High	Tailor watering regimes to provide a competitive advantage for native fish over carp. Dry wetlands that contain large numbers of carp. Manage the drawdown phase to provide triggers for native fish to move off the floodplain and, where possible, strand carp.	Moderate
Proliferation of pest plants	Pest plants may be promoted under certain water regimes, potentially impacting the health of all wetland and floodplain vegetation communities. This, in turn, will impact on dependent fauna, including threatened species.	Certain	Severe	Very High	Time water manipulations to drown seedlings, minimise growth, germination and seed set. Time water manipulations to promote native species. Control current populations and eradicate/control new infestations via existing management strategies (e.g. Parks Victoria pest management	Low

					action plans/strategies). Support partner agencies to seek further funding for targeted weed control programs if necessary.	
Increase in pest animals	The reinstatement of more frequent flooding regimes is likely to provide and maintain more favourable conditions for many terrestrial animal pests. In particular, pigs are swamp dwellers and their impacts on watered areas may be more severe than other species.	Likely	Severe	High	Control pest animal populations via existing management strategies (e.g. Parks Victoria pest management action plans/strategies). Support partner agencies to seek further funding for targeted control programs if necessary.	Moderate
Transport or proliferation of invasive weeds due to construction activity	Proliferation of weeds will have impacts on the health of all wetland and floodplain vegetation communities. This, in turn, will impact on dependent fauna, including threatened species.	Likely	Moderate	Moderate	Develop and adhere to an Environmental Management Plan (EMP) that includes hygiene protocols, enforcement and contractor management.	Low
The potential to favour certain species to the detriment of others or to adversely affect certain species						
Permanent habitat removal or disturbance during construction	Construction of the proposed works will cause disturbance to the floodplain and require the permanent removal of some vegetation/habitat.	Certain	Moderate to Severe	High to Very High	Utilise existing access tracks wherever possible. Design and locate infrastructure/works to avoid and minimise the extent of clearing and disturbance. Ensure clear on-site delineation of construction zones and adequate supervision during works to avoid unauthorized clearance/disturbance.	Moderate
Temporary habitat removal or disturbance during construction	Construction of the proposed works will cause disturbance to the floodplain and require the temporary removal of some vegetation/habitat.	Certain	Moderate	Moderate to Very High	As above. Remediate/revegetate the site once construction activities are complete.	Moderate

Invasion of river red gum in watercourses and open wetlands	Germination of dense thickets of river red gum within watercourses and wetlands, and at the edge of the Berribee Regulator pool may block flow through the system. Obstruction of flows can diminish the effectiveness of future watering events. Prolific germination of seedlings within wetlands will change the habitat structure and the suite of dependent biota.	Certain	Moderate	High	Use of operational strategies to control unwanted germination and establishment, including: • Drowning seedlings. • Timing the recession to avoid optimal conditions for germination in targeted areas (if feasible). Targeted removal of seedling/saplings to remove flow obstructions, if necessary.	Low
Removal of habitat for threatened species created by historic regulation practices	Regulation of the River Murray and Mullaroo Creek has created permanent, fast-flowing habitat in Mullaroo Creek that supports Murray cod and freshwater catfish. Changes to the current, artificial flow regime could affect the suitability of these waterways for these species and could have implications for regional populations.	Likely	Severe	High	Determine flow regime requirements of target species; develop and implement operational arrangements to maintain flow velocities within critical thresholds during watering events. Assess the response of species of concern during and after managed watering events and adjust operational arrangements if required.	Low
Adverse impacts on ecological function and connectivity						
Episodic reduction in hydrodynamic diversity	Installation of regulators within waterways will affect flows and create lentic zones in regulator pools when in operation. This may reduce the extent and variety of aquatic habitat, and change the structure and diversity of wetland and floodplain vegetation communities. In particular, regulator operation is likely to reduce or eliminate fast-flowing habitat that is particularly important for some fish species, including Murray cod.	Likely	Severe	High	Design structures to minimize waterway obstruction and provide through-flow during operations. Develop operational protocols to maintain hydraulic diversity. Assess the response of species of concern during and after managed watering events and adjust operational arrangements if required.	Moderate
Increase in fire frequency, extent and intensity	The reinstatement of more frequent flooding regimes threat will increase the biomass of floodplain vegetation, increasing the fuel load for bushfires.	Possible	Moderate	Moderate	No specific mitigating actions have been identified. If a bushfire occurs on Lindsay Island, Parks Victoria and DEPI will respond as usual in such situations.	Moderate

	An increase in the frequency, extent and duration of bushfire could have impacts on ecosystem form and function.					
Managed inundation regimes do not match flow requirements for key species	The delivery of an inappropriate water regime may occur through inadequate knowledge of biotic requirements or conflicting requirements of particular species with broader ecological communities. This may lead to adverse ecological outcomes, e.g. failure of waterbird breeding events, lack of spawning response in fish, spawning response but no recruitment.	Possible	Moderate	Moderate	Consider the various requirements of key species/communities when developing operating strategies and planning for watering events. Assess the response of species of concern during and after managed watering events and adjust operational arrangements if required. Update operating strategies to capture new information on the water requirements/ response of key species/communities. Target different taxa at different times (e.g. target vegetation one year and fish the next).	Low
Inadequate water regime delivered	An inadequate water regime could be delivered through: • Design and construction issues; • Invalid modelling assumptions and/or flow measurement; • Inadequate or incorrect information regarding water requirements and/or system condition; • Errors in planning and calculation of the volumes required; or • An inadequate volume allocated to the event.. This could result in adverse ecological impacts such as drought-stress of vegetation, loss of habitat and limited breeding opportunities for fauna.	Unlikely	Severe	Moderate	Confirm the validity of modelling assumptions during operations to inform future planning and refine the operating arrangements. Design structures for maximum operational flexibility. Ensure adequate measures are in place to measure inflows/outflows. Assess eocsystem response during and after managed watering events and adjust operational arrangements if required. Maintain strong working relationships with river operators, partner agencies and water holders to facilitate timely issue resolution (e.g. allocation of additional water if required).	Low
Stranding and	Stranding can occur through sudden changes in	Possible	Moderate	Moderate	Develop a 'Fish Exit Strategy' to inform regulator	Low

isolation of fish on floodplains	water levels and/or new barriers preventing native fish from escaping drying areas during flood recessions. This may result in the death of a portion of the native fish population.				operation during the drawdown phase to maintain fish passage for as long as possible and to provide cues for fish to move off the floodplain. Monitor fish movement and adapt operations as required. Continue to build on knowledge and understanding through current studies relating to fish movement in response to environmental watering and cues.	
Barriers to fish and other aquatic fauna movement	Installation of regulators in waterways and wetlands creates barriers to the movement of fish and other aquatic fauna. This can reduce access to feeding and breeding habitat, and limit migration or spawning opportunities.	Possible	Moderate	Moderate	Determine fish passage requirements and incorporate into regulator design (as in Hames, 2014). Specific arrangements for this project include: • A vertical slot fishway at Berribee Regulator • Fish-friendly designs to allow passive passage at other regulators. Continue to build on knowledge and understanding through current studies relating to fish movement in response to environmental watering and cues.	Low
Prolonged inundation of vegetation	Water captured by the regulator and backing-up from the regulator has a potential mismatch between vegetation water requirements. The pool will be deepest and longest near the regulator. Vegetation in this area may get excessive inundation (duration and depth) in order to meet inundation requirements of vegetation at the perimeter of the regulator pool. This has the potential to impact upon the health of wetland communities, including river red gum forest and woodland, and other floodplain habitat.	Possible	Moderate	Moderate	Ongoing monitoring of vegetation health to increase knowledge and understanding of targeted species' requirements and inform adaptive management and/or frequency of operation and to inform Operational Plans. Ensure through-flow when operating structures to more closely replicate a more natural hydraulic gradient. Incorporate information on operations, potential impacts and tolerance of inundation regimes and the role of natural floods in ecosystem function into operational plans to minimise the impact.	Low

7.3. Consideration of significant, threatened or listed species

Throughout project development, significant consideration has been given to the potential impact on significant, threatened or listed species that occur at Lindsay Island (see Section 4). Overall, the project is expected to benefit these species by increasing the frequency, duration and extent of floods of various sizes (see Section 6). However, construction activities will involve physical disturbance to the floodplain and some vegetation clearance is unavoidable. This will result in temporary and permanent vegetation removal and habitat disturbance (see Table 7-5).

In order to minimise the potential impacts on threatened species, detailed vegetation assessments and further assessment of the impacts on all threatened species will be carried out during the detailed design process, to inform final construction footprints and the development of mitigation measures, where necessary. To date, preliminary locations for infrastructure and works have been chosen to minimise vegetation loss. New access tracks and upgrades of existing tracks will be designed to minimise clearance of large trees and understorey vegetation.

Any losses of native vegetation will be offset in line with current state policy. A program-level approach to offsetting is currently being developed, where the primary offsetting mechanism will be the gains in vegetation condition within the areas watered by the various Victorian works-based supply measures. An assessment of vegetation offset requirements based on preliminary construction footprints indicates that the offsets for this proposed supply measure can be met using this approach.

If funded for construction, this proposed supply measure will be referred under the EPBC Act and Victorian EE Act. Measures to avoid and minimise impacts to threatened species will be a key component of the referrals. Such measures will be consolidated in relevant management plans such as a Construction Environment Management Plan (CEMP) and a Threatened Species Management Plan (TSMP).

Monitoring of the response of threatened species to operation (e.g. population abundance, structure and distribution) and the effectiveness of mitigating actions will be critical to inform the planning and management of watering events.

7.4. Risk mitigation and controls

The risk assessment confirms that all identified risks are reduced to acceptable levels (very low to moderate) once well-established risk mitigation controls are implemented. While there are several potential threats could generate high risks to ecological functionality (Table 7-3), these are considered manageable because they:

- Are well known and are unlikely to involve new or unknown challenges
- Can be mitigated through well-established management controls
- Have been successfully managed by the Mallee CMA and project partners (including construction authorities) in previous projects
- Result in very low or moderate residual risks after standard mitigation measures are implemented.

As noted in Lloyd Environmental (2014), characterisation of the residual risk must be read within the context of the works creating a substantial improvement in the ecological condition of the site. The improvement will have a very significant role in mitigating many of the impacts. However, these improvements will take time to be realised and therefore the impacts may seem more significant in the short term.

Six threats retained a residual risk of moderate after implementation of the recommended mitigation strategies (Table 7-6). Further consideration of these threats may assist in further understanding the potential impacts and, in some cases, identifying additional mitigation measures to reduce the residual risk.

Table 7-4. High priority risks, mitigation and residual risk

Threat	Risk without mitigation	Residual Risk Rating	Additional considerations (Lloyd Environmental, 2014)	Guiding documents[2]
Enhancing carp recruitment conditions	Very High	Moderate	Additional targeted carp fishdowns, water level manipulations to disrupt the survival of juveniles and the installation of carp cages may all help reduce carp numbers. In addition, future research on carp control may identify new control measures.	Vinifera Floodplain Management Project Operating Plan (Preliminary) *Fish exit strategy*
Permanent habitat removal or disturbance during construction	High to Very High	Moderate	The risk assessment for these threats will be revised once construction footprints are finalised and detailed vegetation assessments are carried out. If significant species or EVCs are found to be at or close to the site and could be impacted, further actions to reduce the residual risk would include targeted management actions and/or vegetation offsets for the relevant biota.	Basin Plan Environmental Works Program: Regulatory Approvals Strategy (GHD, 2014a) Statutory Approval Requirements (Golsworthy, 2014). *Environmental Management Framework* *Construction Environmental Management Plan* *Offset Strategy* *Threatened Species Management Plan*
Temporary habitat removal or disturbance during construction	Moderate to Very High	Moderate		
Hypoxic blackwater events resulting from watering actions	High	Moderate	The risk assessment has assumed that more frequent inundation will result in more frequent blackwater events than occur currently, and that these events will be of similar magnitude. It is, however, possible that more frequent events may be less intense as tannins and organic material are thought to reduce in subsequent watering events. This is a knowledge gap that could be addressed through ongoing studies.	Assessing the Risk of Hypoxic Blackwater Generation at Proposed SDL Offset Project Sites on the Lower River Murray Floodplain (Ning et al, 2014) Vinifera Floodplain Management Project Operating Plan (Preliminary)
Increase in pest animals	High	Moderate	More intensive culling programs may be needed. Further research into alternative control measures may provide additional control options.	Vinifera Floodplain Management Project Operating Plan (Preliminary)
Increase in fire frequency, extent and intensity	Moderate	Moderate	Unavoidable risk that accompanies a project designed to promote growth of native vegetation in the region.	Mallee Loddon Fire Operations Plan 2014/15–2016/17 (DEPI, 2014)

[2] Documents in italics are yet to be developed

7.5. Risk management strategy

A comprehensive risk management strategy will be developed for the proposed supply measure, building on the work completed for this business case. The strategy will cover ecological and socio-economic aspects to provide a structured and coherent approach to risk management for the life of this project (i.e. construction and operation). The strategy will include review processes and timetables for risk assessments, based on new developments or actions taken, and will assign responsible owner/s to individual risks. This will be an important input into the development of operating arrangements for the site.

The risk management strategy will include mitigating measures to address the following potential ecological impacts, as described in Table 7-5:

- Adverse salinity impacts or water quality outcomes either at the site or downstream
- The potential to increase pest species
- The potential to favour certain species to the detriment of others or to adversely affect certain species
- Adverse impacts on ecological function and connectivity.

Risk assessment and management is not a static process. Regular monitoring and review of the risk management process is essential to ensure that:

- Mitigation measures are effective and efficient in both design and operation
- Further information is obtained to improve the risk assessment
- Lessons are learnt from events (including near-misses), changes, trends, successes and failures
- Risk treatments and priorities are revised in light of changes in the external and internal context, including changes to risk criteria and the risk itself, and
- Emerging risks are identified.

The risk assessment process will continue throughout the development and implementation of this project. It is anticipated that additional threats will be identified and evaluated as the project progresses, and any new risks incorporated into the risk management strategy.

8. Current hydrology and proposed changes (Section 4.5.1)

8.1. River hydrology

The River Murray flow at Vinifera is influenced by the Murray and Goulburn Rivers and all upstream River Murray tributaries. The Vinifera floodplain experiences its largest inundation when the Murray and its upstream tributaries are in flood, generally occurring from late winter to early summer.

Vinifera Park is an elongate floodplain basin aligned parallel to the River Murray. The basin is formed between the terrestrial landscape to the south and the natural levee of the river bank to the north (Ecological Associates, 2014a). The site is predominantly a floodplain environment with the broadly defined Vinifera Creek transecting the central floodplain.

Low-lying meandering watercourses and wetlands in the floodplain are referred to collectively as Vinifera Creek. River flows of 12,500 ML/d introduce water to the creek system from a connection in the east of Vinifera Park. At higher flows minor effluents along the river bank also introduce water to the creek. Under natural conditions, Vinifera Creek would have received inflows from its upstream effluent near this flow threshold and the channel would act as an anabranch.

Water spills from Vinifera Creek to the general forest floor as river flows exceed 15,000 ML/d filling the seasonal wetlands within the Park. Most of the forest inundated at 17,500 ML/d which would have occurred in most years for a median duration of 5 months. Red gum forest and black box woodland on the terrestrial fringe of the floodplain is inundated when river levels exceed 20,000 ML/d.

Most of the forest drains freely as river levels fall. However, wetlands can retain water and would can remain flooded between annual inflow events (Ecological Associates 2006).

8.2. Current floodplain hydrology and infrastructure

Floodplain modifications

An artificial levee has been constructed at the eastern boundary of the park across the floodplain. The levee reduces flooding in private land upstream by isolating it from flooding in the Vinifera system.

Additional modifications to the floodplain upstream of the park have blocked the primary connection between the River Murray and the creek. As a result, the creek now functions as a separate (backwater) wetland. A minor effluent, just downstream of the constructed levee may promote through-flow in a narrow flow band, just before overbank flows commence. Reinstating this connection is a key aim of the *Vinifera Floodplain Management Project.*

Changed hydrology

Regulation of the River Murray has changed flooding patterns at Vinifera Park. The hydrology of the river at Swan Hill was analysed under natural and current conditions as shown in Figure 8-1 and Figure 8-2 (Ecological Associates, 2006).

In summary, under current (regulated) conditions:

- Median monthly flow peaks have declined with current flow regimes, with the greatest impacts in the high flow months from June to January (Figure 8-1)
- The impacts on median flows in autumn are relatively minor (Figure 8-1)
- Flows of less than 10,000 ML/d now occur for long periods (Figure 8-2)
- The duration of flows 10,000 to 15,000 ML/d has approximately halved (Figure 8-2)
- The frequency and duration of 17,500 ML/d has declined by approximately 30 percent (Figure 8-2).

Very high flows of 30,000 ML/d rarely occur in this reach and remain relatively unimpacted by regulation.

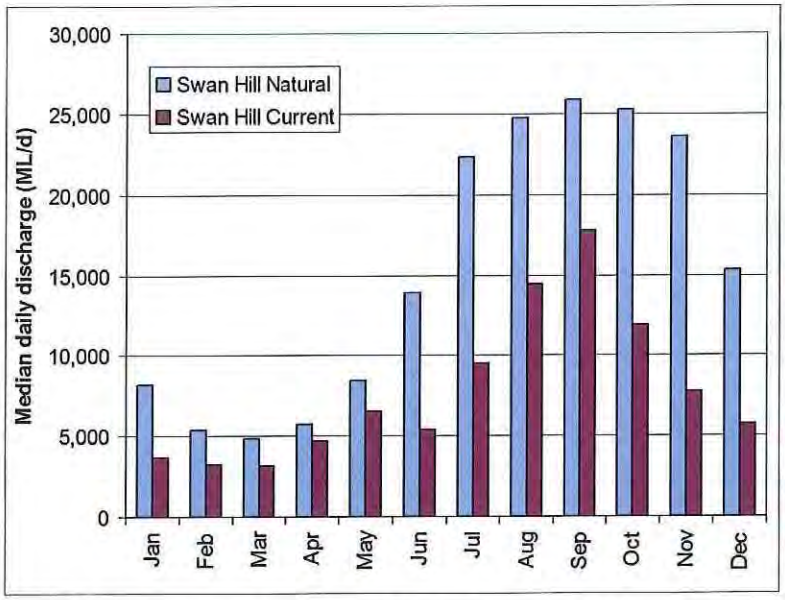


Figure 8-1: Distribution of median flows for each month in the River Murray for natural and current conditions

Source: Derived from MDBC MSM-Bigmod 109 year data (Ecological Associates, 2006).

