

Bookmark Creek Complex Master Plan



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The Department for Environment and Water acknowledges Aboriginal people as the First Peoples and Nations of the lands and waters we live and work upon and we pay our respects to their Elders past, present and emerging. We acknowledge and respect the deep spiritual connection and the relationship that Aboriginal and Torres Strait Islander people have to Country.

The Department works in partnership with the First Peoples of South Australia and supports their Nations to take a leading role in caring for their Country.

The Master Plans Project was funded through the SARFIIP (South Australian Riverland Floodplains Integrated Infrastructure Program); a \$155 million investment program funded by the Australian Government through the Murray Darling Basin Authority and implemented by the South Australian Government to improve the watering and management of River Murray floodplains in South Australia's Riverland.

Project summary

Background

Bookmark Creek is an 8km anabranch, which bypasses 13km of the River Murray channel, including Lock 5, straddling the township of Renmark. The broader complex (encompassing areas from the Ral Ral Floodplain to Disher Creek, including wetlands along the creek and surrounding floodplain) has extremely high social and recreational value to the regional community, with an active and well-established local action group supported by industry groups and key stakeholders.

The River Murray and Mallee Aboriginal Corporation (RMMAC) holds native title over the River Murray and many floodplain areas within the Lock 4 and Lock 5 Reaches, including Bookmark Creek. The First Peoples intimate knowledge and understanding of Country and active participation across all levels is vital to the effective management of this landscape.

In pre-colonial times, Bookmark Creek was a natural creek depression that flowed during periods of high River flows. The Creek has suffered significant changes instigated by European settlement, which brought with it development of the first Australian irrigation district in the late 1880s and then construction of Lock 5 in 1927. These changes meant the Creek was used as a reservoir to supply irrigation water and later as an irrigation disposal basin. The Creek also saw permanent inundation at the inlet following the construction of Lock 5.

Today, as a result of bypassing Lock 5, a significant head difference exists between the inlet and outlet of the Creek. This head difference presents the potential for unique flowing habitat conditions preferred by a number of large bodied native fish species. Currently, however, a series of impeding structures along the Creek prevent it from flowing freely.

The combination of these factors has had adverse impacts on the ecological values of the site and have contributed to significant environmental degradation of the landscape. A lack of funding and available resources has meant that site specific and narrowly defined infrastructure solutions have been proposed in recent years in the absence of a strategic direction for the complex in its entirety. The lack of an overarching plan for coordinated future strategic investment has led to a loss of opportunity and constraints throughout the complex.

The Bookmark Creek Master Plan presents a key opportunity for future works around Bookmark Creek to result in hydrological connectivity through this region, unlocking a suite of environmental, social and economic benefits and supporting the growth and wellbeing of the community.

Master Plans Project objective

The objective of the Project was to develop a '*master plan*' for achieving environmental outcomes in the Bookmark Creek and broader complex through future investment initiatives, in collaboration with community stakeholder groups. The '*master plan*' will provide a dynamic, long-term conceptual layout to guide future investment in support of agreed objectives for River management throughout the Bookmark Creek Complex.

The Master Plans Project was informed through consultation and investigations, which identified and explored the feasibility of a suite of options and has made recommendations on a pathway to proceed, demonstrating the value of further investment. These proposed investments are a combination of infrastructure investments and operational investments, focused on achievement of environmental outcomes.

Ultimately, the outcomes of implementing a program of complementary works within the Bookmark Creek Complex, following the master plan development, are:

- Efficient and effective resource allocation (e-water, people, infrastructure) as a result of having a clear, prioritised pathway for future investment in Bookmark Creek Complex
- Confidence and increased flexibility in operations through having a detailed understanding of the outcomes of operational scenarios and how these contribute towards environmental outcomes
- Enhanced environmental outcomes as a result of increased hydraulic diversity and connectivity, particularly in improving unique fish habitat in the anabranch system
- Enhanced social, economic and recreational benefits associated with improved connectivity, amenity and condition of high value wetlands / floodplains throughout the region.

The finalised master plan is a key milestone in the Sustaining Riverland Environments (SRE) Program initiative, which will deliver practical projects to improve river and wetland health, and support native fish in the River Murray. Projects that are

included in the master plan will have the opportunity to receive funding under the SRE program. In particular those that align strongly with SRE objectives.

While significant investigations and local planning initiatives have been developed in the region, there is no governing strategic direction for the entire complex. Only after key threats, values and objectives have been clearly defined and holistic ecological and hydrological assessment undertaken with continued stakeholder engagement, can informed decisions be made in selecting the most feasible and appropriate infrastructure and management solutions for investment.

While the site has not been used as an irrigation disposal basin for many years, Bookmark Creek is still technically classified as a saline disposal creek which governs the operational guidelines and fails to define an environmental imperative (noting that a Wetland Management Plan has been developed). Redefining the objectives based around key ecological assets and values with all key stakeholders included in the conversation, will inform new operational parameters to reinstate a healthier hydrological and management regime. This will be integrated with other opportunities emerging in the region such as Lock 5 Weir Pool Manipulation and will also be considered in the context of other nearby regional environmental investments such as at the Chowilla and Pike floodplains.

Master planning process

The Master Plans Project began in July 2019 as an initiative of the South Australian Government's South Australian Floodplains Integrated Infrastructure Program (SARFIIP), funded by the Australian Government through the Murray-Darling Basin Authority. The project has occurred over two years and is a continuation of SARFIIP's Environmental Pathways Project (EPP). The EPP aims to ensure that the delivery of water for the environment is managed in an efficient and effective manner, improving the ecological health and resilience of the South Australian River Murray, between Locks 1-7.

Traditional River Murray planning approaches have started first with a set of discrete environmental objectives, to focus development of options for works and measures to best meet those objectives. The Master Plans Project was delivered using a new approach toward River Murray project planning and prioritisation, facilitating an open community forum to generate and collate ideas with a broad range of potential environmental objectives, rather than a single targeted objective. This resulted in a suite of potential '*options*' providing a conceptual layout to guide future investment, which can then be prioritised for funding under future programs based on their alignment with the various objectives of those programs.

Planning at the site scale, including immediate surrounds, enabled an adequate project size for engagement with a variety of stakeholder groups and generated a variety of potential opportunities and outcomes. It also enabled a large enough project footprint to realise a coordinated approach to future management in the broader area.

The productive and beneficial engagement with the RMMAC Working Group through the Master Plans Project highlighted the need to further support opportunities for First Peoples to continue to engage throughout the application of the works and measures. This should be considered for the planning of future master planning projects and the next stages of project implementation.

Site option profiles

Working with key stakeholders within the Riverland community, a comprehensive list of ideas and initiatives to support environmental outcomes along the River Murray has been compiled, collated and refined to form the foundations of the Bookmark Creek Complex Master Plan. These ideas and initiatives have been summarised into 'Site Option Profiles', with some 'Sites' consisting of multiple and in some instances, scalable options.

