Sustaining Riverland Environments wetland risk asessment – Lock 3 to Lock 4

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Foreword

The Department for Environment and Water (DEW) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEW's strong partnerships with educational and research institutions, industries, government agencies, Landscape Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

John Schutz
CHIEF EXECUTIVE
DEPARTMENT FOR ENVIRONMENT AND WATER

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1 Introduction

The Sustaining Riverland Environments Program (SRE) commenced in September 2020 as a continuation of the South Australian Riverland Floodplains Integrated Infrastructure Program (SARFIIP). The overarching objective of the SRE program is to implement a range of projects to sustain Riverland environments and improve the condition of the lower River Murray channel, floodplain and wetland ecosystems, with a focus on recovering native fish populations. The Lock 3 reach is one of three localities chosen for implementation of this program which will investigate possible infrastructure upgrades at key floodplain and wetland sites which could lead to more effective management of environmental water through weir pool manipulation.

This technical note presents the results of a desktop characterisation of groundwater conditions and the salinity risk from groundwater processes at four selected wetlands using existing information. The salinity risk to the wetlands and the possibility of increased salt loads to the river are assessed. The background information and methodology are taken from a similar study of 34 wetlands under the Riverine Recovery Project (Barnett, 2013).

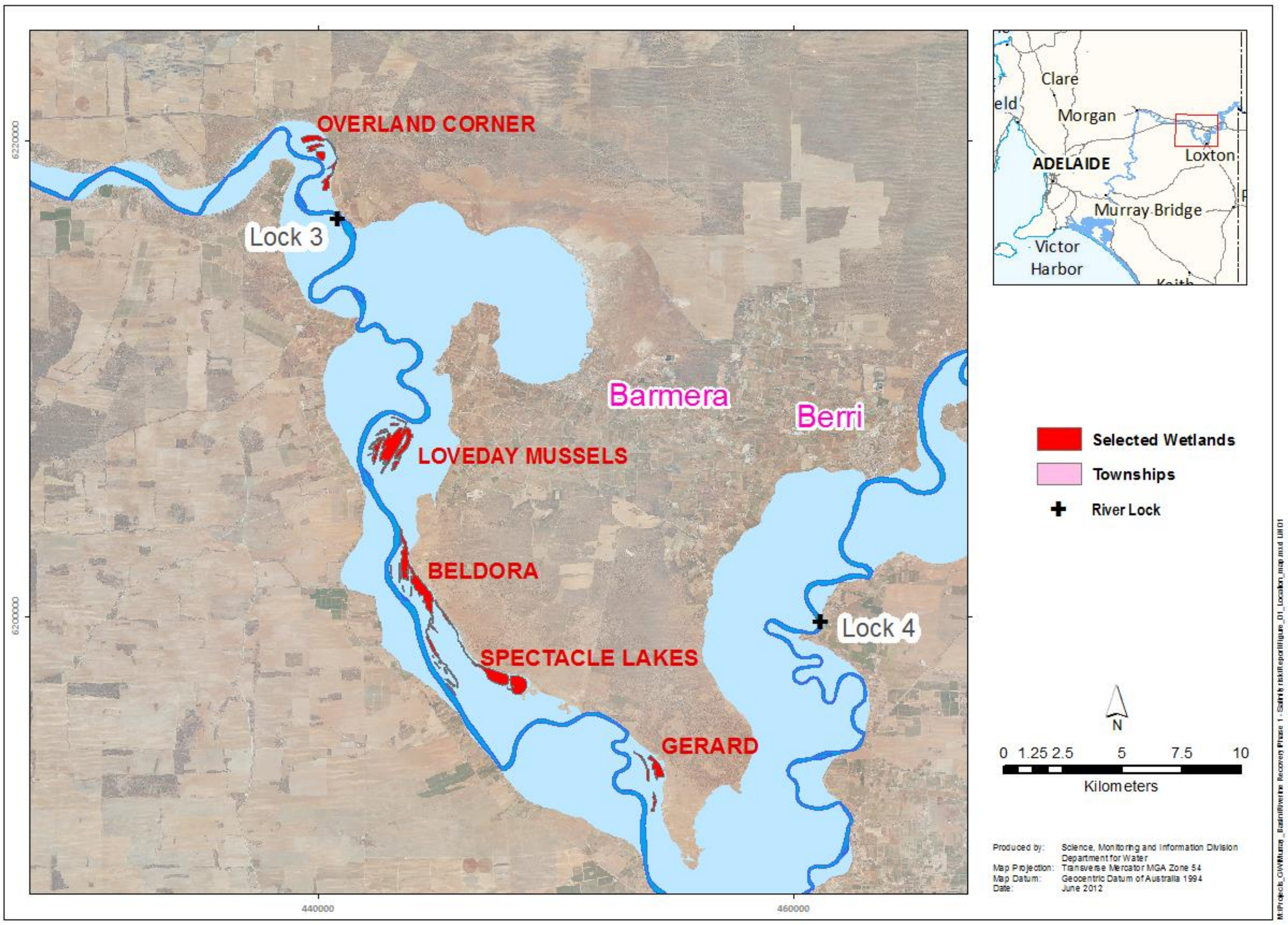


Figure 1. Location of the selected wetlands

2 Floodplain hydrogeology

The River Murray in South Australia lies within an erosional trench that sits within Quaternary and Tertiary sediments. Within the trench are two main Quaternary fluvial sediments: the sandy Monoman Formation and the clayey Coonambidgal Formation (Figure 2). The Monoman Formation is the principal aquifer within the floodplain. In most areas, the watertable lies within the Coonambidgal Formation, which acts as a confining layer for the underlying Monoman Formation sands. The floodplain of the River Murray is the site of natural groundwater discharge for the regional groundwater systems of the Murray Basin, which in South Australia, contain saline groundwater near the river.

The groundwater level in the floodplain is affected by a variety of processes. Regional groundwater flow into the floodplain occurs laterally and by upward leakage from deeper aquifers. Groundwater levels at the edge of the floodplain will be higher if there are irrigation areas on the adjacent highland. Within the floodplain, groundwater levels are generally stable, but may change in response to recharge from rainfall, irrigation occurring on the floodplain, inundation during floods and weir pool manipulations. Evapotranspiration from shallow aquifers may lower groundwater levels on the floodplain, and is dependent on the depth to the watertable, soil type and vegetation type. The width of the floodplain may also influence groundwater levels, as where the floodplain is narrow and there is less area for evapotranspiration to extract shallow groundwater. Pumping from Salt Interception Schemes is designed to lower groundwater levels in both the regional and floodplain aquifers.

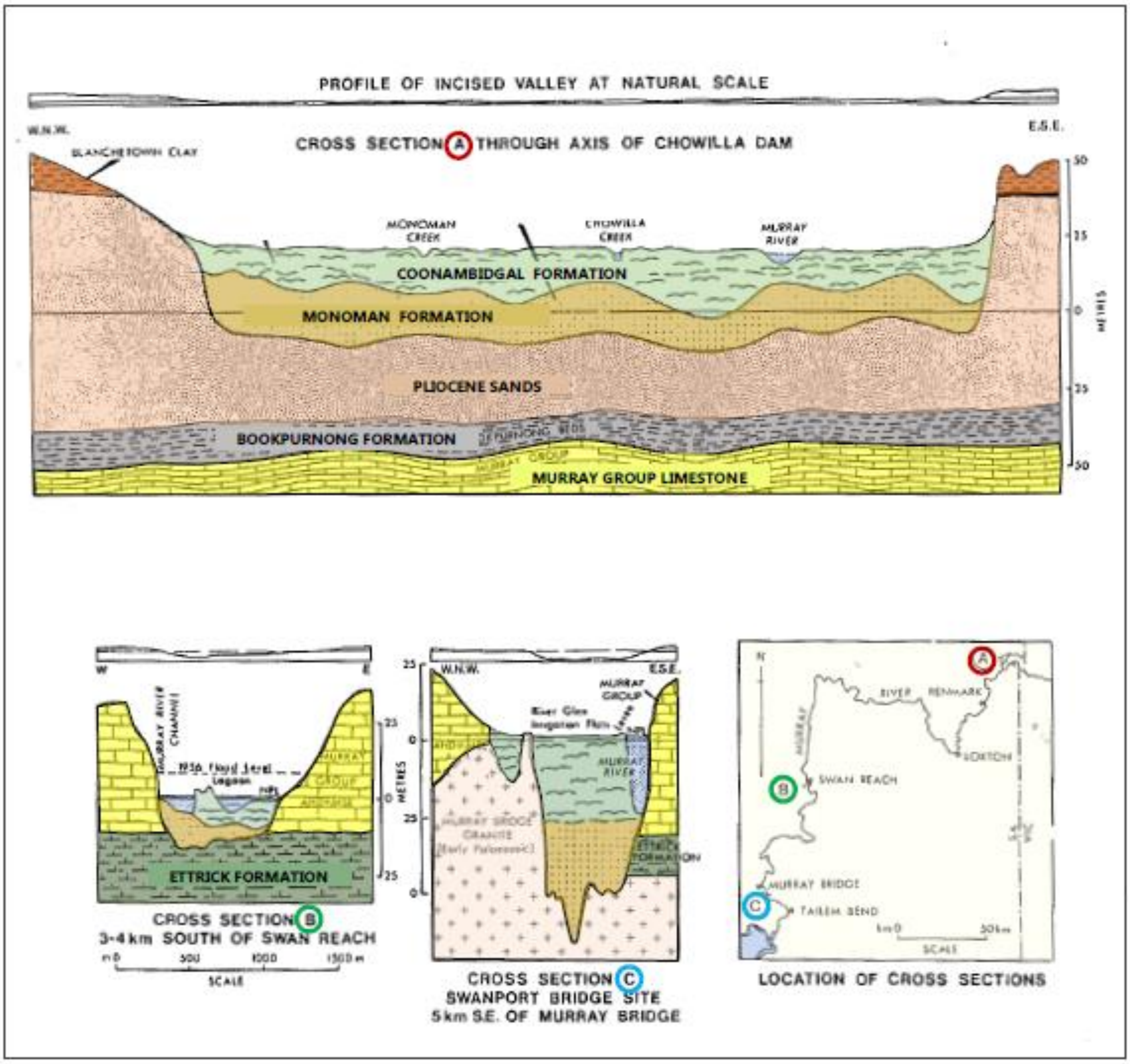


Figure 2. Various river valley cross sections (after Twidale, Lindsay and Bourne, 1978)

3 Wetland characterisation

There are two main categories into which the majority of wetlands along the River Murray can be classified (Jolley et al., 2008) – billabongs without a permanent connection to the river (disconnected) and wetlands that have a permanent connection to the river (connected). In addition to this simple classification, individual wetlands may have three broad flow regime types as shown in Figure 4. These include:

- losing (wetland recharges water to floodplain groundwater)
- gaining (wetland receives discharge from floodplain groundwater)
- perched (wetlands are permanently dry unless with the watertable lying below the surface)

Surveys of 61 wetlands (Crosby et al., 2008) has allowed further characterisation of these wetland types.

Connected wetlands

Wetlands with one connection to the river were found to be either permanent or temporary with salinity ranging from fresh to saline. However wetlands with two or more connections to the river at pool level were found to all be permanent and 85% of them were fresh (Crosby et al., 2008).

Disconnected wetlands

Without a connection to the river, the wetlands were found to be either saline or hypersaline suggesting that a permanent connection to the river is critical to prevent wetland salinisation (Crosby et al., 2008).

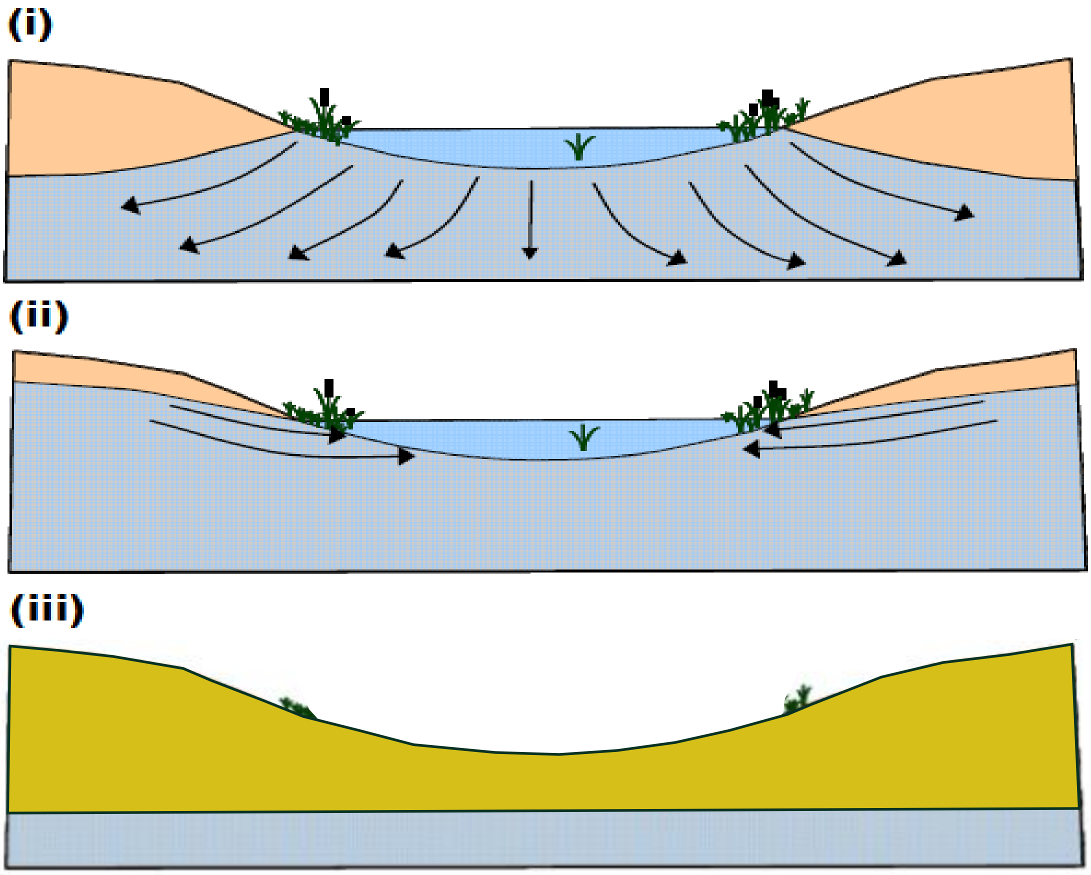


Figure 3. Groundwater flow to and from (i) losing (ii) gaining or (iii) perched wetlands (after Jolly et al., 2008)

4 Wetland salinisation risk

The complexity of floodplain processes, hydrogeological variability and limited data can make it difficult to accurately estimate the groundwater flow regime and the risk of salinisation to the wetlands. In some areas, there is a lack of comprehensive data for most key aquifer properties, and some processes are not well understood. A simplified approach is therefore needed for the rapid assessment of the salinity risks of managing water levels in wetlands.

4.1 Groundwater Processes

From the previous discussion, determining the flow regime of the wetland, whether it is gaining (receiving groundwater discharge) or losing (recharging groundwater), is a very important factor in estimating risk.

The exchange of groundwater in wetlands is often strongly governed by local geomorphology (Jolly et al., 2008). Most wetlands occur at low points in the terrain where heavy textured soils are commonplace due to alluvial depositional processes. If the hydraulic conductivity of these clays and silts (Coonambidgal Formation) are lower than that of the underlying aquifer (Monoman Formation sands), they can impede groundwater movement between the aquifer and the wetland.

Groundwater inputs and outputs are generally considered one of the most difficult components of the wetland water balance to characterise because they tend to be very small, compared to surface water inputs and rainfall (Jolly et al., 2008). This is mainly because of the low hydraulic conductivity as mentioned previously and the generally low hydraulic gradients observed on the floodplain. The relatively short duration of management scenarios and the dependence of any impacts on the previous flooding history are other impediments for accurate quantification of salinity impacts (AWE, 2012).

4.2 Impact of locking

Prior to European settlement, the river would have flowed under a natural gradient downstream, with the river level constantly changing depending on flows into the river from the various upstream tributaries. Regional saline groundwater would have flowed through the floodplain to the river which would have been the lowest point in the landscape (except during flood events).

