# Strategic Management of Heart and Dowd Morass

West Gippsland Catchment Management Authority

## Detail Design Report

Final

4 November 2015

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# 1. Introduction

## 1.1 Overview

Jacobs was commissioned by the West Gippsland Catchment Management Authority (WGCMA) to investigate infrastructure options to meet the strategic management objectives of Heart and Dowd Morass as described below (Water Technology, 2014):

*The Lower Latrobe River and wetlands will be actively managed to support a trajectory of recovery so that Heart Morass and Dowd Morass together provide:*

- *Coastal wetland landscapes characteristic of the Gippsland Lakes,*
- *A mosaic of habitats supported by spatial variation in wetting and drying regimes,*
- *Selected wetland areas protected from salinization,*
- *Feeding, breeding and sheltering habitat for a diverse range of wetland biota, including waterbirds.*

*The Lower Latrobe River and wetlands will be managed by developing and implementing infrastructure arrangements, complementary works, and operating practices that are:*

- *Flexible in the face of uncertainties around climate change and sea level rise and*
- *Adaptable to accommodate actual wetland responses and changing societal priorities.*

Following this investigation the structures identified to provide the greatest value to WGCMA were progressed to detailed design.

## 1.2 Lower Latrobe Wetlands

The lower Latrobe wetlands (Figure 1.1) are located on the floodplain of the Latrobe River, downstream of the Thomson River confluence, between Sale and Lake Wellington. Heart Morass is on the northern floodplain. It has an area of approximately 1,500 ha and comprises private land and Crown Land managed by Parks Victoria. Approximately 1,000 ha of Heart Morass is owned by the Wetlands Environmental Taskforce (WET) Trust. Dowd Morass is on the southern floodplain and has an area of approximately 1,500 ha. It is entirely on Crown Land managed by Parks Victoria.

The Gippsland Lakes and its fringing wetlands are covered by the Ramsar Convention as “Wetlands of International Importance”. This includes parts of the eastern sections of both Heart Morass and Dowd Morass.

The lower Latrobe wetlands provide habitat for a diverse range of water dependent species including waterbirds, plants and a number of threatened communities and species. They are also used extensively for a range of recreational activities including duck hunting, bird-watching and walking.

Until relatively recently, much of Heart Morass was managed for farming. Management activities included raising parts of the levees protecting the Morass from flooding from the Latrobe River and Lake Wellington, and construction of culverts in the levees to enable the Morass to be drained back to the River. More recently, it has been managed for enhancement of its ecological values.

Until the 1970s, the western portion of Dowd Morass was in private ownership and was managed for farming. Heywood’s levee was constructed in the early 1970s to prevent flooding from Lake Wellington and the Lower Latrobe Rivers, and thus allow farming. For the past 40 years however, the whole of Dowd Morass has been in Crown ownership, and has been actively managed to preserve its ecological values. This has included construction and operation of culverts in the south bank of the River for filling and draining