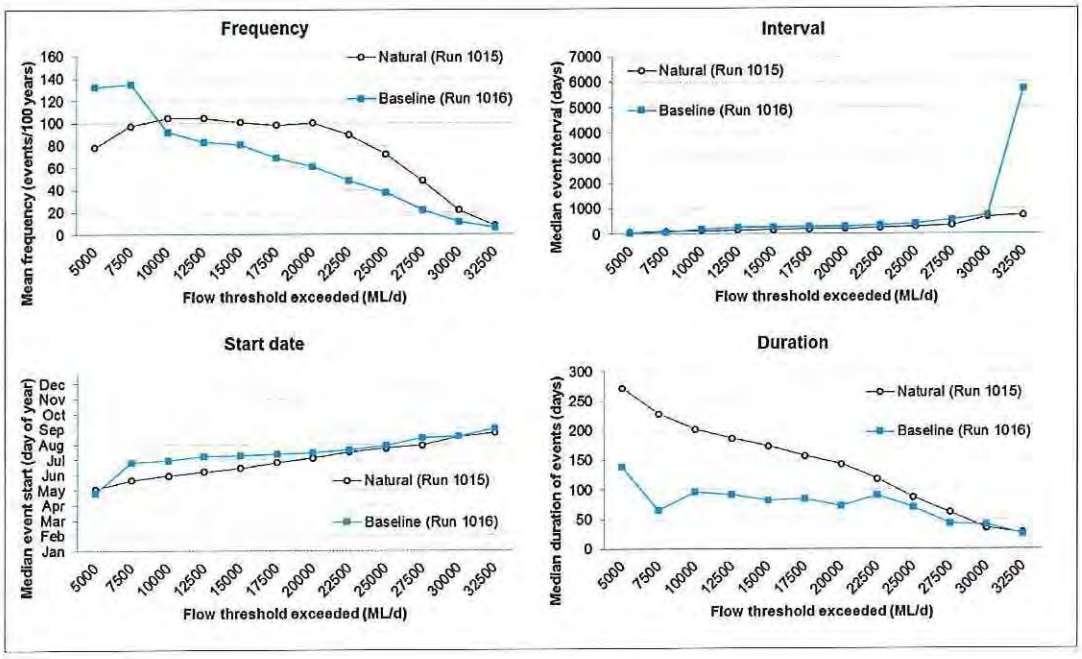


Figure 8-2: Comparison of statistical properties of events at Swan Hill under Natural and Baseline modelled flow scenarios, over a 114 year modelled period (Gippel, 2014)

Hydraulic modelling of Vinifera under baseline condition shows that there is connection of the waterways at 12,500 ML/d, with the floodplain engaging at 15,000 ML/d, with more widespread floodplain inundation at 17,500 – 25,000 ML/d (Figure 8-3).

These hydraulic modelling outputs were derived from steady state conditions, which may not reflect operational River Murray hydrographs and, as such, may result, in lower inundation areas in practise than expressed in the modelling outputs.

For example, the modelled extent shown of 17,500 ML/d in Figure 8-3 represents the absolute maximum extent achieved after a steady state flow of 17,500 ML/d over a period of many months.

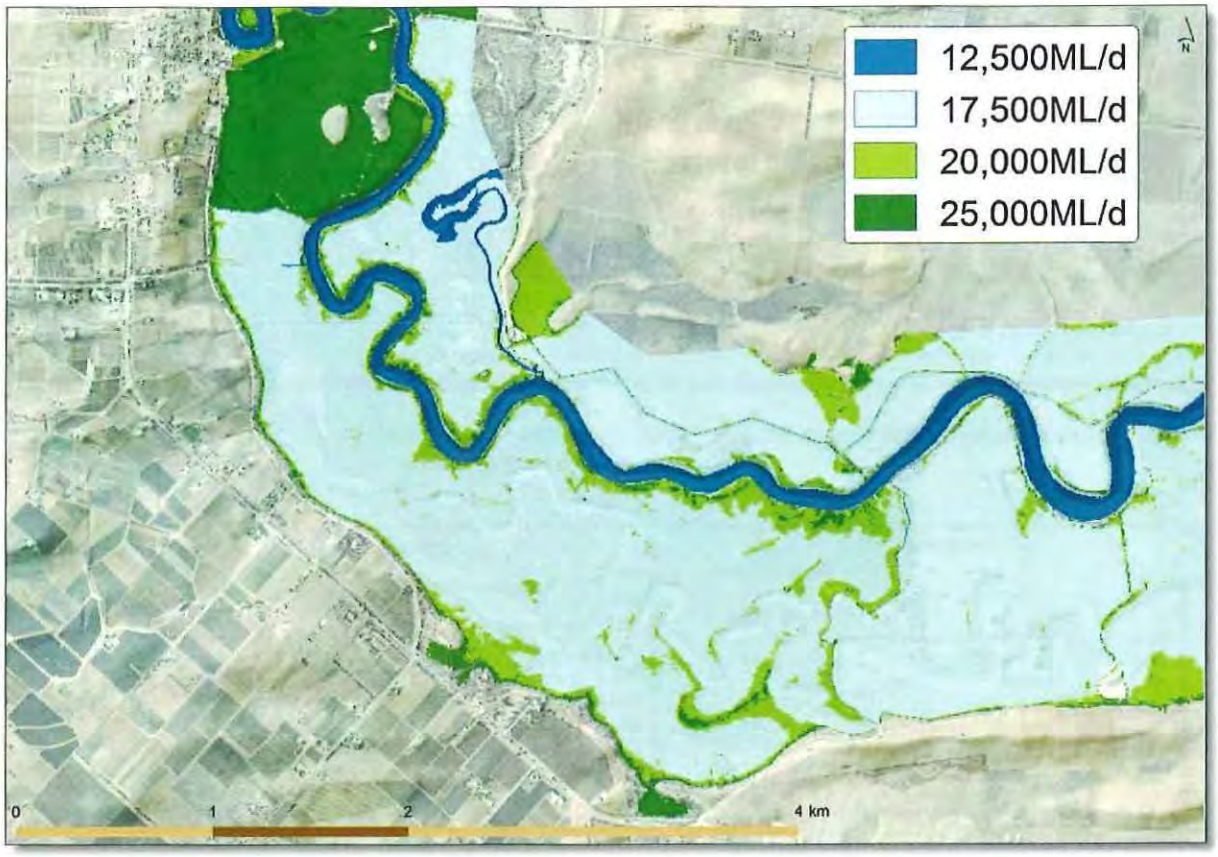


Figure 8-3: Vinifera floodplain inundation at current conditions for flows of 12,500, 17,500, 20,000 and 25,000 ML/d. Source: Jacobs (2014)

8.3. Proposed Changes

Basin Plan flow will contribute toward bridging the gap between natural and baseline conditions as shown in the spells analysis (Figure 8-4) and Table 8-1. Note: Basin Plan 2750 model run number 983 has been used as the basis of this analysis.

The Basin Plan will primarily affect flows less than that required for floodplain watering at Vinifera (Table 8-1). For example a seasonal wetland scenario for Vinifera Creek requires flows of 15,000 ML/day and will occur 8 times in 10 years under baseline, 8.6 times under Basin Plan and 10 naturally. By comparison, inundation of Red Gum Swamp Forest requires flows of 20 000 ML/day and will occur 6 times in 10 years under baseline, 7.8 times under Basin Plan and 10 naturally.

Table 8-1: Comparison of water regimes provided by Natural, Baseline, Basin Plan and the Vinifera measure (Gippel, 2014)

Threshold (ML/d)	WRC	Conditions	Prevalence yrs with event %	Duration Median (days)	Timing	Proposed operations to meet gap	
						Frequency (year in 10)	Approx. Duration
15,000	Seasonal Wetland	With Measure[1]	100	150	Late autumn – early winter	2	5 months
		Basin Plan without measure	82	133	Early winter	-	-
17,500	Red Gum Swamp Forest	With Measure[1]	90	120	Early winter	1	4 months
		Basin Plan without measure	81	110	Early winter	-	-
20,000	Red Gum Forest and Woodland	With Measure[1]	92	120	Early winter	2	4 months
		Basin Plan without measure	72	93	Early to mid-winter	-	-

Source: With Measures figures based upon interpretation of the preliminary operations plan adapted from (Ecological Associates 2014c)

Table 8-1 shows the expected shortfall in frequency and duration between Basin Plan and target flows will be:

- 2 years in 10 to meet the frequency requirements for seasonal wetlands
- 1 year in 10 to address the gap in the frequency requirements for Red Gum Swamp Forest
- 1 year in 10 to address the gap in the frequency requirements for Red Gum Forest and Woodland.

Table 8-1 also shows the proposed works can be operated to meet shortfalls in durations under Basin Plan flows e.g. by making additional to meet the duration requirements of Red Gum Forest and Woodland.

Flows which result in flooding across broader expanses of the Vinifera floodplain e.g. Red Gum Swamp Forest watering events, will also result in flooding of the lower lying areas where the seasonal wetlands occur. This may meet the frequency requirements of the lower lying areas however not meet the duration requirements, as discussed in section 9. This will be taken into account in annual seasonal water planning.

In order to further demonstrate the differences in the scenarios described in Table 8-1, hydrographs of the flow regimes are illustrated in Figure 8-4. The flow regimes represent a wetter than average sequence of years (1990s) and an extremely dry sequence of years (2000s).

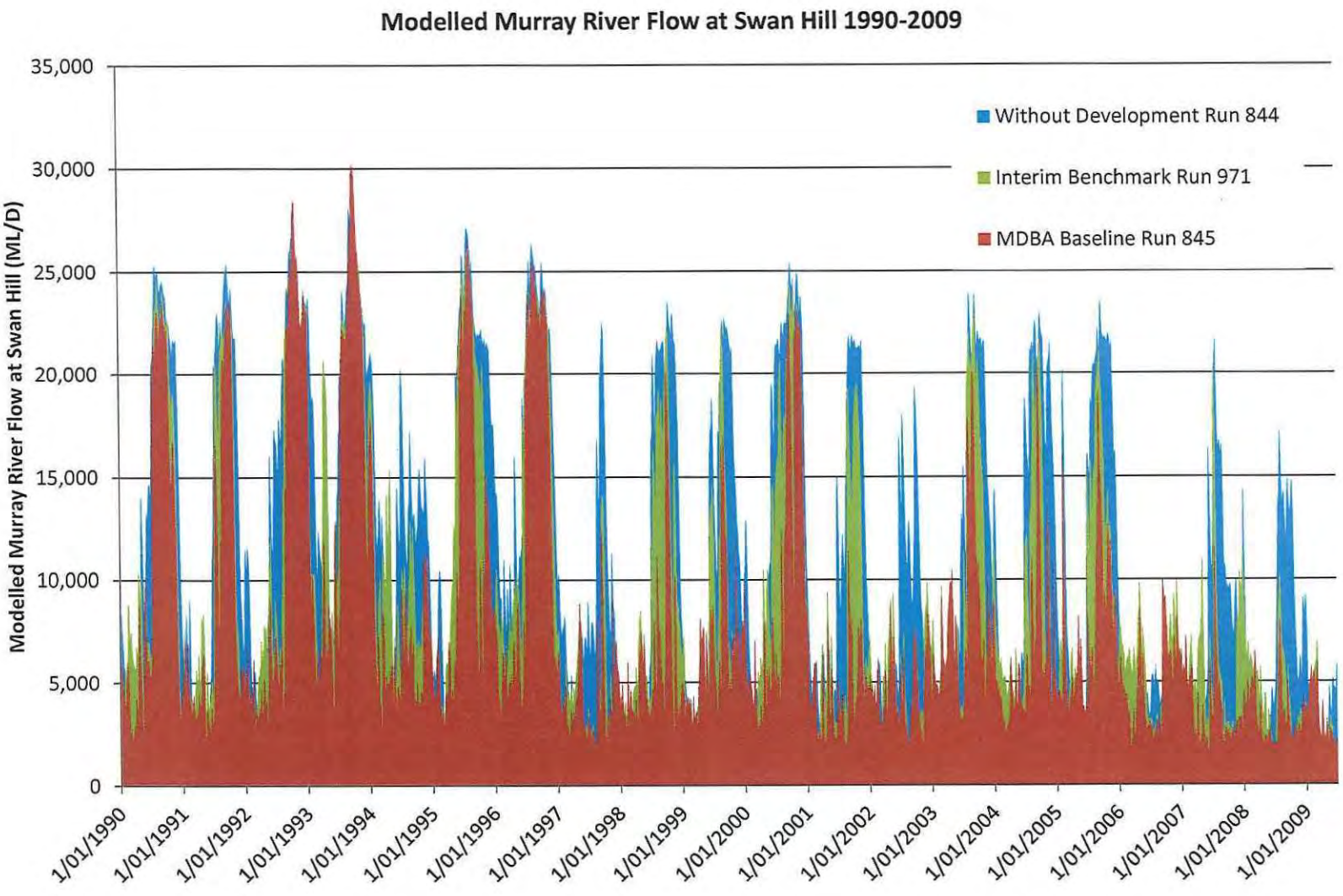


Figure 8-4: Daily Peak Flow by year for different flow regimes at Swan Hill (Data supplied Mallee CMA, 2014)

9. Environmental water requirements (Section 4.5.2)

The environmental water requirements of the *Vinifera Floodplain Management Project* have been identified and contribute to the achievement of ecological objectives and targets for this site (Ecological Associates, 2014a).

The process for identifying the environmental water requirements for this site, built on the work undertaken in establishing ecological objectives. Detailed hydrographic information, spatial data and scientific literature relating to the site was analysed and compared against ecological objectives, which was then combined to generate site-specific environmental water requirements (Ecological Associates, 2014a).

The project considers the environmental water requirements across the following water regime classes:

- Seasonal wetlands
- Red Gum Swamp Forest
- Red Gum Forest and Woodlands.

A key environmental outcome of this project is to maintain productivity and structure of red gum communities, which require inundation 9 years in 10 for 2 to 7 months. Inundation of this extent requires passing flows of approximately 15,000 to 20,000 ML/d, for an extended period, which occurs less-often under the current hydrologic regime.

Environmental benefits for red gum can be achieved using the proposed environmental works, as they are able to extend natural inundation durations as well as retain managed inundation via temporary pumps, at times when high river flows are not available.

Ecological objectives and targets, and their corresponding environmental water requirements, are outlined in Table 9-1. Importantly this table illustrates the flexibility that will be incorporated into the future operation of the proposed works to mimic the variability that would have occurred under natural flow patterns.

Mechanisms to deliver these environmental water requirements are detailed in Section 10.

Table 9-1: Environmental water requirements and ecological objectives (Ecological Associates, 2014a)

Water Regime Class	Flow threshold	Strategy	Frequency	Duration	Timing
Seasonal Wetland	15,000 ML/d	Capture peaks in river flow by closing regulators on the flood recession. Pump water into wetlands if peaks in river flow are too infrequent.	Wetland depth to exceed retention level of wetland nine years in ten. Wetlands completely dry one year in ten.	Five of these events to last more than six months Four of these events to last more than nine months.	Late autumn – early winter
Red Gum Swamp Forest	17,500 ML/d	Capture peaks in river flow by closing regulators on the flood recession. Pump water into wetlands if peaks in river flow are too infrequent.	Flooding to be provided nine times in ten years.	Five of these events to be five months long. Four of these events to be seven months long.	Early winter
Red Gum Forest and Woodland	20,000 ML/d	Capture peaks in river flow by closing regulators on the flood recession. Pump water into forest if peaks in river flow are too infrequent.	Provide flooding nine times in ten years.	Five of these events to be two months Four of these events to be six months long.	Early winter – mid-winter

10. Operating regime (Section 4.6)

10.1. Role of structures and operating scenarios

The proposed works consist of environmental regulators and a range of supporting structures.

The V1, V2 and V4 regulators, in conjunction with Basin Plan flows, will be the primary means of delivering water to Vinifera forest and achieving the ecological objectives for the site.

These works and the existing infrastructure are described in Table 10-1. The volumes in Table 10-1 were derived from scenario modelling to determine the extent of flooding, and depth/area relationships with stage height for each of the regulators. The volumes therefore refer to void space and assumes no losses or return flows. This information, together with the proposed operating regime, will enable the MDBA to model return flows for the full range of operational scenarios during the assessment process.

The sources of water for managed inundation are:

- Gravity inflow from the River Murray via backflow through structure V2
- Pumped inflow from the River Murray (using temporary pumps)[3]
- Gravity inflow from the River Murray via structure V4, and
- overland flow (once flow exceeds 20,000 ML/day).

Table 10-1: Summary of existing and proposed environmental watering infrastructure at Vinifera and its role in the project

Infrastructure[4]	Existing or proposed	Role	Associated Area	Inundation Area (ha)	Volume (GL)
V1	Proposed	Downstream flow control	Whole of project	349.6	2,743
V2	Proposed	Downstream flow control			
Main levee, raised track and overflow sills	Proposed	To retain water at inundations up to 64.4 m AHD			
V3	Proposed	Enables passing of local drainage flows, pass overland flows in large events and prevent backflow onto private land during a managed event.			
V4	Proposed	Allows inflows from the River Murray and prevent backflow into the River Murray when retaining water in the forest during a managed event.			
Drop structure	Proposed	To provide fish passage on return flow to the River Murray	NA	NA	NA

Source: Jacobs (2014a)

[3] Pump infrastructure is not part of the concept design package

[4] There is no existing infrastructure at Nyah Park. All infrastructure listed is part of the proposed works package.

10.2 Operating scenarios

The Vinifera water management works have been designed to provide maximum operational flexibility and can be used to complement Basin Plan flows or to deliver environmental benefits. Five scenarios have been developed to illustrate how these works can be used to achieve environmental outcomes. Scenarios include:

- Default
- Seasonal Fresh
- Vinifera Intermediate
- Vinifera maximum
- Natural inundation.

Each of the scenarios align with the water regime classes for Nyah Park, as illustrated in Table 10-2 below.

Table 10-2: Links between the operating scenarios and water regime classes at Nyah Park

Scenario	> 13,000 ML/d	Up to 17,500 ML/day	Up to 20,000 ML/day	> 20,000 ML/day
Vinifera Creek Seasonal wetland Red gum swamp forest Red gum forest and woodland	Seasonal Fresh	Vinifera Intermediate	Vinifera Maximum	Natural flows All structures open

Table 10-2 shows that a seasonal fresh meets the water requirements of Vinifera Creek. Similarly, a Vinifera maximum operation will meet the requirements of the Red Gum Swamp Forest, as well as the seasonal wetlands and creeks. An overview of each of the operational scenarios is provided below.

Default

This scenario is the default configuration for Vinifera water management structures, in normal regulated flows when environmental watering is not required.

In this scenario all environmental structures are to be open (Table 10-2).

