Amendment date: 28 June 2017

	Title of measure	**Burra Creek 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 works will enable inundation of an area of 407 hectares. This represents 33% of the total forest area and almost all of the flood dependent communities found within the forest, and provides a greater extent of watering than is possible under Basin Plan flows. The works involve the construction of three large regulators, raising tracks to form levees, and the removal of barriers to flow on the floodplain. A detailed description of the proposed works is included in Chapters 3.2 and 12 of the business case **(Attachment B)**.	
4.	**Geographical location of the measure**	
	The Burra Creek floodplain is located on the western bank of the River Murray just upstream of the junctions with the Murrumbidgee and Wakool Rivers. Burra Creek is a 54 kilometer anabranch of the River Murray that diverges from the river near Piangil and rejoins to the north.	
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 provided by the proponent and the travel time is derived from inflow and volume relationship presented in the same report, shown in the tables below.	

Water pooled by raising the regulator downstream		
Level (mAHD)	Area (ha)	Volume (ML)
57.0	0	0
57.3	34	264
57.7	40	383
58.2	82	723
58.7	307	1496
58.8	450	2110

Water pooled without raising the regulator downstream		
inflow (ML/d)	Area (ha)	Travel time (day)
111	32	1.25
243	40	1.25
444	87	1.25
824	182	1.35
1162	255	1.35
1500	327	1.35
1997	479	1.40
2388	579	2.00
4000	800	2.00

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. Flow-level parameters derived from hydrodynamic model report were supplied by the Victorian Government.

DS Swan Hill (ML/d)	Flow to Site (ML/d)
17500	0
19500	0
20000	111
22500	243
25000	444
27500	824
30000	1500
32500	1997
35000	2388

Return flows 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, shown in table below. 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).

Flow (ML/d)	Level (mAHD)
0	57.00
111	57.09
243	57.44
444	57.83
824	58.38
1500	58.82
1997	58.97
2388	59.05
3600	59.10

Surface water loss relationship

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 outlined in the table below has been used in the model.

Operating strategy	Flow to start operation (ML/d)	Regulator status	Duration	Optimal frequency	Resilience period (yr)	Equivalent Natural flow (ML/d)
Fresh[1]	-	All open	4 months	9 in 10 yrs	2	20,000
Intermediate[2]	20,000	Maintain at 58.5 mAHD	1 month	2 in 10 yrs	8	30,000
Maximum[3]	30,000	Maintain at 58.7 mAHD	2 weeks	At every opportunity of flow > 30,000 ML/d		35,000

[1] Not included in the model as there is no additional benefit from current regimes.
[2] Its operation is 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. It is modelled to be operational at 5th opportunity.
[3] Not included in the model due to its rare operations expected

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 works are nested, which means that the area inundated by the Fresh event (BCF) is also inundated by the Intermediate (BCI) and Maximum (BCM) operating level, similarly the intermediate area is included in the maximum operation area. The total area of inundation for each of the operating strategies is given in the table below.

Operation strategy	Inundation area (ha)
Burra Creek Fresh (BCF)	128
Burra Creek Intermediate (BCI)	215
Burra Creek Maximum (BCM)	434

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. The areas provided in the tables for BCI and BCM are the areas additional to the area already inundated by the nested smaller operation(s)

Inundation area (ha) for BCF	SFI Flow				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all	0.0	0.0	0.0	0.0	128.0
Bitterns, crakes and rails	0.0	0.0	0.2	0.2	74.6
Breeding – Colonial-nesting waterbirds	0.0	0.0	0.0	0.0	128.0
Breeding – other waterbirds	0.0	0.0	0.2	0.2	74.6
Redgum Forest	0.0	0.0	0.0	0.0	12.6
Redgum Woodlands	0.0	0.0	0.0	0.0	7.7
Forests and Woodlands: Black Box	0.0	0.0	0.2	0.2	79.6
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	0.0	0.2	0.2	74.6
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	0.0	0.2	0.2	74.6
Long lived fish	0.0	0.0	0.0	0.0	128.0

Inundation area (ha) for BCI	SFI Flow Bands				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	0.0	0.0	0.0	87.0
Bitterns, crakes and rails	0.0	0.0	0.0	0.0	7.5
Breeding – Colonial-nesting	0.0	0.0	0.0	0.0	87.0
Breeding – other waterbirds	0.0	0.0	0.0	0.0	7.5
Redgum Forest	0.0	0.0	0.0	0.0	0.7
Redgum Woodlands	0.0	0.0	0.0	0.0	0.9
Forests and Woodlands: Black Box	0.0	0.0	0.2	0.0	37.2
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	0.0	0.0	0.0	7.5
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	0.0	0.0	0.0	7.5
Long lived fish	0.0	0.0	0.0	0.0	87.0

Inundation area (ha) for BCM	SFI Flow Bands				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	0.0	0.0	0.0	219.0
Bitterns, crakes and rails	0.0	0.0	0.1	0.0	14.1
Breeding – Colonial-nesting	0.0	0.0	0.0	0.0	219.0
Breeding – other waterbirds	0.0	0.0	0.1	0.0	14.1
Redgum Forest	0.0	0.0	0.0	0.0	0.6
Redgum Woodlands	0.0	0.0	0.0	0.0	1.6
Forests and Woodlands: Black Box	0.0	0.0	0.1	0.0	79.8
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	0.0	0.1	0.0	14.1
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	0.0	0.1	0.0	14.1
Long lived fish	0.0	0.0	0.0	0.0	219.0

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.

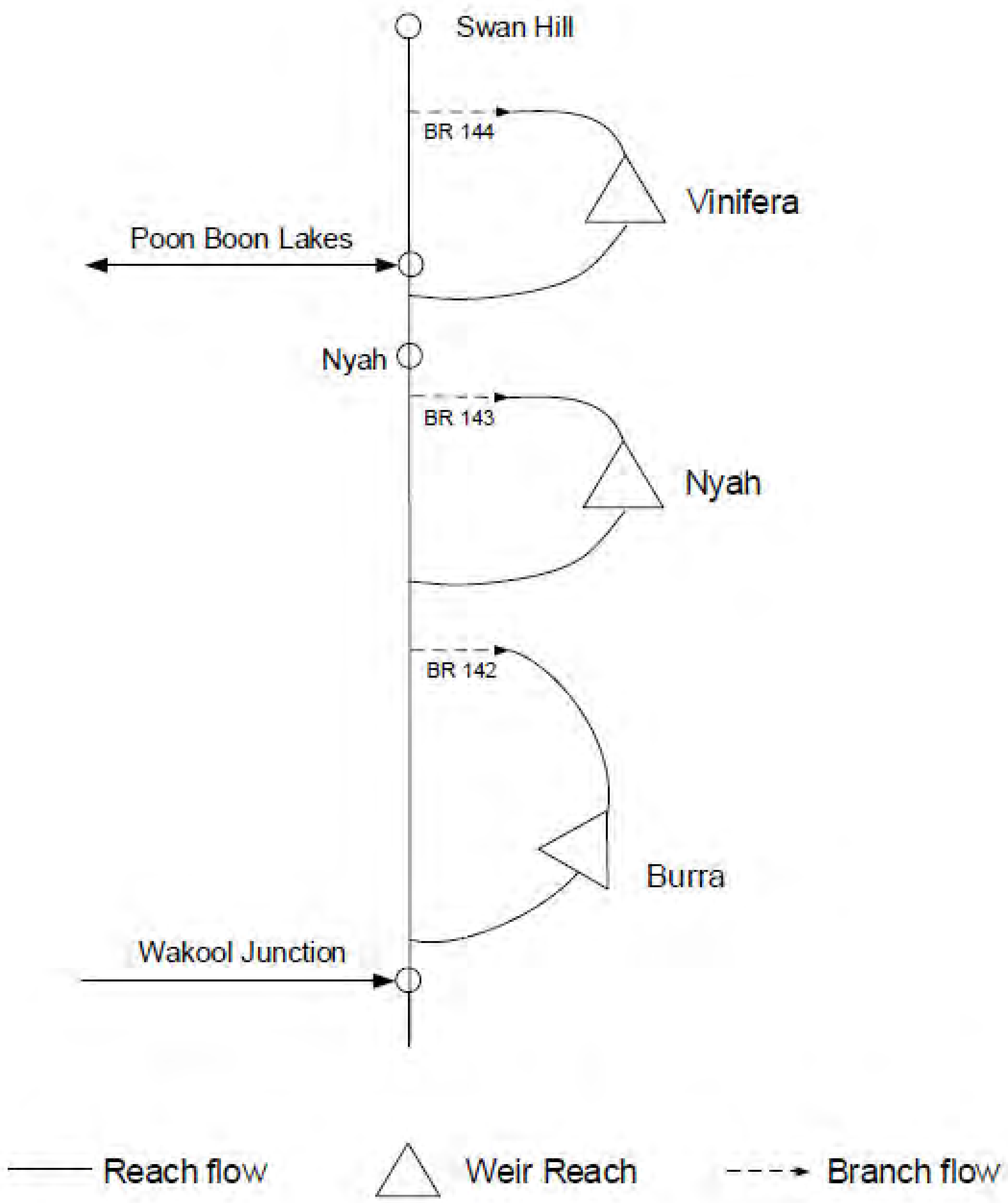
9. Details of relevant constraint measures

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	Burra creek floodplain management project representation in Murray model (based on Bigmod Rev. 266)
B	Mallee CMA, December 2014	Phase 2 Assessment Supply Measure Business Case: Burra Creek Floodplain Management Project

Attachment A - Burra creek floodplain management project representation in Murray model (based on Bigmod Rev. 266)



Sustainable Diversion Limit Adjustment

Phase 2 Assessment

Supply Measure Business Case:

Burra Creek Floodplain Management Project

State Government Victoria Department of Environment and Primary Industries

mallee catchment management authority

Executive Summary

The *Burra Creek 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 Burra Creek floodplain is located on the western bank of the River Murray just upstream of the junctions of the Murrumbidgee and Wakool rivers. Burra Creek is a 54 kilometre anabranch of the River Murray that diverges from the river near Piangil and rejoins to the north. The area enclosed between the creek and the river spans 2,600 ha and is known Macredie Island. Burra North represents the downstream part of the island and covers approximately 1,217 ha. The landscape in Burra North is largely unmodified and comprises wetlands, forest and woodland. The southern part of the island is mainly freehold land and is developed for agriculture.

The area to be inundated, Burra North, is designated as River Murray Reserve and is one of the best-preserved floodplain woodland and shrubland communities in the western Murray Fans bioregion. The system has intact vegetation with an overstorey of black box, a midstorey of lignum and a ground layer with high levels of organic litter, logs and understorey grasses and shrubs. The complex habitat supports a diverse bird community with over 130 bird species reported from the site and local vicinity. The bird fauna is rich in species that depend on woodland and shrubland vegetation such as grey-crowned babbler, brown treecreeper and red-capped robin. The bat fauna is also diverse with twelve species reported from the site.

The Burra Creek area is a low-lying floodplain that was reliably inundated in spring under natural (without regulation) flow conditions. River Murray flows of 17,500 ML/d introduced water into Burra Creek at the downstream river connection in most years providing some permanency of water within the landscape. At flows exceeding 27,500 ML/d water spilled from Burra Creek and river effluents, filling low-lying areas dominated by Lignum Swamp. The surrounding black box areas became inundated at river flows of 30,000 ML/d. Changed river operations has resulted in a decline in the condition and productivity of the floodplain due to the reduced flood frequency and durations.

The *Burra Creek Floodplain Management Project* works aim to complement Basin Plan flows in returning a more natural inundation regime to 407 ha of the Burra North floodplain. In the absent of sufficient flows in the River Murray to provide inflows to the site the works also enable watering of the floodplain through use of temporary pumping.

The project will remove existing blockages to flow on Burra Creek and use three main structures to retain and regulate water over the floodplain. The removal of two barriers in Burra Creek will allow the Burra North section of the channel to completely fill with water when River Murray flows exceed 20,000 ML/d. To prolong floodplain inundation, one of the regulators will be constructed on the creek near the junction with the River Murray to control outflows. Existing tracks will be raised to enable retention of water on the floodplain up to a level of 58.7 m AHD.

The works will be operated to meet environmental watering targets in response to prevailing flow in the River Murray and ecological cues. A key environmental outcome of this project is to maintain productivity and structure of black box communities. Targeted operation of the works in conjunction with Basin Plan flows will enable mean frequency of inundation equivalent to a 30,000 ML/d flow event to be restored providing a significant opportunity to protect and restore the ecological values of the site.

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 Burra Creek project such as Parks Victoria, have provided in-principle support for the progression of the project. Support has also been gained from 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 across the region. .

The *Burra Creek 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. The adoption of these standard mitigation measures minimise the risks associated with the implementation of this project.

Project costs that will be subject to a request for Commonwealth funding total $12,138,362 in 2014 present value terms. Victoria is seeking 100 per cent of these costs from the Commonwealth. In terms 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 Limit (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)
ANCOLD	Australian National Committee on Large Dams
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
FERC	Federal Energy Regulatory Commission
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
VMIA	Victorian Managed Insurance Authority
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
N/A	Not applicable
temp	Temperature
V	Vertical
VIC	Victoria
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
ha	Hectares
m	Metres
mm	Millimetres
mS/cm	Millisiemens per centimetre
µS/cm	Microsiemens per centimetre
$M	Million dollars

1. Introduction

1.1. Context

The *Burra Creek Floodplain Management Project* is a low risk proposal that will deliver a high magnitude of environmental benefits, meeting the outcomes and stated objectives of the Basin Plan.

This Business Case for the *Burra Creek 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 of nine proposed works-based supply measures within Victoria and one of seven within the Mallee Catchment Management Authority (CMA) region including:

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

These measures will work in conjunction with proposed altered river operations and existing environmental infrastructure to deliver the environmental outcomes of the Basin Plan, using much lower volumes of water. Figure 1-1 provides a conceptual overview of the distribution of sites in the Mallee CMA region and the longitudinal connection to the lower Murray region.

1.2. Forest overview

Burra Creek is an anabranch of the River Murray located north of Piangil. The creek extends northward 54 km to just upstream of Major Mitchell Lagoon, where it rejoins the River Murray (Figure 3-1). The floodplain between Burra Creek and the River Murray is known as Macredie Island. The project area is focused entirely on the Burra Creek North area, which represents the downstream part of the island (north of the Piambie channel).

The Burra Creek project site comprises wetlands, forest and woodland areas. It is one of the best-preserved floodplain woodland and shrubland communities in the western Murray Fans bioregion and supports diverse bird, bat and terrestrial reptile species (Ecological Associates, 2014a). The site supports an array of other fauna and flora species, many of these threatened and vulnerable (Alluvium, 2013).

Burra Creek also has important social and cultural values. Studies conducted along the River Murray and its tributaries in the Mallee region have shown that the landform type of the Burra Creek floodplain is generally highly sensitive for Aboriginal cultural heritage values and evidence of past Aboriginal occupation (Bell, 2013). It is also a popular area for forest-based activities include camping, fishing, canoeing, trail-bike riding and horse riding.

Burra Creek is located immediately upstream of the River Murray and Wakool River conjunction. River Murray flow at Burra Creek is influenced by the Murray and Goulburn Rivers and all upstream River Murray tributaries. Burra Creek experiences its largest floods when the River Murray and its upstream tributaries are inundated, generally occurring from late winter to early summer.

Key threats to Burra Creek and its values include the reduced frequency, duration and extent of floods, which is adversely affecting riparian, floodplain and aquatic vegetation, as well as impacting on native fish populations and other fauna.