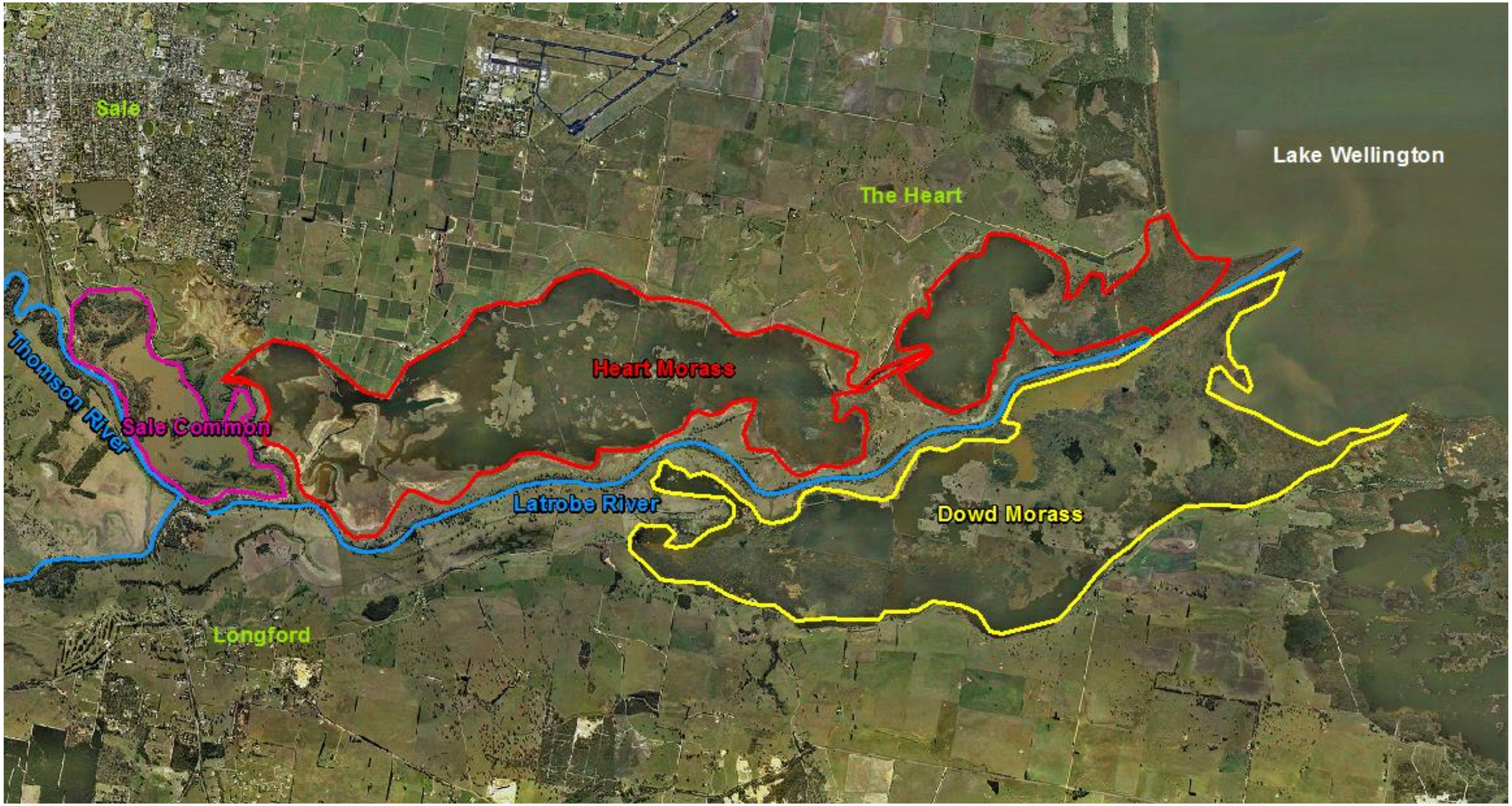



**Figure 1.1 : Lower Latrobe Wetlands (WGCMA)**

The entire lower Latrobe wetland system has been subject to a number of modifying influences since European settlement. The most significant of these have been:

- opening of Lakes Entrance in the late 1800s, which has resulted in increased water levels and salinity in Lake Wellington and the lower Latrobe River, which have in turn impacted on the water and salinity regimes of the wetlands;
- changing land use and increased regulation of flows in the Thomson and Latrobe River catchments; and
- as mentioned above, use of much of the wetlands for farming.

Future climate change is very likely to result in further changes in the salinity and water levels in Lake Wellington and the lower Latrobe, and further changes to the Latrobe and Thomson River flow regimes.

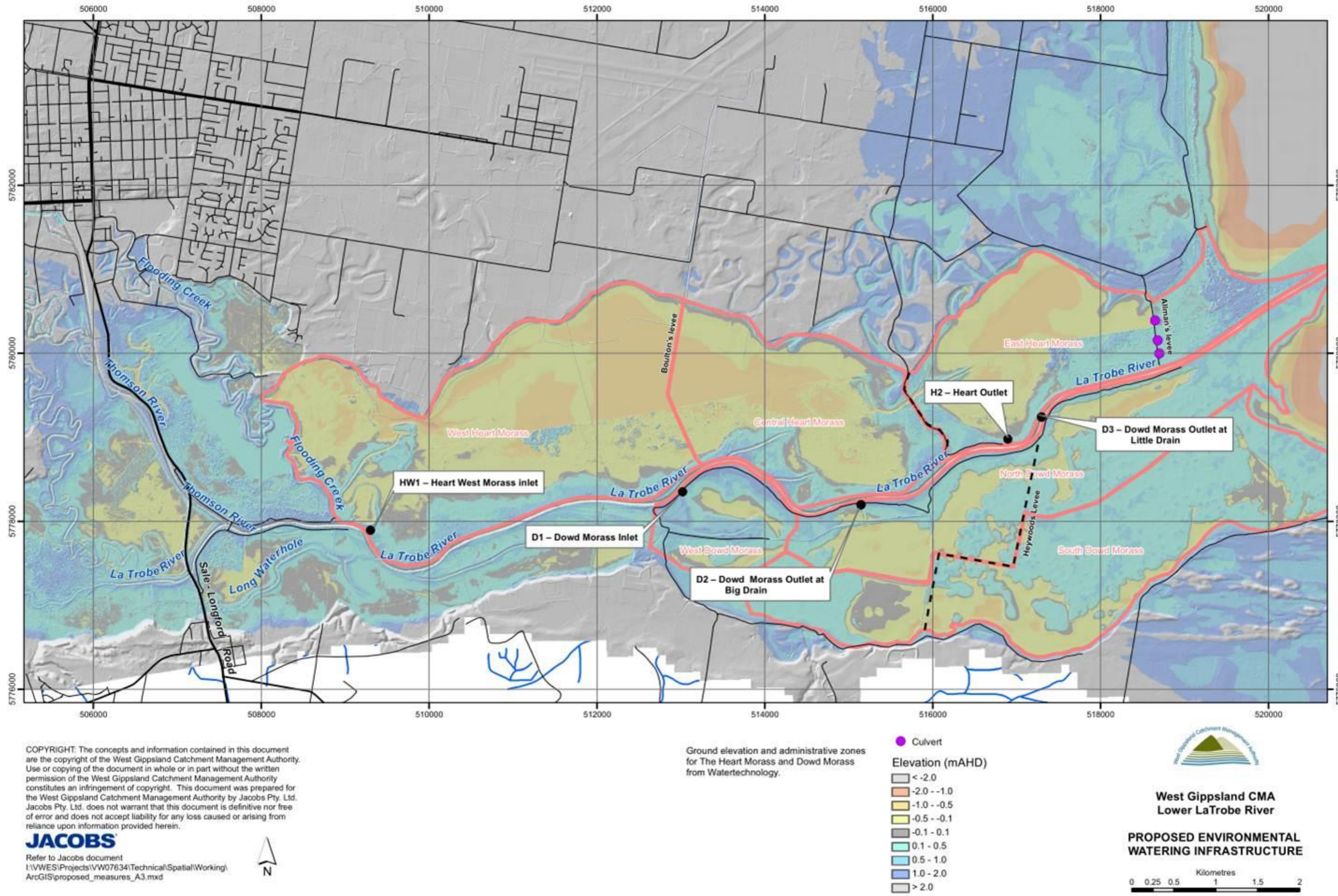
## 1.3 This Report

This report follows the Concept Design Report (Jacobs, 2015) and documents the detailed design of the high priority works identified by the WGCMA.