Seasonal Fresh

The seasonal fresh scenario would provide flow along Vinifera Creek and is achieved through suitable River Murray flow.

During this scenario all environmental regulators would remain in their default position of open (Table 10-2).

Vinifera Intermediate

Intermediate operation of the Vinifera regulators and their associated support structures will enable watering of Vinifera Creek and the lower floodplain more frequently without inundating upper floodplain areas. This scenario requires the opening of structures V1, V2 and V4 and the closure of V3 during Basin Plan or natural flows. Once flows begin to recede, structures V1, V2 and V4 are closed to manage inundation to the desired target level for an appropriate duration. Natural inflows maybe augmented by temporary pumps (Table 10-2).

Vinifera Maximum

Maximum operation of the Vinifera regulators and their associated support structures will enable watering of Vinifera Creek and the upper floodplain areas. This scenario requires the opening of V1, V2 and V4 and the closure of V3 during Basin Plan or natural flows. Once flows begin to recede, structures V1, V2 and V4 are closed to manage inundation to the maximum operating level for an appropriate duration. Natural inflows maybe augmented by temporary pumps (Table 10-2).

Natural Flooding

In order to minimise the impact of the infrastructure on natural inundation patterns it is proposed that all regulating structures will be open allowing full connectivity between the River Murray, Vinifera Creek and the floodplain (Table 10-2).

Transition between operating scenarios

For a range of reasons it may be necessary to change between operation scenario during the course of a watering event.

Factors that may influence a decision to transition between scenarios may include;

- Inflows causing increase in environmental water allocations
- Inflows generating natural flooding
- Response to ecological opportunities or to mitigate risks
- Response to operational opportunities or to mitigate risks
- Response to water quality risk mitigation requirements

An operation matrix (Table 10-2) has been developed which summarises how each structure would be operated to change from one scenario to another. For example, to move from Default conditions to Vinifera Maximum, V3 would be closed and other regulators would be progressively closed to raise water levels in Vinifera Park while maintaining appropriate passing flows.

The 'Condition During Scenario' cells of the matrix (highlighted in blue) show the status of the structures once each scenario has been established and is in operation.

Table 10-3: Operational matrix

Scenario	To Default	To Seasonal Fresh	To Vinifera Intermediate	To Vinifera Maximum	To Natural Flows
Default	Condition During Scenario All structures open	No change	V1, V2, V4 – structures set to height required to achieve operational objectives, (between open and 64.4 m AHD), with through flow maintained. V3 closed	V1, V2, V4 – structures set to maximum operating level 64.4 m AHD, with through flow maintained V3 closed	No change
Seasonal Fresh	No change	Condition During Scenario All structures open	V1, V2, V4 – structures set to height required to achieve operational objectives, (between open and 64.4 m AHD), with through flow maintained. V3 closed	V1, V2, V4 – structures set to maximum operating level 64.4 m AHD, with through flow maintained V3 closed	No change
Vinifera Intermediate	All structures open	All structures open	Condition During Scenario V1, V2, V4 – structures set to height required to achieve operational objectives, (between open and 64.4 m AHD), with through flow maintained. V3 closed	V1, V2, V4 – structures set to maximum operating level 64.4 m AHD, with through flow maintained V3 closed	All structures open
Vinifera Maximum	All structures open	All structures open	V1, V2, V4 – structures set to height required to achieve operational objectives, (between open and 64.4 m AHD), with through flow maintained.	Condition During Scenario V1, V2, V4 – structures set to maximum operating level 64.4 m AHD, with through flow maintained V3 closed	All structures open
Natural Flows	No change	No change	V1, V2, V4 – structures set to height required to achieve operational objectives, (between open and 64.4 m AHD), with through flow maintained. V3 closed.	V1, V2, V4 – structures set to maximum operating level 64.4 m AHD, with through flow maintained V3 closed	Condition During Scenario All structures open

10.3 Timing of operations and risk management

The proposed works provide a high degree of operational flexibility. Ecological Associates (2014c) provides a selection of possible operating scenarios. The decision to initiate an environmental watering event will be based on:

- Water availability
- The floodplain water requirements consistent with the watering regime, ecological objectives and targets
- Operational risks
- Regional context (i.e. survival watering, recruitment watering, maintenance watering) and other river operations that may occur within the river reach.

Mimicking natural variability will provide a diverse range of inundation events, which will restore a mosaic of vegetation consistent with pre-regulation conditions.

With this in mind, the Mallee CMA will seek to collaborate with the MDBA and other stakeholders to help develop new "real time" river information tools that will better inform operations.

The structures will be operated to manage adverse impacts as per the risk mitigation covered in Section 11.

11. Assessment of risks and impacts of the operation of the measure (Section 4.7)

A comprehensive risk assessment of the potential operational impacts of the proposed supply measure has been carried out during development of this business case. It is acknowledged that operation may have a range of impacts, including adverse impacts on cultural heritage, socio-economic values and impacts from operation of structures. This risk assessment process was informed by experience with operating environmental watering projects of similar scale and complexity, including TLM.

11.1. Risk assessment methodology

The risk assessment for the Lindsay Island project was completed in line with the requirements of AS/NZS ISO 31000:2009 (Lloyd Environmental, 2014). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and prioritised mitigation strategies and measures.

Refer to Section 7, Tables 7-1 to 7-4 to view the risk matrix and definitions used in this risk assessment, and further details on the methodology.

The risk assessment was consolidated as the project developed and additional information incorporated into Table 11-1.

11.2. Risk assessment outcomes

Table 11-1 presents a summary of the assessment and subsequent work undertaken, including mitigation measures developed and an assessment of residual risks after these are applied. It should be noted that where a residual risk is given a range of ratings, the highest risk category is listed.

Table 11-1. Risk assessment – threats and impacts of operation of the measure without mitigation and residual risk rating after mitigation, adapted from Lloyd Environmental (2014)

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Adverse impacts on cultural heritage						
Loss of artefacts via erosion; loss of artefacts via inundation	Lindsay Island is considered an area of high cultural heritage sensitivity. Fluvial processes during watering events could damage cultural sites and places, resulting in the loss of artefacts in-situ on the floodplain. This may damage relationships with Indigenous stakeholders and subsequently affect future operation of the works.	Possible	Moderate	Moderate	Preliminary cultural heritage assessment work has been undertaken through the Vinifera Floodplain Due Diligence Assessment (Bell, 2013). A Cultural Heritage Management Plan will be required prior to construction activities and will be developed in partnership with Indigenous stakeholders. This will provide for any further remedial works during/after operations. Implement measures during operations to minimise damage to cultural sites. Proactive engagement with Indigenous stakeholders during operation, which may involve inspection of cultural sites pre and post watering events to monitor and undertake protection works, relocation of artefacts as required, and rehabilitation works.	Low
Damage to relationships with Indigenous stakeholders	This threat could occur through unforeseen impacts on cultural sites during operation, which may damage relationships with Indigenous stakeholders. This could affect the future operation of works and subsequently impact on the site's water-dependent ecological values.	Possible	Moderate	Moderate	As above.	Low
Adverse impacts on socio-economic values						
Restricted access to public land during watering events	Watering events may inundate roads and bridges, limiting or prohibiting public access. This may reduce opportunities for active	Certain	Minor	Moderate	Improved planning and modelling to predict access limitations during operation. Issue public notifications of access changes/limitations prior to watering events.	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
	and passive recreation, and possibly tourism.				Close consultation with tourism industry to ensure timely communication around planned events. Upgrade roads to improve access where practical. Provide boat access as an alternative, where relevant.	
Disturbance of beekeeping and other commercial operations (kayaking, camping, tours etc.)	In addition to restricting access, watering events could inundate vegetation with pollination potential and beehive sites. Watering events could also restrict other commercial operations such as camping and kayaking tours.	Possible	Moderate	Moderate	Engage with the relevant stakeholders (apiarists, licensed tourism operators etc.) to ensure they are aware of the extent of upcoming watering events and can plan accordingly. This will be incorporated into the project stakeholder management strategy.	Low
Rise in river salinity	A key driver to salinity in Lindsay River is discharge of saline groundwater along gaining reaches during a flow recession. Increases in salinity (measured as EC units at Morgan) may breach Basin Salinity Management Strategy requirements and also exceed Basin Plan salinity targets. This may result in poor water quality for downstream users.	Likely	Moderate	Moderate	Provision of dilution flows in the Murray River during and following drawdown. Not operating during high-risk periods. Use regulators to: • Control the level and area of floodplain inundated and rate of recession to manage the volume of saline water returned to the river. • Enable hold periods to be shortened or lengthened to mitigate impact of release of stored water. • Restrict release from impounded areas to allow evaporation and seepage. Ongoing monitoring of groundwater and surface water levels and salinity to inform adaptive management and update of Operational Plans.	Low
Increased mosquito populations	Ponding water on the floodplain has the potential to localised increases in mosquito populations. This could lead to human discomfort, disease exposure and	Possible	Moderate	Moderate	Active community engagement to improve awareness and encourage people to take precautions. This would be carried out as part of wider communication and engagement activities.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
	eventually to negative perceptions about the project.					
Adverse impacts resulting from operating structures						
Structural failure of new works during operation	Structures can be vulnerable to inundation flows during operation via processes and attributes such as: inadequate elevation; insufficient protection from scour; insufficient rock armour; flood preparation including strip boards and handrails.	Possible	Severe	High	Provide adequate protection from erosion during and after operation. Ongoing inspection and maintenance of structures for early identification of potential problems during operation. Flood preparation actions written into O&M documents including removing structural parts likely to be barriers to flow or large debris.	Low
Poor design of structures	This could occur through inadequate technical rigour during design or maintenance, causing maintenance issues or reduced effectiveness in operations.	Possible	Moderate	Moderate	Peer review of structure designs. Develop and implement appropriate maintenance programs.	Low
Unsafe operation of built infrastructure	Unsafe operation, such as breaches of OH&S procedures, could threaten human safety.	Unlikely	Catastrophic	Moderate	Ensure appropriate design that incorporates best-practice OH&S provisions. Operate infrastructure in compliance with OH&S requirements. Develop and implement a suitable maintenance program, in conjunction with Operation and Maintenance Plans. Provide safe access provisions and public safety provisions. Provide appropriate induction and training for staff operating infrastructure and equipment. Provide appropriate personal protective equipment (PPE) and equipment for operations.	Low
Adverse impacts on operation, maintenance and management.						

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Please note: These threats impact operations, but are not caused by the operating regime.						
Lack of clear understanding of roles and responsibilities of ownership and operation	Lack of clear understanding of roles and responsibilities of ownership and operation could prevent the effective operation of the infrastructure.	Possible	Moderate	Moderate	Establish a MoU between all relevant agencies outlining roles and responsibilities during operation. Facilitate shared knowledge of project objectives among asset owners and operators. Develop all documentation with relevant agencies prior to construction, including production of Operation and Maintenance manuals. Ensure emergency response arrangements are in place. Ensure ongoing maintenance of structures and insurance arrangements. Maintain strong working relationships with river operators, partner agencies (including agencies in NSW, SA and Victoria), and Commonwealth and Victorian water holders through regular operations group meetings. Maintain clear lines of communication during operation and reporting of water accounts/flows (i.e. reporting and accounting arrangements).	Low
Lack of funding for ongoing operation, maintenance and management	Insufficient funding for maintenance activities result in deterioration of structures, increasing the risk of failure. Inability to coordinate/direct operations due to insufficient agency resources.	Possible	Severe	High	Maintain strong relationships with investors/funding bodies to secure long term operational funding. Suspend operations if insufficient resources available to support relevant agencies.	Low
Operational outcomes do not reflect hydrological modelling outputs	On-ground outcomes during operation do not meet expectations due to incorrect assumptions, input data, interpretation or inaccurate models.	Possible	Severe	Moderate	Models developed using best available information. Undertake sensitivity modelling to confirm minor discrepancies in model accuracy do not result in	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					dramatic changes to operational outcomes. Models independently peer-reviewed and determined to be fit for purpose.	
Community/ stakeholder resistance, backlash or poor perception	Poor communication with project stakeholders and the community can result in misunderstanding of the project's works and ongoing operations. This may limit on the capacity to operate the site as required.	Possible	Moderate	Moderate	Ongoing stakeholder liaison (early and often) guided by a stakeholder engagement plan. Targeted engagement to address identified concerns of key stakeholders.	Low
Inundation of private land without prior agreement	The only private land to be inundated by this project is currently owned by Trust For Nature and managed for conservation. It is possible that ownership could change and the new owner may not permit inundating.	Possible	Moderate	Moderate	Ongoing engagement with landholders regarding planned watering events and outcomes. Negotiate conservation covenants and/or flood/access easements to be registered on title if ownership changes.	Low

11.3. Risk mitigation and controls

The risk assessment confirms that all the risks identified in the risk assessment are reduced to acceptable levels (very low to moderate) once well-established risk mitigation controls are implemented.

While the risk assessment identifies several potential threats that could generate high risks to the operation of the structures (Table 11-1), these risks are considered manageable because they:

- Are well known and are unlikely to involve new or unknown challenges
- Can be mitigated through well-established management controls
- Have been successfully managed by the Mallee CMA and project partners (including construction authorities) in previous projects
- Result in very low or moderate residual risks after standard mitigation measures are implemented

Two risks retained a residual risk of moderate after implementation of the recommended mitigation strategies (Table 11-2). Further consideration of these threats may assist in further understanding the potential impacts and, in some cases, identifying additional mitigation measures to reduce the residual risk.

While downstream and cumulative salinity impacts cannot be formally ascertained at this time (see Section 7), particular consideration has been given to the potential salinity impacts of the project, as described in Section 11.5.

Table 11-2. High priority risks, mitigation and residual risk

Threat	Risk without mitigation	Residual risk rating	Additional considerations (Lloyd Environmental, 2014)
Restricted access to public land during watering events	Moderate	Moderate	Alternative recreational sites could be promoted as a form of 'offset' during watering events. New infrastructure could be provided to enhance the most common recreational pursuits (e.g. walking tracks and bird hides, campgrounds for campers)
Operational outcomes do not reflect hydrological modelling outputs	Moderate	Moderate	Opportunities for improvement of models identified for action as more information becomes available. Further refinement of models undertaken as project develops and contextual information is provided regarding Basin Plan flows, detailed designs and initial operations

11.4. Salinity Impact Assessment and Mitigation Strategies

A preliminary salinity impact assessment of the *Vinifera Floodplain Management Project* has been completed which includes analysis of both BSMS considerations and real time salinity impacts. The parameters applied in this assessment are based on historically observed surface and groundwater responses. While the salt mobilisation responses can be identified and estimated, the operating regime of the River Murray under the Basin Plan is largely unknown at this point in time and may affect the observed salinity response. The preliminary salinity impact assessment must be considered in this context.

The Victorian Salt Disposal Working Group provides advice to DEPI about Victoria's compliance and implementation of the BSMS, including the assessment of salinity impacts. The Group comprises representatives from DEPI, Goulburn Broken, Mallee and North Central CMAs, G-MW and Lower Murray Water. The Group has reviewed the preliminary salinity impact assessment for the Lindsay Island Floodplain project and considered the findings of the expert peer review (see Appendix L). The Group endorses the assessment methodology as consistent with the BSMS and fit for purpose to support this business case.

Preliminary Salinity Assessment Approach

The study estimated salt loads to the river system using a combination of approaches (semi-quantitative and qualitative) based on an initial desktop assessment of hydrogeological and salinity information and methods including mass balance, flow nets and groundwater mound calculations. Associated salinity impacts at Morgan were derived using the Ready Reckoner developed specifically for environmental watering projects (Fuller and Telfer 2007).

The information provided by these assessments can be used to inform analysis of cumulative impacts of the final suite of Supply, Demand and Constraint Management Measures implemented under the Basin Plan. For detailed information please refer to the Preliminary Impact Assessment for Mallee Environmental Watering Projects – Other Sites (SKM, 2014; Appendix D).

Preliminary salt estimate

The preliminary salinity impact is approximately 0.033 EC for the nominated frequencies of inundation. This initial estimate does not account for implementation of mitigation strategies.

It is expected that successive watering events coupled with natural flood events could return groundwater conditions and salt store to that seen in the 1990's. This 1990s condition can be viewed as being representative of the 'cumulative impact' of a large scale sequence of watering event that represents the maximum salt impact condition (SKM 2014).

The real-time salinity impact immediately downstream of Vinifera floodplain was modelled (over the 25 year benchmark period) and did not result in an exceedance of the salinity targets at Lock 6 or Morgan.

Mitigating measures and their feasibility

While the level of salinity impact is 'not significant' under the BSMS definition (i.e. less than 0.1 EC at Morgan), mitigating strategies can still be used to ensure that any salinity impacts are minimised. The availability of dilution flows and their relative volume, duration and timing of release are important considerations however, without further detail on the whole-of-River Murray system operations, it is not feasible to undertake the myriad of possible modelling scenarios required to determine the most appropriate mitigation strategy (SKM, 2014).

Mitigation strategies are therefore described below in general terms. A more detailed analysis of the potential salinity impacts and risk mitigation strategies is recommended upon approval of this business case. This will be most useful when there is greater certainty about the structure specifications and proposed operating regimes of the River Murray. A range of management responses are available and may be appropriate to consider in minimising the each salinity process triggered. These include:

- Creation of an operations protocol that explicitly connects projected salinity impacts, salinity thresholds for operation and contingency planning; and
- Implementing a monitoring regime that informs both the operation of the structures within the nominated thresholds as well as the overall estimation of salinity impacts downstream.

Should larger impacts occur with time, these will be offset by the less frequent operation and shorter duration of watering events as required.

Significant opportunities exist to manage the way that salt is generated and to mitigate the overall impacts including:

- Optimising the timing of diversion. Generally the rising limb of the flow hydrography in the lower Murray is associated with increasing salinity. Smaller wetlands could be watered earlier, before any significant increase in river salinity caused by flooding upstream. Bringing fresher water into the wetlands will minimise the impact of the salt on release.

- Optimising the timing of releases. Release of water into a falling river will have a more significant impact when flows are low. Releasing into higher flows will minimise local impacts but not necessarily affect the overall salt loads from a BSMS perspective.
- Optimising the rate of release. If water must be released into a very low river, local effects can be mitigated by slowing the rate of release. In some cases, this may be used in conjunction with the above measures.

Monitoring requirements and further analysis

Surface and groundwater data for the Vinifera floodplain is limited both spatially and temporally. This, in turn, limits the ability to refine the quantum of salinity impact. SKM (2014) recommended the implementation of comprehensive monitoring during early operations and the use of information obtained to assess maximum groundwater levels and infer direction of flow. This local scale investigation should form part of a larger scale investigation covering river operations and environmental watering activities taking place along the River Murray System.

