Boundary Creek, Big Swamp and surrounding environment

Remediation and Environmental Protection Plan

Annual Report 2020-2021

Executive summary

The Boundary Creek, Big Swamp and surrounding environment Remediation and Environmental Protection Plan (REPP) was submitted by Barwon Water in December 2019 and accepted by Southern Rural Water in late February 2020.

This Annual Report presents a summary of the work completed by Barwon Water for the REPP during the 2020-2021 year. It also includes the quarterly update for quarter 1 of the 2021/22 financial year which covers the period 1 July to 30 September 2021.

This Annual Report is the second for implementation of the REPP and includes information on:

- Implementation progress and upcoming actions
- Community engagement
- Progress against success targets

The Annual Report also provides a summary of the data captured this year which has informed relevant technical studies and detailed design work. Key data summarised includes:

- Boundary Creek and Big Swamp groundwater levels, surface water flows and water quality.
- Groundwater levels and recovery trends in the Lower Tertiary Aquifer (LTA)
- Water quality and macroinvertebrate sampling for Boundary Creek and the Barwon River.

Key outcomes from the work completed and data gathered in 2020/21 include:

- A continuing recovery trend of groundwater levels in the LTA.
- Groundwater levels through Big Swamp tended to be higher during the 2020/21 monitoring period compared to the 2019/20 period, particularly during summer. This can be attributed to a wetter summer and targeted release of supplementary flows to help keep Big Swamp wet.
- An increase in the pH of the surface water discharging from Big Swamp was also observed during the 2020/21 monitoring period compared to the 2019/20 period, however a corresponding decline in the concentrations and loads of acidity discharging from Big Swamp was not evident. This indicates a shift in the form of acidity rather than a net reduction in the discharge of acidity and coincides with a decline in aluminium concentrations and an increase in iron (II) concentrations. This indicates that the maintenance of flows and increased groundwater levels in Big Swamp has resulted in enhanced iron reduction, a pH increase and a reduction in aluminium solubility. This is consistent with the laboratory results from the soil incubation tests undertaken by Monash University in 2019 which helped inform development of the remediation plan.
- Despite the increase in pH, appropriate treatment of acidity within Big Swamp may still be required to reduce the acidity loads entering Boundary Creek and the timeframes for remediation. This therefore warrants further investigation as has been proposed in the action plan.

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1.0 Introduction

In June 2017, Barwon Water acknowledged that historic management of groundwater pumping had an environmentally significant impact in the Boundary Creek catchment. Reductions in flows caused by groundwater extraction coupled with a drier climate and supplementary flows not reaching the intended area, all contributed to the drying out of Big Swamp. This resulted in the activation of acid sulfate soils and ongoing release of acidic water to the lower reach of Boundary Creek.

In May 2018, Barwon Water established a community and stakeholder working group to participate in the design of a remediation plan for Boundary Creek and Big Swamp. As part of this process, Barwon Water invited the working group to nominate their own technical experts to help support them in their discussions to shape the remediation plan.

In September 2018 Barwon Water's commitment to undertake remedial works was legally strengthened through the issuing of a Ministerial Notice under section 78 of the Water Act, 1989. This notice mandated the development and implementation of the Boundary Creek, Big Swamp and surrounding environment – Remediation and Environmental Protection Plan (REPP) by 1 March 2020.

The section 78 notice defined remediation to be the controls and actions that could be practicably carried out to achieve improved environmental outcomes. In order to align this with an accepted scientific definition for remediation, the REPP further expanded the definition to be "the controls and actions that could be practicably carried out to improve the ecological condition and function of areas confirmed to have been impacted by historical management of groundwater pumping at Barwon Downs, noting that this is likely to be different to the original condition due to the extent of change since European settlement."

In February 2020, Southern Rural Water (SRW) accepted Barwon Water's REPP, which will be delivered under two parallel work packages:

- The Boundary Creek and Big Swamp Remediation Plan to address remediation of confirmed impact in the Boundary Creek catchment resulting from historical management of groundwater extraction.
- The Surrounding Environment Investigation to investigate whether other areas within the regional groundwater system have been impacted by historical management of groundwater extraction.

A key requirement of the section 78 notice and the REPP is the provision of quarterly updates to Southern Rural Water to report on progress with implementation of the plan, as well as an Annual Report. The section 78 notice also stipulates that the Annual Report is required to be submitted to Southern Rural Water and made publicly available by 30 September each year. The annual reports capture progress with implementation of the REPP for the preceeding financial year, an annual work plan for the next 12 months, and a quarterly update for the first quarter of the new financial year.

The 2020-2021 Annual Report is the second Annual Report issued in accordance with the REPP since it was accepted in February, 2020. This annual report outlines progress with implementation of the REPP during the period 1 July 2020 to 30 June 2021, with progress presented in a similar format to that of the quarterly updates. It also provides additional detail on the monitoring and data collected during 2020/21 and tracking against the REPP success targets. The Annual Report also provides an outline of upcoming tasks for implementation for the next 12 months. This constitutes the annual work plan that will form the basis for tracking progress of implementation of the REPP in future quarterly updates.

This Annual Report also includes the quarterly update for the Q1 2021/22 period (i.e. 1 July to 30 September 2021), with Table 1 and Table 5 highlighting the actions completed during Q1 2021/22 for the Boundary Creek & Big Swamp Remediation Plan and the Surrounding Environment Investigation respectively.

2.0 Implementation of the REPP

2.1 Remediation of Boundary Creek and Big Swamp

The REPP included the overview and timelines for remediation depicted in Figure 1. Barwon Water has continued to implement the REPP in accordance with these timelines, completing collection of a full seasonal data set and updating the groundwater-surface water and geochemical models to inform detailed design for the remediation of Boundary Creek and Big Swamp. The detailed design of the hydraulic barriers has also been completed along with design of a downstream contingency measure to be implemented if required. This work forms the basis of key milestone submissions required to be completed by 1 July 2021 and 31 July 2021 respectively.

A list of the specific actions that have been undertaken during 2020/21 is provided in Table 1.

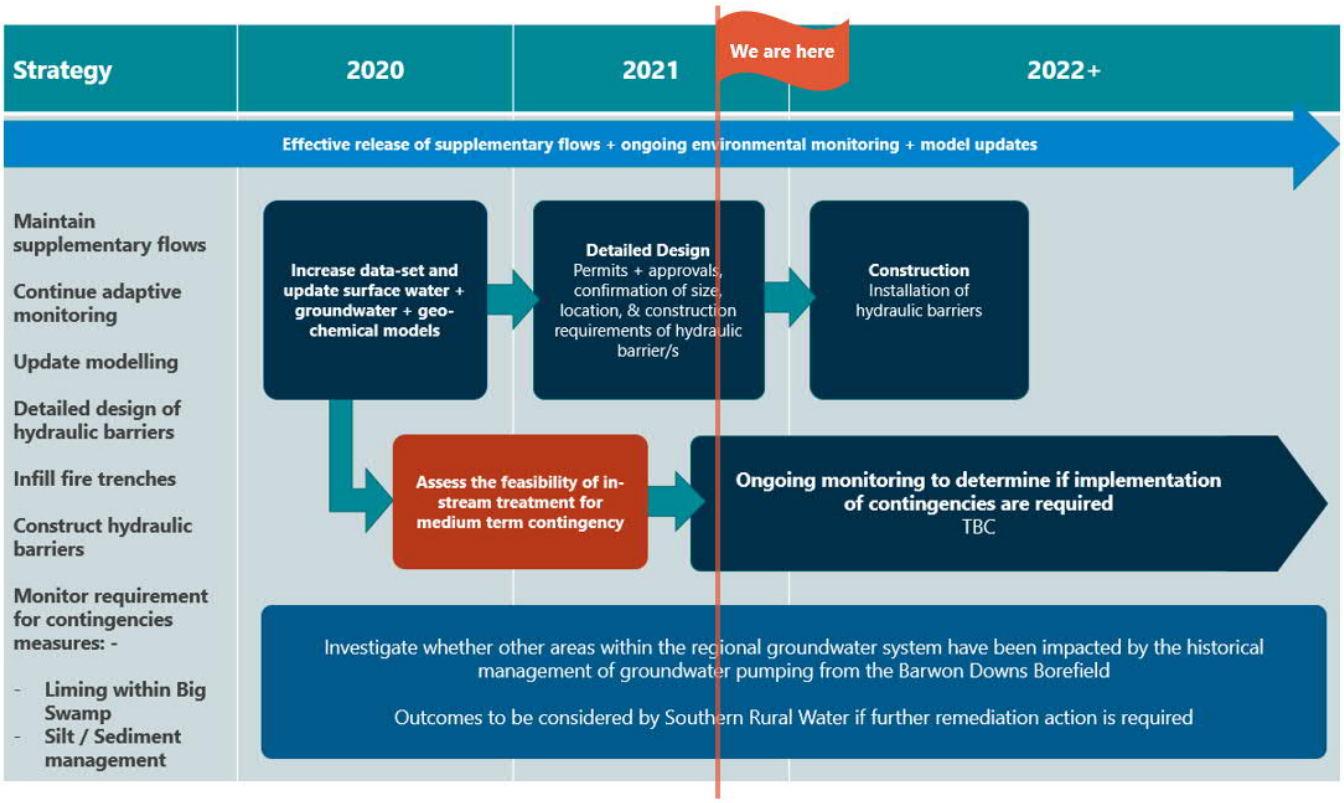


Figure 1: Timeframes for implementation of the REPP

2.1.1 Implementation actions completed during 2020/21 for the Boundary Creek and Big Swamp Remediation Plan

Table 1: Completed actions for Implementation of the Boundary Creek and Big Swamp Remediation Plan during 2020/21

Completed actions - Remediation of Boundary Creek and Big Swamp	Comment / Link
Q1 2020/21 (1 July – 30 September 2020)	
Submission of proposed REPP amendments addressing agreed actions in the REPP feedback work plan for Southern Rural Water consideration	
Governance framework submitted to and accepted by Southern Rural Water, 31 July 2020	
Groundwater and surface water modelling contract awarded to GHD	
Preliminary assessment of data undertaken to help inform scoping of further technical work required and for inclusion in Annual Report	
Submission of Annual Report to Southern Rural Water and report made publicly available, 30 September 2020	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Quarterly update for period 1 July to 30 September (Q1 2020/21) provided as a component of the Annual Report	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Q2 2020/21 (1 October – 31 December 2020)	
Completion of the updated Groundwater-Surface Water modelling for Boundary Creek and Big Swamp. Feedback sought from Southern Rual Water ITRP.	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Confirmed constructability of additional Lower Tertiary Aquifer (LTA) bore within Big Swamp to further assist with determining interaction between the LTA and the swamp at the western end of Big Swamp	
Hydrogeochemical modelling work scoped and a Request for Quote (RFQ) released	
Completion of the Spring macro-invertebrates survey of the Barwon River and Boundary Creek	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Established vegetation baseline monitoring for Boundary Creek and Big Swamp Remediation Plan to allow assessement of changes in vegetation and tracking against vegetation targets	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Remediation Reference Group meeting held on 2 December 2020	
Submitted the quarterly update for the period 1 October to 31 December 2020 to Southern Rural Water and published to web page	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Q3 2020/21 (1 January – 31 March 2021)	
Feedback received from the ITRP on the Groundwater-Surface Water modelling was incorporated into the final modelling report	

Commenced working through and responding to feedback received from Southern Rural Water and the Independent Technical Review Panel (ITRP) on the proposed REPP Ammendments to address Southern Rural Water's original feedback on the REPP Discussions held with Southern Rural Water & ITRP to clarify some feedback and esure it could be addressed appropriately	
Commenced update of hydrogeochemical modelling, including development of requirements for contingency measures for active treatment of acidity loads leaving Big Swamp.	
Commenced design of the hydraulic barriers and contingency measures for active treatment of acidity loads leaving Big Swamp.	
Commenced review and development of success targets for remediation of Boundary Creek & Big Swamp, including possible groundwater recovery targets for the Lower Tertiary Aquifer.	
Remediation Reference Group meeting held on 17 March 2021	
Submitted quarterly update for the period 1 January to 31 March 2021 to Southern Rural Water and published to the web page	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Q4 2020/21 (1 April – 30 June 2021)	
Groundwater-Surface Water modelling report for Boundary Creek and Big Swamp finalised and published to the web page.	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Continued to work through and respond to feedback received from Southern Rural Water and the ITRP on the proposed REPP Ammendments in accordance with the feedback work plan. Discussions held with Southern Rural Water and ITRP to clarify some of the feedback provided and ensure it could be addressed appropriately.	
Completed construction of an additional monitoring bore within Big Swamp to assist with determining interaction between the Lower Tertiary Aquifer (LTA) and Big Swamp at the west end of the swamp.	
Continued development and update of hydrogeochemical modelling, including development of requirements for active treatment contingency measures for management of acidity loads.	
Completed autumn macro-invertebrate and water quality sampling in the Barwon River and Boundary Creek.	
Continued design of the hydraulic barriers and contingency measures for active treatment of acidity loads.	
Continued review and development of success targets for remediation of Boundary Creek and Big Swamp, including possible groundwater recovery targets for the Lower Tertiary Aquifer.	
Remediation Reference Group meeting held 23 June 2021	
Submitted quarterly update for the period 1 April to 30 June 2021 to Southern Rural Water and published to the web page.	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek

2.1.2 Quarterly update for the period 1 July to 30 September 2021 for the Boundary Creek and Big Swamp Remediation Plan

Table 2: Quarterly update - Q1 2021/22 (1 July – 30 September 2021) – Boundary Creek and Big Swamp Remediation Plan

Q1 2021/22 Update (1 July – 30 September 2021)	Comment / Link
Completed detailed design of the hydraulic barriers, submitted to Southern Rural Water on 1 July 2021, and published to the web page	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Completed the review and development of success targets for remediation of Boundary Creek and Big Swamp, including possible groundwater recovery targets for the Lower Tertiary Aquifer. This was submitted to Southern Rural Water on 1 July 2021 as part of the hydraulic barrier detailed design and published to the web page.	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Completed the hydrogeochemical analysis and modelling and assessment of contingency measures for active treatment of acidity loads	
Completion of detailed design of active treatment contingency measure for management of acidity loads. This was submitted to Southern Rural Water on 31 July 2021 and published to the web page.	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Attended and presented at the Southern Rural Water Community Leaders Group meeting on 17 August 2021	
Continued finalisation of the first round of proposed REPP amendments to address Southern Rural Water REPP feedback in accordance with the accepted feedback work plan	
Remediation Reference Group meeting held 8 September 2021	
Submitted the 2020/2021 Boundary Creek, Big Swamp and surrounding environment REPP Annual Report to Southern Rural Water and published to web page	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek

2.1.3 Upcoming implementation actions and milestones for the period 1 October 2021 to 30 September 2022 for the Boundary Creek and Big Swamp Remediation Plan (Annual Work Plan)

Table 3: Upcoming actions for the Boundary Creek and Big Swamp Remediation Plan for the period 1 October 2021 to 30 September 2022

Upcoming tasks – Remediation of Boundary Creek and Big Swamp	Due (if applicable)
Q2 2021/22 (1 October – 31 December 2021)	
Undertake desktop investigation of upstream treatment method for reducing acidity loads within Big Swamp and develop laboratory and field testing plan Feedback will be sought from Southern Rural Water and the ITRP	TBC
Finalise remaining REPP amendments to address Southern Rural Water feedback.	TBC
Undertake spring macro-invertebrate and water quality sampling in the Barwon River and Boundary Creek.	October 2021

Q2 Remediation Reference Group meeting	December 2021
Submit quarterly update for the period 1 October to 31 December 2021 to Southern Rural Water and publish to web page	31/12/2021
Q3 2021/22 (1 January – 31 March 2022)	
Finalise upstream treatment field test plan and commence implementation if determined to be feasible and likely to deliver improved environmental outcomes. Subject to approval by Southern Rural Water	January 2022
Complete field testing of the upstream treatment trial	March 2022
Q3 Remediation Reference Group meeting	March 2022
Submit quarterly update to Southern Rural Water for the period 1 January to 30 March 2022 and publish to web page	31/03/2022
Q4 2021/22 (1 April – 30 June 2022)	
Undertake autumn macro-invertebrate and water quality sampling in the Barwon River and Boundary Creek.	April 2022
Assess outcomes from field testing of the upstream treatment method if the test proceeds Feedback will be sought from the ITRP	
Depending on the outcomes from the field testing of the upstream treatment method (if it proceeds), commence approvals process for implementing relevant remediation actions that are confirmed to be required (i.e. upstream treatment, hydraulic barriers, downstream treatment)	
Q4 Remediation Reference Group meeting	June 2022
Submit quarterly update to Southern Rural Water for the period 1 April to 30 June, 2022 and publish to web page	30/06/2022
Q1 2021/22 (1 July – 30 September 2022)	
Continue approvals process for implementing relevant remediation actions that have been confirmed to be required (i.e. upstream treatment, hydraulic barriers, downstream treatment)	
Q1 Remediation Reference Group meeting	September 2022
Submit 2021-2022 Annual report to Southern Rural Water and publish to web page Annual report to incorporate the quarterly update to Southern Rural Water for the period 1 July to 30 September 2022	30/09/2022

2.2 Surrounding environment investigation

Barwon Water also continued working on the surrounding environment investigation in line with the process summarised in Figure 2. Specific actions that have been completed are outlined below in Table 4. The focus to date has been the design, planning and installation of new site specific monitoring assets. This has included installation of two new stream gauges and 19 monitoring bores. Installation of the remaining three stream gauges and four monitoring bores have been delayed due to a wetter than usual summer and elevated streamflows. These will be installed when conditions allow.

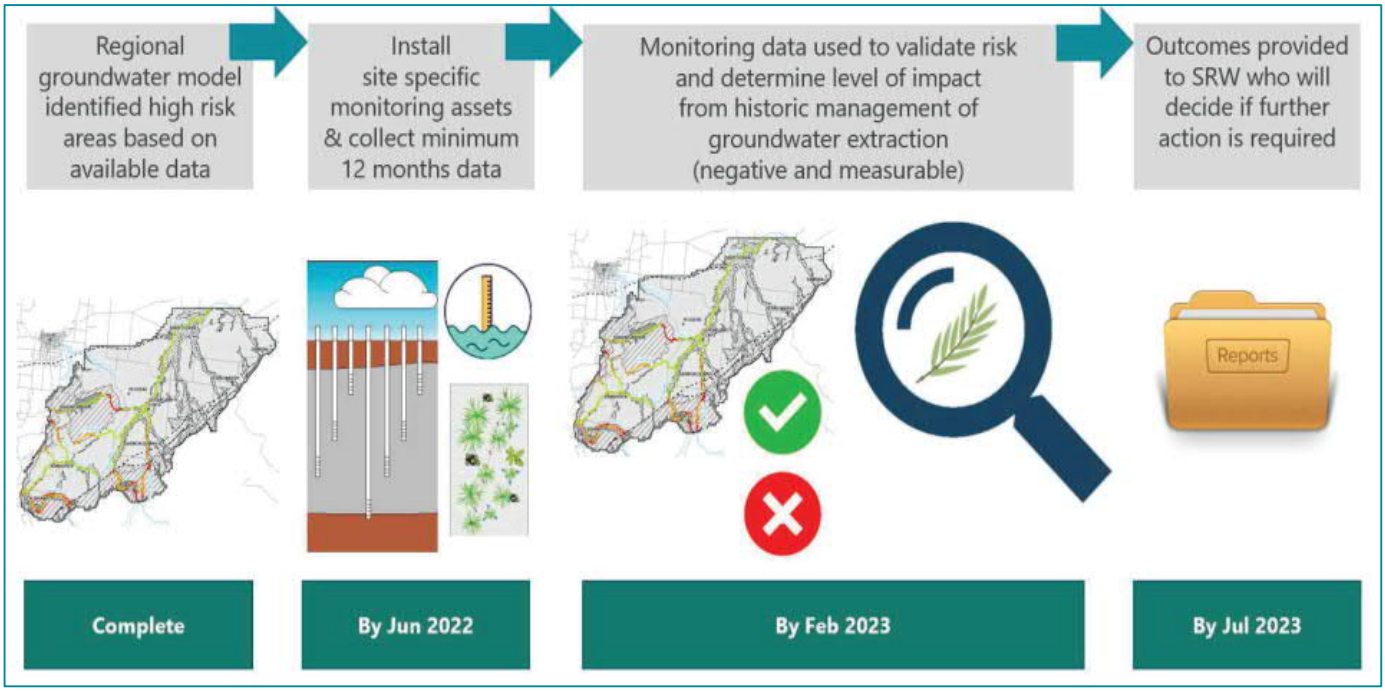


Figure 2: Process overview for the surrounding environment investigation

2.2.1 Implementation actions completed during 2020-2021 for the surrounding environment investigation

Table 4: Completed actions for surrounding environment investigation during 2020/21

Completed actions - Surrounding environment investigation	Comment / Link
Q1 2020/21 (1 July – 30 September 2020)	
Progressed design and planning for installation of additional stream gauges and observation bores in summer 2020/21	
Governance framework submitted to and accepted by Southern Rural Water, 31 July 2020*	
Submission of proposed REPP amendments addressing agreed actions in the REPP feedback work plan for Southern Rural Water consideration*	
Submission of Annual Report to Southern Rural Water and report made publicly available on web page, 30 September 2020	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Quarterly update for period 1 July to 30 September (Q1 2020/21) provided as a component of the Annual Report	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek

Q2 2020/21 (1 October – 31 December 2020)	
Design completed for the 22 monitoring bores to be constructed in the surrounding environment	
Contract awarded for the construction of 22 new monitoring bores in the surrounding environment	
Stream gauge construction completed for the East Barwon River. Construction of the stream gaug on the West Barwon River commenced	Ongoing monitoing undertaken through the Regional Water Monitoring Partnership Data available on the Water Measurement Information System: https://data.water.vic.gov.au/
Implementation of vegetation baseline monitoring program at six proposed bore sites outside Big Swamp.	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Remediation Reference Group meeting held on 2 December 2020*	
Submit quarterly update for the period 1 October to 31 December 2020 to Southern Rural Water and publish to web page*	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Q3 2020/21 (1 January – 31 March 2021)	
Commenced collation of community information regarding sites/issues of concern to inform the surrounding environment Investigation	Information and sites of concern already provided by the community to be considered in the surrounding environment investigations include: • Flows in Gellibrand River / Loves Creek • Acid Sulfate Soil sites • Aquade report • Changes in GDE vegetation identifed in historical vegetation assessments
Commenced development of the framework to formally capture the process for incorporating community information and knowledge into the surrounding environment investigation	The Remediation Reference Group Nominated Experts have provided a case study to assist Barwon Water in developing this framework. Framework shared with the reference group and no changes were proposed.
Stream gauge construction completed for the West Barwon River.	Ongoing monitoing undertaken through the Regional Water Monitoring Partnership Data available on the Water Measurement Information System: https://data.water.vic.gov.au/
Remediation Reference Group meeting held on 17 March 2021*	
Submit quarterly update to Southern Rural Water for the period 1 January to 31 March 2021 and publish to web page*	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek
Q4 2020/21 (1 April – 30 June 2021)	
Commenced construction of 23 new monitoring bores in the surrounding environment	19 of 23 monitoring bores have been installed installed, 4 delayed due to wet weather and site condition constraints.
Remediation Reference Group meeting held on 23 June 2021*	