The key structures proposed are:

- Heart Morass
  - Inlet regulator
  - Outlet regulator
  - Allmans levee culverts
  - River inlets/outlets
- Dowd Morass
  - Inlet regulator
  - Outlet regulators Big Drain and Little Drain
  - Temporary Pump station

**Figure 1.2 : Locality Plan**



# 2. Heart Morass structures

## 2.1 Heart West Inlet regulator

A new inlet regulator is proposed near Flooding Creek to provide direct inflows to West Heart Morass from the Latrobe River. This regulator will also be used to fill Central and East Heart Morass.

The regulator will be as proposed in the Concept Report with dual leaf gates and a box culvert access track crossing. The key driver for a new inlet at this location is to take advantage of the slightly higher river water level compared to sites further downstream as shown on the Locality Plan in Figure 1.2.

### 2.1.1 Functional Requirements

The functional requirements are as follows:

- Provide controlled inflows from the Latrobe River
- Minimise saline inflows
- Minimise the entry of European Carp into the wetlands
- Retain water in Heart Morass when required
- Prevent inflows when the river level is high
- Provide for backflows or drainage after floods
- Maintain access across the site
- Provide a safe work site

### 2.1.2 Design

The capacity of the regulator is based on the following and details shown in Table 2.1:

- Filling the whole of Heart Morass from empty up to EL -0.3m in nominally 7 days.
- Raising the whole morass from EL -0.3m to 0.0m in nominally 21 days.

**Table 2.1 : Heart West regulator design**

| Filling operation | Volume (ML) | Filling Duration (days) | Average inflow ML/d | Regulator | Regulator design flow ML/d |
|---|---|---|---|---|---|
| Fill from empty to Open Water level EL -0.3m | 2,000 | 7 | 300 | 2 No 1.8 x 2.2 m dual leaf gates | 400 |
| Raise from EL-0.3 to 0.0m | 6,400 | 21 | 310 | 2 No 1.8 x 2.2 m dual leaf gates | 400 |

The filling volumes allow for the filling of the entire Heart Morass, compared with the Concept Report which only allowed for filling of the morass west of the proposed Rickety Bridge levee, which is now not expected to be constructed.

The proposed twin bay regulator with a design capacity of 400 ML/d will provide flexibility in providing for a range of flow conditions. Diversion of flows will only occur with significant rises in river level above the typical flow level of 0.2 m.

The bed levels in the western area of Heart Morass are typically EL 0.2m and are the high points that control the hydraulic behaviour of the regulator. A connecting channel is necessary to convey flows from the regulator into the morass and will be 25m wide, and will typically run at EL 0.5m. To achieve the design flow the head difference across the regulator will be 0.2 m with all gates fully open. Higher inflows will occur if the river is above the design level of 0.7m.

### 2.1.3 Operation

The normal operation when filling the morass will be to raise all the gates above the water level to maximise the filling rate, especially to divert short duration flow rises or flushes. If a lower flow rate is required, the gates can be partially opened and operated in submerged weir flow, or operated in free overfall mode as shown in Figure 2.1 below.

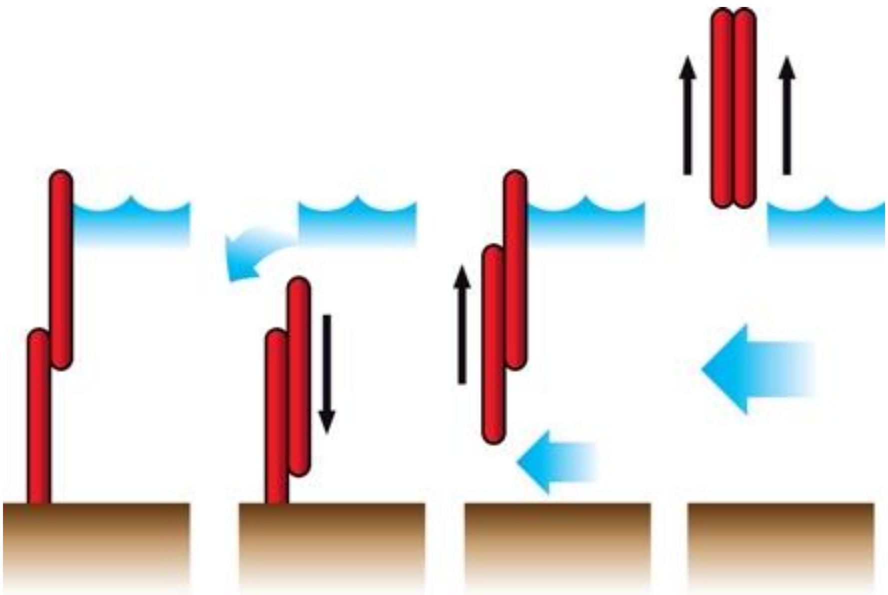


Figure 2.1 : Dual-leaf gates (AWMA 2015, http://www.awmawatercontrol.com.au/)

The gate opening needs to carried out in staged manner to allow the tailwater to progressively rise, thereby minimising the potential for erosion.