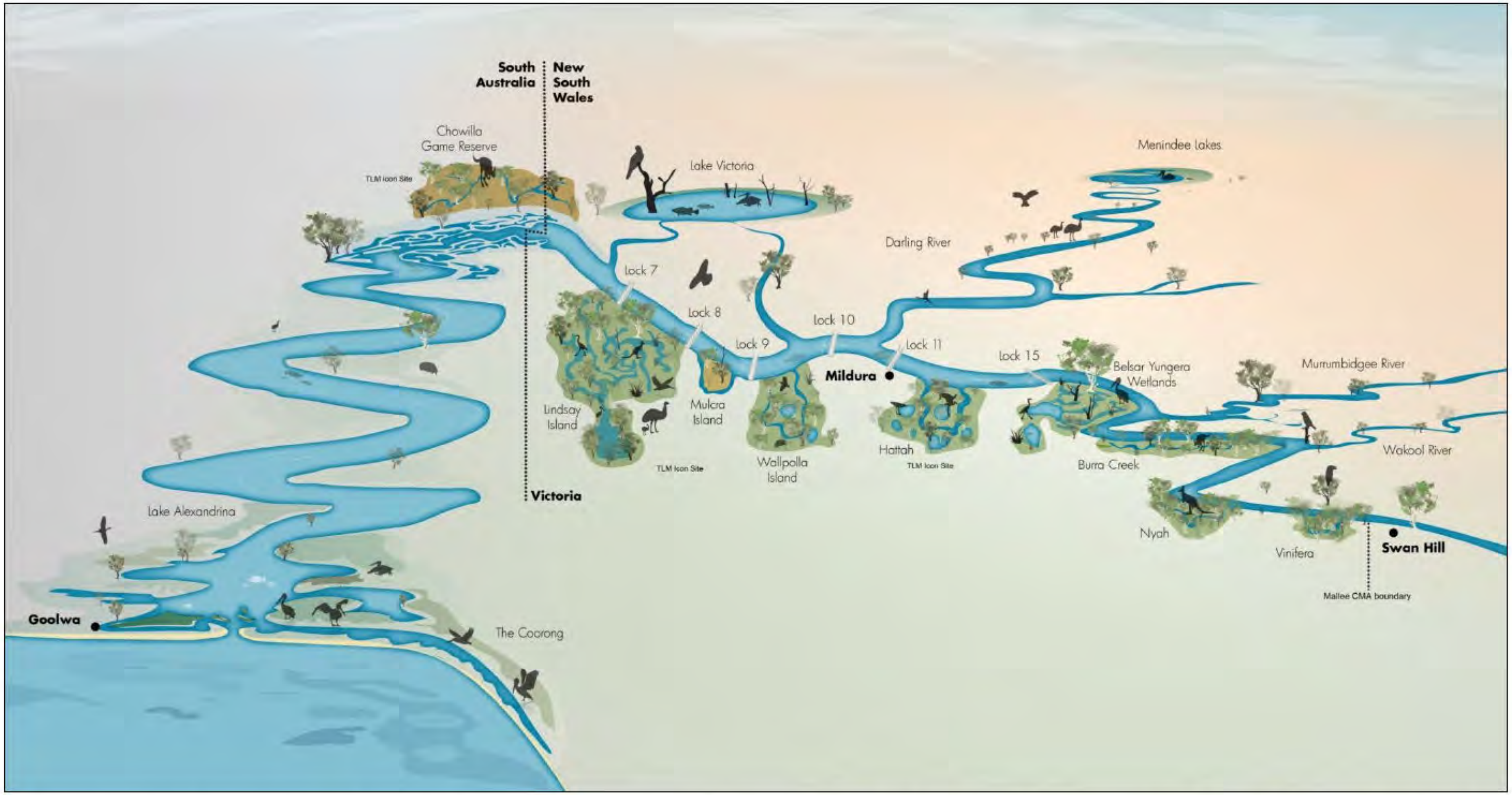


Figure 1-1: Distribution of proposed supply measure sites across the Mallee CMA region, including Vinifera, Nyah, Burra Creek, Belsar-Yungera, Hattah (North), Wallpolla, Lindsay Island; TLM EWMP sites include Hattah, Mulcra Island, Chowilla Game Reserve and parts of Lindsay Island (diagram is not to scale)

1.3. Land tenure

The *Burra Creek Floodplain Management Project* construction activities are located entirely within Crown Land. The total area of the Burra Creek floodplain (including Macredie Island) is 2,600 ha. The project area (Burra North) is 1,217 ha.

The northern half of Macredie Island was managed as State Forest but under recommendations from the Victorian Environmental Assessment Council River Red Gum Forests Investigation (VEAC 2008) has been managed as Murray River Reserve. The area is now managed by Parks Victoria for conservation and recreation purposes.

The southern half of the Island is largely private land, much of which has been cleared for agriculture.

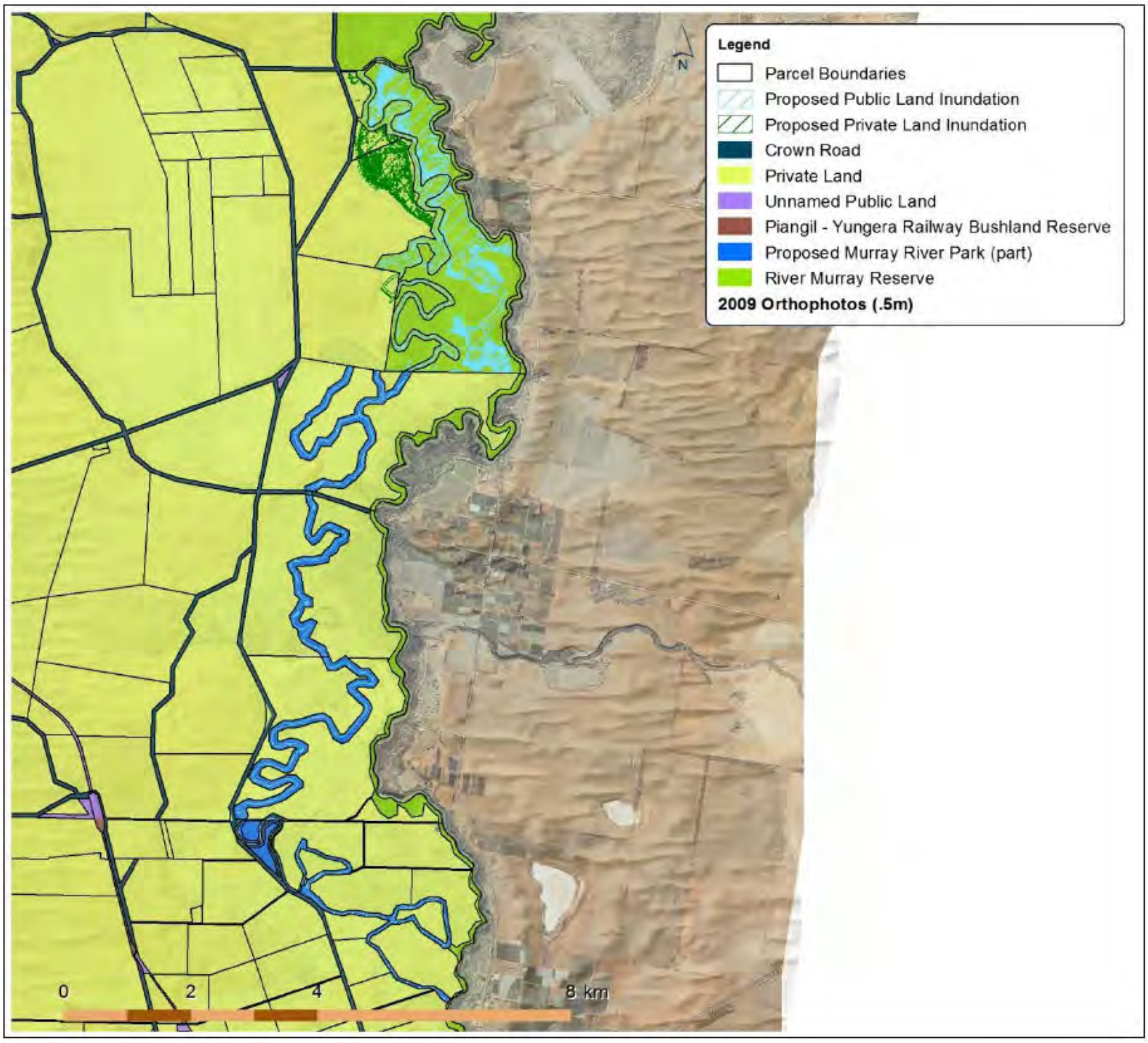


Figure 1-2: Inundation against land tenure at Burra Creek.

Figure 1-2 shows that the proposed works inundate a small area (76 ha) of private land when operated to achieve the maximum inundation extent. This flooding can be avoided by operating the works at below the maximum design level. The only exception is a short section of Burra Creek which is privately owned and has received through-flows with the support of the landowner during previous environmental watering events.

Due to the early stage of project development, it is not yet appropriate to have established flood agreements with the relevant private landholders. This will be resolved in the detailed design stage and provision has been made in the overall project costs to allow this. Preliminary discussions have been held with all affected landholders who have generally been supportive of the project. Formalised flooding agreements with the affected landholders however is not a critical factor to the feasibility of the project for the reasons above.

1.4. The proposal

This project will improve connectivity across this floodplain and will result in environmental benefits beyond what can currently be achieved under the Murray Darling Basin Plan through increased flows alone. The aim is to improve the health of the floodplain ecosystem by increasing the frequency and duration of watering events at this site.

This project provides a unique opportunity to reverse decline and to protect and restore landscape condition, which will provide significant benefit to nationally important species, ecological values, carbon cycling and downstream water quality. This will benefit Burra Creek and the broader Lower Murray region more generally.

A range of options have been investigated to address the reduced flood frequency and duration of the Burra Creek floodplain. The preferred option was chosen on the basis of feasibility, cost-effectiveness and ability to meet the ecological objectives that have been set for the site.

The proposed package of works will return a more natural inundation regime to Burra Creek and its northern floodplain through the construction of three regulators (B1, B2 and B4), raising tracks to form levees and the removal of barriers to flow on the floodplain,. A detailed description of the proposed works package is included in Sections 3.2 and 12 of this business case.

The proposed works will enable inundation of an area of 407 ha (up to 58.7 m AHD) in Burra North and will enable flows throughout Burra Creek to commence at 20,000 ML/d (in the River Murray). This represents 33% of the total forest area and almost all of the flood dependent communities found within the forest and provides a greater extent of watering than is possible under Basin Plan flows.

The overall objective of water management at Burra North is:

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

This will be achieved by:

- restoring seasonal aquatic habitat to Burra Creek
- restoring floodplain productivity to maintain resident populations of vertebrate fauna including bats, sugar glider and lace monitor, and
- contributing to the carbon requirements of the River Murray channel ecosystem.

A representation of the planned works and inundation at Burra North is shown in Figure 1-3 below. 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.

Figure 1-3: Project concept showing overview of proposed works and inundation extent.

1.5. Project development

The feasibility study and business case for the proposed *Burra Creek 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 (DEPI), 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 project at Hattah Lakes, which delivers environmental water to more than 6000 hectares of Ramsar-listed 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 Burra Creek 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 Burra Floodplain project and ensuring it will continue to be a successful project.

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, and
- 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.

Natural inundation of Burra Creek (2011)

3. Project Details (Section 4.1)

3.1. Description of proposed measure, including locality map

The *Burra Creek Floodplain Management Project* is an environmental works and measures project in north-western 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.

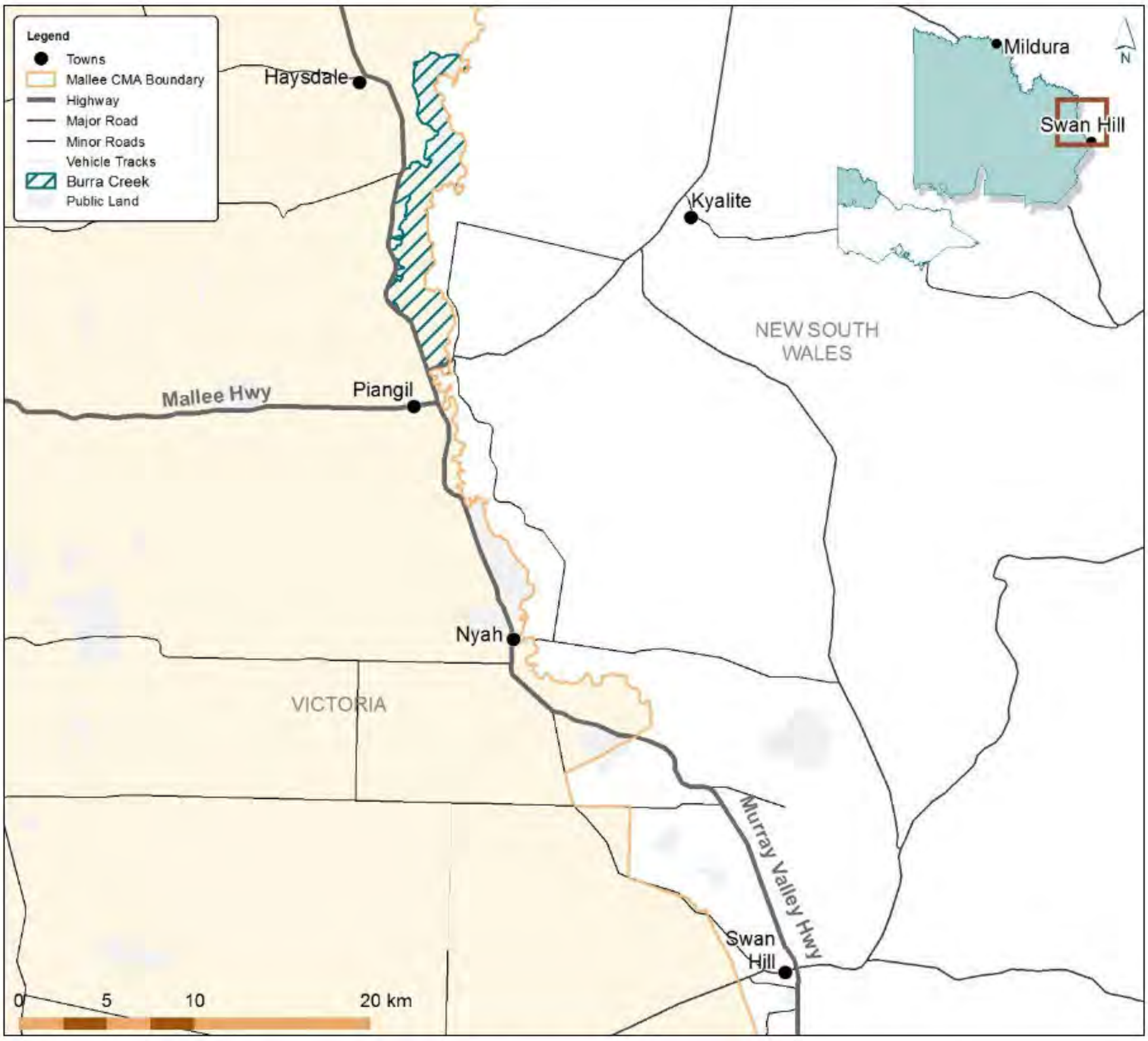


Figure 3-1: Location of the Burra Creek Floodplain Management Project

The purpose of the project is to restore the integrity and productivity of the Burra North floodplain ecosystem by reinstating an appropriate inundation extent, frequency and duration. This will require regulating structures and temporary pumping (in the absence of suitable River Murray flows) to provide a more natural regime.

The project can flood a third of the floodplain to a water level of 58.7 m AHD, requiring a volume of 2,750 ML. Analysis of the inundation flow equivalences (Jacobs, 2014) shows that the proposed works will replicate flows up to 30,000 ML/d (refer Figure 1-2 and Figure 8-3) and will enable flows throughout Burra Creek to commence at 20,000 ML/d.

Some areas of black box and red gum forest that are inundated above river levels of 35,000 ML/d are also inundated by the proposed works, however not to the full extent that would occur under natural flooding. As this project results in ecological benefits in these vegetation classes, they are discussed within this business case.

3.2. Environmental works and measures at point locations

The Burra Creek floodplain is divided into two areas by the Piambie channel. For the purpose of this Business Case these areas are referred to as:

- Burra North which is located to the north of the channel, and
- Burra South which is to the south of the channel.

This project targets flooding in the Burra North area and enables the floodplain to receive water from backflow and through flow. All works are located within this area with the exception of a regulator (B4) at the upstream connection of Burra Creek.

The proposed works at Burra Creek include regulators, levees and overflow sills. Additional works are required to remove man-made barriers to flow on the floodplain. The main elements of the Burra Creek works are illustrated in Figure 3-2 overleaf and described further in Table 3-1 .

The proposed works package includes three regulators:

- B1: the main regulator that will retain water during a managed event as well as controlling flows between Burra Creek and the Murray River
- B2: contains flow in the system during a managed inundation event and prevents it flowing upstream into the Burra South forest
- B4: allows flow into Burra Creek for supply of water to the creek and forest during a natural event (at the upstream end of Burra Creek near Tooleybuc).

The B1 Regulator has been designed to allow bi-directional fish movement and carry the entire outflow of Burra Creek (and forest) with the regulator fully open. A drop structure and rock work is incorporated downstream of the B1 Regulator and near the confluence of the Murray River to protect against erosion when releasing water to the river at the end of a managed watering event and enable downstream fish passage.

Additional works include block banks (levees) and overflow sills to secure local low points in the natural levee system and contain the water within the floodplain. The majority of earthen levees will be built on the alignment of existing forest tracks. A few short lengths of non -trafficable levee will be required at tie in locations where the levee needs to match the natural river levee. In the case of the main levee, this will provide operator access to the regulators. Utilising the existing tracks for the alignment of the levees also reduces the footprint of works in undisturbed areas.

Burra Creek has a number of road embankments, as well as block banks and old regulating structures that were originally constructed to allow pumped irrigation diversions. Removal of these obstructions within the Burra North area is incorporated into the proposed works package as they restrict both through flow and back flow. In the case of the pump diversion banks, the status of the pump diversion infrastructure would need to be established before removal.

