VICTORIAN MURRAY FLOODPLAIN RESTORATION PROJECT

HEALTHY LANDSCAPES, STRONG COMMUNITIES

Operating Plan

Hattah North Environmental Works and Measures Program Addendum to the Hattah Lakes Environmental Works and Measures Program Operating Plan 2016

January 2020

LOWER MURRAY WATER

mallee catchment management authority

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Contents

1 Introduction

This addendum to the Hattah Lakes Operating Plan provides the framework for the operation of the Victorian Murray Floodplain Restoration Project infrastructure in conjunction with the existing TLM infrastructure.

These water management structures have been designed to meet key ecological objectives within the broader legislative requirements and governance.

The Living Murray (TLM) Initiative was established in response to concerns about the environmental health of the River Murray. The initiative has recovered 500 GL of environmental water and has constructed water management structures to enable the efficient and effective use of environmental water. Implementation of environmental watering activities, which are subject to monitoring and review have seen successful ecological outcomes and healthy river system conditions.

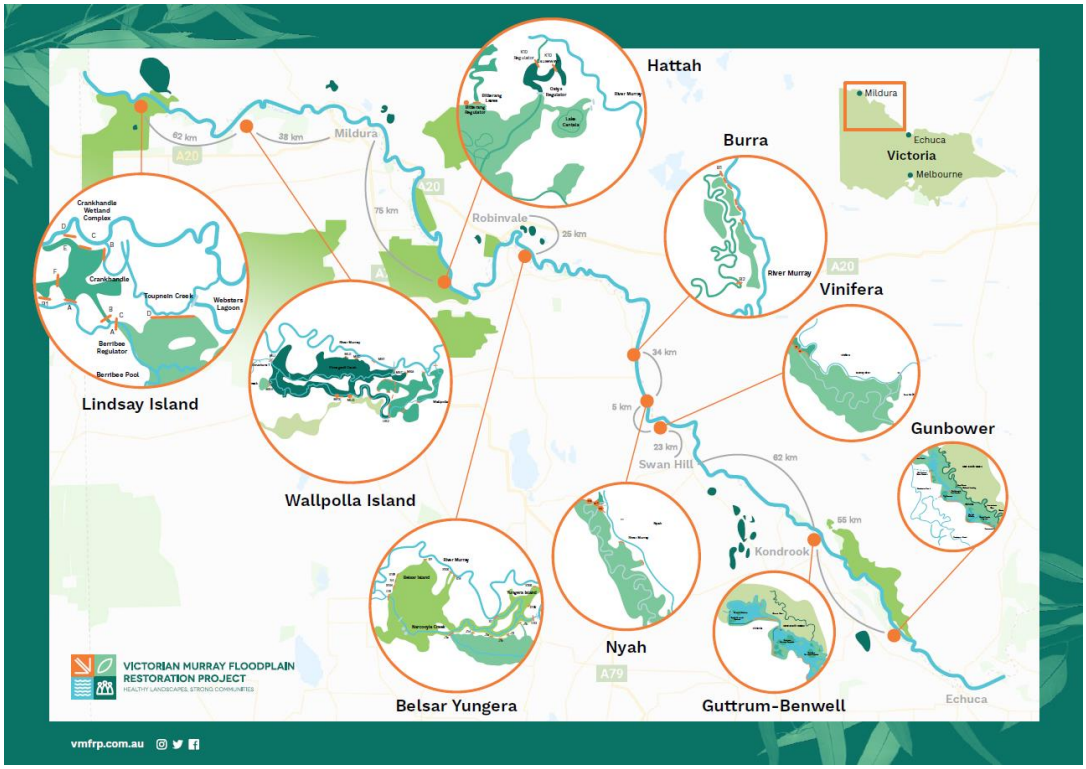
The Living Murray program aims to improve the environmental health of six icon sites that were chosen for their significant ecological, cultural, recreational, heritage and economic values.

The Victorian Murray Floodplain Restoration Project (VMFRP) is being implemented as part of Victoria's obligations under the Murray Darling Basin Plan in partnership with Lower Murray Water, Goulburn Murray Water, Mallee CMA, North Central CMA, Parks Victoria and the Department of Environment, Land Water and Planning (DELWP). The VMFRP Project is funded by the Australian Government's Department of Agriculture.

The VMFRP consists of nine discrete environmental works projects that aim to return a more natural inundation regime across approximately 14,000 ha of high ecological value Murray River floodplain in Victoria through the construction of new infrastructure and in coordination with existing infrastructure operation regimes. Refer to figure 1.

The proposed works will allow environmental water to be diverted from the Murray River to high value wetlands and floodplains. This will mimic the impact of natural flood events and improve the condition of vegetation communities and provide habitat for native fish, birds, frogs and reptiles.

Figure 1. VMFRP Project Locations



1.1 Content of Addendum

This addendum provides the third update of the Hattah Lakes Operational Plan and should be read in conjunction with the 2015 Post Commissioning Update V2 Hattah Operations Plan (MDBA, 2012a). It has been developed in consultation with key stakeholders.

This addendum presents updates on the following:

Existing and proposed infrastructure on the Hattah-Kulkyne National Park floodplain

Ecological objectives and targets

Water requirements and water regimes to meet the objectives

2 Purpose of the Operating Plan

This Operating Plan provides the framework for the operation of the Hattah Lakes water management structures to meet key ecological objectives within the broader context of VMFRP and TLM legislative requirements and governance. The purpose of this addendum to the operating plan is to:

- Summarise the governance arrangements for managed inundation activities at the site;
- Summarise the roles and responsibilities of partner agencies;
- Aid in decision making and planning prior to, during, and after watering events;
- Summarise operational risks and mitigation strategies;
- Outline water measurement arrangements;
- Outline communication and consultation requirements; and
- Provide links to documents containing further detail.

The operating plan also defines the obligation of the various parties to manage and operate the structures as required under the Murray-Darling Basin Agreement (S 52 – 54; *Water Act* (Cth), 2007).

