School of Civil and Environmental Engineering

Water Research Laboratory

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Clybucca Wetlands Management Options Study

WRL TR 2018/32 | April 2020

By D S Rayner, T A Tucker and W C Glamore

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Executive summary

ES.1 Background

The Collombatti-Clybucca floodplain, inclusive of the Clybucca Wetlands, is located on the Macleay River estuary floodplain. The floodplain is located approximately 15 kilometres from the ocean entrance at South West Rocks and has a contributing catchment area of approximately 26,000 hectares. Runoff from the catchment is channelled across the floodplain through a complex network of natural creeks and constructed drainage channels (Figure ES1.1). Downstream water levels within this network are controlled by a tidal floodgate barrage structure located at Menarcobrinni that drains the upstream waters and prohibits tidal inundation from the river.

Historically, the Clybucca Wetlands were a large freshwater wetland complex that extended across the floodplain and was disconnected from the estuary. Early explorers to the area described the Clybucca Wetlands as:

> *"Extensive swamps and lagoons of many thousand acres in extent, whose verdant sea, of high waving reeds and sedge, stretches away to the base of the distant forest ranges. Large flocks of aquatic birds, of wonderful variety, all busily engaged, and fish leaping out of the water in every direction."*

During the early 1960s, large drainage construction works were completed across the Macleay River estuary, including at Clybucca Wetlands, for flood mitigation purposes. These on-ground works modified the creek system and enhanced drainage. This resulted in improved connectively with downstream tidal waters and a tidal barrage was subsequently required at Menarcobrinni to prevent tidal inundation. In addition to flood mitigation, this infrastructure enhanced the agricultural productivity of the low-lying land for pasture grazing.

The extensive drainage network has had unintended environmental impacts, including the production of acidic by-products from the drainage of acid sulfate soils (ASS) and exacerbation of 'blackwater' (i.e. low-oxygen water) runoff into the estuary which has been extensively documented in previous studies (Walker, 1961, 1963 1972; Naylor *et al*, 1998; Webb McKeown, 1997; Tulau and Naylor, 1999; Cheeseman *et al*., 2004; KSC, 2004; Andrews *et al*., 2005; Chartres *et al*., 2005; McLennan *et al*., 2005; Telfer, 2005; Bush *et al*., 2006; Birch, 2010; GeoLINK, 2010; GeoLINK, 2012). As such, the Collombatti-Clybucca floodplain was identified as an acid sulfate soil hotspot priority area in NSW (Tulau and Naylor, 1999). On-ground remediation efforts during the 1990s resulted in the construction of low sills/weirs in the trunk drain network. These works aimed to raise groundwater levels and reduce acid export without impacting agricultural productivity. The remediation of large acid scalds was also undertaken. Despite these efforts, poor water quality, including low pH and low dissolved oxygen, continues to discharge from the low-lying floodplain areas at Clybucca.

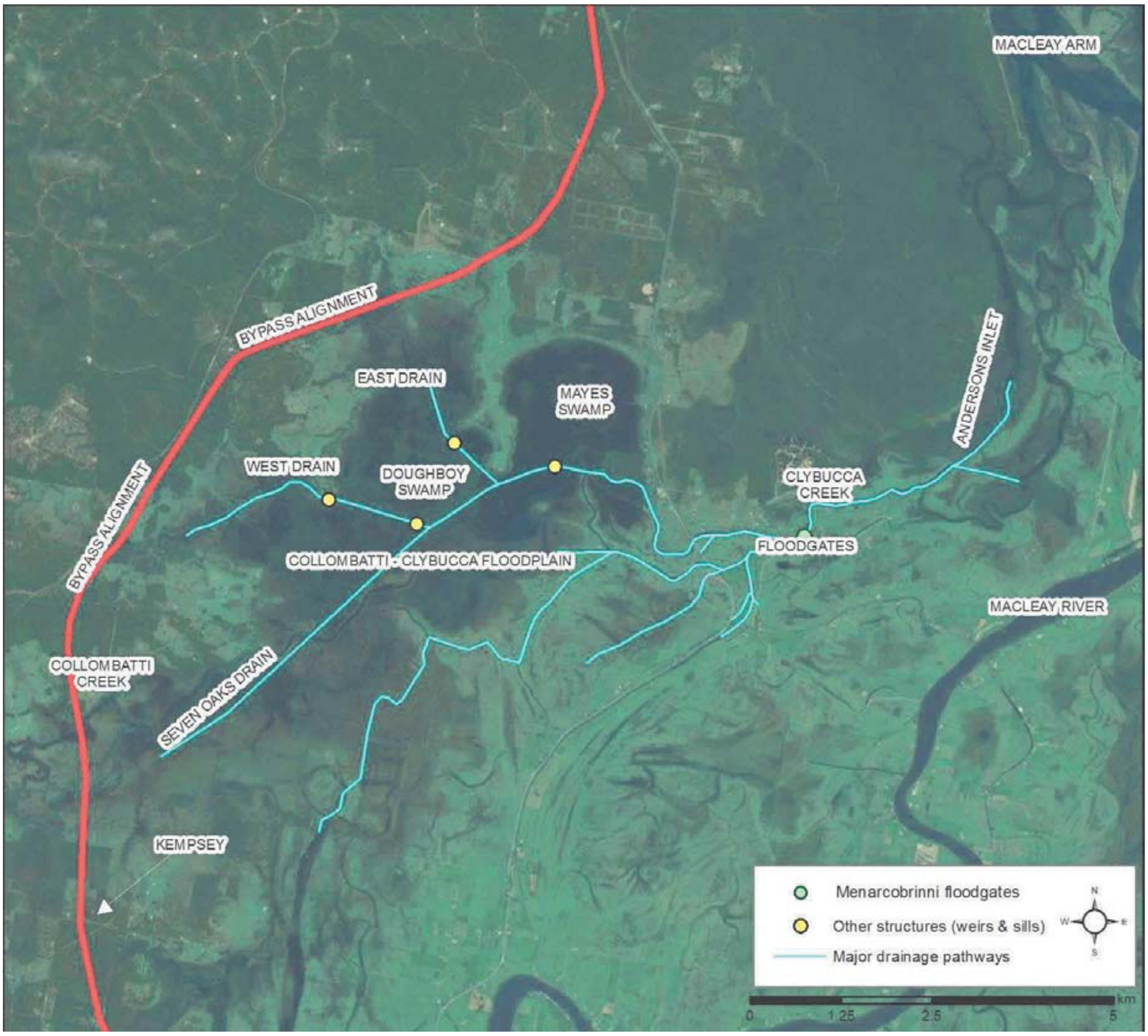

Figure ES1.1: Key features of the Collombatti-Clybucca floodplain

During the Oxley Highway to Kempsey Pacific Highway upgrade project, Transport for NSW (previously NSW Roads and Maritime Services (RMS)) purchased a proportion of the Clybucca wetland complex as part of the biodiversity offset requirements of the project. Elevated land (above the floodplain) was originally purchased as biodiversity offsets for the habitat offset requirement including, wet sclerophyll forest. However, in several instances the property boundaries extended to the low-lying Clybucca Wetland areas of Mayes Swamp and Doughboy Swamp. This provided a unique opportunity where one entity owned the majority of the worst affected acid sulfate soil land across the Collombatti-Clybucca floodplain. Further voluntary acquisitions of low-lying land have occurred over the proceeding years to extend the area owned by RMS. The NSW Environment Protection Authority have also approved a supplementary offset strategy whereby wetland habitats acquired/restored can be used as biodiversity offsets in place of other habitat types. This opportunity has led to the development of large-scale remediation strategies for the ASS affected wetland areas.

The aim of this study is to investigate the feasibility and potential impact of each management option, not only in terms of water quality and wetland extent, but also any potential impact on floodplain inundation, drainage and saltwater intrusion. The options detailed in this investigation provide a range of strategies aimed at improving existing or potential future wetland habitats via the restoration of a natural wetting and drying regime. Any suggested on-ground works are tested to ensure that they improve surface water quality, by reducing acid drainage from the Clybucca floodplain, while not impacting adjacent landholders. Additional outcomes from the study include a detailed literature review, extensive field surveys and monitoring, and validated catchment and hydrodynamic numerical models.

The management options investigated in this study were developed based on extensive field surveys and site understanding with input from the Clybucca Government Working Group. The working group consists of representatives from Local Land Services, Kempsey Shire Council, National Parks and Wildlife Services, Department of Planning, Industry and Environment (formerly OEH), Department of Primary Industry – Fisheries, RMS, NSW EPA and Crown Lands. Community feedback and discussions were an integral contribution to the outcomes of this study. Local landholders, the Seven Oaks Drainage Union, local community groups, and relevant government agencies were consulted on their views regarding a sustainable management solution for the study area. Information gathered from the feedback sessions was included in the development of the management options and integrated with model outputs to establish viable remediation strategies for the study area. Funding for this study has been provided by the Saltwater Recreational Fishing Trust's Flagship Fish Habitat Action Program.

ES.2 Management Options Summary

The management options were developed to mitigate the effects of poor water quality and provide improved hydrological conditions that are more representative of natural wetting and drying conditions common in estuarine backswamp environments. The overall approach of the development of management options was to enable adaptable management onsite, considering factors such as climate change and land ownership, and allow strategic floodplain management to ensure that wetland habitat thrives, resulting in the safekeeping of the estuary health into the future. Management options range from land only options (with no modifications to the drainage infrastructure), to freshwater only management options, to a full tidal remediation scenario. The management options that were assessed as part of this study are summarised in Table ES2.1.

Management options were investigated to understand, not only the potential environmental benefits, but also the impact on surrounding properties, relating to:

- Floodplain inundation;
- Drainage times; and,
- Saltwater intrusion.

Comprehensive field investigations were completed across the Collombatti-Clybucca floodplain to develop a detailed hydrodynamic model. This model was constructed to represent the floodplain as it exists today and collected data was input into the model to verify its ability to replicate the present day conditions (often referred to as the “Base Case”). Once developed, modifications were made to the base case to test “what if” scenarios of different management options. The use of a numerical model allowed for a range of management options to be tested to understand potential impacts under different hydrological conditions.

Results from the hydrodynamic modelling were used to assess the feasibility of each management option in terms of whether environmental remediation will be effective and whether drainage of private land will be affected. Findings from the numerical modelling for the remediation benefits of each of the management options are summarised in Table ES2.2. ‘Kilometres of drain remediated’ (Table ES2.2) has been assessed for freshwater, as length of drain with an increase in water level, and for tidal water, as length of drain from the floodgates to the tidal extent. ‘Hectares of wetland created’ (Table ES2.2) was assessed as the area upstream below a weir invert for freshwater options, or as the maximum tidal extent for tidal options.

Indicative costings are provided in Table ES2.3. Note that these costs only consider detailed design and on-ground works and are intended to guide further discussion relating to management option feasibility. Other costs not included relate to additional factors that may (or may not) be required such as; environmental assessments, consultation, landholder compensation, approvals, additional technical investigation (geotechnical, ASS) etc.

Note that flood modelling is currently being undertaken using the adopted Lower Macleay River flood model (Jacobs, 2019). This model will assess the impact of proposed management options on large, major river flood events (i.e. design 1% AEP).

Table ES2.1: Summary of management options

	Management option	Freshwater/tidal	Description
1	Land management only	Freshwater	Only land management actions such as fencing, weed control, native bush regeneration and acid scald remediation. No modifications to be made to the drainage network.
2	Shallow freshwater on low-lying wetland areas	Freshwater	Modification of weirs and levees to allow for freshwater inundation across low-lying wetland areas.
3	Shallow freshwater on low-lying wetland areas with extension of McAndrews Drain	Freshwater	The same as Management Option 2 with a new swale drain constructed connecting McAndrews Drain to Seven Oaks Drain.
4a	Modified floodgates to allow controlled in-drain tidal flushing	Tidal*	Modification of eight (8) floodgates to allow tidal water into the drainage network up to an elevation of -0.4 m AHD.
4b	Modified floodgates to allow controlled overland tidal flushing	Tidal*	Modification of eight (8) floodgates to allow tidal water into the drainage network and onto the floodplain up to an elevation of 0.0 m AHD.
5a	Decentralise floodgates to multiple locations – overland inundation	Tidal*	Decommission the Menarcobrinni floodgates after installing four (4) smaller floodgate structures upstream to allow overland inundation within Mayes and Doughboy Swamps.
5b	Decentralise floodgates to multiple locations – in-drain only	Tidal*	Decommission the Menarcobrinni floodgates after installing two (2) smaller floodgate structures upstream to allow in-drain tidal only flushing.
6	Fully open floodgates	Tidal	Hinge the floodgate flaps at Menarcobrinni open to allow unrestricted tidal flow.