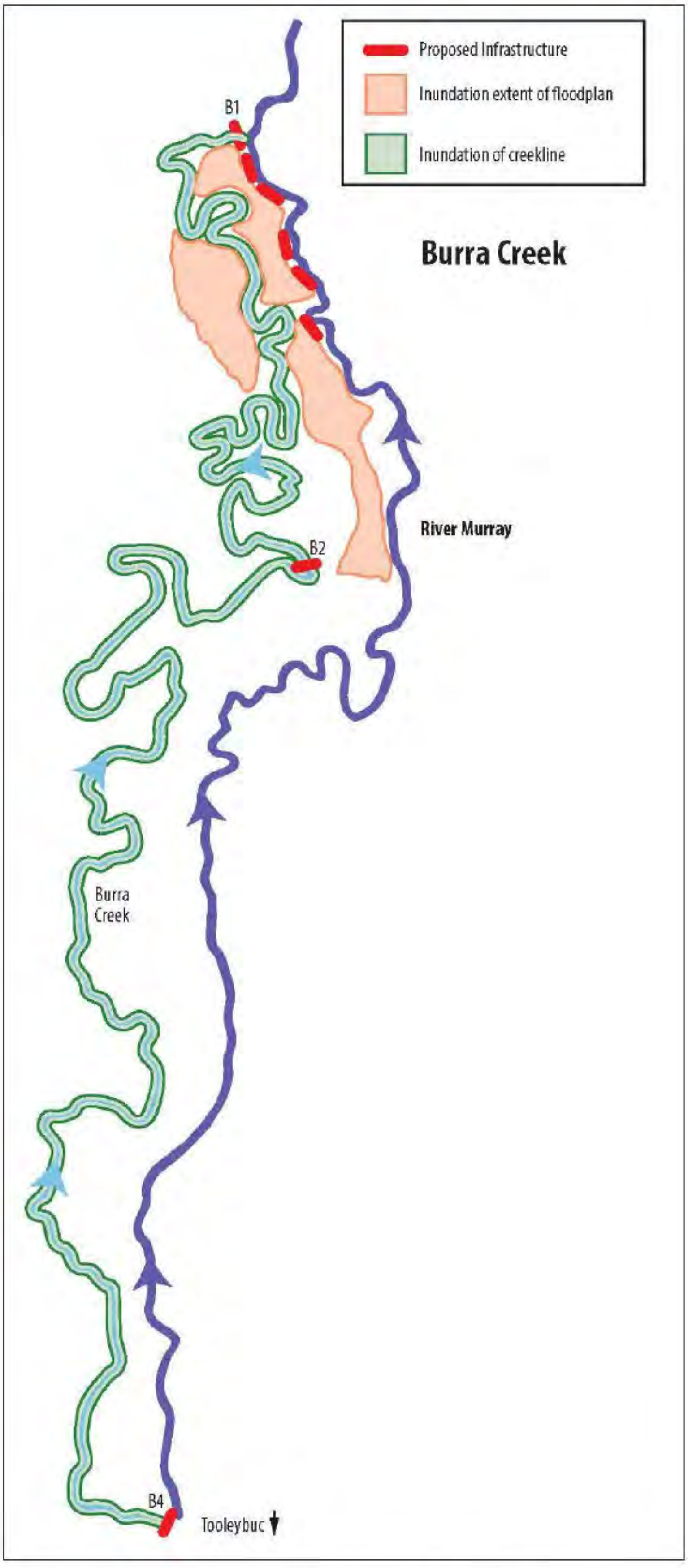


Figure 3-2: Spatial representation of planned works and inundation at Burra Creek.

Table 3-1: Summary of proposed infrastructure works for Burra Creek North floodplain project (Jacobs, 2014a)

Works	Description
B1 Regulator	A six bay regulator located on the downstream end of Burra Creek to retain water on the floodplain and control flows between Burra Creek and the River Murray. Designed to allow fish passage when fully opened. A sheet pile drop structure and rock beaching downstream of will protect against erosion when water is released to the river. This structure will establish a tailwater at the regulator sufficient to prevent sweep out of the hydraulic jump and provide a plunge pool for safe downstream fish passage.
B2 Regulator	A twin pipe culvert regulator at the upstream end of Burra Creek to contain flow during a managed inundation event in Burra Creek North.
B4 Regulator	A pipe culvert regulator located at the upstream end of Burra Creek to allow flow into Burra Creek and the surrounding forest during a natural flood. B4 is located within an existing levee/road that prevents high River Murray flows inundating farmland. The embankment provides access to private property and a house.
Raised Track and Overflow Sill	Minor works including block banks and overflow sills to secure local low points in the natural levee system and contain water within the flood plain. Two levees (1340 m and 1200 m long) will be built on the northern boundary of the Burra Creek site. The first levee will be constructed along the access track from The B1 Regulator to the Murray River and the second levee will be constructed along the access track adjacent to the Murray River on the Eastern side of the forest. The northern levee has two overflow sills located on defined drainage lines to maintain the flow distribution across the flood plain during high river flows. The two overflow sills are 15 and 20m long respectively. The southern levee is provided with a single 380m long overflow sill, which is really a gravelled track at close to natural surface level.
Drop Structure	Situated downstream of the B1 Regulator, the drop structure is necessary to protect banks against erosion upon release of impounded water. The structure will 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 area would be supplied by either natural floods or pumped flows achieving an inundation level of 58.7 m AHD, inundating Burra Creek and the northern floodplain. Analysis of flood flow equivalence has revealed that for Burra North the inundation extent achieved by the works is equivalent to a 35,000 ML/d flow in the River Murray and requires 1474 ML of water (Jacobs, 2014).

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

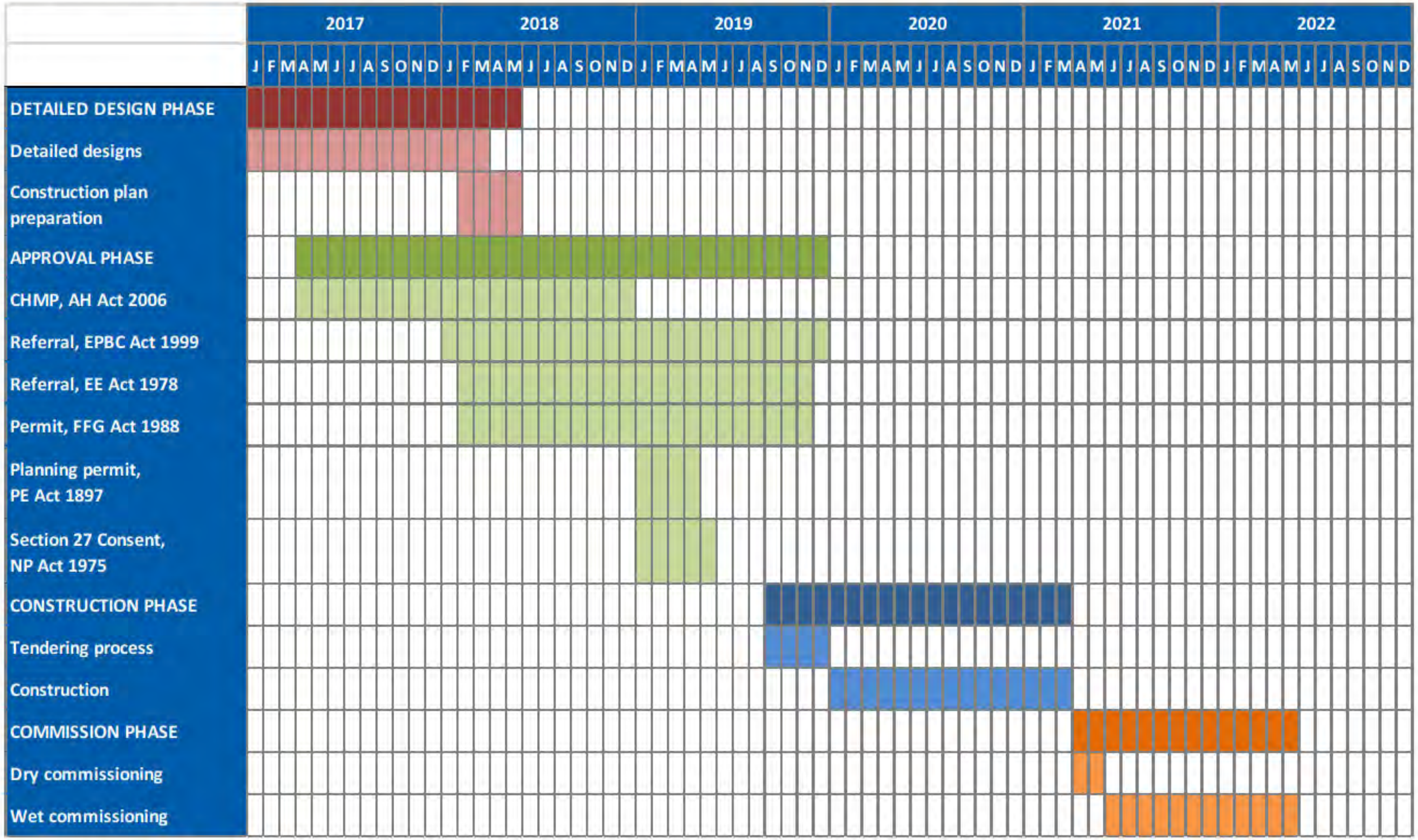
The total cost of the *Burra Creek Floodplain Management Project* is $12,138,362. Further details on costs are provided in Section 14.

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.

Figure 3-3 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 will be fully operational prior to 2024.

Gum tree in flower, following environmental watering (2014)

Figure 3-3: Proposed project delivery schedule



Note: timelines are indicative only and will depend on finalisation of funding arrangements.

4. Ecological values of the site (Section 4.2)

4.1. Fauna values

The ecological significance of Burra Creek is underpinned by its unique location, providing longitudinal connection to the River Murray and its floodplains. It provides 54 kilometres of complex and diverse creek habitat as well as connection to the semi-arid Mallee environment.

Burra Creek north is largely unmodified and comprises wetlands, forest and woodland. It is one of the best-preserved floodplain woodland and shrubland communities in the western part of the Murray Fans bioregion. The system has intact vegetation strata with an overstorey of black box (*Eucalyptus largiflorens*), a midstorey of lignum (*Muehlenbeckia florulenta*) and a complex ground layer with high levels of logs and understorey grasses and shrubs (Ecological Associates, 2014a).

The area supports a diverse bird community with over 140 bird species reported from the site and local vicinity (Brown et al, 2013). Of these, 16 have conservation significance in Victoria or under the EPBC Act, including:

- regent parrot (*Polytelis anthopeplus monarchoides*) and Murray cod, listed as vulnerable under the EPBC Act, and
- six fauna species listed as endangered and ten fauna species as vulnerable on the *Advisory List of Threatened Vertebrate Fauna in Victoria 2013* (DSE, 2013).

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

Eastern rosella (*Platycercus eximus eximus*) at Burra Creek (2014)

The bird fauna is dominated by species that depend on woodland and shrubland vegetation such as grey-crowned babbler (*Pomatostomus temporalis*), brown treecreeper (*Climacteris picumnus*) and red-capped robin (*Petroica goodenovii*). The bat fauna is also diverse with twelve species reported from the site. Bats are largely insectivorous and depend on high levels of floodplain productivity to provide prey (Australian Ecosystems, 2014a).

Burra Creek supports nineteen reptile species including the lace monitor (*Varanus varius*) and curl snake (*Suta suta*) (Brown et al, 2013). The presence of these species indicates the availability of vertebrate prey species such as frogs, birds and small reptiles and that sheltering habitat is available in the form of logs, litter and tree hollows (Ecological Associates, 2014a).

In 2007, six frog species were recorded representing two families, including the nationally threatened growling grass frog (*Litoria raniformis*) (Lumsden, 2007).

The northern floodplain of Burra Creek provides a strongly contrasting habitat to the surrounding floodplain woodland. Under natural unregulated conditions the creek flowed almost every year for about four months. When flowing, the creek would have supported large channel-specialist fish such as the EPBC Act-listed Murray cod (*Maccullochella peelii peelii*). Deep, permanent pools would have supported resident populations of small fish such as gudgeon species and Murray-Darling rainbowfish (*Melanotaenia fluviatilis*) (Ecological Associates, 2014a).

Ten native fish species are encountered regularly in the River Murray near Burra North (Ecological Associates, 2014a). Under natural conditions, seasonal flow in Burra Creek would have provided habitat for large channel-specialist fish such as Murray cod and golden perch. Small, vegetation-dependent fish such as Murray-darling rainbowfish would have dispersed through the creek during flow events and retreated to deep pools when flow ceased.

Flooded lignum and woodland provide habitat for a range of small fish that benefit from submerged aquatic vegetation, woody debris and plant, biofilm and invertebrate food sources. The restoration of floodplain habitat would provide feeding and breeding opportunities for Murray-Darling rainbowfish, carp gudgeon, flathead gudgeon and Australian smelt.

4.2. Vegetation values

Burra Creek has a diverse flora assemblage and supports numerous species of conservation significance. GHD (2013) identified 129 native plant species some of which are of conservation significance (Ecological Associates, 2014a) including:

- 16 recorded species of flora that are listed as rare or threatened on the DEPI Advisory List of Rare or Threatened Species in Victoria (DSE 2005)
- One vegetation community that is considered endangered (Riverine Chenopod Woodland) and four are considered vulnerable in the Murray Fans Bioregion.

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

Burra Creek supports intact remnants of river red gum (*Eucalyptus camaldulensis*) forest and woodland and black box and lignum shrubland communities associated with the higher elevated areas (Ecological Associates, 2014).

Ecological Vegetation Classes

The vegetation communities of the Nyah Park are distributed across the floodplain according to hydrological conditions, soil types 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 14 EVCs have been mapped at the Burra Creek site (Figure 4-1). Of these, 10 are inundation dependent including:

- Floodway Pond Herbland
- Grassy Riverine Forest
- Grassy Riverine Forest / Floodway Pond Herbland Complex
- Lignum Shrubland
- Lignum Swamp
- Lignum Swampy Woodland
- Riverine Chenopod Woodland
- Riverine Grassy Woodland
- Shrubby Riverine Woodland
- Water Body – Fresh.

Other EVCs that are not reliant on flooding for their survival include:

- Woorinen Sands Mallee
- Semi-arid Chenopod Woodland
- Semi-arid Woodland
- Chenopod Mallee.

Of the 14 EVCs present at the site, one EVC, Riverine Chenopod Woodland, has endangered bioregional status, and a further four EVCs are considered vulnerable (Lignum Shrubland, Lignum Swamp, Lignum Swampy Woodland, Riverine Grassy Woodland) (Ecological Associates, 2014a).

Large red gum at Burra Creek

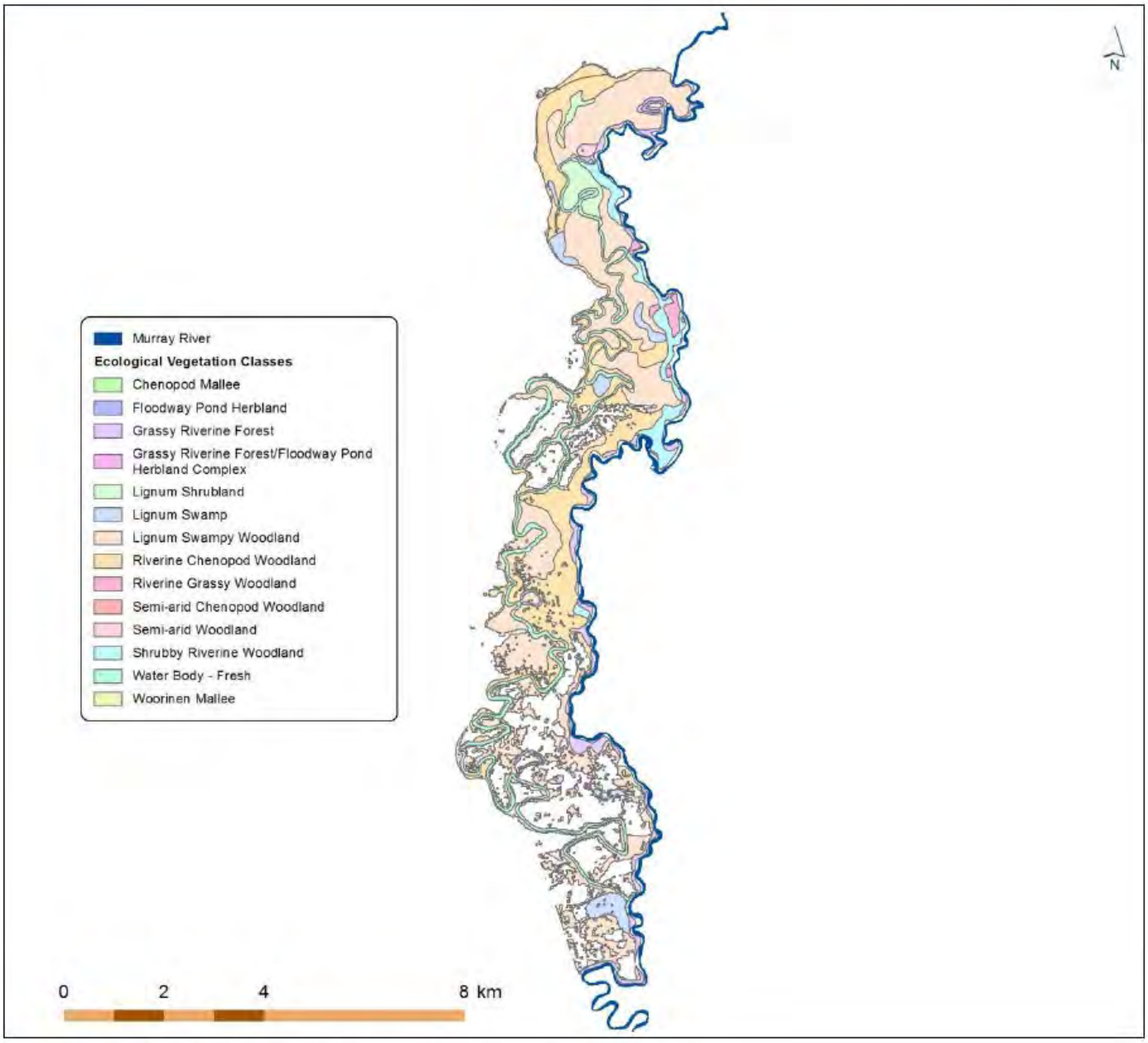


Figure 4-1: Ecological Vegetation Classes present at Burra Creek

Water Regime Classes

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 Burra Creek 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 eight water regime classes (Figure 4-1). Table 4-1 provides a brief description of the five water regime classes at Burra Creek. A more detailed description of the characteristics of these water regime classes is provided in Appendix B.