The Operating Plan is not intended to prescribe particular watering events. The audience for the Operating Plan is summarised in Table 2-1.

The operations described in this report reflect the learnings from the operations as part of The Living Murray inundation at the Hattah Lakes. This document is a 'living document', however, that will be further refined and updated over time by the Mallee CMA if legislation changes, operations in the major river systems etc require it. It is expected that knowledge and information in relation to adjusting and optimising structure operations will improve with each event. As asset owners, Lower Murray Water will adopt their own Operating Plan on completion of construction.

Table 2-1: Intended Audience for the Operating Plan

Audience	Key Requirements	Primary Interest		
		Ecological	Operation	Risk
Event Managers (Lower Murray Water, Goulburn Murray Water, Mallee CMA, RM Operations)	Adaptive management	✓	✓	✓
Land Manager (Parks Vic)	Adaptive management	✓	✓	✓
Other Environmental Managers (DELWP)	Adaptive management	✓		✓
Operators (Lower Murray Water, Goulburn Murray Water & RM Operations)	Operation of structures Accounting		✓	✓
Water holder/funder (TLM-MDBA, CEWH, VEWH)	Accountability	✓	✓	✓
MDBA (BSMS)	Meet legal requirements			✓
Asset Manager (Lower Murray Water, MDBA Assets)	Meet legal requirements		✓	✓

Additional Documents

This addendum is one of six supporting documents to the Hattah Lakes Environmental Water Management Plan (EWMP) (MDBA, 2012b). Each schedule focuses on a specific area of operations for the Hattah Lakes (Table 2-2).

Table 2-2: Additional documents supporting water management at the Hattah Lakes Icon Site

Document	Purpose
Hattah Lakes Environmental Water Management Plan	Environmental Watering Management Plan TLM 2012.
Hattah Lakes Environmental Water Management Plan	Recent draft addendum completed by Waters Edge Consulting for MCMA June 2019. Not yet finalised.
Hydrodynamic Modelling Report (Jacobs, 2016)	Report on Hydrodynamic Modelling of the proposed Bitterang North, K10 Regulator and K10 Causeway sites.
Hattah North Detailed Design Report (R8, 2019	Report on Detailed Design for Hattah Lakes North including Detailed Design Drawings.
Fish Management Plan Hattah Lakes, (ARI, 2018)	Report on Management Options for fish during operation of infrastructure at Hattah-Kulkyne NP
Groundwater salinity monitoring bore specification for SDL project (Jacobs, 2019a)	Report on groundwater salinity monitoring of the proposed inundated areas
Monitoring and Evaluation Reporting Plan (ARI, in prep)	Framework for reporting on monitoring and evaluations, in preparation by ARI. Anticipated completion by February 2020

3 Interactions with other systems or structures

This section looks at the interaction of the VMFRP water management structures with TLM water management structure, Murray River, and waterways and wetlands within the Hattah Lakes system.

The Hattah Lakes System is situated between the Euston (Lock 15) and Mildura (Lock 11) lock and weir structures. For further information on TLM infrastructure interactions with the major river systems, see the 'Hattah Lakes Operation Plan' (MDBA, 2012a).

The project works will leverage natural high River Murray flow events as well as managed environmental flow events using TLM infrastructure to deliver water to the Chalka North and Lake Boolca areas. Table 1 describes the existing TLM infrastructure that will be used with the VMFRP structures. Section 7 details the TLM infrastructure that will be used in different operating scenarios.

Table 1 – Existing infrastructure at Hattah Lakes constructed as part of The Living Murray.

Infrastructure	Description	Role	Associated Area
Messengers Pump Station	7 variable speed axial flow pumps and ancillary works.	Pump water from River Murray to Chalka Creek and Lake Kramen. Can provide flows of up to 1000 Ml/d.	Central lakes, Lake Kramen and associated riparian and floodplain areas

Regulators	Messengers, Oatey's and Cantala Regulators are dual leaf overshot/undershot gate structures. The Kramen Regulator is box culvert with aluminum stop logs	Messengers and Oatey's pond water on the floodplain during operation and provide capacity for controlled releases to the River Murray. Cantala to pond water within Cantala Creek and Lake Kramen to allow through flows to Kramen Creek and Lake. All regulators have also been designed to allow unimpeded through flow during natural high flow events	Central lakes, lake Kramen and associated riparian and floodplain areas
Containment banks1	Breakout, Cantala and Bitterang track raising	Used to hold water on the floodplain by preventing water flowing back to the River Murray during operations	Floodplain areas.