Figure 3 shows how river regulation by locking has imposed a permanent stepped increase in river levels on what was previously a continuous and gradual gradient. This has raised river levels upstream of locks, promoting groundwater recharge to the floodplain and cliff sections, and has lowered river levels downstream of locks which may encourage groundwater discharge back into the river. Generally, the depth to the watertable beneath the floodplain gradually increases upstream of a lock.

The location of the selected wetlands in relation to this conceptual model is shown in Figure 3. These wetlands confirm this model with a transition upstream from connected losing wetlands (Loveday Mussels, Bedora, Spectacle Lakes creek) to disconnected dry wetlands (Spectacle Lakes, Gerard, Overland Corner).

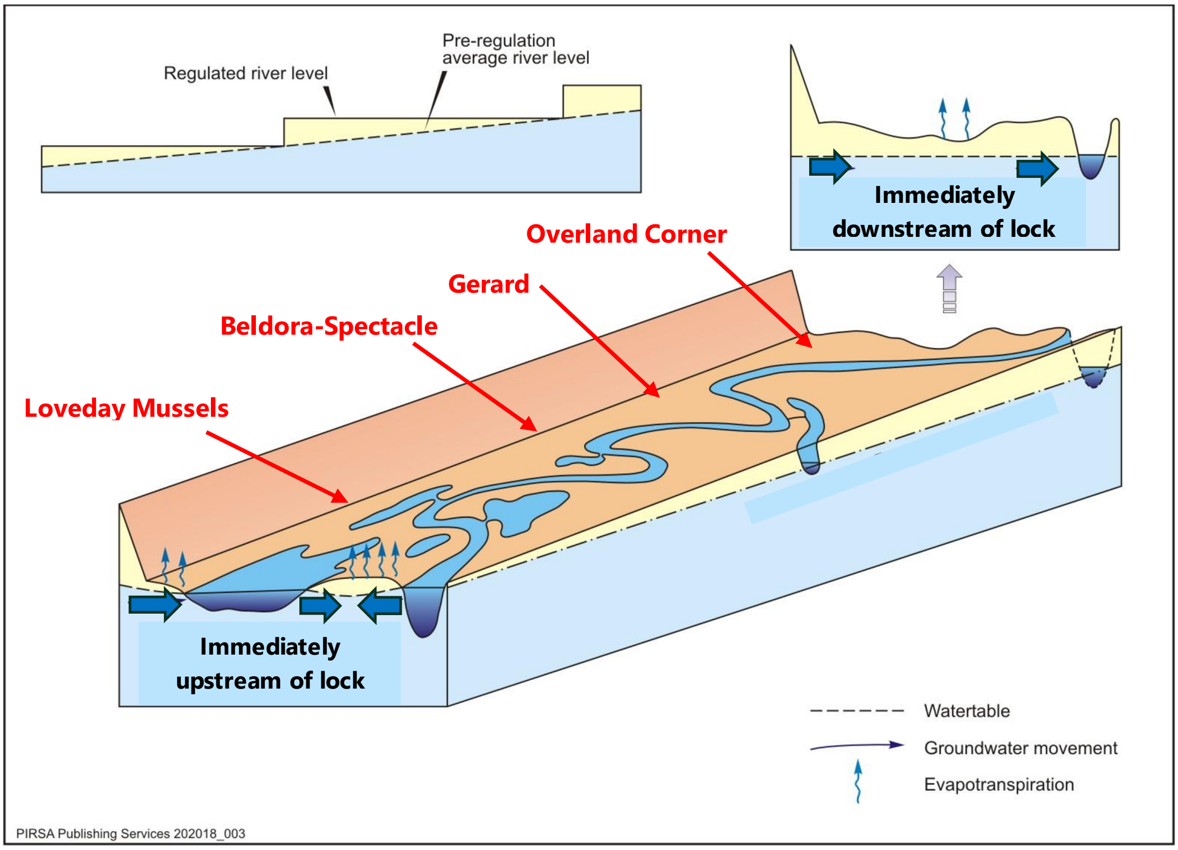


Figure 4. Location of wetlands in relation to the conceptual model of a typical reach

4.3 Parameters considered

The salinity impact of manipulating wetland water levels is dependent on three main hydrogeological parameters:

1. the near-wetland groundwater salinity (the lower the groundwater salinity, the lower the salinity risk);
2. the hydraulic conductivity of the sediments in contact with the wetland (the lower the hydraulic conductivity, the lower the salinity risk). This dependent on whether the wetland lies completely within the clays of the Coonambidgal Formation, or is deep enough to intersect the underlying permeable sands of the Monoman Formation; and
3. the wetland flow regime (a losing wetland has a lower risk than a gaining wetland).

Although groundwater level and salinity data are available for most wetlands from previous monitoring programs, there are some sites where most of the parameters which govern the potential salinisation of wetlands are not readily available. In these cases, other related datasets which are available throughout the SA River Murray floodplain and can be used to give a broad context of risk.

- The health of floodplain vegetation is greatly influenced by groundwater depth and salinity and can be used as a proxy to estimate groundwater salinity (AWE, 2012).
- In river NanoTEM surveys - a low resistivity suggests high salinity groundwater, flow from the aquifer into the river (gaining), and a high resistivity suggests low salinity groundwater, flow into the aquifer from the river (losing).

4.3 Groundwater monitoring

At each wetland, the existing water level and salinity monitoring data was analysed and provided good evidence for the development of the understanding of the interaction between the wetlands and the floodplain groundwater and the assessment of salinity risk. The recorded river level upstream of Lock 3 has been used for this analysis of river/floodplain interaction, with the exception of the Overland Corner site where the level downstream of Lock 3 was used. The monitoring data which is collected and stored by the Murraylands and Riverland Landscape Board, has been uploaded to the SA_Geodata database. Changes to measured water levels as a result of applying density corrections for saline water were small compared to the fluctuations caused by weir pool changes and did not change the interpretation of the monitoring data.

Water level and salinity data have been presented in this report from observation wells that have consistent data quality and maximum length of record, together with a location that is appropriate for informing the analysis of salinity risk. Those observation wells not presented are listed in Appendix A. Recommendations for improvement of the monitoring networks have been made where appropriate and include selecting wells for ongoing monitoring and designating some wells as low priority because they are close to, or have identical trends to the ongoing wells.

5 Loveday Mussels

The Loveday Mussels wetland complex is located 15 river km upstream of Lock 3 and approximately 4 km from the township of Cobdogla and lies between the River Murray to the west, and irrigated highland to the east. The wetland complex is comprised of both permanent and temporary wetland basins which cover an area of about 157 ha. The complex can be classified as connected, with multiple lines of evidence suggesting it is losing water to the floodplain. Groundwater monitoring has been carried out since 2004, with monitoring well locations shown in Figure 5.

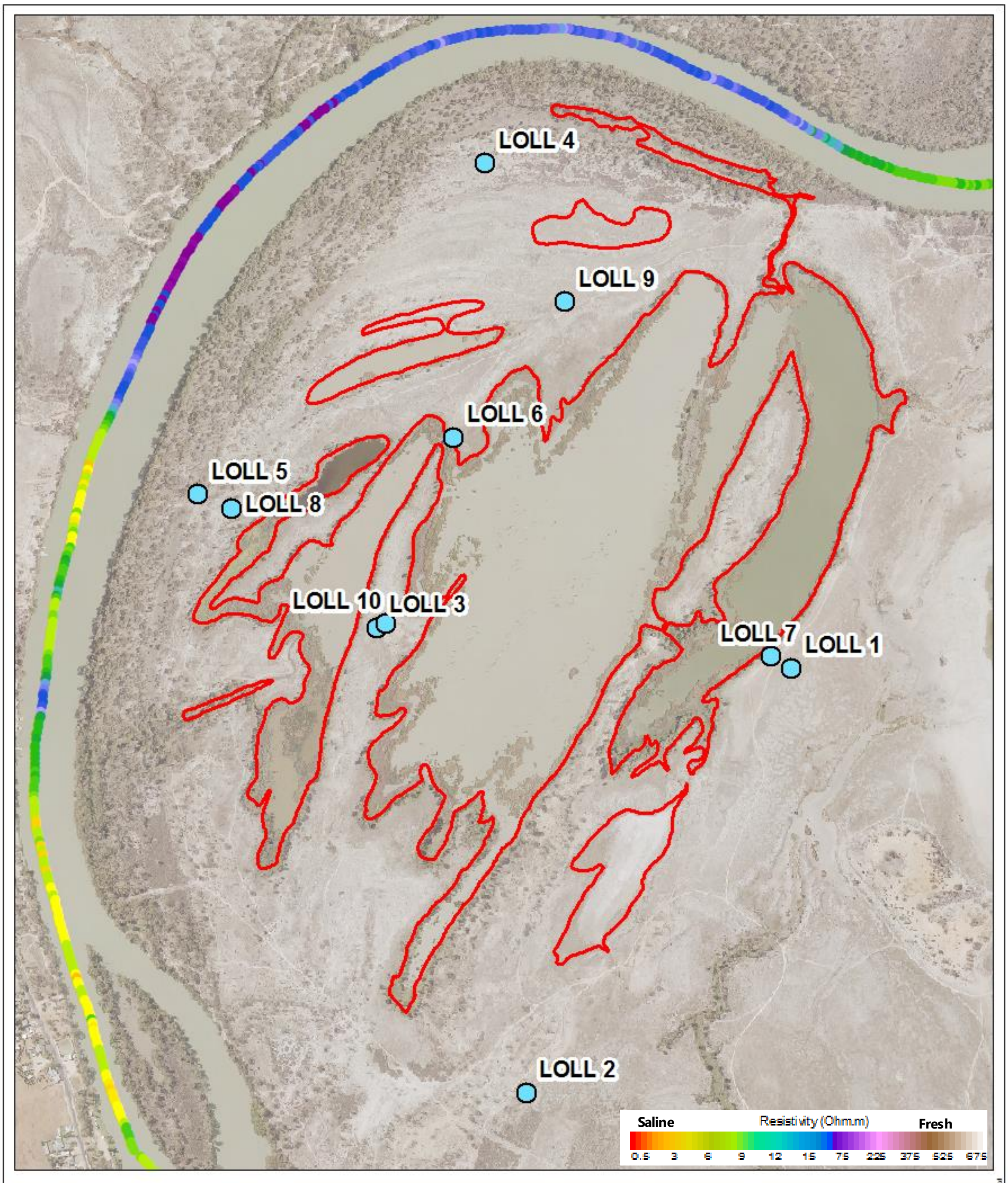
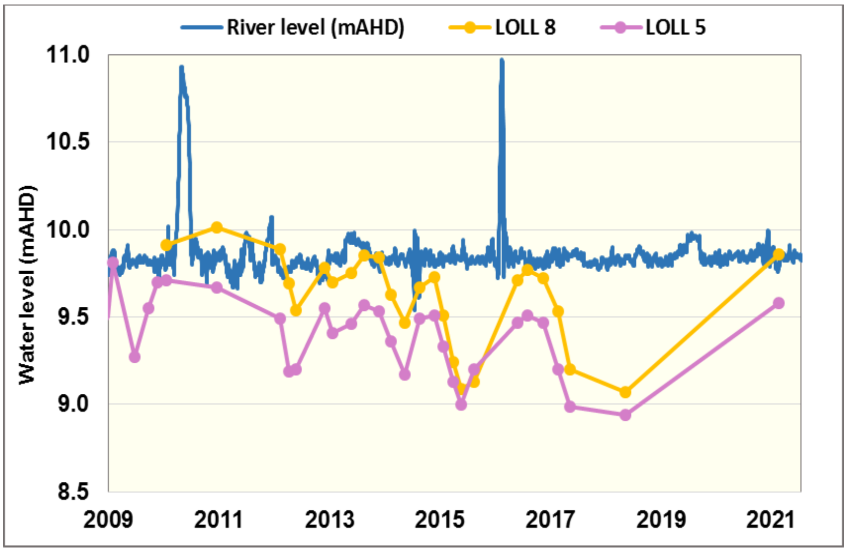
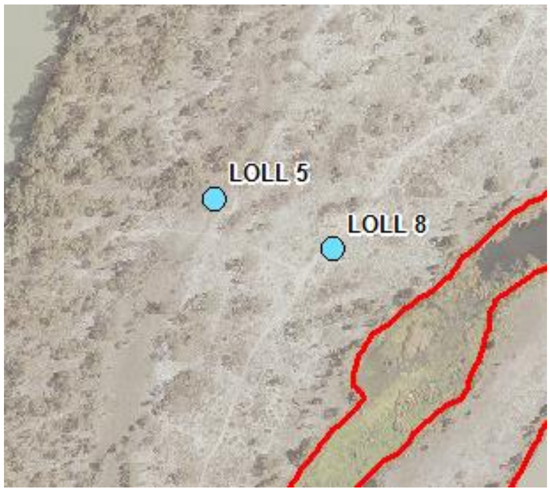


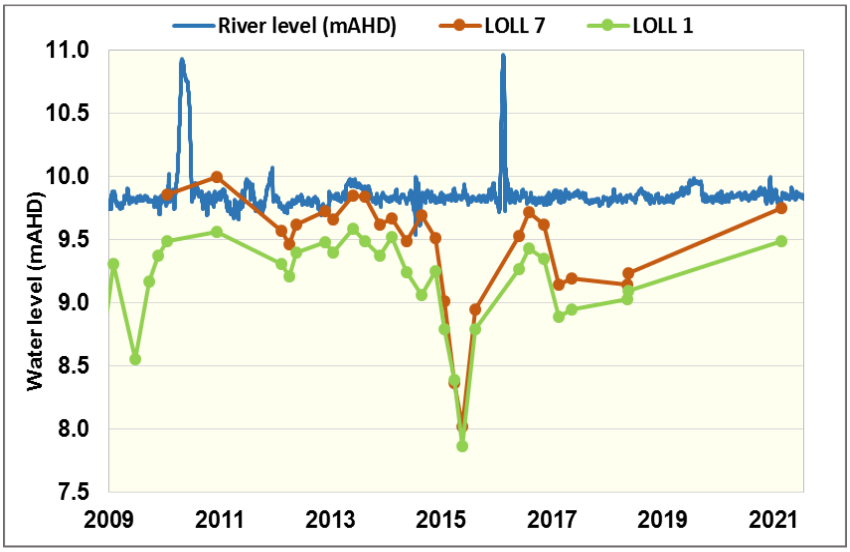
Figure 5. Location of Loveday Mussels wetland complex and monitoring wells

5.1 Monitoring data

The water level and salinity data confirm the conceptual model outlined in Figure 3. Evapotranspiration from the shallow watertable across the floodplain has lowered the watertable and led to salinization of soils and high groundwater salinities. The watertable elevation decreases with increasing distance from the river or permanent wetlands as shown in Figure 6, indicating that water flows out of the river and wetlands into the floodplain. Wells LOLL 7 and 8 are located closer to the wetland. This outward flow seems to be maintained not only during high flows but also during drying events.







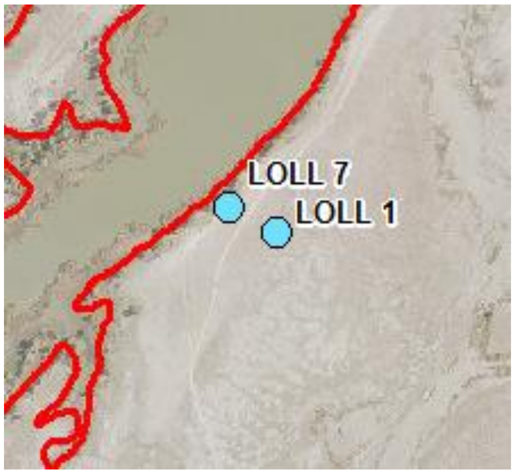


Figure 6. Hydrographs of observation wells near Loveday Mussels wetlands

The salinity trends of these same observation wells are presented in Figure 7 and show those wells closer to the wetland (LOLL 7 and 8) have lower salinities than those further away over most of the monitoring period. This confirms that water flows out of the river and wetlands into the floodplain.