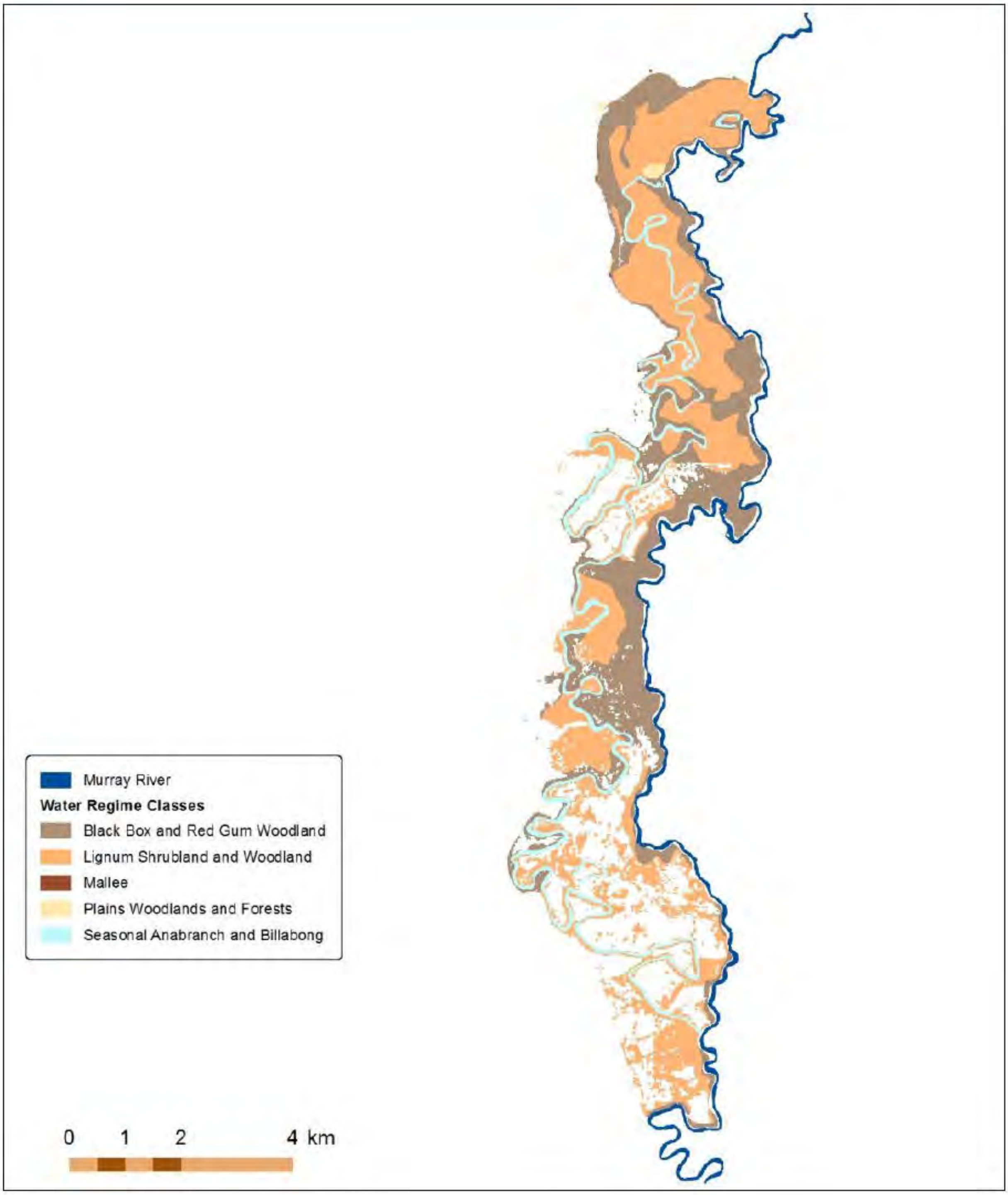


Figure 4-2: Burra Creek Water Regime Classes

Table 4-1 shows that the majority of Burra North is dominated by lignum shrubland and woodland. The proposed supply measure will target the three water regime classes that are most reliant on flooding (Seasonal Anabranch and Billabong; Lignum Shrubland and Woodland; and Black Box and Red Gum Woodland).

Table 4-1: Burra North water regime class areas and corresponding vegetation communities

Water Regime Class	Area (ha)	Area to be watered by this project (ha)	Ecological Vegetation Class
Seasonal Anabranch and Billabong	100	119	Waterbody – Fresh Floodway Pond Herbland
Lignum Shrubland and Woodland	687	230	Lignum Shrubland Lignum Swamp Lignum Swampy Woodland
Black Box and Red Gum Woodland	417	58	Riverine Chenopod Woodland Shrubby Riverine Woodland Riverine Grassy Woodland Grassy Riverine Forest Grassy Riverine Forest / Floodway Pond Herbland Complex
Mallee[1]	1	0	Chenopod Mallee
Plains Woodland and Forest[1]	11	0	Semi-arid Woodland Semi-arid Chenopod Woodland
Unmapped EVCs[2]	1	1	
Total	**1,217**	**407**	

[1] Not inundation dependent.

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

4.3. Current condition

The ecological condition of the Burra Creek has declined due to altered flow regimes, altered inundation patterns and low flow (drought) conditions of the early 2000s. The alteration in water regime is adversely affecting riparian, floodplain and aquatic vegetation, as well as impacting on native fish populations and other fauna.

There has been limited monitoring undertaken in the Burra Cree area. Index of Stream Condition (ISC) assessments conducted in 2010 demonstrate Burra Creek to be in poor condition, with less than 20 percent of priority watering actions met[1]. An Index of Wetland Condition (IWC) assessment conducted in 2010 indicates that wetland condition would improve from moderate to good if the hydrological regime met the requirements.

The condition of water-dependent vegetation along the creek is generally poor with large red gum and black box trees in poor health from an inadequate water regime. Riparian and aquatic macrophytes are largely absent and aquatic fauna such as fish, frogs and tortoise are rare (Ecological Associates, 2014a). Even so, Burra Creek remains one of the best-preserved floodplain woodland and shrubland communities in the western Murray Fans bioregion (Ecological Associates, 2014a). Environmental watering, assisted by temporary works,

[1] http://ics.water.vic.gov.au/ics/, accessed 14 November 2014

has maintained some pockets of river red gum and black box stands in better condition than the rest of the Burra Creek floodplain.

A summary of the current condition of each of the water regime classes targeted by the *Burra Creek Floodplain Management Project* is provided in Table 4-2 below.

Table 4-2: Summary of the current condition of the main water regime classes at Burra Creek

Water regime class	Current condition
Seasonal Anabranch and Billabong	Flooding within the Burra Creek is now too brief to meet the water requirements of flow tolerant aquatic plants and channel specialist fish species. Barriers constructed within the waterway have increased the flow thresholds for through flow in the creek and resulted in a loss of flowing habitat. The condition of flood-dependent vegetation along the creek is poor. Large red gum and black box trees are in poor health from lack of flooding. Riparian and aquatic macrophytes are largely absent and aquatic fauna such as fish, frogs and tortoise are rarely present.
Lignum Shrubland and Woodland	The number of years with flooding has approximately halved under current conditions (see Table 5-2). This has resulted in changes to the vegetation structure. Lignum shrubs are smaller and more widely spaced allowing the groundlayer vegetation to become more dense and diverse. There has been a loss of habitat values for aquatic floodplain fauna such as fish, reptiles and frogs and terrestrial fauna that inhabit these areas between flood periods.
Black Box and Red Gum Woodland	Large floods (> 35,000 ML/d) that inundate this water regime class have not been significantly impacted by river regulation.

Source: Ecological Associates (2014)

Signs of recovery in canopy health at Burra Creek during an environmental watering delivery (2014)

4.4. Past management activities and actions

The Burra Creek area has been strongly influenced by past management activities. As discussed in section 1.3 the southern part of Macredie Island has been cleared for irrigated agriculture. The delineation in land use of Crown Land north of the Piambie channel and the private land to the south is clearly shown in Figure 1-2.

Burra Creek has been modified extensively and now features 24 blockages that impede flow (Figure 4-3). Many are historic and now redundant, while others still provide trafficable access onto Macredie Island. Addressing barriers to flow at key sites on the floodplain is an important component of the *Burra Creek Floodplain Management Project.*

An emergency environmental watering program was initiated in 2003-04 in response to the creek's poor condition and in an effort to prevent catastrophic ecosystem collapse. Over the next five years, environmental water was delivered to the creek using both irrigation and temporary portable pumps. The entire length of Burra Creek received environmental water however it was difficult to achieve the required depth, duration and extent to water stands of riparian red gum and black box. Temporary earthen levees were used to contain water in some areas and increase the depth, duration and extent of flooding. Vegetation in these areas showed a marked improvement (see photos on page 22).

The forest now has a greater level of environmental protection since being reclassified as a River Murray Reserve (VEAC, 2008). Management activities for River Murray Reserve include, but are not limited to, management of pest species, managing fire, preserving natural values and providing recreational opportunities.

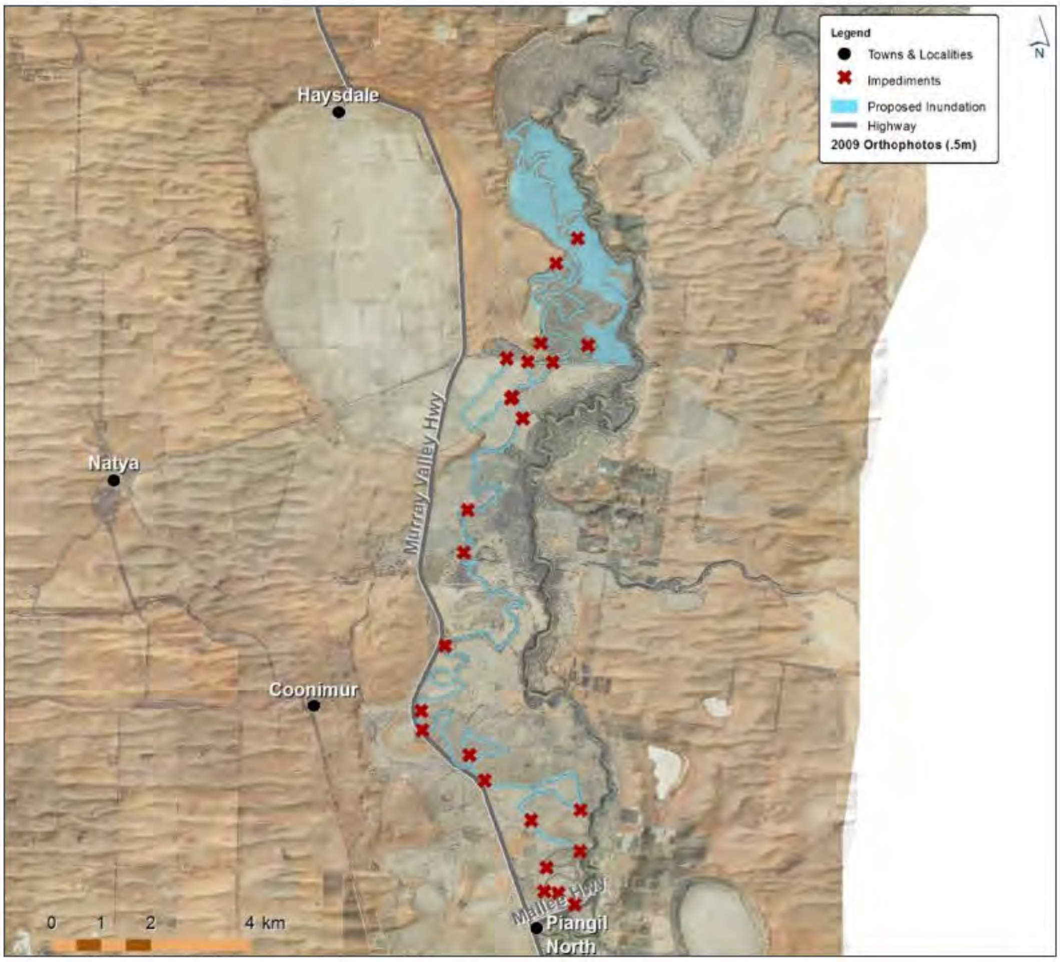


Figure 4-3: Impediments to flow in Burra Creek

Burra Creek in 2014; an area where environmental water requirements were not achieved

Burra Creek in 2014; an area where environmental water requirements were partially achieved

4.5. Other values

In addition to its ecological importance, Burra Creek has important social, economic and cultural values.

Cultural values

Prior to European colonisation, Aboriginal people occupied all aspects of the Victorian landscape. Floodplain studies along the River Murray and its tributaries in the Mallee region have shown that the landform type of the Burra Creek floodplain is generally highly sensitive for Aboriginal cultural heritage values and evidence of past Aboriginal occupation (Bell, 2013).

Sites found within Burra Creek conform to what is known of regional human occupational patterns. Approximately 80 percent of all previous recorded sites are within one kilometre of the River Murray, with most of the balance associated with other wetland environments.

Currently there are no known recorded historic or European cultural heritage values within the proposed Burra Creek works area. This was confirmed via searches of the following (Bell, 2013):

- Heritage Victoria Register and Inventory
- Swan Hill Rural City Council planning schemes and heritage overlays
- GeoVic planning schemes heritage overlays
- Rural City of Swan Hill Heritage Study Stage II: heritage place datasheets (Lovell et al, 2001), and
- Register of the National Estate: Australian Heritage Places Inventory.

Social and economic values

The Burra Creek project site forms part of the River Murray Reserve, which is highly valued for recreation. Major forest-based activities include camping, fishing, canoeing, trail-bike riding and horse riding (DSE, 2004).

The Burra Creek site is also important for economic reasons. The Piambie channel transects the site and is used to convey irrigation water to irrigated horticulture to the west of the project site. The surrounding agricultural land is a major economic resource for the region.

The area is a popular camping destination, attracting visitors from within and outside the district who inject money into the local economy by purchasing supplies during their stay.

5. Ecological objectives and targets (Section 4.3)

Ecological objectives and targets have been developed for the Burra Creek site, drawing on a range of approaches and recommended lines of enquiry including:

- the overarching objectives in Schedule 7 of the Basin Plan
- the Basin-wide Environmental Watering Strategy (MDBA, 2014)
- a review of relevant literature including monitoring data from the TLM initiative (Henderson et al, 2012; Henderson et al, 2013; Henderson et al, 2014)
- desktop and field based flora and fauna surveys (Lumsden, 2007), (Brown et al, 2013)
- site visits, and
- 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).

5.1. Overarching ecological objectives

The overarching objective of water management at Burra Creek is:

*"to **protect and restore** the key species, habitat components and functions of the Burra North ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities".*

This will be achieved by using infrastructure to better meet the water requirements of Burra Creek and its northern floodplain. The proposed works will enable wide spread inundation and have been designed to operate in conjunction with Basin Plan flows. Under low River Murray flows the system can also be watered by temporary pumps, providing protection through drought periods.

5.2. Specific objectives and targets

Specific ecological objectives have been developed for the proposed supply measure based on the key water-dependent values of Burra Creek and the northern floodplain. The objectives will contribute to 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: and

(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 listed threatened species or 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.

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; and

(b) ecological processes depend on hydrologic connectivity longitudinally along rivers, and laterally, between rivers and their floodplains (and associated wetlands) are protected and restored: and

(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: and

(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: Specific ecological objectives and targets for Burra Creek (Ecological Associates, 2014a)

Specific objective	Ecological Targets	Water regime class	Associated Basin Plan Objective
Restore seasonal aquatic habitat to Burra Creek	At least two frog species and two vegetation-dependent fish species are present in Burra Creek in spring annually between 2025 and 2035.	Seasonal Anabranch and Billabongs	1,2,4,6,7,8,9,10,11,14
Restore floodplain productivity to maintain resident populations of vertebrate fauna including bats, sugar glider and lace monitor	All red gum and black box 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. The total abundance of bats in Burra North increases by 25% from 2015 levels by 2030.	Lignum Shrubland and Woodland Black Box and Red Gum Woodland	1,2,4,6,7,8,9,10,11,14
Contribute to the carbon requirements of the River Murray channel ecosystem	The average annual carbon load (dissolved and particulate) to the River Murray from Burra North for the period 2025 to 2035 is double 2015 to 2020 levels.	Lignum Shrubland and Woodland Black Box and Red Gum Woodland	1,2,3,4,6,7,8,9,10,11,14

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, and
- 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 undertaken during an environmental watering delivery to Burra Creek (2014)

5.3. Environmental water requirements

The proposed works will provide flexibility to deliver a wide range of environmental watering events to meet the ecological objectives described in Section 5.2.

The hydrological regime experienced by each water regime class has varied from natural due to river regulation and diversions. The environmental water requirements for each water regime class are described in detail in Section 9. Detailed ecological justification and the water requirements of each water regime class is provided in Appendix B.

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 Burra Creek compared to baseline conditions. The proposed measure is required to bridge the gap between Basin Plan flows and the environmental water requirements of Burra Creek.

A detailed analysis of the frequency, extent and duration provided by the proposed measures, in comparison to the natural flow regime, baseline conditions and under Basin Plan 2750 without measure, are provided in Section 8.

Table 5-2: Comparison of water regimes provided by natural, baseline, Basin Plan and the Burra Creek measure (source: Gippel, 2014)

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 %
17,500	Seasonal Anabranch and Billabong	With Measure[1]	90	210	120	152	90
		Natural	98.2	191	157	181	94
		Baseline	68.4	290	84	198	65
		Basin Plan 2750 without measure	85.1	344	110	185	81
30,000	Lignum Shrubland and Woodland	With Measure[1]	20	68	35	152	20
		Natural	21.9	681	35	234	20
		Baseline	11.4	734	41	234	10
		Basin Plan 2750 without measure	12.3	690	38	233	11
35,000	Black Box and Red Gum Woodland	With Measure[1]	3	5000	15	152	3
		Natural	3.5	4203	15	253	3
		Baseline	1.8	17539	23	297	1
		Basin Plan 2750 without measure	1.8	8626	25	297	1

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

Table 5-2 shows:

- shortfalls in **duration** are expected to be largely met by Basin Plan flows, and
- the proposed works can be operated to meet shortfalls in **frequency** across all 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.