At times when flows are not specifically required to be delivered into the morass, both gates can be set in the fully lowered position, allowing river flushes to directly spill flows into the morass. This can occur during flow events above EL 0.5m with the proposed dual leaf gates. If it is required to prevent all river flows from entering the morass, then the gates would be fully closed.

The proposed regulator is relatively shallow. The invert is 0.8m below the normal river surface level, which is well above the halocline (salt wedge interface) which is at least 2 to 3m below the surface (Water Technology, 2014).

It is proposed that the gates are manually operated using a portable power actuator, given that the gates are currently expected to be operated only a few times per year. The use of such an actuator will also reduce the risk of unauthorised operation. To avoid the risk of electrocution with electric actuators near water, it is proposed to use a petrol powered actuator. The actuator will raise each gate in 5 to10 minutes, depending on gearing.

### 2.1.4 European Carp Management

To manage European carp entry into the morass, a carp screen will be integrated into the inlet. The screen is based on similar designs developed in South Australia which have been used on Goulburn Murray Water regulators on Gunbower Creek (SKM, 2010) to prevent mature carp entering the wetland. The sloping screen consists of 10 mm bars at 41 mm centres. The close spacing of the bars and support frame effectively reduces the waterway area and this has been offset by increasing the inlet width to 50% more than the gate width, which allows for partial blockage of the screen. The screens can be cleaned by raking debris up the screen. During operation, regular site inspections will be needed to monitor debris accumulation, and to undertake removal.

It should be noted that whilst mature carp will be excluded in regulated flows, small carp can still enter during regulated flows, and mature carp will enter the morass during floods events when the levee is overtopped. The morass management plan will therefore need to have a plan to manage carp.

### 2.1.5 Site arrangement

To maintain access along the existing access track the proposed structure will incorporate twin 1800 mm wide x 1200 mm high box culverts. As vehicle traffic is low, and the drop-off is less than 1.5m, the edge of the culverts will be defined with guide posts only, rather than steel guard railing.

The geotechnical investigations identified very soft soils at the site. This has been taken into account in the design with a stabilised foundation to be installed using a Tensar geogrid and crushed rock to improve the bearing capacity. The ground conditions will be difficult during construction, and over time some settlement can be expected. To minimise differential settlement, the inlet, box culverts and outlet will be constructed on a continuous concrete slab.

Seepage control around and under the structure will be made using steel sheet piling.

Downstream of the culverts, a 25 m wide connecting channel will need to be excavated to provide sufficient waterway to link the regulator into the morass. The channel will be topsoiled and grassed to minimise the risk of erosion.

To maintain the current protection the morass receives from the river, the headwall and top of the gates will be set to match the top of the existing river bank/ levee. It is understood that the river overflows at a lower section of bank approximately 200 m west of the site.

The structure does not include provision for flow measurement, however this could be added at a later date by installing a flow meter near the downstream end of each box culvert. A suitable meter is the Sontek Argonaut ultrasonic flow meter, which has been used in similar applications.

### 2.1.6 Safety in Design

The design has been prepared to minimise risks to construction personnel, operators and the public as summarised below.

| **Issue** | **Risk** | **Design** |
|---|---|---|
| Gate operation | Manual handling | Powered actuator |
| Carp Screens | Manual handling | Inclined to suit raking |
| Work platform | Trips and falls | Handrailing and level surfaces |

| | | |
|---|---|---|
| Outlet structure | Fall from height | Height limited to less than 1.5 m<br><br>Guide posts |
| Structure | Entrapment | Inlet screened to prevent entry.<br><br>Box culvert outlet unscreened to prevent people or animals becoming entrapped. |

### 2.1.7 Material Selection

The structure is located in an area with known soil and water salinity issues, and this was considered in the design of the various elements.

For the concrete structure that is located in aggressive soil conditions, an exposure class of B2, and a concrete strength of 40 MPa were adopted. The precast box culverts are also designed to meet this requirement.

For the walkway platform and handrailing that will be subject to periodic flooding, aluminium sections were selected as they will provide a longer life than galvanised mild steel.

The regulator control gates and carp screen are subject to variable water quality conditions with low salinity under normal low river flows to high salinity due to flooding from Lake Wellington. Regulator gates are often made using marine grade aluminium but this may be unsuitable leading to a shorter life, and therefore for the project costing we have assumed Stainless Steel Grade 316 gates. The material choice, and possible use of cathodic protection, will require further investigation with full water quality analyses carried out at periodic intervals to gain an understanding of the service requirements prior to construction. The assessment needs to consider at least the following:

- Maximum salinity and chloride content
- Duration of high salinities
- Wetting and drying phases
- PH
- Temperature
- Differential salinity with freshwater on one side and saline water on the other,
- Possible anaerobic silt deposits
- Operational changes to introduce fresh water into the morass to reduce salinity, and
- Expected life and cost of different materials

### 2.1.8 Constructions Issues

The new regulator is to be constructed approximately 10 m from the river bank permitting most of the work to be done away from the river. The final part of the work will be constructing the entry channel into the river.

The inlet will require removal of native vegetation and this will require assessment prior to construction.