Priority monitoring relies on measurements of salinity, water level from observation wells and fixed surface water monitoring sites. These include:

- Two new bore sites to be drilled close to the inundation areas.
- Three data logger sites to capture continuous salinity and water level data – additional sites may be required where inundation activities present access issues.
- Six bores sites monitored for water level and salinity before, during and immediately after watering events, and every three months between events.
- Additional surface water data (flow, level and salinity) collected at Nyah (north of Vinifera) and new gauge sites be established adjacent to the new groundwater bore sites and the inlet and outlet structures.

11.5. Risk management strategy

As noted in Section 7.3, a comprehensive risk management strategy will be developed for the proposed supply measure, building on the work completed for this business case. The strategy will cover ecological and socio-economic aspects to provide a structured and coherent approach to risk management for the life of this project (i.e. construction and operation).

With regard to potential operational impacts, the risk management strategy will focus on the following issues, as described in Table 11-1:

- Potential impacts on socio-economic values, including salinity impacts;
- Operation of structures; and
- Maintenance and ongoing management.

Risk assessment and management is not a static process. Regular monitoring and review of the risk management process is essential to ensure that:

- Mitigation measures are effective and efficient in both design and operation
- Further information is obtained to improve the risk assessment
- Lessons are learnt from events (including near-misses), changes, trends, successes and failures
- Risk treatments and priorities are revised in light of changes in the external and internal context, including changes to risk criteria and the risk itself, and
- Emerging risks are identified.

The risk assessment process will continue throughout the development and implementation of this project. It is anticipated that additional threats will be identified and evaluated as the project progresses, and any new risks incorporated into the risk management strategy.

12. Technical feasibility and fitness for purpose (Section 4.8)

12.1. Development of designs

The options selected for the *Vinifera Floodplain Management Project* have been developed to complement the delivery of basin plan flows. They offer opportunities to provide environmental water to sites during times of water shortage and by allowing delivery of water to higher parts of the floodplain beyond the reach of regulated releases to meet target inundation frequency, extent and duration parameters. In developing options for the project consultants were asked to consider the following:

A. Maximising environmental benefit from operation of the proposed works by:

- Targeting areas that are difficult to reach with run of River Murray flows
- Considering lifting water from areas flooded by works to higher elevations with temporary pumps
- Providing the ability to deliver water to high value target areas without requiring large storage releases to generate overbank flow and without relying on removal of system constraints
- Ensuring that works can be used to magnify the effects of natural flows or regulated releases with minimal additional water use
- Designing infrastructure which will be flexible in its use to allow implementation of operational strategies developed through adaptive management of the site.

B. Maximising cost effectiveness, environmental benefits and water efficiency returns for investors through:

- Analysis of existing environmental works in the region and incorporating lessons learned from the construction and operation of these projects
- Pragmatic analysis of available infrastructure options
- Striking a balance between capital investment and ongoing operating costs to deliver a cost effective solution.

C. Ensuring practical and economic constructability of the project by:

- Siting structures on existing access tracks and provision of construction access plans
- Utilisation of locally obtainable construction materials where practical
- Use of advantageous geological features within the landscape where possible
- Incorporating information and experience obtained during the construction and operation of nearby works regarding seepage, structure settlement and stability, construction dewatering and downstream erosion control.

D. Ensuring compatibility with nearby existing infrastructure and operational practice by:

- Use of common design features with nearby infrastructure
- Taking into account operational capabilities of existing infrastructure which is integral to the operation of the proposed works
- Development of operational access plans
- Working with G-MW during options selection and development of concept designs.

E. Minimising negative impacts on the environment, cultural heritage and other river users by:

- Striving to maintain natural flow paths and capacities on the floodplain to minimise impact on natural floods
- Using existing disturbed footprints where possible
- Minimising site disturbance and the size of the footprint of any new infrastructure that is required

- Considering the use of multiple cascading structures to mimic hydraulic gradient and avoid extensive networks of tall levees.

12.2. Design criteria used

In addition to the broad considerations above, specific design criteria have been developed to inform the development of concept designs. These criteria have been developed through reference to current literature and best practice guidelines and through targeted workshops. Detailed descriptions of design rational and criteria are provided in the Appendix E concept design report. A summary of key design criteria is provided below.

Capacity and Flow Conveyance

The structures (including levees) were designed to meet a range of hydraulic criteria. Generally there was no single design flow. Criteria that influenced the structure size and geometry were:

- Erosion control (head differential) of the combined system
- Capacity to fill the forest
- Fish passage
- Erosion control (defined spillways) at the structures.

The arrangement of structures, levees and overflow sills has been designed to minimise the potential for erosion over the whole range of flow conditions. This is consistent with the intent of making the system reasonably transparent to natural overbank flows. This required a tiered approach to hydraulic design for through flow, as follows:

- Pass low and medium flows through hard structures (regulators) until a tail water develops
- Pass higher flows through purpose designed overflow sills, with rock protection, located on natural flow paths, and
- Overtop the earthen levee only after the tail water is fully developed and the levee/track is near submerged by the tail water.

The head differential that is acceptable for a given structure type ranges from high at concrete regulators to low at earthen levees (Jacobs 2014a).

Fish Passage

A fish passage workshop was held on the 16th of July 2014 involving key fish ecologists, representatives from design consultancies and constructing authorities. All seven of the proposed supply measures within the Mallee CMA region were considered.

Specific outcomes from the workshop relevant to design of the Vinifera works included the following:

- Engineering designs will incorporate appropriate and practical mechanisms to ensure fish passage to and from the river through regulating structures can occur.
- The operation of regulator V2 will allow for passive fish passage. Structure V2 has been designed to allow fish passage when fully opened and also during regulating events.

Gate Design

A gate assessment workshop was held in Tatura on 26 August 2014 and included representatives from G-MW operations and major projects as well as from Jacobs and Mallee CMA. The object of this workshop was to determine appropriate design criteria for each of the regulating structures within the project.

During this workshop the adoption of the dual leaf gate system in use on the existing TLM Hattah Lakes Environmental Regulators was confirmed. Design of smaller regulators at the site was standardized to use mechanically actuated penstock gates installed on the upstream face of box culvert structures.

Freeboard

The design crest level for each of the structures has been set based upon the design water level (DWL), and a freeboard allowance of up to 0.5m.

Minimum freeboard of 0.3m above DWL has been adopted for levees and allows for a clay core to extend to 0.15m minimum above the DWL plus protective cover. Defined spillways have been incorporated into levees to direct flow to appropriately protected areas during overtopping events.

Design Life of works

The design life of the concrete and embankment structures within the project is 100 years when appropriately maintained. Mechanical components will have a design life of 25 to 30 years (Jacobs, 2014a).

12.3. Concept design drawings

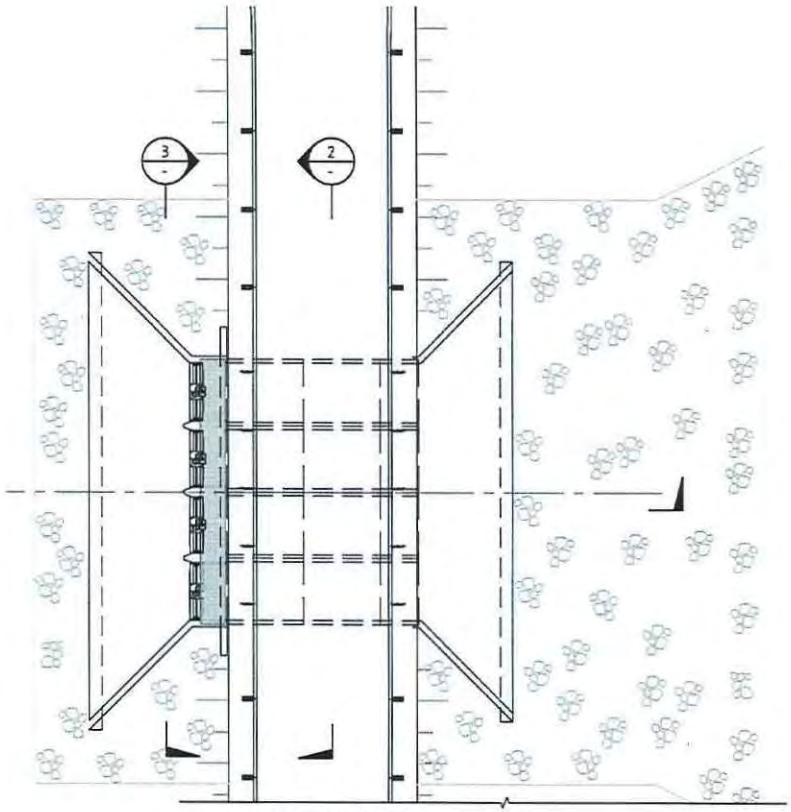
A description of the proposed works package has been provided in section 3.2.

Concept designs have been prepared for both the proposed works summarised below in Table 12-1.

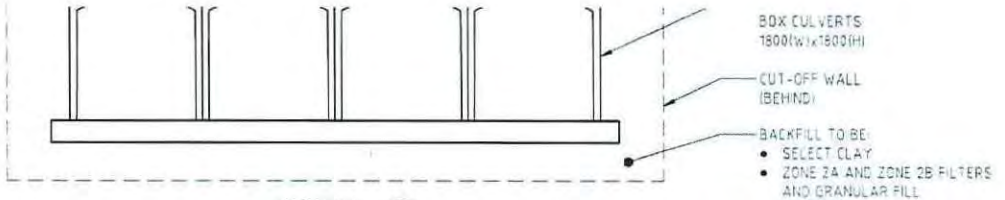
Table 12-1: Elements of the Vinifera works (Jacobs, 2014a)

Works	Description
V1 – Regulator	New ten bay regulator to retain water within Vinifera Creek allowing release of gravity controlled water to the very north-western tip of the Vinifera floodplain. 10 box culverts, 4 with dual leaf combination gates and 6 with single leaf gates.
V2 – Regulator	New four bay regulator allowing the release of water into the bend directly adjacent to the River Murray in the northern section of the Vinifera floodplain. 4 box culverts with split leaf combination gates
Main Levee	1087 m long raised track, to a maximum height of 1700 mm, incorporating 2 x 70m long overflow sills.
Drop structure	Rock structure to minimise erosion risk associated with the return of the impounded water to the River Murray.
V3 – Pipe culvert	New pipe culvert regulator on Vinifera creek to pass both local drainage and overland flows in large events. 1,200 mm diameter concrete pipe with penstock gate.
V4 – Pipe culvert	New pipe culvert to allow inflows from the River Murray and prevent backflow to the River Murray when retaining water on the floodplain during a watering event. 1,200 mm diameter concrete pipe with penstock gate.
Raised track sections and overflow sills	Seven overflow sill works, to contain water on the floodplain. The location of overflow sills to align with existing roads where possible, to reduce environmental and cultural heritage impacts.

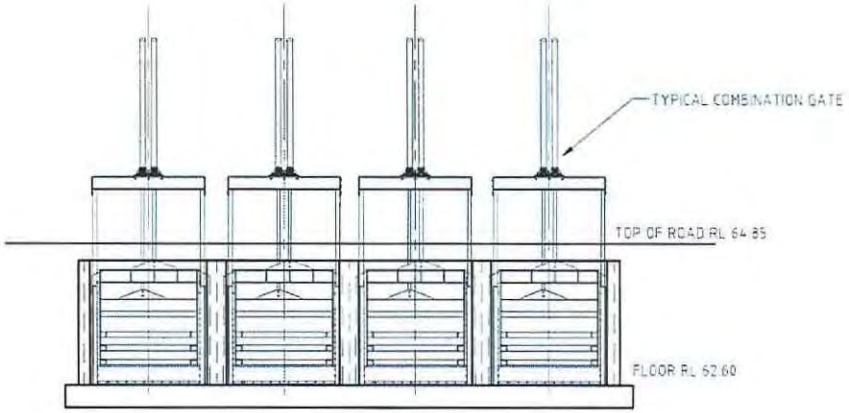
As part of the design process, concept design drawings for each of these structures have been developed and are provided within the design report attached as Appendix E. Figure 12-1 shows the plan and section view of the proposed V2 Regulator incorporating road crossing and provision of an area protected from traffic for operators to manipulate the gates.



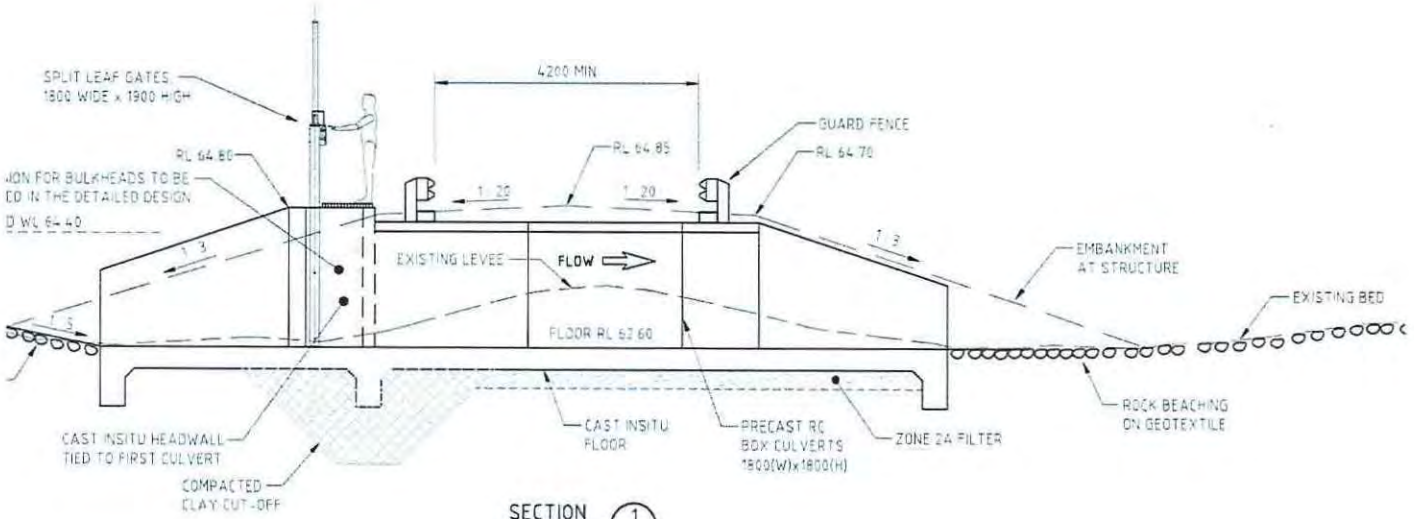
SITE V2 - PLAN
SCALE 1:200



SECTION 2
SCALE 1:100



SECTION 3
SCALE 1:100



SECTION 1
SCALE 1:100

NOT FOR CONSTRUCTION

1:100 0 1 2 3 4

1:200 0 2 4 6 8

PRELIMINARY ISSUE

mallee

JACOBS

CLIENT Mallee Catchment Management Authority

PROJECT CONCEPT DESIGN OF SDL PROJECTS

DRAWN	DRAWING CHECK	REVIEWED	APPROVED

TITLE
VINIFERA - SITE V2
REGULATOR - PLAN AND SECTION

12.4. Location of activities to be undertaken, access routes, footprint area

The location of each structure has been selected to maximize the efficiency of the works whilst minimizing impacts on cultural heritage, native vegetation and the visual or recreational amenity of the park and adjacent landholders. In addition, access requirements for future operation and maintenance have also been taken into consideration.

Figure 12-2 shows the location of the works. Where possible structures have been located:

- to maximize access from the Murray Valley Highway
- on existing tracks, or
- other areas of disturbance.

This approach minimizes the loss of vegetation, damage to cultural heritage values and improves future ease of access.

Specific set down areas, passing bays and construction footprints will be defined during the development of detailed designs and approvals. Experience from previous environmental works has shown that the selection of these smaller set down areas and construction footprints is best done as a collaborative exercise between cultural heritage advisors, ecologists and construction engineers.

For the purposes of preparing an estimate of vegetation impacts a nominal footprint at each of the proposed regulator sites was used along with nominal widths for access tracks and levees. These estimates were conservative and provide a correspondingly conservative (high) estimate of vegetation impacts.

Comprehensive mapping of these access arrangements and construction footprint is provided in Jacobs 2014a (Appendix E).

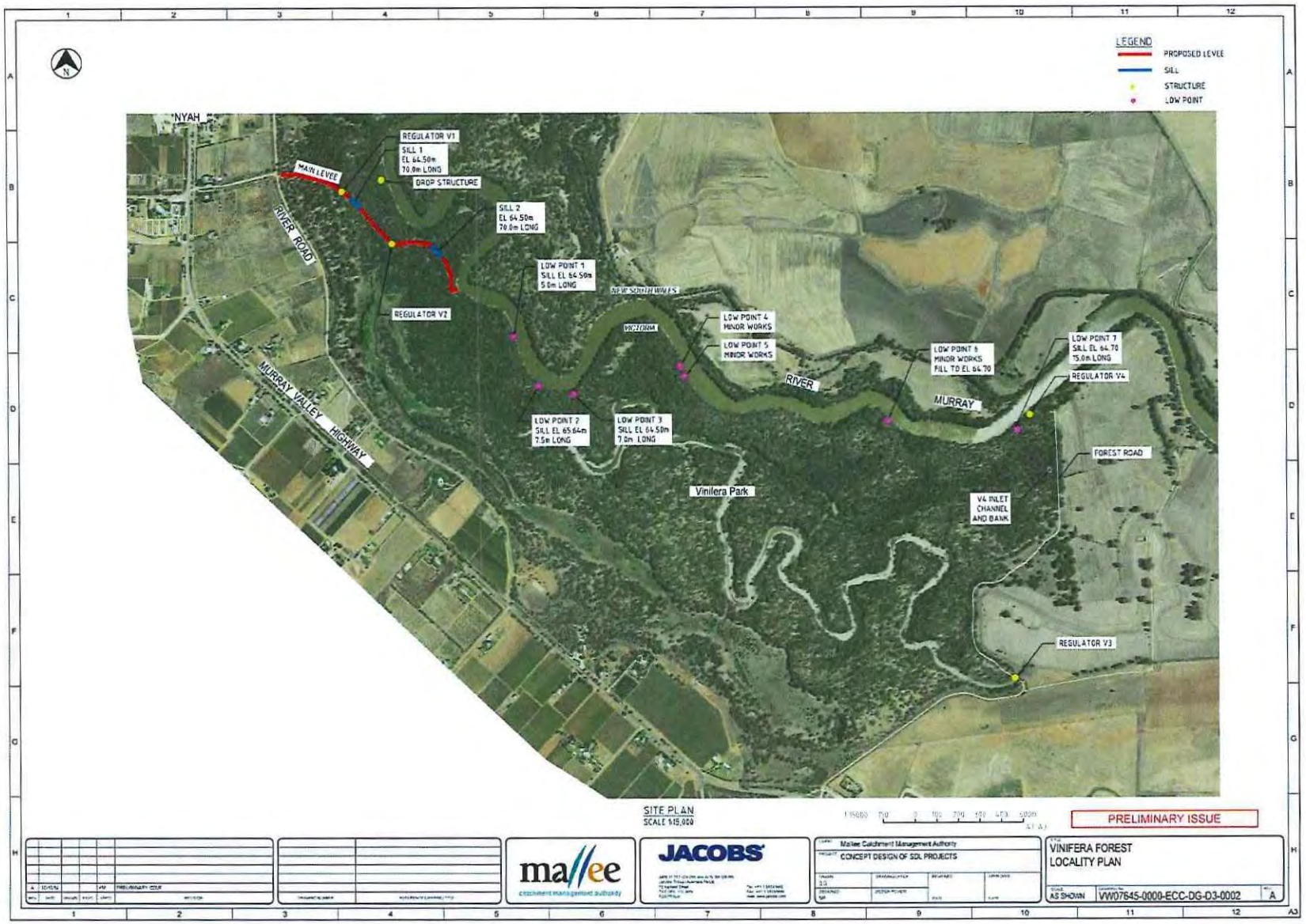


Figure 12-2: Location of proposed works and access tracks (Jacobs 2014a)

12.5. Geotechnical investigation results

Geotechnical investigations have provided valuable information that has informed and instilled confidence in the structure designs and associated costing. Geotechnical investigations were carried out in the vicinity of V2 and V3 (Aitken Rowe, 2012). The investigation included drilling three boreholes to depths greater than 6m to assess the consistency and density of subsoil material. Based on the findings of the investigation, it was recommended that:

- The structures may be founded on the underlying material at the two sites
- The structures may alternatively be founded on the existing fill if it is removed, replaced and re-compacted
- Scour protection is likely to be required in the vicinity of the structures.