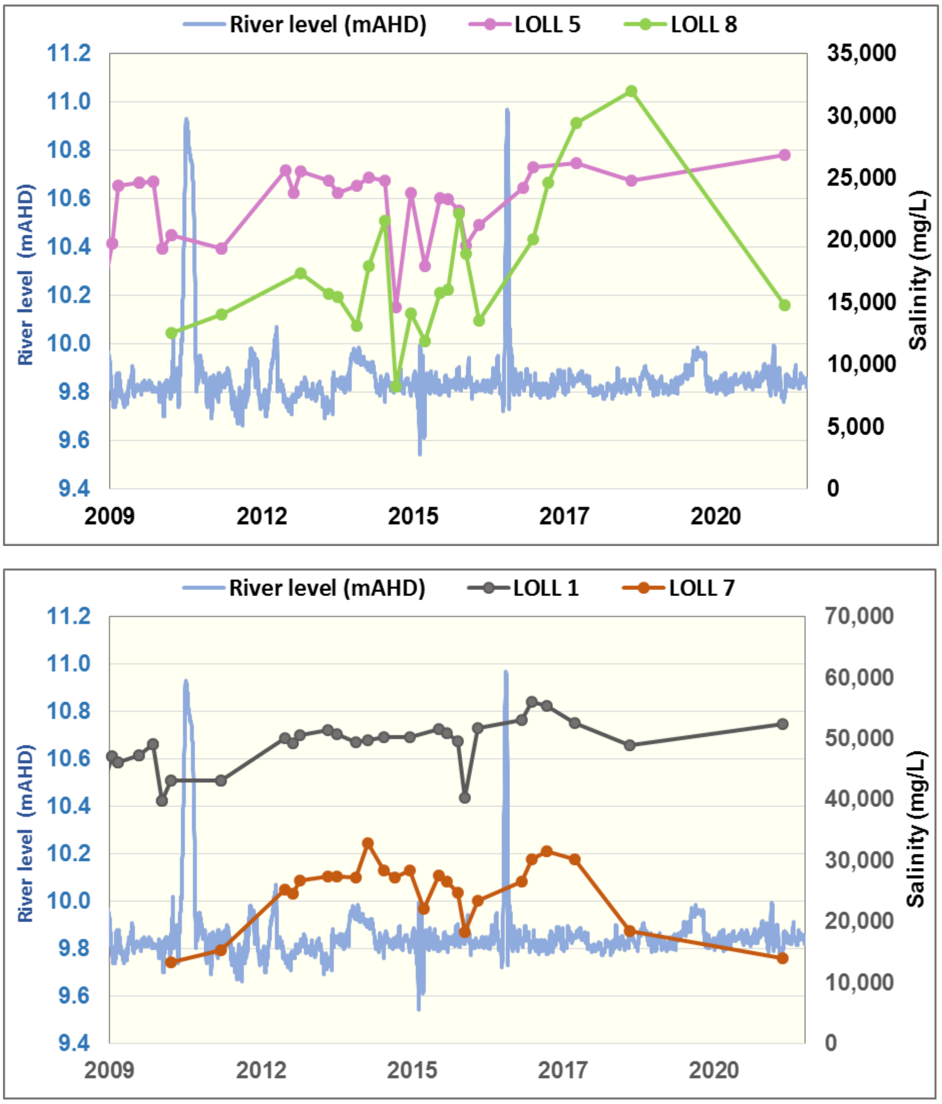


Figure 7. Salinity trends of observation wells near Loveday Mussels wetlands

Of particular interest is the salinity trend for LOLL 4 shown in Figure 8. This well is located 220 m from the river and has a groundwater level about 30 cm lower than the river which is inducing flow into the floodplain. This is supported by the high resistivity indicated by the in-stream NanoTem (blue line in Figure 5) and the healthy vegetation near the river. The slow decrease in groundwater salinity is most likely the result of the lateral movement of fresher water from the river which was initiated by locking.

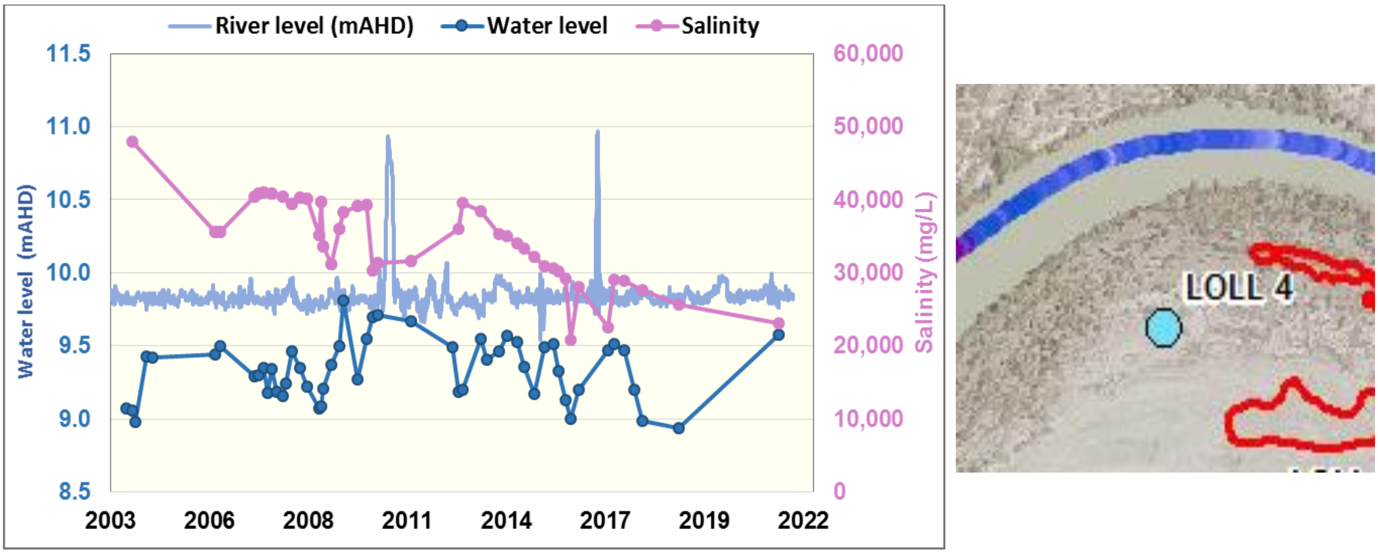


Figure 8. Water level and salinity trends for LOLL 4

Elsewhere on the floodplain, observation wells show generally stable trends for the high salinities which are generally over 30 000 mg/L (Figure 9).

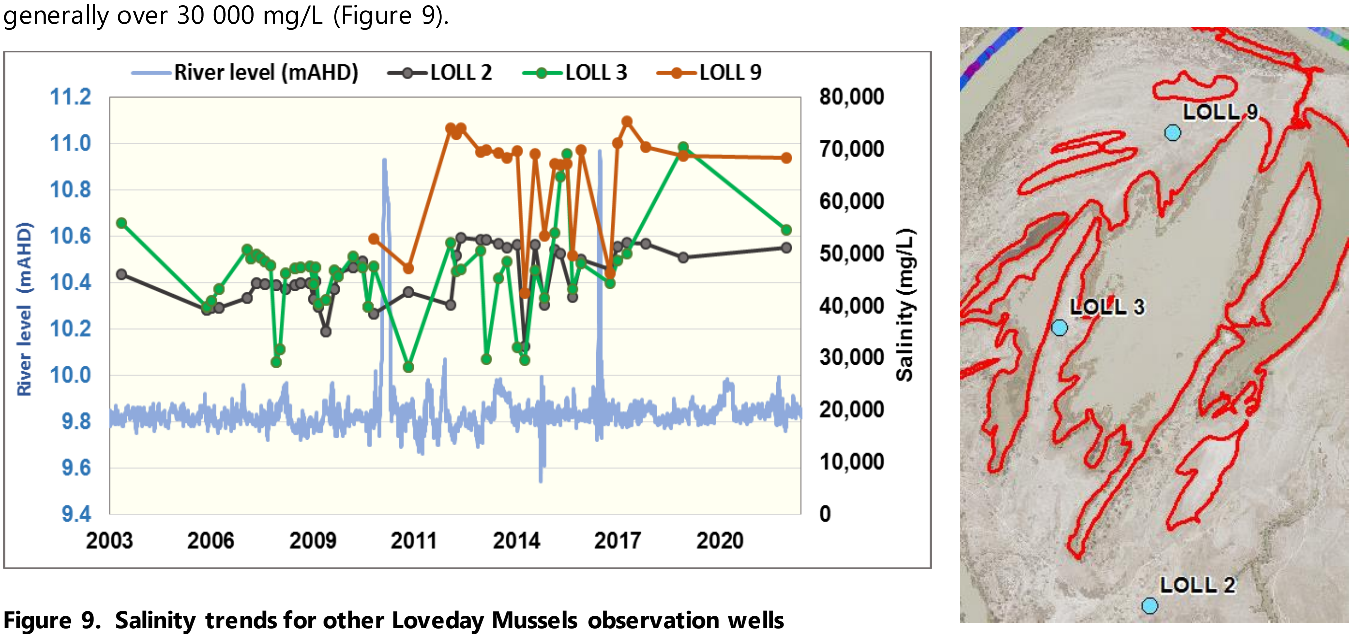


Figure 9. Salinity trends for other Loveday Mussels observation wells

The response of wells LOLL 3, 6 and 7 (which are located closest to the wetland) to wetland management can be seen in Figure 10. It shows drying of the wetland has a marked effect on groundwater levels but generally does not significantly increase salinity levels (with the exception of LOLL 3 during 2015). This is the case for the prolonged drying period during the millennium drought (2007 to 2009) which would normally be expected to present the highest risk of salinization of the wetland.

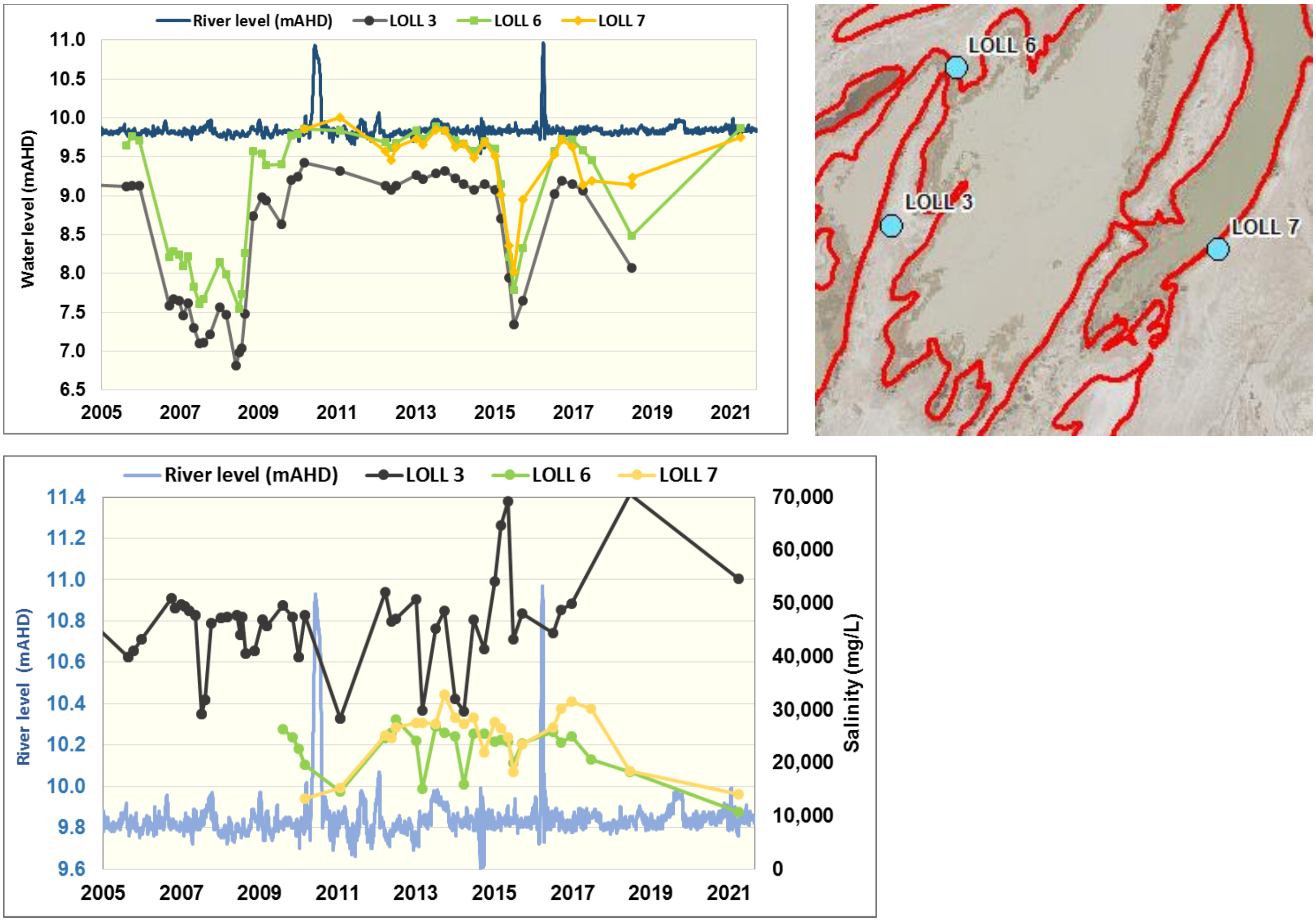
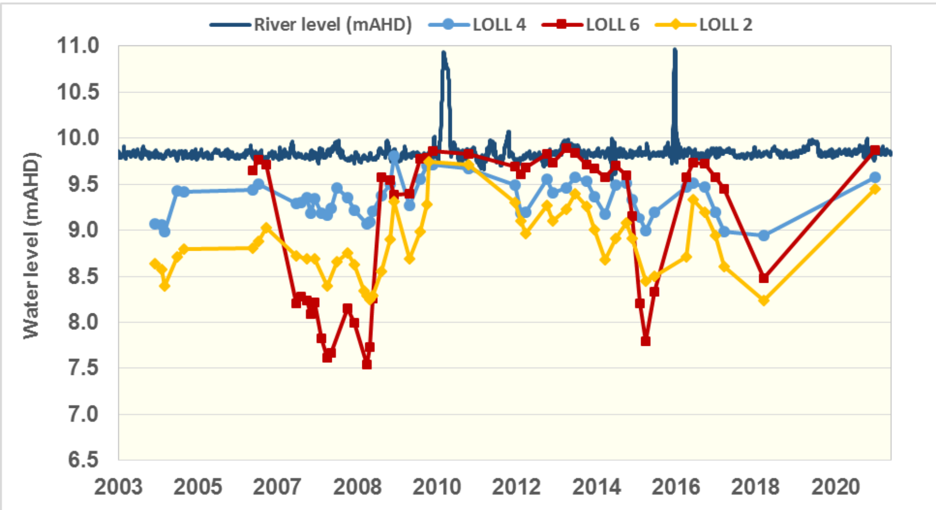


Figure 10. Groundwater level and salinity response to Loveday Mussels wetland drying

The water level data also reveals some information about the aquifer properties. The observation wells are completed in the Monoman Sands aquifer which is overlain by clays of the Coonambidgal Formation which are up to 3 m thick in this area and can sometimes confine or pressurise this sand aquifer. Figure 11 shows the response to drying events of wells LOLL 2 and 4 (which are located over 400 m from the wetland) occur at almost the same time as well LOLL 6 which is immediately adjacent to the wetland. This indicates a pressure response rather than a water level decline responding to the physical movement of water through the aquifer which would result in a much slower and smaller water level response.



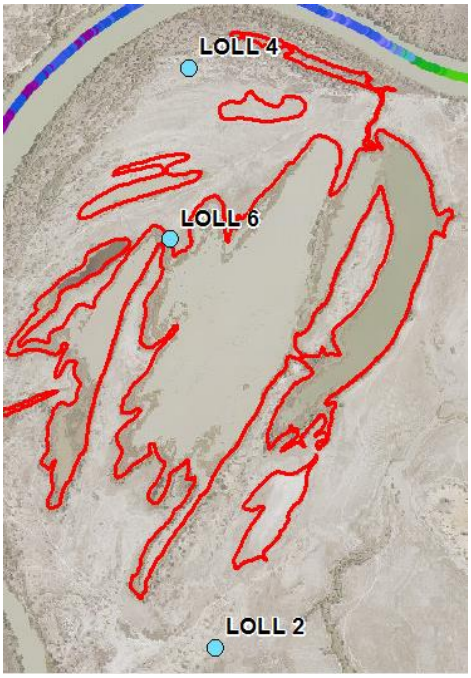


Figure 11. Pressure response of Monoman Sands aquifer

5.2 Monitoring recommendations

The only change recommended for the existing network is to delete LOLL 10 which is located very close to LOLL3 and duplicates trends observed in that well and has a shorter monitoring record.