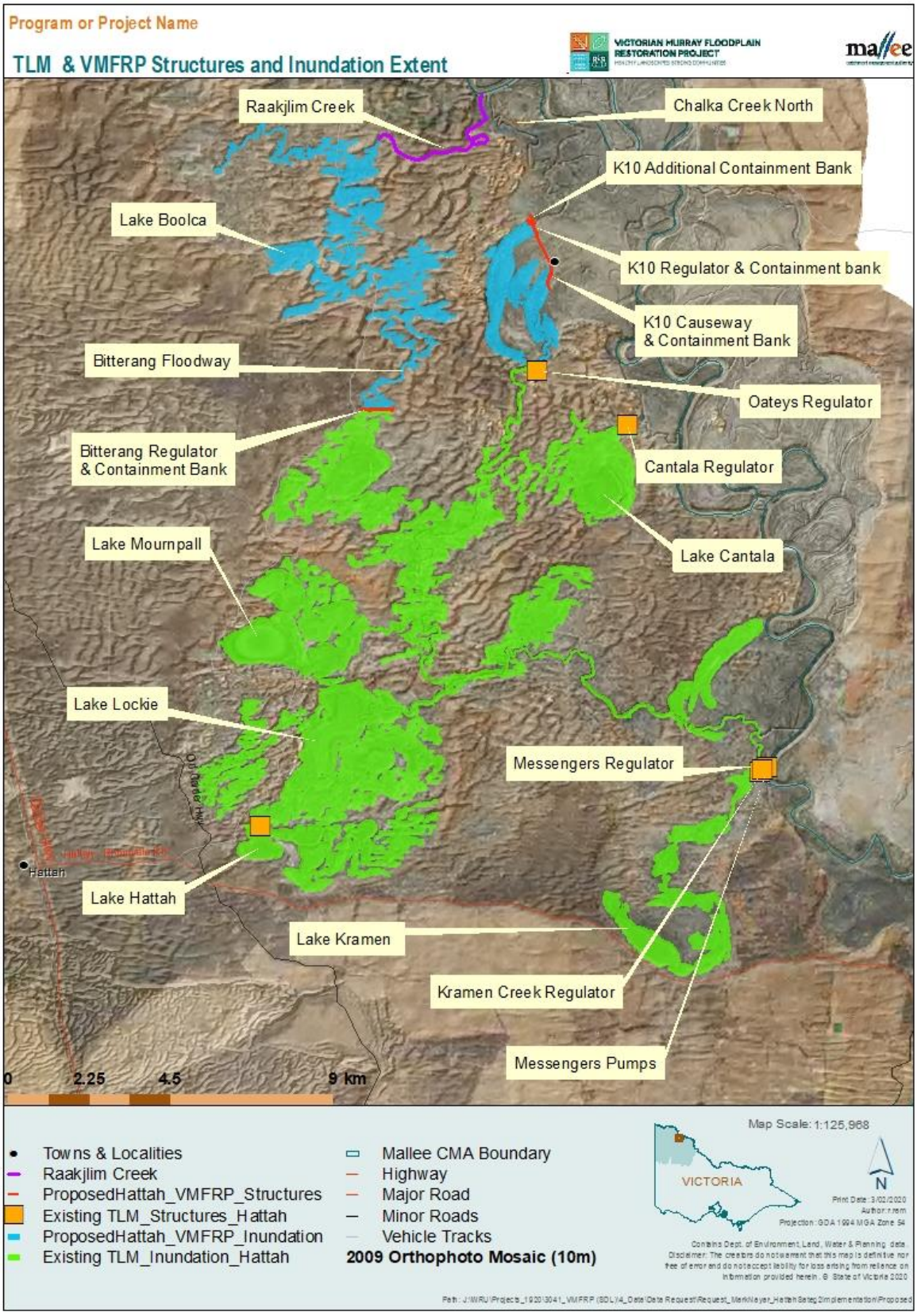
3.1 VMFRP Structures

The infrastructure works to be delivered for the Hattah Lakes North project comprise:

- The K10 regulator and containment bank
- K10 causeway regulator and containment bank
- Bitterang regulator, containment bank and hardstand

[1] These have been referred to as 'levees' in previous reports

Figure 2 – Hattah Lakes North – Existing TLM structures and inundation extent as well as proposed VMFRP structures and inundation extent.



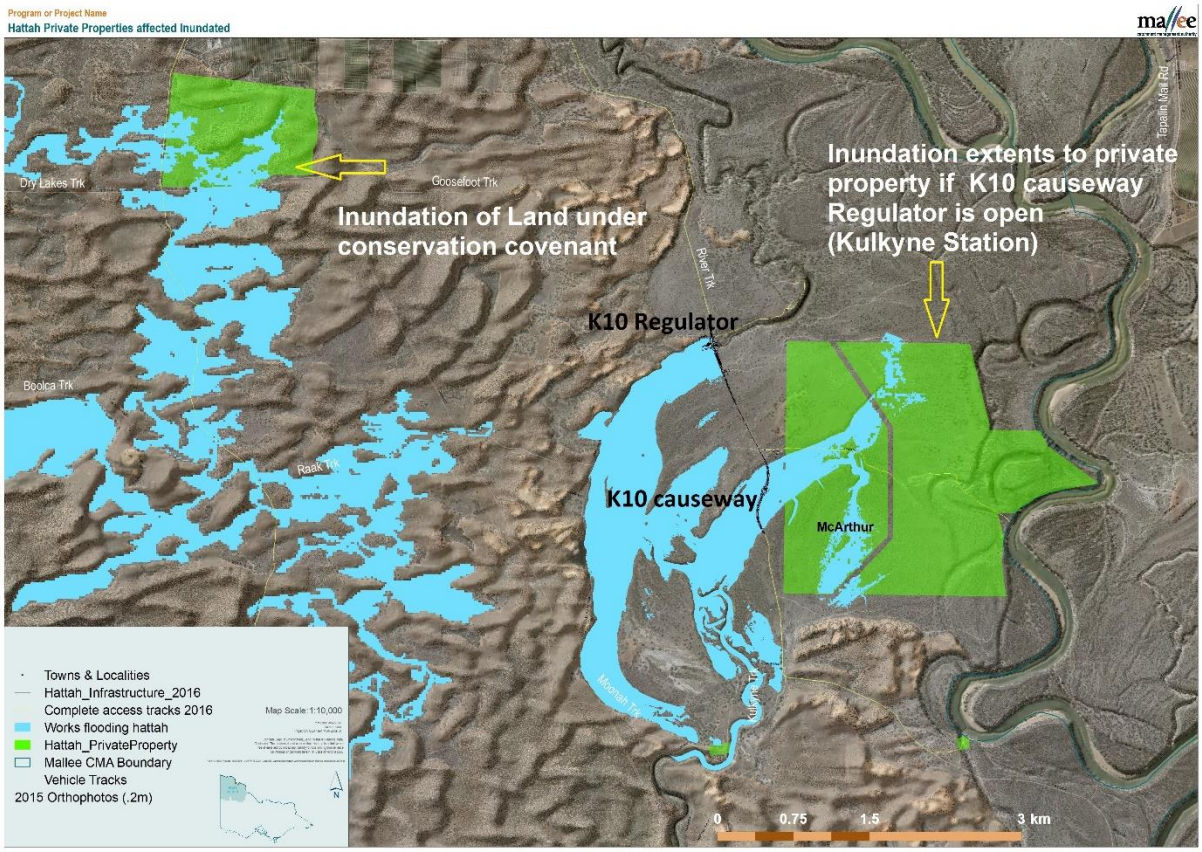
3.2 Interactions within the park

The project has extensively engaged with Parks Victoria as the Land Manager and private landowners; including the potential for managed inundation to extend onto ecologically valuable areas of private land. These areas include:

- Approximately 37 ha of land under a conservation covenant in the Lake Boolca area. Flooding of this land can be avoided by actively controlling the temporary pumps at the Bitterang regulator to operate the works at less than maximum design level.
- Approximately 75 ha at Kulkyne Station in the Chalka North inundation area. Flooding of this land can be actively controlled by operation of the K10 causeway regulator.