The detail design is shown in Appendix B.

## 2.2 Heart Outlet

The proposed outlet for Heart Morass is to re-purpose the existing four pipe structure located in East Heart Morass. It is well located with a connecting drain into the Heart East Morass. The structure is visually in good condition and is currently fitted with simple aluminium penstocks on the morass end, and flood gates on the river end.

### 2.2.1 Operation

The normal operation at this site is for the penstock gates to be closed to hold water in the morass. The gates would only be opened to drain out and flush out the morass into the Latrobe River.

The current penstock gates are not easy to operate and are considered a temporary solution only. It is proposed that a new manually operated penstock gate be fitted to the upstream headwall at each pipe. This will enable the morass water levels and outlet flows to be controlled and operated in a safe and secure manner. The penstocks will be fitted with a gearbox that is only operated with a special drive unit, the same unit to be used for the Heart West inlet, to prevent unauthorised operation.

When the morass has drained down to river level, further outflows cannot occur due to the lack of head. The morass will then dry out depending on the net evaporation rate, which is 100 mm /month in summer.

### 2.2.2 Flood gates

It is understood that due to sustained westerly winds, the level in Lake Wellington at the western end will draw down below normal level, which in turn will draw down the river level at this location. This affect commonly occurs and can be utilised to drain additional water from the morass. A head differential of up to 300 mm has been reported, but may only last a few hours before dropping. It is therefore proposed to upgrade the existing floodgates to enable automatic drainage operation. At other times water levels in the river will rise and the floodgates will prevent reverse flows, particularly to prevent saline water from Lake Wellington entering the morass.

Flood gates usually require a moderate head to open and flow freely. For this site with the very low head, a lighter Low Head Prime floodgate is recommended. Due to its weight of 35 kg and low available head, only partial opening will occur so the flows are expected to be about 25% of a fully open pipe. This would equate to about 15 ML/d per pipe.

A disadvantage of the floodgates is that unless they are manually fully opened, they will restrict outflows into the river. A new lifting arrangement is proposed to safely open the gates when in drainage mode to maximise outflow capacity.

Given the ability to pass extra flows as opportunities arise and to automatically prevent saline intrusions, it is considered that retaining upgraded flood gates on the structure would be beneficial.

### 2.2.3 Material Selection

The existing concrete structure is in a good condition based on a visual inspection, and no protective works are proposed. It is possible that the freshwater conditions following saline flooding events are beneficial.

For the new handrailing, that will be subject to periodic flooding, aluminium sections were selected as they will provide a longer life than galvanised mild steel.

The floodgates are permanently immersed in water and will be manufactured from fibreglass reinforced polyester, along with stainless steel grade 316 fittings, which are both suited to marine type conditions.

The regulator control gates and carp screen are subject to variable water quality conditions with low salinity during the initial filling of the morass, to high salinity when flooded from Lake Wellington, and higher salinity due to evaporation of the residual water in the morass. The high salinities can be reduced if the gates are opened to let in low salinity river water.

For the project costing we have assumed Stainless Steel Grade 316 gates and screens. The material choice will require further investigation with full water quality analyses carried out at periodic intervals to gain an understanding of the service requirements prior to construction.

#### 2.2.4 Site arrangement

The banks on the connecting channel to the Latrobe River are eroding and it is proposed that the banks be stabilised with rock beaching.

The detail design is shown in Appendix B.

## 2.3 Allman's levee

Allman's levee defines the eastern boundary of Heart Morass. The average crest height is EL 0.68m which is considered by the WGCMA to be adequate.

A geotechnical investigation was carried out on Allman's levee. The majority of the existing levee appears to be in good condition; with the north-south portion having been recently improved (Jacobs, 2015).

In order to prevent inflows from Lake Wellington and to retain water in East Heart Morass, the three existing culverts should be removed and the levee re-instated.

## 2.4 Other existing drainage structures

There are five pipe inlet/outlet structures through the river bank that currently provide for filling and drainage of the Central and Eastern sections of Heart Morass.

The future viability of these structures is addressed in a separate report (Jacobs, 2015 c).

## 2.5 Operational Summary

A summary of how the Heart inlet and outlet structures are proposed to be utilised is shown in Table 2.2 below.

**Table 2.2 : Heart Morass Operation Summary**

| Operation | Inlet Regulator | Outlet Regulator | Comments |
|---|---|---|---|
| Normal | Set gates with top sill set at EL0.5m AHD (both upper and lower gates in lowered position) | Close all penstock gates to retain water in morass<br>Floodgates to be in closed position | Allows river flushes into morass to top up water level. |
| Filling phase | When high flows expected, raise both gates to divert water into morass.<br>Continue until required level is reached, or river flows reduce. | Close all penstock gates to retain water in morass<br>Floodgates to be in closed position | |
| Flushing phase | Open both gates | Open all gates as required.<br>Raise floodgates to fully open position | |

| | | | |
|---|---|---|---|
| Automatic drainage at normal river level | Close gates | Open all penstocks<br>Floodgates to be in closed position, but free to open when river level drops | Allows for automatic drainage when river drops and prevents saline backflows |
| Flood events | Open gates | Open all gates | Provide flushing flows |
| Flushing phase after morass flooded by Lake Wellington (levees overtopped) to reduce salinity | Fully open gates to allow morass to drain back into river as lake and river levels recede to normal levels.<br>Leave gates open to allow river flows to enter morass to flush salty water.<br>Close gates when salinity level in morass reaches acceptable level. | Fully open penstocks and floodgates to allow morass to drain back into river.<br>Leave all gates open to allow for flushing flows.<br>Close gates when salinity level in morass reaches acceptable level. | The time to flush salt through this system will take several months depending on lake recession time, river flows, salinity levels, rainfall and evaporation. |

# 3. Dowd Morass structures

## 3.1 Dowd West Inlet Regulator

A new Inlet Regulator is proposed to be installed in the West Dowd Morass approximately 2km upstream of Big Drain, which will provide WGCMA the ability to divert flows into the western area of the morass.