Table 1. Monitoring recommendations for Loveday Mussels wetland

Existing bores to continue monitoring	New bores proposed	Existing bore upgrades	Low priority existing bores	Frequency of monitoring?
LOLL 1, 3, 5-8			LOLL 2, 4, 9, 10	Before start and at the end of management action, then monthly intervals thereafter.

5.3 Conceptual models

Figure 12 presents simplified conceptual models of groundwater flow processes before and during wetland management actions which are based on the analysis of monitoring trends. Areas of blue represent low salinity water while red areas represent saline groundwater. Evapotranspiration from the shallow watertable across the floodplain has lowered the watertable and led to water flowing out of the river and wetlands into the floodplain. During drying, there may be localised flow reversal toward the wetland.

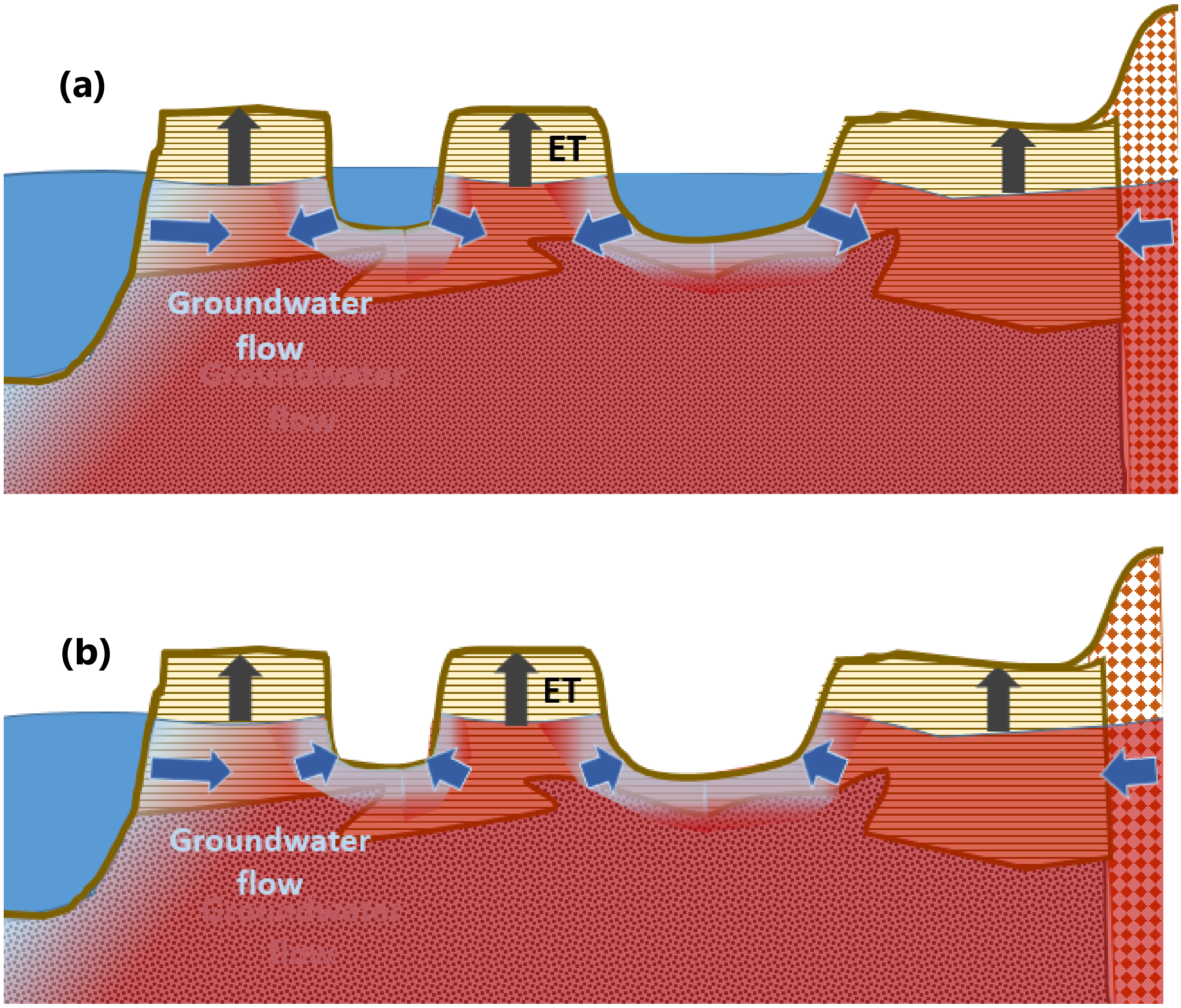


Figure 12. Conceptual models of (a) before and (b) during wetland management in Loveday Mussels wetland

5.2 Salinity risk

The dominant floodplain process of evaporative discharge from the shallow watertable has induced recharge or flow out of the river and permanent wetlands into the floodplain. This process is enhanced by high flows and weir pool raising events. The monitoring data suggests this outward flow is maintained during drying events. However, even if a flow reversal did occur during wetland drying, the water returned to the wetland would be low salinity water which had previously been recharged from the wetland under normal conditions. The salinity risk from weir pool manipulation for wetland salinization and increased river salt loads can therefore be considered low.

6 Beldora

The Beldora wetlands are adjacent to the River Murray, approximately 13 km southwest of Barmera and contain a number of permanent and semi-permanent wetlands covering an area of 133 ha. The complex can be classified as connected. Similar to the Loveday-Mussels complex, evapotranspiration from the shallow watertable across the floodplain has lowered the watertable and led to salinization of soils and high groundwater salinities. Regional groundwater flows into the floodplain from the northeast under low gradients. Groundwater monitoring has been carried out since 2004, with monitoring well locations shown in Figure 13.

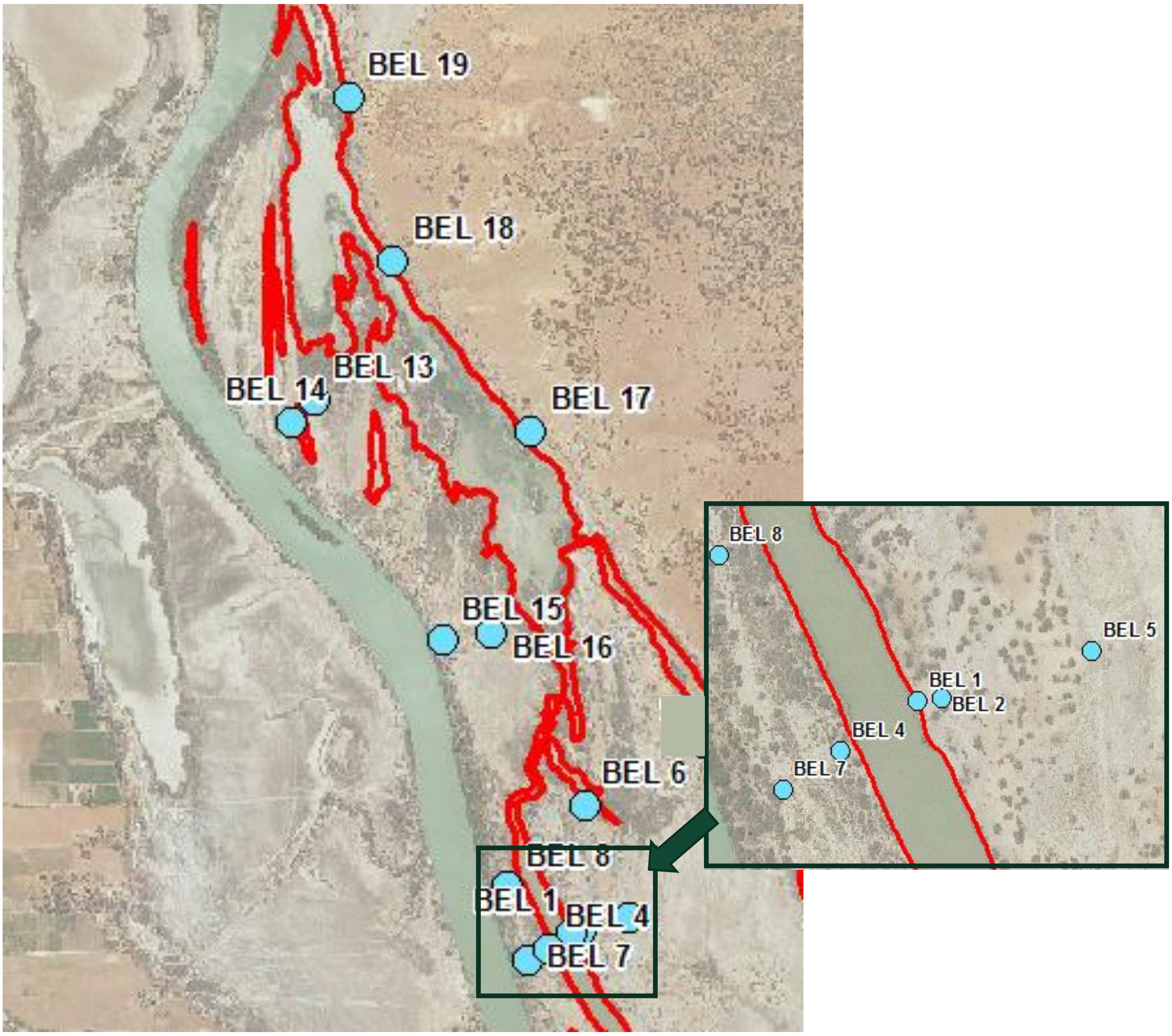


Figure 13. Location of Beldora wetland complex and monitoring wells

6.1 Monitoring data

The watertable elevation decreases with increasing distance from the river or permanent wetlands as shown in Figure 14, indicating that water flows out of the river and wetlands into the floodplain as a result of evaporative discharge. This outward flow seems to be maintained not only during high flows but also during drying events, however there may be very localised flow reversal toward the wetland in some areas.

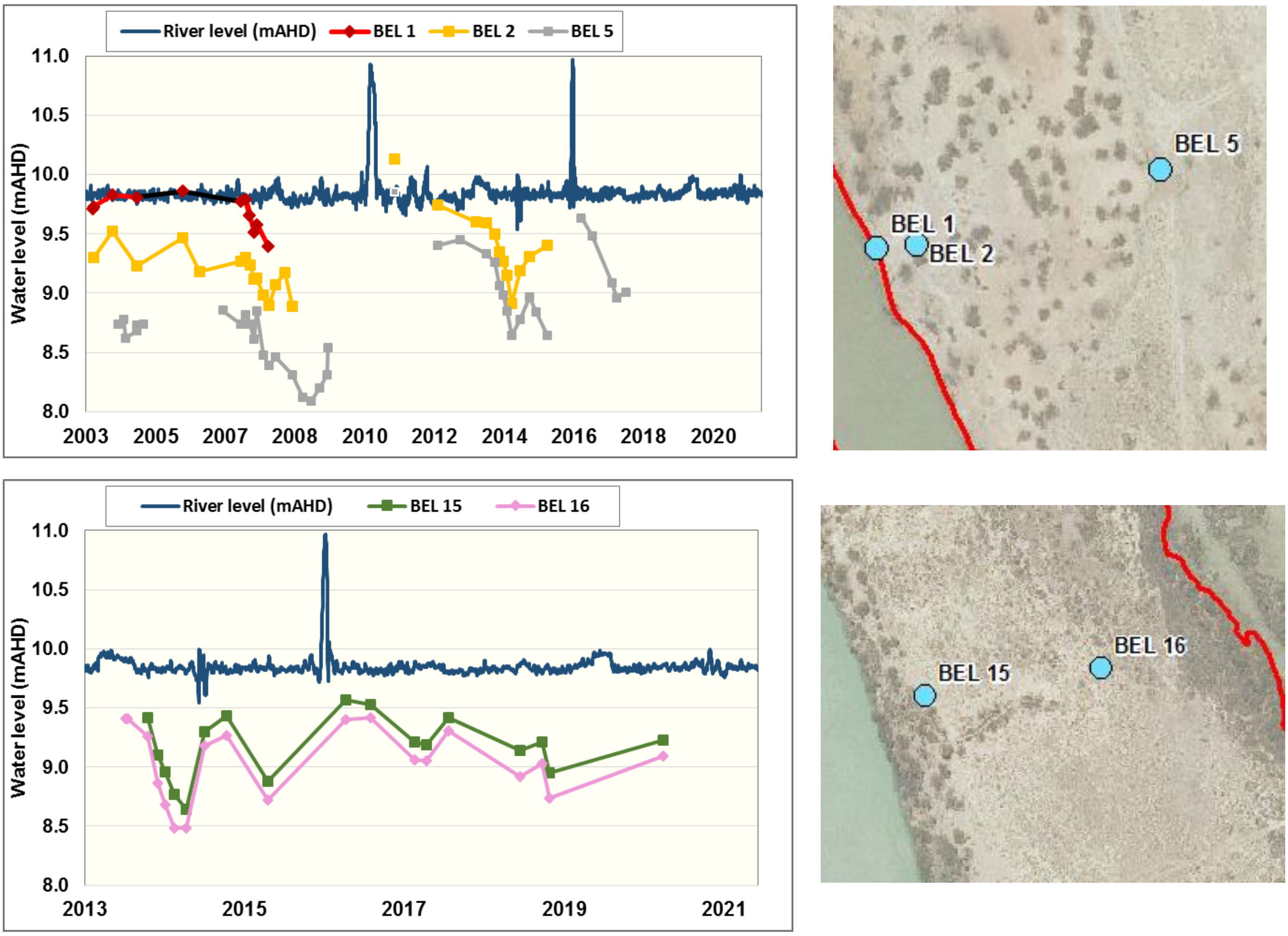


Figure 14. Hydrographs of observation wells near Beldora wetlands

The salinity trends of these same observation wells are presented in Figure 15 and show those wells closer to the wetland (BEL 1/1A and 15) have lower salinities than those further away over most of the monitoring period. This confirms that water flows out of the river and wetlands into the floodplain. Salinity results for BEL 5 show possible 'freshening' during the 2010 flood event due to the vertical infiltration of river water. However, this could also be the result of water percolating down the annulus between the casing and the side of the hole during inundation.

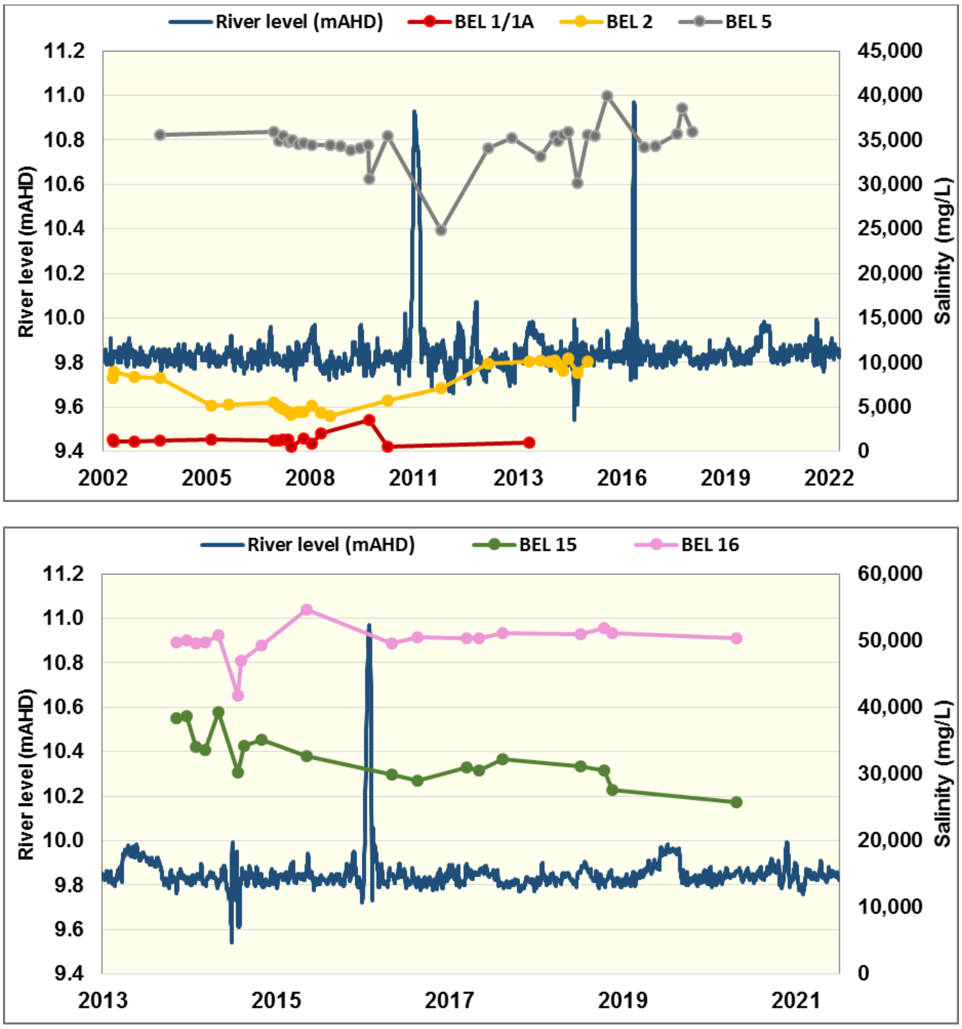


Figure 15. Salinity trends of observation wells near Beldora wetlands

The Beldora North wetland abuts the highland on the northeastern edge of the floodplain. There is therefore, a potential salinity risk resulting from lateral inflows of saline regional groundwater from the northeast in response to a weir pool lowering or drying of the wetland. However monitoring data suggests the regional flow gradient toward the river is quite low. Monitoring trends from wells BEL 17, 18 and 19 (Figure 16) along the wetland boundary indicate that evaporative discharge from the narrow strip of floodplain between the wetland and the highland is sufficient to lower the watertable below river level. This means that the narrow floodplain would intercept regional inflows even during drying events.