Table ES2.2: Summary of remediation benefits for each management option

Option number	Management option	Kilometres of drain remediated	Drain remediation strategy	Wetland Area (ha)	Wetland type
1	Land management only	None	-	None	-
2	Freshwater on low-lying wetland areas	12.5	Fresh	285	Fresh
3	Freshwater on low-lying wetland areas with extension of McAndrews Drain	12.5	Fresh	285	Fresh
4a	Modified floodgates to allow controlled in-drain tidal flushing	13.0	Tidal	None	Tidal
4b	Modified floodgates to allow controlled overland tidal flushing	22.5	Tidal	240	Tidal
5a	Decentralise floodgates to multiple locations – overland inundation	16.0	Tidal	115	Tidal
5b	Decentralise floodgates to multiple locations – in-drain only	6.6	Tidal	None	Tidal
6	Fully open floodgates	51.5	Tidal	725	Tidal

Table ES2.3: Summary of indicative implementation costs (on-ground works only*)

Option number	Management option	Design	On-ground Works	Ongoing#
1	Land management only^	$40,000	$80,000	$50,000
2	Freshwater on low-lying wetland areas	$20,000	$160,000	$5,000
3	Freshwater on low-lying wetland areas with extension of McAndrews Drain	$40,000	$280,000	$10,000
4a	Modified floodgates to allow controlled in-drain tidal flushing	$15,000	$160,000	$5,000 – $10,000
4b	Modified floodgates to allow controlled overland tidal flushing	$15,000	$160,000	$5,000 – $10,000
5a	Decentralise floodgates to multiple locations – overland inundation	$70,000	$350,000 - $500,000	$10,000 – $15,000
5b	Decentralise floodgates to multiple locations – in-drain only	$60,000	$600,000 - $1M	$10,000 – $15,000
6	Fully open floodgates	$10,000	$60,000	$5,000 – $10,000

*Does not include other factors such as environmental assessment, consultation, landholder compensation, approvals, additional technical investigation (geotechnical, ASS) etc. See Section 6 for list of sources of costs and benefits.
^Develop plan of management, initial fencing, and weed control.
#Ongoing cost relates to individual management option only. Ongoing general land management cost are additional. Monitoring costs are additional.

ES.3 Management areas

The Clybucca wetland complex was divided into three important management areas based on their individual hydrological characteristics. The three areas and their position in relation to RMS property boundaries (as of December 2019) are shown in Figure ES3.1 and include:

1. Mayes Swamp;
2. Yerbury's Scald (including land to the south of Seven Oaks Drain); and
3. Doughboy Swamp.

The management areas span the lowest lying sections of floodplain with the majority of Mayes Swamp and Yerbury's Scald below 0.0 m AHD (i.e. mean sea level), and Doughboy Swamp below +0.3 m AHD (Figure ES3.2). With the exception of three properties on the east of Mayes Swamp, the management areas are within the RMS property boundaries.

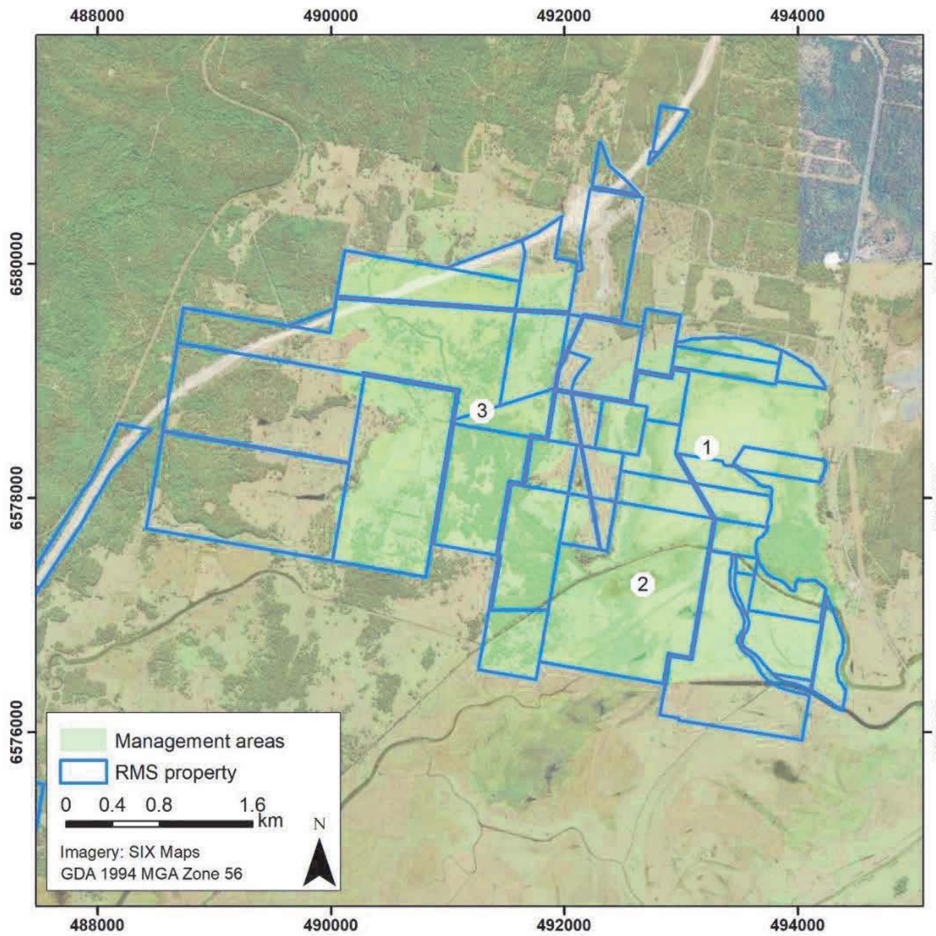

Figure ES3.1: Important wetland management areas on the Clybucca floodplain including; (1) Mayes Swamp, (2) Yerbury's Scald and (3) Doughboy Swamp

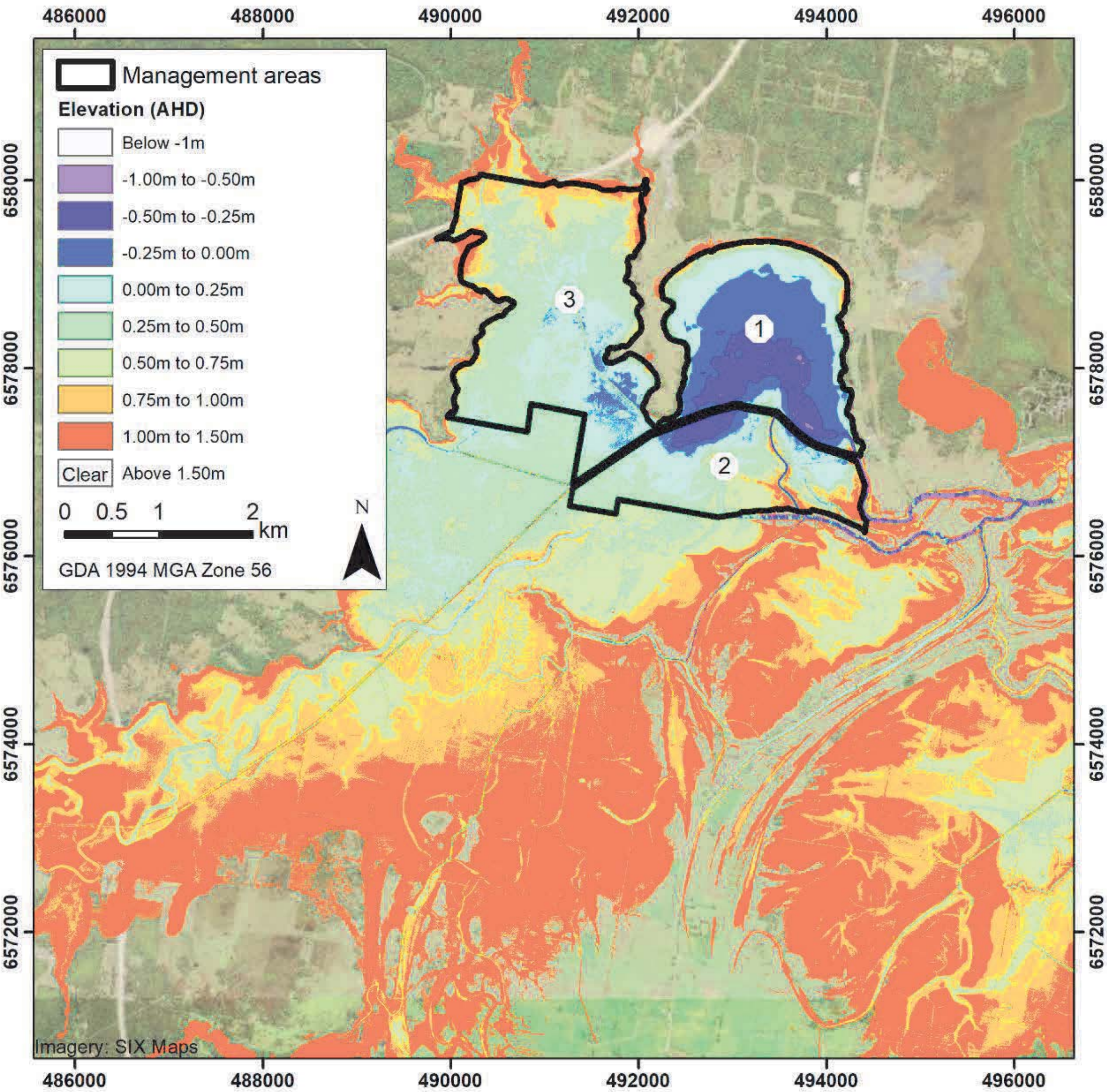

Figure ES3.2: Floodplain topography and key wetland management areas

ES.4 Management option modelling summary

ES4.1 Management Option 1: Land management only

Description

Management Option 1 does not include any modifications to the existing drainage network. Management recommendations for this option are land based as they will not impact water movements across the floodplain. This option comprises land management actions including:

- Fencing to exclude stock and pest species from rehabilitation areas;
- Pest and weed management;
- Wet pasture management;
- Fire risk management;
- Access control;
- Native bush regeneration; and
- Acid scald remediation.

These actions can be undertaken on RMS land with the aim of promoting native freshwater wetland on low-lying areas and more generally native vegetation rehabilitation across the management areas. This option can be implemented for all management options presented. However, water movements across the floodplain will govern where benefits can be fully realised.

Results

Land management options (such as fencing and revegetation) will not impact the floodplain hydrology. Changes in roughness across the floodplain may occur, however, this effect is negligible on floodplain hydrology. Subsequently, no numerical modelling analysis has been completed for this option.

Considerations

The approach to remediation outlined in Management Option 1 will require ongoing costs, including:

- Maintenance of fencing;
- Fire risk management;
- Drainage maintenance responsibilities; and
- Ongoing weed and pest management.

ES4.2 Management Option 2: Shallow freshwater on low-lying wetland areas

Description

Management Option 2 aims to improve the natural wetting and drying cycle of the low-lying ASS affected management areas as well as improve water quality (i.e. reduce acid and blackwater discharge) by raising the water table to provide shallow freshwater inundation on key management areas. This strategy would be implemented using the following remediation actions (Figure ES4.1):

- Construction of a new weir across Seven Oaks Drain at the downstream/eastern extent of Mayes Swamp with a crest level of 0.0 m AHD;
- Construction a new weir on the swale drain connecting Seven Oaks Drain and McAndrews Drain with a crest level of 0.0 m AHD;
- Removal/lowering of drainage levee banks along Seven Oaks Drain within RMS property boundary;
- Construction of a new weir across the East Drain near the Seven Oaks Drain confluence with a crest elevation of +0.1 m AHD.

Note that the present-day elevation of Yerbury's Sill is approximately -0.3m AHD.

Results

The numerical modelling results indicate (Figure ES4.2, Figure ES4.3 and Table ES4.1):

- Shallow freshwater inundation on Mayes Swamp increases by 20% during day-to-day conditions. The frequency of inundation increases, whereas there is minimal change in inundation depth;
- Yerbury's Scald remains inundated with freshwater (provided regular freshwater catchment inflows occur);
- Doughboy Swamp has a significant increase in inundation time from irregular inundation, to up to permanent inundation in areas below +0.1 m AHD;
- The average inundation depth across Yerbury's Scald and Doughboy Swamp increases by up to 30 cm during typical daily conditions;
- The water table is raised within 12.5 km of acid affected drainage channel;
- 285 hectares of freshwater wetland is created;
- There is a minor increase in drainage time across adjacent floodplain areas following a minor inundation event (approx. 1 year catchment event) with the greatest increase in drainage time occurring on the floodplain adjacent to Doughboy Drain. This was predicted to increase the surface water drainage time from 2 days (present day) to 2.5 days (for the modelled inundation level).

Considerations

In addition to the model results, the following implementation considerations have been identified:

- Access across Seven Oaks Drain at Yerbury's Sill will be inhibited. Additional works may be required to maintain access (e.g. rebuild existing dilapidated wooden bridges);
- Seven Oaks Drain levee banks would be lowered, which may impact access, particularly in the Mayes Swamp area;
- Sediments from the lowered levee banks will require disposal; and,
- Changes to the drainage network will need to be completed in consultation with the Seven Oaks Drainage Union and adjacent floodplain landholders.