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 *Burra Creek Floodplain Management Project*.

Table 5-3: Links between water regime classes and the ecological objectives for Burra Creek and its northern floodplain

Ecological objective	Seasonal Anabranch and Billabong	Lignum Shrubland and Woodland	Black Box and Red Gum Woodland
Restore seasonal aquatic habitat to Burra Creek	✓		
Restore floodplain productivity to maintain resident populations of vertebrate fauna including bats, sugar glider and lace monitor		✓	✓
Contribute to the carbon requirements of the River Murray channel ecosystem		✓	✓

6. Anticipated ecological benefits (Section 4.4.1)

6.1. Current condition and management

The creeks, wetland and floodplain systems of the Burra Creek Floodplain support a variety of aquatic and terrestrial ecological communities (see Section 4). The current condition, and past management activities and actions are discussed in Section 4.3 and 4.4, respectively.

6.2. Ecological benefits of inundation

The proposed Burra Creek supply measure will restore flooding frequency and duration and improve productivity to areas of creek, billabongs and forest.

Drawing upon the ecological response monitoring outcomes associated with previous environmental watering at Burra Creek and at other sites such as the Hattah Lakes, it is expected the observed trend of improved ecological condition (Henderson, 2014) would continue 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 at Burra Creek north below.

Seasonal anabranch and billabong

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; Alluvium, 2013a).

Burra Creek is a deeply incised anabranch with deep pools that would have rarely dried out under pre-regulation condition. The creek would have provided a continuous corridor of riparian vegetation under a canopy of red gum and black box.

An improved flooding regime will promote the growth of in-stream and riparian aquatic macrophytes. Resident populations of small-bodied native fish will recolonise the deep pools within the creek, migrating between pools and the River Murray when water levels are high in spring. Large-bodied fish such as Murray cod will be able to access the creek over a greater range of river flows.

The creek provides a complimentary environment to surrounding floodplain woodland. Snakes, lizards and waterbirds would find prey in vegetation along the creek. Dense riparian vegetation provides shelter to several waterbird species and provides seasonal forage for large herbivores such as western grey kangaroo and black wallaby (Ecological Associates, 2014a).

Lignum shrubland and woodland

Inundation of lignum shrubland represents an extension of the habitat for aquatic floodplain fauna such as fish, reptiles and frogs. Their bushy structure and debris provides a productive substrate for epiphytes that supports high macroinvertebrate productivity and also provides shelter from predators. Floodwater draining from lignum will carry dissolved and particulate carbon as well as algae and invertebrates which will contribute to the food web of the river channel.

Between flood events, lignum is an important habitat for terrestrial vertebrate fauna including snakes and lizards (Ecological Associates, 2014a).

Black box and red gum woodland

Black box and red gum woodland is present on high ground along the river levee and near the terrestrial boundary of the floodplain. The canopy is open and the community has a diverse, shrubby understorey that includes lignum, nitre goosefoot (*Chenopodium nitrariaceum*), spreading saltbush *(Rhagodia spinescens)* and ruby saltbush (*Enchylaena tomentose*). The ground layer comprises low shrubs, herbs and a range of terrestrial grasses.

Tree recruitment and the productivity of the vegetation are strongly linked to flooding. Flooding maintains a diverse tree age structure and a complex understorey plant community that is required by carpet python and other vertebrate fauna.

The diversity of birds is particularly high because black box woodland contributes to the habitat requirements of both riverine and dryland species. Black box woodland supports a high proportion of ground foragers and hollow-nesting species. Black box woodlands are important for canopy feeding bush birds such as superb fairy-wren, little friarbird and blue-faced Honeyeater. Black box woodland also supports seasonal migrants normally associated with higher rainfall areas such as grey fantail and white-bellied cuckoo-shrike.

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 the twelve species of bats and the insectivorous birds found on the Burra Creek floodplain (Ecological Associates, 2014a). Black box in particular is an important habitat component for insectivorous bats.

This project provides a significant opportunity to improve and enhance the important ecological values of Burra Creek and the northern floodplain.

6.3. Proposed ecological benefits

The proposed Burra Creek supply measure addresses deficiencies in the water regime of the northern section of Burra Creek and adjacent lignum and black box floodplain vegetation. When flooded the creek would provide seasonal aquatic habitat for frogs and small fish. Flooding of the adjacent floodplain will improve vegetation health and productivity and connection with the River Murray will enable biota and nutrient exchange.

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

The anticipated ecological benefits that are expected for each water regime class as a result of the project are outlined in Table 6-1.

Table 6-1: Water regime class, strategy, objectives and ecological benefits (Ecological Associates, 2014a)

Water regime	Strategy	Ecological benefit
Seasonal anabranch and billabongs	Remove blockages in the Burra North section of Burra Creek Regulate the channel to capture peaks in flow or to store pumped water.	Restoration of inundation will promote the growth of in-stream and riparian aquatic macrophytes. If deep pools are present, a resident population of small-bodied native fish will establish, migrating between pools and the River Murray when water levels are high in spring.
Lignum shrubland 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.	Lignum grows quickly and forms dense, continuous thickets. Provides an extension of habitat for aquatic floodplain fauna e.g. fish, reptiles and frogs. Provides a productive substrate for epiphytes that support high macroinvertebrate productivity and shelter from predators. Inundated lignum is also used as a platform by nesting waterbirds including ibis and spoonbill. Floodwater draining from lignum will carry dissolved and particulate carbon as well as algae and invertebrates, which will contribute to the food web of the river channel.
Black box and red gum 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.	Tree recruitment and the productivity of the vegetation are enhanced. Inundation maintains a diverse tree age structure and a complex understorey plant community that is required by carpet python and other vertebrate fauna. The diversity of birds is increased because black box woodland habitat improves. Black box woodland supports ground foragers and hollow-nesting species and canopy feeding bush birds such as superb fairy-wren, little friarbird and blue-faced honeyeater benefit. Seasonal migrants such as grey fantail and white-bellied cuckoo-shrike benefit. Habitat improves for insectivorous bats. Floodwater draining from woodland carries dissolved and particulate carbon, algae and invertebrates contributing to the food web of the river channel.

6.4. 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 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
- monitor progress against those targets on a regular basis
- evaluate the implications of the results for the operational parameters of the scheme, and
- 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 accordingly.

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

- evaluating water use
- measuring ecological outcomes against ecological targets
- refining conceptual models and improving knowledge, and
- managing risk.

The Burra Creek 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 and their targets. 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 Burra Creek 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 the 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 Murray-Darling Basin Authority's (MDBA) 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.

Photo point monitoring has been undertaken within the Burra Creek project site during environmental water deliveries, which will provide baseline data for future watering (2014)

7. Potential adverse ecological impacts (Section 4.4.2)

7.1. Overview

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 Burra Creek Floodplain, 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 TLM, 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 Burra Creek Floodplain 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.

7.2. 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, and

- assessments 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.

7.3. 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 of potential adverse ecological impacts with and without 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
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	Possible	Moderate	Moderate	As above.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
	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.					
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. Where possible and useful, water can be disposed within the site (pump to higher wetlands). Continue to undertake water quality monitoring before, during and after watering events to inform adaptive management strategies and real-time operational decision making.	Low
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 Burra Creek 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 pl[redacted]	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
					watering events if sufficient volumes not available.	
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 action plans/strategies). Support partner agencies to seek further funding for targeted weed control programs if necessary.	Low
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	Proliferation of weeds will have impacts on the health of all wetland and floodplain vegetation communities. This, in turn, will impact on	Likely	Moderate	Moderate	Develop and adhere to an Environmental Management Plan (EMP) that includes hygiene protocols, enforcement and contractor	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
due to construction activity	dependent fauna, including threatened species.				management.	
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
Adverse impacts on ecological function and connectivity						
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	Possible	Moderate	Moderate	No specific mitigating actions have been identified. If a bushfire occurs on Burra Creek Floodplain, Parks Victoria and DEPI will respond as us[redacted]	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
	bushfires. An increase in the frequency, extent and duration of bushfire could have impacts on ecosystem form and function.				such situations.	
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
Prolonged inundation of vegetation	Vegetation in the deepest parts of the regulator pool may receive excessive inundation (duration and depth) if the water requirements of vegetation at the perimeter of the pool are met. This is likely to cause localized impacts on vegetation health, possibly death of some less tolerant species.	Possible	Moderate	Moderate	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
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	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 ecosystem response during and after	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
	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.				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).	
Stranding and isolation of fish on floodplains	Stranding can occur through sudden changes in 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.	Possible	Moderate	Moderate	Develop a 'Fish Exit Strategy' to inform regulator 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.	Low
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). Continue to build on knowledge and understanding through current studies relating to fish movement in response to environmental watering and cues.	Low

7.4. 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 Burra Creek Floodplain (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 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.

7.5. 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, and
- 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.

7.6. 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, and
- 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.

Table 7-6: 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 fish downs, 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.	Burra Creek Floodplain 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		
Low DO levels	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) Burra Creek Floodplain 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.	Burra Creek 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

8. Current hydrology and proposed changes (Section 4.5.1)

8.1. Pre-regulation river hydrology

Burra Creek is located immediately upstream of the River Murray and Wakool River conjunction. River Murray flow at Burra Creek is influenced by the Murray and Goulburn Rivers and all upstream River Murray tributaries. Burra Creek experiences its largest floods when the River Murray and its upstream tributaries are inundated, generally occurring from late winter to early summer.

Burra Creek is a deeply incised anabranch of the River Murray extending over 54 kilometres through the Burra Creek floodplain. The creek diverges from the River Murray downstream of Piangil at 1320 river kilometres and re-joins the River Murray at 1296 river kilometres. The area between the creek and the River Murray forms Macredie Island.

Water first enters Burra Creek at the downstream river connection when River Murray discharge exceeds about 17,000 ML/d (pers. comm. Malcolm Thompson Mallee CMA 14/8/14 cited by Ecological Associates, 2014a). Under natural conditions, high river levels created sustained and almost annual flow in Burra Creek during winter and spring providing permanent aquatic habitat in the deep pools of the creek.

The creek became completely connected at river discharges of approximately 20,000 ML/d (Alluvium, 2013; Jacobs, 2014) creating through flow conditions within the waterway.

Floodplain inundation commences in the central part of the island at flows exceeding 27,500 ML/d as water spills out of Burra Creek and from River Murray effluents (Ecological Associates, 2014a). These areas are mainly vegetated by lignum swamp.

The floodplain in the Burra North area is completely inundated at flows exceeding 30,000 ML/d (Jacobs, 2014). This results in additional flooding of low-lying areas including lignum shrubland and woodland (Ecological Associates, 2014a). Prior to regulation River Murray flow events of 30,000 ML/d were a regular occurrence at Burra Creek, with a median frequency of 2.1 events in 10 years. The period between successive 30,000 ML/d flow events extended for approximately 2 years, (mean interval of less than 681 days) (Gippel, 2014).

A discussion of the changes from the pre-regulation hydrology is provided below.

8.2. Current floodplain hydrology

Floodplain modifications

As discussed in section 4.4, there are over 24 blockages in Burra Creek. The key implications of these artificial blockages (Alluvium, 2014; Bain, 2013; Ecological Associates, 2014a; Jacobs, 2014) are summarised below:

- the movement of backwater that enter the downstream connection at river flows of 17,500 ML/d is impeded by blockages.
- the flow threshold of the upstream connection of the creek has been raised from 20,000 ML/d to 30,000 ML/d impacting on the capacity of the creek to sustain through-flows.
- water delivered through an effluent in the mid-section of Burra Creek when river discharge exceeds about 20,000 ML/d is unable to spread throughout the creek due to banks and narrow culverts (Jacobs, 2014).
- through-flow now occurs with a frequency of 1 in 10 years and with a median duration of less than one month (Ecological Associates, 2014a) compared to almost annual under natural conditions.

Changed hydrology

The hydrology of the River Murray at Swan Hill was analysed under natural and current conditions (Ecological Associates, 2006). Median monthly flow peaks have declined under current conditions 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 as illustrated in Figure 8-1 (Ecological Associates, 2014a).

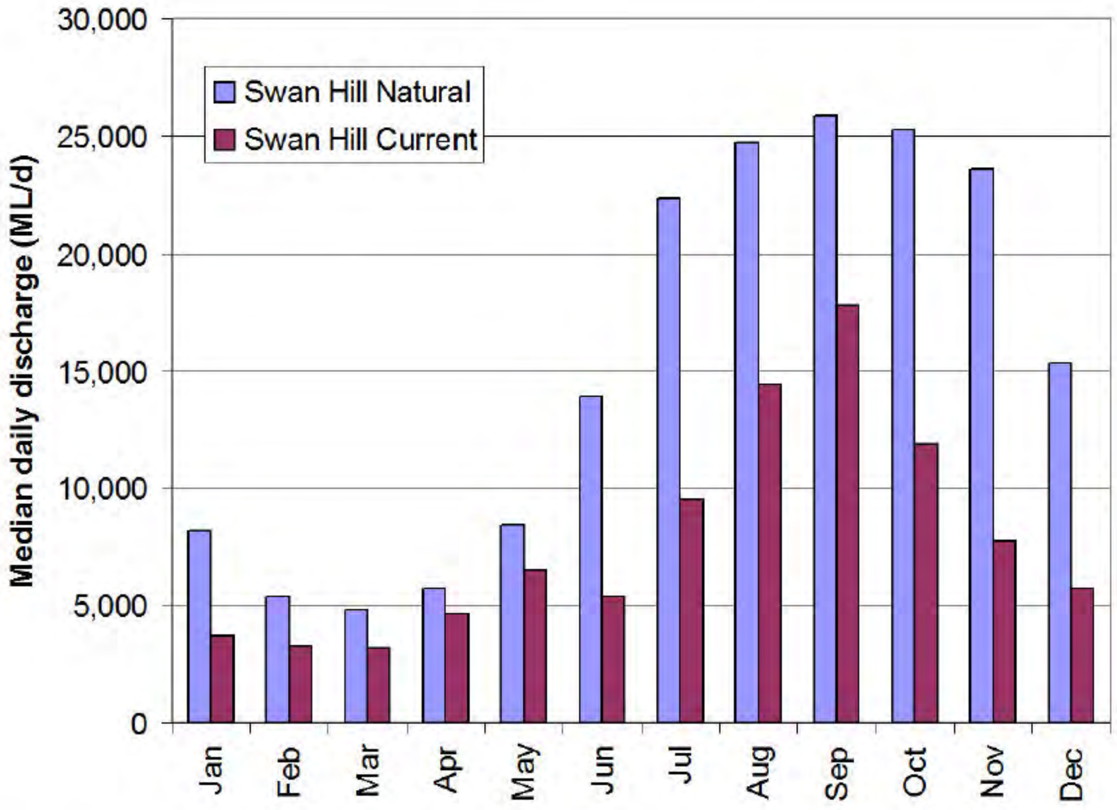


Figure 8-1: Distribution of median flows for each month in the River Murray for natural and current conditions. Derived from MDBC MSM-Bigmod 109 year data (Ecological Associates, 2006)

Spells analysis of River Murray modelling outputs (Figure 8-2) shows that compared to natural conditions:

- flows of less than 10,000 ML/d now occur for long periods
- flows of 20,000 ML/d has almost halved in duration and the frequency declined from 10 events every 10 years to only six events, and
- the frequency of 30,000 ML/d flows has halved from 2 events to 1 every 10 years.

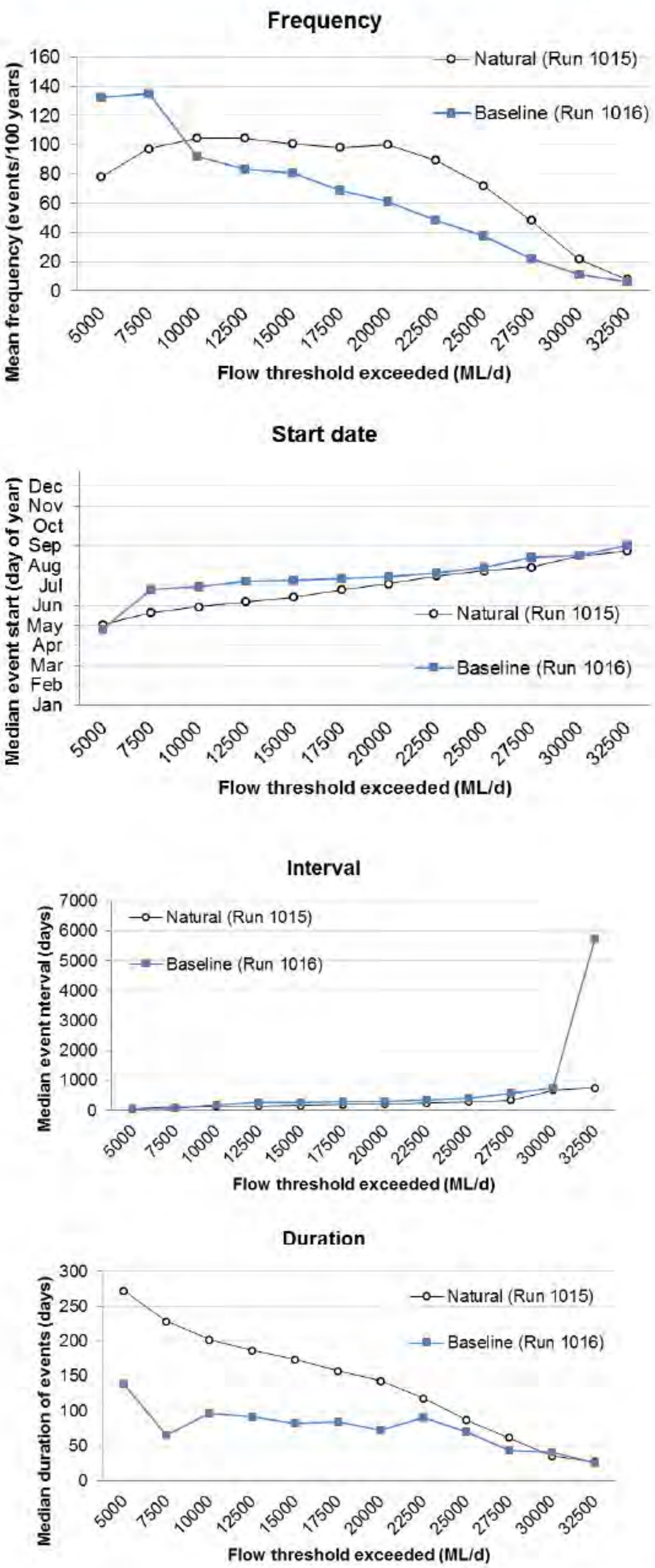


Figure 8-2: Spell event frequency, median duration and median interval for natural (unregulated) and current conditions (Swan Hill gauge). Derived from MDBC MSM-Bigmod 109 year data (Ecological Associates, 2006)

The river is now managed in a low-flow state for a greater proportion of time in order to deliver water efficiently to downstream consumers. The low-flow component of the hydrology is characterised by a high frequency of brief flow peaks less than 10,000 ML/d (Figure 8-2).