### 3.1.1 Functional Requirements

The functional requirements are as follows:

- Provide controlled inflows from the Latrobe River
- Retain water in Dowd Morass when required
- Minimise carp entry
- Allow drainage of Dowd Morass into the Latrobe River
- Prevent backflows when the river level is high
- Maintain access across the site
- Provide a safe work site

### 3.1.2 Site Location Options

Two options were investigated for the inlet with one involving excavation of a connecting channel over a high pressure gas pipeline and the other to the east of the gas pipeline.

To assess the options a Dial Before You Dig investigation was carried out, and the physical location of the pipeline confirmed with the depth of cover over the gas pipeline determined to be 1.6m. The owners of the gas pipeline, Jemena Gas Transmission Pty Ltd, provided an extensive list of conditions for any works over their pipeline.

In order to determine the best option, the two primary options are compared in the table below.

**Table 3.1 : Dowd West Inlet Regulator - Site Options**

| **Site** | **1** | **2**<br>**(Option 3 on WGCMA options 21/04/15)** |
|---|---|---|
| Location | Downstream (East) of gas pipeline<br><br>No constraints on design | Connecting channel over gas pipeline<br><br>Must maintain 1.2 m cover to gas pipe to protect the pipe and avoid buoyancy effects.<br><br>Limits depth of excavation |
| Land tenure | Parks Vic | Parks Vic |
| Design options | Could deepen connecting channel by 0.2m or more to increase capacity and operational flexibility. | Limited depth is just adequate to achieve desired flow. |

| | | |
|---|---|---|
| Connecting channel | Up to 1.5 m deep,<br><br>10m wide bed, 120 m long | Up to 0.4m deep,<br><br>10 m wide bed, 90 m long |
| Channel Earthworks | 2,000 $m^3$<br><br>Indicative Cost $20,000 | 1,500 $m^3$<br><br>Indicative Cost $15,000 |
| Gas pipeline protection | Nil | Concrete slab $4,000<br><br>Jemena's compliance conditions |
| River level at west end of Heart West morass required to deliver 200 ML/d through the Dowd inlet<br><br>% of time above level | WL > 0.6m<br><br>Existing conditions: 8.8% time above this level<br><br>Sea level rise: 14% time above this level | WL > 0.75m<br><br>Existing conditions: 6.5% time above this level<br><br>Sea level rise: 8.6% time above this level |
| Environmental issues | Native vegetation requires removal | Native vegetation requires removal |

An inlet regulator could be constructed at either Site 1 or Site 2. It was assessed that the capital cost at either site would be comparable. The key benefit of Site 1 is that the regulator can deliver flows of up to 200 ML/d at a lower river level, and this will be important in drought periods. Also it can pass flow at river levels marginally above the typical base river flow level of 0.2m.

The new regulator at Site 2 requires a higher river level to achieve the same inflow and whilst some of Jemena's conditions can be readily met, eg pipe buoyancy, and protective concrete slab, there will be additional work and documentation to be submitted to satisfy Jemena, as well as a substantial risk during construction that will require management.

It is recommended that the location of the Dowd Inlet Regulator be at Site 1, downstream of the gas pipeline. This site provides the greatest operational flexibility and eliminates the risk associated with construction over the gas pipeline. It is recognised that there is the potential for increased cultural heritage issues associated with this site and these will need to be managed during construction via the cultural heritage management plan.

### 3.1.3 Design

The capacity of the regulator is based on the following and details shown in Table 3.2:

- Filling the West and North morass from empty up to EL +0.1m in 5 days.
- Raising the West and Central morass from EL +0.1m to +0.4m in 14 days.

Table 3.2 : Dowd West Inlet Regulator - Hydraulic Design

| Filling Operation | Volume (ML) | Filling Duration (days) | Average inflow ML/d | Regulator | Regulator design flow ML/d |
|---|---|---|---|---|---|
| Fill from empty to Open Water, EL +0.1m | 910 (West & North) | 5 | 180 | 1 No 1.8 x 1.9 m dual leaf gates | 200 |
| Raise from EL+0.1 to 0.4m | 1050 (West & North) | 14 | 75 | 1 No 1.8 x 1.9 m dual leaf gates | 200 |

The proposed single bay regulator will have a capacity of 200 ML/d and provide flexibility by allowing for a range of flow conditions. The design and operation for this regulator will be the same as for the Heart West Inlet Regulator shown in Section 2.1.

No geotechnical investigations have been carried out for the new Dowd inlet site to date. Investigations were carried out at Big Drain and were similar to the Heart West site. As the landforms are the same, very similar poor ground conditions are expected at Dowds and this has been assumed for design.

Construction of the proposed inlet regulator will require removal of native vegetation and this will require assessment prior to construction.