A total of 5 'Site Option Profiles' within the Bookmark Creek Complex have been developed:

1. Bulyong Island
2. Ral Ral Floodplain (West)
3. Bookmark Creek
4. Goat Island Paringa Paddock
5. Disher Creek.



Site option profiles

Bulyong Island

Location: Weir Pool 5, River Chainage Markers 588 to 582
Land Tenure: Crown Record

Wetland Size: 2,382 hectares (Ha)
Normal Pool Level: 16.4 mAHD

PROPOSED OPTIONS	
Option #1:	Improve floodplain condition in the ex-disposal basin, by supporting opportunities for environmental watering and increasing the duration of floodplain watering associated with managed and natural high-flow events, including weir pool raising by enabling the retention of water to 17.2 mAHD, exploring the potential of utilising and repairing existing disposal basin infrastructure and the installation of complementary structures and embankments.
Description	<p>This option aims to explore the capability to retain water by utilising the existing disposal basin infrastructure, the installation of new regulating structures and complementary blocking banks to 17.2 mAHD, in order to extend the duration of watering events such as those associated with weir pool raising, high-flow events as well as promoting opportunities for water delivering via pumping.</p> <p>Due to the prior function as a disposal basin, there is a significant network of blocking banks and complementary structures designed to support the retention of water on the floodplain. This presents an opportunity to investigate and where needed, remediate these existing structures to support holding water within the wetland and extend the duration of watering events such as those associated with managed and natural high-flow events. To achieve this, a number of outflow points would also need to be investigated and potentially remediated to ensure water is retained.</p> <p>This also includes exploring opportunities for water delivery through an old Renmark Irrigation Trust (RIT) network, used previously to support the transport of water from the RIT network to Bulyong island.</p>
Outcomes	<ul style="list-style-type: none"> • Benefits associated with an improved watering regime. • Conservation and improvement of wetland vegetation. • Improved soil moisture conditions.

Option #2:	Investigate the opportunity for water delivery through the assessment and repair of RIT infrastructure that was used previously to support the transport of water from the RIT network to Bulyong island.
Description	This option aims to utilise current RIT infrastructure to allow additional watering of the floodplain. To achieve this, a number of structures would need to be investigated and potentially remediated through 'Option 1' to ensure water can be transported to Bulyong Island through the RIT network.
Outcomes	<ul style="list-style-type: none"> • Benefits associated with an improved watering regime. • Conservation and improvement of wetland vegetation. • Improved soil moisture conditions.

Option #3:	Improve floodplain condition in the Eastern Basin, by supporting opportunities for environmental watering and increasing the duration of floodplain watering associated with managed and natural high-flow events, including weir pool raising by enabling the retention of water to 17 mAHD, exploring the potential of utilising and repairing existing disposal basin infrastructure and the installation of complementary structures and embankments.
Description	This option aims to support the capability to maximise the opportunity presented by weir pool raising and capacity to retain water, through the installation of regulating structures and complementary blocking bank to 17 mAHD. This will support the capacity to extend the duration of watering events such as those associated with high-flow events and weir pool raising, as well as prompting opportunities for delivering water via pumping.
Outcomes	<ul style="list-style-type: none"> • Benefits associated with an improved watering regime. • Conservation and improvement of wetland vegetation.

- Improved soil moisture conditions.

SITE BACKGROUND

Description

Bulyong Island is located within the Murray River National Park on the eastern bank of the River Murray, upstream of the town of Renmark. The island is physically separated from the town of Renmark by Ral Ral Creek, an anabranch of the River Murray that flows along its eastern margin. Bulyong Island contains a variety of fluvial landforms including discontinuous levees, oxbows, back swamps, lakes and low terraces¹.

Cultural Significance

The River Murray and Mallee Aboriginal Corporation (RMMAC) holds native title over the River Murray within the Lock 5 Reach. The First Peoples intimate knowledge and understanding of Country and active participation across all levels is vital to the effective management of this landscape

Post-colonial Use

Bulyong Island was formerly used as a saline drainage water disposal basin. By October 1967 a series of embankments and an inlet/outlet structure had been established and the area began to receive drainage water from the Renmark and Chaffey Irrigation areas. Discharge to the island occurred until 1983, when the disposal basin was taken out of commission. The flood of 1989 breached the basin embankment. The embankments were further removed in 1990 so that the basin lost its holding capacity. Relics of some regulating structures still remain. In June 1991, the island was established as part of the Murray River National Park¹.

WETLAND ECOLOGY

Bulyong Island is within the Murray River National Park which conserves a significant proportion of South Australia's floodplain environments which are not represented widely in other reserve systems¹.

Flora and fauna: There is limited information on the flora and fauna composition at the site and no recent survey has been conducted. The major vegetation communities within Bulyong Island include river red gum (*Eucalyptus camaldulensis*) and black box (*Eucalyptus largiflorens*) woodland, lignum and samphire/ chenopod shrublands¹. The island is home to a number of species, such as western grey kangaroos, emus, pelicans, kingfishers and parrots².

WETLAND MANAGEMENT

Current Management:

Bulyong Island is currently under the management of the National Parks and Wildlife Service SA and can only be accessed via boat or canoe (no vehicle access). The closest boat launching point is at the Goolwa Street boat ramp. The Island is a popular recreational area for boating and fishing.

Infrastructure:

The Island has minimal infrastructure to support active environmental water management. As noted above, a series of embankments and an inlet/outlet structure were installed in 1967 in support of the drainage irrigation areas. The basin embankment has since been breached, and further sections of the embankment have been removed, diminishing its holding capacity. Relics of some regulating structures still remain.

ISSUES AND DRIVERS

As part of the Master Planning Project engagement process, an ongoing register of issues and drivers relating to sites and options was maintained. These highlighted key considerations and investigations that would need to be factored in and undertaken as part of any next steps towards realising the outcomes described within the option profiles. For Bulyong Island, these included:

Environmental

- Potential investigations are needed into salinity impacts and groundwater issues at the site as well as feasibility of recovery, and high flow dynamics/impediments.
- Potentially need comparative analysis of expanding water on floodplain with a downstream regulator vs pumping onto floodplain.
- Introducing Exotic Flora and Fauna: There is a risk of enabling access of pest species to Bulyong Island via construction activities.

Cultural

- There are areas of potential cultural significance that would need to be protected during weir pool manipulation.

Community/Social

- Bulyong Island landholders must be engaged through design and construction.

Operational/logistics

- Integrity tests on embankments are required, including managing for potential spill-over impacts.
- Ongoing operations and maintenance costs and access need to be considered.
- A breach in existing embankment will need to be remediated.

KEY STAKEHOLDER INVOLVEMENT

- Commonwealth Environmental Water Office (CEWO)
- Murray-Darling Basin Authority (MDBA)
- Murraylands and Riverland Landscape Board
- National Parks and Wildlife Service SA
- Renmark Irrigation Trust (RIT) – including the Environmental Watering Committee
- Renmark Paringa Council
- Renmark Paringa Landcare
- River Murray and Mallee Aboriginal Corporation (RMMAC)
- SA Water

REFERENCES

1. DENR. Murray River National Park Management Plan (Including Rilli Island, Media Island and Kapunda Island Conservation Parks). 1994.
2. National Parks and Wildlife Service South Australia, Department for Environment and Water. Murray River National Park [Internet]. 2020 [cited 2020 Nov 23]. Available from: https://www.parks.sa.gov.au/find-a-park/Browse_by_region/Murray_River/murray-river-national-park

Bulyong Island

Inundation Extents

-  5GL - At pool conditions
-  16.8 mAHD (20GL 50cm - Weir Pool Raise)
-  17.2 mAHD (Option 1)
-  17.0 mAHD (Option 3)
-  Proposed Works
-  Proposed Embankment

Option # 2

Option # 1

Option #3



0 0.25 0.5 Kms

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Data Source DEW - TOPO, Aerial Imagery 2014, DEM,
Wetland Structures, Model Flow Extents

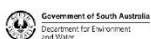
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Ral Ral Floodplain (West)

Location: Weir Pool 5, River Chainage Markers 608 to 569

Land Tenure: Certificate of Title

Wetland Size: 477 hectares (Ha)

Normal Pool Level: 16.4 mAHD

PROPOSED OPTION	
Option #1:	Improve floodplain condition on the western Ral Ral Floodplain, by supporting opportunities for environmental watering and increasing the frequency of floodplain watering associated with managed and natural high-flow events, including weir pool raising, by enhancing connectivity through the installation of supporting infrastructure.
Description	<p>This option aims to support the capability to maximise the opportunity presented by weir pool raising and high-flow events to water the floodplain, through the installation of supporting infrastructure that increases creek and floodplain connectivity.</p> <p>This will occur through the installation of a regulating structure immediately north of the Goolwa Street boat ramp that will commence to flow at 16.6 mAH. There will be no requirement for complementary blocking banks.</p> <p>This option will be completed in conjunction with the Renmark Irrigation Trust (RIT) Environmental Watering Committee and associated Management Guidelines to ensure efforts harmonise with existing plans for the floodplain.</p>
Outcomes	<ul style="list-style-type: none"> • Conservation and improvement of floodplain vegetation. • Improved soil moisture conditions.