Submit quarterly update for the period 1 April to 30 June 2021 to Southern Rural Water and publish to web page*	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek

* Denotes actions also captured in Table 1: Completed actions for Implementation of the Boundary Creek and Big Swamp Remediation Plan during 2020/2

2.2.2 Quarterly update for the period 1 July to 30 September 2021 for the surrounding environment investigation

Table 5: Quarterly Update - Q1 2021/22 (July – September 2021) – Surrounding environment investigation

Q1 2021/22 Update (July – September 2021)	Comment / Link
Continued collection of data from new monitoring assets for the surrounding environment investigation	Ongoing monitoing undertaken through the Regional Water Monitoring Partnership Data available on the Water Measurement Information System: https://data.water.vic.gov.au/
Q1 Remediation Reference Group meeting held on 8 September 2021*	
Submitted 2020-2021 Annual report to Southern Rural Water and published to web page* Annual report to incorporate the quarterly update to Southern Rural Water for the period 1 July to 30 September 2021*	https://www.yoursay.barwonwater.vic.gov.au/boundary-creek

* Denotes actions also captured in Table 2: Quarterly update - Q1 2021/22 (1 July – 30 September 2021) – Boundary Creek and Big Swamp Remediation Plan

2.2.3 Upcoming implementation actions and milestones for the period 1 October 2021 to 30 September 2022 for the surrounding environment investigation (Annual Work Plan)

Table 6: Upcoming actions for the surrounding environment investigation for the period 1 October 2021 to 30 September 2022

Upcoming tasks – Remediation of Boundary Creek and Big Swamp	Due (if applicable)
Q2 2021/22 (1 October – 31 December 2021)	
Continue collection of data from new monitoring assets for the surrounding environment investigation	
Subject to streamflows and site conditions, complete stream gauge installations for the Gellibrand River, Barongarook Creek and Barwon River downstream of the confluence with Boundary Creek	TBC – subject to safe river levels
Subject to safe site conditions install 4 remaining surrounding environment monitoring bores	TBC – subject to safe conditions
Continue collation of community information regarding sites/issues of concern to inform the surrounding environment investigation	
Q2 Remediation Reference Group meeting*	December 2021
Submit quarterly update for the period 1 October to 31 December 2021 to Southern Rural Water and publish to web page*	31/12/2021

Q3 2021/22 (1 January – 31 March 2022)	
Continue collection of data from new monitoring assets for the surrounding environment investigation	
Subject to streamflows and site conditions, complete stream gauge installations for the Gellibrand River, Barongarook Creek and Barwon River downstream of the confluence with Boundary Creek	TBC – subject to safe river levels
Subject to safe site conditions install 4 remaining surrounding environment monitoring bores	TBC – subject to safe conditions
Q3 Remediation Reference Group Meeting*	TBA
Submit quarterly update to Southern Rural Water for the period 1 January to 31 March 2022 and publish to web page*	31/03/2022
Q4 2021/22 (1 April – 30 June 2022)	
Continue collection of data from new monitoring assets for the surrounding environment investigation	
Q4 Remediation Reference Group Meeting*	TBA
Submit quarterly update to Southern Rural Water for the period 1 April to 30 June 2022 and publish to web page*	30/06/2022
Q1 2022/23 (1 July – 30 September 2022)	
Continue collection of data from new monitoring assets for the surrounding environment investigation	
Q1 Remediation Reference Group Meeting*	TBA
Submit 2021-2022 Annual report to Southern Rural Water and publish to web page* Annual report to incorporate the quarterly update to Southern Rural Water for the period 1 July to 30 September 2022	30/09/2022

* Denotes actions also captured in Table 2: Quarterly update - Q1 2021/22 (1 July – 30 September 2021) – Boundary Creek and Big Swamp Remediation Plan

3.0 Issues register

Table 7 below outlines any issues that have been identified during implementation of the REPP that may impact future implementation activities.

Table 7: Issues register

Issue	Likelihood	Consequence	Comments
Coronavirus (COVID-19) pandemic limits/delays engagement with stakeholders and the community	Medium	Low	Coronavirus (COVID-19) impacted face-to-face stakeholder and community engagement with a Remediation Working Group meeting proposed for March 2020 and postponed due to restrictions. Email updates were provided in lieu of a face-to-face meeting. From December 2020 onwards Remediation Reference Group meetings have been undertaken via zoom on a quarterly basis. These meetings have been well attended with most members being able to attend online.
Coronavirus (COVID-19) pandemic impacts availability of appropriate consultants or contractors to undertake required work for implementation of the REPP	Low	Low	To date Barwon Water has experienced little impact on availability of consultants and contractors to complete work for this project during the coronavirus (COVID-19) pandemic.
Continued Wet conditions	Medium	Medium	Wet conditions during the 2020/21 summer period delayed installation of some of the new stream gauges and monitoring bores required for the surrounding environment investigation. If wet conditions persist into summer 2021/22 and again prevents installation of the new monitoring sites this could impact milestone timeframes for the surrounding environment investigation. Additionally, wet conditions during summer 2021/22 could also impact on any works to be carried out in Big Swamp and Boundary Creek during this period as part of remediation.
Extended remediation timeframes	Medium	Low	The hydrogeochemical modelling has indicated that even with implementation of the hydraulic barriers, the timeframe for removal of existing acidity loads in the swamp could still be in the order of 35 years without treatment of acidity within the swamp. In line with the feedback received from the ITRP and community representatives it is therefore proposed to investigate a novel upstream treatment method, which if successful, may reduce the long term remediation timeframes. This investigation will, however, push out the short-term timeframes for implementation of further remediation actions as it needs to be undertaken prior to installation of the hydraulic barriers.

4.0 Community and stakeholder engagement

Barwon Water is committed to continuing an open and transparent relationship with the community and key stakeholders during the implementation of the Boundary Creek, Big Swamp and surrounding environment Remediation and Environment Protection Plan.

The ongoing coronavirus (COVID-19) pandemic has presented challenges in meeting its community and stakeholder working groups in traditional settings.

Online meetings commenced in December 2020 with all members who indicated they wished to remain part of the project. The working group was renamed to the remediation reference group. Members of the reference group include Land and Water Resources Otway Catchment (LAWROC), Colac Otway Shire, Geelong Environment Council, Friends of the Barwon, Upper Barwon Landcare Network, Boundary Creek landowners and the Corangamite Catchment Management Authority. As the Traditional Owners of the land covered by the remediation plan and the Registered Aboriginal Party, Eastern Maar Aboriginal Corporation has also been invited to be a member of the working group. Whilst they have not yet been available to attend meetings, Barwon Water has maintained an open invitation to keep Eastern Maar informed of progress with the project as a key stakeholder.

The group continues to be supported by their own nominated independent technical experts to provide specialist advice and support, Dr Vanessa Wong (Monash University), Professor Richard Bush (Monash University) and Dr Darren Baldwin (Charles Sturt University).

A further three online meetings were held throughout 2021. In between meetings, direct communication with reference group members continued over email to share updates such as the availability of quarterly reports on the project.

Barwon Water continued to share regular updates to its dedicated Your Say at Barwon Water platform for the project including the publication of various technical reports and studies and latest news articles.

Ongoing updates to the communication and engagement strategy continued throughout the 2020/21 year to maintain the most up to date messaging and activities for the project.

The focus for the 2021/22 year will be broader based community engagement to provide updates on the project and ongoing quarterly meetings with the working group. At this stage planning for this will be a hybrid of in-person and online events depending on current health directions.

5.0 Success targets

Table 8 below summarises the interim success targets that were outlined in the REPP, as well as performance to date against those targets. Further detail is provided for each success target in the sections below the table. In order for successful remediation to be demonstrated, all success targets need to be achieved concurrently, while some targets such as flows in Boundary Creek need to also be achieved for a minimum period of two consecutive years to confirm sustainability. Therefore, while some interim target values may have been observed, they have not been observed for sufficient time and, as such, the target status remains listed as 'in progress'.

It is also important to note that, as outlined in the REPP, some of these targets required further review and updating to ensure they were based on the latest data and information provided from the recent technical studies. A review of success targets was a key milestone in the REPP to be submitted to Southern Rural Water by 1 July 2021. The draft updated success targets developed during this review are provided in Table 9 and subject to acceptance by Southern Rural Water before they can be adopted. As such the interim success targets continue to be used for reporting purposes in this report.

Success targets for the surrounding environment will also be developed if adverse impacts resulting from historical groundwater extraction at Barwon Downs are confirmed and remediation determined to be required in accordance with the Section 78 Notice and the REPP.

Table 8: Remediation success targets as provided in the REPP

Success target	Measurement	Timeframe	Status
Recovery trend for groundwater levels in the LTA (subject to median climate and no additional groundwater extraction above the current PCV limit)	Monitoring of groundwater levels in observation bores 64229, 64236, 82844 and 109131 to develop hydrographs to confirm a recovery trend line in LTA groundwater levels	The term of the s78 notice	In Progress
No further encroachment of terrestrial woodland into the swamp plain	Independent monitoring of established transects to map changes in distribution and area, with current vegetation mapping to form the baseline for assessment of change along with condition scores.	Within 10 years of implementation of hydraulic barriers	In Progress
No encroachment of Lowland Forest dominant species into areas of Damp Forest	Independent monitoring of established transects to map changes in distribution and area, with current vegetation mapping to form the baseline for assessment of change along with condition scores.		In Progress
No loss of structural or floristic diversity along the main channel and western end of the swamp.	Independent regular monitoring of quadrats to assess changes in species diversity over time, with a baseline assessment undertaken to form the basis for measuring changes in structural or floristic diversity along with condition scores.		In Progress
Increase diversity of understorey species within the swamp plain, with a focus on ferns and sedges	Independent monitoring of established transects to map changes in distribution and area, with current vegetation mapping to form the baseline for assessment of change along with condition scores.		In Progress
Big Swamp BH01 water table level less than 1.0 m below ground level* maintained for a period of 2 years	Water table levels	Within 10 years of implementation of hydraulic barriers	In Progress
Big Swamp BH06 water table level less than 1.5 m below ground level* maintained for a period of 2 years	Water table levels	Within 10 years of implementation of hydraulic barriers	In Progress
Big Swamp BH09 water table level less than 1.8 m below ground level* maintained for a period of 2 years	Water table levels	Within 10 years of implementation of hydraulic barriers	In Progress
Big Swamp BH12 water table level less than 1.9 m below ground level* maintained for a period of 2 years	Water table levels	Within 10 years of implementation of hydraulic barriers	In Progress
Big Swamp BH15 water table level less than 1.0 m below ground level* maintained for a period of 2 years	Water table levels	Within 10 years of implementation of hydraulic barriers	In Progress

Success target	Measurement	Timeframe	Status
At least 0.5 ML/day flow maintained at site 233228 Boundary Creek @ Yeodene stream gauge maintained for a period of 2 years (Subject to passing flow conditions being enforced at 'McDonald's Dam' in accordance with its licence conditions - dam licence no. WLE043336)	Flow ML/day	Within 10 years of implementation of hydraulic barriers	In Progress
Annual median pH equal to or greater than 6.5* at site 233228 Boundary Creek @ Yeodene stream gauge maintained for a period of 2 years To be refined pending completion of geochemical modelling (Dec 2020).	pH equal to or greater than 6.5* (annual median)	Within 10 years of implementation of hydraulic barriers	In Progress

*When these targets were initially established, additional data was required to be collected to enable the modelling of the hydrological and geochemical processes through the swamp and for this to be used to refine the forecast of the achievable target for this measure. The interim target of median pH of 6.5 has been selected based on the SEPP Guidelines. The interim target for water table levels for each bore have been set based on a very short period of data and depending on the final locations of the hydraulic barriers, the location of the water table level targets may be revised to ensure protection of key areas and vegetation. The draft revised targets that have been submitted to SRW for consideration are outlined in Table 9 below.

Table 9: Draft remediation success targets as proposed from the review of remediation success targets due 1 July 2021

Functional Group	Current success target	Recommended success target
Lower Tertiary Aquifer	Recovery trend for groundwater levels in the LTA	Recovery of regional LTA hydraulic heads such that vertical hydraulic gradients between LTA and overlying HSUs reach stable hydraulic gradients (i.e. at nested observation bores to be identified through the surrounding environment investigation)
		LTA bores immediately to the west of the swamp (109113, 109132, 109131) to have hydraulic heads greater than 150 mts (elevation of western edge of the swamp) and LTA bore TB1c, greater than 143 mts (elevation of the eastern edge of the swamp)
		Recovering LTA hydraulic heads in vicinity of Big Swamp (i.e. BH01-PB, TB1c, 109113, 109132, 109131) to be higher and remain higher than the surface elevation of the swamp within 10 years.

Functional Group	Current success target	Recommended success target
Quaternary Aquifer	Maintain monitoring bore water levels at individual bores above target water levels	Maintain monitoring bore water levels at individual bores above target water levels: • BH01 – water level above 0.7m bgl • BH02 – water level above 1.2m bgl • BH03 – water level above 1.6m bgl • BH04 – water level above 0.6m bgl • BH05 – water level above 1.0m bgl • BH06 – water level above 1.0m bgl • BH07 – water level above 0.4m bgl • BH08 – water level above 0.4m bgl • BH09 – water level above 1.5m bgl • BH10 – water level above 2.0m bgl • BH11 – water level above 1.5m bgl • BH12 – water level above 1.2m bgl • BH14 – water level above 0.15m bgl • BH15 – water level above 0.2m bgl
Ecohydrology	No further encroachment of terrestrial woodland into the swamp plain	No further encroachment of terrestrial woodland into the swamp plain (Units 1 to 4) with a target of zero tree cover on the swamp plain (vegetation units 1-4)
	No encroachment of Lowland Forest dominant species into areas of Damp Forest	No encroachment of Lowland Forest dominant species into areas of Damp Forest (Unit 6) through maintaining canopy cover at 10-30%
	No loss of structural or floristic diversity along the main channel and western end of the swamp	Establishment of suitable canopy cover of between 10-30% in vegetation unit 5 to maintain the diversity and abundance of mesic specialist species
	Increase diversity of understory species within the swamp plain, with a focus on ferns and sedges	Rehydration of the area covered by vegetation Units 1 to 4 of at least 54% to allow an increase diversity of understory species within the swamp plain, with a focus on ferns and sedges.
Hydrology	At least 0.5 ML/day flow maintained at Boundary Creek at Yeodene stream gauge maintained for a period of 2 years	At least 0.5 ML/day flow maintained at Boundary Creek at Yeodene stream gauge maintained for a period of 2 years.
Hydrochemistry	Annual median pH equal to or greater than 6.5* at Boundary Creek (stream gauge 233228) and Yeodene stream gauge maintained for a period of 2 years	Annual median pH equal to or greater than 6.5* at Boundary Creek (stream gauge 233228) and Yeodene stream gauge maintained for a period of 2 years

5.1 Recovery trend for LTA groundwater levels

Groundwater levels in the observation bores nominated in the REPP for the interim success targets have continued to show a recovery trend since groundwater extraction ceased from the Barwon Downs Borefield. In line with the REPP feedback received from Southern Rural Water, this recovery target has been reviewed and refined as as proposed in Table 9 above.

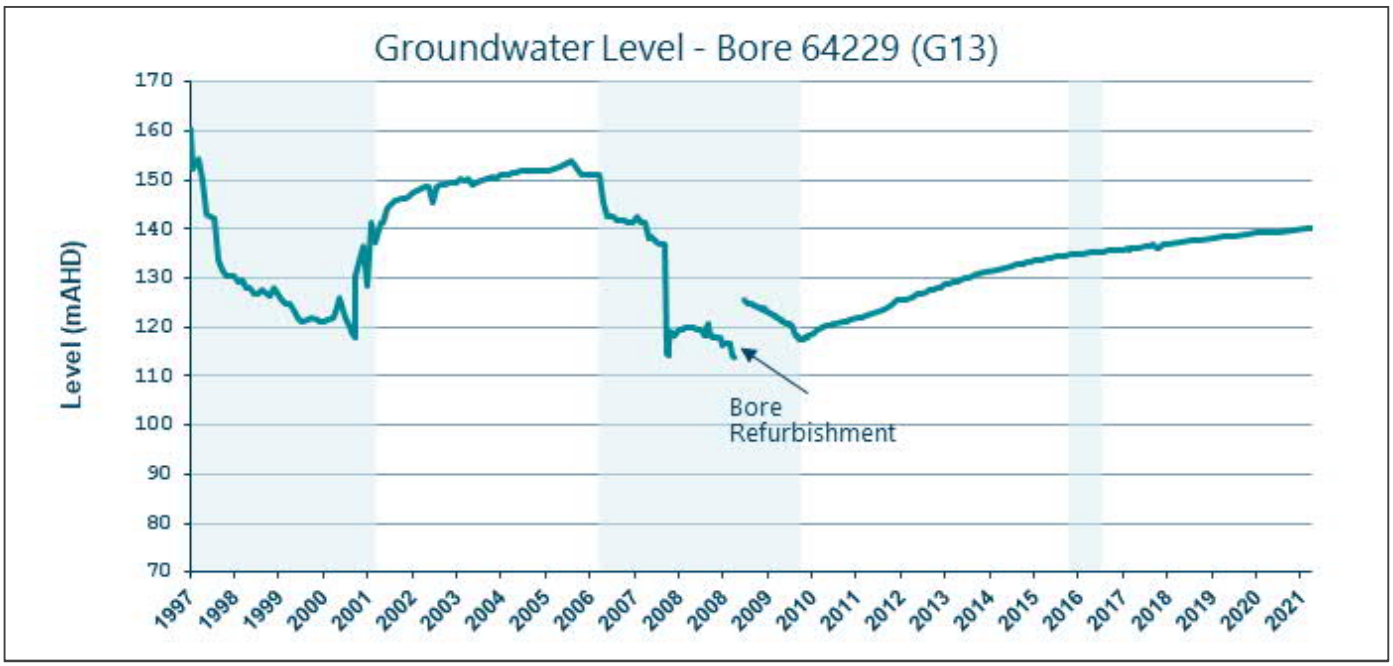


Figure 3: Groundwater Level – Bore 64229 (G13)

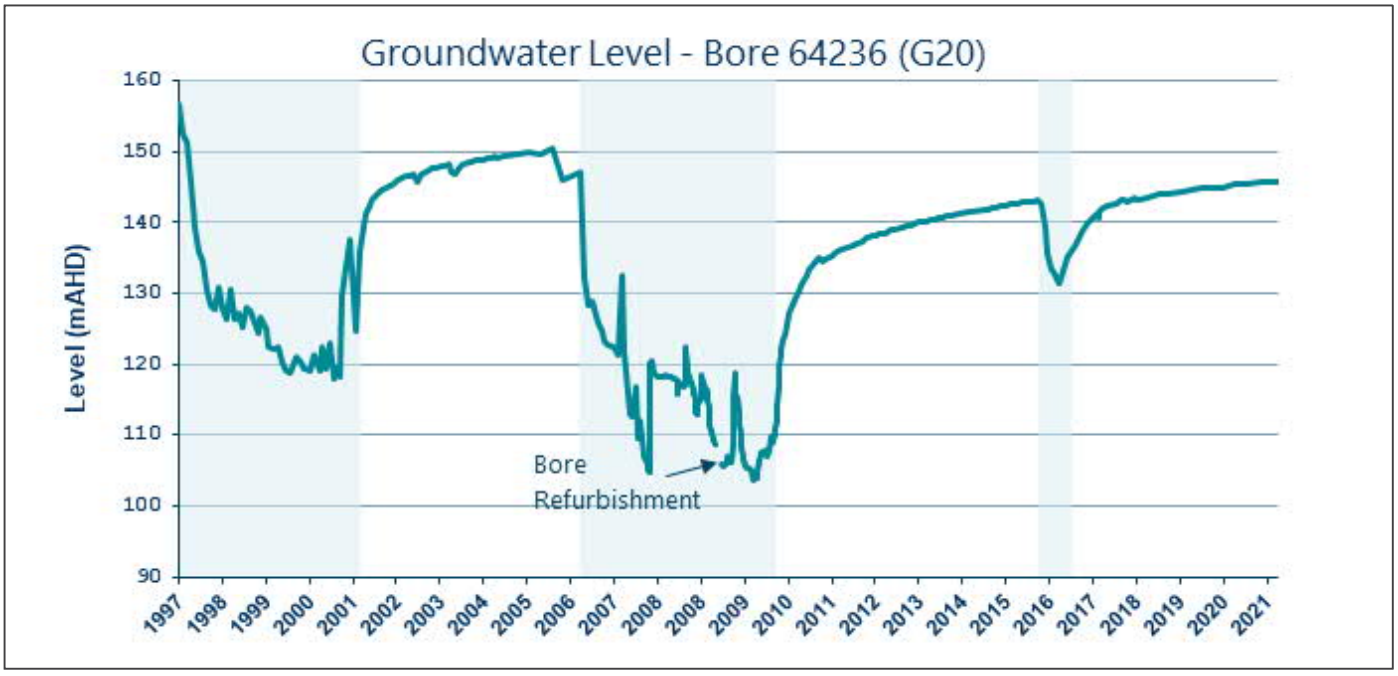


Figure 4: Groundwater Level – Bore 64236 (G20)

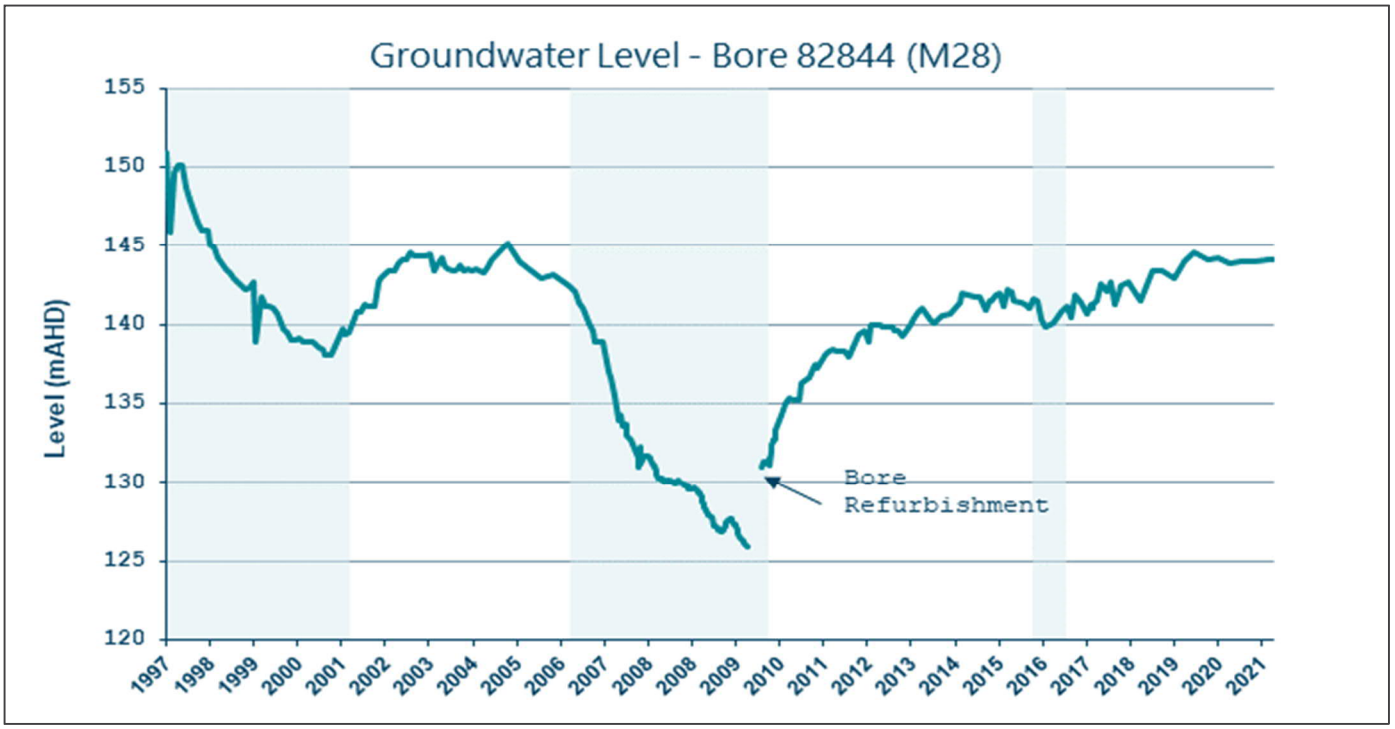


Figure 5: Groundwater Level – Bore 82844 (M28)