## 3.2 Dowd Outlet structures

The Eastern (Lake Wellington) end of Dowd Morass has no closed boundary, as Heywoods Levee is discontinuous with numerous breaches along its length, and therefore would be expected to have some hydraulic connection to Lake Wellington.

It is proposed that drainage of Dowd Morass into the Latrobe River be upgraded at two locations:

- Existing outlet at Big Drain
- Existing outlet at Little Drain

### 3.2.1 Big Drain Outlet

The Big Drain Outlet currently consists of a twin DN900 RC pipe structure with concrete headwalls. It is fitted with floodgates on each end and overall the structure visually appears to be in good condition.

Parks Victoria has advised that the current floodgates are an OHS risk to operate due to the angle of lift required. Therefore to improve safety along with flow capacity, it is proposed to replace the existing floodgates with new penstock gates on the south (morass) end. The proposed gates are similar to the proposed upgrade for the Heart Outlet structure.

As for Heart Outlet structure the new floodgates will be installed on the river end, or replaced depending on condition, to allow for automatic drainage and to prevent saline water flowing into the morass. A new lifting arrangement is proposed to safely open the flood gates when in drainage mode to maximise outflow capacity.

The Big Drain structure can also be used for inflows to selectively fill the North Dowd Morass, though this would require the floodgates to be manually opened to pass flows.

The theoretical capacity of the existing outlet is 60 ML/d based on a head loss of 50 mm and the floodgate and proposed penstock fully open.

The existing stainless steel mesh type carp screen is readily blocked with vegetation, and it is proposed that it be replaced with a new carp screen, similar to that proposed for the Heart West inlet which is less prone to blockage.

The proposed works are shown in Appendix B

### 3.2.2 Little Drain Outlet

The Little Drain Outlet comprises a single DN750 steel pipe structure with concrete headwalls, and is fitted with floodgates on each end. Overall the structure is visually in good condition, although the downstream river end is in-filled with earth and is currently non- operational.

To improve operational safety and capacity of the structure, it is proposed to replace the floodgates with a new penstock gate on the south (morass) end. A new floodgate will be fitted to the river end with a lifting arrangement to safely open the gates when in drainage mode to maximise outflow capacity.

The theoretical capacity of the existing outlet is 30 ML/d based on a head loss of 50mm and the flood gate and penstock fully open.

The existing stainless mesh steel carp screen is prone to blockage and it is proposed that it be replaced with the same type as proposed for the Heart West inlet.

The proposed works are shown in Appendix B .

### 3.2.3 Temporary pump station

In order to achieve a lower water level in the morass than the river level at a rate greater than can be achieved by evaporation, pumping would be required.

In most years gravity flows to the river and evaporation can be utilised to largely drain Dowd's Morass, and pumping is expected to be required only occasionally, eg once in 5 to 10 years. Given this relatively low usage a temporary pump arrangement is proposed to facilitate the simple and safe installation of pumps when required. Based on BOM data at East Sale, net evaporation over the summer period is over 100 mm /month so considerable drawdown will usually be achieved. These rates are confirmed by data recorded during the pump trials in 2004 and 2005 (Raulings et al, 2011).

A pump trial was carried out in 2005 using two large capacity pumps. The report did not specify the pump flow rate, simply stating that 250 mm and 300 mm agricultural pumps were used. It is expected that a similar 300mm flood type pump would have maximum capacity of 25 ML/d.

A temporary pump station would involve hiring a diesel powered pump set(s) and associated suction and discharge pipework. A permanent pump well with a diameter of 2.4 m and 4 m deep would provide suitable conditions in which to install the suction pipes for two 25 ML/d pumps, however the capital cost of at least $50,000 would not be justified for the proposed occasional pumping.

It is therefore proposed to provide a hardstand area for the pumps and to provide a clear stabilised section of creek bank to facilitate pumping as and when required.

To provide for public access along the access track whilst pumping it is proposed that a 900 mm wide x 450 mm high box culvert be installed under the track to allow the temporary discharge pipeline, expected to consist of two 300mm diameter pipes, to be installed under the track during pumping events. The culvert ends would be blanked off with timber sleepers to prevent soil ingress when not in use.

A formal pump capacity based on area and depth lowered is not possible in such a complex morass with no defined boundaries. The pumping rate will depend on the water management objectives at the time of a pumping event.

It is suggested two pumps be used to provide flexibility in operation. It is expected high flows will occur whilst the water level is between +0.2 m to -0.1m, then reduce as natural obstructions though the morass restrict flows. The lack of connectivity will result in some areas being drained and others not. From an ecological perspective this is ideal as it provides a wide diversity of wet and dry sub-areas (P. Boon pers. comm.)

The pump site is a frequently used public site. There have been issues over the years with vandalism and this is a key factor in planning how the pumping will be carried out. The key issues and preliminary solutions are as follows:

- Install temporary security fence around pump set up to minimise tampering.
- Install temporary security cameras to inform a security firm or police to intervene
- Visit site daily to monitor pumps
- Store fuel in a bunded area to minimise risk of environmental damage
- Minimise diesel fuel stored on site and place in secure area to minimise the risk of theft.
- A temporary block may be required in Heywood's levee to prevent inflows from Lake Wellington, as done in the trial pumping and would need to be assessed at the time.

The proposed works to facilitate future pumping events are shown in Appendix B.

## 3.3 Operational Summary

A summary of how the Dowd inlet and outlet structures are proposed to be utilised is shown in Table 3.3.