Table ES4.1: Summary of standing water drainage time for floodplain areas following an approx. 1 year catchment event (+0.75m AHD inundation level)

Location	Time taken for floodplain to drain (days)	
	Base case	Management Option 2
Doughboy Drain floodplain	2.0	2.5
Shackles Drain floodplain	0.7	0.8
Southern floodplain	0.4	0.4
Upper Seven Oaks Drain floodplain	2.1	2.2
West Drain floodplain	5.3	5.6

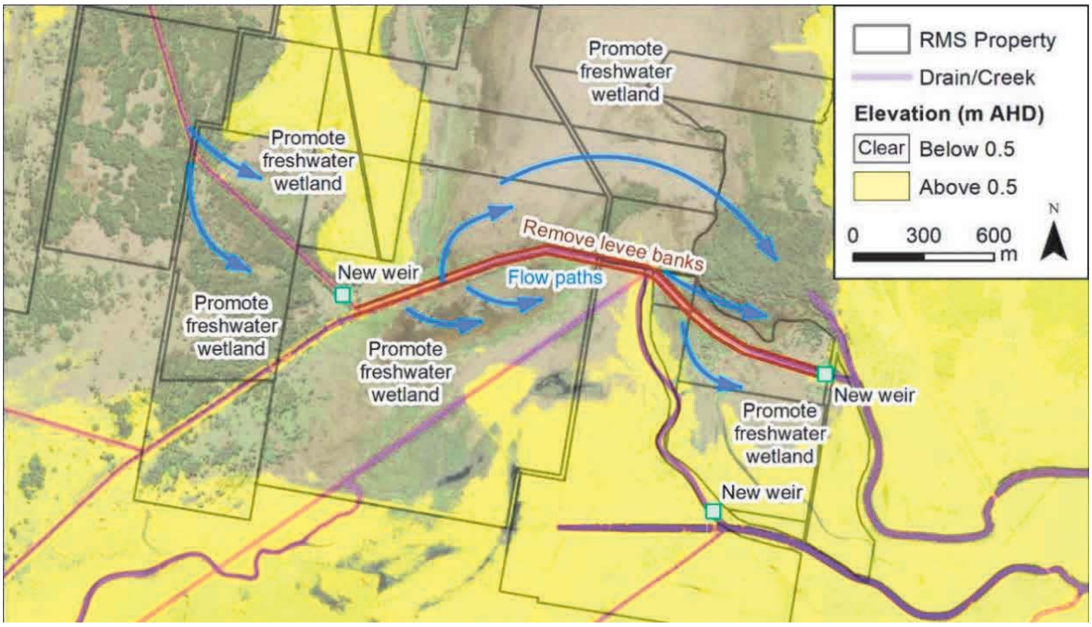

Figure ES4.1: Diagram outlining modifications to the drainage network and conceptual flow paths for Management Option 2

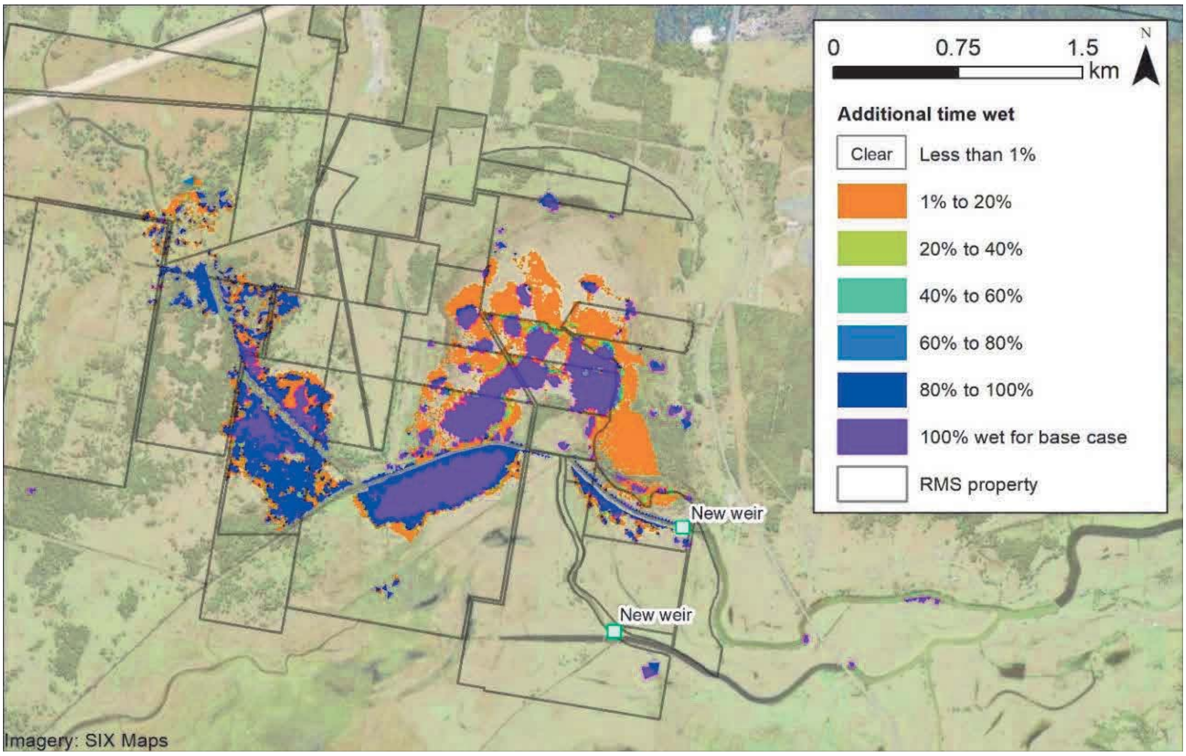

Figure ES4.2: Difference in inundation time between the base case and Management Option 2 during day-to-day conditions (includes a 6 month runoff event)

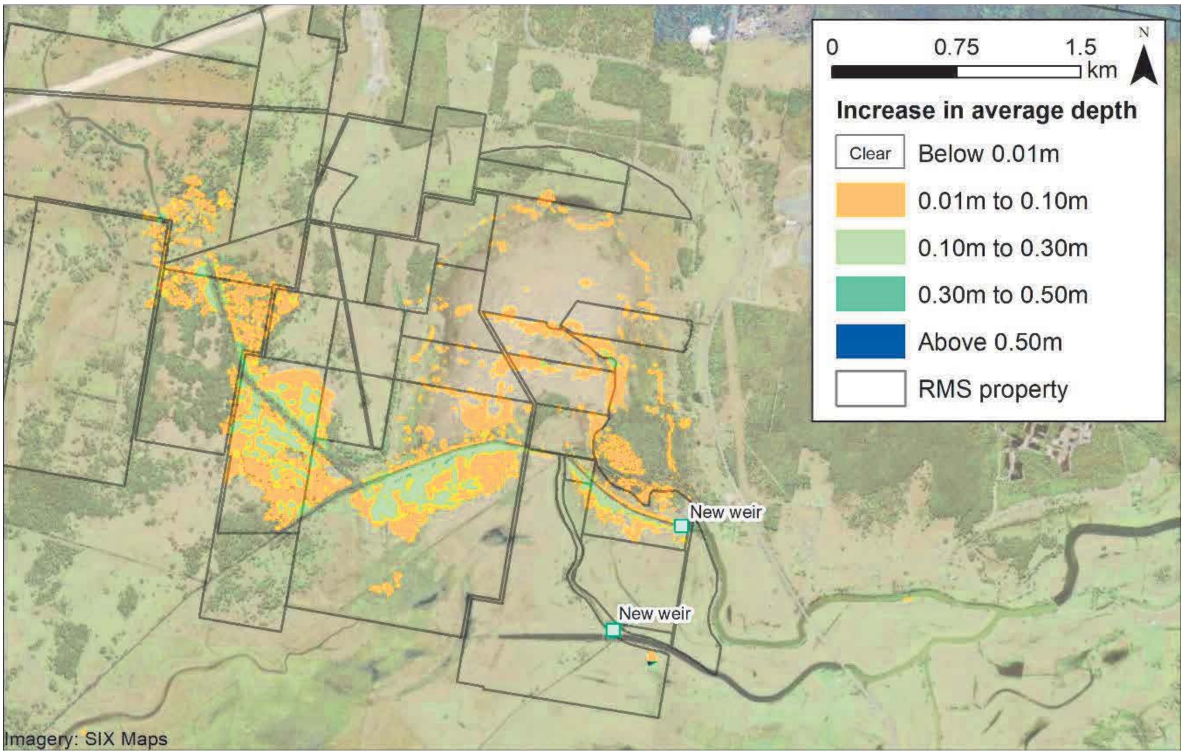

Figure ES4.3: Difference in inundation depth between the base case and Management Option 2 during day-to-day conditions (includes 6 month runoff event)

ES4.3 Management Option 3: Shallow freshwater on low-lying wetland areas with McAndrews Drain extension

Description

Management Option 3 involves extending McAndrews Drain along its existing alignment to connect to Seven Oaks Drain near West Drain. (Figure ES4.4). This strategy aims to provide improved (or maintained) drainage for upstream floodplain areas whilst enabling the potential for more significant changes to be made on the drainage network within RMS property boundaries. The design and implementation of this strategy requires careful consideration to ensure the remediation objectives within RMS areas are not compromised, whilst providing drainage benefit for upstream landholders. Implementation of the new drain has been assessed as well as the remediation actions proposed in Management Option 2 (e.g. to allow a comparison between a modified network with and without the new drain).

Results

The hydrodynamic modelling results indicate (Figure ES4.5, Figure ES4.6 and Table ES4.2):

- The majority of the floodplain has a change in inundation equal or less than ±0.10 m, which results in a change in inundation time of less than ±20% when compared to Management Option 2 for day-to-day conditions;
- The water table is influenced within 12.5 km of the drainage network, thereby reducing acid export (as per Management Option 2);
- 285 hectares of freshwater wetland is created when it becomes inundated due to drainage modifications (as per Management Option 2);
- Extension of McAndrews Drain with a drain invert elevation of 0.0 m AHD and a shallow and wide channel geometry, results in a small reduction in drainage time (0 to 6 hours, depending on location) in comparison to Management Option 2 following inundation to approximately 1 year event levels;
- Floodplain drainage times for Doughboy Drain floodplain and West Drain floodplain areas remain slower than present day conditions, even with the drain extension in place;
- Drainage of the floodplain upstream of RMS properties (upper Seven Oaks Drain floodplain) occurs slightly quicker than present day conditions (2 days with drain extension compared to 2.1 days during present day); and
- As the proposed drain extension is shallow and wide, the drain is unlikely to impact/lower the local groundwater table below 0 m AHD.

Table ES4.2: Summary of drainage time for standing water on floodplain areas following an approx. 1 year catchment event (+0.75m AHD inundation level)

Location	Time taken for floodplain to drain (days)		
	Base case	Management Option 2	Management Option 3
Doughboy Drain floodplain	2.0	2.5	2.3
Shackles Drain floodplain	0.7	0.8	0.7
Southern floodplain	0.4	0.4	0.4
Upper Seven Oaks Drain floodplain	2.1	2.2	2.0
West Drain floodplain	5.3	5.6	5.5

Considerations

In addition to the model results, the following implementation considerations have been identified:

- Construction of the new drain would need to consider direct environmental impacts, such as clearing trees and disturbing habitat along the proposed drain alignment;
- Excavation of the new drain may result in excavation of acid sulfate soils that will likely require treatment and/or disposal;
- Weed management within the new drain would need to ensure that efficiency is maintained; and
- Responsibility for maintenance and overall ownership of the proposed drain extension would need to be considered.