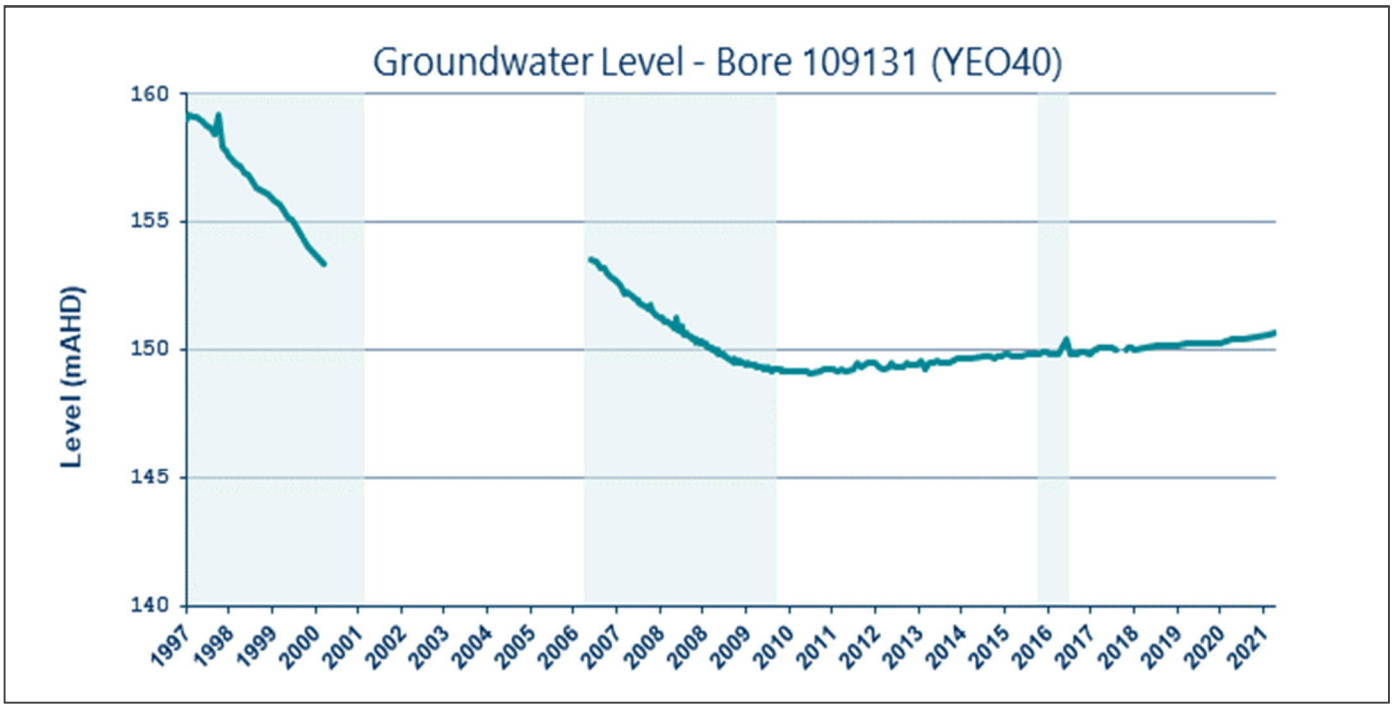


Figure 6: Groundwater Level – Bore 109131 (YEO40)

5.2 Big Swamp vegetation

Ongoing vegetation monitoring within Big Swamp was established during 2020/21. The vegetation monitoirng report is available in the document library on the Boundary Creek Remediation web page: https://www.yoursay.barwonwater.vic.gov.au/boundary-creek

The monitoring program that has been established will allow progress to be tracked against the following success targets as outlined in the REPP:

- no encroachment of terrestrial woodland into the swamp plain
- no encroachment of Lowland Forest dominant species into areas of Damp Forest
- no loss of structural or floristic diversity along the main channel and western end of the swamp
- increased diversity of understorey species within swamp plain, with a focus on ferns and sedges.

Monitoring of vegetation for Big Swamp and Boundary Creek has also been designed to identify any unintended changes in vegetation and inform consideration of possible contingencies required to address these changes.

Additional monitoring may need to be incorporated into the vegetation monitoring program to accommodate the refinement of the ecohydrological targets proposed through the success target review, if accepted by Southern Rural Water.

Vegetation monitoring for the surrounding environment investigation was also established at the same time as the vegetation monitoring for Big Swamp.

5.3 Big Swamp groundwater levels

All hydrographs for the monitoring bores in Big Swamp have been provided in Appendix A – Big Swamp Groundwater Hydrographs. The hydrographs in Figure 7 to Figure 11 below represent groundwater levels from bores BH01, BH06, BH09, BH12 and BH15 and are those for which interim Big Swamp groundwater level targets have been set, as shown in Table 10.

Table 10: Groundwater level targets (water level meters below ground level)

Bore	Target WL (m bgl)
BH01	1.00
BH06	1.50
BH09	1.80
BH12	1.20
BH15[1]	1.00

[1] Target water level based on sulfide horizon > 10 %S

The interim targets are based on limited groundwater level monitoring data from within the swamp (between June 2019 and December 2019) and the targets will be revised as part of further work. The groundwater levels are above the interim target level at BH01, BH06 and BH09 between July 2020 and June 2021, however, the levels are around or below the interim level in BH12 and BH15.

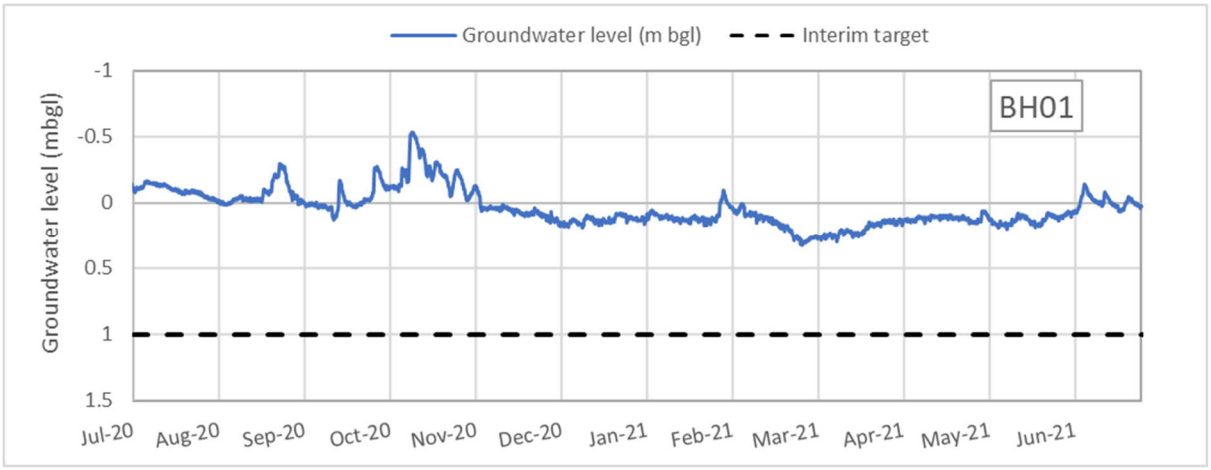


Figure 7: Groundwater hydrograph and interim target at BH01

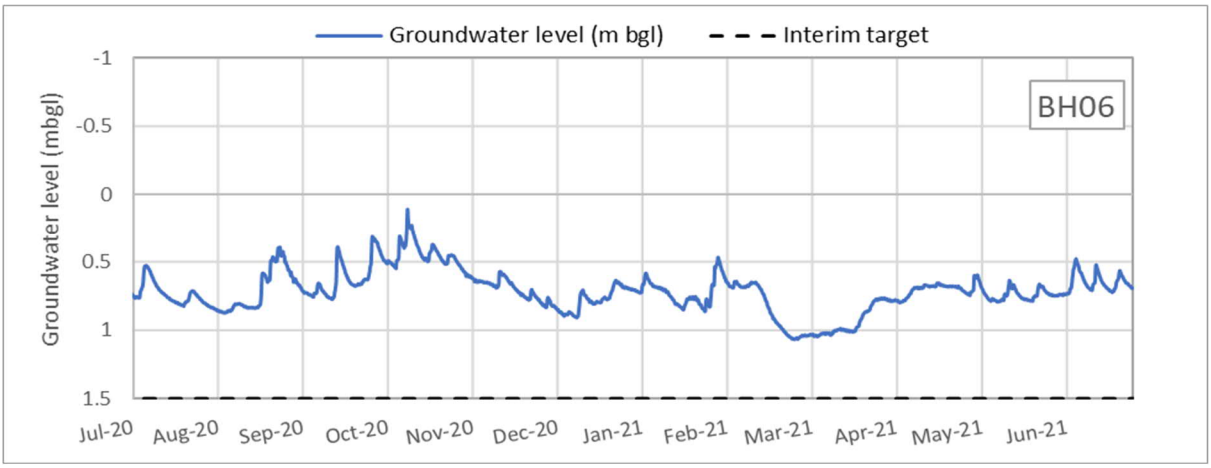


Figure 8: Groundwater hydrograph and interim target at BH06

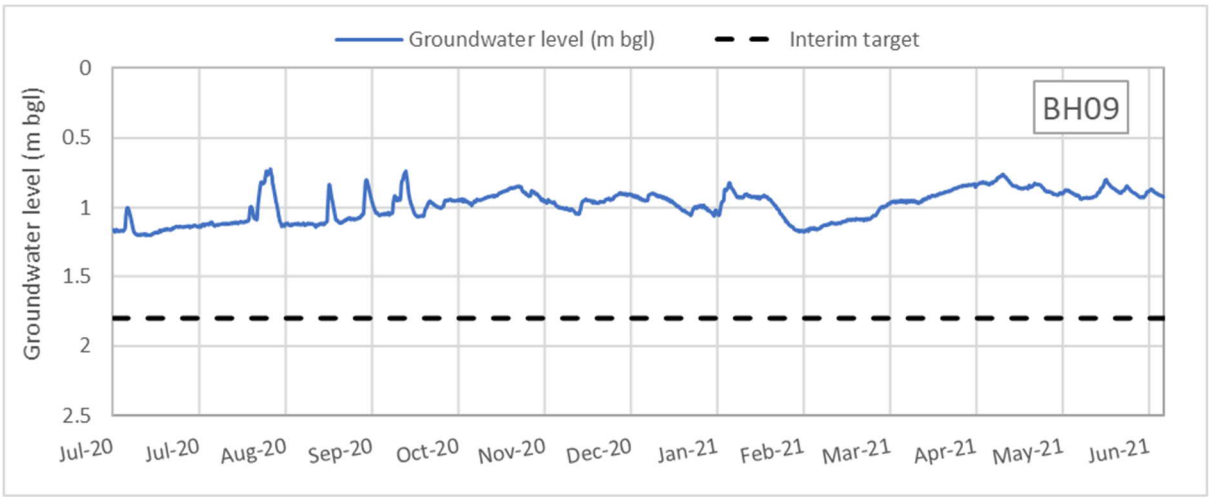


Figure 9: Groundwater hydrograph and interim target at BH09

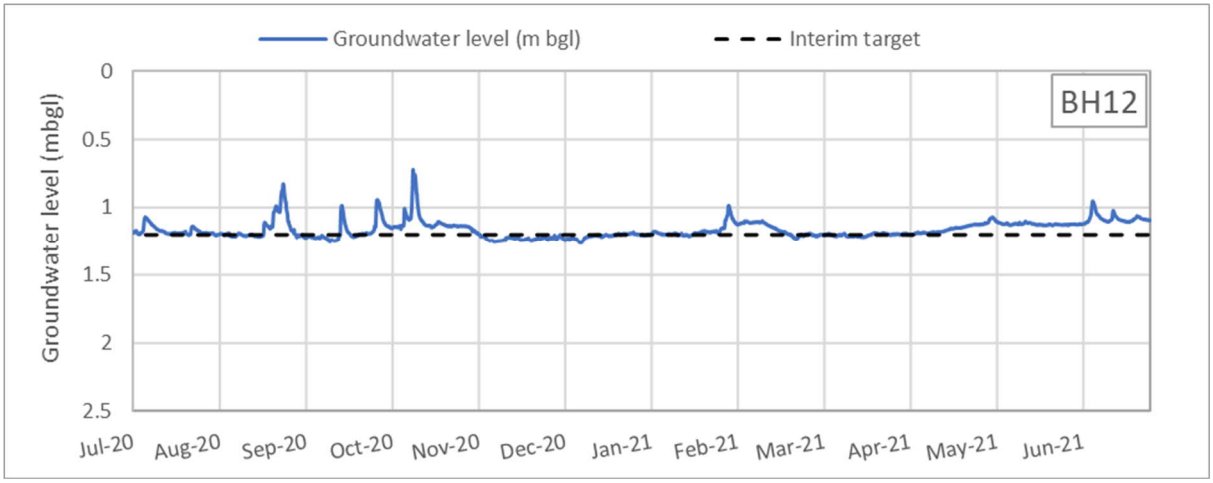


Figure 10: Groundwater hydrograph and interim target at BH12

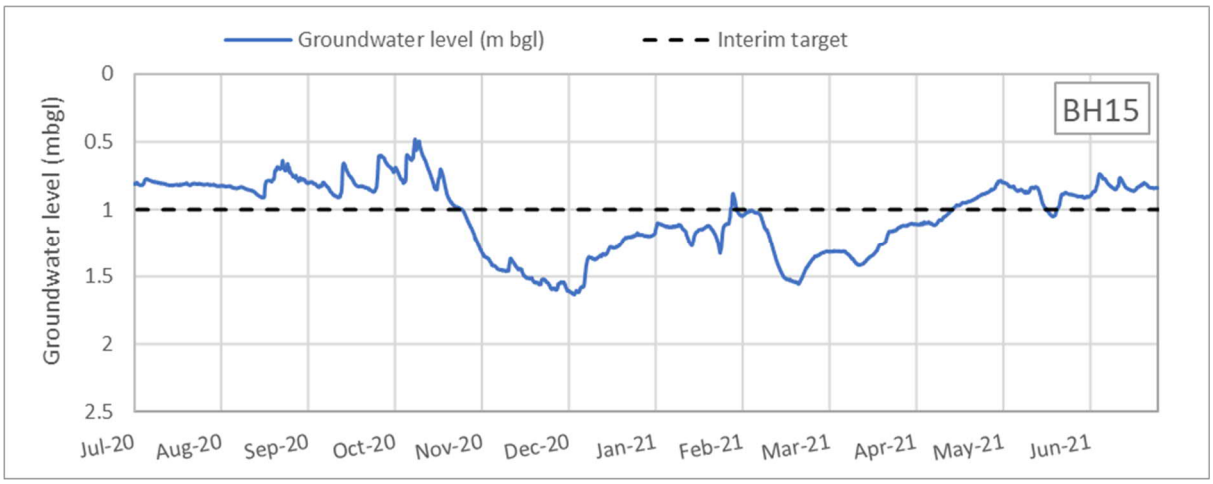


Figure 11: Groundwater hydrograph and interim target at BH15

5.4 Surface water flow in Boundary Creek

Approximately 560 ML of water was released into Boundary Creek as a supplementary flow during the 2020/21 year to try to maintain flow in Boundary Creek and keep Big Swamp wet. Figure 12 below presents the streamflow in Boundary Creek during the release of supplementary flows in 2020-21 at various gauges located along the creek. Comparison of the upstream and downstream McDonald Dam gauges suggests that the supplementary flows were generally passed in full.

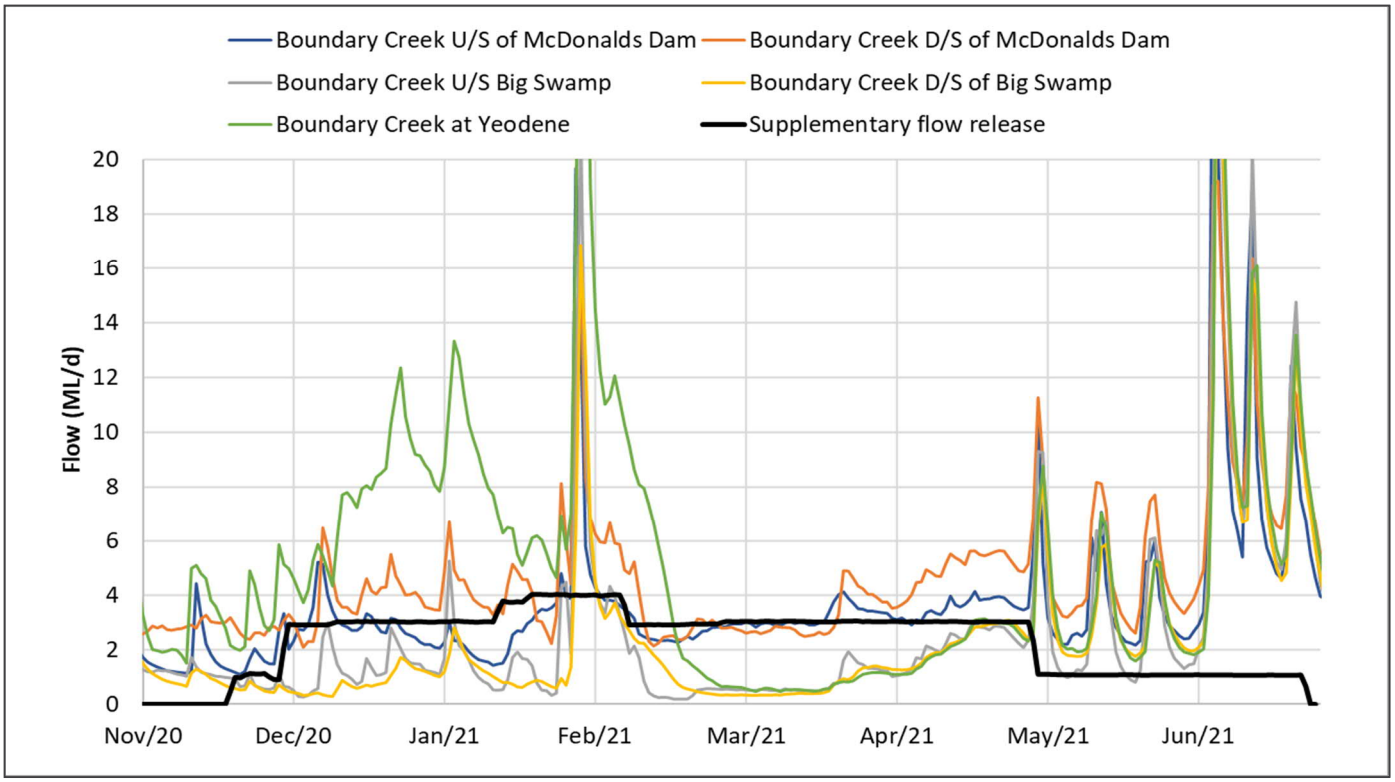


Figure 12: Flows for Boundary Creek during supplementary flow releases for 2020/21

The charts in Figure 13 to Figure 17 show the supplmentary flows released to Boundary Creek in 2020/21 and the flows recorded at each of the stream gauges located along Boundary Creek from upstream of McDonald's Dam down to the Yeodene gauge. The raw flow data for the Boundary Creek @ Yeodene gauge and supplementary flow release data is included in Appendix B – Surface Water flow in Boundary Creek.

The flow data presented indicates that the supplementary flow release predominantly occurred during the summer low-flow period between November and April, with a reduction in releases down to approximatly 1ML/day from May to June. The data also confirms that, as expected and as predicted by the surface water modelling, the majority of losses in Boundary Creek occur between the stream gauge downstream of McDonald's Dam and the stream gauge upstream of Big Swamp.

Flow in Boundary Creek upstream and downstream of Big Swamp were the lowest between November 2020 to January 2021, and late February to late March 2021, with a relatively large flow event in February 2021. Over November and December 2020, average flows upstream of the swamp were 1.2 ML/day while average flows downstream of the swamp were 0.8 ML/day, indicating an average loss of ~0.4 ML/day over this period. Similarly, in March 2021, average flows upstream of the swamp were 0.51 ML/day while average flows downstream of the swamp were 0.33 ML/day, indicating an average loss of ~0.2 ML/day over the same time period.

Inflows upstream of the swamp did not cease over the monitoring period, with a minimum flow of 0.2 ML/day recorded even during summer low flow conditions. Outflows downstream of the swamp diminished to 0.3 ML/day in December 2020 and through late February to March 2021; however, there were no cease to flow events. The apparent increase in the minimum flow downstream of Big Swamp may reflect the discharge of some storage over this period but may equally represent discrepancies in gauging accuracies under low flow rates.