**Table 3.3 : Dowd Morass Operation Summary**

| Operation | Inlet Regulator | Big Drain Outlet | Little Drain Outlet |
|---|---|---|---|
| Normal | Set gates with top sill at EL0.5m AHD (both upper and lower gate in lowered position)<br>Allows river flushes into morass to top up water level. | Close both penstocks to retain water in morass<br>Floodgates to be in closed position | Close penstock<br>Floodgate to be in closed position |
| Filling phase | When high flows expected, raise gates to divert water into morass.<br>Continue until required level reached, or river flows reduce. | Close both gates to retain water in morass<br>Floodgates to be in closed position | Close gate<br>Floodgate to be in closed position |
| Drawdown phase | Close gate | Open gate until morass WL is the same as the river WL (approx. EL 0.2mAHD)Raise floodgates to fully open position<br>Evaporation will lower WL<br>Pumping may be required in some years | Open gate until morass WL is the same as the river WL (approx. EL 0.2mAHD)<br>Raise floodgate to fully open position<br>Evaporation will lower WL |

| | | | |
|---|---|---|---|
| Automatic drainage at normal river level | Close gate | Open both penstocks<br>Floodgates to be in closed position, but free to open when river level drops | Open penstock<br>Floodgate to be in closed position, but free to open when river level drops |
| Flushing phase | Open gate | Open all gates | Open both gates |
| Flood flows | Open gate | Open all gates | Open both gates |
| Flushing phase after morass flooded by Lake Wellington (levees overtopped) to reduce salinity | Fully open gates to allow morass to drain back into river as lake and river levels recede to normal levels.<br>Then leave gates open to allow river flows to enter morass to flush salty water.<br>Continue until salinity level in morass is acceptable, then close gates. | Fully open all gates to allow morass to drain back into river.<br>Close gates | Fully open both gates<br>Leave gates open to allow for flushing flows<br>Continue until salinity level in morass is acceptable, then close gate. |

# 4. Cost Estimates

The capital cost estimates for the above works have been prepared and summarised in Table 4.1. Details of the estimates are included in Appendix A.

**Table 4.1 : Summary of Capital Cost Estimates**

| Site | Capital Cost (Ex GST) |
|---|---|
| Heart West Inlet | $510,000 |
| Heart Outlet | $225,000 |
| Dowd Inlet | $358,000 |
| Big Drain | $147,000 |
| Little Drain | $69,000 |
| **TOTAL** | **$1,309,000** |

## 4.1 Basis of Capital Cost Estimates

### 4.1.1 Introduction

The cost estimates are based on the detailed design presented in Appendix B. The estimates were developed from calculated quantities and are based on current market rates for work activities for similar structures constructed in Northern Victoria, as well as quotations for major items such as regulator gates. All costs are in 2015 prices. The cost estimates have been prepared based on the assumption that construction will be delivered through a lump sum construction contract.

Typically for this level of design a 15% contingency would be included in the estimates. However as no local market information was available at the time of preparation of the estimates and the works are likely to be let in small packages of 1 to5 structures a contingency of 20% is recommended and has been included.

### 4.1.2 Assumptions

The following assumptions have been made in the preparation of the cost estimates:

- The regulating gates and carp screens are manufactured using Stainless Steel Grade 316
- A 10% allowance has been made for WGCMA internal management costs in the delivery of the project.
- No allowance has been made for site supervision and/or superintendent services by a third party.
- No allowance has been made for handling and potential disposal of contaminated soil/fill (i.e. Acid Sulphate Soils).

- No specific allowance has been made for latent site conditions.
- All cost estimates are exclusive of GST

#### 4.1.3 Note regarding the cost estimates

Jacobs has prepared cost estimates set out above for the purpose of seeking project funding. The estimates have been prepared using information reasonably available to the Jacobs employee(s) who prepared this report, and based on assumptions and judgments made by Jacobs. Actual prices, costs and other variables may be different to those used to prepare the cost estimates and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. Jacobs does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the cost estimate.

# 5. Conclusion

This report has documented the detailed design of structures to improve water management in both Heart and Dowds Morass. The works include two new inlet regulators to increase inflows when opportunities arise, as well as upgrading three outlet structures to drain the wetlands to normal river levels. A summary of the works is shown in Table 5.1.

**Table 5.1 : Summary of Proposed Works**

| Site | Works Summary |
|---|---|
| Heart West Inlet | New twin bay 1800 mm wide regulator, with carp screen |
| Heart Outlet | Four DN900 pipe culverts<br>Retrofit with penstocks and floodgates, and carp screen<br>Decommission culverts in Allmans levee |
| Dowd Inlet | New 1800 mm wide regulator, with carp screen |
| Big Drain Outlet | Twin DN900 pipe culverts<br>Retrofit with penstocks and floodgates, and carp screen<br>Provisional works for temporary pumping |
| Little Drain Outlet | Single DN750 pipe culvert<br>Retrofit with penstock and floodgate, and carp screen |

# 6. References

1. Jacobs (2015). “Strategic Management of Heart and Dowd Morass – Geotechnical Factual Report”, January 2015.

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3. Jacobs (2015) c “Strategic Management of Heart and Dowd Morass – Heart Morass Minor Infrastructure”, July, 2015.

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5. Raulings EJ, Morris K, Roache MC, and Boon PI (2011), ”Is hydrological manipulation and effective management tool for rehabilitating chronically flooded, brackish-water wetlands?”, Freshwater Biology, (2011) 56, 2347-2369.