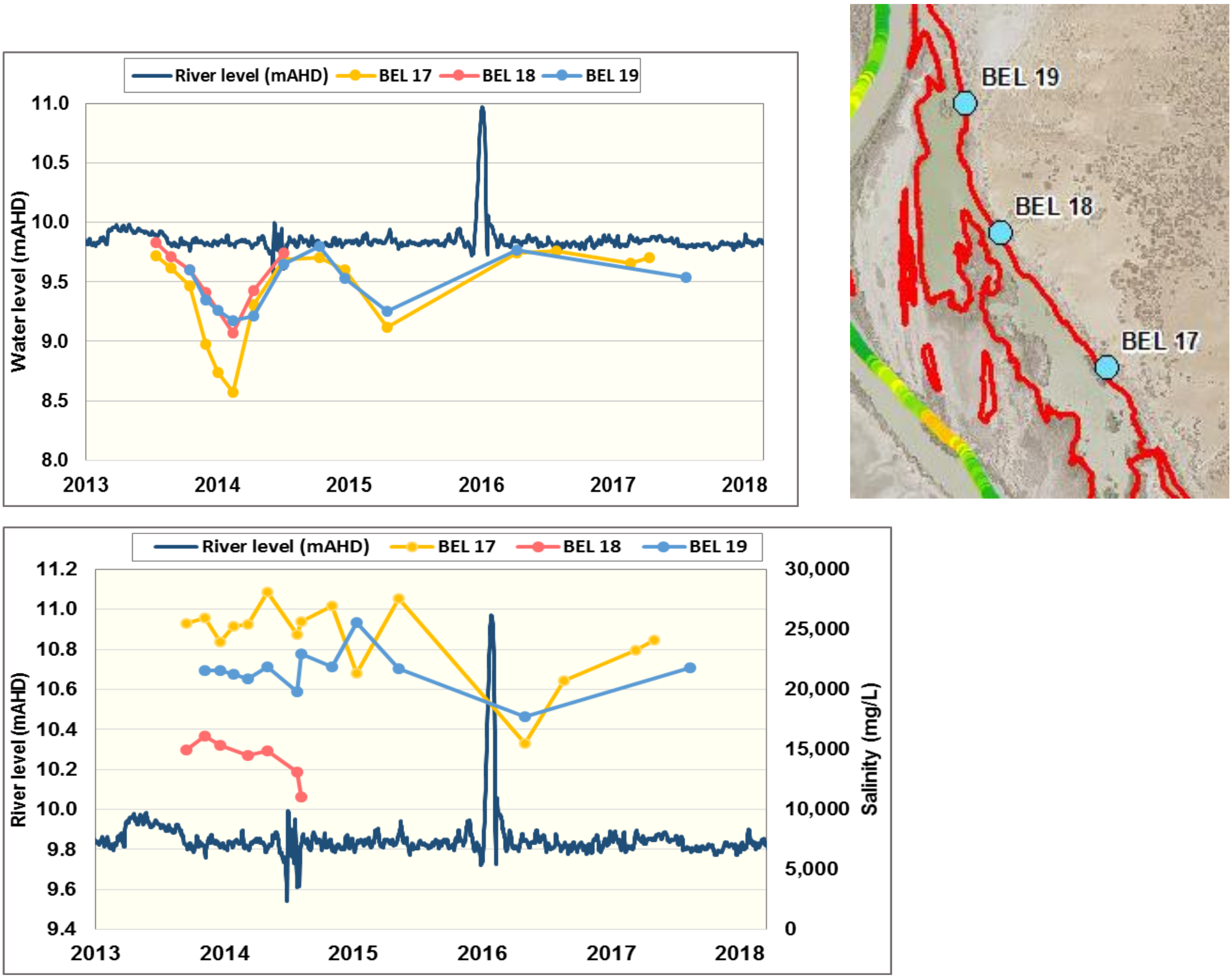


Figure 16. Water level and salinity trends of observation wells adjacent the highland

6.2 Monitoring recommendations

The existing wells in transects provide good information on groundwater processes, as do the wells along the highland margin to the east. In isolation, wells BEL 6 and 8 do not have a complete monitoring record and could be removed from the network. Wells BEL 1A and 2 appear to be no longer usable and have provided useful information in the past that confirms the permanent wetland conceptual model. Ideally, they should be replaced but it should not be considered a high priority.

Table 2. Monitoring recommendations for Beldora wetland

Existing bores to continue monitoring	New bores proposed	Existing bore upgrades	Low priority existing bores	Frequency of monitoring?
BEL 5, 7, 11-19		BEL 1 and 2 should be replaced, but with low priority	BEL 6, 8	Before start and at the end of management action, then monthly intervals thereafter.

6.3 Conceptual models

Simplified conceptual models of groundwater flow processes before and during wetland management actions are presented in Figure 17. Evapotranspiration from the shallow watertable across the floodplain has lowered the watertable and led to water flowing out of the river and wetlands into the floodplain. During drying, there may be very localised flow reversal toward the wetland.

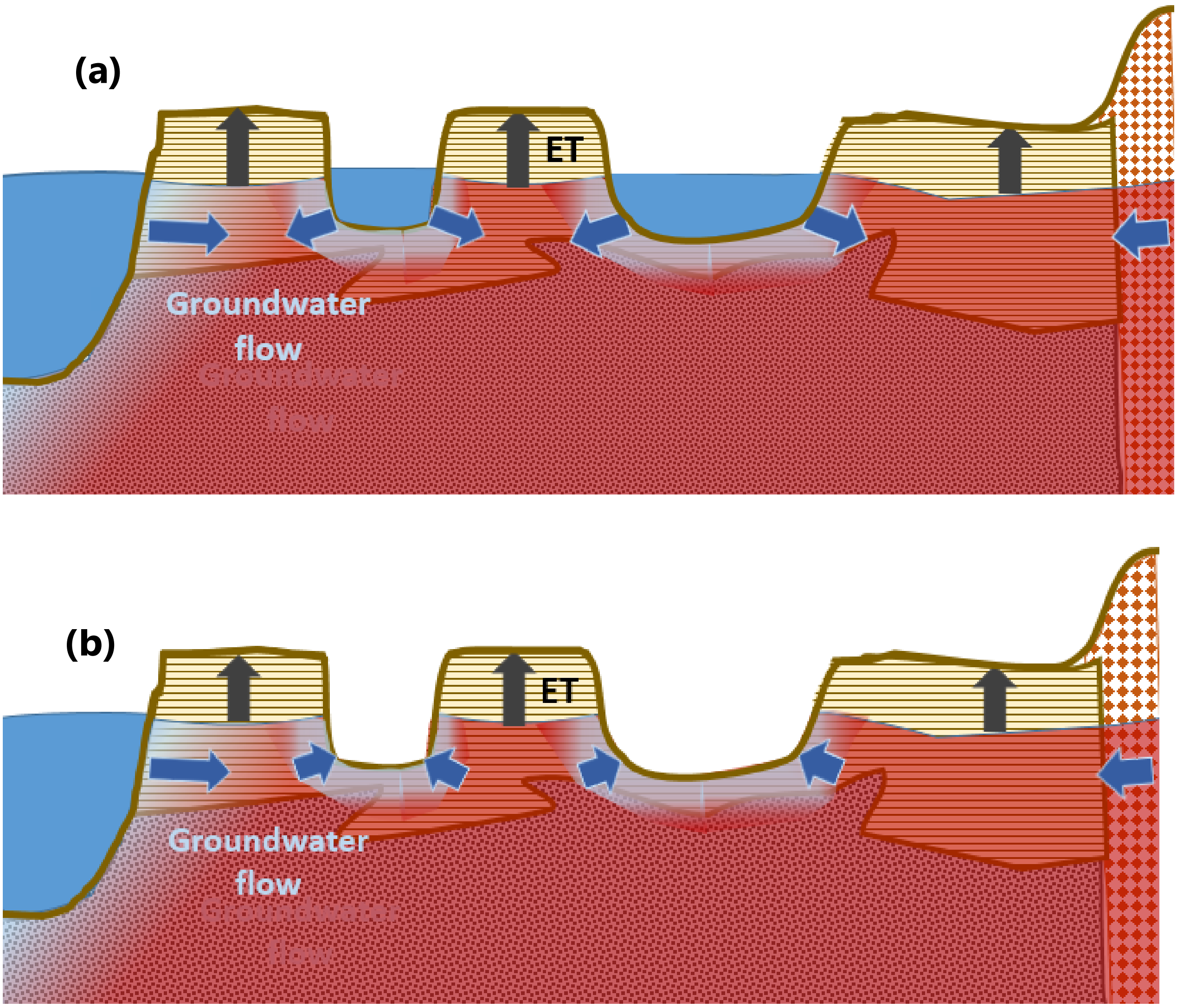


Figure 17. Conceptual models of (a) before and (b) during wetland management in Beldora wetland

6.2 Salinity risk

The dominant floodplain process of evaporative discharge from the shallow watertable has induced recharge or flow out of the river and permanent wetlands into the floodplain. This process is enhanced by high flows and weir pool raising events. The monitoring data suggests this outward flow is maintained during drying events. However, even if a flow reversal did occur during wetland drying, the water returned to the wetland would be low salinity water which had previously been recharged from the wetland under normal conditions. Regional inflows from the northeast are intercepted by the narrow floodplain. The salinity risk from weir pool manipulation for wetland salinization and increased river salt loads can therefore be considered low.

7 Spectacle Lakes

Spectacle Lakes has been identified as a wetland of national significance. The wetland complex covers about 137 ha and is normally dry and can be classified as perched. It overlies a shallow saline watertable at a depth of about 2 m. The floodplain experiences evaporative discharge from the shallow groundwater. Groundwater monitoring has been carried out since 2004 at sites adjacent to Spectacle Lakes creek, with monitoring well locations shown in Figure 18.

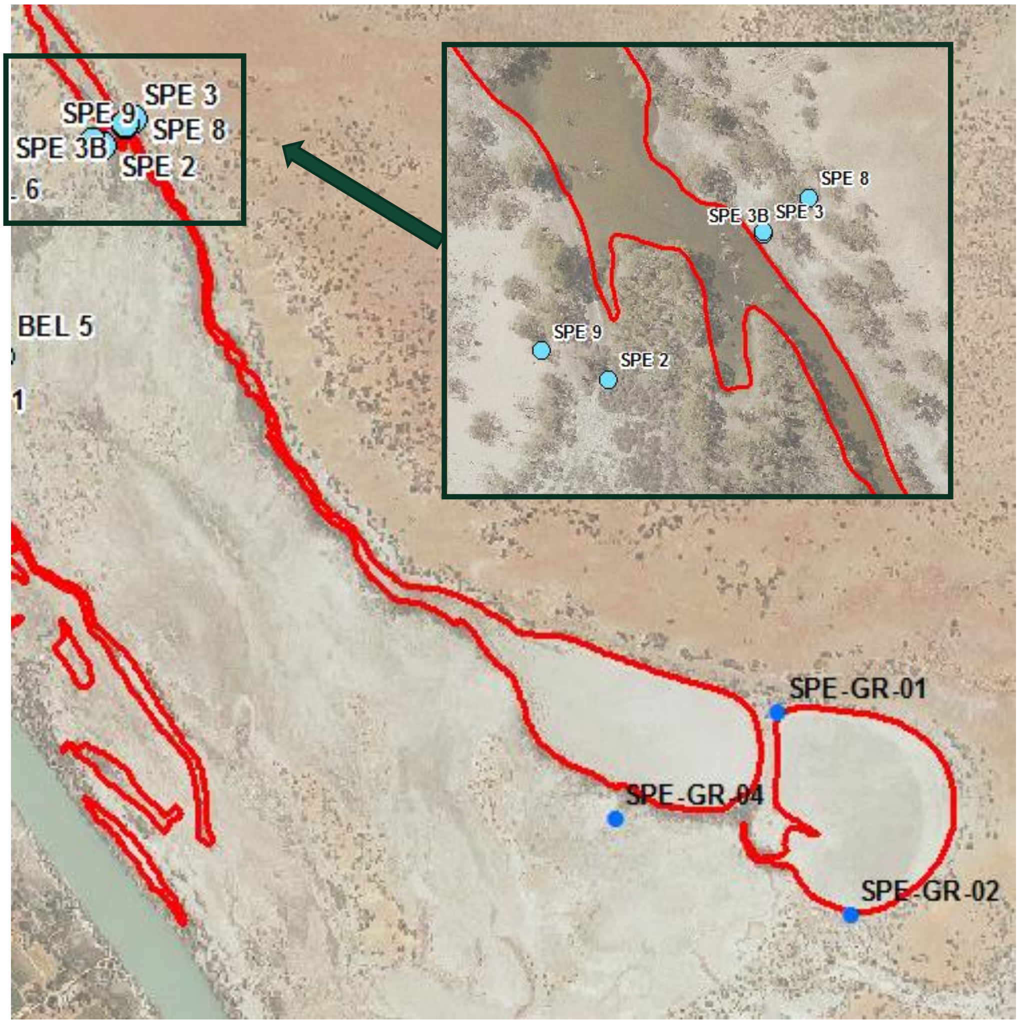


Figure 18. Location of Spectacle Lakes wetland complex and monitoring wells

7.1 Monitoring data

The monitoring data collected so far only covers the Spectacle Lakes creek which is permanently inundated. The surface water/groundwater interaction is similar to the Beldora wetland complex. The water levels show a gradient away from the creek in response to floodplain evaporative discharge as shown in Figure 19. This gradient is maintained during wetland drying apart from short periods of flow reversal. There appears to be a discrepancy in the reference level for well SPE 3B which results in possibly an error of about one metre in the levels shown in the hydrograph below when compared to the levels recorded in well SPE 3 at the same location. The anomalous levels for SPE 3 above river level in 2005 are most likely due to water levels being measured from ground level rather than the top of casing.