Option #2:	Improve floodplain condition on the western Ral Ral Floodplain, by supporting opportunities for environmental watering and increasing the frequency and duration of floodplain watering associated with managed and natural high-flow events, including weir pool raising, by enabling the retention of water through the installation of regulating structures and complementary embankments to 17.2 mAHD.
Description	<p>This option aims to support the capability to maximise the opportunity presented by weir pool raising and capacity to retain water, through the installation of regulating structures and complementary blocking banks (including building-up of existing road alignments) along Goolwa Street and the outer floodplain to 17.2 mAHD. This will support the capacity to extend the duration of watering events such as those associated with high-flow events and weir pool raising, as well as prompting opportunities for delivering water via pumping.</p> <p>This option will be completed in conjunction with the RIT Environmental Watering Committee and associated Management Guidelines to ensure efforts harmonise with existing plans for the floodplain.</p>
Outcomes	<ul style="list-style-type: none"> • Conservation and improvement of floodplain vegetation. • Improved soil moisture conditions.

SITE BACKGROUND

Description

The Ral Ral Floodplain (west) is located north of Renmark and Bookmark Creek. Habitats within the floodplain have a variety of features, including flow paths, pools and rises. These areas are connected during high flow events, although human activity has altered the topography, altering the natural hydrological regimes. The floodplain has several active and inactive environmental watering sites, including Johnson's Waterhole, Jane Eliza Woodlot, Namoi Street, Begara Street, Paroo Street and Warrego Street¹.

Cultural Significance

The River Murray and Mallee Aboriginal Corporation (RMMAC) holds native title over the River Murray within the Lock 5 Reach. The First Peoples intimate knowledge and understanding of Country and active participation across all levels is vital to the effective management of this landscape.

Post-colonial Use

Prior to the regulation of flows in the River Murray and the construction of locks and weirs, the Ral Ral floodplain (west) would have had a more variable water regime. The stabilisation of water levels has led to permanent inundation of low-lying areas and reduced frequency and duration of inundation of the surrounding floodplains.

WETLAND ECOLOGY

The Ral Ral Floodplain area is generally dry and naturally flooded when flows in the River Murray exceed 60,000 megalitres per day (ML/day), with a natural frequency of one in three-five years. Currently there are three active environmental watering sites (Johnson's Waterhole, Jane Eliza Woodlot, and Namoi Street) and three identified, but inactive sites (Begara Street, Paroo Street and Warrego Street). The Ral Ral Floodplain has been affected by reduced inundation frequency, human recreational activities, pest animal pressure, saline ground water impacts, long-term inundation by saline ground water and inappropriate inundation from storm water ^{1,2}.

Flora and fauna:

The major vegetation communities within Ral Ral floodplain (West) include river red gum (*Eucalyptus camaldulensis*) and black box (*Eucalyptus largiflorens*) woodland, lignum and samphire/ chenopod shrublands and sedgeland ^{2,3}. There is limited information of the fauna composition at the site as no recent surveys have been conducted.

WETLAND MANAGEMENT

Current Management:

The floodplain is managed by the Renmark Paringa Council in conjunction with the RIT. The RIT Environmental Watering Committee, which consists of irrigators, and representatives from Council, the Commonwealth Environmental Water Office and local community groups, has formed to actively improve the ecological health of the floodplain. RIT has established the Management Guidelines for the Environmental Watering Sites Adjacent to the Renmark Irrigation District, which identifies numerous sites that can receive environmental water via RIT infrastructure as well as future sites that would greatly benefit from receiving environmental water but require further investigations to support its delivery. The Guidelines also outline the required infrastructure works for specific watering sites as well as a watering schedule through 2024. Recreational activities on the floodplain including hiking, biking, camping and fishing³.

In recent years the Ral Ral flowpath has been opened to enhance inundation of the floodplain through weir pool raising, with resultant strong vegetation response.

Infrastructure:

Infrastructure supporting the current e-watering sites within the Ral Ral Floodplain (west) is highlighted below³.

- **Johnson's Waterhole:** Water is supplied via the Renmark Irrigation Trust water system. Additional watering by sprinklers is supporting plantings of native species around the edges of the wetland. New installations at the waterhole have been, or will be, completed as noted in the management guidelines report:
 - Small bank at the south-western end of the site with a 300 mm diameter concrete pipe.
 - Hume floodgate on the wetland side to maintain water at full supply (17 mAHd).
 - Approximately 600 m of channelling to connect the site to the south-eastern flow paths.
 - 1,350m of channelling to connect the site to the Jane Eliza Woodlot.
- **Jane Eliza Woodlot:** Water is supplied by the RIT private line via Davis Street. New installations include a floodgate placed on the wetland side and the 2x350 mm and 1x 500 mm concrete pipes under the southern road embankment.
- **Namoi Street:** Water is supplied by the RIT network via Namoi Street. New installations have been or will be completed as noted in the management guidelines report:
 - 360 m of embankment at 17.2 mAHd.
 - Re-profiled old embankment to create a 2 m wide bank along the southern side of the present track.
 - 180 m of 300 mm deep channelling to connect the adjacent three floodplain depressions and to breach the northern track/old bank.
 - 300 mm diameter concrete pipe through the major embankment fitted with a Hume floodgate on the northern side.
- **Warrego Street:** Water is supplied by the RIT network. New installations at the waterhole have been or will be completed as noted in the management guidelines report:
 - 200 m of pipeline plus valve and meter to connect end of E11 to watering site.
 - 380 m x 2 m wide embankment along the northern side of the floodplain to 18.2 mAHd.
 - 60 m x 2 m wide embankment across the site's northern flow path to 18.2 mAHd.
 - 300 mm diameter concrete pipe through the northern flow path embankment with a Hume floodgate on the wetland side.
- **Paroo Street:** Water is supplied by sprinklers.

ISSUES AND DRIVERS

As part of the Master Planning Project engagement process, an ongoing register of issues and drivers relating to sites and options was maintained. These highlighted key considerations and investigations that would need to be factored in and undertaken as part of any next steps towards realising the outcomes described within the option profiles. For Ral Ral, these included:

Environmental

- Construction and operations need to be mindful of the presence of salt in groundwater and accumulation of salt from evaporation of surface water.
- Potential loss of floodplain connectivity needs consideration.
- Investigations needed to review current infrastructure and sill levels, understand weir pool manipulation interactions and any downstream impacts.

Community/Social

- Potential loss of community access in the area - appropriate community engagement and planning needs to be undertaken.