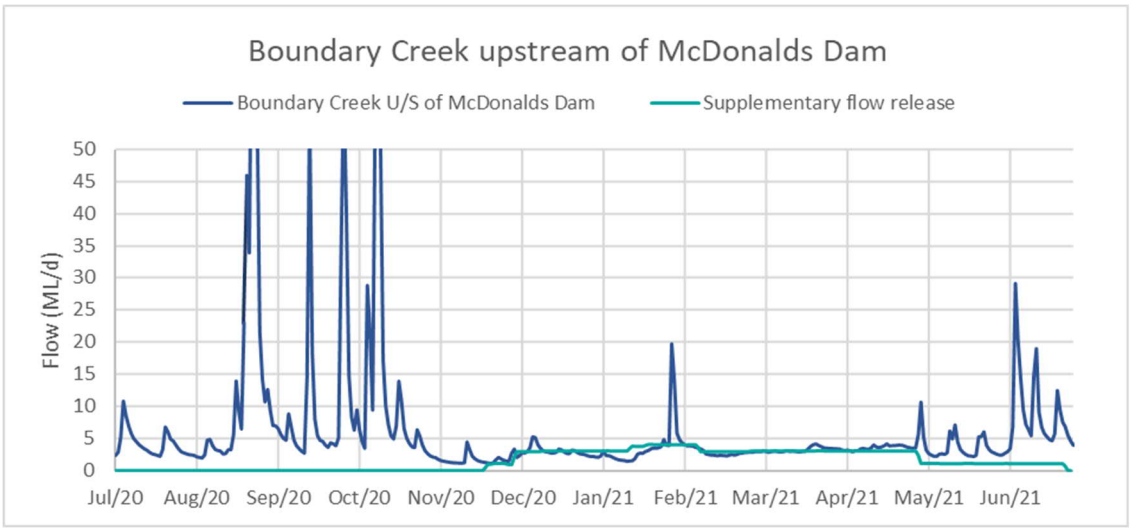


Figure 13: Flows for Boundary Creek upstream of McDonalds Dam and supplementary flow releases for 2020/21

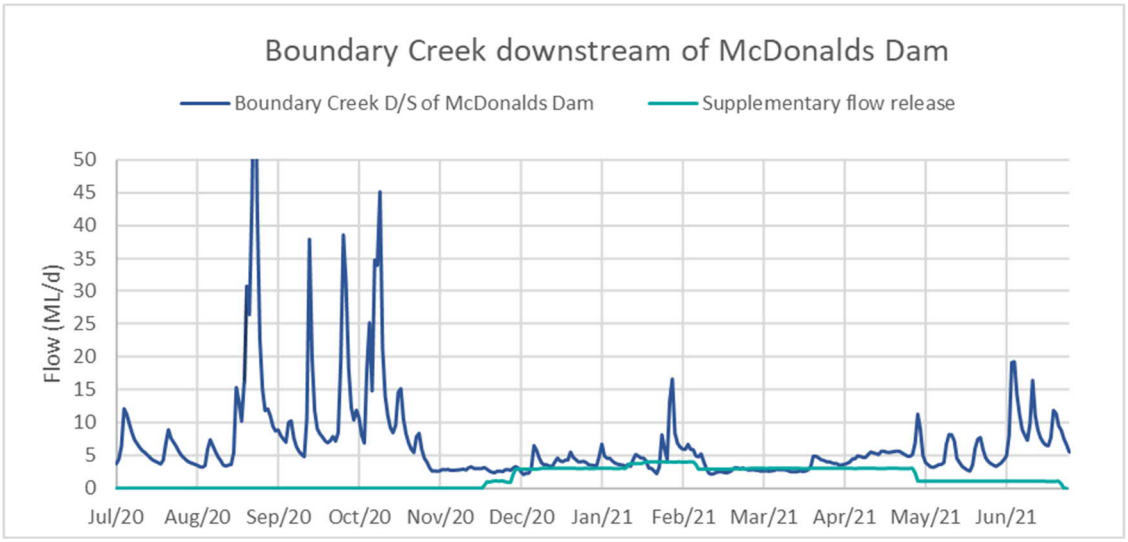


Figure 14: Flows for Boundary Creek downstream of McDonalds Dam and supplementary flow releases for 2020/21

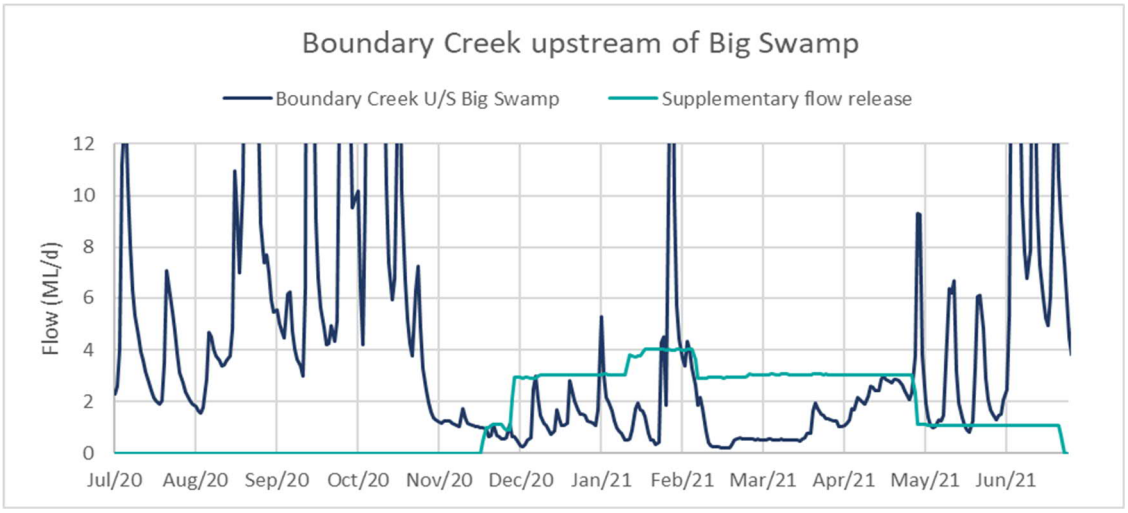


Figure 15: Flows for Boundary Creek upstream of Big Swamp and supplementary flow releases for 2020/21

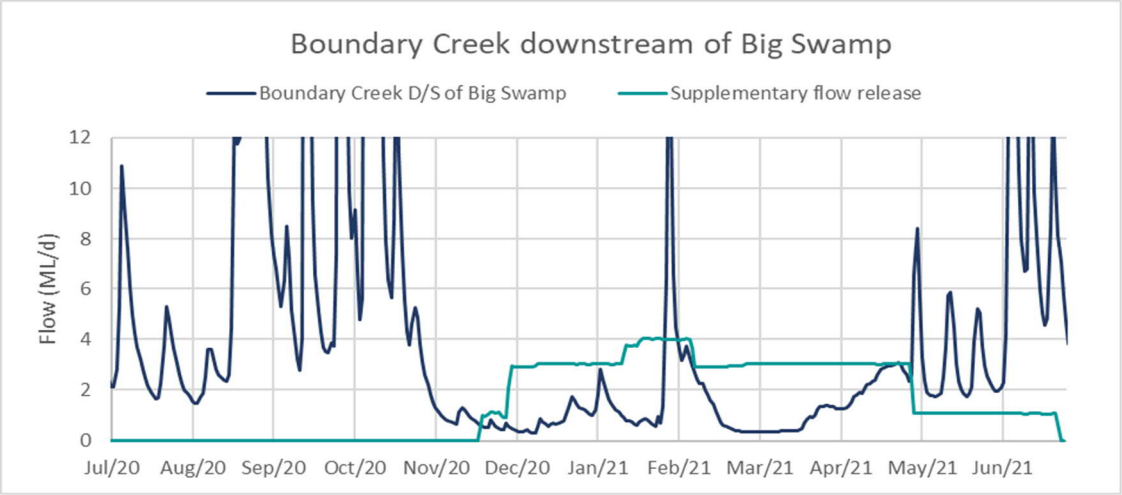


Figure 16: Flows for Boundary Creek downstream of Big Swamp and supplementary flow releases for 2020/21

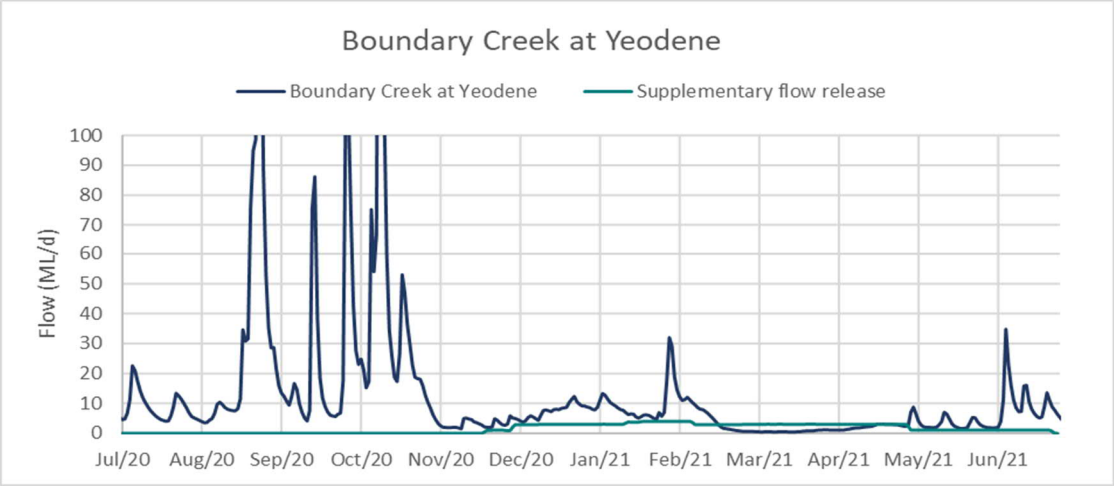


Figure 17: Flows for Boundary Creek at Yeodene and supplementary flow releases for 2020/21

Summary statistics for the surface water flows in Boundary Creek upstream of Big Swamp, Downstream of Big Swamp and at Yeodene for the 2020-21 monitoring period compared to historical monitoring data has been provided in Table 11, Table 12 and Table 13 below, respectively.

This data illustrates that low flows in Boundary Creek during the 2020/21 period were higher than previous monitoring periods, with the 10th percentile flow rate increasing from 0.36 to 0.54 ML/Day Upstream of Big Swamp, from 0.01 to 0.45 ML/Day downstream of Big Swamp and from 0.0 to 1.1 ML/Day at Yeodene between the 2019/20 and 2020/21 periods. Similarly, the 25th percentile flow rates increased from 0.56 to 1.09 ML/Day upstream of Big Swamp, from 0.11 to 0.93 ML/Day downstream of Big Swamp and from 0.72 to 2.41 ML./Day at Yeodene between the 2019/20 and 2020/21 periods.

This suggests that elevated rainfall coupled with targetted supplementary flows during the 2020/21 period have helped to maintain low flows through the Boundary Creek system.

Table 11 Summary flow statistics for Boundary Creek Upstream of Big Swamp

Period	Flow (ML/Day) for corresponding percentiles				
	10%	25%	50%	75%	90%
2019-20	0.36	0.56	2.22	6.60	16.44
2020-21	0.54	1.09	2.21	5.46	10.60

Table 12 Summary flow statistics for Boundary Creek Downstream of Big Swamp

Period	Flow (ML/Day) for corresponding percentiles				
	10%	25%	50%	75%	90%
2019-20	0.01	0.11	1.76	5.46	13.68
2020-21	0.45	0.93	2.24	5.07	11.84

Table 13 Summary flow statistics for Boundary Creek at Yeodene

Period	Flow (ML/Day) for corresponding percentiles				
	10%	25%	50%	75%	90%
2000-21	0.00	0.00	0.95	5.64	15.80
2019-20	0.00	0.72	3.02	8.77	20.67
2020-21	1.11	2.41	6.03	11.04	26.93

5.5 Boundary Creek pH

Surface water quality monitoring for Boundary Creek at stream gauge 233275A (Upstream) and 233276A (Downstream) of Big Swamp and at Yeodene (233228) have been summarised below. Data have been illustrated for both the 2020-21 monitoring period as well as the 2019/20 period for context and comparison. Over the 2020/21 monitoring period, surface water pH upstream of the swamp ranged between 6 and 8 and is consistent with monitoring during 2019-20. Downstream of the swamp, surface water pH increased from 3.6 in August to 5.9 in May. This represents a significant increase in the observed range in pH (2.9 to 3.6) observed during the 2019/20 monitoring period. Similarly, surface water pH at Yeodene increased from 3.5 in November 2020 to 6.2 in August 2021. This again represents a significant increase from the 2019-20 monitoring period, which ranged from 3.3 to 4.6. The observed increase in surface water pH at Yeodene during 2021 represents the longest period of monthly recorded pH values >4.5 since 2006.

While this could be interpreted as an improvement in the quality of water discharging from Big Swamp, the range of acidity concentrations observed downstream of Big Swamp during the monitoring period (24-303 mg/L $CaCO_3$) remained comparable with those observed during the 2019/20 monitoring period (24-300 mg/L). This is also true of the observed loads of acidity discharging from Big Swamp which ranged from 106 to 515 kg/day $CaCO_3$ over the 2020/21 monitoring period compared to 14-480 kg/day over the 2019-20 monitoring period. The drivers behind this are discussed further in the following section, but are reflective of the higher flows observed in Boundary Creek and through Big Swamp in 2020/21.

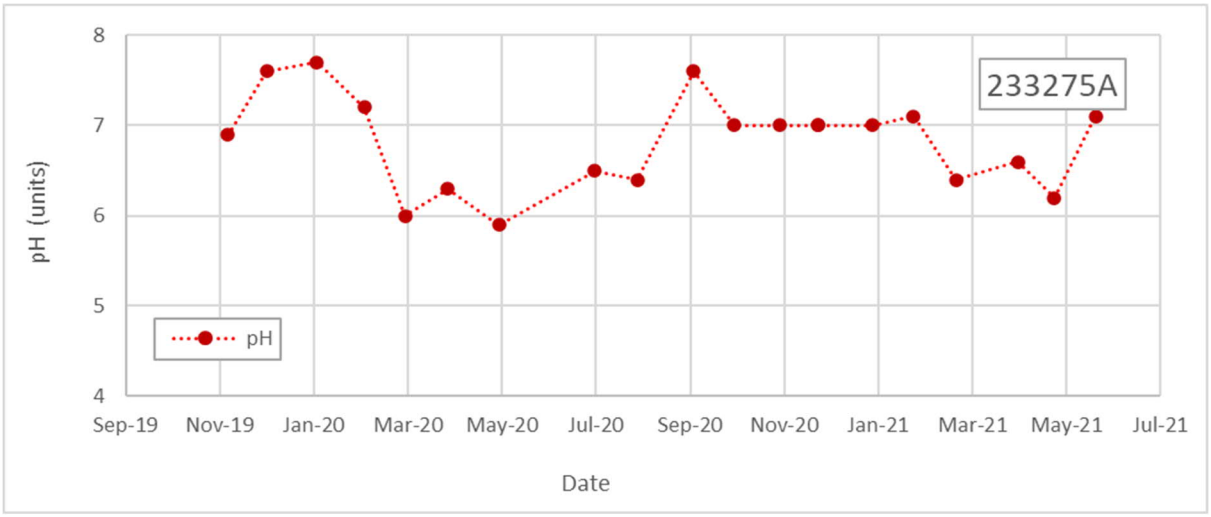


Figure 18: pH of surface water upstream of Big Swamp

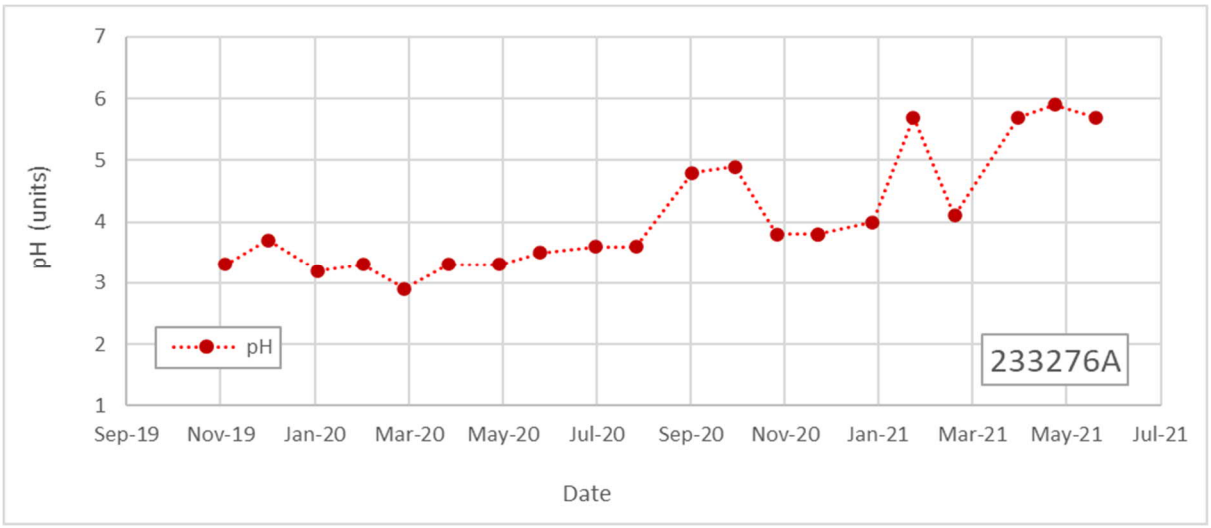


Figure 19: pH of surface water downstream of Big Swamp

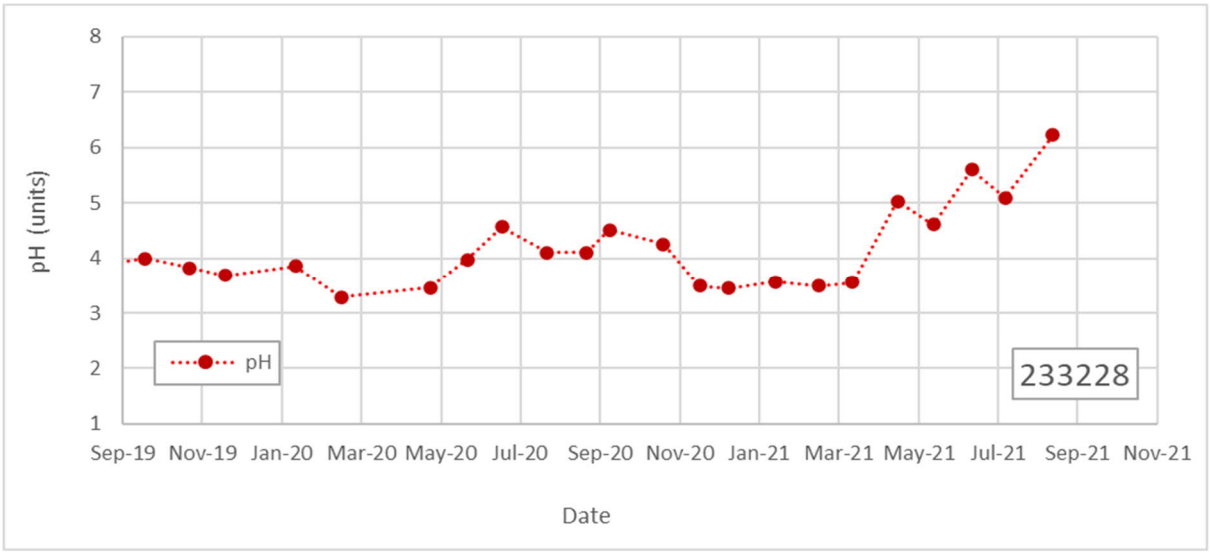


Figure 20: pH of surface water downstream at Yeodene

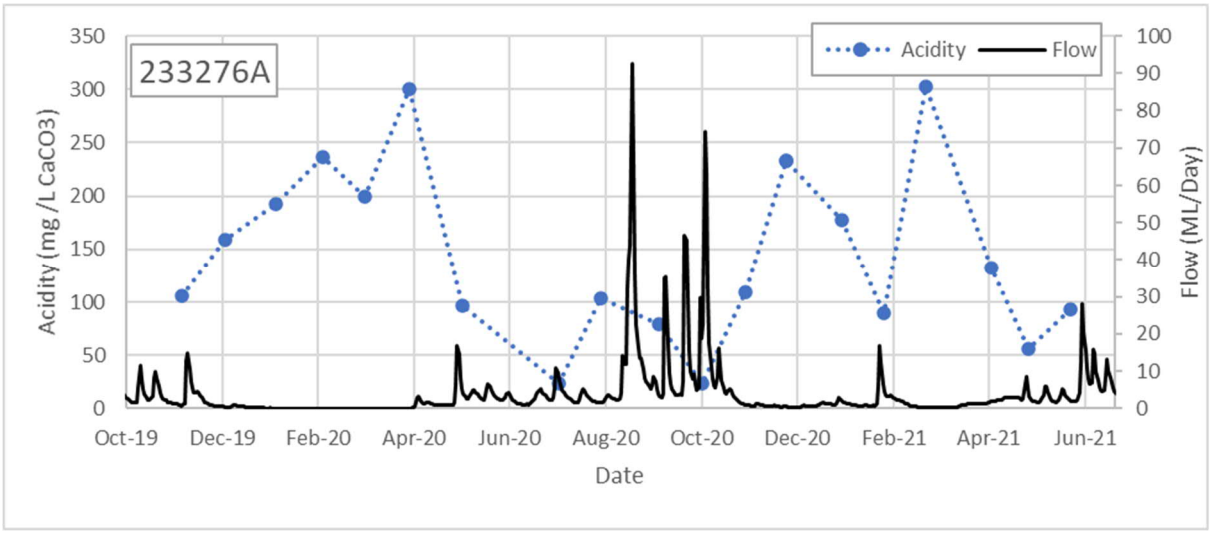


Figure 21: Acidity concentrations vs flow downstream of Big Swamp

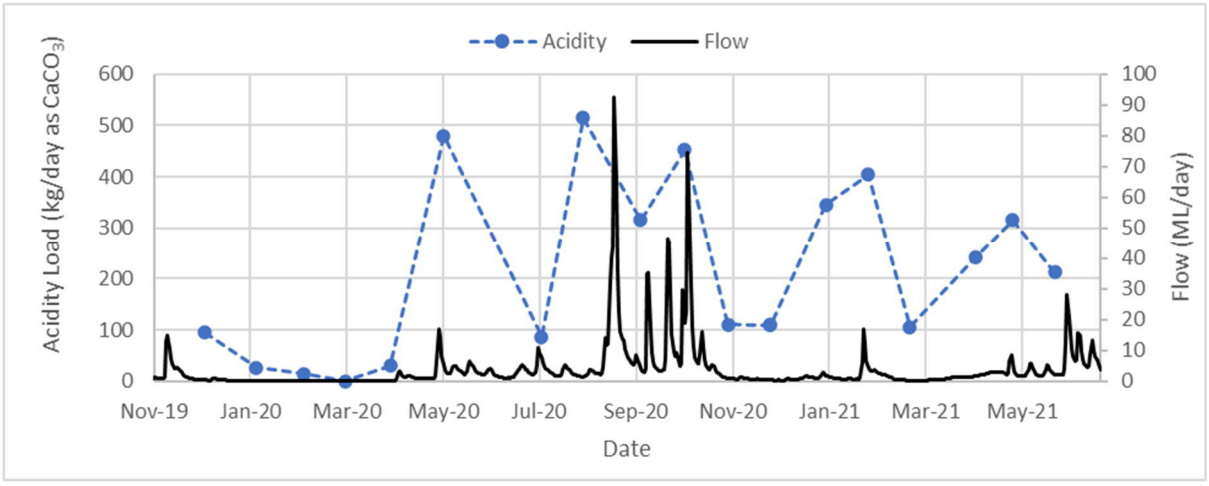


Figure 22: Acidity loads vs flow downstream of Big Swamp

6.0 Further Monitoring and Assessment

The following sections present summaries of the data collected and preliminary analysis that has been undertaken in addition to the information presented above in relation to the REPP success targets. It also includes a summary of the technical assessments that have been undertaken, as well as some of the regional groundwater information previously reported in the Gerangamete Groundwater Licence Annual Report.