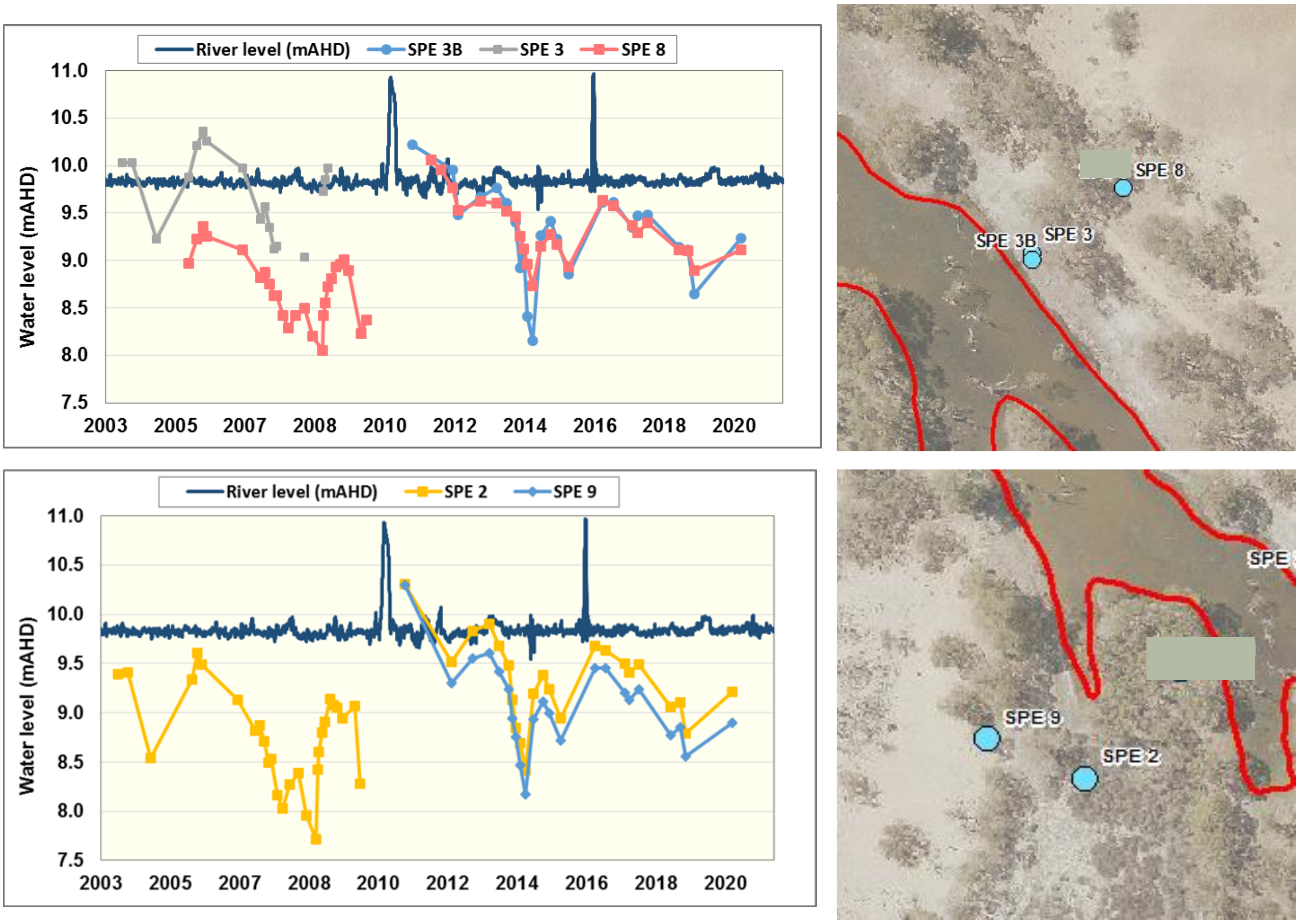


Figure 19. Hydrographs of observation wells near Spectacle Lakes creek

The salinity trends of these same observation wells are presented in Figure 20 and show those wells closer to the wetland (SPE 3/3B and 2) have lower salinities than those further away over most of the monitoring period. This confirms that water flows out of the creek into the floodplain. Salinity results for SPE 2 and SPE 3/3B show an increase in salinity during drought-induced drying of the creek during 2007-09. This increase was too rapid to have been caused by evaporative discharge and is most likely caused by lateral flow toward the creek of more saline groundwater normally located further away. Possible 'freshening' during the 2010 flood event due to the vertical infiltration of river water can be seen. However, this could also be the result of water percolating down the annulus between the casing and the side of the hole during inundation.

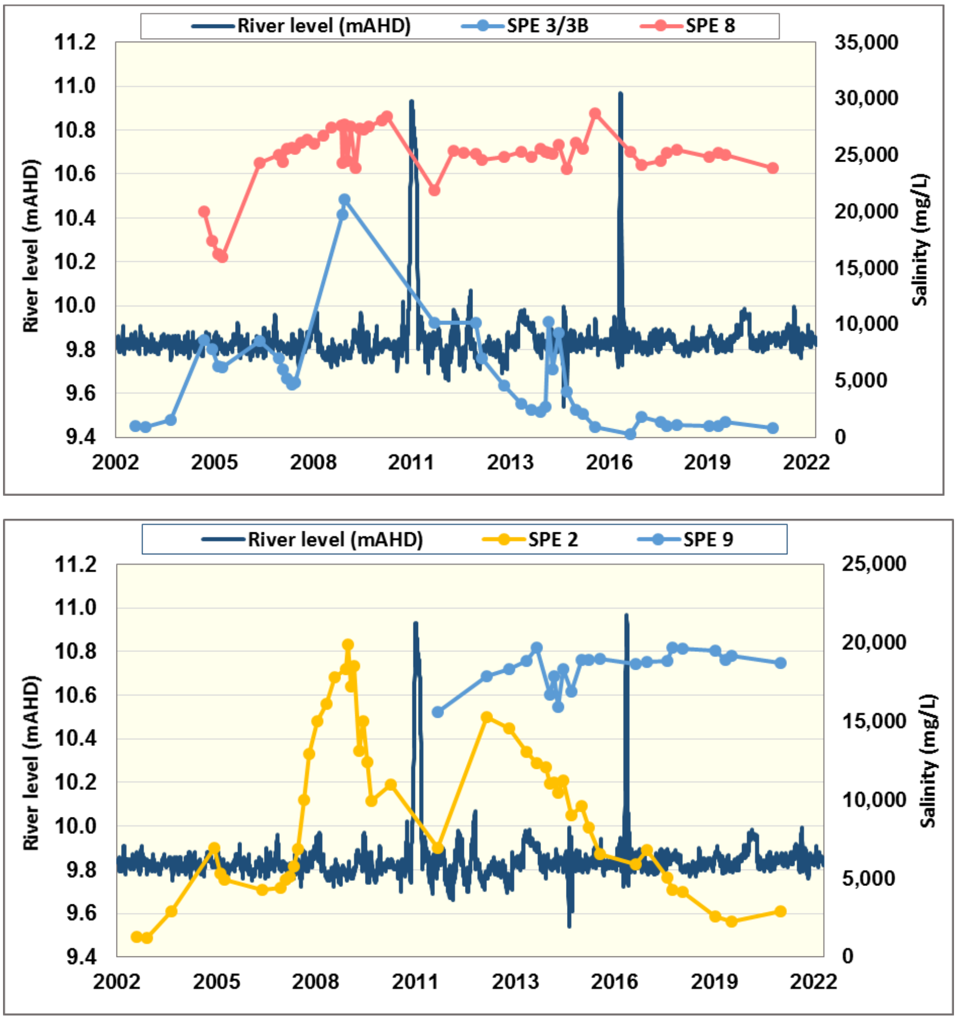


Figure 20. Salinity trends of observation wells near Spectacle Lakes creek

7.2 Monitoring recommendations

The wells adjacent to the creek are providing useful information. However there is no current monitoring at Spectacle Lakes. Three wells drilled in 2005 located around the lakes (SPR-GR-01, 02 and 04) should be included in the network for on-going monitoring, together with well MOO 2002 if it is still exists (Figure 21). In addition, a new well in the centre of each 'lake' should be constructed to measure the groundwater response to inundation.

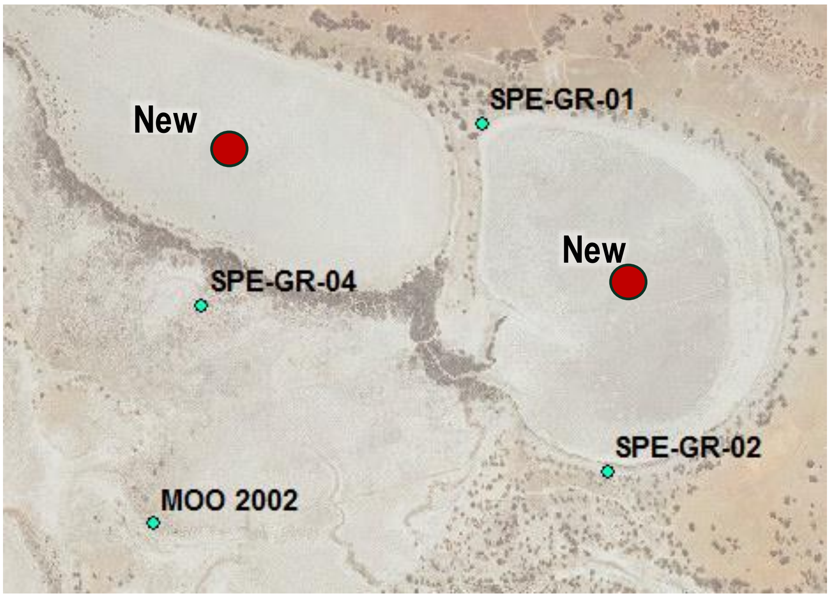


Figure 21. Location of new observation wells at Spectacle Lakes

Table 3. Monitoring recommendations for Spectacle Lakes wetland

Existing bores to continue monitoring	New bores proposed	Existing bore upgrades	Low priority existing bores	Frequency of monitoring?
SPE 2, 3B, 8, 9	SPEGR 01, 02, 04 2 new wells to be drilled in lake beds			Before start and at the end of management action, then monthly intervals thereafter.

7.3 Conceptual models

Simplified conceptual models of groundwater flow processes before and during wetland management actions are presented in Figure 22 for Spectacle Lakes (the models for Spectacle Lakes creek would be very similar to Beldora wetlands). Evapotranspiration from the shallow watertable across the floodplain has lowered the watertable and led to water flowing out of the river into the floodplain. Inundation of this normally dry perched wetland located some distance from the river would result in local watertable mounding.

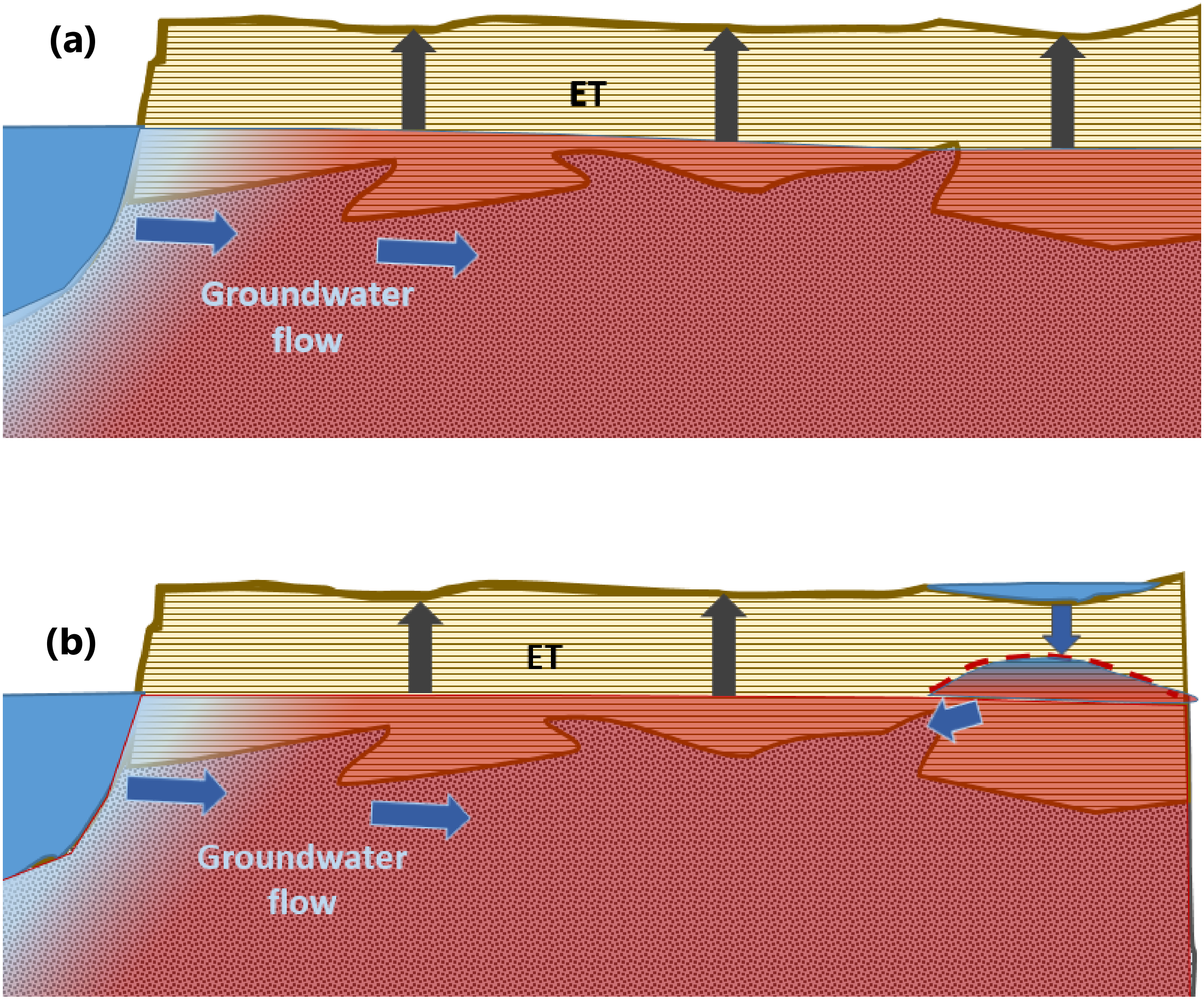


Figure 22. Conceptual models of (a) before and (b) during wetland management in Spectacle Lakes wetland

7.2 Salinity risk - Spectacle Lakes creek

The dominant floodplain process of evaporative discharge from the shallow watertable has induced recharge or flow out of the river and permanent wetlands into the floodplain. This process is enhanced by high flows and weir pool raising events. The monitoring data suggests that short periods of flow reversal are observed during drying events. The water returned to the wetland would be low salinity water which had previously been recharged from the wetland under normal conditions. The salinity risk from weir pool manipulation can therefore be considered low.

7.4 Salinity risk - Spectacle Lakes

Inundation of this normally dry perched wetland located some distance from the river presents a low risk for wetland salinization and increased river salt loads because the evaporative discharge from the floodplain would negate the impacts of any watertable mounding.

8 Gerard

The Gerard wetland complex covers an area of about 33 ha of temporary perched wetlands (Figure 23). Putjeda Creek is now disconnected from the River Murray and appears to intersect saline floodplain groundwater which forms a semi-permanent pool. There has been no groundwater monitoring carried out at this site.

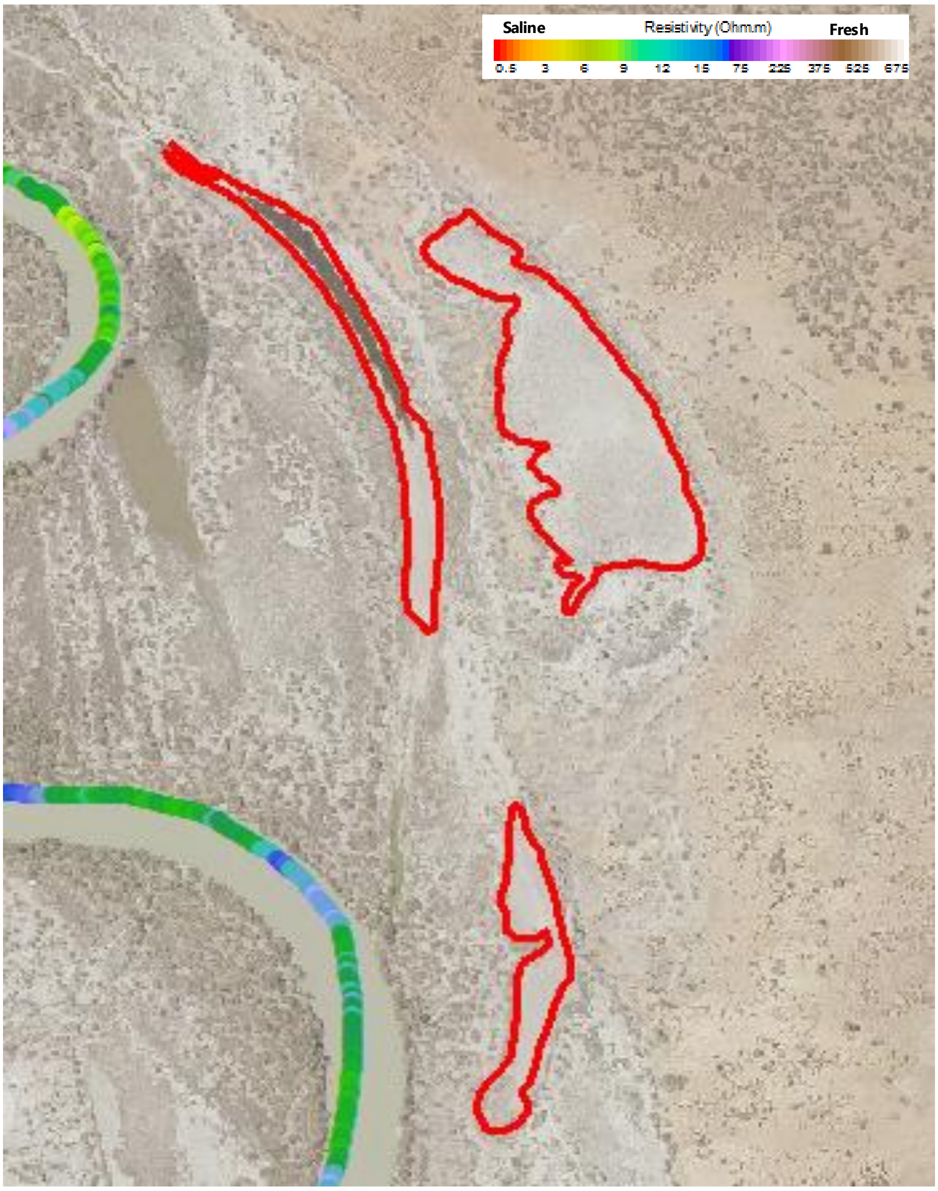


Figure 23. Location of Gerard wetland complex and monitoring wells

The groundwater conditions and floodplain processes are likely to be very similar to those at the Overland Corner wetland complex. The in-stream NanoTem and healthy riverbank vegetation suggest the river is losing water to the floodplain.