Operational/logistics

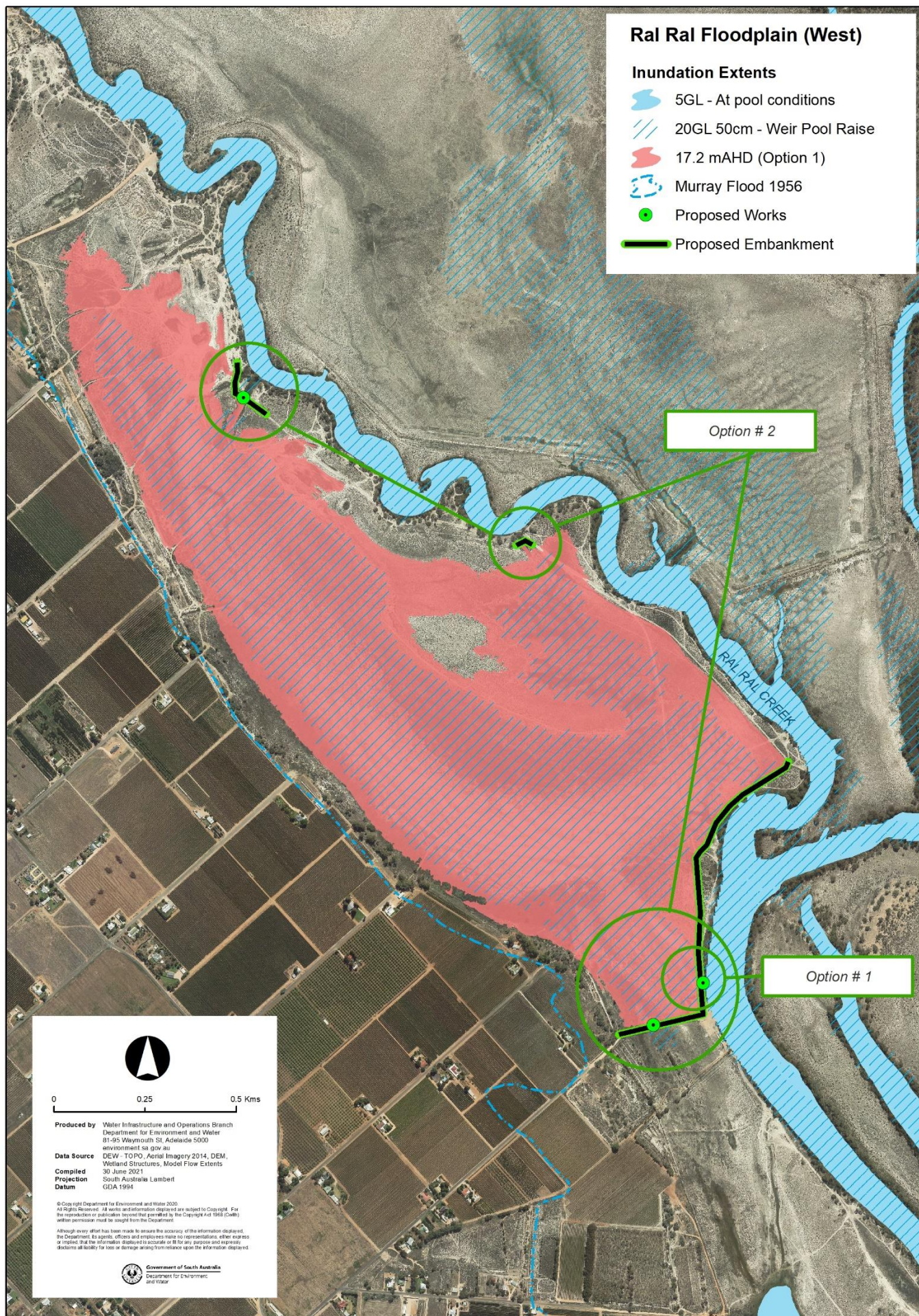
- Current structure has integrity issues that need addressing.
- Ongoing costs and community security issues need to be considered.

KEY STAKEHOLDER INVOLVEMENT

- Commonwealth Environmental Water Office (CEWO)
- Murray-Darling Basin Authority (MDBA)
- Murraylands and Riverland Landscape SA
- National Parks and Wildlife Service SA
- Renmark Irrigation Trust (RIT) – including the Environmental Watering Committee
- Renmark-Paringa Council
- Renmark-Paringa Landcare
- River Murray and Mallee Aboriginal Corporation (RMMAC)
- SA Water

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1. Connecting and Rehabilitating the Ral Ral Floodplain- Regional land partnerships 5 year project. Renmark Paringa Council, RIT and Renmark Paringa Landcare; 2019.
2. Reviving the Ral Ral floodplain- An options analysis paper. Renmark Paringa Council and Renmark Irrigation Trust; 2012 Aug.
3. Harper A, Harper M. Management Guidelines- Environmental Watering Sites Adjacent to Renmark Irrigation District. Renmark Irrigation Trust; 2019.



Bookmark Creek

Location: River Murray anabranch,
River Chainage Markers 568.7 to 555

Land Tenure: Certificate of Title

Creek Length/Floodplain Size: 8 km, 25 (Ha)

Normal Pool Level: 16.3 mAHD U/S and 13.2 mAHD D/S

PROPOSED OPTIONS	
Option #1:	Improve flow conditions and fish passage within the creek by reviewing the inlet and downstream outlet structures and where needed, replacing them with new infrastructure that optimises flow outcomes in the creek and allows for fish passage.
Description	<p>The current inlet structure restricts the flow within Bookmark Creek and prevents fish passage. This option aims to review and, where needed, replace structures with infrastructure that will permit fish passage and optimise flow outcomes for the creek. This will allow small and medium-bodied fish to pass, whilst improving hydraulic conditions. Both structures will be designed in consideration of environmental and community needs (e.g. pedestrian use, vehicle use).</p> <p>Active weir pool manipulation in Weir Pool 5 also presents an opportunity to create seasonal hydraulic diversity.</p> <p>A number of ancillary structures exist (roads, bridges, etc.) that would need to be reviewed and potentially upgraded to mitigate impacts and optimise outcomes.</p> <p>Any new or upgrades to structures will be mindful of the recreational opportunities such investment within the creek will present (i.e. canoeing, boating, bush-walking).</p>
Outcomes	<ul style="list-style-type: none"> • Conservation and improvement of wetland vegetation. • Improved hydraulic conditions for fish. • Improved fish passage. • Improved recreational activities.
Option #2:	Improve flow conditions and fish passage within the creek and support floodplain inundation and water retention on the Bookmark Creek floodplain, by reviewing the inlet and downstream outlet structures and where needed, replacing them with new infrastructure that optimises flow outcomes in the creek, allows for fish passage and can control water levels to support floodplain inundation and water retention.
Description	<p>In addition to the activities proposed in 'Option 1', the downstream structure will be investigated to support floodplain inundation at NPL (normal pool level) at Lock 5 and aligning with the potential inundation weir pool manipulation and high-flow event present, for improvements to watering inundation extent, event duration and watering frequency.</p> <p>Floodplain watering outcomes are consistent with the proposed Renmark Irrigation Trust (RIT) plan for improvements to floodplain conditions adjacent the creek.</p>
Outcomes	<ul style="list-style-type: none"> • Benefits associated with an improved watering regime. • Opportunities for conservation and improvement of wetland vegetation and fauna. • Improved soil moisture conditions. • Improved hydraulic conditions for fish. • Improved fish passage. • Improved recreational activities. • Promote inundation opportunities.