6.1 Big Swamp groundwater levels

Groundwater level data for the monitoring bores in Big Swamp that were identifed in the REPP for remediation success targets have been presented and discussed in section 5.3 Big Swamp groundwater levels. Hydrographs for all of the Big Swamp monitoring bores have been provided in Appendix A – Big Swamp Groundwater Hydrographs.

The location of each monitoring bore in Big Swamp is illustrated in Figure 23 below. This figure has been included to demonstrate the proximity of surface water flow paths in relation to the monitoring bores to allow discussion of groundwater and surface water connection and potential influence on groundwater chemistry.

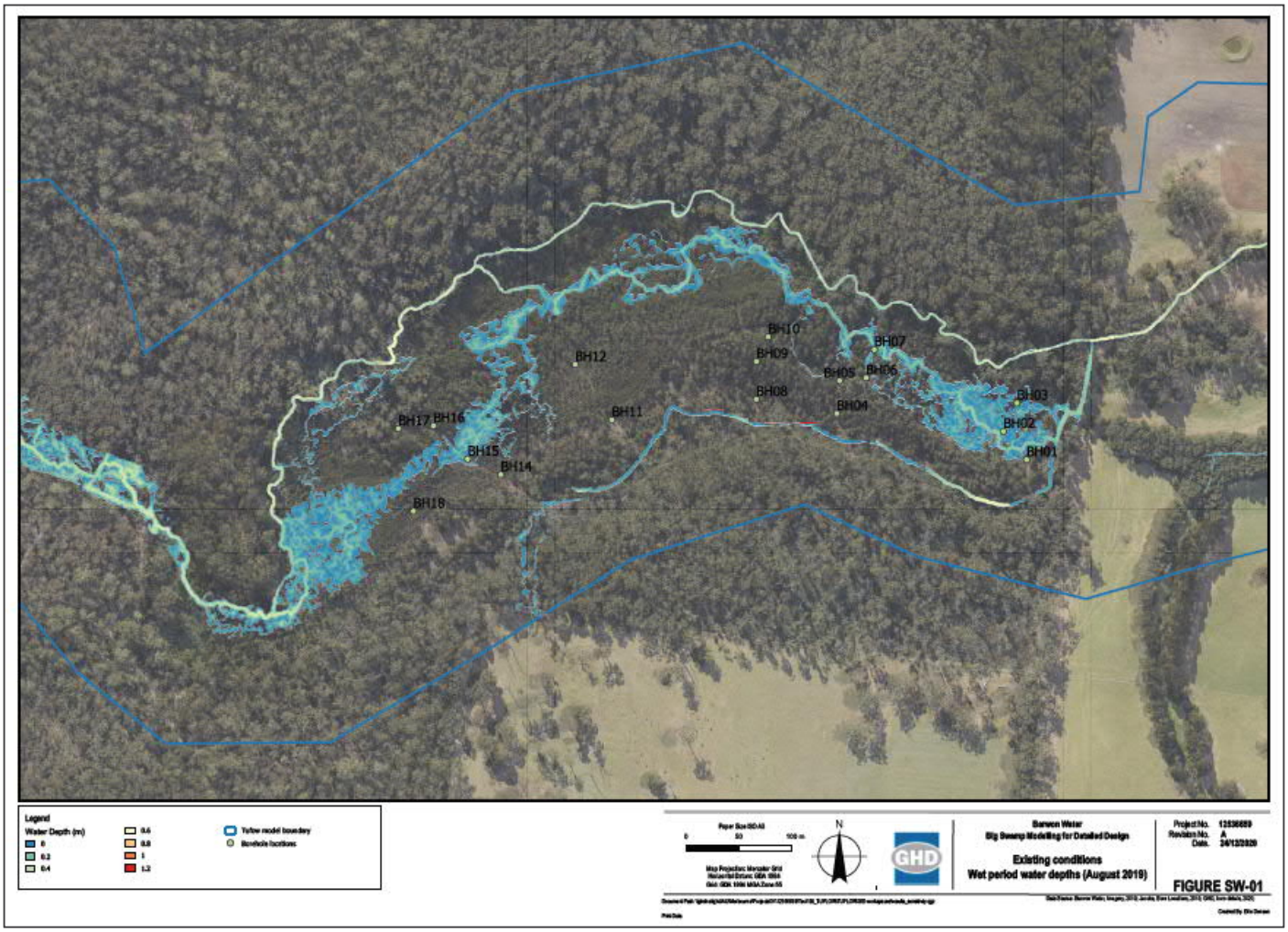


Figure 23: Monitoring bore locations in Big Swamp

Transect 1

Transect 1 is comprised of monitoring bores BH01, BH02 and BH03 which are located near the eastern (downstream) end of the swamp. Groundwater responses along this transect peaked in October at between 0.5 and 0.7 m above ground level (agl), falling to between 0.3 m below ground level (bgl) and 0.1 m agl in March. The groundwater levels are similar between BH02 and BH03 while the groundwater levels at BH01 are slightly lower. Groundwater levels along the transect exhibit responses similar to surface water flows at the gauge downstream of Big Swamp. Groundwater levels over the 2020-21 monitoring period were generally higher than during the 2019-20 monitoring period, particularly at BH03 and BH02.

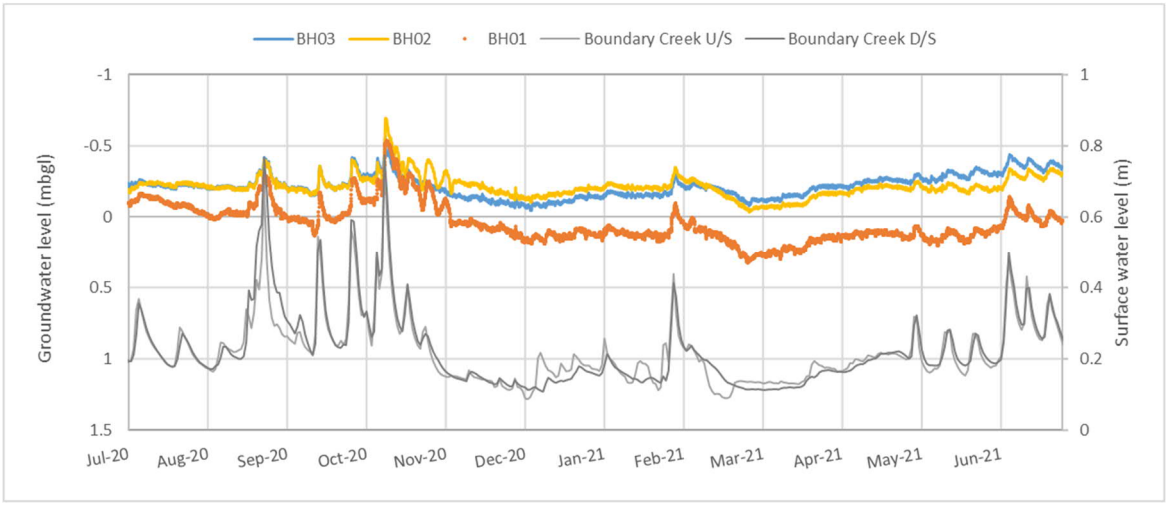


Figure 24: Groundwater hydrograph at transect 1 and streamflow upstream and downstream of Big Swamp

Transect 2

Transect 2 is comprised of monitoring bores BH04, BH05, BH06 and BH07.

Groundwater levels in BH04 exhibited minimal seasonal variation and levels were around ground surface over the monitoring period, suggesting limited interaction with surface water.

BH05 and BH06 exhibited greater variation, with increases of around 0.5 m in response to individual flow events, suggesting greater connection to surface water. This is consistent with the modelled surface water flow paths in the swamp which indicate that BH04 is the furthest from surface water flow paths in this transect.

Groundwater levels in BH06 ranged from 0.1 m bgl in October 2020 to 1 m bgl in March 2021. The drop in groundwater levels coincide with lower stream levels and suggest close connection to surface water. Groundwater levels in BH07 remained around 0.5 m agl between July and November 2020 before falling by around 0.4 m to 0.14 m agl in March 2021.

Groundwater levels in BH06 are the most responsive in the transect, followed by and BH05, BH07 and finally BH04. This may reflect the relative order in which groundwater interacts with surface water along this transect and the relative proximities to surface water flow paths.

Groundwater levels during the 2020-21 monitoring period were generally higher along the transect compared to the 2019-20 monitoring period, particularly over the summer months in which levels in 2021 were approximately 0.5 m higher than during the equivalent period in 2021.

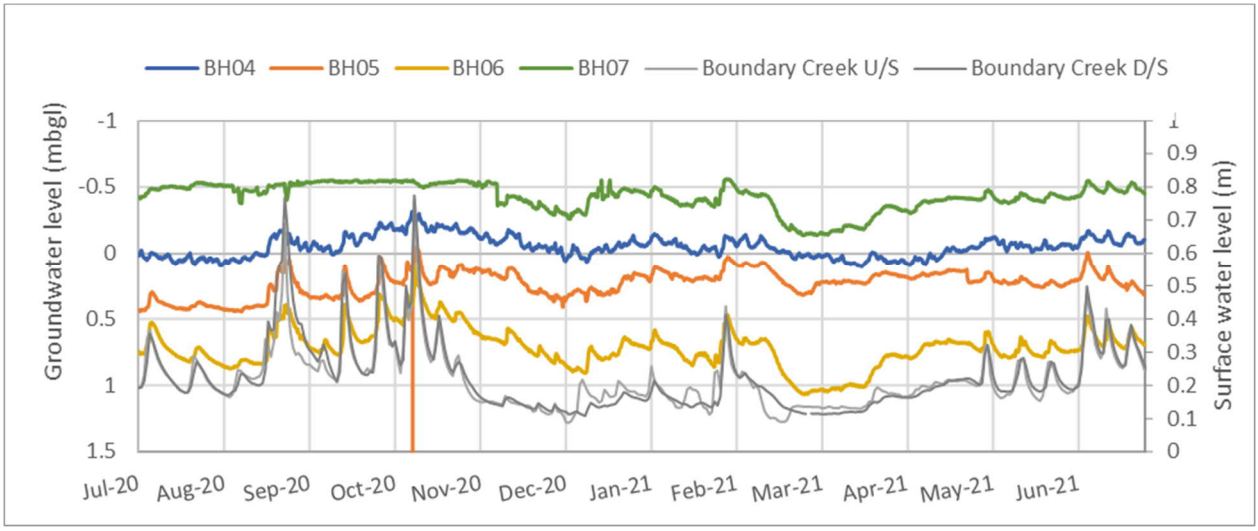


Figure 25: Groundwater hydrograph at transect 2 and streamflow upstream and downstream of Big Swamp

Transect 3

Transect 3 is comprised of monitoring bores BH08, BH09, and BH10.

Groundwater levels in BH08 exhibited minimal variation in response to individual flow events. Levels were ~0.7 m bgl over the monitoring period, but did decline in February when flow through the swamp diminished. This response is similar to BH04 in transect 1 and consistent with limited groundwater-surface water interaction towards the southern boundary of the swamp further from surface water flow paths.

Groundwater levels in BH09 and BH10 increased by up to 0.4 m in response to individual flow events. This indicates that groundwater is relatively connected to surface water at these sites. In BH10, levels ranged from ~0.4 m bgl in January 2021 to 1 m bgl in February, while BH09 had a deeper water levels around 1 m bgl.

Groundwater levels in BH09 and BH10 exhibited an increase between February and March which did not coincide with any flow increase in Boundary Creek.

The rapid decline in groundwater levels in BH10 following diminished flows in early February illustrate the importance of flow maintenance in maintaining higher groundwater levels at this location.

Groundwater levels in this transect were significantly higher during the 2020-21 monitoring period than during the 2019-20 monitoring period, with summer level minimums of 0.8 to 1.2 m bgl observed during 2021 compared to between 1.0 and 1.7 m bgl during the equivalent 2020 period.

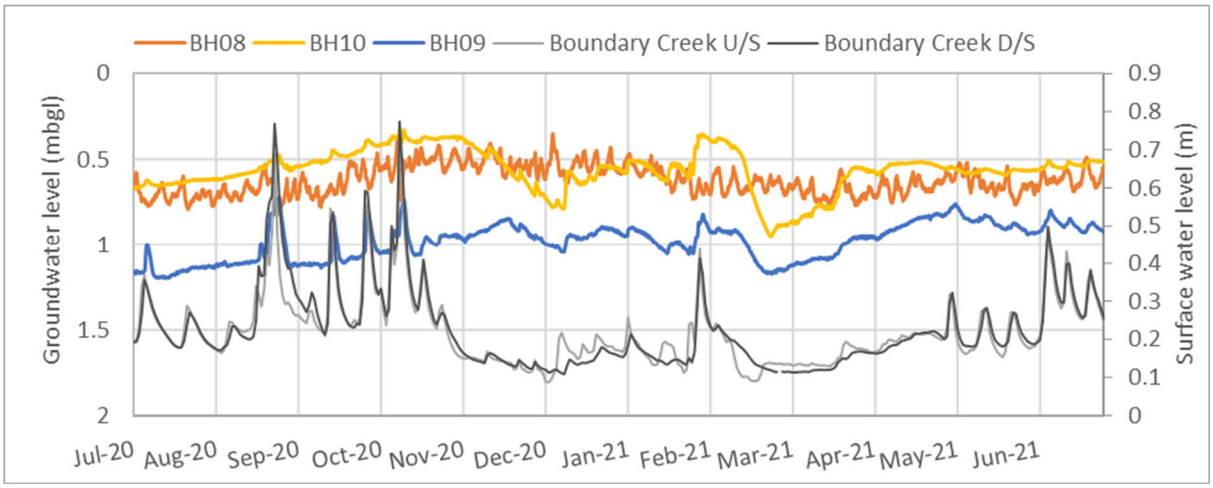


Figure 26: Groundwater hydrograph at transect 3 and streamflow upstream and downstream of Big Swamp

Transect 4

Transect 4 is comprised of monitoring bores BH11 and BH12.

Groundwater levels in BH11 and BH12 increased by ~0.5 m in response to individual flow events, indicating some connection to surface water, though responses tended to be greater at BH11 than BH12. Levels in BH11 fell from ~1.0 m bgl in November to ~1.5 m bgl in February-March, while those in BH12 exhibited limited decline over the same period.

The minimum groundwater levels observed during the 2020-21 monitoring period were higher than observed during the 2019-2020 period, with minimum groundwater levels of between 1.2 and 1.5 m bgl observed during the 2021 summer compared to between 1.5 and 2.1 m bgl over the equivalent 2020 period.

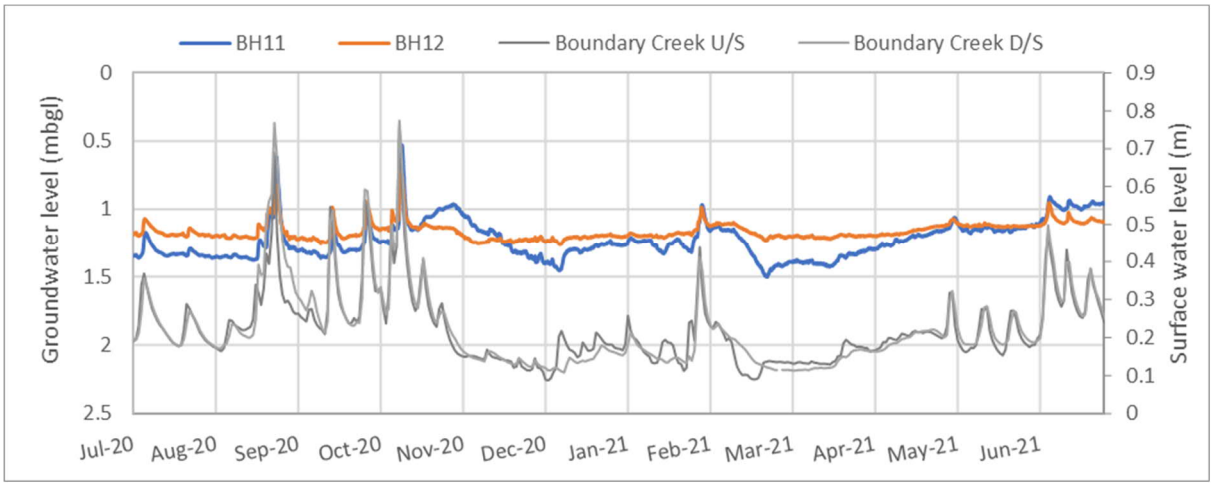


Figure 27: Groundwater hydrograph at transect 4 and streamflow upstream and downstream of Big Swamp

Transect 5

Transect 5 is comprised of monitoring bores BH14, BH15, BH16 and BH17.
Groundwater levels in BH14 exhibited diminished increases to individual flow events and seasonal fluctuations from around 1.0 m bgl in December 2020 to between 0.5 m bgl in July 2021. These responses are consistent with other bores located along the southern boundary of the swamp at greater distance from surface water flow paths, such as BH04 and BH08.

Groundwater levels in BH17 also exhibited minimal response to individual events, which may reflect a greater distance away from the two major modelled surface water flow paths. Level's in BH17 did fall from around 0.5 m bgl in November 2020 to 1.5 m bgl in March in response to drier summer conditions.

Groundwater levels in BH15 and BH16 exhibited minor responses to individual flow events under wet conditions between June and September. Between October and December, groundwater levels in these bores fell relatively rapidly, from approximately 0.5 and 1.0 m bgl, respectively, to approximately 1.5 and 2.1 m bgl. The decline in groundwater levels coincides with a reduction in surface water levels from 0.8 m to 0.1 m, suggesting that such changes in the flow regime has a critical impact on groundwater levels in this area.

The minimum groundwater levels observed during the 2020-21 monitoring period were approximately 0.5 m higher at BH14, BH15 and BH17 during drier summer conditions compared to the equivalent conditions during the 2019-20 monitoring period. The range in groundwater levels observed at BH16 were similar during the 2020-21 monitoring period compared to the 2019-20 monitoring period.

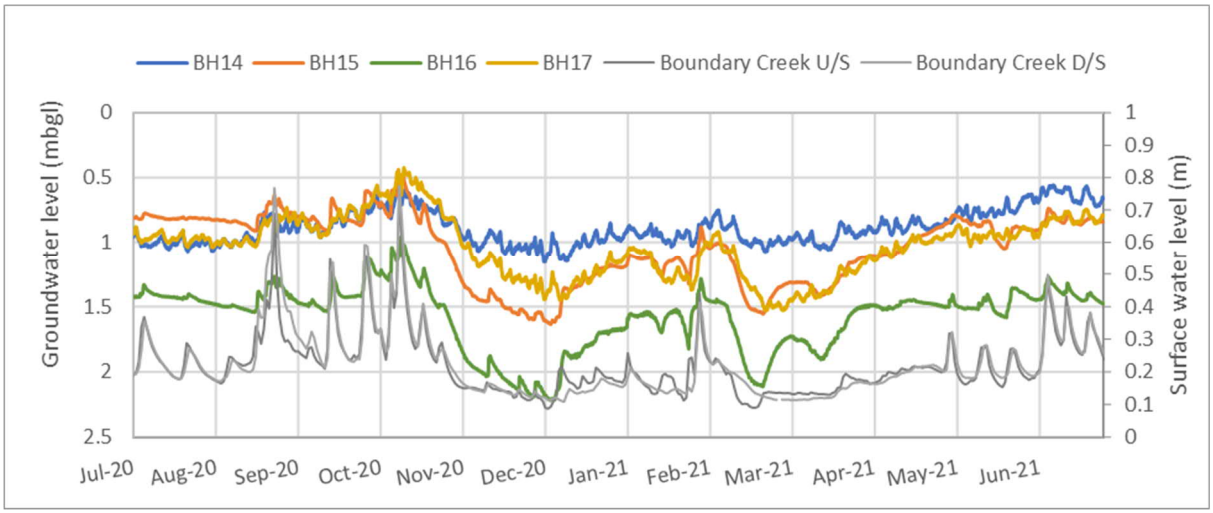


Figure 28: Groundwater hydrograph at transect 5 and streamflow upstream and downstream of Big Swamp

BH18

Groundwater levels in BH18 ranged from approximately 1.0 m bgl to 0.5 m bgl. Both the range and minimum groundwater levels observed during the 2020-21 monitoring period were lower than during the 2019-20 period, with an increase in the minimum level of ~0.5 m and a commensurate reduction in the range.

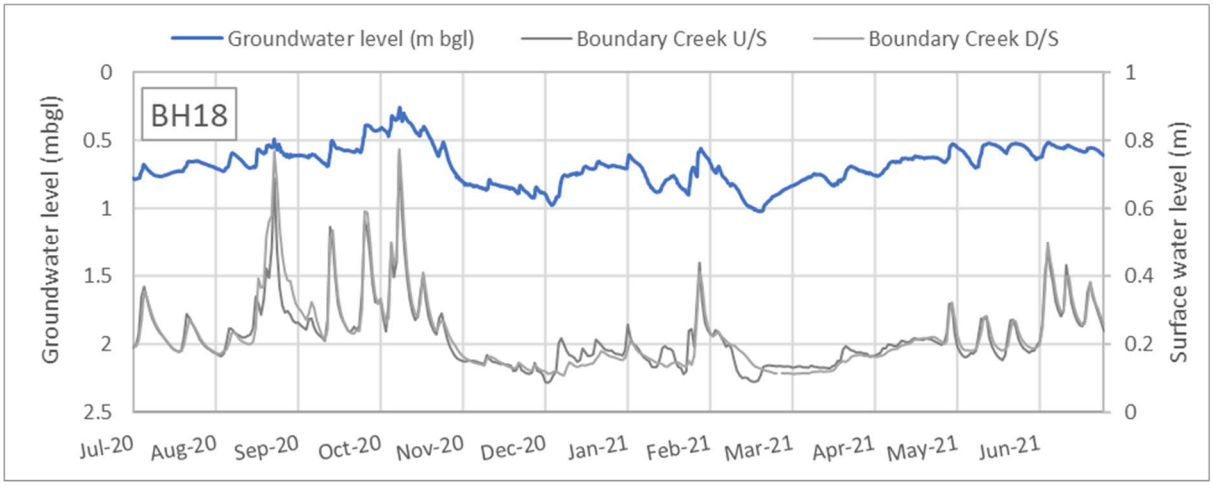


Figure 29: Groundwater hydrograph at transect BH18 and streamflow upstream and downstream of Big Swamp

TB1 Bores

Groundwater levels in TB1c screened in the LTA exhibited an increase of ~0.2 m over the 2020-21 monitoring period and a maximum level ~1 m higher than the minimum observed during the 2019-20 monitoring period. This is consistent with the ongoing recovery of groundwater levels in the LTA following the cessation of groundwater extraction from the aquifer.

Groundwater levels in TB1a (screened in the alluvial aquifer) and TB1b (screened in the MTD) ranged from 2 to 0.5 m bgl and are similar to fluctuations observed during the 2019-20 period. Levels in TB1a were more varied than TB1b and exhibited responses more similar to surface water hydrographs, as is anticipated for the alluvial aquifer with greater connection to surface driven processes.