At the time of preparation of this business case, geotechnical investigations had recently been completed and laboratory testing and reporting were underway. The foundation conditions at each site will need to be reviewed based on the outcomes from the geotechnical investigation and the designs modified as required. Based on the initial observations from the investigation program it is not envisaged that substantial design changes will be required (Jacobs, 2014a).

12.6. Alternative designs and specifications

There have been numerous studies undertaken over the past decade to investigate the most effective design for watering the Vinifera floodplain. This previous work has been taken into account to determine the preferred options proposed in this business case. As the preferred options became clearer more detailed analysis (GHD, 2014) was carried out on the four options outlined in Table 12-2.

Each of the four options was assessed against a range of design considerations (section 12.1) which resulted in Option 4 being chosen as the preferred option.

Table 12-2: Options that were subject to detailed analysis (GHD, 2014)

Options		Details	Area Inundated	Cost ($/ha)
Option 1	Existing option	Targets an inundation level of 64.4 m AHD and comprises two regulating structures (V1, V2) and a long raised track located in the north-western section of the floodplain, and one regulator (V3) located at the southern tip of the floodplain. Includes other works to manage access and retain inundation flows: ▪ Three short levees ▪ One box culvert.	331 ha	$11,800
Option 2	Including bend area	Targets an inundation level of 64.4 m AHD and comprises two regulating structures (V1, V2), a shorter main raised track located in the north-western section of the floodplain and one regulator (V3) located at the southern tip of the floodplain. Includes other works to manage access and retain inundation flows: ▪ Three short levees ▪ Two box culverts	350 ha	$10,300
Option 3	Regulator shifted south	Targets an inundation level of 64.4 m AHD and includes realignment of the main raised track and regulator (V2) from the north-west to south-east of the floodplain. Includes other works to manage access and retain inundation flows: ▪ Levee support in the north west of the floodplain ▪ Three short levees on the western side of the floodplain ▪ One box culvert.	266 ha	$6,600
Option 4	Extending area on existing option 1	Targets an inundation level of 64.4 m AHD and comprises two regulating structures (V1, V2), a long raised track located in the north-western section of the floodplain and one regulator (V3) located at the southern tip of the floodplain. Includes other works to manage access and retain inundation flows: ▪ Three short levees ▪ Controlled release of inundation in the far north of the floodplain.	340 ha	$11,500

Please note: the costs per hectare presented in this table were taken from preliminary work during options assessment and are not directly comparable with costs presented throughout the business case which have been subject to considerable refinement.

12.7. Ongoing operational monitoring and record keeping arrangements

The operational monitoring regime will form a key component of the operating plan developed for the site and will assign roles and responsibilities for agencies tasked with undertaking this monitoring. Critical areas of operational monitoring include those associated with water accounting and water quality which will be assigned to the constructing authority.

The project team has many years of experience in river and asset management and maintenance on the River Murray floodplain including the construction and operation of TLM Works at Hattah Lakes and Gunbower Island. Along with this experience comes the necessary orginisational capacity including data management and asset management systems required to maintain and operate large works. They also have systems in place to manage data generated by operations including water accounting and water quality monitoring data. Operating and maintenance considerations will be documented in an operations manual.

Maintenance and operating costs will be similar to other environmental works projects delivered through TLM. The designs incorporate simple, easy to operate structures without automation, specialist equipment or telemetry (Table 14-3).

Pumping will be needed approximately one year in 10 years for Vinifera using portable pumps. This will require approximately 2,743 ML to be pumped per event (Table 14-3).

The concept design report (Jacobs, 2014a) details considerations given to construction and operation of each of the proposed structures. This will be further refined during the detailed design stage, with additional Workplace Health and Safety considerations prepared.

Surface water flow and water quality monitoring will be implemented to ensure the water volume used and the water quality impacts of the project are recorded to appropriate standards and that this informs management and operations.

Groundwater monitoring will also be implemented to ensure salinity risks are appropriately managed.

An Operations Plan will describe how the infrastructure is to be operated for maximum environmental benefit while carefully managing risks. It will describe procedures for the Vinifera works and interactions with River Murray Operations and floods.

12.8. Peer review of concept designs

Prior to the commencement of the Advanced Concept Designs a workshop was held including representatives from GHD, SA Water, G-MW and an independent expert reviewer engaged by DEPI to provide advice regarding specific areas to be addressed during further design work. The outcomes of this review were provided to Jacobs as input into the Advanced Concept Design.

Jacobs have undertaken their own internal reviews of material during development of designs as well as incorporating feedback provided by G-MW and the Mallee CMA on draft reports.

During the development of concept designs, draft material including geotechnical investigation specifications and design documentation have also been provided to independent experts engaged by DEPI. The expert peer reviewers engaged were:

- Phillip Cummins (engineering)
- Shane McGrath (engineering).

The outcomes of the expert review process are provided in Appendix L.

13. Complementary actions and interdependencies (Section 4.9)

The proposed *Vinifera Floodplain Management Project* supply measure will affect the Victorian Murray (SS2) surface water sustainable diversion limit (SDL) water resource unit. This SDL resource unit is anticipated to be affected by this supply measure through an adjustment to the SDL, pending confirmation of a final off-set amount by the MDBA.

Any potential inter-dependencies for this supply measure and its associated SDL resource unit, in terms of other measures, cannot be formally ascertained at this time. This is because such inter-dependencies will be influenced by other factors that may be operating in connection with this site, including other supply/efficiency/constraints measures under the SDL adjustment mechanism, and the total volume of water that is recovered for the environment.

It is expected that all likely linkages and inter-dependencies for this measure and its associated SDL resource unit, particularly with any constraints measures, will become better understood as the full adjustment package is modelled by the MDBA and a final package is agreed to by Basin governments.

Similarly, a fully comprehensive assessment of the likely risks for this supply measure and its SDL resource unit cannot be completed until the full package of adjustment measures has been modelled by the MDBA, and a final package has been agreed between Basin governments.

The operation of the proposed works is not dependent on the operation of any existing works.

Under current arrangements, the operation of the existing TLM infrastructure nearby is undertaken by G-MW at the request of MDBA River operators, following advice from Hattah Operating Group, which is chaired by the Mallee CMA. This arrangement ensures local requests for the operation of the TLM works are integrated into broader river operations and provides a proven model for the operational governance of the proposed works.

Complementary actions beyond water management will include pest plant and animal control programs and other NRM activities funded by state and federal programs delivered by local agencies as per current arrangements.

13.1. Cumulative impacts of operation of existing and proposed works

The operation of the proposed works in conjunction with Basin Plan flows, constraints management measures, operating rule changes and other proposed or existing environmental works will have both positive and negative cumulative impacts on the system and river users.

The benefits of integrating the operation of works along the River Murray and the delivery of Basin Plan flows will include water efficiencies and the provision of appropriate ecological cues across multiple river reaches. Potential negative impacts may include cumulative salinity and other water quality impacts.

River scale benefits will include provision of nursery habitat for fish larvae and juvenile fish spawned upstream during elevated flows or operation of environmental works. These fish will return to the river as the water is drawn down from the floodplain contributing to the fish stocks of the River Murray.

On a local scale, the cumulative impacts of the proposed Vinifera project and the proposed Nyah Island works on downstream water quality will need to be monitored. It is expected that basin plan flows will more than meet any dilution flow requirements proposed and existing works as well as delivering environmental and water quality benefits along the full length of the river. The operation of the proposed Vinifera works in conjunction with the Nyah infrastructure, and other nearby environmental watering events such as the return of a more natural flow regime to the Little Murray Near Swan Hill, will dramatically increase available

floodplain habitat for valued flood-dependent fauna beyond that provided by the operation of either project, or environmental water deliveries, in isolation.

Holistic planning across the Basin will be required to mitigate potential negative impacts and maximise the social and ecological contribution of the Vinifera project to the outcomes of the Basin Plan.

14. Costs, benefits and funding arrangements (Section 4.10)

14.1. Introduction

Consistent with the guidance given on page 26 of the Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases, a formal cost benefit analysis has not been undertaken as yet for this project because the main benefit of the project (in this case, the SDL adjustment) cannot be reliably estimated in time to inform this business case.

However from a qualitative perspective, Victoria considers that, on balance, the benefits of this project will significantly outweigh its costs. The rationale for this assertion is that a broad range of enduring social, economic and environmental benefits can be pre-emptively assumed to arise from this project. These include:

- The social and economic benefits that will accrue for local and regional communities and businesses associated with its construction and operation
- The increased social and environmental amenity at this site arising from improved environmental health, increasing its attraction for tourism and recreational activities
- The broader regional economic benefit of taking less water out of productive use as a consequence of undertaking this project and being credited with an SDL Offset.

It must also be recognised that these immediate benefits can be assumed to have a range of positive secondary and tertiary benefits through the 'multiplier effect'. For example, the investment committed to construction of the project will benefit local businesses and families through jobs, materials purchase and normal every day expenditure.

Drawing an overall conclusion from the matters described above, it can be assumed that more than any other factor over the long term, the local and regional communities located close to this site will significantly benefit from the environmental amenity dividend generated by this project over its lifetime.

By contrast, it is difficult to envisage any significant social, economic and environmental disbenefit arising from direct operation of this asset in the manner described in this business case.

The Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases require that business cases identify benefits and costs that support a compelling case for investment, including a detailed estimate of financial cost and advice on proposed funding arrangements.

This chapter provides this information on the following:

- Capital cost estimates
- Operating and maintenance costs
- Funding sought and co-contributions
- Ownership of assets
- Project benefits.

These costs and benefits are outlined both in undiscounted terms in the year in which they occur, and in 'present value' terms, discounted to 2014 dollars by a central real discount rate of 7%. This discount rate is suggested by the Victorian Department of Treasury and Finance (DTF) for projects of this kind, and is also consistent with the Commonwealth Office of Best Practice Regulation (OPBR) advice on the choice of discount rate. A project timeframe of 30 years is used for the analysis, as per Victorian DTF guidelines for Economic Evaluation for Business Cases. Year 1 of this time period is 2016 when design costs are incurred.

14.2. Cost estimates

Total project implementation costs are $9,122,148 in Present Value 2014 dollars.

This business case presents the cost to fully deliver the project (i.e. until all infrastructure is constructed, commissioned and operational), including contingencies. Cost estimates for all components in this proposal are based on current costs, with no calculation undertaken of future cost escalations. To ensure sufficient funding will be available to deliver the project in the event that it is approved by the MDB Ministerial Council for inclusion in its approved SDL Adjustment Package to be submitted to the MDBA by 30 June 2016, cost escalations will be determined in an agreed manner between the proponent and the investor as part of negotiating an investment agreement for this project.

Total capital costs, including contingencies but excluding design costs, in Present Value 2014 dollars are $5,332,891. The cost of individual structures is outlined in Table 14-1.

Capital cost estimates for this project have been developed by engineering consultancies responsible for project designs, using real-world costs from recently constructed environmental infrastructure projects in the area (e.g. Hattah Lakes and Gunbower Forest), in conjunction with agencies involved in these and other projects. These cost estimates have been peer reviewed by the Expert Review Panel, comprised of recognised experts (as described in Section 17).

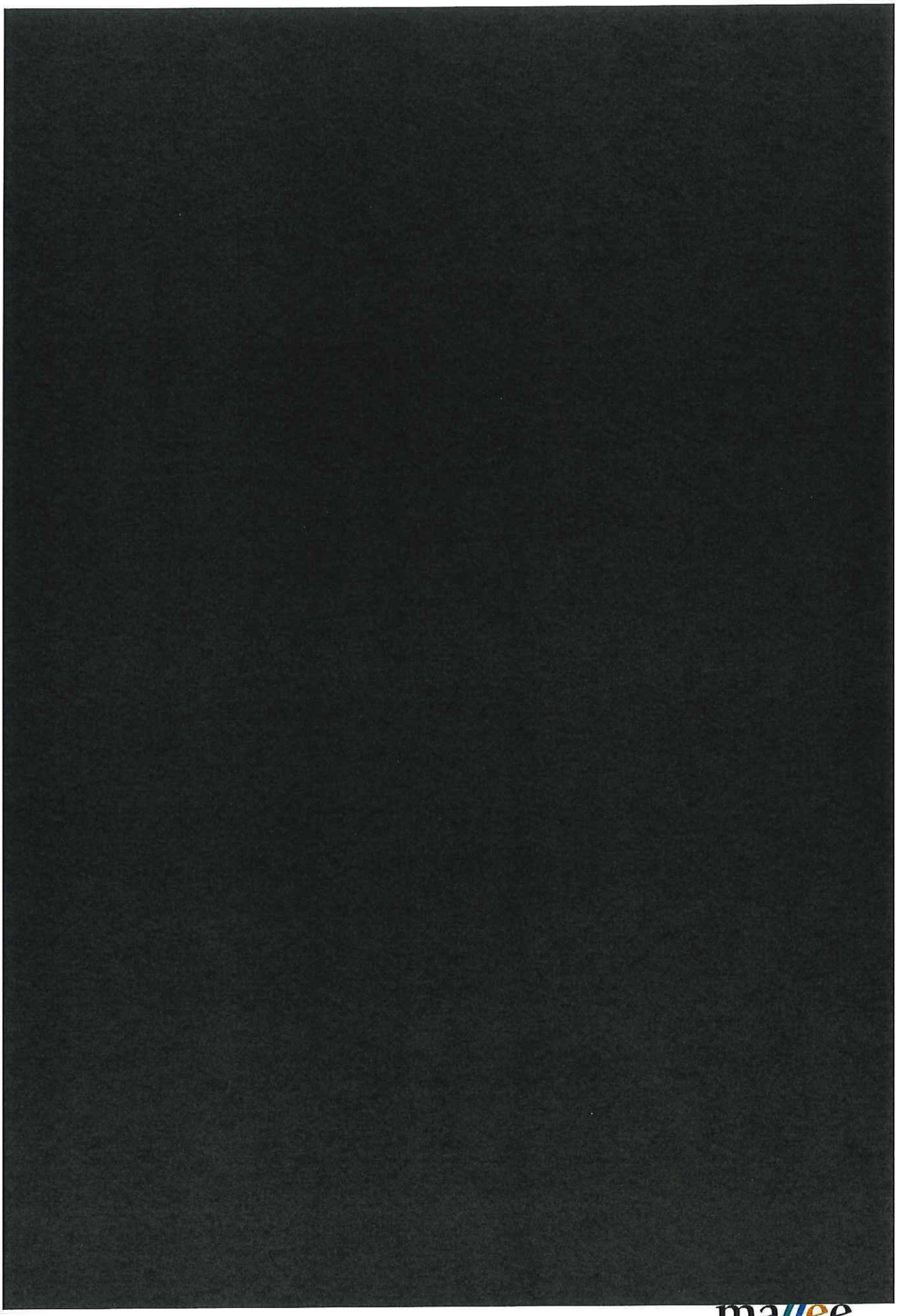
Contingencies form 44% percent of the total capital costs. This reflects the current level of development of designs and incorporates, but is not limited to, contingencies associated with geotechnical uncertainty. Risks associated with wet weather, flooding and delays associated with approvals in construction are costed separately.

Project implementation costs that are in scope for Commonwealth Supply or Constraint Measure Funding are summarised by project stage in Table 14-2. Only forward looking costs have been included (that is, costs already incurred are not included in the table). Note that Table 14-2 does not include funding to coordinate the delivery of the final package of works-based supply measures; this will be determined as part of negotiating an investment agreement for this project.

It is important to note:

- Costs incurred for monitoring related to verifying the performance and integrity of newly constructed infrastructure have been included as commissioning costs.
- Costs expressed in this document are present day values and investors will need to consider indexation and cost variations as appropriate.
- The costs presented here relate to the implementation of this project in isolation.

[redacted]



14.3. Operating and maintenance costs

A full estimate of ongoing costs can only be developed after this proposal is built into Basin-scale modelling of post-SDL adjustment operations and the likely frequency of operation estimated

Operating and maintenance costs for the project are summarised in Table 14-3. As the precise operating procedures of the project will be detailed subsequent to this business case, Table 14-3 outlines the operating costs as an average annual cost and maximum annual cost to reflect the environmental water delivery via temporary pumping.

Operation and maintenance are based on a 30 year timeframe and does not include asset renewal.

14.4. Projects seeking Commonwealth Supply or Constraint Measure Funding (funding sought and co-contributions)

Victoria will be seeking 100 per cent of project funding for this supply measure proposal from the Commonwealth. The funding requested will ensure the proposed supply measure is construction ready, built in accordance with all regulatory approval requirements and conditions, and fully commissioned once construction is completed. No co-contributions are provided for project capital costs.