The affected private property parcels are shown in Figure 3.

Figure 3 – Hattah lakes North – Inundation extents and Private Property Boundaries



The owners of Kulkyne Station, Oatey's Hut and Sextons Camp will have access restrictions during construction. Access to these properties during managed flood events will be maintained.

4 Governance

4.1 Governance Arrangement for Operating the VMFRP Structures

Structures will be owned and operated under an agreement between Lower Murray Water and Goulburn Murray Water. The Mallee CMA and environmental water holders will plan and select the areas of inundation as per their published Seasonal Watering Proposals.

4.2 Sourcing Water for Managed Inundation Events

Environmental watering at the site will be undertaken in accordance with the VEWH's annual seasonal watering plan and in partnership between Lower Murray Water, Goulburn Murray Water,

the Mallee CMA and Parks Victoria. The VMFRP works will leverage natural high River Murray flow events as well as managed environmental flow events using TLM infrastructure to deliver water to the Chalka North and Lake Boolca areas.

5 Site Characteristics Guiding Managed Inundation

The Hattah Lakes North project builds on environmental water infrastructure in the southern lakes complex constructed under The Living Murray program (TLM) commissioned in 2013. The northern Hattah lakes are at a higher elevation and are mostly ephemeral wetlands, as opposed to the southern permanent to semi-permanent southern Hattah Lakes. The northern Hattah Lakes are among the last part of the Hattah floodplain to be inundated during a natural event. The area comprises a mosaic of small wetlands with floodways confined between sand dunes of the Lowan and Woorinen Formations. Two floodways connect the area to the broader Hattah floodplain. Raakjlim Creek passes water from Chalka Creek North to the Lake Boolca Area and the Bitterang floodway extends north from Lake Bitterang.

The Hattah Lakes North project allows a larger area of the floodplain to be inundated by integrating with existing environmental works on the Hattah floodplain. Modelling has confirmed that the construction of the proposed infrastructure will allow an additional 1,130 ha of floodplain to be inundated. These managed inundation events aim to provide ecological benefits through restoring an enhanced natural watering regime to the environment. These areas were not included in The Living Murray program scope.

5.1 Waterflow and Operating Thresholds

Under natural conditions water began to spread into Raakjlim Creek when River Murray discharge at Euston exceeded 100,000 ML/day and created significant inundation of lakes at flows exceeding 120,000 ML/day (Refer to Figure 2). Lake Boolca was filled when river flow exceeded 140,000 ML/day. However, stop banks constructed on Raakjlim Creek now block the passage of water so that flows of up to 160,000 ML/day do not enter the area (Ecological Associates, 2007; Jacobs, 2014)

The Bitterang floodway has a naturally high sill level and only passes water northwards at very high flows, greater than 160,000 ML/day (Jacobs, 2014).

5.1.1 Lake Boolca Area

It is proposed to restore the flooding regime to the Lake Boolca area by increasing the frequency and duration of inflows via the Bitterang floodway (Refer to Figure 2).

A containment bank and regulator will be constructed in the existing TLM Bitterang containment bank on the floodway to manage the delivery of environmental water to the Lake Boolca area. The containment bank and regulator will be operated to detain water over an area as large as 710 ha, including Lake Boolca, and will address ecological targets for flooding frequency and duration.

The Bitterang Containment Bank was constructed during the TLM works to facilitate flooding in the central Hattah floodplain by preventing the escape of water to the north. With the addition of a regulator it could also be used to pass and detain flood water in the Lake Boolca area. A four-bay regulator would be constructed in the existing containment bank and would be designed to pass 100 ML/day.

The Bitterang Regulator will operate under three scenarios and in conjunction with TLM works

- Natural flood events
- Managed inundation – gravity releases to the northern floodplain area
- Managed inundation – pumped discharge to the northern floodplain area

In natural flood events, the regulator may be opened to allow the passage of water from Lake Bitterang to the north. Flood levels will be able to rise and fall without interference. Alternatively, the regulator may be closed to prevent flood water from draining so that floods can be prolonged to meet ecological water requirements. Temporary pumps may be used to supplement flood or manage flows.

With the Bitterang Regulator in place, inundation under the TLM program (floodplain inundation scenario to 45 m AHD) may be allowed to spread into the Bitterang floodway by gravity. Under this scenario the pool will generate a flow of approximately 100 ML/day at the regulator and over 30 days will distribute water over approximately 300 ha, including Lake Boolca. Under the TLM program it is planned to operate the floodplain inundation scenario to 45 m AHD one in eight years.

The extent of inundation achieved by gravity feed through the Bitterang Regulator can be increased by pumping water across the containment bank. In this scenario, the regulator would be closed while the TLM floodplain area is operated at 45 m AHD. A pump would be used to re-lift the water over the containment bank from Lake Bitterang to the Bitterang floodway. At a flow of 300 ML/day for 30 days, a level of 45.11 m AHD can be achieved against the northern side of the containment bank which distributes water over 710 ha using a total water volume of 9 GL .

When flooding requirements are met this water will be left on the floodplain to undergo natural drawdown and evaporation processes. This water cannot be returned to the Murray River via a natural drainage pathway.