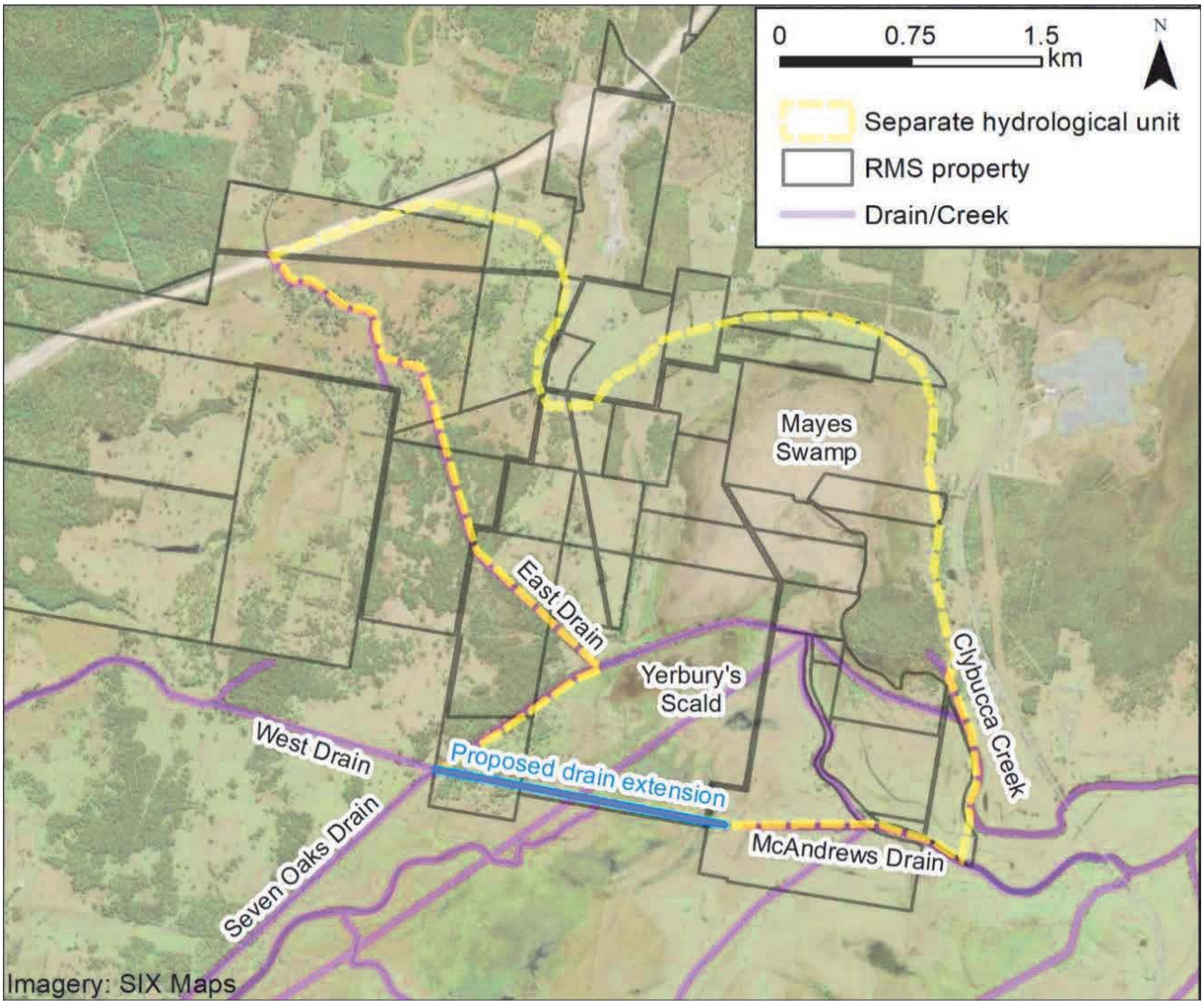

Figure ES4.4: Schematic of proposed drain extension from McAndrews Drain to Seven Oaks Drain within RMS land, including separate hydrological units

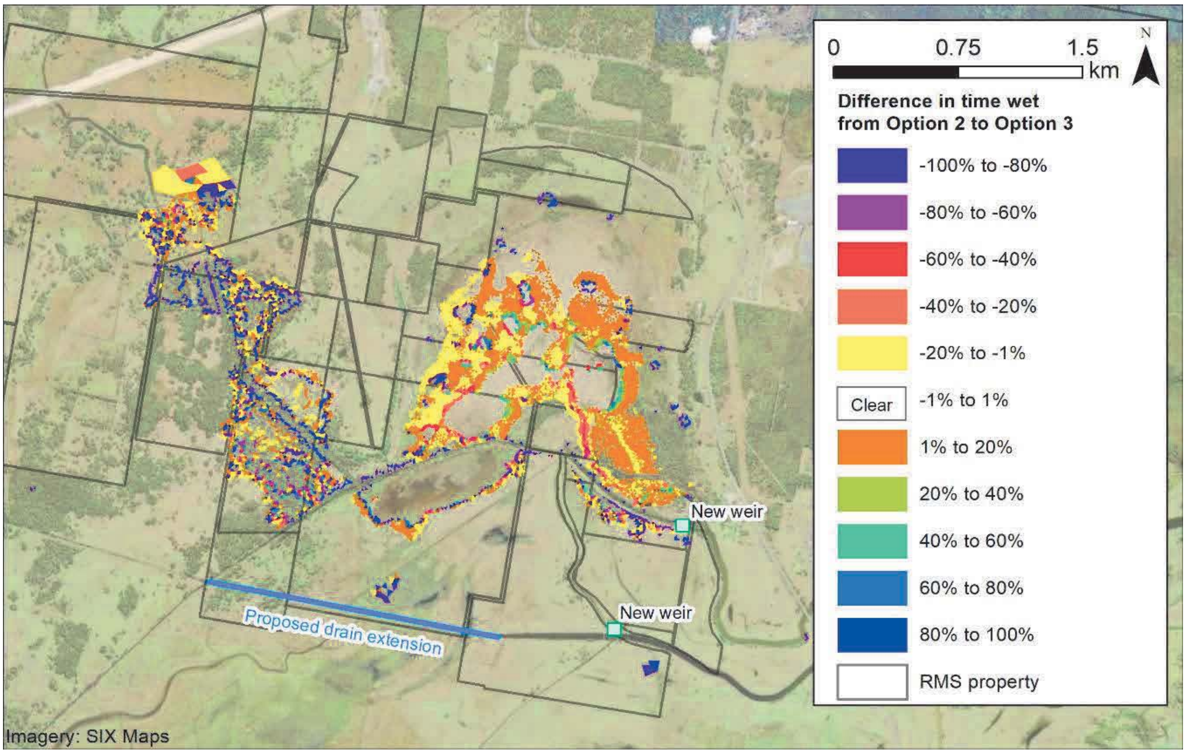

Figure ES4.5: Difference in inundation duration between Management Options 2 and 3 during day-to-day conditions (includes 6 month runoff event)

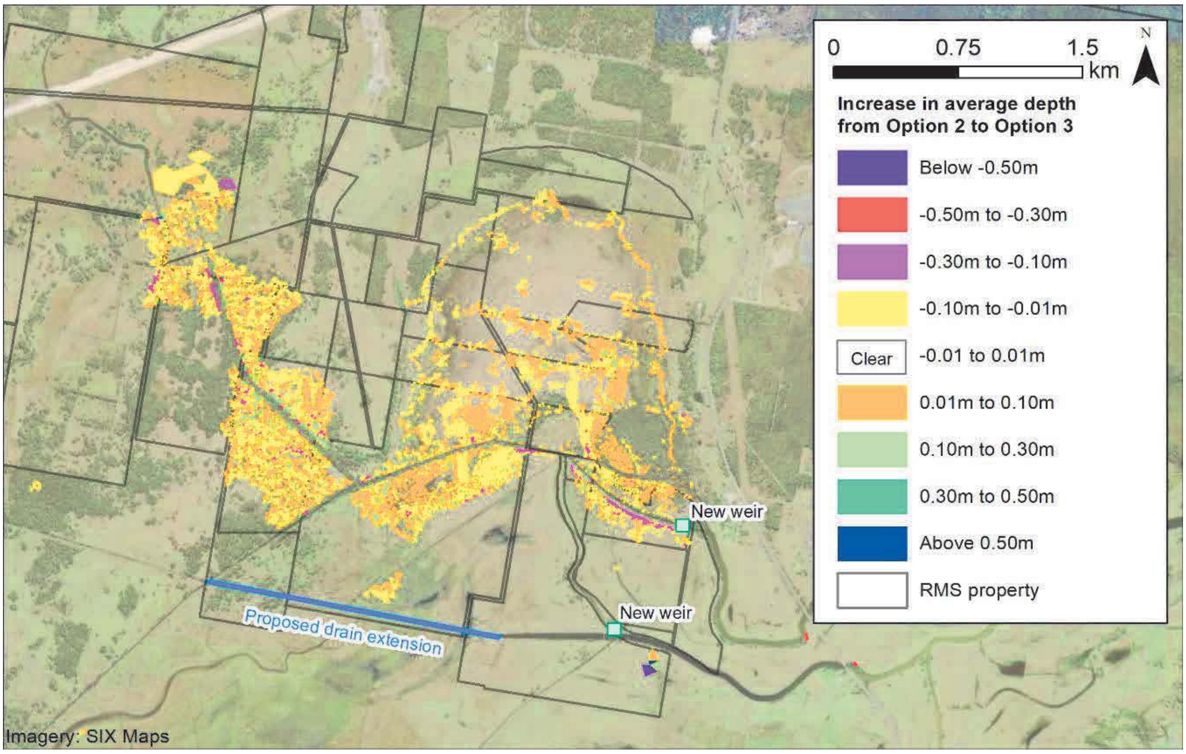

Figure ES4.6: Difference in inundation depths between Management Options 2 and 3 during day-to-day conditions (includes 6 month runoff event)

ES4.4 Management Option 4a: Modify floodgate to allow controlled tidal flushing in-drain

Description

Management Option 4a involves the implementation of eight (8) auto-tidal floodgates at the Menarcobrinni barrage to allow controlled in-drain only tidal flushing upstream of the floodgates. This is achieved by establishing a tidal cut-off trigger level of -0.4 m AHD at the auto-tidal floodgates. This approach aims to improve in-drain water quality and allow increased and improved aquatic connectivity. Controlled tidal flushing was previously trialled at Menarcobrinni (KSC, 2004).

Results

The results of the numerical modelling indicate (Figure ES4.7):

- Very low-lying (-0.3 m AHD) private land in Mayes Swamp, adjacent to Clybucca Creek is inundated at low tide flushing levels;
- Approximately 10% of estuarine salinity levels occur at the downstream boundary of Mayes Swamp (Figure ES4.8);
- During a tidal cycle, limited tidal flushing (~70 m^3) is permitted upstream of the floodgates;
- Tidal flushing will occur infrequently during spring tides with a trigger level of -0.4 m AHD;
- In-drain tidal flushing influences 12.5 km of the drainage network, including to Yerbury's Sill within Seven Oaks Drain and throughout McAndrews Drain;
- Monitoring of drain salinity levels and active management of auto-tidal gate operational regime may enable more significant flushing outcomes to be achieved; and
- Benefits associated with weed management and buffering of acid will occur at downstream sections of the drainage network near Menarcobrinni floodgates.

Considerations

In addition to the model results, the following implementation considerations have been identified:

- Saltwater vegetation intrusion upstream of the floodgates (such as mangroves) may occur and potentially require management;
- Monitoring and adaptive management measures to maximise environmental outcomes and limit impacts to private land;
- The potential influence of tidal water on groundwater salinity;
- The potential influence of tidal water on extractions (groundwater and surface water) for irrigation or stock; and,
- The type of floodgate modification chosen and its management (including maintenance).

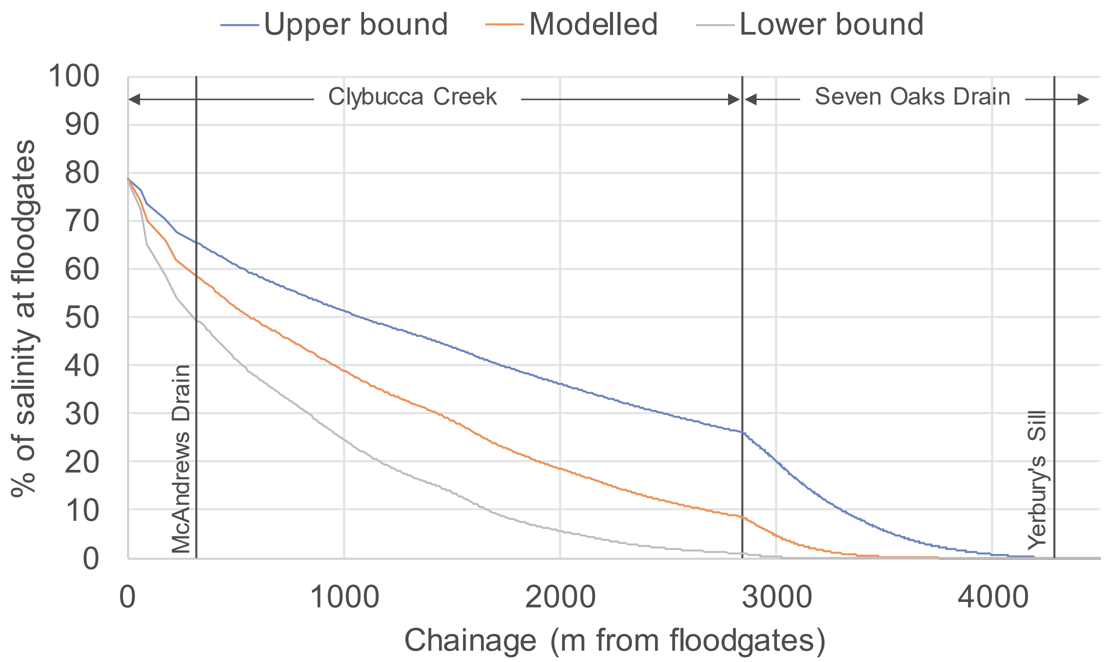

Figure ES4.7: Maximum level of salinity within Clybucca Creek for auto-tidal floodgates with a cut off level of -0.4 m AHD during dry conditions (no freshwater inflows)