14.5. Ownership of assets

To inform an eventual decision on proposed financial responsibility for ongoing asset ownership costs, and the preferred agency to undertake this role, DEPI convened a workshop with the key delivery partners for Victoria's proposed supply measures. Attendees at the workshop included representatives from:

- Mallee CMA
- North Central CMA
- DEPI
- Parks Victoria
- G-MW.

The workshop was convened as a theoretical scoping exercise to draw on pre-existing expertise to evaluate the set of criteria that an agency would need to possess in order to effectively own, operate and maintain an asset like this proposed supply measure. Key criteria evaluated included:

- Access to capability to perform the required functions, either directly or under contract
- Access to suitable resources which can be deployed in a timely, efficient manner
- Sufficient powers conferred under legislation to enable services to be provided
- Demonstrable benefit or linkage to primary business mission or activities
- Ability to collaborate and co-ordinate effectively with multiple parties
- Risks are allocated to those best placed to manage them.

Participants at the workshop were collectively of the view that while a number of Victorian agencies possessed many of the key criteria needed to perform this role, more information was needed before a conclusive decision could be made on which agency was overall the best fit. This included a more determinative sense of the full suite of adjustment measures that were likely to be agreed to across the Basin, and their spatial distribution, so that opportunities to capitalise on economies of scale could be more fully investigated.

On this basis, DEPI advises that the delegation of asset ownership and operation, including any associated proposed financial responsibility, cannot be formally ascertained at this time. Such decisions are generally whole-of-Victorian government, and sufficient information is not currently available to enable a formal position on this matter to be clarified.

In line with good financial practice, any long-term arrangements for asset ownership, operation and maintenance should maximise cost-efficiencies where they can be found. This includes options to 'package up' ongoing ownership, operation and maintenance where this is deemed the most cost-effective approach.

DEPI will be in a position to provide more formal advice on the state's preferred long-term arrangements for this supply measure once the full suite of Victorian proposals under the SDL adjustment mechanism has been more definitely scoped. This is anticipated to occur during the course of 2015, pending receipt of advice from the MDBA on likely adjustment outcomes.

14.6. Project benefits

The main benefit of this project (SDL adjustment) will be calculated after submission of this business case, and cannot be included in this document. However, the project will also produce additional significant environmental, social and economic benefits to the region, driven by the environmental improvement generated by the project. A study was commissioned into the quantifiable benefits of the project other than water savings (provided in Appendix F), which drew on a Total Economic Value (TEV) framework and involved the 'benefit transfer' method of transferring unit values from original studies in a similar context.

The quantified economic values produced by the project reflect the broader Victorian community's willingness to pay (WTP) for specific types of environmental improvement, as well as an estimate of the consumer surplus

associated with increased recreation produced by this environmental improvement. Specific benefits include (Aither, 2014):

- Improved healthy native vegetation: studies have shown that the Victorian community values improvements to the health of native vegetation, specifically River Murray red gum forests[5]. Values were applied to 238 hectares of the project area.
- Improved native fish populations: the same studies reveal a community WTP for improvement in native fish populations, calculated at an estimated 0.2% increase in native fish populations in the river produced by the project[6].
- Increased frequency of colonial water bird breeding: previous analysis reveals a community WTP for an increase in the frequency of water bird breeding in the River Murray ($12 per year per household)[7]. Under the assumption that site represents 0.2% of this River Murray value, a value for increased water bird breeding to the Victorian community was developed
- Increased recreation: Mallee CMA staff estimated that the Vinifera project was estimated to increase the net annual tourist visitor days to the site by 1,500 days[8]. Using previous studies that estimated the economic value of a visitor day ($134 per visitor day[9]), the economic value of an increase of 1,500 visitor days was estimated.

The economic value of these four[10] quantified economic benefits associated with the Vinifera project are presented in Table 14-4. The 'present value' estimates assume benefits start accruing in the year of commissioning (2020) and continue annually for the remaining years of the analysis timeframe (30 years). They are discounted to 2014 using a 7% discount rate.

[5] Bennett et al (2007) found that annual household willingness to pay for improvement to the health of 1000 hectares of river red gum forests was $3.90 for Bairnsdale households and $1.20 for Melbourne residents (local residents identified no willingness to pay for this improvement. We adjust these values with CPI from 2007 to 2014

[6] Bennett et al (2007) found that annual household value for this change was estimated at $0.97 per Melbourne household, $1.43 per 'rest of Victoria' household, and $1.00 per 'local region' household. We adjust these values with CPI from 2007 to 2014.

[7] We adjust this source value for CPI from 2011 to 2014. Please note that this was not undertaken in the Aither report.

[8] Some minor negative impacts in visitor numbers were expected during inundation events, but these were expected to be offset by significant increases in visitor numbers over time.

[9] We again account for CPI from the source study in 2007 to 2014.

[10] Please note that the value for changes to healthy native vegetation, native fish population and frequency of colonial water-bird breeding may constitute a 'double-count' of environmental value, depending upon how the CSIRO SDL Adjustment Ecological Elements Method is employed. How this method will be employed is unknown at the time of this business case submission.

Table 14-4: Economic benefits produced by the project ($2014) (Aither, 2014)

	Annual value ($M)	Present value ($M)[11]
Healthy native vegetation	$0.46	$4.1
Native fish population	$0.24	$2.2
Frequency of colonial water-bird breeding	$0.07	$0.66
Recreation	$0.24	$2.2
Total	**$1.02 million**	**$9.2 million**

A number of unquantified benefits are also identified for the project, namely:

- Cultural heritage: cultural heritage sites will be impacted by the project, including scar trees that depend on seasonal high river flows and natural inundation regimes, and are currently stressed The scarred trees may benefit from improved environmental conditions, while other cultural sites (e.g. hearths) may benefit from increased protection works undertaken through the Cultural Heritage Management Plan developed for this project.
- Apiarists: the beehives that currently exist at Nyah Vinifera Park depend on seasonal flowering of river red gum forests, which will increase in regularity and reliability due to the project. This should increase the number of hives at each site, and the number of active sites. This value is not quantified.

In terms of impacts on the local community of the project, Compelling Economics developed a REMPLAN input-output model of the Mildura-Wentworth region. Using this model, the impact of the proposed works at Vinifera can be estimated in terms of employment, output, wages and salary, and industry value added.

During the 12 month construction phase of the proposed works, the additional expenditure will result in $6.75 million of gross output and 16 jobs in the region. After this construction phase, the expenditure on operation and maintenance of $160,000 million per year would result in $292,000 in annual gross output and one additional job.

These numbers illustrate the regional benefits of the project but are not proposed to be included in the cost-benefit analysis.

[11] $2014, discount rate of 7% over 30 years. Please note that the 'present value' estimates in the Aither document differ from numbers reported here, as Aither estimated 30 years of benefit whereas in this project benefits commence in the fourth year of the 30 year analysis period, producing only 26 years of benefit.

15. Stakeholder management strategy (Section 4.11.1)

The Mallee CMA has worked with key stakeholders and interested community groups to develop the concept for the *Vinifera Floodplain Management Project* over an extended period of time from 2012 to 2014. Engagement via formal and informal methods has directly informed this project and helped contribute to its development. Communication and engagement activities conducted throughout the Business Case phase have included:

- More than 110 face-to-face briefing sessions, meetings, presentations and on-site visits, engaging more than 635 people, which is reflective of the wide range of project stakeholders and population density surrounding the project site
- Fact sheets, media releases, electronic communication (website, emails, newsletters), brochures and correspondence.

This direct approach to engagement has helped ensure the views and local knowledge of key stakeholders and community members have been directly integrated into the project, resulting in broad community support for the proposed works at Vinifera, as evidenced by the receipt of letters of support from:

- Materially-affected land managers such as Parks Victoria
- Aboriginal stakeholders
- Adjacent private landholders
- Regional Development Australia and Regional Development Victoria – Loddon Mallee
- Local government (Swan Hill Rural City Council)
- Community groups and organisations.

Broad community support for this proposed project is further evidenced by the sustained interest in the proposal as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates. A full list of the letters of support received for this project are listed in Appendix G.

15.1. Communication and Engagement Strategy

A detailed Communication and Engagement Strategy has been developed for this project and key stakeholders identified. This strategy has helped to ensure those who are materially affected by the project and the broader community have been consulted and their views adequately considered and responded to by the Mallee CMA (RMCG, 2014).

This strategy reflects the intent of the *Principles to be applied in environmental watering* outlined in the Basin Plan (MDBA, 2012a), aligns with the directions of the Victorian Government's Environmental Partnerships policy (Victorian Government, 2012) and is consistent with the principles of the Community Engagement and Partnerships Framework for Victoria's Catchment Management Authorities (Community Engagement and Partnership Working Group 2012) (RMCG, 2014).

The Communication and Engagement Strategy includes:

- Identification of key stakeholders of the Burra Creek project
- Detailed analysis of the stakeholders, which have been divided into three groups according to their level of interest in and influence on the project
- Analysis of stakeholders' issues and sensitivities
- Clearly articulated objectives and engagement approaches designed to meet the needs of different stakeholder groups
- Communication and engagement activities for both the Business Case and implementation phases of the project.

An overview of the Vinifera Floodplain Communications and Engagement Strategy and the outcomes from the Business Case phase is provided in the following sections. The full Strategy is provided in Appendix H.

15.2. Identification of key stakeholders and engagement approaches

Stakeholders have been characterised into three groups relating to their interest and influence on the project outcomes. Relative to each other, Stakeholder Group 1 has the highest level of interest in and influence on the project outcomes, Stakeholder Group 2 has a moderate level of interest in and influence on the project outcomes and Stakeholder Group 3 has a lower level of interest in and influence on the project outcomes (RMCG, 2014).

Stakeholder Group 1 has been further defined into two key types; project partners and project stakeholders. Project partners are differentiated from project stakeholders for the purposes of defining appropriate communication and engagement approaches as they have a direct role in the design and development of the project (i.e. as investors, land managers, construction or operational managers) (RMCG, 2014).

The engagement approach for Stakeholder Group 1 can be described as high intensity, targeted and tailored to the needs of each individual stakeholder. On the iap2 public participation spectrum, the aim of the engagement approach for project partners is to COLLABORATE in the planning, construction and operation phases of the Vinifera project. For project stakeholders, the aim is to INVOLVE stakeholders in all phases of the Vinifera project (RMCG, 2014).

The engagement approach for Stakeholder Group 2 is of moderate intensity, targeted and more generic in nature in comparison to Stakeholder Group 1. On the iap2 public participation spectrum, the aim of the engagement approach for Stakeholder Group 2 is to CONSULT stakeholders on the planning, construction and operation phases of the Vinifera project (RMCG, 2014).

The engagement approach for Stakeholder Group 3 is of lower intensity, publicly accessible and generic in nature. On the iap2 public participation spectrum, the aim of the engagement approach for Stakeholder Group 3 is to INFORM stakeholders on the planning, construction and operation phases of the Vinifera project.

Table 15-1 provides a list of stakeholders and a summary of the issues and sensitivities of each of the three Stakeholder Groups (RMCG, 2014).

Table 15-1: Stakeholders of the Vinifera Floodplain Management Project and summary of issues and sensitivities

Stakeholder group	Stakeholder	Summary of issues and sensitivities
Group 1a: Project partners	DEPI Parks Victoria MDBA G-MW	Land inundation Restoring the natural ecology Consistency with Basin Plan Environmental water responsibilities Managing impacts of works on visitors and recreation Responsibility for construction/operations Impacts of water volume on river flow Appropriate infrastructure to maximise the impact of environmental watering Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture
Group 1b: Project stakeholders	**Indigenous community:** Wadi Wadi Elders. Adjacent freehold landholders. **Local community**: townships Nyah, Nyah West, Vinifera and Swan Hill. **Mallee CMA Community Committees:** Land and Water Advisory Committee (LWAC), Aboriginal Reference Group (ARG), The Living Murray Community Reference Group (CRG) (Hattah Lakes and Lindsay-Wallpolla Icon Sites). **Local Government:** Swan Hill Rural City Council. Commonwealth Environmental Water Holder (CEWH). Victorian Environmental Water Holders (VEWH).	Impact to cultural heritage and indigenous values Future environmental health of country Land inundation Restoring the natural ecology Continuity and quality of irrigation water supply Local knowledge, history and a sense of ownership of the areas involved Impact to local amenity, recreation, economy and environment Impacts of water volume on river flow Appropriate infrastructure to maximise the impact of environmental watering Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture Ensuring that proposed activities and outcomes are acceptable to the wider community Consistency with planning scheme

Stakeholder group	Stakeholder	Summary of issues and sensitivities
Group 2	**Other environmental organisations:** Murray-Darling Freshwater Research Centre, Murray Darling Association, Environment Victoria, Australian Conservation Foundation, Lower Murray Water. **Community-based environment groups:** Nyah West Landcare Group, Birdlife Australia (Mildura Branch), River Watch, Sunraysia Field Naturalists Club, Sporting Shooters Association of Australia (Nhill), Murray-Darling Wetlands Working Group, Victorian National Parks Association. **Indigenous organisations/groups:** North West Native Title Claimants, Murray Lower Darling Rivers Indigenous Nations (MLDRIN), Swan Hill and District Aboriginal Cooperative, Wadi-Wamba-Berapa Native Title Group. **Other community groups/businesses:** Regional Development Australia and Regional Development Victoria – Loddon Mallee, 4WD clubs, angling clubs, tourism businesses, license holders (firewood, bee keeping, fishing), Rotary, Probus, Progress associations, CWA, Lions. **Park users/visitors:** Nyah Vinifera Park.	Impact to local amenity, recreation, economy and environment Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture
Group 3	**Wider community:** Mallee region, Victoria, Murray Darling Basin	As above

15.3. Communication and engagement approaches and outcomes from the Business Case phase

The overall response to engagement activities undertaken to date has been positive. Engagement activities were tailored to the stakeholder's interest in the project and provided the opportunity to identify issues/sensitivities and reach agreed outcomes.

For all communication and engagement activities completed through the Business Case phase, Mallee CMA has kept a detailed record of:

- Who has been consulted and the outcomes
- How consultation outcomes have been considered and responded to by the Mallee CMA
- The extent of stakeholder and community support for the project.

The outcomes of consultation undertaken during the business case phase will directly inform the communication and engagement strategy for the implementation phase of this project.

An overview of the communication and engagement approaches and main outcomes from the consultation by stakeholder group is provided in Table 15-2.

A more detailed analysis of the approaches is provided in the Vinifera Communication and Engagement Strategy (Appendix H: Section 3-4, pp. 9-25).

Table 15-2: Summary of consultation outcomes from the Business Case phase

Stakeholder group	Communication/engagement approach	Focus of consultation	Summary of consultation outcomes (Mallee CMA response)	Evidence of support for the project
Group 1: Project partners	Intensive engagement through: Sustainable Diversion Limits Offset Projects Steering Committee: Hattah -Vinifera meetings (monthly) Design team meetings Negotiations regarding roles and responsibilities One-on-one discussions as required.	Siting of proposed infrastructure Design parameters of proposed infrastructure Downstream water quality impacts Adjustments/clarifications to technical information and/or presentation of information in business case Monitoring and management of salinity and turbidity during operation of proposed infrastructure.	Adjusted structure location to reflect stakeholder advice Designs developed in accordance with stakeholder preferences/requirements Operational scenarios for proposed infrastructure investigated to minimise water quality impacts Business case adjusted in accordance with feedback received Salinity investigations undertaken, monitoring and management strategies considered Planned ongoing engagement with project partners.	Letters of support for the project from partner agencies such as Parks Victoria and Goulburn-Murray Water Sustained, consistent high-level involvement in project development throughout business case phase.
Group 1: Project stakeholders	Small group (face-to-face) briefing sessions with Mallee CMA, including on-site visits Face-to-face engagement and on-site visits with Aboriginal stakeholders Presentations conducted by Mallee CMA.	Inundation of private land Minimisation of harm to sites of cultural heritage, in line with legislative requirements Monitoring and management of salinity and turbidity during operation of proposed infrastructure.	Specific control mechanisms included in project proposal to include/exclude private land inundation in line with stakeholder preference Works proposed for existing tracks/disturbed areas where possible to minimise harm to sites of cultural heritage Preliminary cultural heritage assessment completed to inform project development Salinity investigations undertaken, monitoring and management strategies considered Planned ongoing engagement with project stakeholders.	Letters of support from Aboriginal stakeholders, adjacent freehold landholders, Mallee CMA community committees and local government (Swan Hill Rural City Council) On-going discussions/preliminary approval processes completed with Swan Hill Rural City Council, resulting in a strong working relationship. Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.

Stakeholder group	Communication/engagement approach	Focus of consultation	Summary of consultation outcomes (Mallee CMA response)	Evidence of support for the project
Group 2	Teleconference briefing sessions with Mallee CMA staff Presentations conducted by Mallee CMA staff.	Social (e.g. public access) and economic (e.g. financial investment in region) challenges/opportunities Impact on apiary operations.	Operational scenarios for proposed infrastructure investigated to minimise restrictions to public access. Clear and accessible information provided regarding proposed project Consideration of apiary requirements in planning operation of infrastructure Planned ongoing engagement with project stakeholders.	Letters of support from tourism operators, as well as key organisations and community groups such as Regional Development Australia and Regional Development Victoria – Loddon Mallee, Sunraysia Branch Victorian Apiarists Association and Riverwatch. Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.
Group 3	Information accessed through the Mallee CMA website	Impacts on water quality during operation of proposed infrastructure.	Operational scenarios for proposed infrastructure investigated to minimise water quality impacts. Planned ongoing engagement with project stakeholders	Letters of support Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.
All stakeholders	Information package accessed on the Mallee CMA website (fact sheets, case studies, photos, contact information) Project up-dates	As above	As above	Letters of support Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.

15.4. Proposed consultation approaches for the implementation phase

A proposed communication and engagement strategy has also been prepared for each Stakeholder Group for the implementation phase of the Vinifera project. This strategy has been directly informed by the outcomes of the consultation activities undertaken during the business case phase of the project.

An overview of the planned communication and engagement approaches is provided in Table 15-3. A more detailed analysis of the approaches, including key constraints is provided in the Vinifera Communication and Engagement Strategy (Appendix H: Section 3-4, pp. 9-25).

A large effort has been invested in the communication and engagement activities in order to develop broad community support for the Vinifera project. The project has high visibility among materially affected and adjacent landholders/managers, along with Aboriginal stakeholders and other interested parties, ensuring the advice and concerns of those involved have been considered and responded to accordingly. This strong commitment to working directly with project partners and the community will be ongoing throughout the construction and implementation phases of the project, further cementing community support for the Vinifera project and ensuring it will continue to be a successful project.