Hydraulic modelling of Burra Creek under current conditions shows that there is connection of the waterways with River Murray at 22,500 ML/d, flow through and floodplain engagement at 27,500 ML/d, with more widespread floodplain inundation at 30,000 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 than shown in Figure 8-3.

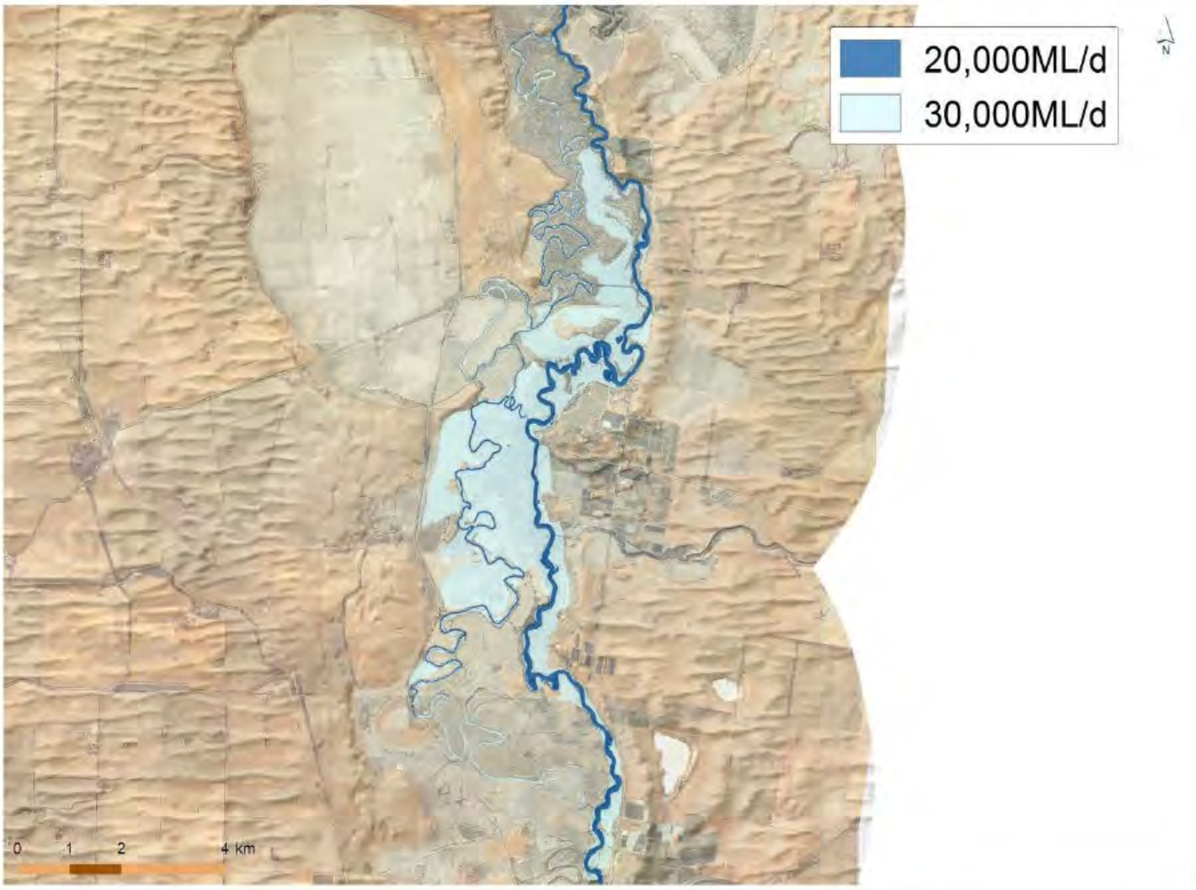
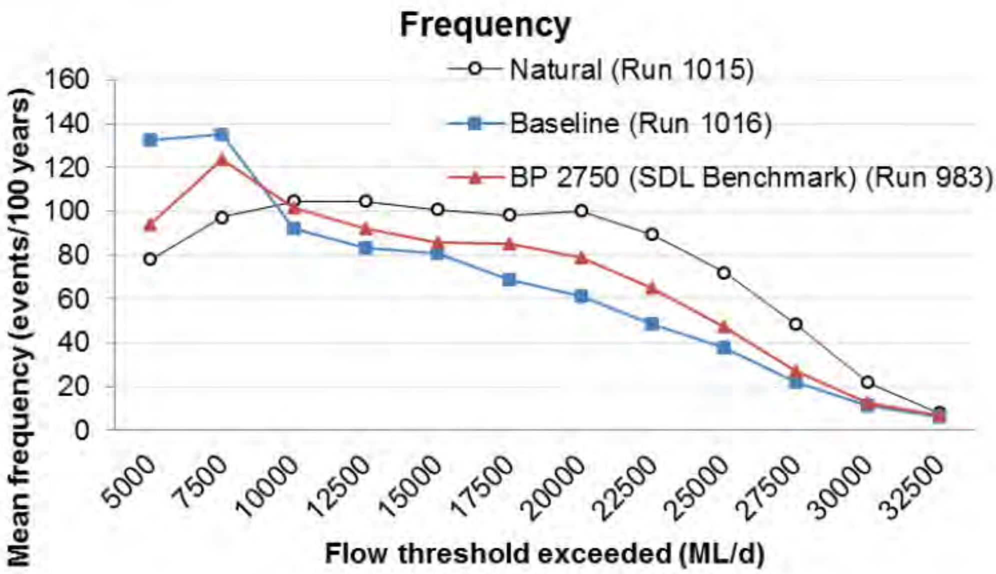


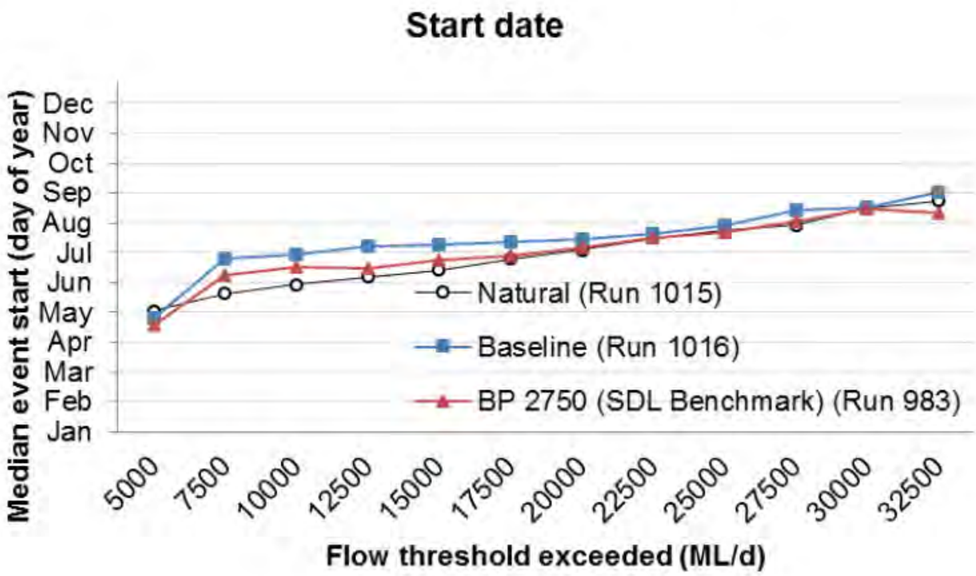
Figure 8-3: Burra Creek inundation at current conditions for flows of 20,000 and 30,000 ML/d (Jacobs, 2014).

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 Burra Creek (Table 8-1). For example flows of 17,500 ML/day will occur 6.8 times in 10 years under baseline, 8.5 times under Basin Plan and 9.8 naturally. By comparison flows of 30,000 ML/day will occur once in 10 years under baseline, 1.2 times under Basin Plan and 2 naturally.


Frequency
Natural (Run 1015)
Baseline (Run 1016)
BP 2750 (SDL Benchmark) (Run 983)
Mean frequency (events/100 years)
160
140
120
100
80
60
40
20
0
5000
7500
10000
12500
15000
17500
20000
22500
25000
27500
30000
32500
Flow threshold exceeded (ML/d)


Start date
Median event start (day of year)
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
Natural (Run 1015)
Baseline (Run 1016)
BP 2750 (SDL Benchmark) (Run 983)
5000
7500
10000
12500
15000
17500
20000
22500
25000
27500
30000
32500
Flow threshold exceeded (ML/d)

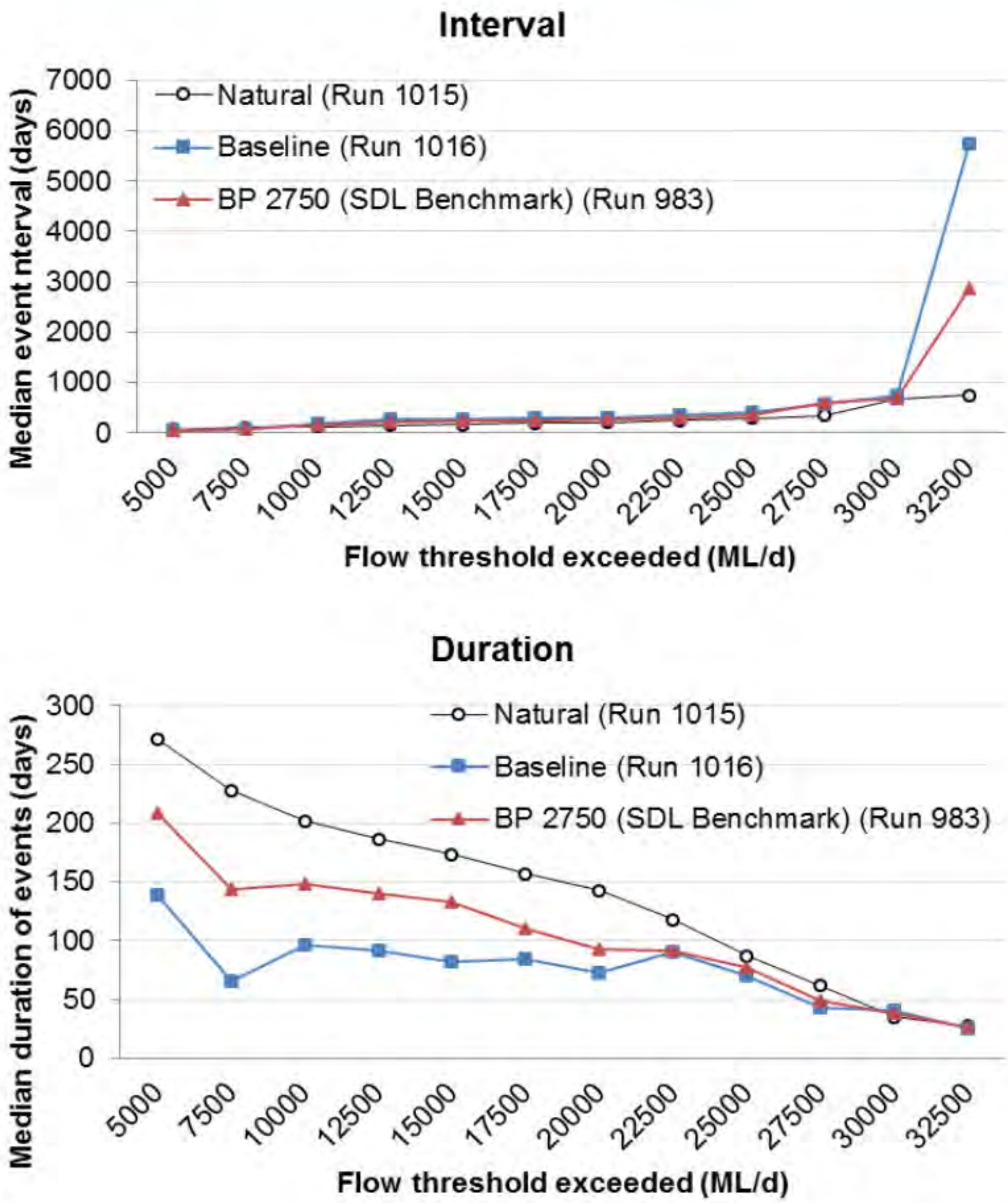


Figure 8-4: Comparison of statistical properties of events at Swan Hill under the Natural, Baseline and BP 2750 modelled flow scenarios, over a 114 year modelled period

Table 8-1: Proposed operating plan to meet the shortfall in flood frequency and duration for Burra Creek North under the Basin Plan (2750) without measures scenario (source: Gippel, 2014)

Threshold (ML/d)	WRC	Conditions	Prevalence yrs with event %	Duration Median (days)	Timing	Proposed operations to meet gap	
						Frequency (year in 100)	Approx. Duration
17,500	Seasonal anabranch and billabong	With Measure[1]	90	120	Late autumn – early winter	10	4 months
		Basin Plan without measure	81	110	Late autumn – early winter		
30,000	Lignum Shrubland and Woodland	With Measure[1]	20	35	Late autumn – early winter	10	5 weeks
		Basin Plan without measure	11	38	Late winter		
35,000	Black Box and Red Gum Woodland	With Measure[1]	3	15	Late autumn – early winter	2	2 weeks
		Basin Plan without measure	1	25	Early spring		

[1] 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 between the Basin Plan and target flows will be:

- one year in ten to meet the frequency requirements for seasonal anabranch and billabongs
- one year in ten to meet the frequency requirements for lignum shrubland and woodland, and
- During extended dry periods only to address the gap in the frequency requirements for black box and red gum woodland.

Table 8-1 also shows the Basin Plan flows will:

- meet the duration requirements once flow thresholds are exceeded for each of the water regime classes, and
- typically occur later than the proposed start date for operations which is consistent with the variability that will be incorporated into the proposed operations.

Flows which result in flooding across broader expanses of the Burra Creek North floodplain e.g. lignum shrubland and woodland, will also result in flooding of the lower lying areas where the seasonal billabongs and watercourses 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 8-5. The flow regimes represent a wetter than average sequence of years (1990s) and an extremely dry sequence of years (2000s).