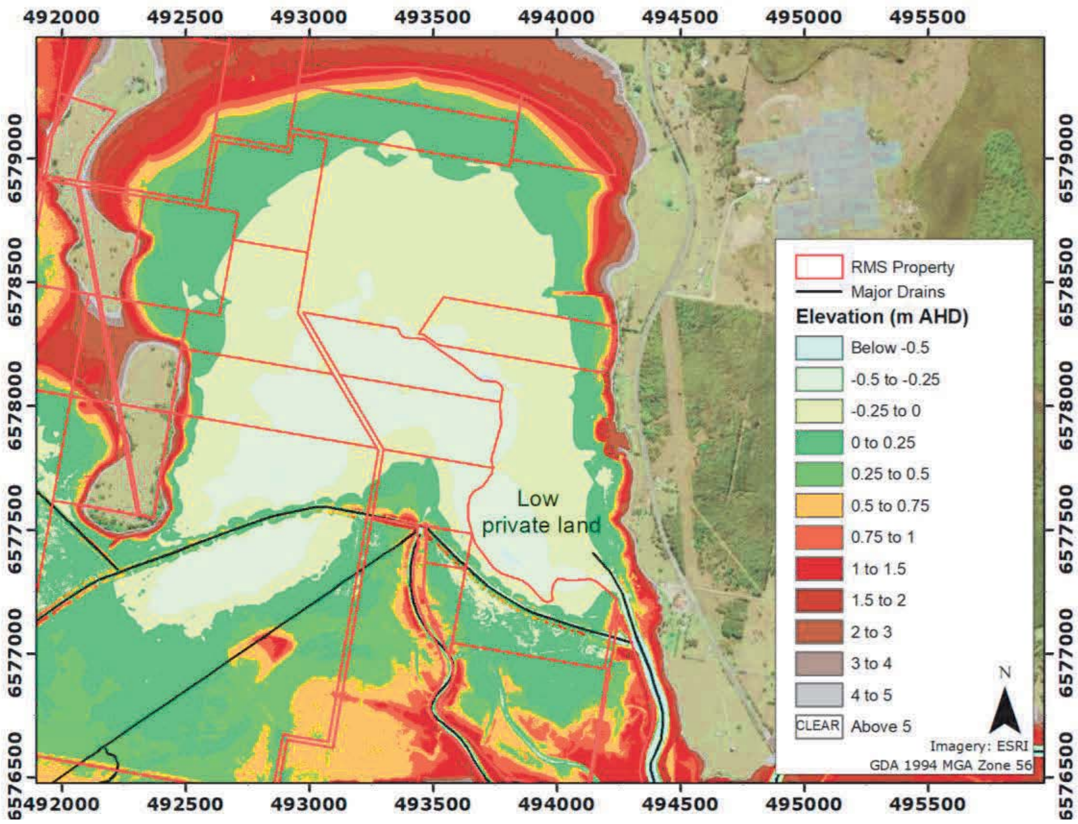

Figure ES4.8: Low-lying (-0.3 m AHD) private land within Mayes Swamp

ES4.2 Management Option 4b: Modify floodgate to allow controlled overland tidal flushing

Description

Management Option 4b involves the modification of eight auto-tidal floodgates at Menarcobrinni to allow controlled tidal flushing upstream of the floodgates to a level that will inundate low-lying floodplain within the management area below mean sea level. This is achieved with a tidal trigger level of 0.0 m AHD, hence enabling tidal exchange on every tide. This approach aims to create extensive aquatic habitat in-drain, intertidal wetlands and improved water quality.

Results

The hydrodynamic modelling results indicate (Figures ES4.9 to ES4.12):

- Significant areas of low-lying floodplain within the management areas are permanently inundated by up to 0.30 m of tidal water, including private land to the east of Mayes Swamp;
- Inundation of low-lying floodplain has a salinity up to 80% of the salinity level at the Menarcobrinni floodgates (which can range from fresh to ocean salinity levels);
- 240 hectares of intertidal wetland is created;
- Average catchment runoff events (< 1 year event) do not result in saline waters spilling onto private land; and
- 13 km of drain will be flushed with tidal water improving water quality and providing additional aquatic habitat.

Considerations

In addition to the model results, the following implementation considerations have been identified:

- Saltwater vegetation intrusion upstream of the floodgates (such as mangroves) may occur and need management;
- The potential influence of tidal water on groundwater salinity;
- The potential influence of tidal water on extractions (groundwater and surface water) for irrigation or stock;
- The type of floodgate modification and its management (including maintenance);
- Consideration will need to be taken to assess the impact of existing freshwater ecology; and
- Prior consultation will need to be conducted with floodplain landholders where tidal water would potentially inundate private landholdings on the east of Mayes Swamp.

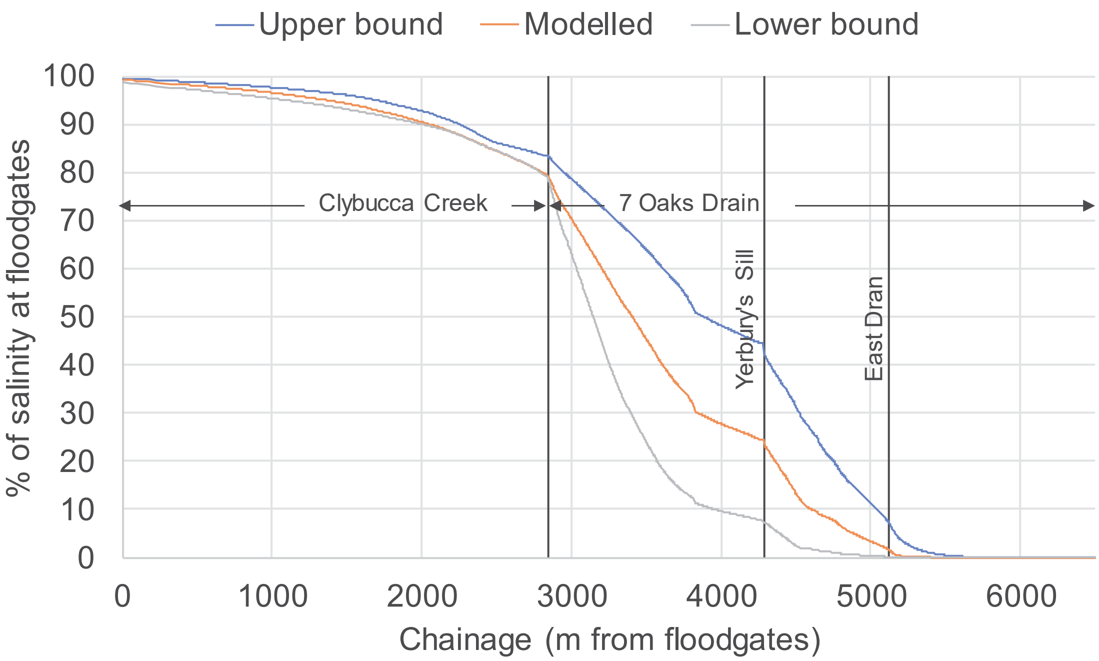

Figure ES4.9: Maximum salinity level and extent over a three-month period between Seven Oaks Drain and the Menarcobrinni floodgates with an auto-tidal cut off level of 0.0m AHD

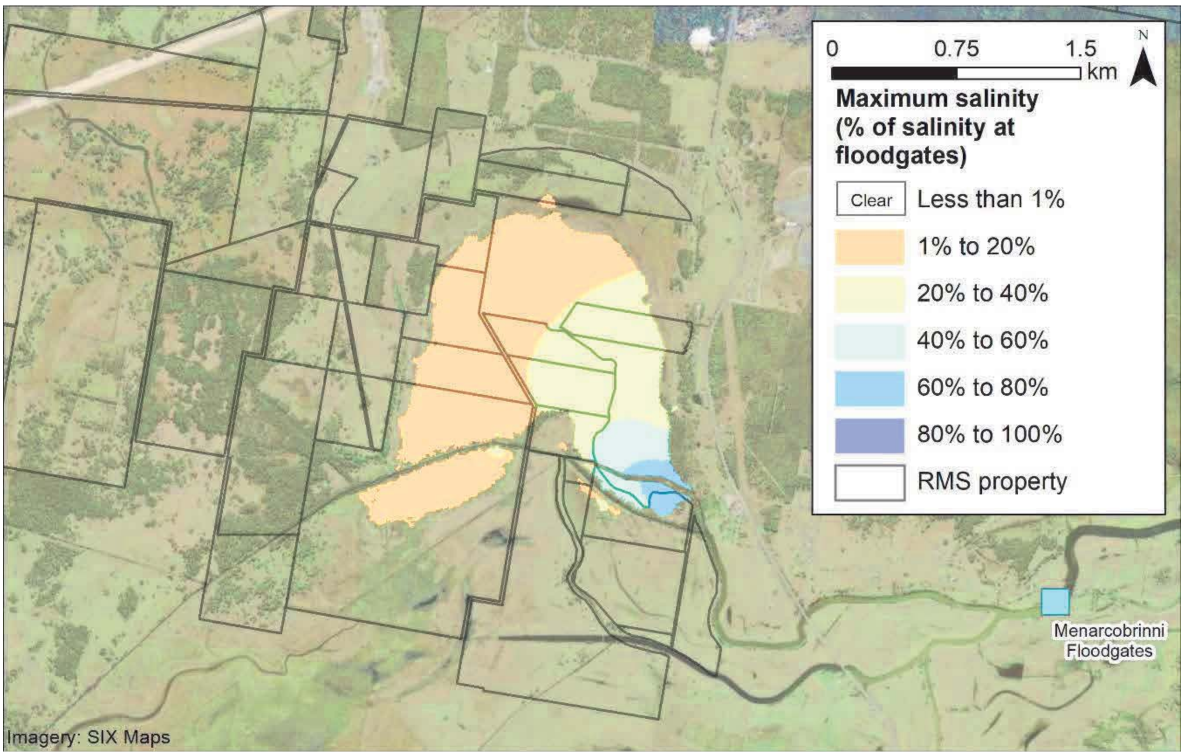

Figure ES4.10: Maximum salinity reached over a three-month period with an auto-tidal floodgate cut off level of 0.0 m AHD

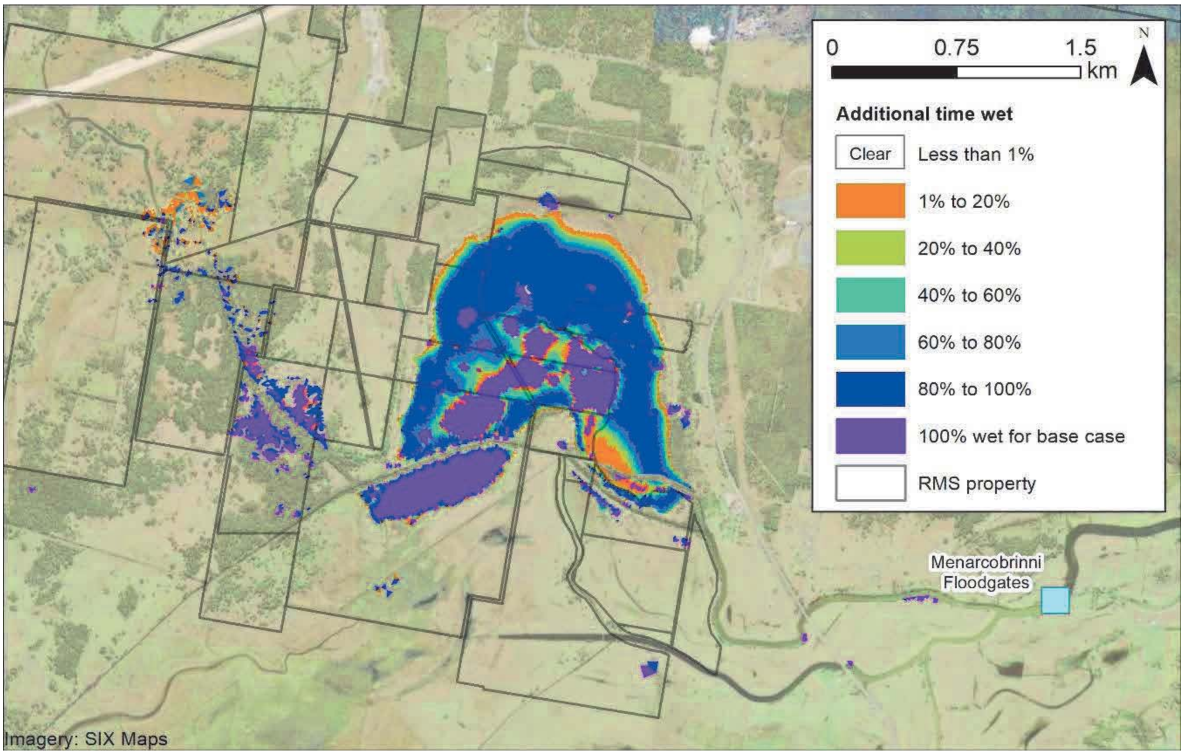

Figure ES4.11: Difference in inundation duration between the base case and Management Option 4b during day-to-day conditions (includes 6 month runoff event)