SITE BACKGROUND

Description

Bookmark Creek is an 8km anabranch that bypasses Lock 5 and 13 km of the River Murray channel, straddling the township of Renmark. The creek is permanently connected at Lock 5 pool level via the upstream inlet structure, and flows back to the river channel within the Lock 4 weir pool via the downstream road crossing structure. A significant head difference between the inlet and outlet exists due to the bypass, presenting unique flowing habitat conditions beneficial to a number of native fish species. These conditions are not currently utilised due to the two impeding structures along the creek. The creek has extremely high social and recreational value to the regional community with an active and well-established local action group, supported by industry groups and key stakeholders¹.

Cultural Significance

The River Murray and Mallee Aboriginal Corporation (RMMAC) holds native title over the River Murray within in the Lock 5 Reach. The First Peoples intimate knowledge and understanding of Country and active participation across all levels is vital to the effective management of this landscape.

Post-colonial Use

Bookmark Creek has suffered significant changes instigated by European settlement, including the development of the first Australian irrigation district in the late 1880s and then construction of Lock 5 in 1927. These changes meant the creek was used as a reservoir to supply irrigation water and later as an irrigation disposal basin. The creek also experienced permanent inundation at the inlet following Lock 5 construction. The combination of these factors has had adverse impacts on the ecological values of the site and has contributed to significant environmental degradation of the landscape¹.

WETLAND ECOLOGY

Bookmark Creek was considered to have low ecological value at its time of assessment in 1986, but its value is likely to have increased since this assessment ^{2,3}. The creek is considered a high priority site for management and on-ground works because it could provide unique flowing habitat conditions which benefit a number of large-bodied native fish species, however these conditions are currently unable to be delivered due to the two impeding structures along the Creek ^{1,4}.

Flora: No vegetation surveys have been undertaken at Bookmark Creek and as such, no vegetation of conservation significance has been formally identified. Vegetation associations observed along Bookmark Creek and wetland include river red gums, black box with an understory of lignum, samphire sp., bulrush and common reed. See reference for further details of species composition at site¹.

Fauna: Six frog species have been recorded at Bookmark Creek, among them the vulnerable southern bell frog (*Litoria raniformis*)¹. Nine native species and five non-native species of fish have also been recorded in the creek. See reference for further details of species composition at site¹. Lower abundances were observed at sites upstream than at sites downstream, likely due to infrastructure preventing movement between habitats.

WETLAND MANAGEMENT

Current Management:

The Bookmark Creek is managed by the Murraylands and Riverland Landscape Board and by the operation of the upstream flow-control structure (structure managed by the Department for Environment and Water (DEW) Infrastructure Operations and Maintenance Team located near the Jane Eliza Estate. It is possible for flows to enter Bookmark Creek through the Council's infrastructure via a pipe near the Jane Eliza waterway. The Bookmark Creek Action Group has been actively engaged in the restoration, rehabilitation and management of the site since 1997. Given the close proximity of the site to the township of Renmark, the creek offers ample opportunities for fishing, canoeing and other recreational activities. Maintaining the integrity of Bookmark Creek is fundamentally important to both the Bookmark Creek Action Group and the broader community¹. There has been ongoing investment and commitment to the site from DEW over many years.

Infrastructure:

The Bookmark Creek inlet regulator is located at the junction of Bookmark Creek and Jane Eliza Estate Lagoon and consists of a bank and pipe culvert with a sluice gate control valve. There is also a structure around the inlet pipe which prevents reeds from blocking the inlet pipe. The outlet road crossing structure is near Nelwart Swamp and consists of a bank and four pipe culverts. While the site has not been used as an irrigation disposal basin for many years, Bookmark Creek is still technically classified as a saline disposal creek.

ISSUES AND DRIVERS

As part of the Master Planning Project engagement process, an ongoing register of issues and drivers relating to sites and options was maintained. These highlighted key considerations and investigations that would need to be factored in and undertaken as part of any next steps towards realising the outcomes described within the option profiles. For Bookmark Creek, these included:

Environmental

- Potential investigations required on salt risks to floodplains and associated groundwater, inundation impacts on flowing fish habitats and fish ecology assessments.
- Potentially need comparative analysis of expanding water on floodplain with a downstream regulator vs pumping onto floodplain.

Community/Social

- Consideration needed of impacts on Angove Family Winemakers, 23rd Street Distillery and canoe trail compatibility at design stage.
- Proximity to township means that community interest is high.
- Implementation needs to be cognisant of other investments in this area.

Operational/logistics

- A detailed wetland management plan is required.
- The area needs to be declassified as a drainage basin.
- Early engagement with MDBA needed on inlet structure, which needs upgrading.

KEY STAKEHOLDER INVOLVEMENT





- Bookmark Creek Action Group
- Commonwealth Environmental Water Office (CEWO)
- Murray-Darling Basin Authority (MDBA)
- Murraylands and Riverland Landscape Board
- National Parks and Wildlife Service SA
- Private Landholders
- Renmark Irrigation Trust (RIT) – including the Environmental Watering Committee
- Renmark Paringa Council
- Renmark Paringa Landcare
- River Murray and Mallee Aboriginal Corporation (RMMAC)
- SA Water

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Bookmark Creek (Northern Section)

Inundation Extents

-  16.3 mAHD -
at pool water level height
at the Lock 5 weir
-  16.8 mAHD -
water level at the Lock 5
weir for a 20GL 50cm raise
-  ~5 GL - At pool conditions
-  Proposed Works

Option #1

Option #2

REMARK



0 0.25 0.5 Kms

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Department for Environment and Water
81-95 Waymouth St, Adelaide 5000
environment.sa.gov.au

Data Source DEW - TOPO, Aerial Imagery 2014, DEM,
Wetland Structures, Model Flow Extents

Compiled 30 June 2021

Projection South Australia Lambert

Datum GDA 1994





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Bookmark Creek (Southern Section)

Inundation Extents

-  16.3 mAHd -
at pool water level height
at the Lock 5 weir
-  16.8 mAHd -
water level at the Lock 5
weir for a 20GL 50cm raise
-  Proposed Works
-  ~5 GL - At pool conditions

Option #1 & #2



0 0.25 0.5 Kms

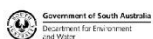
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Government of South Australia
Department for Environment
and Water

Paringa Paddock-Goat Island

Location: Straddles Weir Pool 4 and 5, River Chainage Markers 566 to 560

Land Tenure: Certificate of Title

Wetland Size: 66.8 hectares (Ha)

Normal Pool Level: 13.2 to 16.3 mAH

PROPOSED OPTIONS	
Option #1:	Improve flow conditions and fish passage within Astons Creek, through to the outer horseshoe by reviewing the inlet and downstream outlet structures and where needed, replacing them with new infrastructure that optimises flow outcomes in the anabranch and allows for fish passage.
Description	<p>The current inlet and outlet structures restrict the flow within Astons Creek, which feeds into the outer horseshoe billabong west of the Old River and prevents fish passage. This option aims to review and where needed, replace with infrastructure that will permit fish passage and optimise flow outcomes for the anabranch. This will allow small and medium-bodied fish to pass, whilst improving hydraulic conditions.</p> <p>A number of ancillary structures exist (roads, bridges, etc.) that would need to be reviewed and potentially upgraded to mitigate impacts and optimise outcomes.</p> <p>Active weir pool manipulation in Weir Pool 5 also presents an opportunity to create seasonal hydraulic diversity.</p> <p>Detailed designs have been created to support this option as part of the Riverine Recovery Project (RRP).</p>
Outcomes	<ul style="list-style-type: none"> Enhanced capacity for greater exchange between the river and wetlands. Improved fish passage. Improved hydraulic conditions for fish.
Option #2:	Improve flow conditions and fish passage within the anabranch and support floodplain inundation and water retention on the adjacent floodplain area, by reviewing the inlet and downstream outlet structures and where needed, replacing them with new infrastructure that optimises flow outcomes in the creek, allows for fish passage and can control water levels to support floodplain inundation and water retention.
Description	<p>In addition to the activities proposed in 'Option 1', the downstream structure will be investigated to support floodplain inundation at NPL (normal pool level) and align with the potential inundation provided by weir pool manipulation and high-flow events, improving inundation extent, event duration and watering frequency.</p> <p>Floodplain watering outcomes are consistent with the proposed Renmark Irrigation Trust (RIT) plan for improvements to floodplain conditions adjacent the creek.</p> <p>Detailed designs have been created to support this option as part of the Riverine Recovery Project (RRP).</p>
Outcomes	<ul style="list-style-type: none"> Benefits associated with an improved watering regime. Conservation and improvement of wetland vegetation. Improved soil moisture conditions. Enhanced capacity for greater exchange between the river and wetlands. Improved fish passage.