5.1.2 Chalka North floodplain

Under the TLM works, water released from Oatey's Regulator is conveyed northwards by Chalka Creek North to return to the River Murray. The Chalka North works will create a second tier of inundation using water released from the regulator. Outflows towards the River Murray will be controlled by structures at three locations to create a pool extending over 420 ha when water is stored at the maximum level of 43.5 m AHD using a total water volume of 6.8 GL

The K10 Regulator will be constructed on Chalka Creek north at the existing River Track crossing. The regulator will incorporate a containment bank that extends 794 m across the creek along the existing track and will raise water levels above the channel bank and into the adjacent Red Gum Woodland.

At a level of 43.5 m AHD water also spreads to the east, and a second structure is required to prevent water escaping back to the River Murray. The second structure, K10 Causeway & Containment Bank, extends over 722 m and will incorporate a penstock gate regulator to allow water to move freely when the Chalka North Pool is not in operation. The K10 causeway and Containment Bank will raise the road level 0.3 m above the maximum pool level and will maintain access along the River Track when the Chalka North Pool is in operation.

The area to the east of the K10 Causeway & Containment Bank includes the private land of Kulkyne Station. Water may be excluded from this area by closing the penstock gate regulator in the K10 Causeway & Containment Bank when the Chalka North Pool is filled. Should the opportunity arise to water this area of floodplain then the regulator would be opened.

Most water stored in the Chalka North Pool will return to the River Murray at the conclusion of flooding events when the K10 regulator is opened. Some water retained in floodplain depressions will be lost to drainage and evaporation.

The Chalka North structures will be operated in conjunction with TLM works and in response to natural flooding events.

In natural flooding events, the structures will remain open as river levels rise and water enters the floodplain. The structures may be closed when the floodplain starts to drain in order to capture

floodwater and meet the environmental targets for flood duration. When flooding requirements are met, the water will be released to the River Murray via Chalk Creek North.

The Oatey's Regulator Pool is operated to meet the requirements of the lakes and floodplain of the central Hattah area. The pool may be filled by pumped water or by capturing flood peaks. When flooding requirements are met, the water released from Oatey's Regulator may be detained by the Chalka North structures to meet flooding requirements in this area.

In large natural flooding events, if environmental requirements have been met, the structures will remain open and will not be operated.

5.2 Rating curves

The hydraulic interaction between the lakes and the River Murray is complex. The different operating scenarios also add difficulties to the hydrodynamic modelling of the managed inundation events.

In the Hattah model, the River Murray is not modelled with the upstream flow and downstream rating curve boundary conditions common to most 2D hydraulic models. Instead, the River Murray is modelled as a downstream tailwater, with the entrance to Chalka Creek modelled using previously derived flow-level relationships.

During Detailed Design Jacobs (2016) undertook hydrodynamic modelling of the VMFRP sites. Refer to their report for further information.

6 Details of Structures

The designed package of works for the Hattah Lakes North Project Is comprised of:

- Gated regulators: concrete structures equipped with flow control gates located in waterways to control the flow of water into and out of the inundated areas. These structures are designed to capture natural floods and manage inundation releases. The gates are designed to allows natural floods to pass unhindered.
- Containment banks: earthen banks that, in combination with regulator, impound water in targeted areas for managed inundation. For a majority of the Hattah lakes North project the containment banks will be built on the alignment of existing access tracks with the tracks reinstated on top of the banks. There is a small (<100m) low ground area to the northwest of the K10 regulator requiring minor bank construction which cannot be located on existing track alignment.
- Hardstands: an area established for the purposes of pumping that will be the location of temporary diesel-powered pump sets. The design allows a dedicated area for the temporary pumps, access provisions for operation and fuelling, and the mobilisation and demobilisation.

The specific works for the Hattah lakes North project includes (Refer to figure1);

- K10 regulator: three bays, 2000 mm wide x 4000 mm high dual leaf gates
- K10 Containment Bank: 794 m containment bank in existing track alignment
- K10 Additional Containment Bank: <100 m containment bank to the North-West of the K10 regulator
- K10 Causeway Regulator: three bays, 1800 mm wide x 1300 mm high penstock gates
- K10 Causeway Containment Bank: 722 m containment bank in existing track alignment
- Bitterang Regulator: five bays, 1200 mm wide x 1200 mm high penstock gates

- Bitterang Containment Bank: 300 m track widening to allow operator access
- Bitterang Regulator hand stand: 10 m x 10 m hardstand area for pump set up

Examples of the proposed types of works to be delivered by the Hattah Lakes North project are shown in figure 3 and 4.

Figure 1 – A regulating structure at Mullaroo inlet, similar to the K10 regulator proposed

Figure 2 – A containment bank constructed under TLM, similar to those proposed for Hattah North

7 Operations

The Hattah Lakes North works have been designed to provide inundation to additional areas on the floodplain. The project will enable the replication of key components of the natural hydrology of the system to these areas

The infrastructure has been designed to be operated in several possible flow regimes consistent with the requirements set out in the business case. Transitioning between scenarios is possible and provides a high level of operational flexibility when delivering planned watering events or responding to natural inflows.

7.1 Chalka North

Water will be delivered to the Chalka North area either as a flood capture or TLM release event as described further in Table 2. Inundation of areas of the privately owned Kulkyne Station will be managed via the proposed K10 causeway regulator.

The works will provide for the inundation of up to 420 ha of floodplain. The inundated areas are shown in Figure .

The primary mechanism for delivering water to the Chalka North area will be via releases of water from the central lakes area from behind the existing Oatey's Regulator, constructed as a TLM initiative. This water will then be held within Chalka Creek North and its associated floodplain by the K10 regulator on Chalka Creek at Raak Crossing. Inundation of areas of the privately owned Kulkyne Station will be managed via regulators on the K10 Causeway and containment bank.