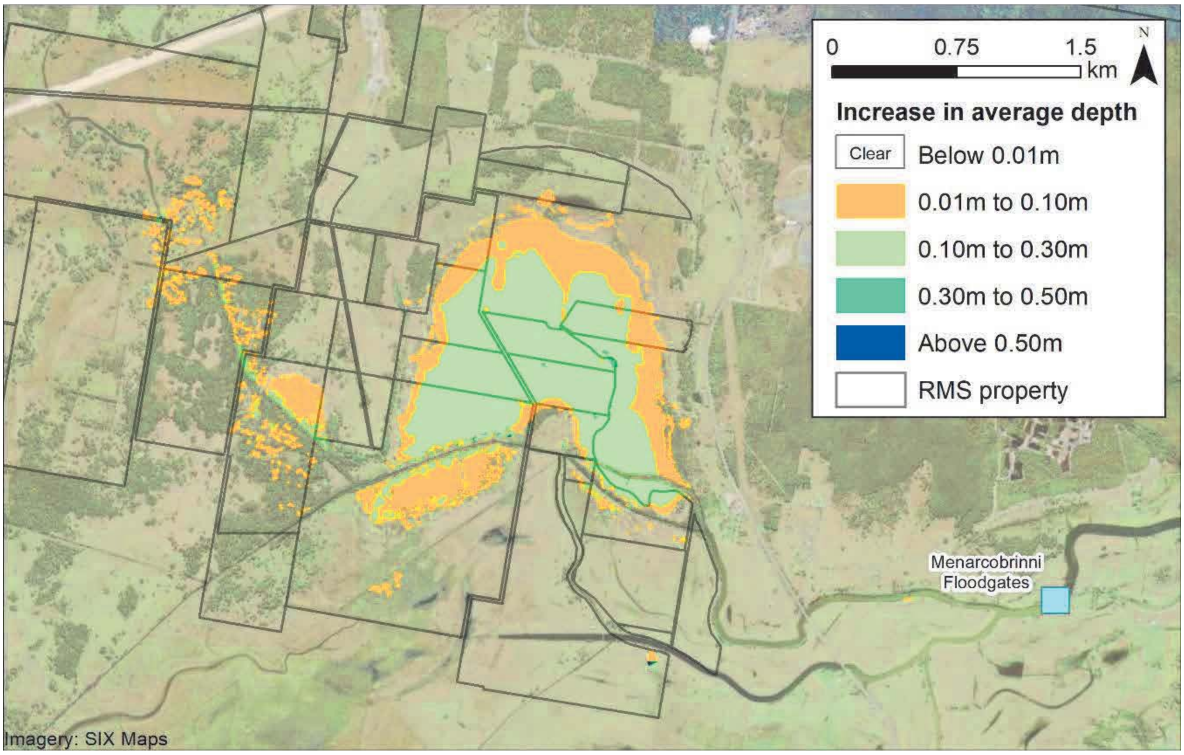

Figure ES4.12: Difference in inundation depths between the base case and Management Option 4b during day-to-day conditions (includes 6 month runoff event)

ES4.6 Management Option 5a: Decentralise Menarcobrinni floodgates and replace with multiple upstream structures – with tidal wetland inundation

Description

Management Option 5a involves decentralising the Menarcobrinni floodgates to locations upstream of the low-lying floodplain Doughboy Swamp and Mayes Swamp management areas (Figure ES4.13). This approach encourages overland inundation of the low-lying floodplain areas, creating significant areas of intertidal wetland habitat and improving poor water quality resulting from acid sulfate soils and blackwater runoff. Floodgate locations considered for Management Option 5b are located at narrow sections in the drainage network where multi-culvert structures have been assumed.

Results

The results of the numerical modelling indicate (Figure ES4.14):

- Significant tidal inundation across low-lying areas of RMS property;
- Significant tidal inundation of private land would occur without extensive additional on-ground mitigation measures;
- Approximately 1 km of additional levee banks required, with additional small floodgates structures at key locations would need to be constructed to prevent inundation across private land within Doughboy Swamp and the floodplain surrounding Doughboy Drain (Figure ES4.15);
- Approximately 1.2 km of additional levee banks would need to be constructed on the north bank of Seven Oaks Drain and a floodgate structure would need to be constructed on Clybucca Creek upstream of its intersection with Seven Oaks Drain to prevent inundation of low-lying land within Mayes Swamp (Figure ES4.16);
- Increased vulnerability to river backwater flooding (Menarcobrinni headworks crest elevation = +1.1 m AHD);
- 115 hectares of additional intertidal wetland created to the south of Seven Oaks Drain; and
- Up to 16 km of drain exposed to full tidal flushing.

Considerations

In addition to the model results, the following implementation considerations have been identified:

- Continued maintenance options for the Menarcobrinni floodgates (unless they are removed);
- Additional mitigation structures will be needed to prevent inundation of private land;
- Additional modelling would be needed to validate floodplain hydrodynamics with mitigation structures to prevent inundation of private property in place;
- The impact of turning freshwater habitat to saltwater habitat would need to be assessed; and

- Ownership of new floodgate structures would need to be addressed including responsibility for maintenance.

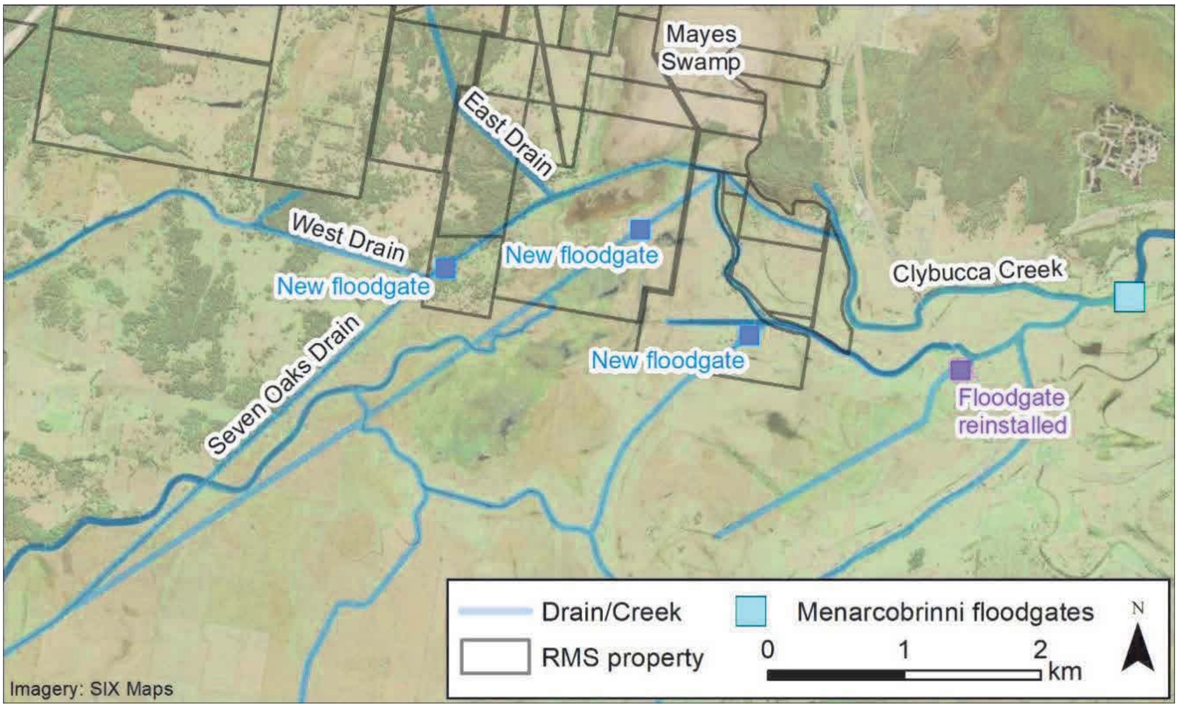

Figure ES4.13: Management Option 5a for location of upstream decentralised floodgates

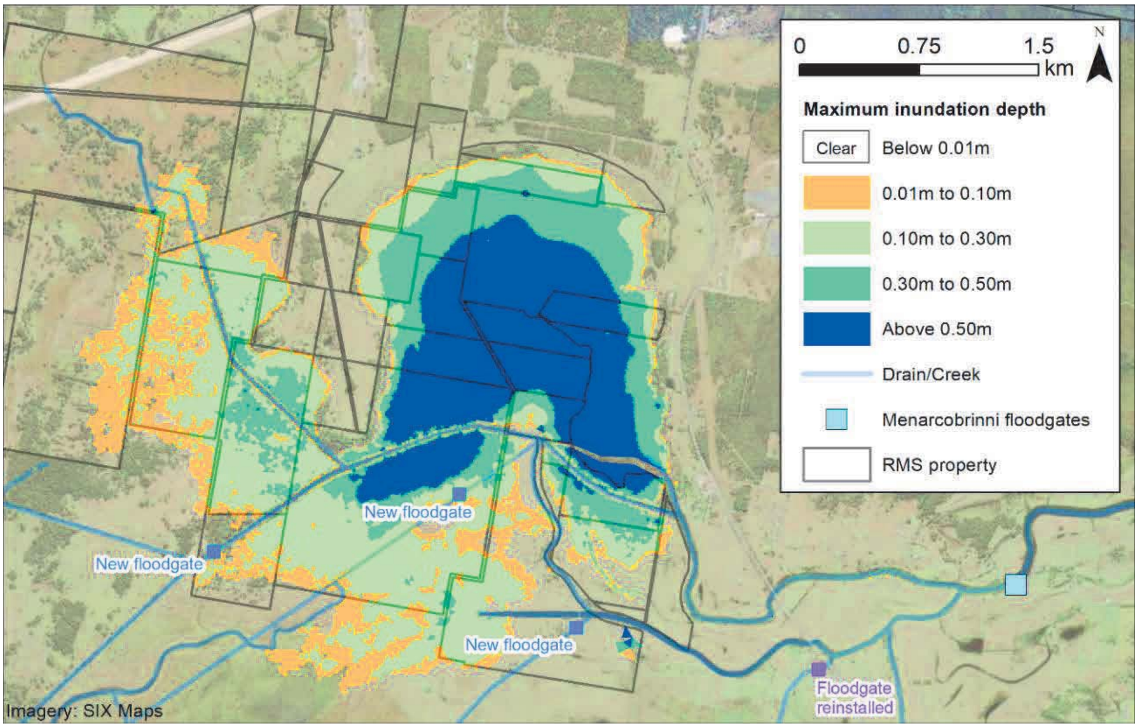

Figure ES4.14: Maximum tidal inundation depth and extent for Management Option 5a over a three-month dry period

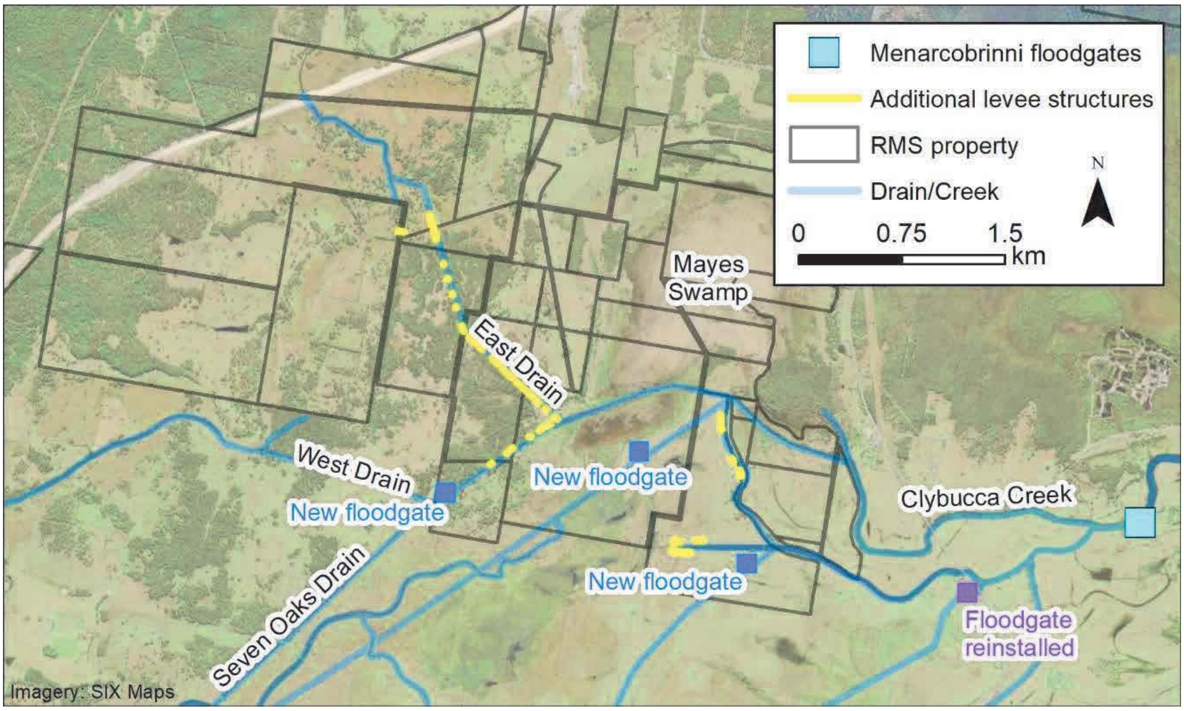

Figure ES4.15: Indicative location of structures to protect private land south of Seven Oaks Drain and within Doughboy Swamp from inundation for Management Option 5a