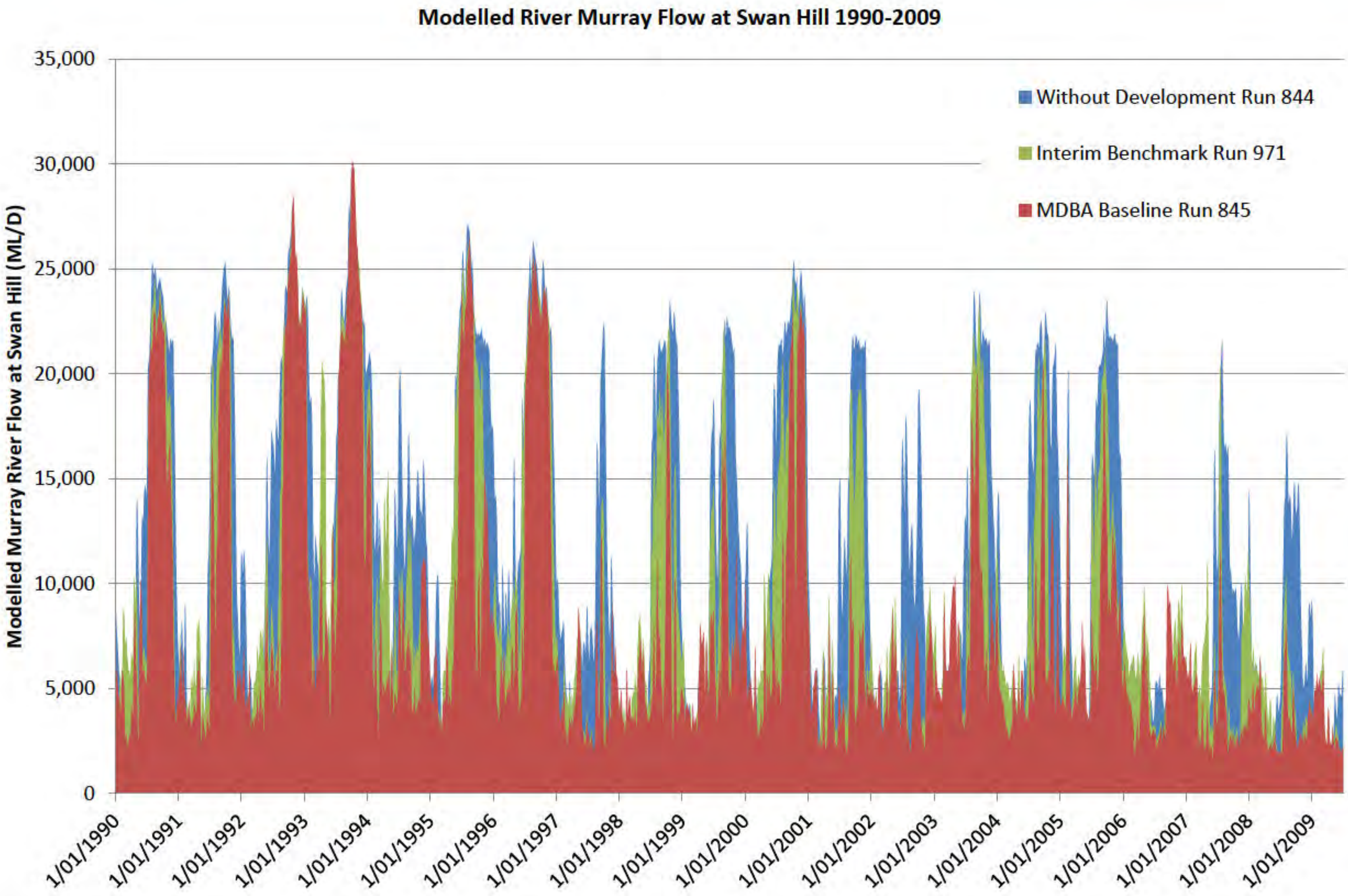


Figure 8-5: Daily Peak Flow by year for different flow regimes at Swan Hill (Data supplied Mallee CMA, 2014)

9. Environmental water requirements (Section 4.5.2)

The environmental water requirements of the *Burra Creek Floodplain Management Project* have been identified (**Table 5-2** and Table 8-1) and contribute to the achievement of ecological objectives and targets for this site (Ecological Associates, 2014).

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).

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

- Seasonal Anabranch and Billabongs
- Lignum Swamp and Woodlands, and
- Black Box and Red Gum Woodlands.

The Burra Creek system will support a diversity of water depths in accordance with landscape formations and topography. The creek is deeply incised enabling an approximate water depth of 3 – 4 meters during operation of the works.

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 (adapted from Gippel, 2014)

Water Regime Class	Flow threshold	Strategy	Frequency	Duration	Timing
Seasonal Anabranch and Billabongs	17,500 ML/d	Regulate the channel to capture peaks in flow or to store pumped water.	9 years in 10	Variable, typically 4 months	Late autumn – early winter
Lignum Shrubland and Woodland	30,000 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.	2 years in 10	Variable, median duration of 20 days	Late autumn – early winter
Black Box and Red Gum Woodland	35,000 ML/d	Enhance health by flooding lignum shrubland and woodland areas adjacent to this water regime class	Infrequent operations expected	Some operations to extend duration may be required	Late autumn – early winter

10. Operating regime (Section 4.6)

10.1. Role of the structures

The proposed works consist of three environmental regulators and a support levee.

The works, in conjunction with Basin Plan flows, will be the primary means of delivering water to Burra Creek and achieving the ecological objectives for the site.

In summary, the structures will be operated to achieve environmental watering targets in three ways:

- under normal flow conditions (when no environmental watering is occurring) all regulators will be open.
- when a peak flow is anticipated, the regulator will remain open to allow floodwater to enter and to allow movement of aquatic fauna between the river and floodplain. As the river levels fall, the regulators will be closed to store flood water. The level at which water is stored will depend on the ecological objectives of the event. When the hydrological targets of the watering are met, water will be released back to the river.
- if peak flows are too infrequent to meet environmental watering targets, part or all of the system may be flooded by temporary pumps[3] installed on the river bank.

These works and the existing infrastructure is described in Table 10-1. The volume in Table 10-1 was 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.

Table 10-1: Role of proposed environmental watering infrastructure at Burra Creek

<table>
<tr><th>Infrastructure[4]</th><th>Role</th><th>Associated Area</th><th>Inundation Area (ha)</th><th>Volume (GL)</th></tr>
<tr><td>B1 Regulator</td><td>Retain water during a managed event as well as controlling flows between Burra Creek and the River Murray.
The drop structure is to protect against erosion when the B1 Regulator is releasing water to the river.</td><td rowspan="4">Whole of project</td><td rowspan="4">407</td><td rowspan="4">3</td></tr>
<tr><td>B2 Regulator</td><td>To contain flow in the system during a managed inundation event and prevent it flowing upstream into the Burra South forest.</td></tr>
<tr><td>B4 Regulator</td><td>Retain water during a managed event as well as controlling flows between Burra Creek and the River Murray.</td></tr>
<tr><td>Levee</td><td>Contain the water within the floodplain as well as passing natural flows</td></tr>
</table>

[3] Pump infrastructure is not part of the design package
[4] There are no existing environmental regulators at Burra Creek North

10.2. Operating scenarios

The Burra Creek 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 in order to summarise the range of scenarios possible. These include:

- Default
- Seasonal Fresh
- Burra Intermediate
- Burra Maximum, and
- Natural Inundation.

Each scenario aligns with the water regime classes for Burra Creek North, as illustrated in Table 10-2 below.

Table 10-2: Links between the operating scenarios and water regime classes at Burra Creek North

<table>
<tr><th>Corresponding river flow</th><th>20,000 ML/d</th><th>20,000 - 30,000 ML/day</th><th>30,000 ML/day</th><th>> 30,000 ML/day</th></tr>
<tr><td>Seasonal anabranch and billabongs</td><td>Seasonal Fresh</td><td rowspan="2">Burra Intermediate</td><td rowspan="3">Burra Maximum</td><td rowspan="3">Natural flows
All structures open</td></tr>
<tr><td>Lignum shrubland and woodland</td><td></td></tr>
<tr><td>Black box and red gum swamp woodland</td><td></td><td></td></tr>
</table>

Table 10-2 shows that a seasonal fresh meets the water requirements of seasonal anabranches (Parnee Malloo Creek). Similarly, a Nyah maximum operation will meet the requirements of the Red Gum Swamp Forest, as well as the seasonal wetlands and anabranches.

An overview of each of the operational scenarios is provided below.

Default

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

In this scenario all environmental structures are to be open.

Seasonal Fresh

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

During this scenario all environmental regulators would remain in their default position of open.

Burra Intermediate

Intermediate operation of the Burra Creek regulators will enable watering of Burra Creek and the lower floodplain in the south more frequently without inundating upper floodplain areas. This scenario requires the opening of B1, B2 and B4 during Basin Plan or natural flows. Once flows begin to recede, B1, B2 and B4 are closed to manage inundation to the desired target level for an appropriate duration. Natural inflows maybe augmented by temporary pumps.

Burra Maximum

Maximum operation of the Burra regulators and their associated support structures will enable watering of Burra Creek and the upper floodplain areas. This scenario requires the opening of B1, B2 and B4 during Basin Plan or natural flows. Once flows begin to recede, B1, B2 and B4 are closed to manage inundation to the maximum operating level for an appropriate duration. Natural inflows maybe augmented by temporary pumps.

Natural Inundation

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, Burra Creek and the floodplain.

Transition between operating scenarios

For a range of reasons it may be necessary to change between operating scenarios 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, and
- response to water quality risk mitigation requirements.

An operation matrix (Table 10-3) 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 Burra Maximum B1, B2 and B4 would be opened to allow River Murray flows to enter Burra Creek and closed to augment flow with temporary pumps if required.

The 'Condition during scenario' sections of the matrix show the status of the structures once each scenario has been established and is in operation. This matrix shows a selection of available operational configurations for the purposes of illustrating the flexibility of the works package.

During transition to all structure open under flood conditions, regulators are progressively opened until tail water and headwater levels are matched. The structure may then be completely opened to allow unimpeded passage of natural flows.

Table 10-3: Operational matrix

	Scenario	Default	Seasonal Fresh	Burra Intermediate	Burra Maximum	Natural Flows
From	To					
	Default	Condition During Scenario All structures open	No change	B1, B2, B4 – set to maintain target level	B1, B2, B4 – set maximum level 58.7 m AHD	No change
	Seasonal Fresh	All structures open	Condition During Scenario All structures open	B1, B2, B4 – set to maintain target level	B1, B2, B4 – set maximum level 58.7 m AHD	No change
	Burra Intermediate	All structures open	All structures open	Condition During Scenario B1, B2, B4 – set to maintain target level	B1, B2, B4 – set maximum level 58.7 m AHD	All structures open
	Burra Maximum	All structures open	All structures open	B1, B2, B4 – set to maintain target level	Condition During Scenario B1, B2, B4 – set maximum level 58.7 m AHD	All structures open
	Natural Flows	No change	No change	B1, B2, B4 – set to maintain target	B1, B2, B4 – set maximum level 58.7 m AHD	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, and
- the 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 Burra Creek Floodplain 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	The Burra Creek Floodplain 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 Burra Creek 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 eve[redacted]	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 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. ***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 dramatic changes to operational outcomes. Models independently peer-reviewed and	Moderate

					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	A small area of private land will be inundated by this project. This land is currently managed for conservation however it is possible that ownership could change and the new owner may not permit inundation.	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. Design-based mechanisms to exclude flooding from areas of private land built into project.	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, and
- 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 *Burra Creek Floodplain Management Project* has been completed which includes analysis of both Basin Salinity Management Strategy (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 Basin Salinity Management Strategy (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 *Burra Creek Floodplain Management 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.

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).

There is some uncertainty related to assumptions made in the analysis. Where uncertainty was identified for a given parameter, a conservative value was assumed or upper bound used. This approach is likely to overestimate the magnitude of the salt load.

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

Preliminary salt estimate

The preliminary salinity impact estimate for the *Burra Creek Floodplain Management Project* is 0.041 EC for the nominated frequencies of inundation. This impact is deemed 'not significant' under the BSMS. The preliminary analysis does not account for implementation of mitigation strategies.

The real-time salinity impact immediately downstream of Nyah 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 estimated impact is not deemed significant under the BSMS, any potential impacts can be minimised using suitable mitigation strategies. The availability of dilution flows and their relative volume, duration and timing of release are important considerations for designing suitable mitigation strategies with more sophisticated control of diversion and release for these projects (SKM, 2014). Without further detail on the whole-of-river operations it is not feasible to undertake the myriad of possible modelling scenarios required to determine the most appropriate mitigation strategy.

Mitigation strategies are therefore described below in general terms. More detailed analysis of the potential salinity impacts and risk mitigation strategies is recommended upon approval of this business case, potentially using a daily river operations model. This will 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 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 to bring fresher water into wetlands and minimising the salt impact on the release,
- optimising the timing of releases so that water is released into a higher river, and

- optimising the rate of release so that, if high salinity water must be released, localised impacts can be minimised.

Monitoring requirements and further analysis

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:

- three new bore sites to be drilled close to the inundation areas
- four data logger sites to capture continuous salinity and water level data – additional sites may be required where inundation activities present access issues, and
- Five bore sites monitored for water level and salinity before, during and immediately after watering events, and every three months between events.

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 *Burra Creek 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 by:

- 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 avoiding 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, and
- erosion control 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 tailwater develops.
- pass higher flows through purpose designed overflow sills, with rock protection, located on natural flow paths.
- overtop the earthen levee only after the tailwater is fully developed and the levee/track is near submerged by the tailwater.

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.

Outcomes from the workshop relevant to design of the Burra Creek included:

- Engineering designs will incorporate appropriate and practical mechanisms to ensure fish passage to and from the river through regulating structures can occur.
- The B1 Regulator has been designed to provide low velocities for fish passage directly through the regulator. There is limited fish passage through the B2 Regulator's pipe culvert. Fish passage occurs in situations of low or static flow and over the embankment in high flows. No fish passage has been allowed for through the pipe culvert of the B4 Regulator (Jacobs, 2014).

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 maximum design water level (DWL), and a freeboard allowance of up to 0.5m.

Minimum freeboard of 0.3m above design water level (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

Concept designs have been prepared for the proposed works, as described in Section 3.2. Concept designs drawings for each structure is provided within the design report (Appendix E.)

Figure 12-1 shows the plan and section view of the proposed B1 Regulator incorporating road crossing and provision of an area protected from traffic for operators to manipulate the gates.

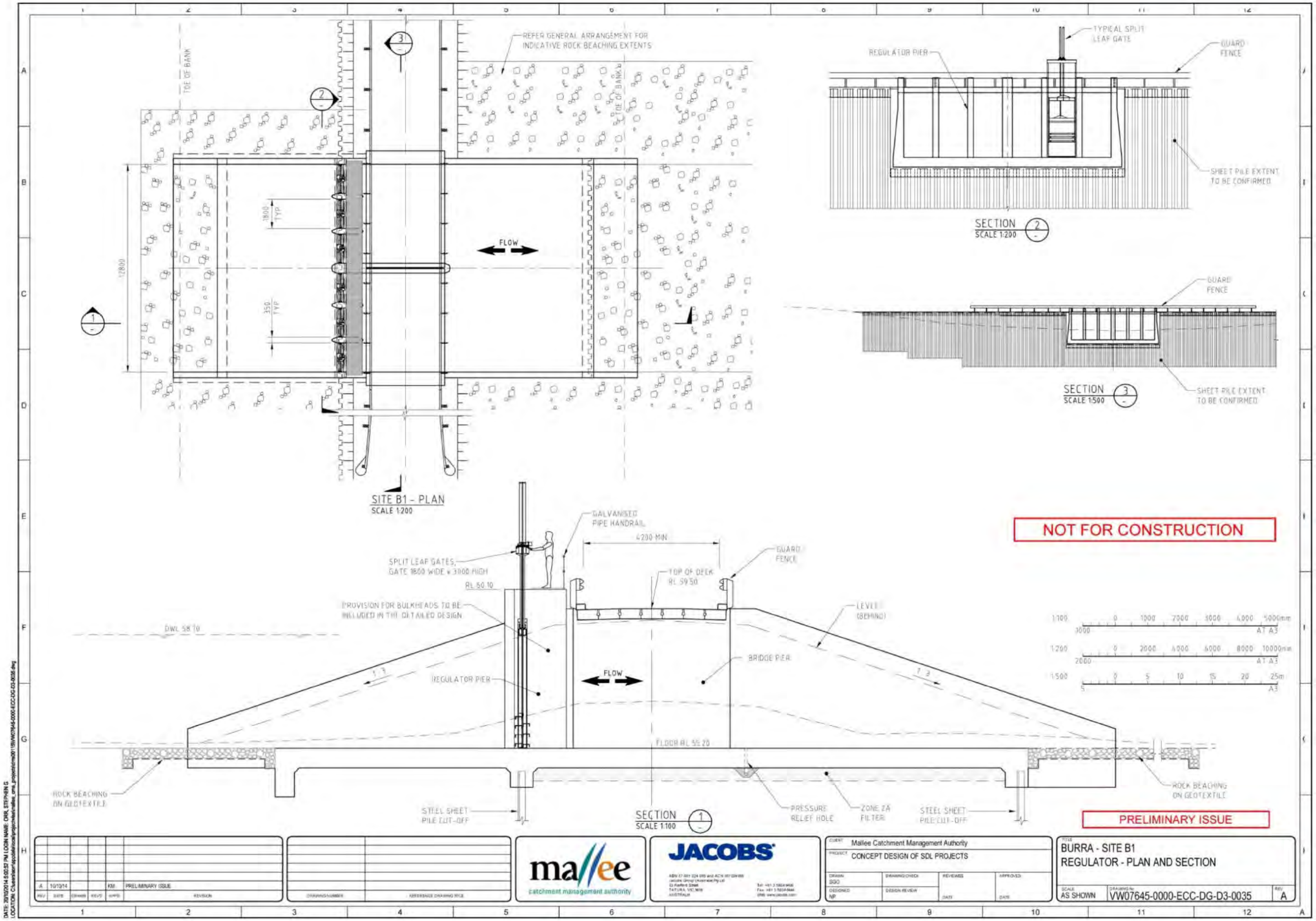


Figure 12-1: General arrangement for the B1 Regulator (Jacobs 2014a).

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).