Table 2 – Operating Scenarios for Chalka North

Scenario	Description	Structure Operation
Natural flood	• Infrastructure to allow natural floods to pass unhindered.	• K10 and K10 causeway regulators to be fully opened.
Flood capture	• Capture can occur when discharge at Euston Weir exceeds 60,000 ML/d. • Peaks at Euston Weir up to 120,000 ML/d may be captured.	• K10 regulator is to be operated to maintain design water level (maximum) when the flood peak starts to recede. • K10 causeway regulator is to be operated in accordance with the agreement with the private landowner of Kulkyne Station. • Water is released from the K10 regulator when the flood duration target is met.
Retain releases from TLM Area Retain releases in the Hattah North area delivered through the southern lakes using TLM infrastructure	• Releases from Oatey's regulator occur when TLM inundation level is between 42.5 and 45.0 m AHD.	• K10 and K10 Causeway regulators are closed and water is released from Oatey's Regulator. • When target inundation level is achieved gates on K10 regulator are operated to maintain level for duration of inundation period. • At completion of managed event, release occurs through the K10 regulator gates at a predefined flow rate (not exceeding 825ML/d). • Release of water though K10 Causeway regulator in an environmental flow event can only occur if there is agreement from the landholder to the east who owns this area of floodplain. If the land is inundated then the K10 Causeway regulator will need to remain open to drain by backflow via K10 regulator.

7.2 Lake Boolca Area

Water will be delivered to the Lake Boolca area using gravity and temporary pumping arrangements, as further described in Table 3 . The works will provide for the inundation of up to 710 ha of floodplain.

Water will be delivered to the Lake Boolca area by opening the proposed Bitterang North Regulator and allowing water contained south of the existing Bitterang containment bank to flow through via gravity. When flows through the regulator equalise, the regulator will be shut and temporary pumps will be able to be cued to deliver additional water to the Lake Boolca area. The use of these temporary pumps both reduces the time taken for water to spread through the Lake Boolca area and increases the extent of watering possible.

Table 3 - Operating Scenarios for Lake Boolca Area

Scenario	Description	Structure Operation
1. Natural flood	• Infrastructure to allow natural floods to pass unhindered.	• Bitterang Containment bank regulator to be fully opened
2. Flood capture	• Capture can occur when flood levels in Lake Bitterang exceed 45 m AHD (equates to a River Murray flow of approximately 140,000 ML/d)	• Bitterang Containment bank regulator is to be closed when the flood peak starts to recede. • Water may be detained in the Lake Boolca area indefinitely.
3. Managed inundation – gravity release	• The TLM inundation level; needs to be at 45.0 m AHD to commence gravity release.	• The Bitterang Containment bank regulator should be open as long as flow is required to the Lake Boolca Area. • It is expected the peak flow rate will be approximately 100 ML/d and will inundate approximately 300 ha.
4. Managed inundation – pumped releases	• The TLM inundation level needs to be at 45.0 m AHD to commence pumped releases.	• A temporary pump will be installed at the Bitterang Containment bank regulator. • The Bitterang Containment bank regulator will be closed. • Water will be pumped from Lake Bitterang to the northern side of the containment bank at a rate of up to 300 ML/d.

8 External Considerations for Operations

8.1 Upstream and Downstream Considerations

- Minimum river heights to operate pumps is 38.3 m AHD (flows approximately 5000 ML/day at Euston)
- Re-use of net flows from upstream and downstream to optimise timing of e-water delivery; time environmental water events at Hattah to use water calculated as being returned to the river during other upstream environmental watering activities
- Water quality of inflows to the lakes

- Water quality of return flows particularly with regard to water quality targets outlined in the Basin Plan, including targets for salinity, blackwater and cyanobacteria
- Dilution flows required in the advent of the release of water from the lakes impacted by a blackwater event

8.2 Power Supply

The Messengers pump station on the River consists of 7 axial pumps each with a capacity of 144 ML/d, providing an overall capacity of 1008ML/d. This is the maximum pumping capacity when there is a low head differential between the River Murray and pump heights. Each pump motor is rated to 280 kW (515A) with a highest running load of 236 kW (434A). The overall power requirement of the pump station is 1.65 MW (approx. 2MW) (3038 A).

Power is provided to the pump station via three phase mains-delivered electricity. The underground 2 phase power line within the park is owned and operated by GMW.

Powercor is the power supply company and supply is susceptible to interruption. This has implications as the pumps may only be started with GMW staff on site to ensure that Occupational Health and Safety requirements are met.

9 Water Use

9.1 Flow Types

There are four general operating scenarios (plus maintenance):

- Natural inflows/outflows – Scenario 1
- Enhance natural (extend duration) – Scenario 2
- Enhance natural (extend duration and extent) – Scenario 3
- Managed event (pumped event from dry) – Scenario 4
- Maintenance (in years with and without a watering operation to prepare for an event, or post and event

These Scenarios are described in detail in Section 8.

Based on inflow types, the scenarios fit into three groups for water measurement purposes: natural inflows (includes Scenarios 1 and 2), a hybrid event (a combination of natural and pumped flows (Scenarios 3)), or pumped only flows (Scenario 4).

9.2 Water Requirements

The water requirements for managed inundation of the Hattah Lake North areas are detailed in Section 5.1.

9.3 Accounting Water Used in Managed Inundation Events

Water use will be accounted for through the TLM and VMFRP infrastructure.

The key aspect to consider with water delivery for the Hattah Lakes system is that it is a storage system with controlled inflows and outflows at Chalka Creek South and Chalka Creek North. While significant volumes of water can be stored on the floodplain during pumping and natural large events (due to the lakes in the system), up to 50% of flows entering the Hattah Lakes system could potentially return to the River Murray.