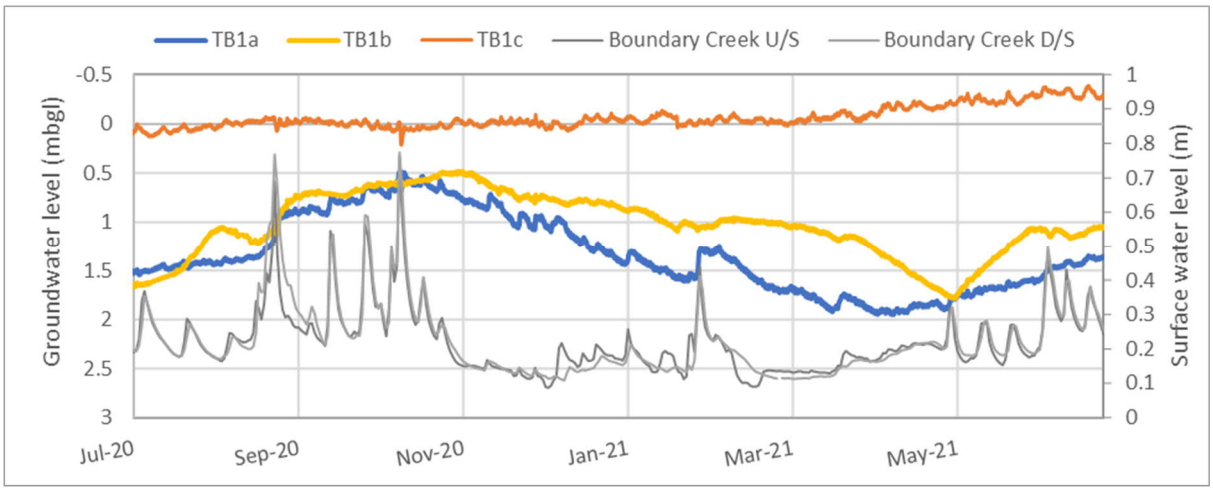


Figure 30: Groundwater hydrograph at transect TB1 and streamflow upstream and downstream of Big Swamp

6.2 Water quality

6.2.1 Dissolved ions

Aluminium concentrations upstream of Big Swamp ranged from <0.01 to 0.12 mg/L and were below the guideline for protection of 95% of freshwater aquatic species (ANZECC & ARMCANZ, 2000). Concentrations downstream of the swamp ranged from 1.0 to 11 mg/L and would be above the guideline values for pH values >6.5. While the range in aluminium concentrations for the 2020-21 monitoring period remains similar to those observed during the 2019-20 monitoring period, a clear yet variable decline in aluminium concentrations is apparent since December 2019 as evident in Figure 31.

In contrast and as shown in Figure 33, concentrations of iron, particularly iron (II), have increased since October 2020, with concentrations increasing from 4.8 mg/L in October 2020 to 80 mg/L in March 2021. The average concentration over the 2020-21 monitoring period was 45 mg/L compared to <25 mg/L over the 2019-20 period.

This data indicates a shift in the relative contribution of acidity in surface water discharging from Big Swamp, with a higher proportion of acidity in the 2019-20 period derived from aluminium and H+ ions, and a higher proportion over the 2020-21 period derived from iron (II). This is consistent with the maintenance of reducing conditions in the swamp under relatively wet conditions in 2020-21, resulting in increased iron reduction, higher pH values and subsequently, lower concentrations of dissolved aluminium (as a result of the reduced solubility of aluminium at higher pH values).

Importantly, and as discussed in the section above, these results indicate a shift in the relative contribution of acidity and not a net reduction in the concentration or load of acidity discharging from Big Swamp. It would be anticipated that a higher contribution of acidity derived from iron (II) would ultimately yield similar pH effects on the Barwon River via oxidation to iron (III) to those associated with aluminium and H+ derived acidity. However, it would also be anticipated that the oxidation of iron (II) to iron (III) would occur further along the flow path of Boundary Creek or the Barwon River. This is consistent with observations made by Austral (2021) which found iron floc (iron (III) hydroxide) build ups near the confluence of Boundary Creek and the Barwon River during 2021.

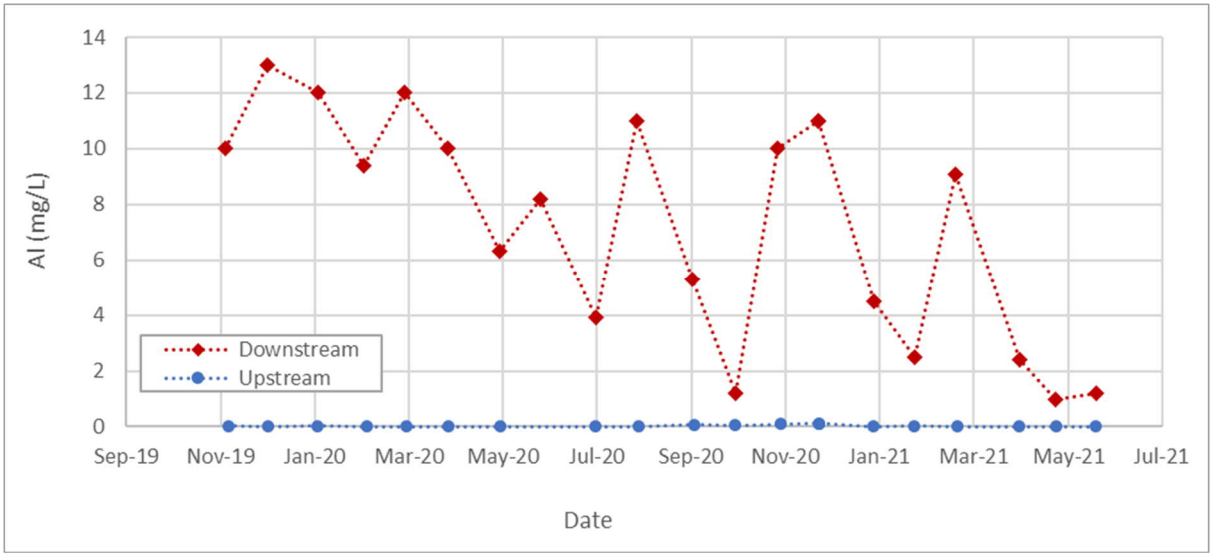


Figure 31: Aluminium concentrations in surface water upstream and downstream of Big Swamp

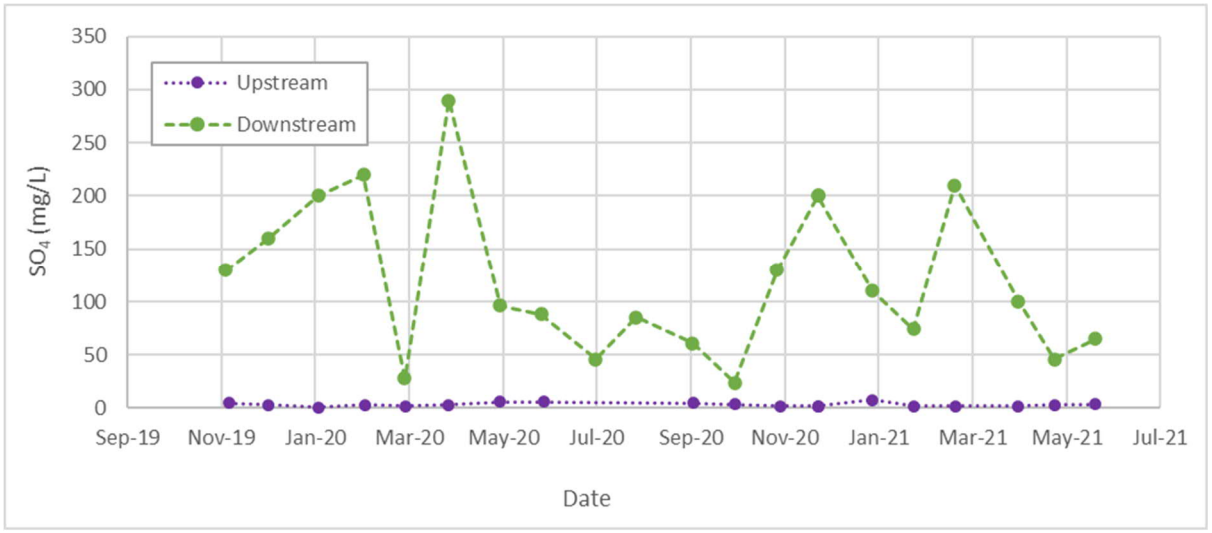


Figure 32: Sulfate concentrations in surface water upstream and downstream of Big Swamp

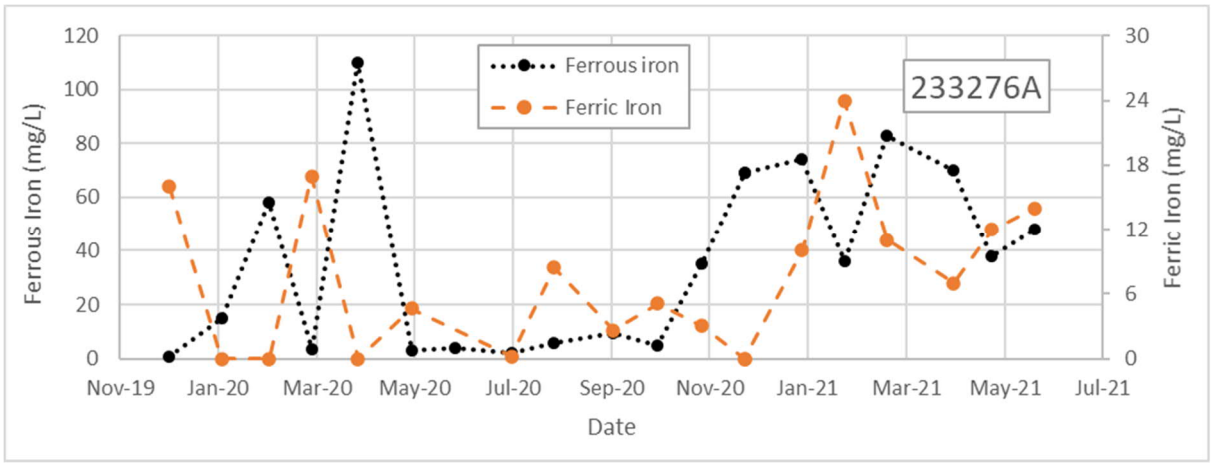


Figure 33: Iron (II) and Iron (III) concentrations in surface water upstream and downstream of Big Swamp

6.2.2 Groundwater chemistry

A comprehensive review of groundwater chemistry was undertaken as part of the Hydrogeochemical modelling of Big Swamp and Boundary Creek (Jacobs, 2021). This indicated that the key analytes associated with acid sulfate soil processes in big swamp and potential water quality impacts to Boundary Creek and the Barwon River were associated with acidity, pH, iron, aluminium and sulfate. Accordingly, the below section summarises trends in these analytes over the 2020-21 monitoring period.

Figure 34 below summarises the average concentration of acidity in groundwater at individual monitoring bores in Big Swamp (+/- 1 SD) while Figure 35 illustrates how these concentrations vary spatially. Accordingly, the figures illustrate that groundwater acidity in Big Swamp tends to be lower in the downstream portion of the swamp (across transects 1 and 2) and along the southern margin of Big Swamp (at BH14, BH08 and BH04).

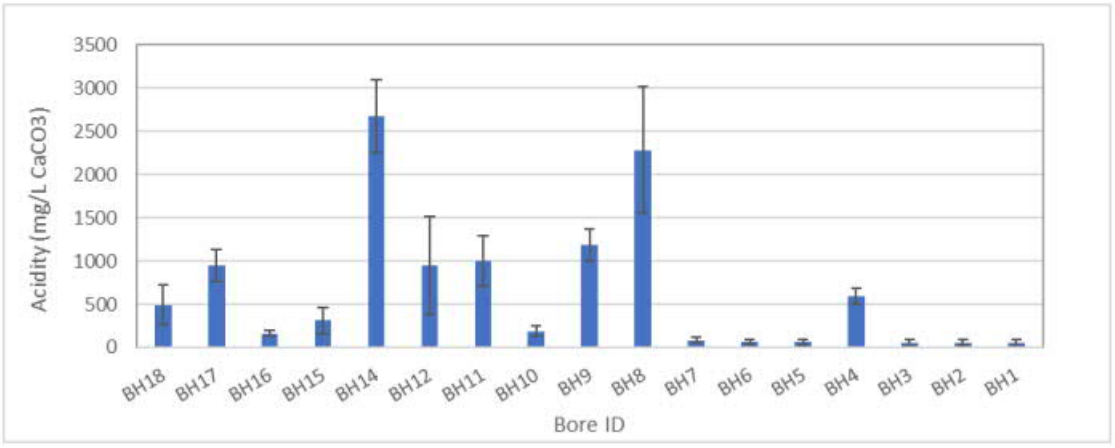


Figure 34: Average groundwater acidity in Big Swamp – error bars indicate +/- 1SD (Jacobs, 2021)

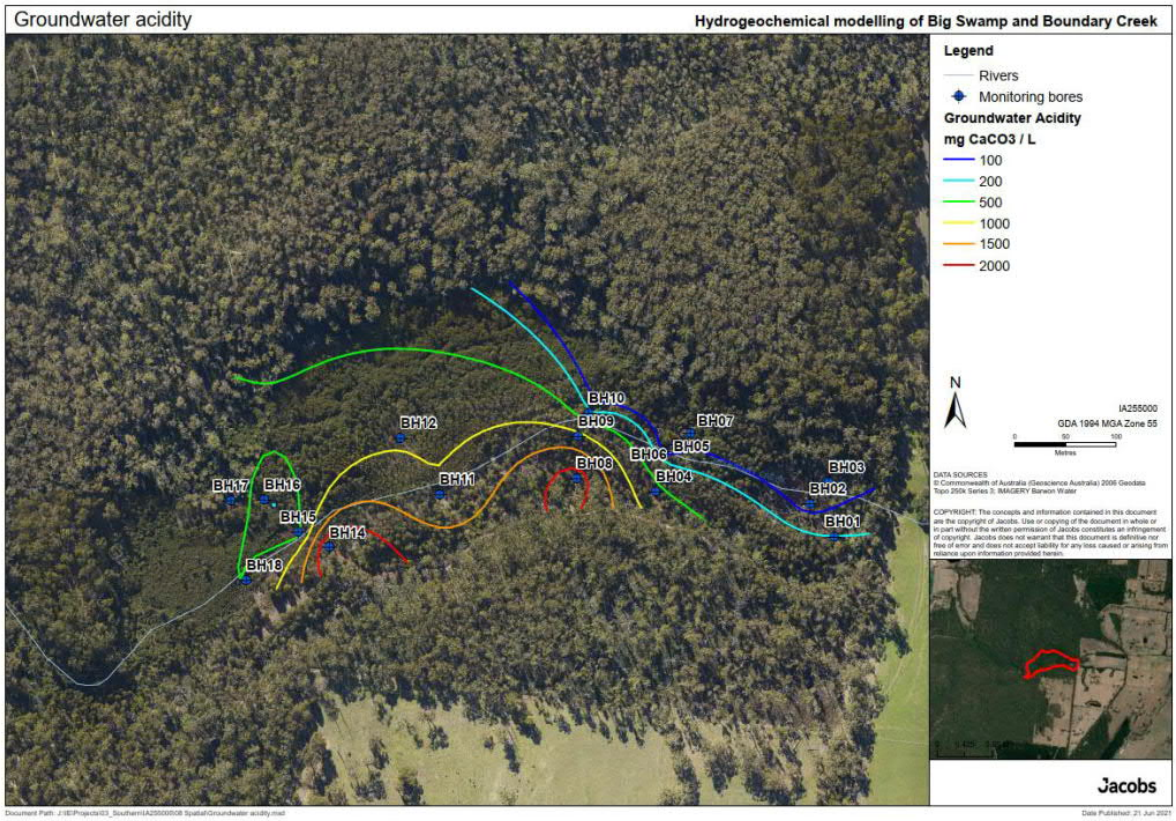


Figure 35: Spatial variability of groundwater acidity across Big Swamp (Jacobs, 2021)

Transect 1

Groundwater pH is illustrated in Figure 36 and shows that with the exception of one sample collected in BH02 during November 2020, groundwater pH in this transect ranged between 6.4 and 7.3 and is relatively consistent with monitoring in 2019-20 in which pH ranged from 5.6 to 7.3. The concentration of groundwater acidity ranged from 34 to 252 mg/L along the transect over the monitoring period (
Figure 37). These concentrations are relatively low compared to other transects suggesting that the flushing of acidity from this portion of the swamp has already occurred to some degree. Peak concentrations occurred during the 2020-21 summer period, likely as a result of a combination of reduced dilution from rainfall infiltration and surface water interaction, sulfide oxidation and the evapo-concentration of acidity in groundwater during this time.

Groundwater aluminium concentrations along Transect 1 were low or below detection due to the low solubility of aluminium at the pH range observed, indicating that aluminium is not likely to be the key driver of acidity of groundwater in this portion of the swamp.

Concentrations of iron (II) and iron (III) in groundwater were typically <40 mg/L along the transect, indicating that groundwater acidity is dominantly derived from iron. Concentrations of iron (II) decreased during the 2020-21 summer period while concentrations of iron (III) increased, suggesting a decrease in iron reduction during the summer period when surface water flows and groundwater levels are lower. This is consistent with enhanced sulfide oxidation and/or the oxidation of iron (II) to iron (III) via enhanced oxygen availability in the groundwater system at this time when groundwater levels decline and is consistent with observations made during 2019-20 annual reporting.

Concentrations of sulfate in groundwater along Transect 1 were ≤6 mg/L over the 2020-21 monitoring period. This represents a significant decline in sulfate concentrations in BH01 compared to the 2019-20 monitoring period and the likely flushing of sulfate from the groundwater system. Further, there is no clear seasonal variability in sulfate concentrations over the monitoring period. This suggests that variations in iron (II) and iron (III) concentrations discussed above are more likely to be related to the shifts between the relative oxidation states and not the input of iron via sulfide oxidation, as a correlation between iron and sulfate concentrations would be expected if this was the case.