SITE BACKGROUND

Description

The Goat Island-Paringa Paddock wetland complex is located on the west side of the River Murray between the towns of Renmark and Paringa. The wetland complex extends on either side of Lock 5 and includes an outer horseshoe (i.e., the Billabong) and an inner horseshoe lagoon (i.e., Old River). The Old River is the former river channel, which has silted up over time, and is now a terminal permanent wetland connected to the Lock 4 weir pool. The Old River outlet occurs as a single wide connection with the River Murray approximately 700 m below Lock 5, creating a head difference that facilitates water movement through the wetland. The Billabong is located to the west of The Old River and is fed by Astons Creek which originates upstream of Lock 5.

Cultural Significance

The River Murray and Mallee Aboriginal Corporation (RMMAC) holds native title over the River Murray within the Lock 4 and 5 Reach. The First Peoples intimate knowledge and understanding of Country and active participation across all levels is vital to the effective management of this landscape.

Post-colonial Use

Prior to river regulation, Goat Island-Paringa Paddock would have been a free-draining temporary wetland complex with water levels responding to changes in the river level. During low flow periods in late summer and winter, the wetlands and watercourses would have drawn down, re-filling as river levels increased into spring and summer. The Old River wetland was historically part of the main river channel, with a cutting to the east of Goat Island that connected through to the river on both sides (as a shortcut). Whilst the cutting may have been natural, it is likely to have been deepened in the late 1800s to shorten the travel distance for paddle steamers. After the construction of Lock 5, the cutting that separated Goat Island became the main channel and the upstream end of the Old River wetland began to silt up. This resulted in the Old River becoming a terminal, horseshoe shaped wetland with one connection to the river channel and some areas of the floodplain becoming temporary wetlands.

WETLAND ECOLOGY

The Goat Island-Paringa Paddock wetland complex bypasses Weir 5 and has relatively fast-flowing water through some of the areas within the wetland, such as the Billabong within Paringa Paddock wetland. The wetlands have been assessed to have high conservation value^(1,2).

Flora: Vegetation composition at Goat Island-Paringa Paddock wetland complex includes river red gum and black box woodland and forest, lignum, saltbush and samphire shrublands, reedbeds, sedgelands and herblands. See⁽³⁻⁵⁾ for detailed description of flora at site. Smooth heliotrope (*Heliotropium curassavicum*) was the only exotic species recorded at the latest survey in 2018. The tree and vegetation survey concluded that the trees in this wetland complex were mainly in the good or excellent Tree Condition Index (TCI) but the overall vegetation species richness were considered low⁽⁴⁾.

Fauna: The wetland complex provides a diversity of habitats for fauna. Cormorants and pelicans were among the most abundant species detected during the bird surveys that have been conducted, probably due to a combination of factors like access to permanent wetlands, close proximity to foraging areas and good roosting sites for cormorants. See references ⁽³⁻⁵⁾ for further details about species composition at the site. Fish and frog surveys have been conducted over several occasions ^(3,4,6). Paringa Paddock wetland complex has a diverse fish assemblage that is dominated by small native species. A total of 13 fish species have been caught across the different surveys, including eight native species and five exotic species. A total six species of frogs have been recorded at the complex, among them the listed southern bell frog.

WETLAND MANAGEMENT

Current Management:

Goat Island-Paringa Paddock is managed by the Department for Environment and Water (DEW) in conjunction with the Renmark-Paringa Council. In addition, the Nature Foundation South Australia (NFSA) also supports watering efforts on Goat Island. A number of public and private land titles exist over the wetland complex. Private landowners, including several irrigators, adjoin the western boundary of the wetland along the edge of the outer horseshoe. The Renmark Irrigation Trust (RIT) manages the adjacent irrigated land and the irrigation water diverted from the wetland. In addition, two private caravan parks are situated adjacent to the northern floodplain. The wetland floodplain is managed for conservation and public recreation. Several recreational paths are present throughout the wetland complex for walking, birding, fishing, wildlife viewing and biking. Recent works have increased management opportunities for wetting and drying cycles in order to reinstate a more natural state and build resilience towards changes in climate and the impacts of drought.

Infrastructure:

Recent infrastructure works were completed in 2019 to support wetting and drying cycles within Paringa Paddock. Other structures include a total of five pipe culvert structures that are present underneath roads. Known issues include a structure on the Billabong that has obstructed flows, which inhibits fish passage through this area. Structures on Astons Creek Inlet and Deep Creek are Murray-Darling Basin Authority (MDBA) joint venture structures in need of remediation. Discussions between DEW, MDBA and SA Water are ongoing.

ISSUES AND DRIVERS

As part of the Master Planning Project engagement process, an ongoing register of issues and drivers relating to sites and options was maintained. These highlighted key considerations and investigations that would need to be factored in and undertaken as part of any next steps towards realising the outcomes described within the option profiles. For Paringa Paddock-Goat Island, these included:

Environmental

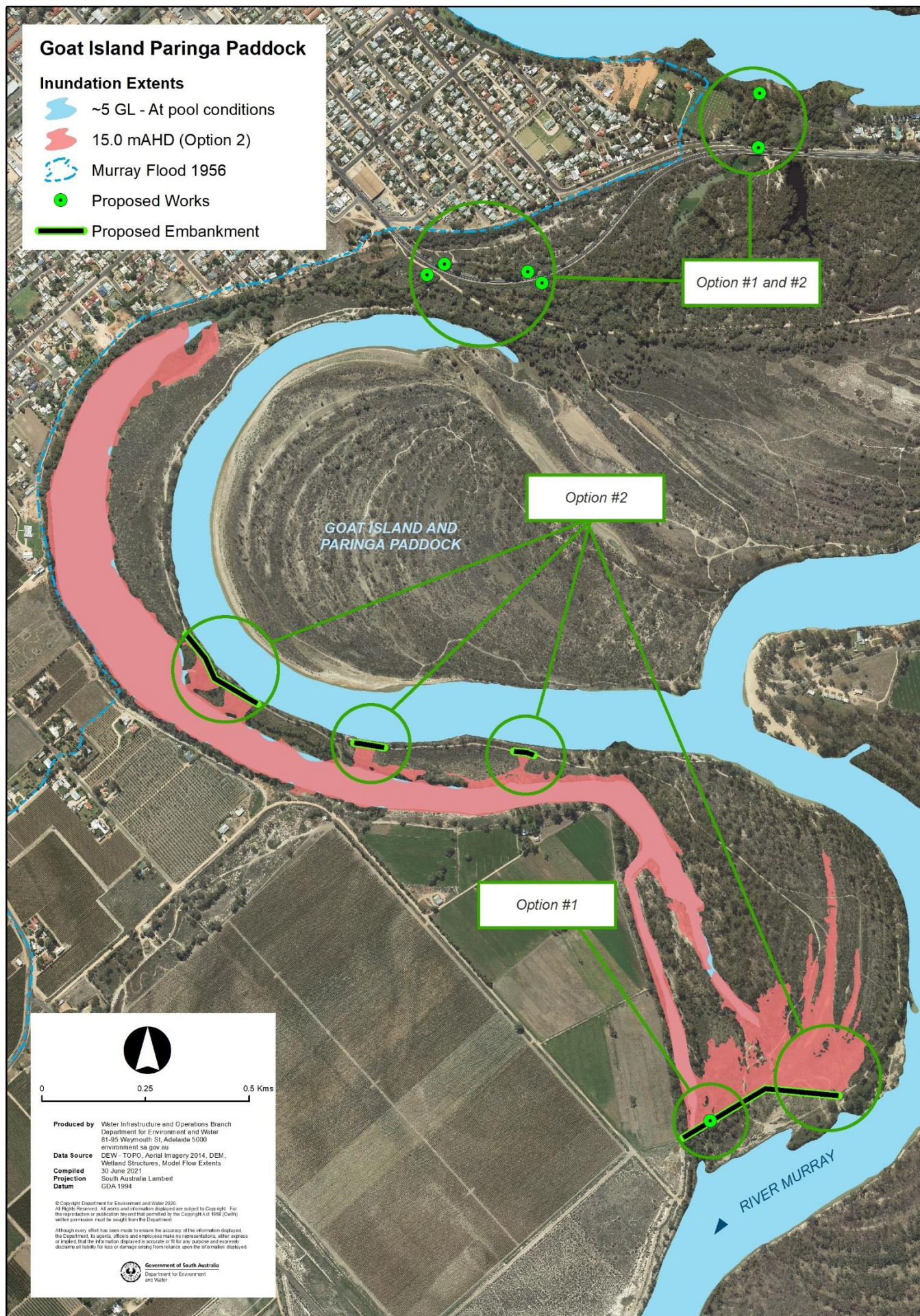
- Potential investigations needed into salinity impacts and groundwater issues at the site as well as feasibility of recovery, and high flow dynamics/impediments including in relation to the road/stormwater drainage system.
- Acid sulfate soils are present within the wetland and this would require further consideration before any construction works or wetting and drying activities are undertaken^(5,7).

KEY STAKEHOLDER INVOLVEMENT

- Commonwealth Environmental Water Office (CEWO)
- Friends of the Riverland Parks
- Murray-Darling Basin Authority (MDBA)
- Murraylands and Riverland Landscape Board
- National Parks and Wildlife Service SA
- Nature Foundation SA (NFSA)
- Renmark Irrigation Trust (RIT) – including the Environmental Watering Committee
- Renmark Paringa Council
- Renmark Paringa Landcare
- River Murray and Mallee Aboriginal Corporation (RMMAC)
- SA Water

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Disher Creek

Location: Weir Pool 4, River Chainage Markers 551 to 543.5

Land Tenure: Crown Record

Wetland Size: 100 hectares (Ha)

Normal Pool Level: 13.2 mAHD

PROPOSED OPTION	
Option #1:	Improve floodplain condition in the Western section by enabling the retention of water through the installation of regulating structures and complementary embankments to 14.6 mAHD. This will support opportunities for increasing the extent and duration of floodplain watering associated with managed and natural high-flow events, including weir pool raising, as well as pumping.
Description	<p>This option aims to maximise the opportunity presented by weir pool raising and capacity to retain water, through the installation of regulating structures and complementary blocking bank to 14.6 mAHD. This will support the capacity to extend the duration of watering events such as those associated with high-flow events and weir pool raising, as well as prompting opportunities for delivering water via pumping. Any activities included in this option need to be mindful of the potential impacts on Murray hardyhead populations currently present in the basin.</p> <p>This option will be completed in conjunction with the Renmark Irrigation Trust (RIT) Environmental Watering Committee and associated Management Guidelines to ensure efforts harmonise with existing plans for the floodplain.</p>
Outcomes	<ul style="list-style-type: none"> • Benefits associated with an improved watering regime. • Conservation and improvement of wetland vegetation. • Improved soil moisture conditions.

Option #2:	Improve floodplain condition in the Eastern section by enabling the retention of water through the installation of regulating structures and complementary embankments to 14.2 mAHD. This will support opportunities for increasing the extent and duration of floodplain watering associated with managed and natural high-flow events, including weir pool raising, as well as pumping.
Description	<p>This option aims to maximise the opportunity presented by weir pool raising and capacity to retain water, through the installation of regulating structures and complementary blocking bank to 14.2 mAHD. This will support the capacity to extend the duration of watering events such as those associated with high-flow events and weir pool raising, as well as prompting opportunities for delivering water via pumping. Any activities included in this option need to be mindful of the potential impacts on Murray hardyhead populations currently present in the basin.</p> <p>This option will be completed in conjunction with the RIT Environmental Watering Committee and associated Management Guidelines to ensure efforts harmonise with existing plans for the floodplain.</p>
Outcomes	<ul style="list-style-type: none"> • Benefits associated with an improved watering regime. • Conservation and improvement of wetland vegetation. • Improved soil moisture conditions.

SITE BACKGROUND

Description

Disher Creek is located on the northern bank of the River Murray Floodplain, approximately 8 km south of Renmark within the Murray River National Park (Lyrup Flats). The Disher Creek Basin is used for saline water disposal from the surrounding agriculture land. The holding capacity of the basin is 360 megalitres (ML). Water exceeding this capacity is pumped to the Noora Saline Water Disposal Basin in order to prevent saline groundwater from entering the river. Recent watering activities are aimed at supporting the nationally threatened small-bodied fish, Murray hardyhead (*Craterocephalus fluviatilis*). Disher Creek is one of only four known habits that support Murray hardyhead populations along the River Murray in South Australia¹.

Cultural Significance

The River Murray and Mallee Aboriginal Corporation (RMMAC) holds native title over the River Murray within the Lock 4 Reach. The First Peoples intimate knowledge and understanding of Country and active participation across all levels is vital to the effective management of this landscape.

Post-colonial use

Disher Creek became a saline water disposal basin in 1967, which collected drainage water from the Renmark irrigation area via the Renmark Area Drainage Disposal Scheme (RADDs). In 1982, the Noora Drainage Disposal Scheme was commissioned which enabled excess water from Disher Creek and Berri basins to be pumped to the Noora Saline Water Disposal Basin in order to reduce the potential salinity impacts on the River Murray¹.

WETLAND ECOLOGY

Disher Creek was assessed as having low conservation value^{2,3}, although the wetland is home to the Murray hardyhead (*Craterocephalus fluviatilis*), a small bodied native fish which is critically endangered at a national level, and therefore is an important site to manage for this species. Disher Creek is also part of the Murray River National Park⁴.

Flora and fauna

The major vegetation communities within Disher Creek include river red gum (*Eucalyptus camaldulensis*) and black box (*Eucalyptus largiflorens*) woodland but many of the trees were dead at the latest assessment in 2008. Other vegetation communities include lignum, chenopod and samphire shrublands but many are in poor condition due to the past and current use of the area as a disposal basin^{1,5}. There is limited information on the flora and fauna composition at the sites as no recent surveys have been conducted.