The key conditions for water delivery purposes are:

- commencement of natural inflows require 26,000 ML/d or greater at Euston. The river will be unregulated.
- water can be stored in the lakes system and may be released to a regulated river.
- not all inflows can be measured i.e. overbank flows and Cantala regulator.
- being possible to calculate the initial volume held in the lakes by gauge boards/stations and capacity tables. This approach will be consistent with volumes held in large storages (such as Hume Dam, Dartmouth Dam, Lake Victoria and Menindee).
- Water may switch from regulated flow to unregulated flow and vice versa during an event.

9.3.1 Measurement Types

The measurement types and location for the Hattah Lakes Works and Measures are outlined in Table 4; Table 5 provides a matrix of the flow measurement and accounting methods for the operating scenarios as well as the transitional periods between operating scenarios.

Table 4 - Summary of flow measurement types and location at Hattah Lakes

Site	Flow Measurement	Purpose
Messengers Regulator	Height and Flow	For use during managed and hybrid events.
Oatey's Regulator	Height and Flow	For use during managed and hybrid events.
K10 Regulator	Height and Flow	For use during managed and hybrid events.
Bitterang Regulator	Height and Flow	For use during managed and hybrid events

Table 5 - Flow measurement and accounting methods for scenarios and transitional states between operating scenarios

To / From	Pumped event	Natural inflows
Pumped event	Pumping As required. Regulators Lake Little Hattah open All other regulators closed Water Measurement/Accounting Methods Inflow – measured by pump meter. Outflow – measured at Oatey's, K10, Bitterang, and Messengers Regulators.	**Event then becomes a hybrid event** (assuming river levels are equal to or higher than the water volume upstream of Messengers Regulator) Pumping Turn off. Regulators Open to allow inflows. Water Measurement/Accounting Methods Inflow – water balance based on volume in lakes.
Natural inflows	Event then becomes a hybrid event Pumping Turn on. Regulators All closed.(except Little Hattah regulator) Water Measurement/Accounting Methods Starting water volume – based on gauge board readings and capacity tables for lakes. Inflow – measured by pump meter.	Pumping Nil. Regulators- Messengers Regulator - open to allow inflows and outflows. Close upon recession if extending duration. Oatey's Regulator - open to allow inflows and outflows. Close upon recession if extending duration. Cantala Regulator – open to allow inflows and outflows (outflows subject to receding hydrograph conditions). Kramen Regulator – open to allow inflows Little Hattah regulator- open to allow inflows and outflows. Close upon recession if extending duration K10 Regulator - open to allow inflows and outflows. Close upon recession if extending duration. Bitterang Regulator - open to allow inflows and outflows. Close upon recession if extending duration. Water Measurement/Accounting Methods Not Applicable – fully natural event. Volume added to the lakes can be measured by gauge boards at Oatey's, Cantala, Kramen, Little Hattah, K10,

To / From	Pumped event	Natural inflows
		Bitterang, and Messengers Regulator, and by capacity tables. Note: possible overbank flows may occur during large floods.

10 Operating Risks and Mitigation Measures

10.1 Ecological, Cultural Heritage and Socio-Economic Threats

Ecological Assessments and a Cultural Heritage Management Plan are being undertaken as part of the project.

Shared operational risks associated with environmental watering are managed through an annual process that Mallee CMA participates in. This process includes discussion of risk learnings of from the previous year, risk assessment for the coming year, and improving risk management processes.

In addition to the above measures, a monitoring, evaluation and reporting (MER) framework is being put together for the VMFRP project that includes ecological, cultural and socio-economic outcomes of managed inundation events at the VMFRP sites.

10.2 Salinity

The in-river salinity impacts (at Morgan, South Australia) potentially caused by the proposed actions at Hattah Lakes were assessed relative to a base case scenario by SKM (2014).

The assessment concluded that the magnitude of the salinity impacts of the proposed watering scenarios was low to insignificant. This is because groundwater at the northern end of Chalka Creek is assumed to be low salinity as indicated by bore salinity measurements near the creek.

SKM (2014, p. 90) expects that multiple managed inundation events will raise groundwater levels which may increase the salt load impact on the floodplain and river system.

Based on the uncertainty of the inundation events on salinity over time, SKM have recommended a monitoring program. This would comprise of groundwater and surface water monitoring. The MCMA monitors an existing network of bores within Hattah Kulkyne National part and undertakes a long-term salinity monitoring program to assess the impact of inundation events on groundwater levels and groundwater quality. To assist in the monitoring of salinity impacts of Chalka North inundation the VMFRP, with assessment and recommendations from Jacobs (2019), has proposed five new bores within the proposed project inundation area. These will be integrated into the existing MCMA monitoring network and monitoring program. Monitoring and ongoing assessment of risks will occur consistent with the Basin Salinity Management Strategy. In addition to the regular groundwater monitoring, Mallee CMA will manage the monitoring of surface water quality within the lakes, during operations. These monitoring activities are critical to verify modelled salinity impacts and to provide timely advice for management of any water quality issues arising during operation of the works

10.3 Risks Associated with Structures

The owner and operator have responsibility for management of risks to the integrity of the structures themselves. These risks are managed through operation of the structures within their design capabilities, monitoring of structural integrity and through maintenance.

Risk frameworks are being put together for the management and operation of the structures.

11 Operational Costs

The operations and maintenance (O&M) arrangements considers all activities to operate, maintain, monitor and report on the Hattah Lakes North works.

The funding arrangements for ongoing management costs have not formally been established at this time. Funding arrangements could involve cost sharing with the Commonwealth, or partially or in whole funding by Victoria. There are multiple funding options currently being considered and will require further deliberation by DELWP, DTF, and the Commonwealth.

The estimated operations and maintenance costs for the project are summarised in Table 5. The precise operating procedures of the project will be detailed in the operations planning to be finalised as part of Stage 2 which includes the scope of works, schedule and cost estimate for the project. Stage 2 addresses the matters listed in the most recent guidance on the content of proposals for Supply and Constraint Measures. The operating costs in Table 5 are provided as an average annual cost and maximum annual cost to reflect the environmental water delivery via temporary pumping and will be updated as part of stage 2 works for the Hattah Lakes North project. Environmental water entitlement storage and works licencing costs are not included in this cost estimate.