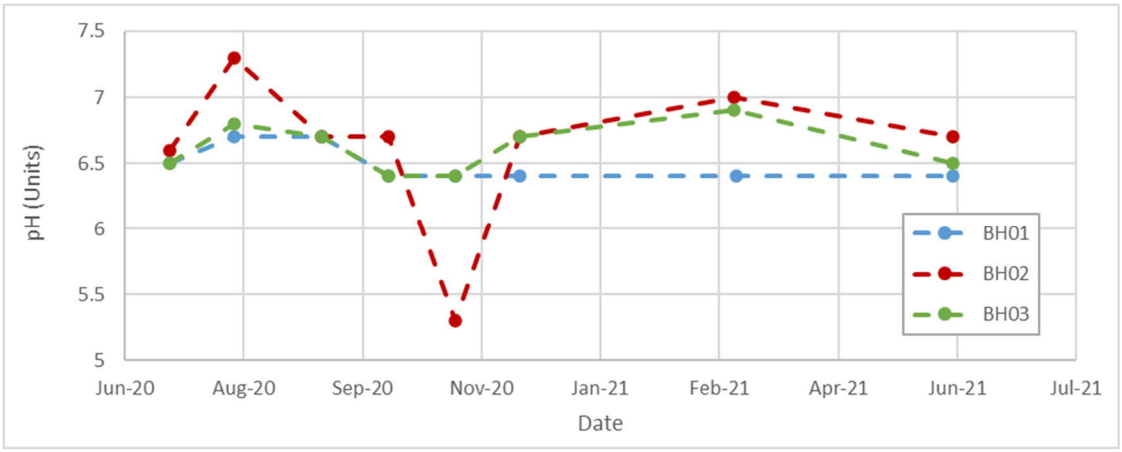


Figure 36: Groundwater pH along Transect 1

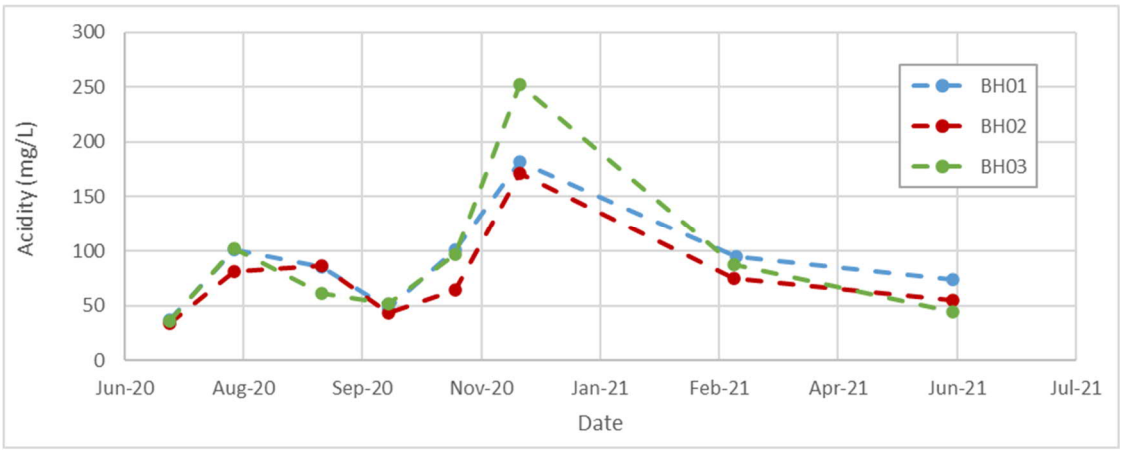


Figure 37: Groundwater acidity concentrations along Transect 1

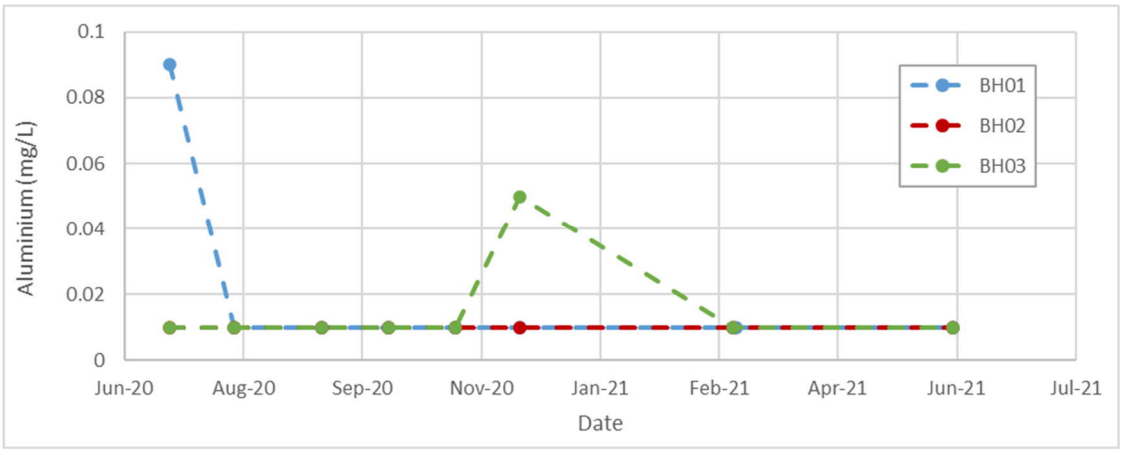


Figure 38: Groundwater aluminium concentrations along Transect 1

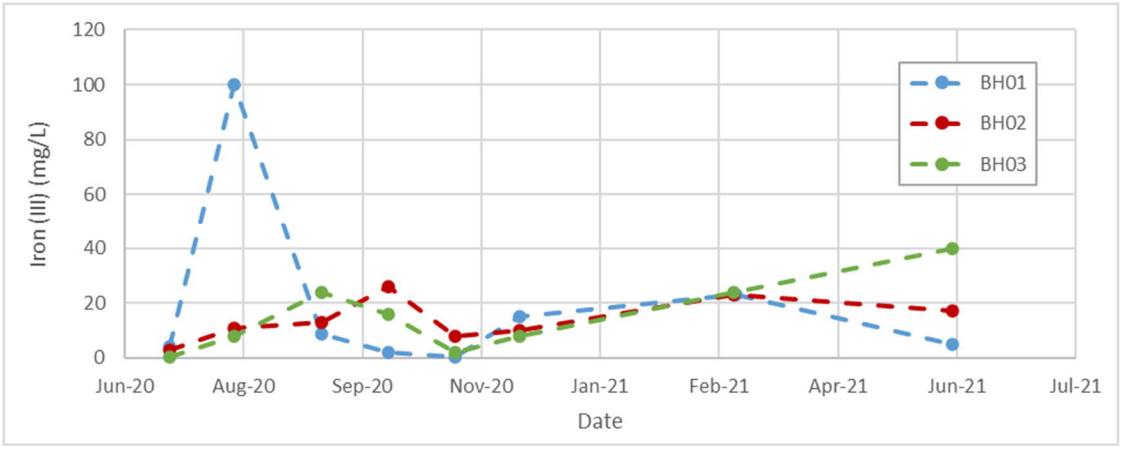


Figure 39: Groundwater iron (III) concentrations along Transect 1

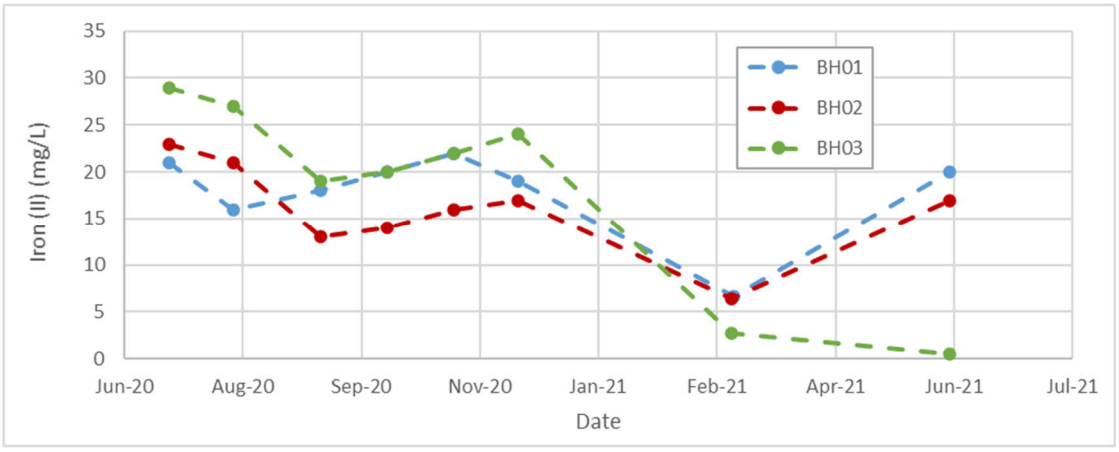


Figure 40: Groundwater iron (III) concentrations along Transect 1

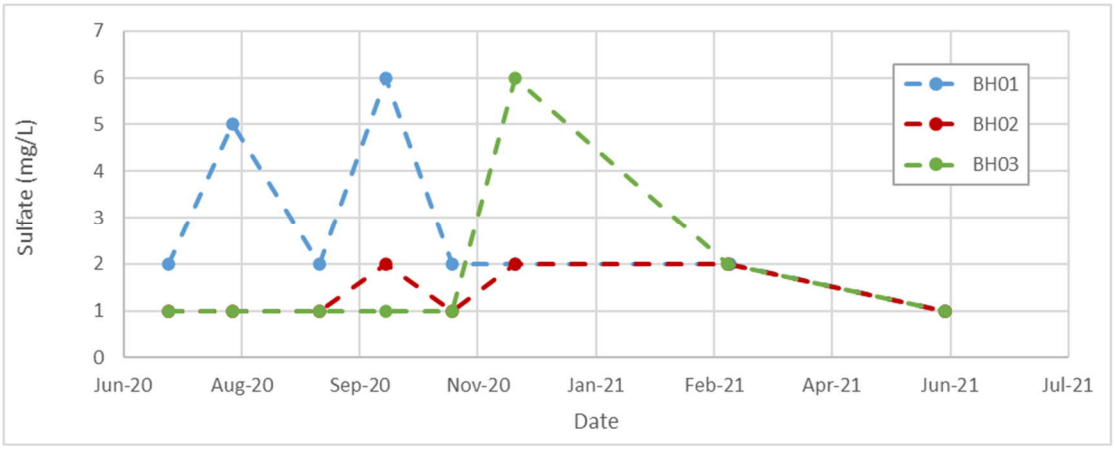


Figure 41: Groundwater sulfate concentrations along transect 1

Transect 2

Groundwater pH along Transect 2 ranged from 5.5 to 6.6 at BH05, BH06 and BH07 and from 4.4 to 5.5 at BH04. This is consistent with higher concentrations of acidity at BH04 and generally consistent with observations during the 2019-20 monitoring period.

Concentrations of groundwater acidity ranged from 36 to 520 mg/L across the transect and were generally higher at BH04 compared to other bores. However, concentrations of acidity in BH04 exhibited a consistent decline over the monitoring period from over 500 mg/L in June to August 2020 to 232 mg/L in June 2021, suggesting the ongoing flushing of acidity from groundwater in this location. Concentrations of acidity at BH05, BH06 and BH07 increased during the 2020-21 summer period, likely as a result of a combination of reduced dilution from rainfall infiltration and surface water interaction, sulfide oxidation and the evapo-concentration of acidity in groundwater during this time.

Similar to the 2019-20 monitoring period, the concentration of iron (II) and iron (III) were variable across Transect 2 and no clear seasonal trend was observed. Concentrations over the monitoring period were 0.2-190 mg/L for iron (III) and 0.1-410 mg/L for iron (II) and were similar to the 2019-20 monitoring period. Of interest, a consistent decline in the concentration of Fe (II) was observed in BH04 over the 2020-21 monitoring period from over 300 mg/L in July-August 2020 to <150 mg/L in June 2021. This suggests the flushing of iron (II) from groundwater in this area, which has resulted in a reduction in the overall concentration of acidity in this area.

Aluminium concentrations were ≤0.08 mg/L in groundwater in BH05, BH06 and BH07 and ranged from 7.6 to 2.5 mg/L in BH04. This represents a general decline in aluminium concentrations across the transect compared to the 2019-20 monitoring period, particularly in BH04 which fell from >7 to 2.5 mg/L over the monitoring period compared to a fall from 12 to 5.6 mg/L over the 2019-20 monitoring period.

Concentrations of sulfate ranged from 10 to 94 mg/L across BH05, BH06 and BH07 and from 1,200 to 500 mg/L at BH04. Similar to aluminium concentrations, this represents a general decline in sulfate concentrations across the transect compared to the 2019-20 monitoring period, particularly in BH04 which fell from 1,200 to 500 mg/L over the monitoring period compared to a fall from 1,400 to 1,200 mg/L over the 2019-20 monitoring period.

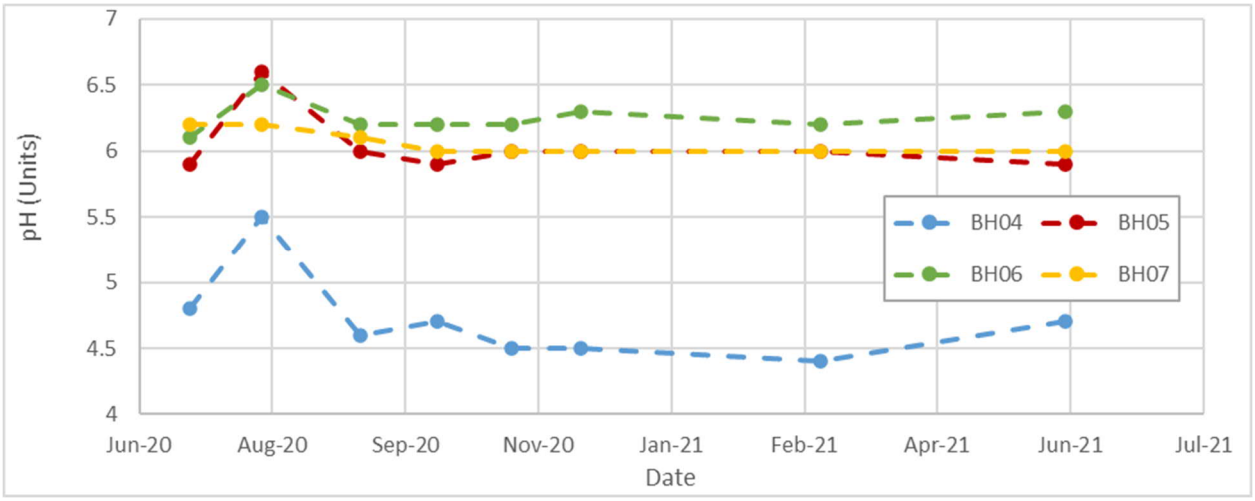


Figure 42: Groundwater pH along Transect 2

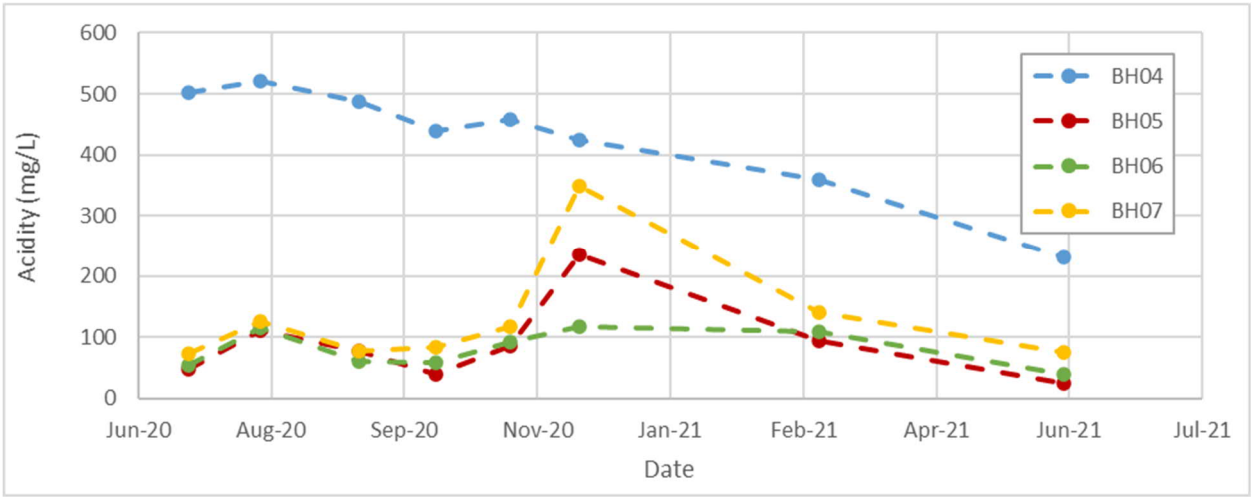


Figure 43: Groundwater acidity concentrations along Transect 2

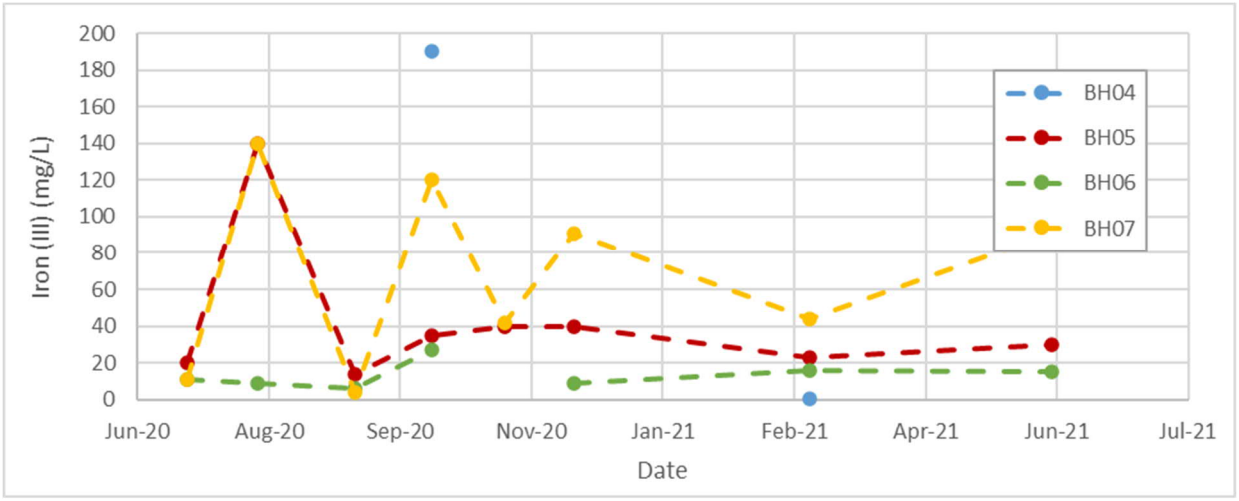


Figure 44: Groundwater iron (III) concentrations along Transect 2

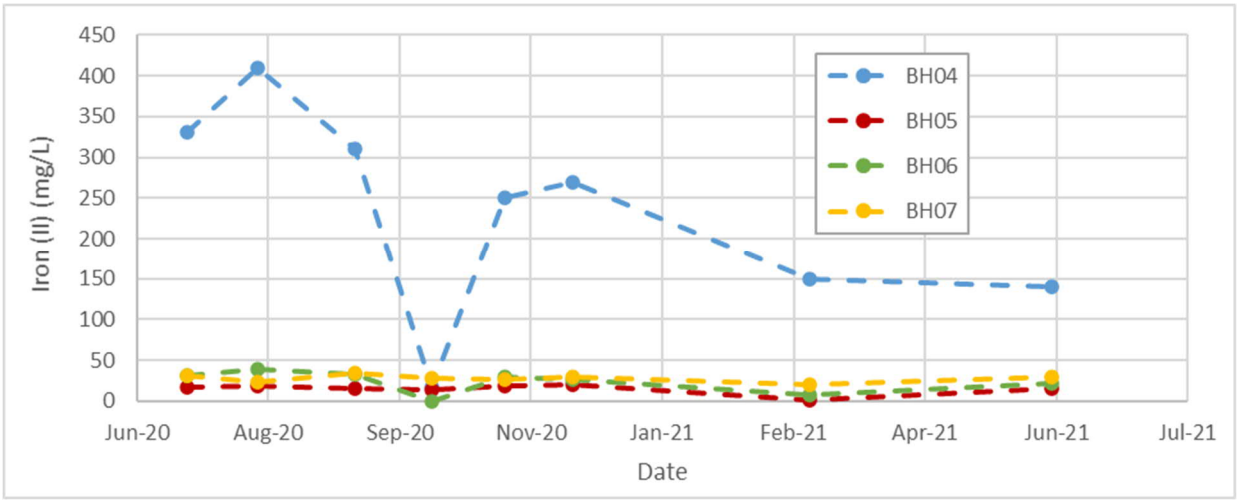


Figure 45: Groundwater iron (II) concentrations along Transect 2

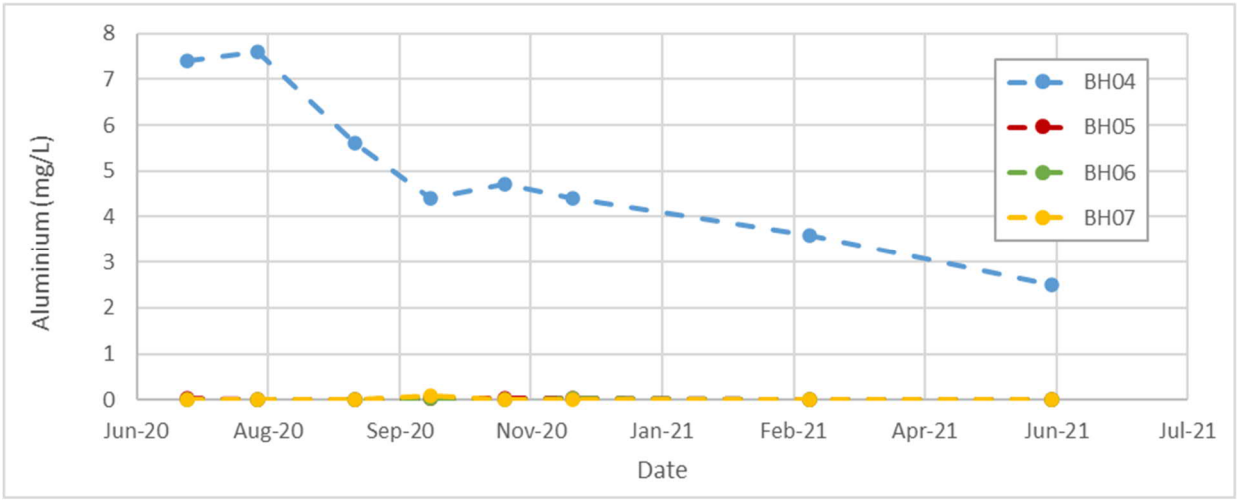


Figure 46: Groundwater aluminium concentrations along Transect 2

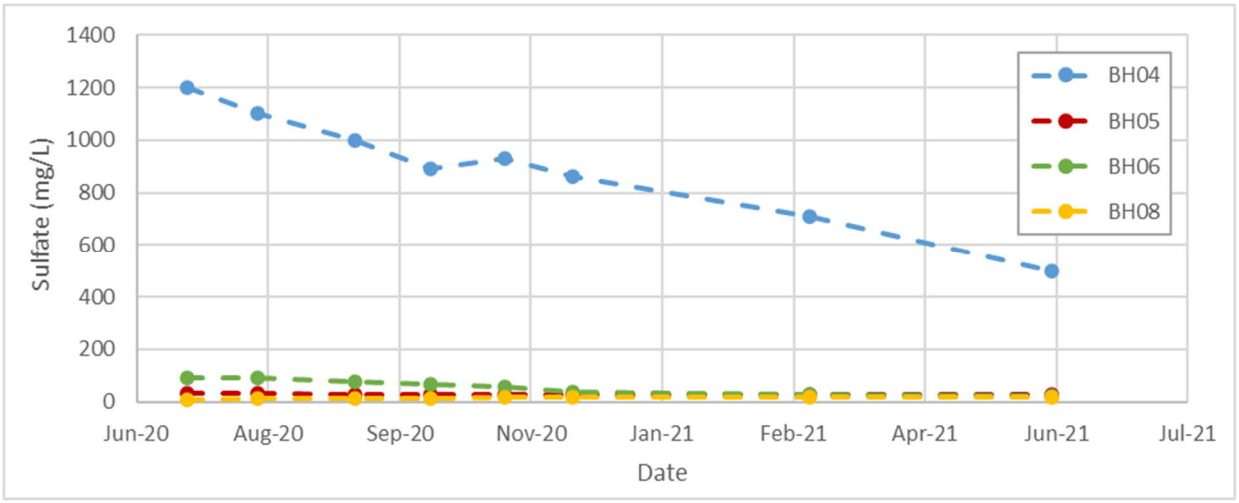


Figure 47: Groundwater sulfate concentrations along Transect 2

Transect 3

Groundwater pH along Transect 3 ranged between 3.5 and 4.5 in BH08 and BH09 and between 5.4 and 6.0 at BH10 during the 2020-21 monitoring period. This is similar to the range in pH observed during the 2019-20 monitoring period.

Similar trends in groundwater acidity concentrations were observed with concentrations ranging between 758 and 2,000 mg/L CaCO3 in BH08 and BH09 and between 77 and 287 mg/L CaCO3 in BH10. This is consistent with prior observations which suggested greater flushing of acidity closer to surface water paths near BH10 compared to BH08 and BH09. A general decline in groundwater acidity was observed in BH08 and BH09 from >1,500 mg/L CaCO3 and >1,000 mg/L, respectively, to <1,000 mg/L CaCO3. This represents a decline in acidity from the 2019-20 monitoring period and suggests the ongoing flushing of acidity from groundwater in this area.

Trends in groundwater acidity are further reflected by trends in the concentrations of iron (II), aluminium and sulfate, with higher concentrations observed at BH08, followed by BH09 and subsequently BH10. Similar to acidity, concentrations in iron (II), aluminium and sulfate declined over the monitoring period in BH08 and BH09.