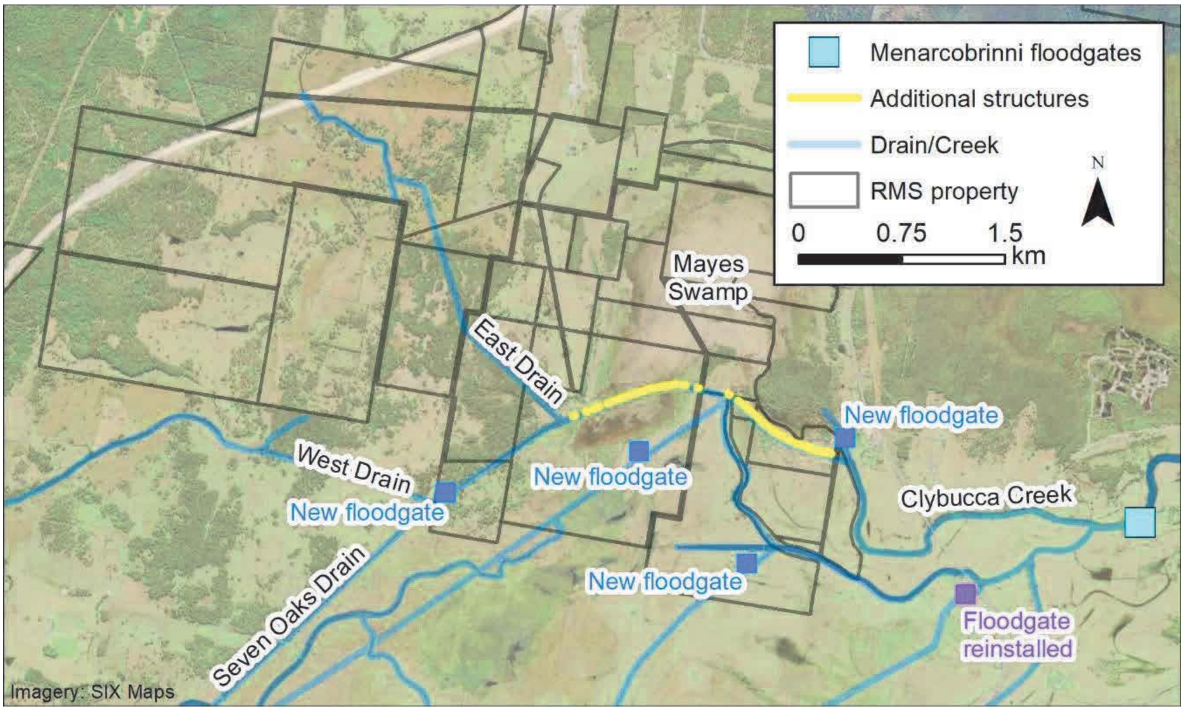

Figure ES4.16: Indicative location of structures to protect private land within Mayes Swamp from inundation for Management Option 5a

ES4.7 Management Option 5b: Decentralise Menarcobrinni floodgates and replace with two upstream structures – with no tidal inundation

Description

Management Option 5b involves decentralising the Menarcobrinni floodgates to locations downstream of the low-lying floodplain management areas (Figure ES4.17). These locations limit overland inundation of the low-lying floodplain areas and maintain the existing level of protection from river backwater flooding, while obtaining benefits associated with tidal flushing and aquatic connectivity. The individual management of sub-catchment areas upstream of the structures is also possible under this scenario. Floodgates constructed for this configuration need to be sufficiently large to provide drainage conveyance to drain the floodplain following flood events.

Results

The results of the numerical modelling indicate (Figure ES4.18 and Figure ES4.19):

- Minor tidal inundation of private land is predicted. This can be mitigated by the construction of small floodgate structures on side channels (Figure ES4.20);
    - Re-installing floodgate flaps on an existing structure on a drain to the south of McAndrews Drain; and
    - Adding an additional 20 m of levee with a floodgate on the end of a drain on the west bank of Humpty-back Creek;
- Humpty-back Creek (parallel to Macleay Valley Way) experiences in-channel tidal inundation;
- There is a small change to (present day) day-to-day inundation across the floodplain (increase in average depth of less than 0.10 m and average inundation time of less than 20% was caused by a slight change in where the tidal boundary is located) for a 6 month catchment rainfall event;
- Changes to drainage efficiency is negligible; and
- Up to 6.6 km of drain will be flushed with tidal water improving water quality and providing additional aquatic habitat.

Considerations

In addition to the model results, the following implementation considerations have been identified:

- Continued maintenance options for the Menarcobrinni floodgates (unless they are removed);
- Additional mitigation structures will be needed to prevent inundation of private land;
- Additional investigation of new floodgate headworks may be required to optimise detailed design and validate floodplain hydrodynamics;
- Consultation with landholder upstream of Menarcobrinni floodgates; and

- Ownership of new floodgate structures, including responsibility for management/maintenance.

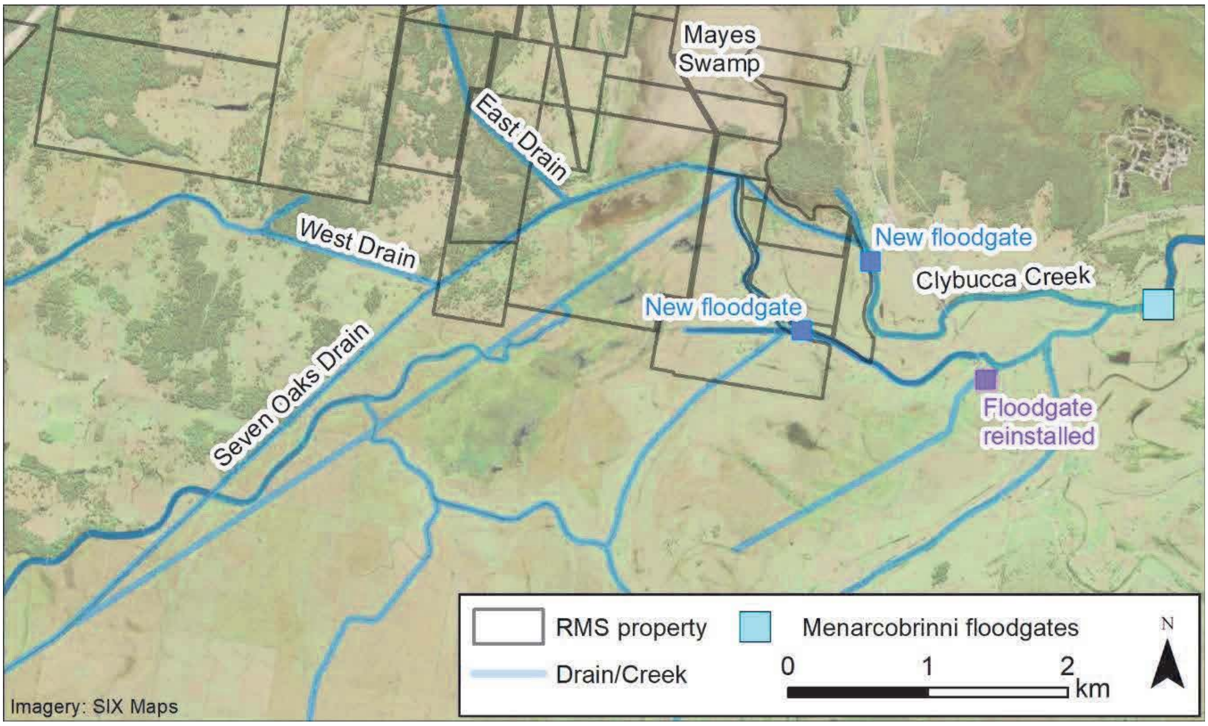

Figure ES4.17: Management Option 5b for location of upstream decentralised floodgates

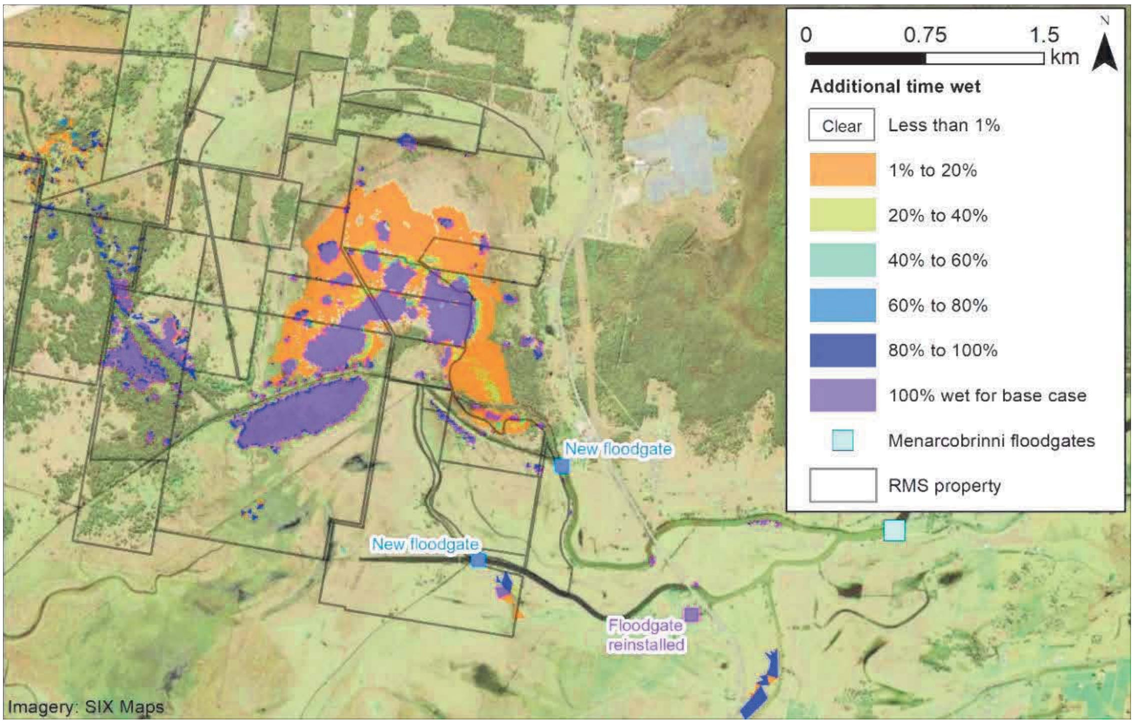

Figure ES4.18: Difference inundation duration between the base case and Management Option 5b during day-to-day conditions (includes 6 month runoff event)

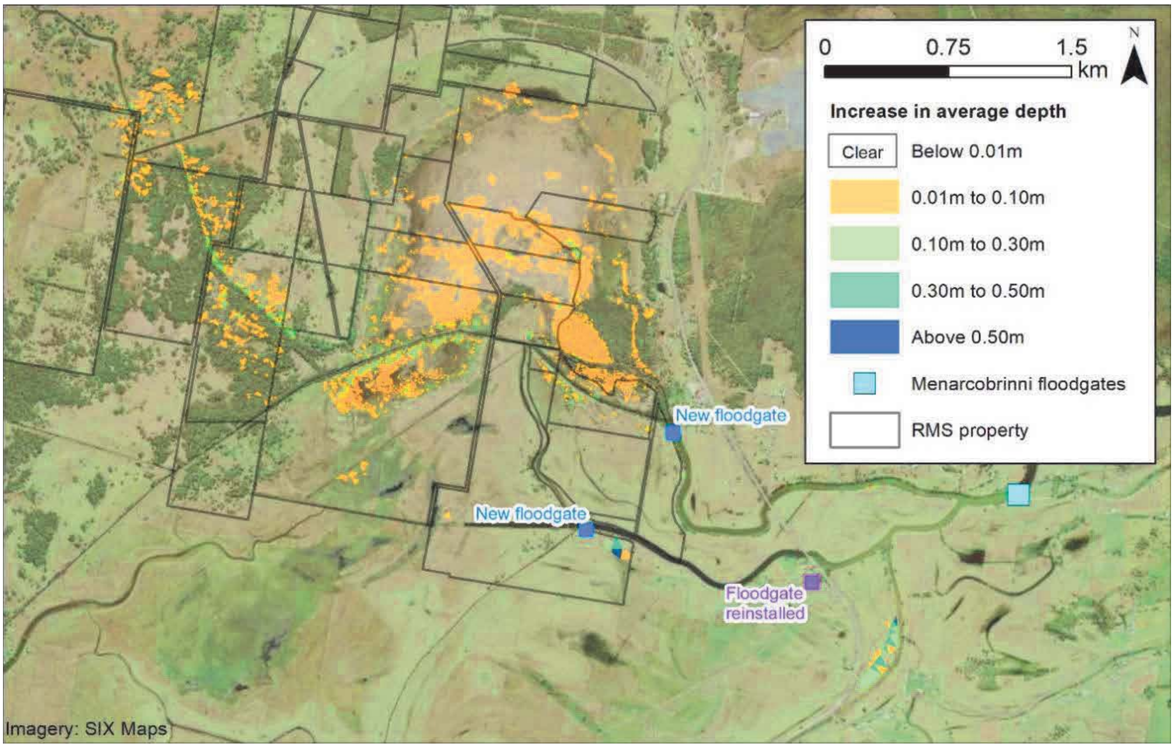

Figure ES4.19: Difference in inundation depths between the base case and Management Option 5b during day-to-day conditions (includes 6 month runoff event)