Operation and maintenance are based on a 30-year timeframe and excludes asset refurbishment and replacement expenses. Major refurbishment and replacement costs for VMFRP assets would need to be funded by government and be subject to normal funding practices.

Table 5 – Hattah Lakes North Project Average and Annual Cost Estimate (VMFRP Project Team, 2019)

Item	Average Cost ($/year)	Maximum Cost ($/year)	Responsible party	Notes
Capital maintenance and operating	$191,300	$191,300	LMW	Assumes 3% of construction capital value. This figure is adopted based on advice from GMW regarding industry standard for similar works. LMW O&M guidelines range from 2-7% dependent on materials.
Temporary pumping	$56,287	$375,246	Mallee CMA	Assumes one event every 10 years
Ecological monitoring	$86,512	$86,512	Mallee CMA	Based on TLM monitoring requirements for Mallee CMA
Salinity monitoring	$57,530	$57,530	Mallee CMA	Allowance for monitoring five new groundwater bores as required, based on CMA costs
Compliance monitoring	$10,814	$10,814	Mallee CMA	Allowance for monitoring conditions resulting from works approvals

Project management	$40,553	$40,553	Mallee CMA	Allows 0.25FTE from Mallee CMA
Total	$442,996	$761,954		

12 Communications

12.1 Community Communication and Engagement Strategy

The Hattah Lakes Icon Site has a Community Communication and Engagement Strategy and a Target Communication Plan specific to the site (The Regional Development Company, 2010) for the TLM works.

The VMFRP complements the TLM Works through the integration of structures within the Hattah North floodplain. To reflect the amalgamation between TLM and VMFRP objectives, a Stakeholder Engagement and Communication Plan was developed to ensure awareness amongst all stakeholders and the wider community of the merged operations.

The VMFRP Stakeholder Engagement & Communication Plan is attached as Appendix 1 and will be updated as appropriate as part of the Stage 2 works for the Hattah Lakes North project.

Information provided to the media regarding watering actions must be carried out in accordance with The VMFRP Communication Plan.

As the Icon Site Manager, the Mallee CMA is committed to establishing and maintaining strong relationships within the local community during watering operations. A vital tool in the consultation process is structured engagement with the community through engagement with key stakeholders and advisory groups.

12.2 Indigenous Engagement

Indigenous stakeholders are consulted to ensure the Indigenous community has an opportunity to provide input into water management and a chance to raise and identify their cultural and spiritual links to the lakes. These stakeholders are representatives of each of the Aboriginal parties who have a vested interest in the lakes.

Indigenous consultation is managed via the Mallee CMA Indigenous Facilitator and through the Mallee CMA Aboriginal Reference Group. This group provides a valuable single source for Indigenous engagement, advice, input and recommendation.

The reference group has Indigenous representatives who ensure that cultural heritage and values are considered and incorporated by the Icon Site Manager. The representatives also distribute information about Icon Site management into the Aboriginal communities.

12.3 Communication during managed events.

Mallee CMA leads communication activities for upcoming and ongoing TLM watering events and coordinates these via the Hattah Operations Group. Communication for VMFRP watering events will merge into this process. The Mallee CMA prepares a Communications Plan each year that covers environmental watering events for the entire Mallee CMA region, including Hattah.

The plan is a high-level framework for communication and engagement activities, relating to that years' environmental watering. It addresses all wetlands listed in the Mallee CMA Seasonal Watering Proposals, including the Seasonal Watering Proposal for the Mallee Living Murray Icon Sites and will incorporate watering proposals for Hattah North under the VMRP.

The plan does not cover government agencies as a stakeholder as this engagement occurs at an operational level, predominantly via the Hattah Operations Group for the Hattah Lakes site.

Parks Victoria will be responsible for communicating with its stakeholders and visitors regarding any impacts on visitor experience such as road closures, access restrictions to areas of the park and water quality issues.

During routine river operations or in the event of a broad, basin scale event such as blackwater, the MDBA and CMAs will work together to communicate with local agencies.

12.4 Complaints and Enquiries

Complaints and enquiries relating to the environmental watering process shall be directed to MCMA.

Parks Victoria will be responsible for dealing with complaints and enquiries regarding visitor access to the park and water quality concerns within the park

13 Water Management Operations Record

A record of water management operations is maintained as part of this Operations Plan Addendum.

The purpose of the record is to document how well the infrastructure and management arrangements at Hattah Lakes meet environmental watering needs and manage risk. The record documents watering plans, actions and outcomes. An entry is made at the conclusion of each watering event and includes analysis of the strengths and weaknesses of operating arrangements.

The record is used to revise and refine the Hattah Lakes Operations Plan as well as to inform annual watering actions, to ensure that water delivery is as efficient and effective as possible and that risks are managed appropriately.

The Water Management Operations Record comprises the following information:

- Event Water Year
- Watering Objective – This identifies the primary objective(s) of the watering event. Detailed rationales are provided in the Annual Watering Proposal.
- Operational Targets – The key thresholds that were set for operations, such as wetland water levels, watercourse discharge or structure settings (fish screens) and the dates on which they were to be achieved. This can be presented as a target hydrograph or a table. Operational targets will be required for each watercourse and wetland.
- External Factors – External factors that influenced operations are presented. These could include river flows, rain events, risk management or structure malfunction. Their influence on operations is described.
- Operational Outcomes – The actual water levels / flow rates / total water volume used/structure settings achieved and dates. This can be presented as an annotated hydrograph or table. Operational outcomes will be required for each watercourse and wetland.
- Performance – How well were the watering objectives met?
- Risk Management – How well were known risks monitored? How well were they managed?
- Considerations for future operations

14 References

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VMFRP Project Team, 2019. *Stage 2 Implementation Proposal for the Hattah Lakes North Project.* s.l.:s.n.

Appendix 1: Stakeholder Engagement & Communication Plan