WETLAND MANAGEMENT

Current Management

Disher Creek lies within the Murray River National Park (Lyrrup Flats) and is managed by the National Parks and Wildlife SA, in conjunction with SA Water and the Murraylands and Riverland Landscape Board Wetland Team. Current management aims to maintain water levels in Disher Creek at appropriate water depths (> 60 cm) and water levels (13.2-13.4 mAHD - Lock 4 normal pool level is 13.2 mAHD) within the northern basin habitat area for Murray hardyhead, and to support a viable saline ecosystem which supports aquatic and littoral zone vegetation.

Due to water levels in Disher Creek being held above pool level as well as the highly saline water present in the vicinity of the Disher Creek River Murray Inlet at Bank D (approximately > 60,000 μScm^{-1}), the Disher Creek inlet structure is usually in the closed configuration to prevent saline water disposal into the River Murray.

Excluding times when River Murray water levels and flows are high enough to remove the salinity risks of opening the Disher Creek inlet, inflows into the creek occur via the Renmark Area Drainage Disposal Scheme (RADDs), Environmental Water pumped from the River Murray.

Murtho Salt Interception Scheme (SIS) saline discharge water can also be utilised during times when an Environmental Water allocation is unavailable near the upper pool level. The Disher Creek outlet structure is typically maintained in the closed configuration and saline outflow from Disher Creek is managed through pumping to the Noora Saline Water Disposal Basin, with pumping rates adjusted to suit inflows as needed (+13.2 mAHD). Recent management efforts at Disher Creek have focused on maintaining water levels to support the Murray hardyhead population, and providing environmental watering events during spring and summer to freshen the creek and support higher levels of Murray hardyhead egg survival. Water levels in Disher Creek are managed by adjusting the stop log configuration in the flow-through structure at Bank A.

Infrastructure

Water is delivered to the Disher Creek Basin from the Renmark Area Drainage Disposal Scheme (RADDs) via a pipeline and an open concrete channel, which then fills the basin from the north. Environmental Water delivery into Disher Creek is via the RADDs channel (pumped by the Renmark Irrigation Trust), and also via pumping from the River Murray over the closed inlet structure at Bank D.

Water may also be delivered to Disher Creek via the Murtho SIS. During Lock 5 flow events exceeding 15,000 megalitres per day (ML/day), if River Murray salinity is less than 450 μScm^{-1} , the Disher Creek inlet structure at Bank D may be opened to provide connectivity and flushing to the creek, a controlled release through the pipe culvert outlet structure (located on the southern embankment of the Disher Creek basin) may also occur – for either of these management options to be undertaken, the basin water level at the inlet must be lower than the river level, and the water level at the outlet must be higher than the river level respectively. The outlet pipe culvert may also be opened when river flows exceed 38,000 ML/day, enabling the basin to be flushed⁽⁶⁾.

ISSUES AND DRIVERS

As part of the Master Planning Project engagement process, an ongoing register of issues and drivers relating to sites and options was maintained. These highlighted key considerations and investigations that would need to be factored in and undertaken as part of any next steps towards realising the outcomes described within the option profiles. For Disher Creek, these included:

Environmental

- Investigations and/or consideration needed of potential Murray hardyhead impacts, vegetation objectives and possible salinity impacts.
- There are also some risks associated with acid sulfate soils at this site and this would require further assessment before any on-ground work progresses⁷.

Cultural

- Strong Aboriginal Waterways Assessment (AWA) and First Peoples cultural interests in the area.

Community/Social

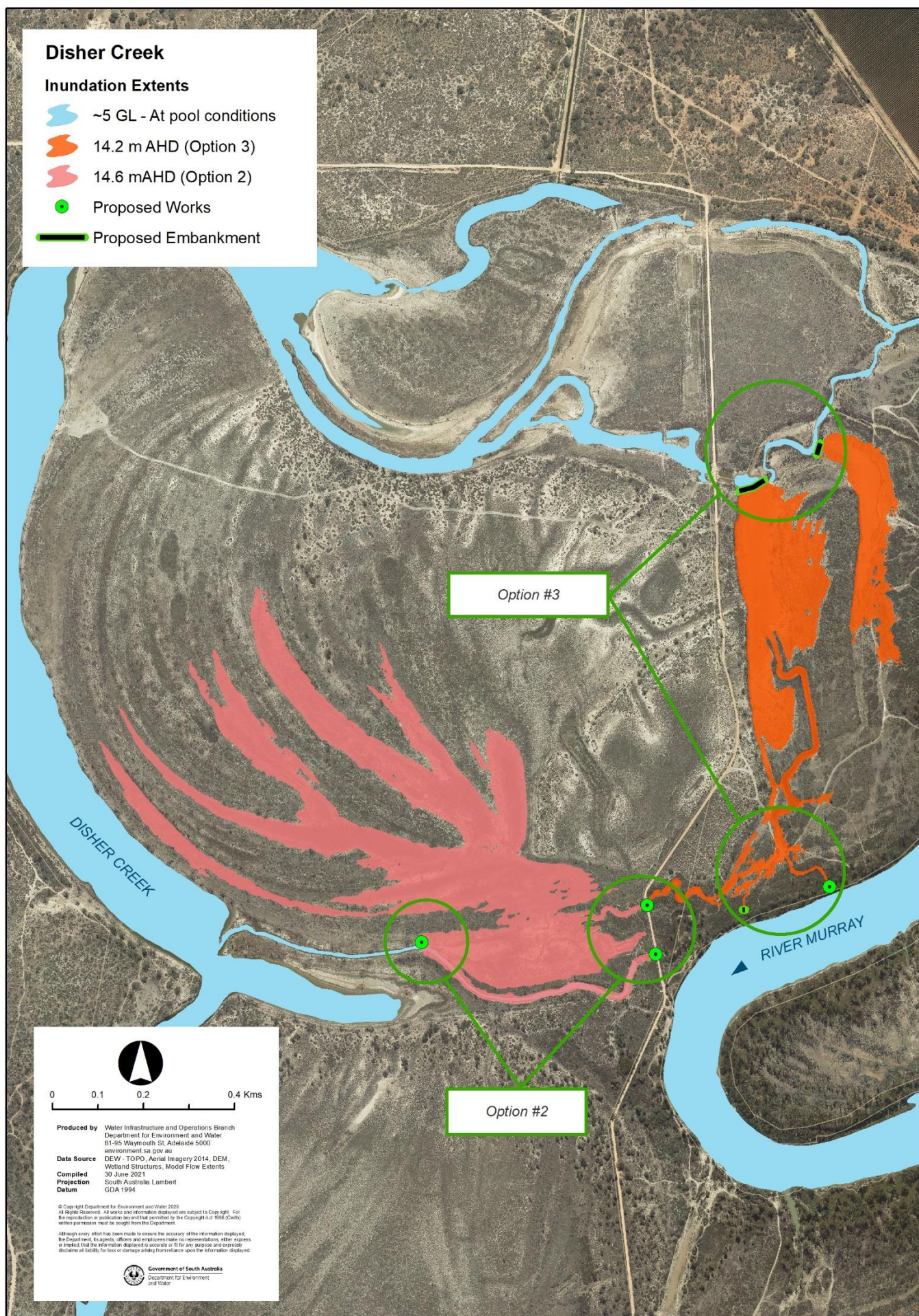
- Campers will have access to site and security will be an issue.

KEY STAKEHOLDER INVOLVEMENT

- Commonwealth Environmental Water Office (CEWO)
- Murray-Darling Basin Authority (MDBA)
- Murraylands and Riverland Landscape Board
- National Parks and Wildlife Service SA
- Renmark Irrigation Trust (RIT) – including the Environmental Watering Committee
- Renmark Paringa Council
- Renmark Paringa Landcare
- River Murray and Mallee Aboriginal Corporation (RMMAC)
- SA Water

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