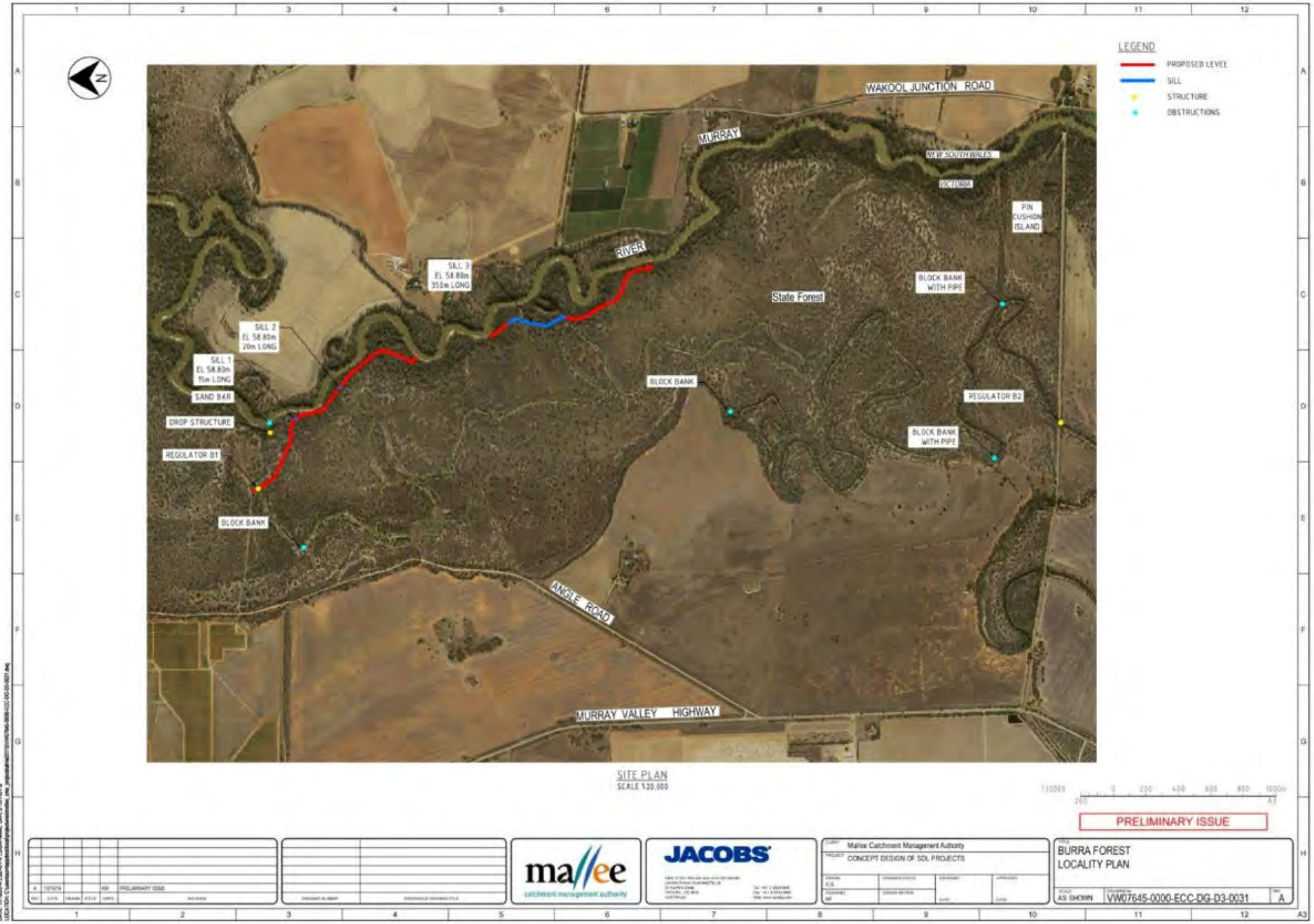


Figure 12-2: Location of the Burra Creek Floodplain Management Project proposed works.

12.5. Geotechnical investigation results

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,2014)

12.6. Alternative designs and specifications

A number of different options were considered when investigating the most effective design for watering the Burra Creek floodplain. Detailed analysis (GHD, 2014) was carried out on the three additional options to the preferred option including:

- Burra Creek North – Option 1
- Burra Creek North – Option 2 (tiered inundation)
- Burra Creek South – Option 3
- Burra Creek South – Option 4 (higher level).

A summary of the key elements of the options considered is presented in Table 12-1. Each of the four options was assessed against a range of design considerations (section 12.1) which resulted in the selection of Burra Creek North – Option 1 was selected as the preferred option on the grounds of practicality of implementation and cost effective delivery of ecological outcomes.

Table 12-1: Options that were subject to detailed analysis (GHD, 2014)

Options		Details	Area Inundated
Option 1	Burra Creek North	Current concept drawings (as described in Section 3.2)	407 ha
Option 2	Burra Creek North	This option waters the same area as the preferred option, but with two tiers that would separate the watering regime for higher areas of the floodplain. This could be added as a subsequent stage to the preferred option.	407 ha
Option 3	Burra Creek South	This involved watering 124 ha of the floodplain to 59.3 m AHD with a small regulator and some raised tracks on the eastern side of the area, adjacent to the River Murray.	124 ha
Option 4	Burra Creek South	Increases the DWL over the site to 59.4 m AHD. A rock weir would be needed to control outflows to the site.	150 ha

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 organisational capacity including data management and asset management systems required to maintain and operate large works. The team also have systems in place to manage data generated by operations including water accounting and water quality monitoring data.

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

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 Burra Creek 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 experts engaged to review the engineering components of this project were Phillip Cummins and Shane McGrath.

13. Complementary actions and interdependencies (Section 4.9)

The proposed *Burra Creek 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 Murray-Darling Basin Authority (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 and natural cues 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; however water quality impacts will be substantially offset due to increased Basin Plan flows in the River Murray.

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 Burra Creek project and the proposed Belsar-Yungera Floodplain Management Project on downstream water quality will need to be monitored. It is expected that Basin plan flows will more than meet any dilution flow requirements of the 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 works in conjunction with the proposed Belsar-Yungera Floodplain Management Project and high river flows will dramatically increase available floodplain habitat for flood-dependent fauna beyond that provided by operation in isolation.

Holistic planning across the Basin will be required to mitigate potential negative impacts and maximise the social and ecological contribution of the Burra Creek 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; and
- 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, and
- 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

The total project cost is $12,138,362 (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 of cost escalation either accounting for the taken from estimating the cost to the time for construction to commence or for escalation during execution of the project. 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 $7,787,033. This 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 an Expert Review Panel, comprised of recognised experts (as described in Section 17 and see Appendix 7).

Contingencies form 48 percent of the total capital costs. In additional to these contingency specifically costed risks including, inundation from flooding, wet weather delays and delays due to approvals during construction have been included. This reflects the current level of development of designs and incorporates, but is not limited to, contingencies associated with geotechnical uncertainty.

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 that:

- 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]

[redacted]

[redacted]

[redacted]

[redacted]

[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 final operating strategy is yet to be finalised, Table 14-3 presents operating costs as an average annual cost and maximum annual cost to reflect the range environmental water delivery costs, including temporary pumping. Operation and maintenance costs 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.

[redacted]

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, and
- 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, and
- 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 52 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 0.3% 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 0.3% 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 Burra Creek project was estimated to increase the net annual tourist visitor days to the site by 1,000 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 1,000 visitor days was estimated.

The economic value of these four[10] quantified economic benefits associated with the Burra Creek 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	$0.1	$0.9
Native fish population	$0.37	$3.3
Frequency of colonial water-bird breeding	$0.1	$1
Recreation	$0.1	$1.5
Total	$0.7 million	$6.7 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 Burra Creek 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 Burra Creek 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 $8.9 million per year of gross output and 21 jobs in the region. After this construction phase, annual operations and maintenance expenditure will result in output of $382,000 per annum and 1 additional job in the region.

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 and project partners have worked with key stakeholders and interested community groups to develop the concept for the Burra Creek 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 approaches have included:

- More than 80 face-to-face briefing sessions, meetings, presentations and on-site visits, engaging more than 234 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 Burra Creek, as evidenced by the receipt of letters of support from:

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

A list of the letters of support received for this project is provided in Appendix G.

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.

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, and
- Communication and engagement activities for both the Business Case and implementation phases of the project.

An overview of the Burra Creek Communications and Engagement Strategy and the outcomes from the Business Case phase are 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 Burra Creek project. For project stakeholders, the aim is to INVOLVE stakeholders in all phases of the Burra Creek 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 Burra Creek 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 Burra Creek 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 Burra Creek 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 of Piangil 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
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:** Kooloonong Natya 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	Impact to local amenity, recreation, economy and environment Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture

Stakeholder group	Stakeholder	Summary of issues and sensitivities
	Darling Rivers Indigenous Nations (MLDRIN), Mildura and District Aboriginal Services **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:** Murray River Reserve	
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, and
- 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 Burra Creek 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.

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, Kooloonong Natya Landcare Group, 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 Burra Creek 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 is provided in the Burra Creek 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 Burra Creek project. The project has high visibility among materially affected and adjacent landholders/managers, along with Aboriginal stakeholders and other interested parties. It is critical to the project that 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 and ensuring success for the Burra Creek 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 Information package accessed on the Mallee CMA website (fact sheets, case studies, photos, contact information)	Inform	Accessible throughout implementation phase 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 Burra Creek 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 infrastructure-based projects on land managed by Parks Victoria.

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 Burra Creek 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 Burra Creek are listed in Table 16-1.

Table 16-1: Regulatory approvals anticipated for Burra Creek (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 Burra Creek: Upstream from Banrock, Coorong and Riverland Ramsar sites Eight migratory waterbird species use the site Presence of 21 nationally threatened species and 3 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
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 relate 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.
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, and
- 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 Pr[redacted]

Board (PCB) regarding the regulatory approvals needed for Victorian projects, the resolution of associated issues and development of 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

A Due Diligence Assessment Report has been completed for the project (Bell, 2013) Appendix K. This assessment focussed on the activity areas for the project. The desktop and field inspections did not identify any previously unrecorded Aboriginal cultural heritage sites within 100m of the proposed structures. The closest cultural heritage site is a scarred tree 1,470m to the northeast of the B1 Regulator location. Under the Aboriginal Heritage Act 2006 the Burra Creek floodplain is specified as an area of cultural heritage sensitivity in accordance with several categories, and the preparation and approval of a Cultural Heritage Management Plan (CHMP) will be required 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 *Burra Creek 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.

The expert review process has concluded that the underlying feasibility and outcome investigations have effectively provided a soundly based proposal which is fit for purpose.

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.

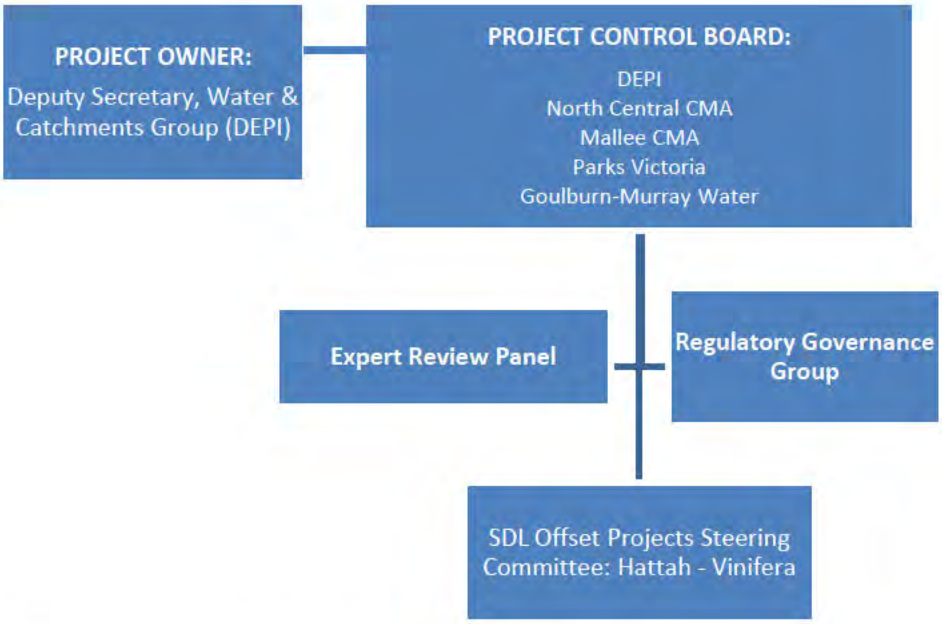


Figure 17-1: Governance arrangements during business case development.

SDL Offset Projects Steering Committee: Hattah - Vinifera

At the project level, development of the business case for the *Burra Creek 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)
- DEPI representative/s (land manager representative and coordinator of regional environmental advice and approvals)
- Goulburn-Murray Water (G-MW) representative/s
- SA Water representative/s
- Murray-Darling Basin Authority 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 Living Murray 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 Living Murray 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
- 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
- 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 Figure 3-3 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 Burra Creek site, the Operations Group membership will consist of partners and stakeholders, including the Murray- Darling Basin Authority, the Victorian Department of Environment and Primary Industries, Goulburn Murray Water, 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 Burra Creek 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. G-MW is the Victorian State Constructing Authority (SCA) for the MDBA. 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 delivery (Section 4.11.4)

A comprehensive risk assessment of the project development and construction phases has been carried out. 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 Burra Creek Floodplain 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 and construction without mitigation and residual risk rating with mitigation, adapted from Lloyd Environmental (2014)

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Unexpected delays in obtaining statutory approvals	The high environmental and cultural values of Burra Creek 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
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	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					authorities. Contractual arrangements that accommodate changes resulting from fire incidents. Appropriate insurance for contractors, equipment and liability.	
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
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	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					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.	
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

18.3 Risk mitigation and controls

While the risk assessment identifies several potential threats that could generate high risks to construction (Table 18-1), 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 project team (including construction authorities) in previous projects
- Result in very low or moderate residual risks after standard mitigation measures are implemented.

The risk assessment confirms that all risks are reduced to acceptable levels (moderate or lower) once well-established risk mitigation controls are implemented. Two threats retained a residual risk of moderate after implementation of the recommended mitigation strategies (Table 18-2). Additional considerations may assist in further understanding, and in some cases reducing, the residual risk rating.

Table 18-2: High priority risks, mitigation and residual risk

Threat	Risk without mitigation	Residual risk rating	Additional considerations
Inadequate geotechnical information	High	Moderate	Obtaining peer review of designs and geotechnical information prior to engagement of contractors.
Floods	High	Moderate	The risk of a flood occurring is unpredictable and mitigation options are limited. Flood risks must be adequately considered in project costs. This is reflected in the inclusion of explicit costing for flood risk in the cost estimates for this business case.

18.4 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 provide a structured and coherent approach to risk management for the life of this project (i.e. construction and operation). With regard to the potential threats to project development and construction, the risk management strategy will focus on the following issues, as described in Table 18-1:

- Ability to complete construction
- Project development and delivery

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.

19.Reference documents

Alluvium 2013. Burra Creek Management Project SDL Adjustment Supply Measure Phase 1. Mallee Catchment Management Authority, Mildura.

Aither 2014. Burra Creek Water Management Works-Benefits for the Basin Plan Sustainable Diversion Limits offset program business case. Report for the Mallee CMA.

Bain, M. 2013 Burra Creek water management options project. Irymple, Victoria: Mallee Catchment Management Authority.

Bell, J 2013. Watering the River Red Gums Sites - Burra Creek, Northwest Victoria Due Diligence Assessment.

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.

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.

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

DSE 2014. Ecological Vegetation Classes by Bioregion, Department of Sustainability and Environment, Victoria.

DTF 2013. Economic Evaluation for Business Cases Technical guidelines. August 2013, p.25. OBPR reference: http://www.dpmc.gov.au/deregulation/obpr/reporting-publications/publications/guidance/docs/006_Cost-benefit_analysis.pdf (Accessed 14 October 2014)

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 Pty Ltd. 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 Associates report AL040-1-D prepared for Mallee Catchment Management Authority, Irymple.

Ecological Associates 2014b. SDL Floodplain Watering Projects: Monitoring and Evaluation. Report AL045-1-B. Report for the Mallee CMA.

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

Fuller D.A., & Telfer A.L., 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 – Burra, Nyah and Vinifera SDL sites. GHD, Melbourne, Victoria.

GHD 2014. Nyah, Vinifera and Burra Creek – Review of Water Management Options and Concept Designs.

31/31585. Report for the Mallee Catchment Management Authority.

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

Jacobs 2014. Hydrodynamic modelling of SDL sites. Burra Creek – preliminary modelling report. Irymple, Victoria: Jacobs report VW07597 prepared for Mallee Catchment Management Authority.

Jacobs 2014a. SDL Adjustment Supply Measures, Concept Design - Burra Creek**.** 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.

Henderson M, Wood D, Cranston G, Hayward G, Campbell C, Johns C and Vilizzi L 2012. The Living Murray Condition Monitoring at Hattah Lakes 2011/12: Part A – Main Report Final Report prepared for the Mallee Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC.

Henderson M, Freestone F, Wood D, Cranston G, Campbell C, Vlamis T and Vilizzi L 2013. The Living Murray Condition Monitoring at Hattah Lakes 2012–13: Part A – Main Report. Final Report prepared for the Mallee Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC.

Henderson M, Freestone F, Vlamis T, Cranston G, Huntley S, Campbell C and Brown P, 2014. The Living Murray Condition Monitoring at Hattah Lakes 2013–14: Part A – Main Report. Final Report prepared for the Mallee Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC.

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

Lumsden, L., Brown, G., Cheers, G. and Palmer, C. 2007. Floodplain Fauna Surveys – Macredie Island and Burra Forest. Report by the Arthur Rylah Institute for Environmental Research for the Mallee Catchment Management Authority.

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

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 flooplain, Murray-Darling Freshwater Research Centre. Report for the Mallee CMA.

RMCG 2014. Burra Creek 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.

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 1990VEAC 2008. River Red Gum Forests Investigation. Victorian Environmental Assessment Council, East Melbourne, Victoria.

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

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

20. Appendices

Appendix A:

Burra Creek proposed works and inundation extents.

Appendix B:

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

Appendix C:

Ecological Associates 2014b. SDL Floodplain Watering Projects: Monitoring and Evaluation. Report AL045-1-B. Report for the Mallee CMA.

Appendix D:

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

Appendix E:

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

Appendix F:

Aither 2014. Burra Creek Water Management Works-Benefits for the Basin Plan Sustainable Diversion Limits offset program business case. Report for the Mallee CMA.

Appendix G:

Burra Creek letters of support.

Appendix H:

RMCG 2014. Burra Creek 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:

Bell, J 2013. Watering the River Red Gums Sites - Burra Creek, Northwest Victoria Due Diligence Assessment.

Appendix L:

Expert Review Panel Reports.

20.1. Appendix A: Proposed works