Table 15-3: Communication and engagement strategy for the implementation phase

Stakeholder group	Engagement approach	iap2 level of engagement	Number / timing
Group 1: Project partners	Intensive engagement throughout project planning and development including design and construction meetings, on-site visits and other engagement methods as relevant	Collaborate	Ongoing
Group 1: Project stakeholders	Tailored events (e.g. site tours, funding announcement, commencement of construction)	Involve	Funding announcement/commencement of construction Site tours as required
Group 2	Teleconference briefing sessions with Mallee CMA staff Presentations conducted by Mallee CMA staff	Consult	Ongoing as required Throughout implementation phase
Group 3	Videos accessed through the Mallee CMA website	Inform	Accessible throughout implementation phase
	Information package accessed on the Mallee CMA website (fact sheets, case studies, photos, contact information)		As soon as possible after funding is confirmed Updated and accessible throughout implementation phase
All stakeholders	Project up-dates accessed through the Mallee CMA website and social media channels (e.g. e-newsletter, Twitter and other social media) Media communication (e.g. media releases, newspaper articles, radio interviews, television interviews)	Inform	Regularly throughout implementation phase As required throughout construction and operation One media release associated with each watering event

16. Legal and regulatory requirements (Section 4.11.2)

Obtaining statutory approvals is an essential consideration for the *Vinifera Floodplain Management Project*.

The process of obtaining the necessary approvals can be complex and can present risks to the timeline, budget and delivery of the project.

Early identification of statutory approvals required, background investigations required to complete the approvals, interdependencies between approvals as well as timeframes associated with both the preparation and assessment/consideration of submissions have been identified as important elements critical to the timely delivery of environmental watering projects (Golsworthy, 2014).

In order to guide the approvals process, DEPI and the Mallee CMA commissioned management strategies to guide the approvals process (GHD, 2014a, Golsworthy 2014). The strategies provide a clear understanding of the current relevant legislation as well as the approvals required, based on the type and location of planned works, the cultural heritage, flora and fauna values present within the works footprint, and the past experience of the Mallee CMA and partner agencies in completing approvals for large, infrastructure-based projects within National Parks.

16.1. Regulatory approvals

GHD (2014a, Appendix I) and Golsworthy (2014, Appendix J) have identified the approvals, permits and licences likely to be required prior to the commencement of construction. An assessment of relevant issues based on the proposed construction footprint at Vinifera has indicated the need to obtain several approvals under local government, State and Commonwealth legislation.

Approvals *refers to all environmental and planning consents, endorsements and agreements required from Government agencies by legislative or other statutory obligations to conduct works (GHD, 2014a).*

The approvals required for Vinifera Floodplain are listed in Table 16-1.

Table 16-1: Regulatory approvals anticipated for Vinifera Floodplain (GHD, 2014a)

Approvals required	Description
Commonwealth legislation	
Environmental Protection & Biodiversity Conservation Act 1999 Referral	A number of potentially affected "matters of national environmental significance" (MNES) are present at Vinifera Floodplain: • Upstream from NSW Central Murray State Forests, Banrock, Coorong and Riverland Ramsar sites • 14 migratory waterbird species use the site • 19 nationally threatened species and 4 threatened ecological communities.
Victorian legislation	
Environmental Effects Act 1978 Referral	Relevant to one of the six referral criteria for individual potential effects (i.e. potential extensive or major effects on the health or biodiversity of aquatic, estuarine or marine ecosystems, over the long term).
Planning & Environment Act 1987 Planning permit Public Land Managers Consent	Applicant to request permission from public land manager to apply for a planning permit for works on public land A planning permit application is then submitted with supporting documentation: likely to include an offset strategy and threatened species management plan Local Council refers applications and plans to appropriate authorities for advice

Approvals required	Description
Aboriginal Heritage Act 2006 Cultural Heritage Management Plan	A CHMP is required when a listed high impact activity will cause significant ground disturbance and is in an area of cultural heritage sensitivity as defined by the Aboriginal Heritage Regulations 2007 (Part 2, Division 5): Relevant high impact activities relates to: (xxiii) a utility installation, other than a telecommunications facility, if the works are a linear project with a length exceeding 100 metres (other than the construction of an overhead power line or a pipeline with a pipe diameter not exceeding 150 millimetres). To be prepared by an approved Cultural Heritage Advisor
Water Act 1989 Works on waterways permit	Application for a licence to construct and operate works on a waterway.
National Parks Act 1975 Section 27 consent	Approval for a public authority to carry out its functions in a national park.
Flora & Fauna Guarantee Act 1988 Protected flora licence or permit	Application for approval to remove protected flora within public land for non-commercial purposes. Will need to include targeted surveys for threatened/protected species considered likely to be present at the site and impacted by proposed works.

The following supporting documents will be required and likely to be requested through referral decisions on planning permit conditions (GHD, 2014a):

- An offset strategy for native vegetation losses
- An environmental management framework
- A threatened species management plan
- A cultural heritage management plan.

The application process for each approval, the responsible agency, timing of submissions and timeframe for decisions are outlined in the Regulatory Approvals Strategy (GHD, 2014a). The Strategy includes an indicative program for effecting regulatory approvals that predicts a minimum 31-week period to obtain all required approvals. This timeframe assumes that an Environmental Effects Statement is not required, all applications (including supporting documentation) are already prepared and that there are no significant delays during the assessment process. The Strategy also notes that there are a number of linkages and dependencies between approvals, where for example, some approvals cannot be issued until another is approved e.g. a planning permit cannot be granted until there is an approved CHMP.

A Regulatory Governance Group (RGG) is supporting the delivery of business case requirements related to regulatory approvals by providing a mechanism for high-level engagement with responsible agencies at an early stage to streamline the regulatory approvals process. The RGG provides advice to the Project Control Board (PCB) regarding the regulatory approvals needed for Victorian projects, the resolution of associated issues and develop a program-level strategy to obtain approvals.

16.2. Legislative and policy amendments and inter-jurisdictional agreements

At the state level, a legislative change may be needed to address the requirement to secure native vegetation offsets prior to clearing. As the primary offsetting mechanism is expected to be the gains in vegetation condition within the areas watered by the various Victorian works-based supply measures, i.e. the outcomes of the measures once operational, this requirement cannot be met. DEPI will investigate a suite of options to

address this issue during the detailed design for this measure, including the potential for a planning scheme amendment. Note that the other options to be investigated do not require legislative changes.

Matters related to other regulatory approvals necessary for the implementation of this supply measure are discussed elsewhere in this Business Case.

No other amendments to state legislation or policy are anticipated. This includes any formal amendments to state water sharing frameworks, or river operations rules or practices.

Further to this, no changes to the Murray-Darling Basin Agreement 2008 are required to implement this measure, nor do any new agreements need to be created either with other jurisdictions or water holders in the Basin.

16.3. Cultural heritage assessment

An Aboriginal due diligence assessment of proposed structure locations has been prepared for the site (Grinter et al, 2014) Appendix K. A desktop analysis indicated that there are two sites of Aboriginal significance within 100m of proposed structures for the Vinifera site (noting that there are many more Aboriginal places within the vicinity of the site). Field inspections identified two previously unrecorded sites comprising ring trees near the main raised track structure. Under the Aboriginal Heritage Act 2006 the Nyah-Vinifera area (including the Vinifera site floodplain) is specified as an area of cultural heritage sensitivity in accordance with several categories and a Cultural Heritage Management Plan will need to be developed prior to commencement of works.

17. Governance and project management (Section 4.11.3)

Appropriate governance and project management arrangements have been put in place to minimise risks to investors and other parties from the proposed supply measure. The sections below describe the governance arrangements during business case development and proposed arrangements during project implementation.

17.1. Governance arrangements during business case development

A Project Control Board (PCB) was convened by DEPI to oversee the development of business cases for the nine Victorian works-based supply measures. The PCB is comprised of senior executives from DEPI, the Mallee and North Central CMAs, G-MW and Parks Victoria. This has ensured high level engagement of responsible agencies and has assisted in identifying and resolving program-level issues during development of business cases. The PCB's role has been to ensure that:

- All business cases meet the requirements set out in the Phase 2 Guidelines (reference);
- All business cases are of a high and consistent standard, and delivered within specified timelines;
- The technical basis of each business case is robust, credible and fit for purpose; and
- That appropriate consultation with stakeholder agencies, affected persons and the community was carried out during business case development.

The PCB has been supported by an Expert Review Panel and Regulatory Governance Group, and project-specific governance arrangements set up by the North Central and Mallee CMAs (see Figure 17-1).

The *Vinifera Floodplain Management Project* business case has been endorsed by the PCB as part of the final package of Victorian business cases to be submitted for assessment under Phase 2 of the SDL adjustment mechanism.

Expert Review Panel

An Expert Review Panel ('the Panel') was set up to examine the critical elements of each business case at key stages and assess quality, credibility and whether the element is fit for purpose. The Panel was chaired by David Dole and comprised of experts in engineering (including geotechnical, structural, hydraulic and water system operations), hydrology and ecology. Its members include:

- Phillip Cummins (engineering)
- Shane McGrath (engineering)
- Dr Chris Gippel (hydrology)
- Andrew Telfer (salinity)
- Professor Terry Hillman (ecology).

The following evaluations were carried out during the development of this business case:

- Engineering: Review of concept engineering designs (hydraulics and structures), the scoping of geotechnical investigations to support water management structure design and construction costs
- Hydrology: Review of hydrodynamic and hydrological models, data, modelled scenarios and outputs
- Salinity: review of assessments of potential salinity impacts of works and measures projects
- Ecology: Review of the descriptions of ecological values, the ecological objectives and targets, and environmental water requirements, and the descriptions of anticipated ecological outcomes and environmental water requirements.

The expert review process has led to the conclusion that the underlying feasibility and outcome investigations have provided soundly based proposals which are fit for purpose (see Appendix L).

Regulatory Governance Group

The Regulatory Governance Group (RGG) was established to support the delivery of business case requirements related to regulatory approvals. The RGG was comprised of relevant staff from Victorian approvals agencies, including DEPI, Parks Victoria and Aboriginal Affairs Victoria. The RGG provided advice to the PCB regarding the regulatory approvals needed for Victorian projects, the resolution of associated issues and develop a program-level strategy to obtain approvals (Appendix I).

Setting up the RGG has provided a mechanism for high-level engagement with responsible agencies at an early stage to streamline the regulatory approvals process for proposed supply measures. While the RGG ceased operation when all business cases were finalised for submission (December 2014), the Group may be reconvened by the PCB as required.

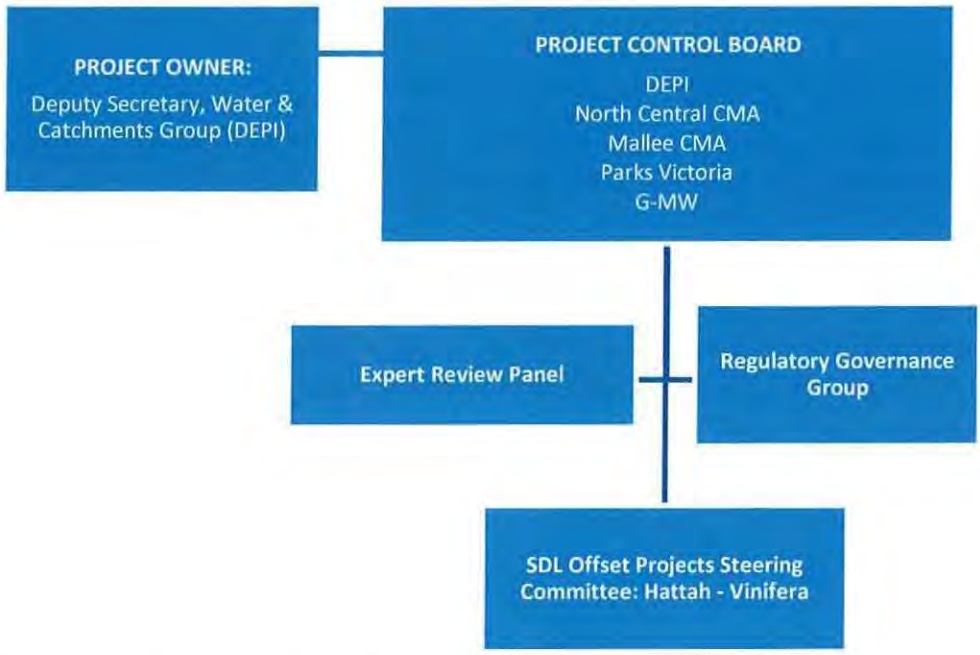


Figure 17-1: Governance arrangements during business case development.

SDL Offset Projects Steering Committee: Hattah - Vinifera

At the project level, development of the business case for the *Vinifera Floodplain Management Project* was overseen by the SDL Offset Projects (Hattah- Vinifera) Steering Committee (Mallee CMA, 2014a). The committee's role was to ensure the business cases developed for these sites are of a high quality, consistent standard, and that they meet the requirements of the Commonwealth (Mallee CMA, 2014a).

Specifically the committee was responsible for the following functions in the development and delivery of the relevant SDL project business cases (Mallee CMA, 2014a):

- Provision of advice on the development and proposed delivery of SDL projects from a technical perspective
- Ensuring projects developed and the supporting business cases produced are technically rigorous and sound
- Providing guidance to resolve project-specific issues
- Monitoring the development of business cases to ensure a consistent approach and that required information is provided, in accordance with the Phase 2 Guidelines for Supply and Constraint Measure Business Cases provided by the Commonwealth
- Providing advice on project procurement from a technical perspective.

The committee was comprised of the following members (Mallee CMA, 2014a):

- Chief Executive Officer, Mallee CMA
- The Living Murray Coordinator, Mallee CMA
- Manager Water, Mallee CMA
- Parks Victoria representative/s (land manager representative)
- Department of Environment and Primary Industries (DEPI) representative/s (land manager representative and coordinator of regional environmental advice and approvals)
- G-MW representative/s
- SA Water representative/s
- MDBA representative/s.

The Steering Committee met monthly, with extraordinary meetings scheduled as necessary. The committee ceased operation when all business cases were finalised for submission (December 2014) (Mallee CMA, 2014a).

17.2. Governance arrangements during project implementation

To ensure that this proposed supply measure is delivered on time, arrangements will be put in place that ensure appropriate senior oversight of project governance and delivery. This will allow for the successful completion and operation of the measure as part of the SDL adjustment mechanism.

These arrangements will be predominantly based around those that were used to deliver the four TLM Environmental Works and Measures Program (EWMP) projects within Victoria, complemented by existing state government frameworks, which together will underpin a set of robust and thorough processes for procurement and project management. Key aspects of the proposed governance and project management for this supply measure will include:

Project management structure and team

The project management structure and team will be overseen by the project owner, currently anticipated to be DEPI. In line with the governance arrangements that have underpinned the Business Case preparation for this proposed supply measure, DEPI will be supported by a PCB, comprised of senior executives from DEPI, the relevant Victorian CMAs, the relevant constructing authorities (e.g. G-MW; SA Water), Parks Victoria and the Commonwealth.

It is expected that the PCB will be comprised of appropriate senior management representation from each of the participating agencies, who will have the required decision-making authority to oversee all elements of implementation. In line with the successful governance arrangements that were utilised during the EWMP and the outcomes of the workshop on ongoing asset management arrangements (see Section 14.5), the relevant constructing authority would be well placed to undertake the construction of the supply measure, supported by the relevant CMA.

Procurement strategy

As the primary delivery agency, the relevant constructing authority would be expected to manage procurement during the construction of the supply measure, operating under the high-level oversight of the PCB. Supporting this, the relevant CMA will play a critical role by assisting in the development of a procurement strategy, which would be approved by the PCB. More specific details of the preferred approach for procurement will be detailed in the construction proposal.

Project Steering Committees or related governance mechanisms

In line with good governance practice, and again drawing on the experience of the Living Murray, it is expected that the PCB would meet regularly throughout the construction of this proposed supply measure to ensure that milestones and timelines are met, and to resolve any potential arising issues.

As noted above, it is expected that PCB members would have the required decision-making authority to address any emerging risks, including the following:

- Identifying and resolving issues, including those that might impact timelines/budget
- Providing guidance to resolve project-specific issues
- Ensuring appropriate consultation with key stakeholder agencies and the community
- Closely monitoring implementation to ensure timelines and budgets are met, and
- Making recommendations to DEPI on any issues that may arise during construction.

Monitoring and reporting during implementation

It is anticipated that the PCB would be the key conduit for monitoring and reporting during the implementation of this proposed supply measure. This would include:

- The relevant constructing authority providing regular implementation updates at each PCB meeting, and
- Consideration of any milestone or payment reporting that is likely to be required under all contractual funding arrangements associated with this supply measure.

Design and implementation plan with timelines

As noted, the PCB will meet regularly throughout the construction phase of this proposed supply measure to ensure milestones and timelines are met, to review designs, and to resolve any arising issues. The relevant CMA will play a critical supporting role by assisting the constructing authority with statutory approvals and the development of the construction proposal, as well as managing discrete projects to support detailed designs and the implementation/construction of the supply measure.

A detailed work plan will document the key tasks and the agency responsible, associated resources and timelines for the implementation of the supply measure.

Refer to Table 3-2 for a proposed project delivery schedule outlining timelines for the implementation of this project.

Operations Group

An Operations Group will be established to assist and advise on the commissioning and operation of this proposed supply measure. This Group will provide a forum to involve project partners in the decision-making process, to consider broader system operations (e.g. of the River Murray and other environmental watering events) during planning and operations, and to inform stakeholders of operations and progress.

For the Vinifera site, the Operations Group membership will consist of partners and stakeholders, including the MDBA, DEPI, G-MW, Lower Murray Water, Parks Victoria, the Commonwealth Environmental Water Holder and the Victorian Environmental Water Holder. Other agencies and organisations may be invited to participate as guests or observers.

The key responsibilities of the Operations Group will be to ensure the necessary planning, monitoring, communication and reporting arrangements are established prior to and during events and to identify and monitor any event risks or issues. This allows for safe and effective operation of the works, real time response and adaptive management when necessary.

17.3. Governance expertise of partner agencies

Implementation of the project at Vinifera will be a partnership between four agencies: Mallee CMA, DEPI, Parks Victoria and G-MW.

Mallee CMA

The primary responsibility of the Mallee CMA is to ensure that natural resources in the region are managed in an integrated and ecologically sustainable way. The Mallee CMA's work is based on rigorous science and delivered through meaningful partnerships with government agencies, industry, environmental organisations, private land managers, Indigenous stakeholders and the broader community. All delivery arrangements are formalised through a range of mechanisms including operating agreements, service level agreements and landholder incentive / tender management agreements, the application of comprehensive MERI frameworks; and the application and interpretation of complex spatial data.