8.1 Monitoring recommendations

A new well in the centre of the wetland should be constructed to measure the groundwater response to inundation in addition to another well immediately to the west of the area of inundation to measure the extent of any watertable mounding caused by infiltration of surface water (Figure 24). Existing well LOX2011 should also be monitored if it is usable.

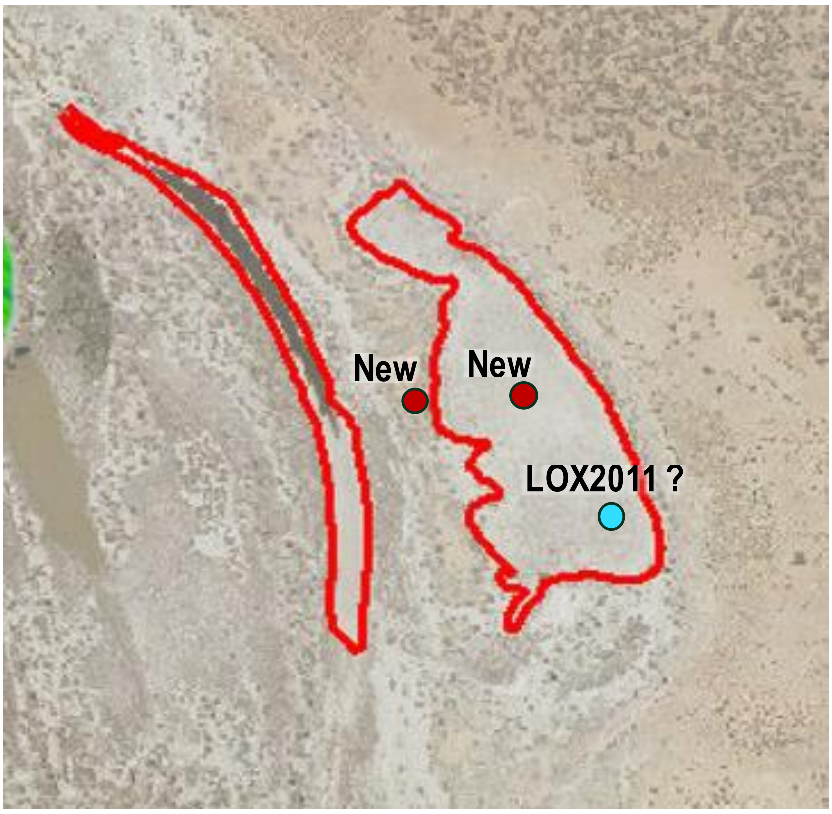


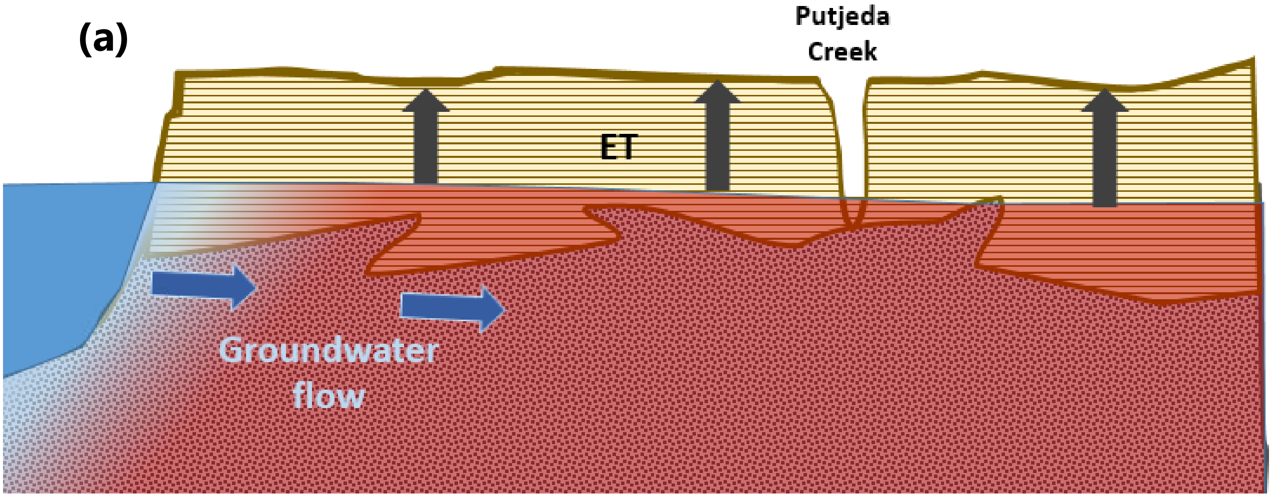
Figure 24. Location of new observation wells at Gerard

Table 4. Monitoring recommendations for Gerard wetland

Existing bores to continue monitoring	New bores proposed	Existing bore upgrades	Low priority existing bores	Frequency of monitoring?
LOX 2011 ?	2 new wells to be drilled in lake bed and immediately to the west			Before start and at the end of management action, then monthly intervals thereafter.

8.2 Conceptual models

Simplified conceptual models of groundwater flow processes before and during wetland management actions are presented in Figure 25 for Gerard wetland. Evapotranspiration from the shallow watertable across the floodplain has lowered the watertable and led to water flowing out of the river into the floodplain. Inundation of this normally dry perched wetland located some distance from the river would result in local watertable mounding.



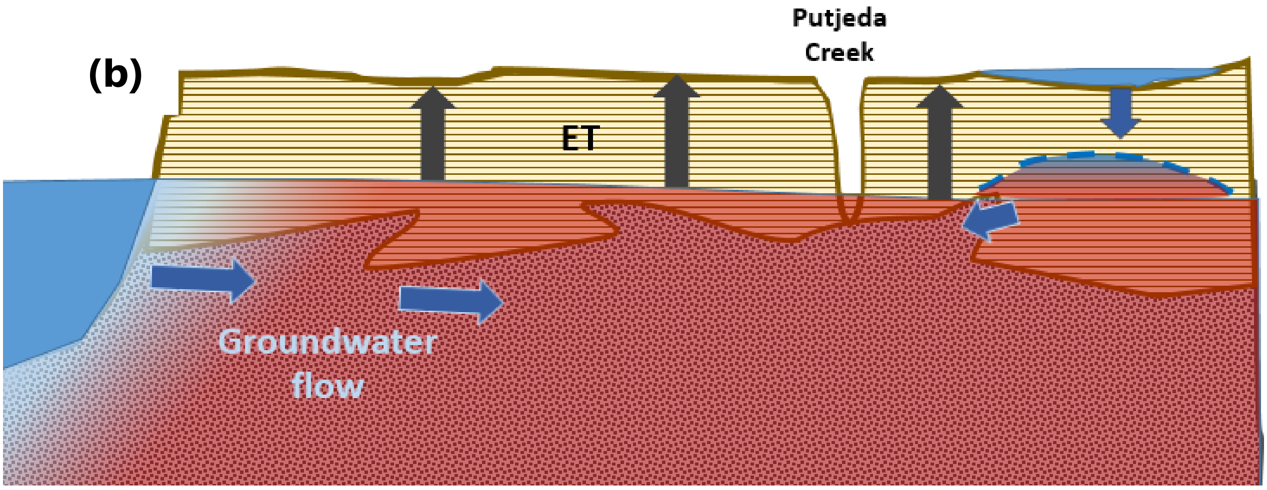


Figure 25. Conceptual models of (a) before and (b) during wetland management in Gerard wetland

8.3 Salinity risk

Inundation of this normally dry perched wetland located some distance from the river presents a low risk for wetland salinization and increased river salt loads because the evaporative discharge from the floodplain would negate any watertable mounding. Putjeda Creek intercepts the watertable and will intercept any flows toward the river caused by watertable mounding beneath the wetland. It may contribute a slug of saline water to the river during initial flows through it.

9 Overland Corner

Located immediately downstream of Lock 3, the wetland complex is normally dry and overlies a shallow saline watertable at a depth of about 2 m. The temporary wetlands cover an area of 78 ha. The floodplain experiences evaporative discharge from the shallow groundwater. Regional groundwater flows into the floodplain from the north and east under low gradients, with irrigation on the adjacent highland possibly augmenting these inflows. The complex can be classified as perched. Groundwater monitoring has been carried out since 2004, with monitoring well locations shown in Figure 26.

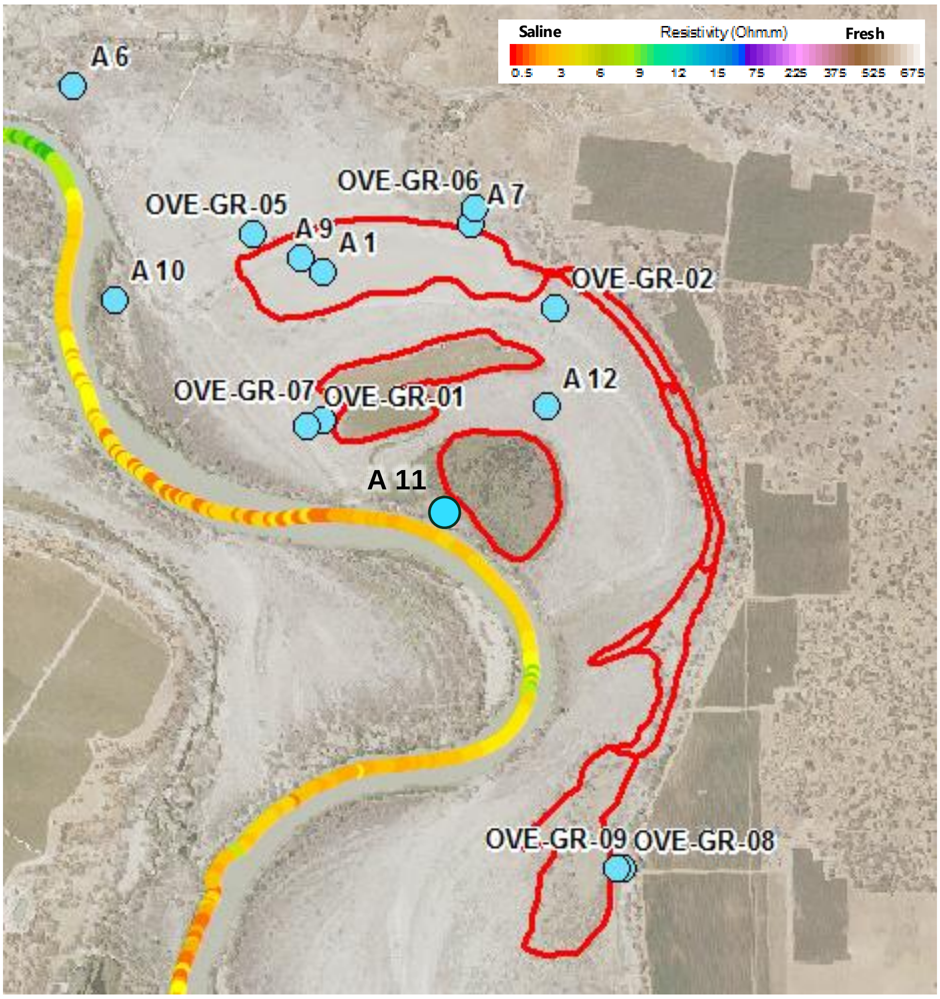


Figure 26. Location of Overland Corner wetland complex and monitoring wells

9.1 Monitoring data

The evaporative discharge has also lowered the watertable beneath the floodplain below river level. Figure 27 shows that during normal pool levels between floods and pumping projects, a slight gradient existed away from the river with A10 close to the river, having a higher water level than A9 in the centre of a dry wetland.

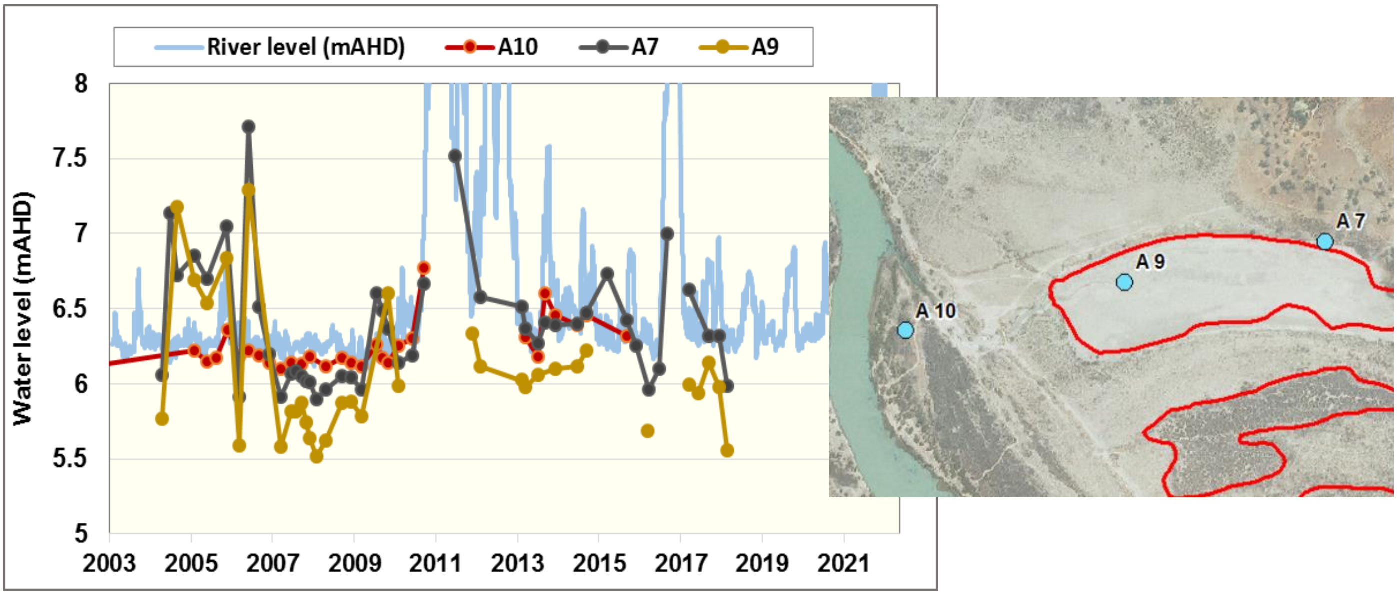


Figure 27. Hydrographs of selected Overland Corner observation wells

The evaporative discharge has generally increased floodplain groundwater salinities to levels above the regional groundwater, especially in the lowest points where discharge would be greatest (wells A1, A11, OVEGR01, OVEGR07).