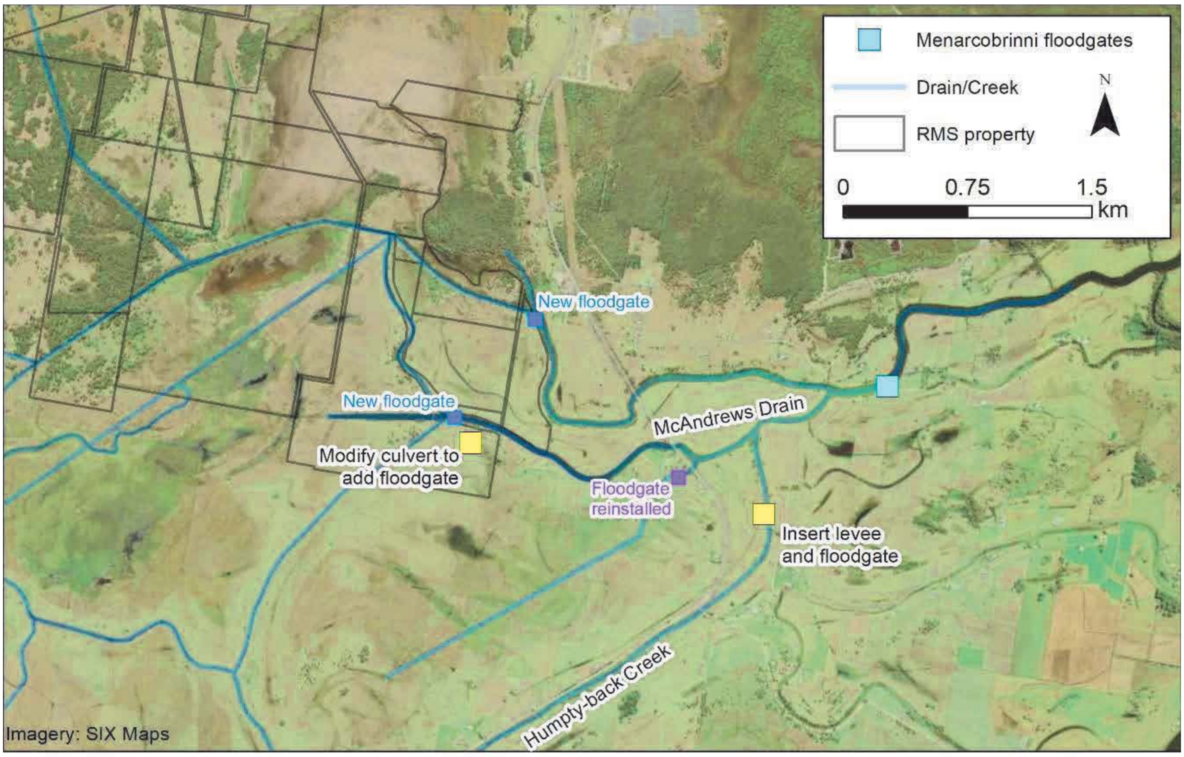

Figure ES4.20: Location of new infrastructure to prevent inundation of private land for Management Option 5b

ES4.8 Management Option 6: Floodgates fully open

Description

Management Option 6 investigates fully hinging open the 21 floodgates at the Menarcobrinni barrage to allow water flow in both directions. This management option aims to quantify the impacts of no floodgate restrictions during normal tidal conditions. This strategy would result in the greatest change (hydrologically and ecologically) to the floodplain and in the extensive creation of intertidal habitat. Impacts to existing floodplain drainage, water quality and private floodplain landholders is significant. By hinging open the gates, but leaving the structure and gates intact, the gates can be closed prior to flood events and prevent backwater flooding from the Macleay River.

Results

The results of the numerical modelling indicate (Figure ES4.21 to ES4.23):

- Mayes Swamp would be permanently inundated with depths from 0.10 m to above 0.50 m;
- Inundation of private property on the south west of Doughboy Swamp would occur at depths between 0.01 m and 0.10 m up to 100% of the time;
- Inundation of private property to the south of Seven Oaks Drain and south of McAndrews Drain would occur up to depths of 0.30 m up to 100% of the time;
- Concentrations of salinity on the floodplain would reach a maximum of 60% - 100% of the salinity at the Menarcobrinni floodgates;
- Up to 725 hectares of saltwater wetland is created when the floodplain is inundated with tidal water; and,
- Up to 51.5 km of drain will be flushed with tidal water improving water quality and providing additional aquatic habitat.

Considerations

The following implementation considerations have been identified in this Scenario:

- Other management options implemented;
- Extensive change of floodplain ecology;
- Value and extent of habitat creation;
- Impact of climate change on drainage;
- Change in land use;
- Land ownership;
- Changes to flood risk; and
- Overall change in floodplain hydrology.

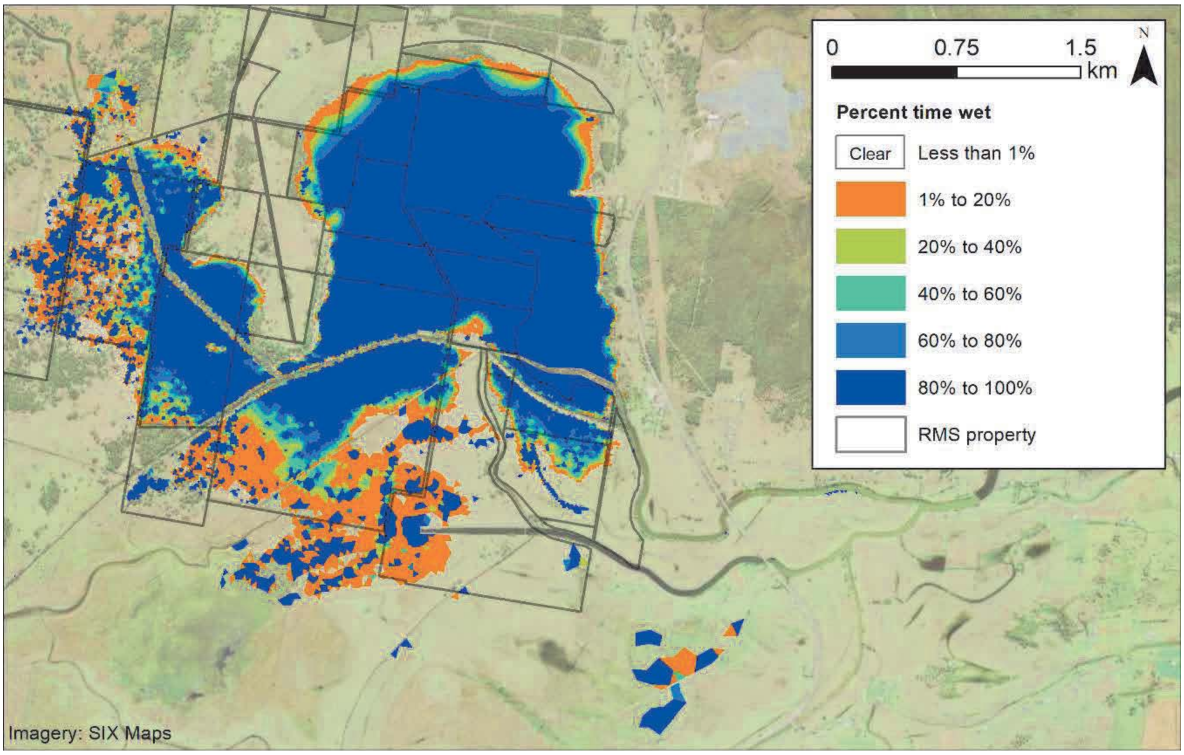

Figure ES4.21: Percent tidal inundation duration with Menarcobrinni floodgates hinged open

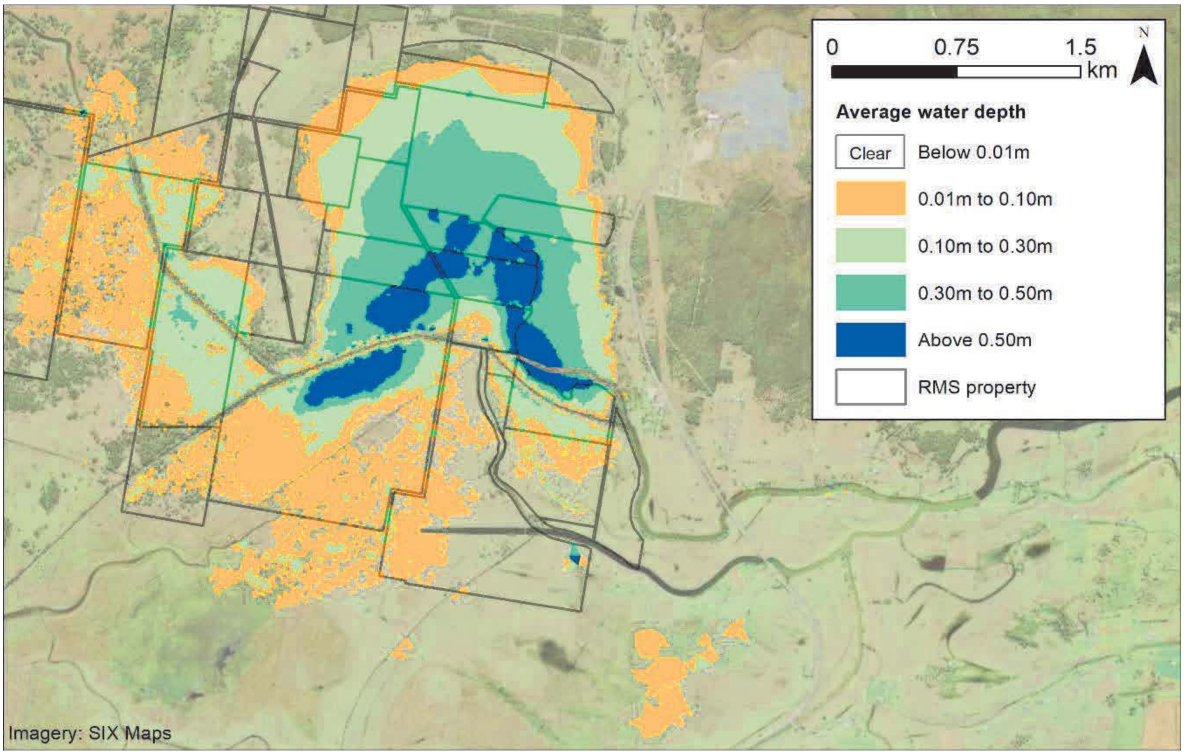

Figure ES4.22: Average tidal inundation depth (over a dry three-month period) with Menarcobrinni floodgates hinged open

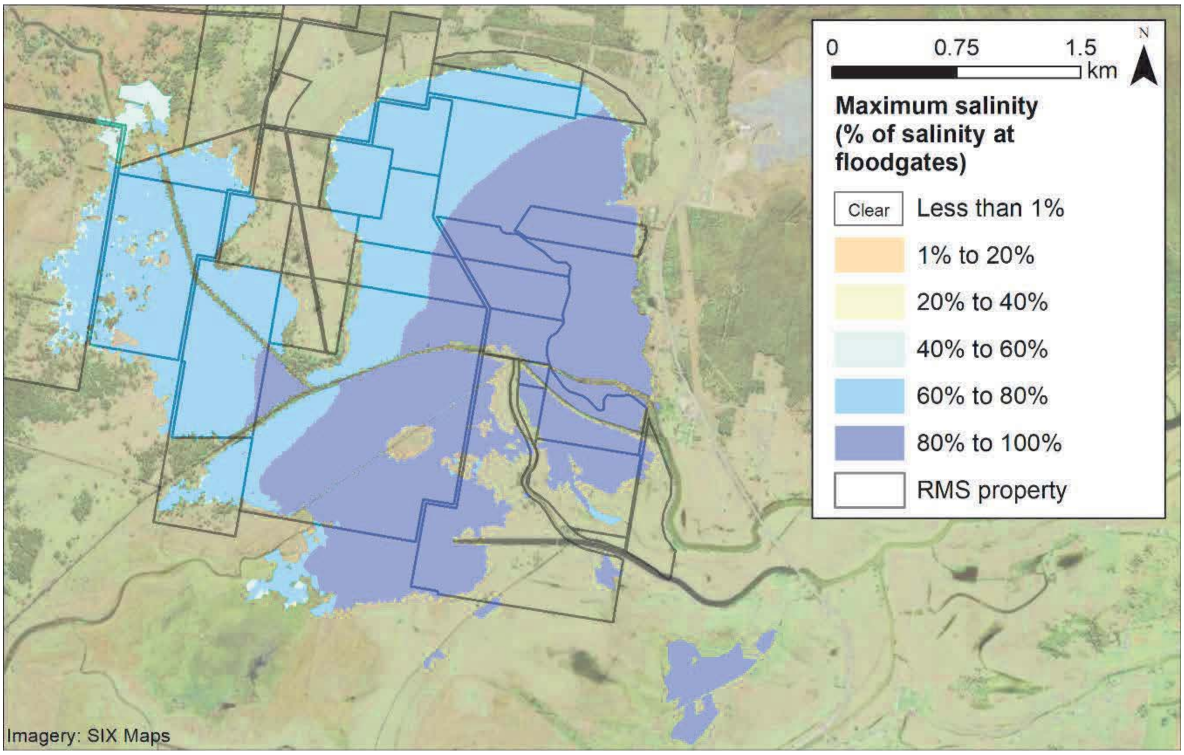

Figure ES4.23: Maximum saline intrusion (over a dry three-month period) with Menarcobrinni floodgates hinged open