The Mallee CMA have a proven track record in successfully delivering a vast range of environmental projects which have varied in complexity, monetary value (up to multi-million dollar projects); and in spatial extent (from concentrated focal points to landscape scale programs).

Operating within policies and controls approved and overseen by the Mallee CMA Board ensures transparent and accountable governance systems that embody performance and continuous improvement. These governance arrangements include a quality management approach to project management, with policies and procedures for project management, contractual arrangements, procurement and risk management.

Department of Environment and Primary Industries

The primary responsibility of DEPI in regard to this project is to act as its sponsor through the project assessment process established by the Intergovernmental Agreement on Murray-Darling Basin Water Reform 2014 (IGA). As part of this process, DEPI will represent the State of Victoria in negotiations with Commonwealth Government agencies to secure funding for the project, consistent with the commitments and arrangements outlined in the above mentioned IGA.

Once a funding agreement is reached for this project, DEPI will then assume an oversight role for the rollout of the project consistent with the terms of the funding agreement. As indicated previously, this oversight will be applied through the establishment of a PCB for the purposes of this project and any others that secure Commonwealth Government funding. It is envisaged that this PCB will be chaired and operated by DEPI. Its primary focus will be to ensure that milestones and timelines are met and where necessary, to resolve any emerging issues that present a material risk to the conduct and/or completion of this project.

Over the past decade, DEPI has had considerable experience in undertaking such oversight roles to a high standard for major Commonwealth funded water infrastructure projects in Victoria. Notable examples in this regard include the Living Murray Environmental Works and Measures projects at Gunbower, Hattah Lakes, Mulcra and Lindsay Islands, the G-MW Connections Program and the Lake Mokoan project.

Parks Victoria

Parks Victoria is a statutory authority, created by the *Parks Victoria Act 1998* and reporting to the Minister for Environment and Climate Change. Parks Victoria is responsible for managing an expanding and diverse estate covering more than 4 million hectares, or about 17 per cent, of Victoria.

Parks Victoria is committed to delivering works on the ground across Victoria's park network to protect and enhance park values. Parks Victoria's primary responsibility to ensure parks are healthy and resilient for current and future generations and manage parks in the context of their surrounding landscape and in partnership with Traditional Owners.

Parks Victoria works in partnership with other government and non-government organisations and community groups such as the Department of Environment and Primary Industries, catchment management authorities, private land owners, friends groups, volunteers, licensed tour operators, lessees, research institutes and the broader community.

Health Parks Healthy People is at the core of everything Parks Victoria does. Parks and nature are an important part of improving and maintaining health, both for individuals and the community. Parks Victoria has a clear role to play in connecting people and communities with parks.

Goulburn-Murray Water

G-MW provides rural water and drainage services in northern Victoria and is also the Victorian State Constructing Authority (SCA) for the MDBA. G-MW is the Victorian Murray Resource Manager, with responsibilities for water accounting and liaison with MDBA on planned and actual Victorian diversion operations. G-MW manages $4 billion of its own assets and a further $2 billion of MDBA assets to fulfil its functions. As SCA, G-MW was the delivery authority for the Hattah and Gunbower Living Murray Projects in Victoria. G-MW has the asset management and design and construction policies and controls in place to delivery against a large capital works program. These policies and controls will direct G-MW's activities for the delivery of each of the SDL Offset projects.

18. Risk assessment of project development and construction (Section 4.11.4)

A number of threats to successful project delivery were identified, as described in Table 18-1. The risk assessment process was informed by the past experience of the project team in the development and construction of environmental watering projects of similar scale and complexity, including TLM.

18.1. Risk assessment methodology

The risk assessment for the Lindsay Island project was completed in line with the requirements of AS/NZS ISO 31000:2009 (Lloyd Environmental, 2014). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and prioritised mitigation strategies and measures.

Refer to Section 7, Tables 7-1 to 7-4 to view the risk matrix and definitions used in this risk assessment, and further details on the methodology.

The risk assessment was consolidated as the project developed and additional information incorporated into Table 18-1.

18.2. Risk assessment outcomes

Table 18-1 presents a summary of the assessment and subsequent work undertaken, including mitigation measures developed and an assessment of residual risks after these are applied. It should be noted that where a residual risk is given a range of ratings, the highest risk category is listed.

Table 18-1: Risk assessment – Potential impacts to project delivery without mitigation and residual risk rating with mitigation

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Unexpected delays in obtaining statutory approvals	The high environmental and cultural values of the Vinifera Floodplain may result in a lengthy regulatory approvals process, due to requests for additional information to clarify the potential impacts and proposed mitigation measures. Numerous conditions could also be placed on permits and approvals to ensure appropriate controls are in place during construction to minimise impacts.	Certain	Moderate	High	General: • CEMP developed and implemented; monitoring during construction to ensure compliance. • Site-based approvals group convened to engage with the relevant regulatory authorities • Project delivery timelines informed by Regulatory Approvals Strategy to minimise unexpected delays. Cultural heritage: • Preliminary assessment to inform structure design and location • A CHMP will be developed in consultation with Indigenous stakeholders and implemented during construction to minimise impacts on cultural values.	Low
Delays to construction planning and completion	Time and cost overruns could occur if the time required to obtain all necessary approvals is not embedded in the project planning and delivery timeframe.	Certain	Moderate	High	As above, and: Maintain strong working relationships with partner agencies (including agencies in NSW, SA and Victoria) through regular design and construction group meetings. Incorporate potential for delays into contractual arrangements.	Low
Weather related delays	Adverse weather (such as storms, heat waves) may create short-term delays to works through limitations to site access due to poor track conditions, OH&S and fire safety considerations.	Certain	Moderate	High	Consider weather conditions and medium to long-term forecasts when sequencing site works to minimise impacts and inform program scheduling to accommodate extreme weather events. Incorporate potential for delays into contractual arrangements, including appropriate terminology and clauses to ensure the principal and client are not put at undue risk for natural events.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Floods	Natural floods may inundate the site and restrict access during construction, leading to cost increases and delays. These issues may be compounded by local weather conditions preventing demobilisation at the site.	Possible	Severe	High	Physically managing flows, as far as practical, through river operations. Utilise long-range weather forecasts, flow forecasts and general flow data (travel time, historical/predictive flows) to provide advance warning of floods to ensure sufficient lead time for demobilisation. Maintain strong working relationships with partner agencies (including agencies in NSW, SA and Victoria) through regular design and construction group meetings to assist timely issue resolution. Incorporate potential for delays into contractual arrangements, including appropriate terminology and clauses to ensure the principal and client are not put at undue risk for natural events. Contingency planning for inundation events. Obtain insurance covering inundation events.	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Fire	Equipment that can create sparks, such as angle grinders and welding equipment, can cause fires that threaten worker safety and require site evacuation. Bushfires (other causes) can have similar outcomes. Depending on the size and severity, fires can cause project delays and increase costs.	Unlikely	Severe	Moderate	Include safety provisions for relevant equipment in the CEMP and the site safety plan. Ensure comprehensive fire management plans are in place prior to construction that include: • Training and equipment requirements for on-ground personnel. • Site access/equipment restrictions that apply on fire danger days. • Emergency response (including evacuation) if a fire does occur. Monitor bushfire danger by liaising with DEPI, CFA, BOM and other relevant authorities. Contractual arrangements that accommodate changes resulting from fire incidents. Appropriate insurance for contractors, equipment and liability.	Low
Poor contractual arrangements	Ambiguous contractual arrangements may lead to confusion regarding the scope of work to be delivered and/or multiple contract variation requests. This can delay construction and have significant financial impacts.	Possible	Moderate	Moderate	Seek expert/legal advice on contractual arrangements. Ongoing supervision of contractors.	Very Low
Poor engineering design	Poor engineering design can create a number of issues, including: • Design not fit for purpose • Difficulties in operation • Increased maintenance costs • Reduced design life	Possible	Moderate	Moderate	Detailed designs and construction drawings peer reviewed before they are finalised. Early engagement of contractors and operators to provide feedback on design practicalities/constructability.	Very Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Inadequate geotechnical information	Unforeseen geotechnical conditions encountered during construction may require significant alteration to existing designs or relocation of infrastructure causing project delays and additional expense.	Possible	Severe	High	Appropriate geotechnical investigations conducted carried out during the design phase to reduce uncertainty. Conservative design of structures to allow for variations to geotechnical conditions.	Moderate
Unclear roles and responsibilities	Unclear roles and responsibilities could hinder effective project development and construction.	Possible	Moderate	Moderate	Establish a MoU between all relevant agencies outlining roles and responsibilities during project development and construction. Ensure appropriate contractual arrangements are in place between the project owner and the agencies responsible for construction management, approvals preparation, etc. Maintain strong working relationships with river operators, partner agencies (including agencies in NSW, SA and Victoria), and Commonwealth and Victorian water holders through regular design and construction group meetings. Maintain clear lines of communication with all partner agencies and project stakeholders during project development and delivery.	Low
Insufficient resourcing	Insufficient resourcing available for agency staff and equipment. This will impact on the ability to deliver the project within agreed timelines and budget.	Possible	Moderate	Moderate	Clear identification of roles, responsibilities, associated activities and resourcing requirements; funding agreements negotiated on the basis of these requirements. Maintain strong relationships with investors/funding bodies to secure adequate resources for project development and delivery.	Low

19. References

Aither 2014. Social and economic assessment- Vinifera Water Management Works, Benefits for the Basin Plan Sustainable Diversion Limits offset program business case. Report for the Mallee CMA.

Alluvium 2013a. Nyah Management Project SDL Adjustment Supply Measure Phase 1 Submission. Mallee Catchment Management Authority Mildura, Vic.

Alluvium 2013b. Vinifera Park Water Options Project. A report prepared for the Mallee Catchment Management Authority, Irymple, Victoria.

Aitken Rowe 2012. Geotechnical investigation – Nyah and Vinifera Water Management Options, Nyah and Vinifera, Vic. Report by Aitken Rowe to Alluvium.

Bennett et al (2007). Valuing the protection of Victorian Forests: Murray River Red Gums and East Gipplsland. Funded by Victorian Environmental Assessment Council, Crawford School, ANU.

Brown, G., D. Bryant, and G. Horrocks 2013. *Terrestrial vertebrate fauna surveys of the Burra Creek and Nyah-Vinifera reserves, northern Victoria.* Irymple: Arthur Rylah Institute Report to Mallee Catchment Management Authority, Irymple, Victoria.

Bureau of Rural Sciences 2009. River Murray Corridor Victorian AEM Mapping Project. Boundary Bend-Nyah GIS. Commonwealth of Australia (Geoscience Australia), 2009.

Cook 2012. Preliminary investigation of the floodplain vegetation of Nyah-Vinifera Forest. Patterson Lakes, Victoria: Australian Ecosystems report prepared for Wadi Wadi Community and Friends of the Earth.

Community Engagement and Partnership Working Group 2012, Community Engagement and Partnerships Framework for Victoria's Catchment Management Authorities, Victorian Catchment Management Forum.

Cunningham, S.C., P. Griffioen, M. White, and R. MacNally. Mapping the condition of river red gum (*Eucalyptus camaldulensis Dehnh.*) and black box (*Eucalyptus largiflorens F. Muell.*) stands in The Living Murray Icon Sites. Stand condition report 2010. Canberra: Murray-Darling Basin Authority, 2011.

Davies, P., J. Harris, T. Hillman, and K. Walker 2008. *Sustainable Rivers Audit SRA Report 1. A report on the ecological health of rivers in the Murray-Darling Basin 2004-2007.* Canberra: Murray-Darling Basin Commission.

DSE 2005. Advisory List of Rare or Threatened Plants In Victoria. Department of Sustainability and Environment. Melbourne, Victoria.

DSE 2011. Nyah Vinifera Floodplain Management Unit Environmental Water Management Plan. Department of Sustainability and Environment. Melbourne, Victoria.

DSE 2013. Terrestrial vertebrate fauna surveys of the Burra Creek and Nyah-Vinifera reserves, northern Victoria. A report to the Mallee Catchment Management Authority. Report for the Mallee CMA.

DEPI 2014. Ecological Vegetation Classes by Bioregion, Department of Environment and Primary Industries, Victoria.

Ecological Associates 2006. *Investigation of water management options for the Murray River - Nyah to Robinvale.* Irymple, Victoria: Ecological Associates Report AL009-4-B prepared for Mallee Catchment Management Authority.

Ecological Associates 2007. Final Report: Water Management Options for the River Murray – Nyah to Robinvale Stage II. Report to the Mallee Catchment Management Authority, Mildura.

Ecological Associates 2014a. SDL Rationale and Outcomes. Ecological Associated report AL040-1D prepared for Mallee Catchment Management Authority, Irymple.

Ecological Associates 2014b. SDL Floodplain Watering Projects: Monitoring and Evaluation. Ecological Associated report AL045-1-B prepared for Mallee Catchment Management Authority, Irymple.

Ecological Associates, 2014c. SDL Floodplain Watering Projects: Operational Plan. Report prepared for Mallee CMA, Irymple.

Fuller DA & Teller AL, 2007. Salinity Impact Assessment Framework – Living Murray Works and Measures Consultancy report by URS and AWE for Murray Darling Basin Commission, April 2007.

GHD 2013. Flora Census Summary Report. Report for the Mallee CMA.

GHD 2014. Nyah, Vinifera and Burra Creek Review of Water Management Options and Concept Designs. Report for the Mallee CMA.

GHD 2014a. Basin Plan Environmental Works Program: Approvals Strategy. Report for the Department of Environment and Primary Industries.

Gippel, C.J. 2014. Spells analysis of modelled flow for the River Murray from Swan Hill to the South Australia Border. Fluvial Systems Pty Ltd, Stockton. Mallee CMA November

Grinter, B., Edwards, A. & Bell, J 2014. Nyah-Vinifera Park, River Red Gums National Park Due Diligence Assessment. Jo Bell Heritage Services Pty. Ltd. Euroa, Victoria.

Hames, F. 2014. Fish Passage Workshop. Arthur Rylah Institute for Environmental Research Unpublished Client Report for Mallee Catchment Management Authority, Department of Environment and Primary Industries, Heidelberg, Victoria.

Jacobs 2014. Hydrodynamic modelling of SDL sites - Vinifera preliminary modelling report. Irymple, Victoria: Jacobs report prepared for Mallee Catchment Management Authority.

James Golsworthy Consulting 2014. SDL Offsets Projects, Statutory Approval Requirements, Belsar, Burra, Hattah, Lindsay, Nyah, Vinifera and Wallpolla. Report for the Mallee CMA.

Lloyd Environmental 2014. SDL offsets projects – risks investigation, assessment and management strategy. Report for the Mallee Catchment Management Authority, Irymple, Victoria.

Mallee CMA 2010. Nyah Vinifera Floodplain Management Unit Environmental Watering Plan. Mallee Catchment Management Authority, Irymple, Victoria.

Mallee CMA 2014. Mallee CMA SDL Offset Projects. Presentation July 2014.

Mallee CMA 2014a. Sustainable Diversion Limits Offset Projects Steering Committee: Vinifera to Hattah Lakes, Terms of Reference. Mallee CMA, Mildura.

MDBA (Murray Darling Basin Authority) 2012. Basin Plan. Canberra, ACT.

MDBA (Murray-Darling Basin Authority) 2014. Basin-wide environmental watering strategy. MDBA, Canberra.

Ning, N., Linklater, D., Baldwin, D. and Baumgartner, L. 2014. Assessing the Risk of Hypoxic Blackwater Generation at Proposed SDL Offset Project Sites on the Lower River Murray Floodplain. Report prepared for the Mallee Catchment Management Authority, Victoria.

RMCG 2014. Vinifera Floodplain Sustainable Diversion Limits Offset Project, Final Communication and Engagement Strategy. Report for the Mallee CMA.

SKM 2014. *Preliminary Salinity Impact Assessment for Mallee Environmental Watering Projects – other sites* Report for the Mallee CMA

Telfer A. L., Hatch M A , and Shintodewi P. A., 2006. Atlas of Instream NanoTEM 2006 Australian Water Environments report 45755bb

Thorne R , Hoxley G and Chaplin H , 1990 Nyah to the South Australian Border Hydrogeological Project, Cross Sections and Plans Rural Water Commission of Victoria, Investigations Branch Report 1988/5, June 1990.

VEAC 2008 River Red Gum Forests Investigation. Victorian Environmental Assessment Council, East Melbourne, Victoria

Victorian Government 2012, Environmental Partnerships, Victorian Government, Melbourne, Victoria.

Water Technology 2014. Mallee CMA Sustainable Diversion Limit Offset, Water Resourcing Arrangement. Report prepared for Mallee Catchment Management Authority, Irymple, Victoria

White, M., et al 2003.*The Vegetation of North-West Victoria.* Heidelberg. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment.

Young, W.J. 2001 *Rivers as Ecologicol Systems.* Edited by W.J. Young. Canberra· Murray-Darling Basin Commission.

20. Appendices

Appendix A:

Vinifera proposed works and inundation extents.

Appendix B:

Ecological Associates 2014a. SDL Rationale and Outcomes. Ecological Associated report AL040-1D prepared for Mallee Catchment Management Authority, Irymple.

Appendix C:

Ecological Associates 2014b. SDL Floodplain Watering Projects: Monitoring and Evaluation. Ecological Associated report AL045-1-B prepared for Mallee Catchment Management Authority, Irymple.

Appendix D:

SKM 2014. Preliminary Salinity Impact Assessment for Mallee Environmental Watering Projects – other sites. Report for the Mallee CMA.

Appendix E:

Jacobs 2014a. Vinifera SDL Adjustment Supply Measures Advanced Concept Design Report. Report for the Mallee CMA.

Appendix F:

Aither 2014. Social and economic assessment- Vinifera Water Management Works, Benefits for the Basin Plan Sustainable Diversion Limits offset program business case. Report for the Mallee CMA.

Appendix G:

Vinifera letters of support.

Appendix H:

RMCG 2014. Vinifera Sustainable Diversion Limits Offset Project, Final Communication and Engagement Strategy. Report for the Mallee CMA.

Appendix I:

GHD 2014a. Basin Plan Environmental Works Program: Approvals Strategy. Report for the Department of Environment and Primary Industries.

Appendix J:

James Golsworthy Consulting 2014. SDL Offsets Projects, Statutory Approval Requirements, Belsar, Burra, Hattah, Lindsay, Nyah, Vinifera and Wallpolla. Report for the Mallee CMA.

Appendix K:

Grinter, B., Edwards, A. & Bell, J 2014. Nyah-Vinifera Park, River Red Gums National Park Due Diligence Assessment. Jo Bell Heritage Services Pty. Ltd. Euroa, Victoria.

Appendix L:

Expert Panel Reports.