Figure 28 shows a groundwater level response to the pumping projects carried out in 2004 and 2006, as well as flooding events. Groundwater salinities also show signs of 'freshening' during these events due to the vertical infiltration of fresh water as shown in Figure 22. However, salinity values for wells A12 and OVEGR01 remain quite high and are generally stable at normal pool levels. Well A1 shows the greatest reduction because it is located in the centre of a wetland. Depending on the construction of this well, some of the very low salinity values recorded may be the result of water percolating down the annulus between the casing and the side of the hole during inundation.

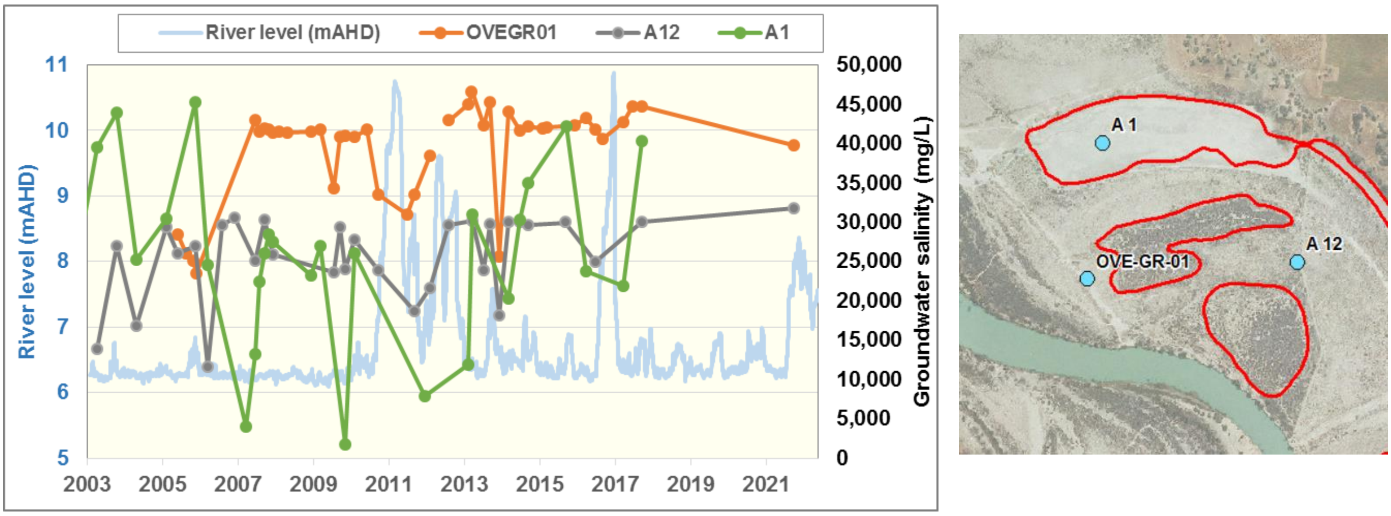


Figure 28. Salinity trends in Overland Corner observation wells

9.2 Monitoring recommendations

The existing network is providing useful information. The construction of wells A1 and A9 (which are often inundated) should be checked and upgraded if necessary to prevent ingress of surface water adjacent to the well casing. The use of data loggers to record water levels for these wells during inundation is recommended and the feasibility should be investigated. Monitoring of well A11 (water level and salinity) is important to observe impacts of inundating the wetland close to the river.

If inundation of the northern extent of the wetland complex (Option 2) is contemplated, the inclusion of additional existing monitoring wells (drilled for previous SIS investigations) is recommended. These wells (Figure 29) have an advantage in that some are completed in the shallow Coonambidgal Formation (A6, OCF1, OCF3) and others completed in the deeper Monoman Formation (OBSWELL1, 2, 3 and 5) which may determine if there are different responses to inundation in the different aquifers.

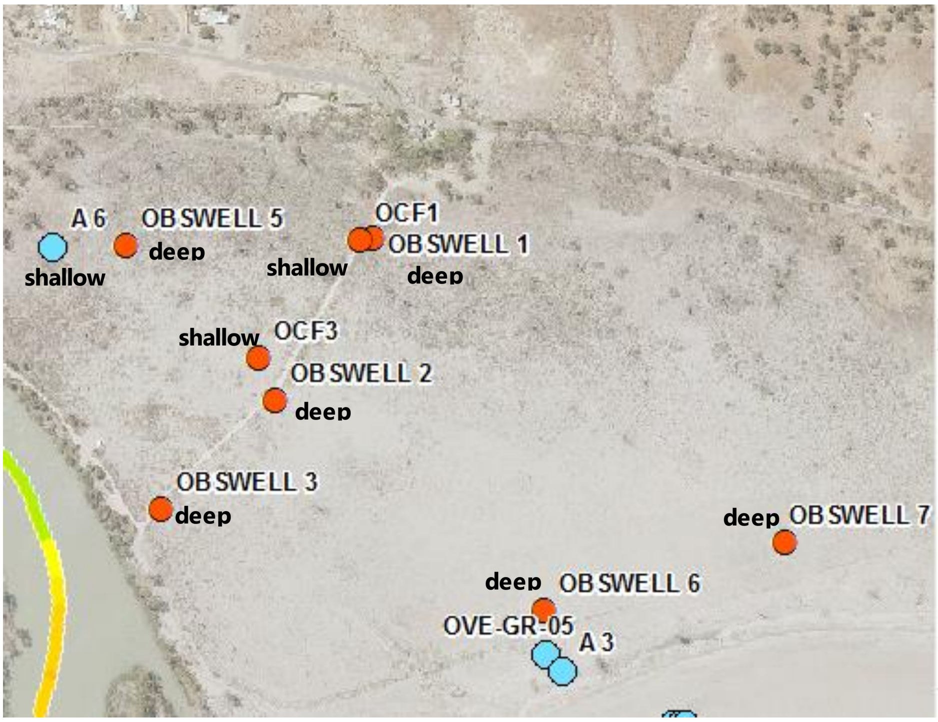


Figure 29. Location of new observation wells at Overland Corner

Table 5. Monitoring recommendations for the Overland Corner wetland

Existing bores to continue monitoring	New bores proposed	Existing bore upgrades	Low priority existing bores	Frequency of monitoring?
A1, A3, A6, A9, A11, A12 OVEGR 01, 02, 03, 04, 05, 06, 07,	OBSWELL 1, 2, 3, 5, 6, 7 OCF 1, 3	A1, A9 Construction to be checked to prevent leakage down the casing	OVEGR 08, 09	Before start and at the end of management action, then monthly intervals thereafter.

9.3 Conceptual models

The conceptual model below depicts the groundwater processes derived from the observed monitoring trends.

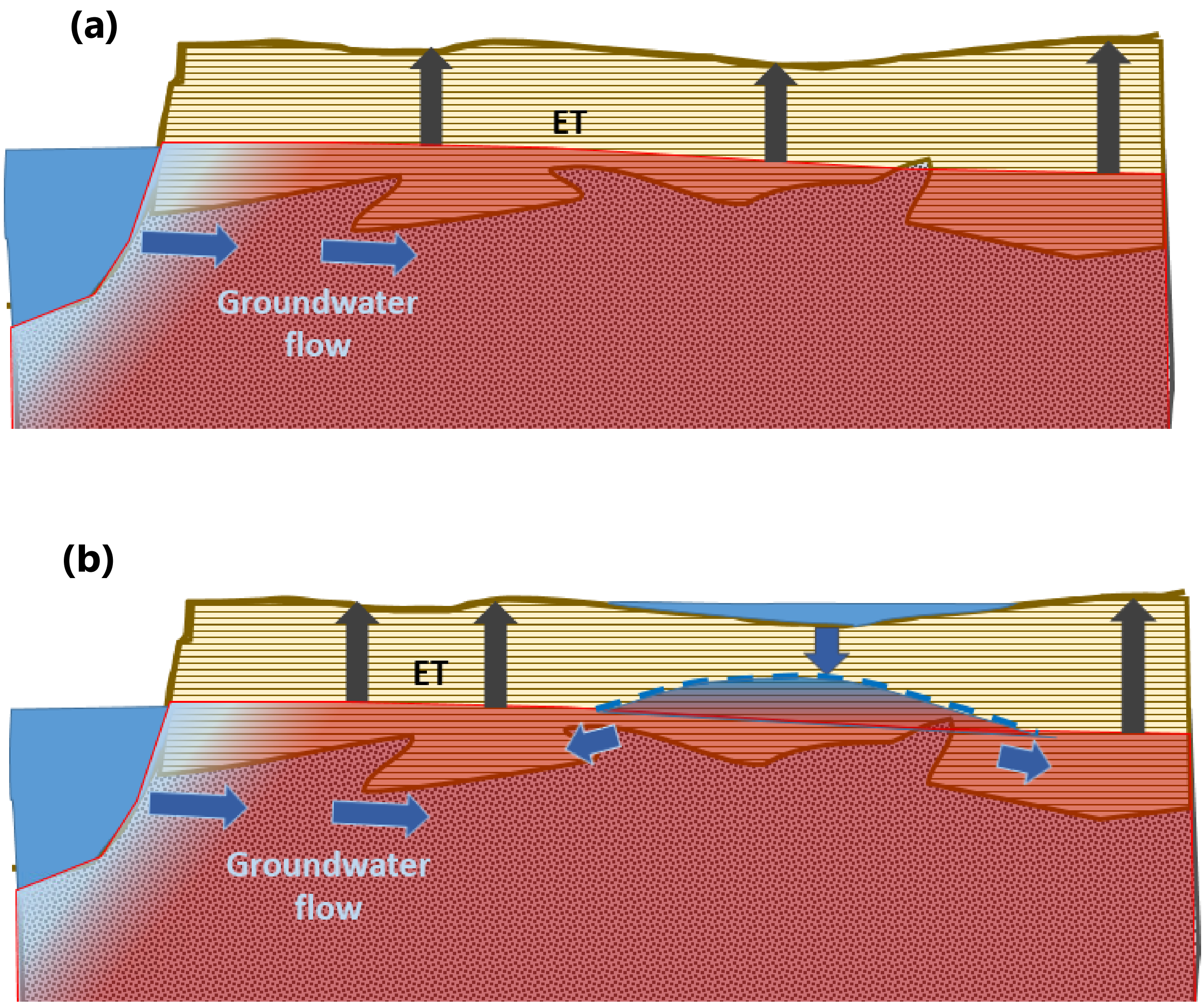


Figure 30. Conceptual models of (a) before and (b) during wetland management in Overland Corner wetland

9.4 Salinity risk

Inundation of this normally dry perched wetland located some distance from the river presents a low salinity risk because the evaporative discharge from the floodplain would negate any watertable mounding. The impacts of inundating the wetland located adjacent to the river should be monitored carefully using well A11.

10 New well construction

It is recommended that new wells be drilled to a depth of at least 2 m below the current watertable level. The slotted interval should extend above the current watertable level to ensure salinity samples are representative of the top of the aquifer. It is also recommended that the slotted interval be covered with geofabric to prevent the ingress of very fine material which could block the well. A cement seal at the ground surface is required to prevent ingress of surface water for those wells that would be inundated by flooding.

11 Salinity risk summary

Despite a transition in a typical reach upstream of a lock from connected losing wetlands (Loveday Mussels, Bedora, Spectacle Lakes creek) to disconnected perched wetlands (Spectacle Lakes, Gerard, Overland Corner), the risk of wetland salinization and increased salt loads to the river from wetland management practices in all sites has been assessed as being low based on the available monitoring data. This is mainly because the dominant floodplain process of evaporative discharge from the shallow watertable has induced recharge or flow out of the river and permanent wetlands into the floodplain.

For connected permanent wetlands, this process is enhanced by high flows and weir pool raising events. The monitoring data suggests this outward flow is maintained during drying events. This may be due to the monitored water level changes being a pressure response due to the confinement of the Monoman Sands aquifer by the Coonambidgal Formation clays. However, even if a flow reversal did occur during wetland drying, the water returned to the wetland would be low salinity water which had previously been recharged from the wetland under normal conditions.

Inundation of normally dry perched wetlands may present a salinity risk to the river if they are in close proximity, and if watertable mounding occurs which could create a gradient toward the river resulting in groundwater discharge. All of the selected perched wetlands (Spectacle Lakes, Gerard and Overland Corner) are located some distance from the river and the evaporative discharge from the floodplain would negate this risk. The exception is one wetland at Overland Corner which is immediately adjacent to the river which should be monitored during inundation events.

This technical note presents the salinity risk from groundwater processes resulting from management of environmental water through weir pool manipulation which attempts to reproduce natural processes that would have been occurring for hundreds of years before weirs were constructed. The impacts of previous naturally occurring events (e.g. wetland drying during the millennium drought, natural flood events) as well as historical weir pool raising and lowering events, should be examined for their impacts on wetland health and river salinity which could help inform an assessment of likely impacts associated with future manipulation events.

12 Conclusions

Prior to European settlement, the hydrogeological processes beneath the floodplain were quite dynamic in response to the highly variable surface water flows within the River Murray watercourse. Following river regulation through locking, a new steady state hydrogeological equilibrium was established, with evapotranspiration from the shallow watertable becoming the dominant discharge mechanism. This process has salinized low lying areas, increased the salinity of floodplain groundwater and lowered its elevation. This lowering of the watertable has induced lateral flow from the river and permanent wetlands into the floodplain which is most pronounced in the reaches upstream of locks.

Monitoring of floodplain groundwater levels and salinity have shown that inundation due to natural flooding and wetland management through drying provide only a short term perturbation to the steady state equilibrium whilst providing well documented environmental benefits. The monitoring has increased the understanding of groundwater flow processes and recorded a consistent groundwater response to repeated management cycles. As discussed on page 16, the detection of a pressure response in the Monoman Sands aquifer indicates that the monitoring of water level changes in any observation well does not mean that groundwater is moving to or from that well. Changes in groundwater salinity are a more accurate indicator of actual groundwater movement through the floodplain.

More importantly, the monitoring data strongly indicates that the salinity risk due to management of the selected wetlands between Locks 3 and 4 is low. The drilling of new observation wells is proposed to improve local groundwater data at sites which are poorly characterised, and recommendations are made for improving on-going monitoring.

13 References

Barnett, S.R., 2013. Riverine Recovery Project. Wetlands Project Element 1C Baseline Surveys - Desktop Groundwater Assessment. Internal report.

Crosbie, R.S., Jolly, I.D., McEwan, K.L., Holland, K.L., 2008. The Characterisation of the Hydrology and Salinity Regimes of the Wetlands of the Lower River Murray, Australia. CSIRO Land and Water. Unpublished paper.

Department for Water, 2012. Riverine Recovery. Groundwater Salinity Risk Assessment. Technical Note.

DEW (2021). *Border to Lock 3 groundwater model: Environmental management operations, Volume 1: Report*, DEW Technical report (in prep), Government of South Australia, Department for Environment and Water.

Jolly, I.D., Crosbie, R.S., McEwan, K.L., Holland, K.L., Lamontagne, S., Moe, K. and Simmons, C., 2008. Project 054121: Surface Water – Groundwater Interactions in River Murray Wetlands and Implications for Water Quality and Ecology. Final Report to the Centre for Natural Resource Management. CSIRO: Water for a Healthy Country National Research Flagship.

Telfer, A.L., Palfreyman, C.J., Berens, V. & Hatch, M.A., 2005, Atlas of Instream NanoTEM 2004. AWE report 42417a, prepared for Murray Darling Basin Commission and Mallee Catchment Management Authority.

Twidale, C.R., Lindsay, J.M. and Bourne, J.A., 1978. Age and origin of the Murray River and gorge in South Australia. Royal Society of Victoria. Proceedings, 90(1):27-42.

14 Appendix A

Observation well	**Reason not used**
LLOL 9, 10	Water level and salinity trends identical to nearby wells
BEL 4, 7	Water level and salinity trends identical to nearby wells
BEL 3, 6, 8,	Inadequate monitoring record
BEL 11- 14	Same trend as BEL15 and 16 but fewer records
OVE-GR-05, 06, A1	Inadequate monitoring record, water levels identical to adjacent wells
OVE-GR-08, 09	Short monitoring record, located 1 km from main wetlands
A8, 12	Very short monitoring record, A12 not surveyed
A6	Located 800 m from nearest wetland
OVE-GR-01, 02, 07	Water level and salinity trends identical to nearby wells
OVE-GR-03, 04	Inadequate monitoring record, about 1 km from main wetlands