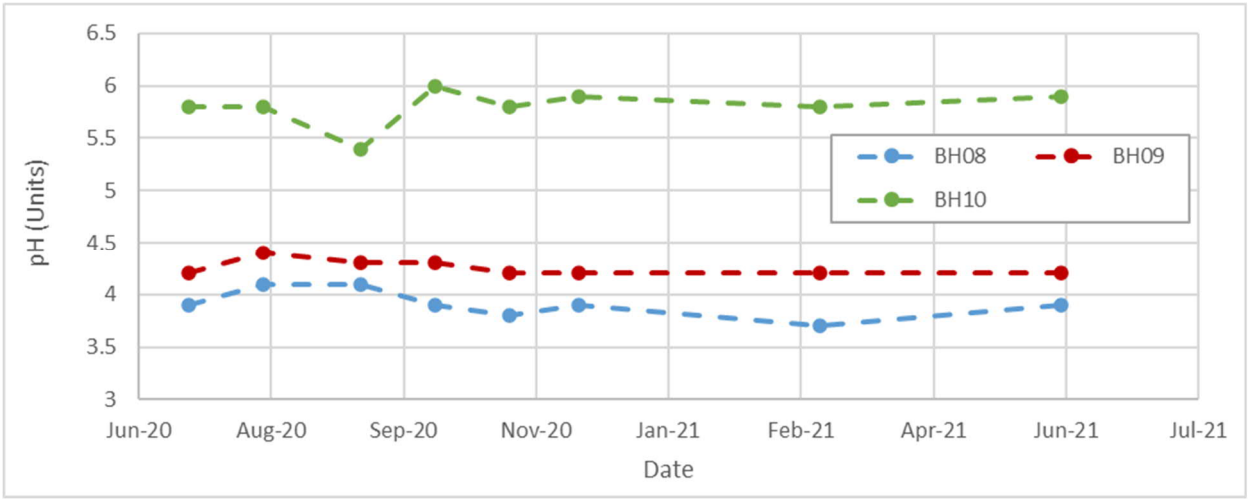


Figure 48: Groundwater pH along Transect 3

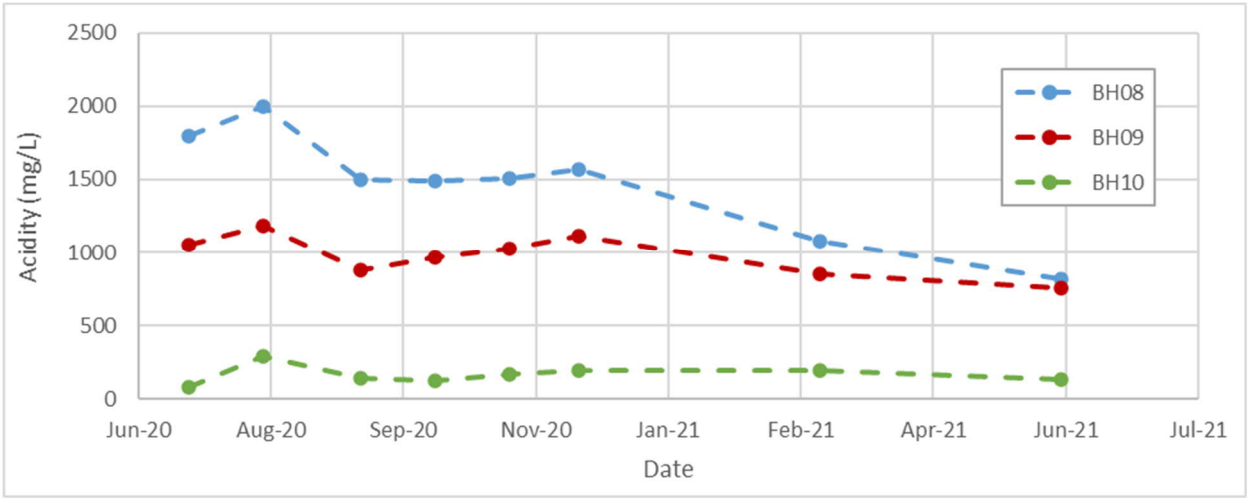


Figure 49: Groundwater acidity concentrations along Transect 3

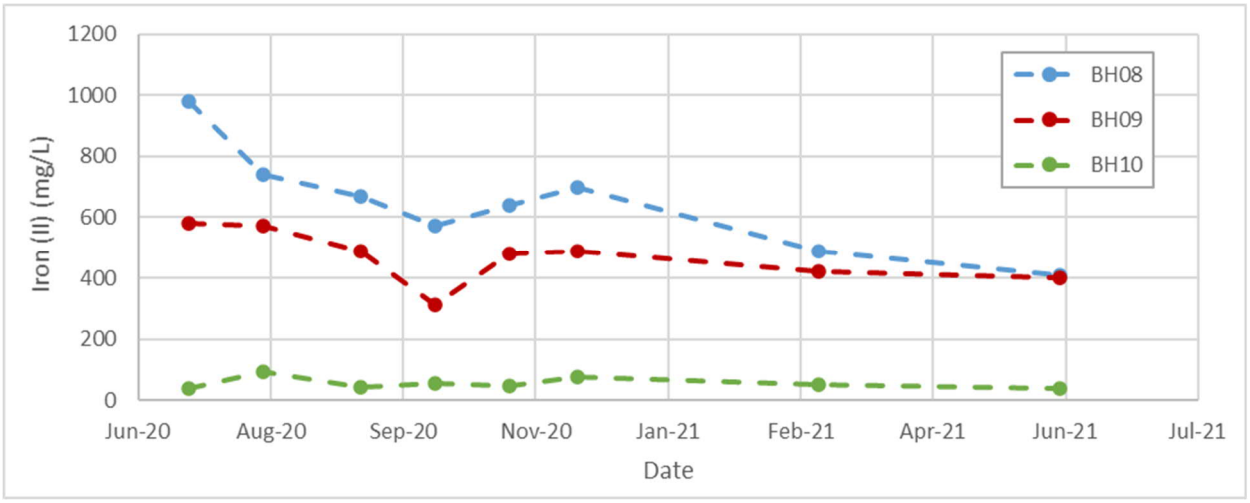


Figure 50: Groundwater iron (II) concentrations along Transect 3

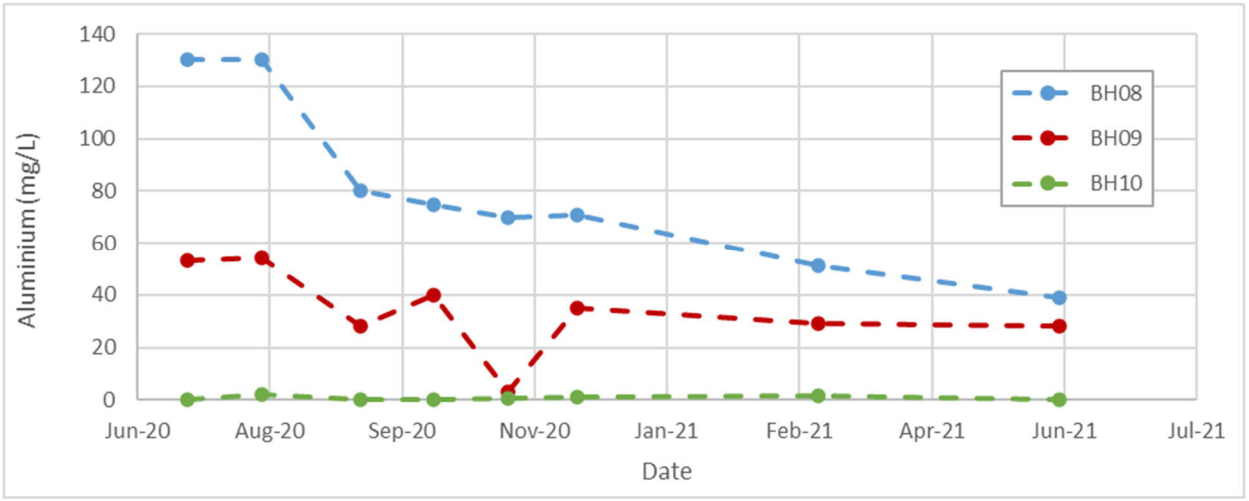


Figure 51: Groundwater aluminium concentrations along Transect 3

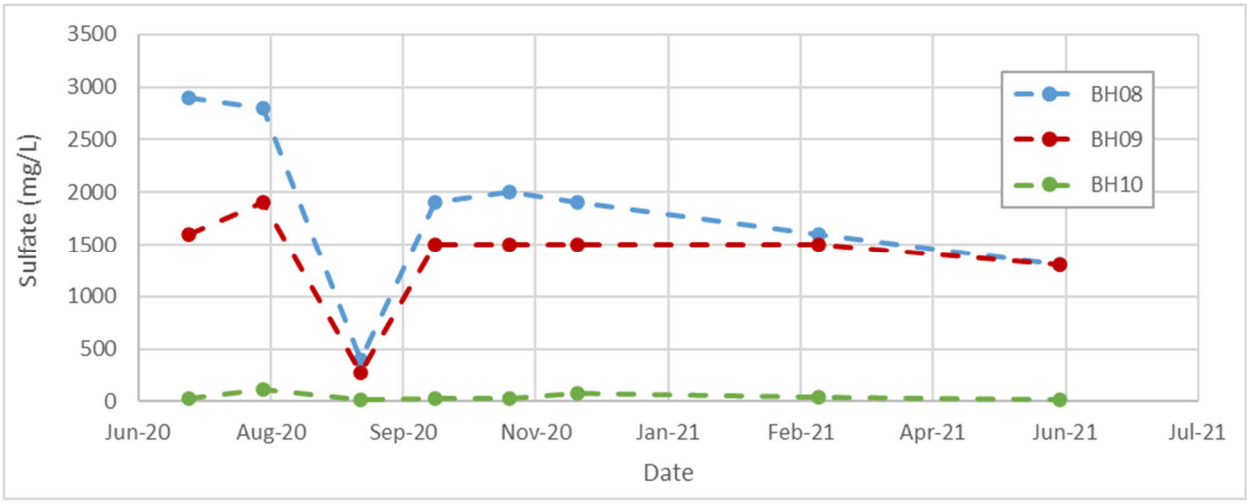


Figure 52: Groundwater sulfate concentrations along Transect 3

Transect 4

Groundwater pH in BH11 and BH12 ranged between 3.0 and 3.5 during the 2020-21 monitoring period and is relatively consistent, though less variable, than the pH values observed in the 2019-20 monitoring period.

Acidity concentrations ranged from 254 to 1,080 mg/L CaCO3 in BH11 and from 524 to 859 mg/L CaCO3 in BH12. These concentrations are broadly consistent with those observed during the 2019-20 monitoring period and represent moderately high concentrations of acidity within the swamp. Similar to the 2019-20 period, concentrations of acidity peaked during December.

Concentrations of iron (II) ranged from 64 to 450 mg/L across the transect, while concentrations of aluminium ranged from 24 to 86 mg/L and sulfate from 410 to 1,600 mg/L. Concentrations of these analytes were more variable at BH11 than BH12, likely reflecting greater groundwater-surface water interaction in this area. A general decline in the concentration of iron (II), aluminium and sulfate was observed over the monitoring period, though this was more apparent and variable in BH11, suggesting greater flushing of acidity from groundwater in this area.

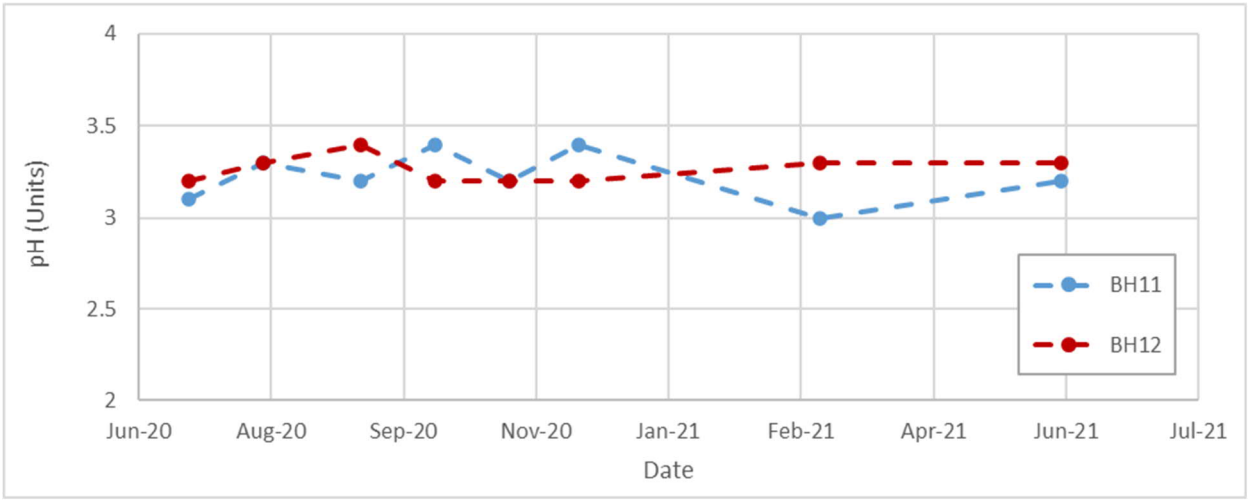


Figure 53: Groundwater pH values along Transect 4

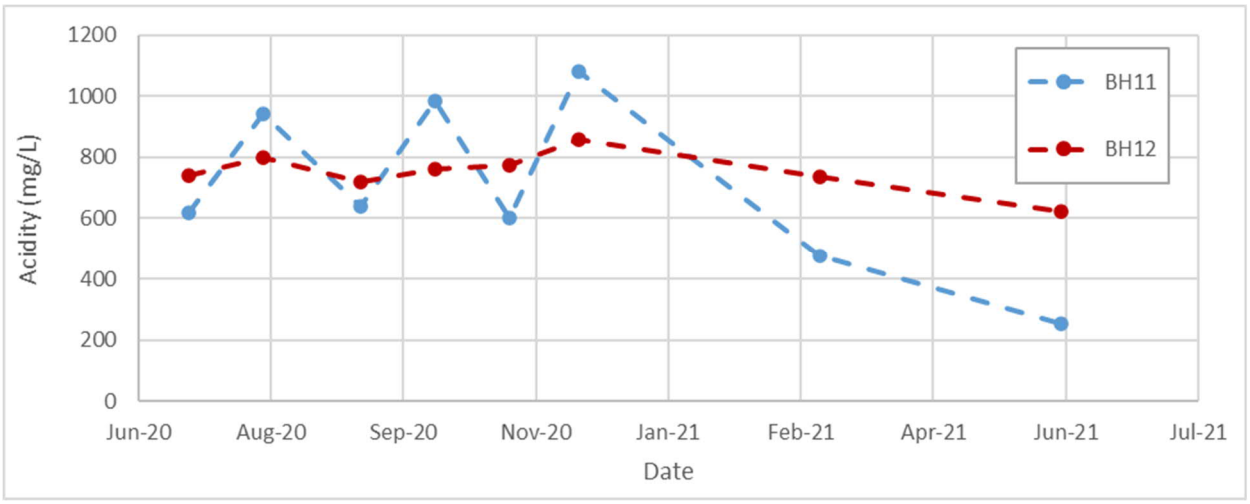


Figure 54: Groundwater acidity concentrations along Transect 4

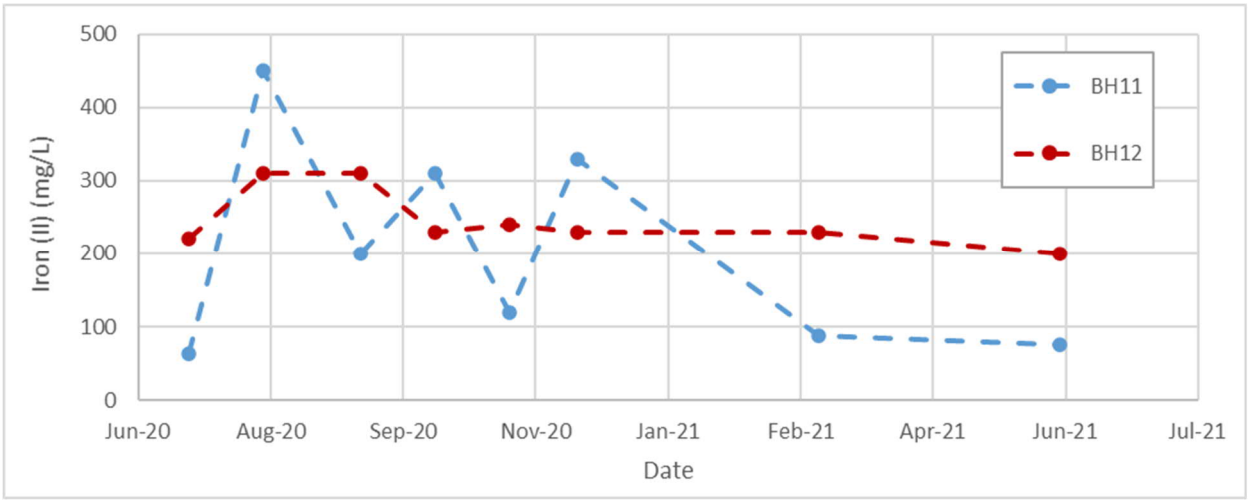


Figure 55: Groundwater iron (II) concentrations along Transect 4

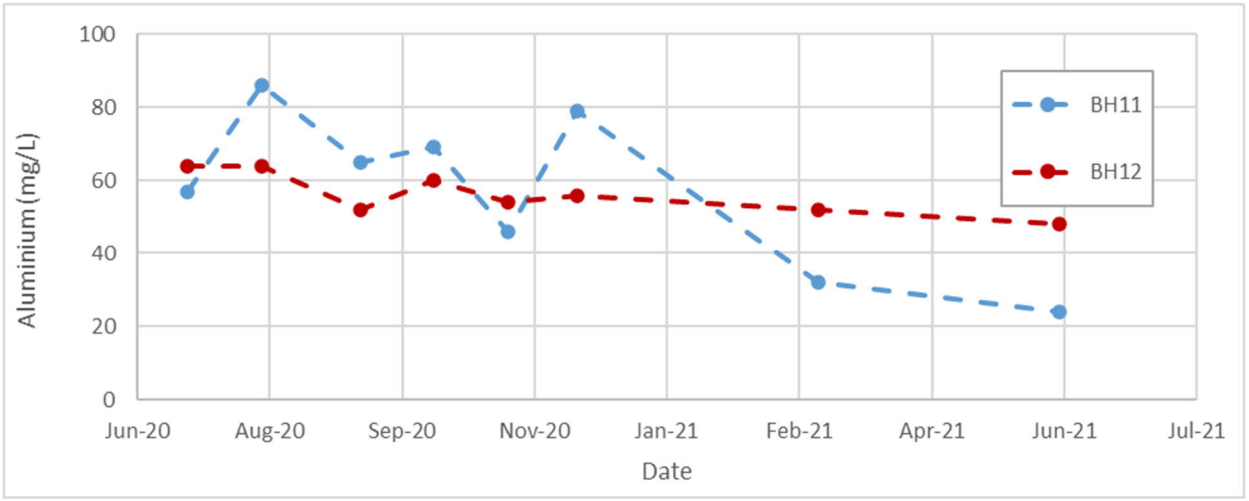


Figure 56: Groundwater aluminium concentrations along Transect 4

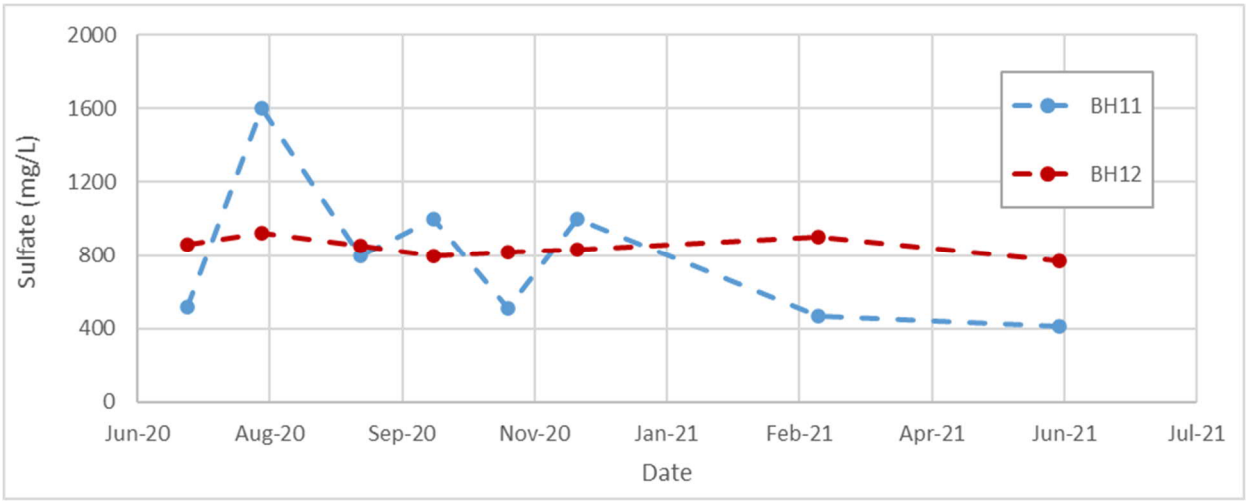


Figure 57: Groundwater sulfate concentrations along Transect 4

Transect 5

Groundwater pH along Transect 5 variably ranged between 3.5 and 4.5 in BH14, BH16 and BH17 over the 2020-21 monitoring period and was relatively consistent with observations from the 2019-20 monitoring period. Groundwater pH at BH15 was the lowest along the transect which is also consistent with observations made during the 2019-20 period.

Groundwater pH at BH15 exhibited a general decline over the monitoring period from 3.8 in August 2020 to 3.1 in June 2021. This may suggest that seasonal pH increases only occur at this bore during prolonged wetter conditions that have yet to be sufficiently sustained over the 2021 winter period to yield pH increases via iron reduction.

Concentrations of acidity were <1,000 mg/L CaCO3 across BH15, BH16 and BH17, but exceeded 2,400 at BH14. This is consistent with greater accumulation of acidity along the southern margin of the swamp where flushing of acidity via groundwater-surface water interaction is less active. Concentrations of acidity showed a general increase in BH15 and is consistent with the observed trends in pH. Concentrations of acidity generally declined in BH14 from 3,100 mg/L CaCO3 in August 2020 to 2,400 mg/L CaCO3 in July 2021 and is consistent with the seasonal variability of acidity concentrations at BH14 which were observed over the 2019-20 monitoring period. Concentrations of groundwater acidity are higher along Transect 5 compared to other transects in Big Swamp and is consistent with a greater depth to watertable in this area resulting in enhanced sulfide oxidation.

Concentrations of iron (II) along Transect 5 tended to fall between the summer months and winter months, while the converse was observed of aluminium concentrations. This suggests that unlike other transects where iron reduction is enhanced in shallow groundwater during the winter months, groundwater along Transect 5 is dominated by the infiltration of oxidised and acidified leachate with elevated aluminium concentrations. This is consistent with the conceptual model presented in the hydrogeochemical modelling report (Jacobs, 2021) which suggests that the western portion of the swamp is dominated by the infiltration of acidic leachate while the eastern portion of the swamp is dominated by the discharge of groundwater in which iron reduction has occurred.

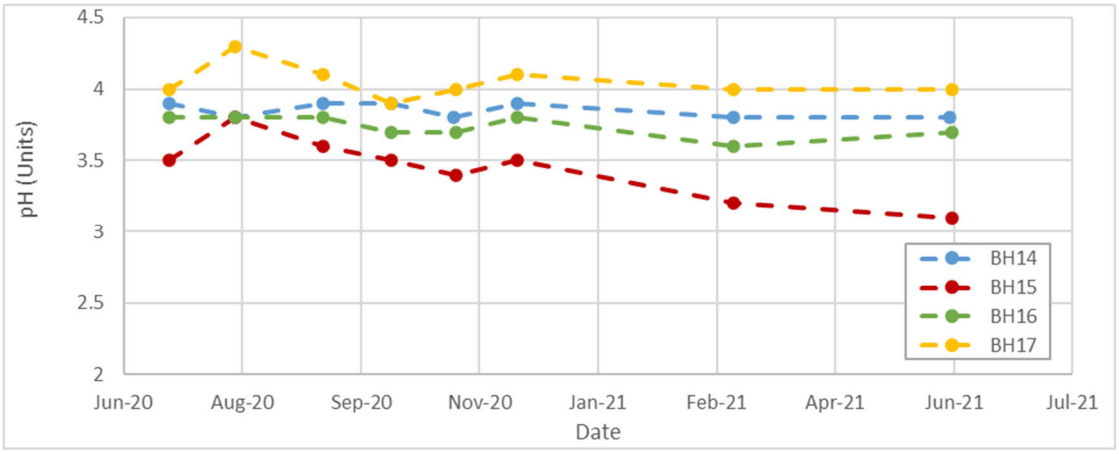


Figure 58: Groundwater pH along Transect 5

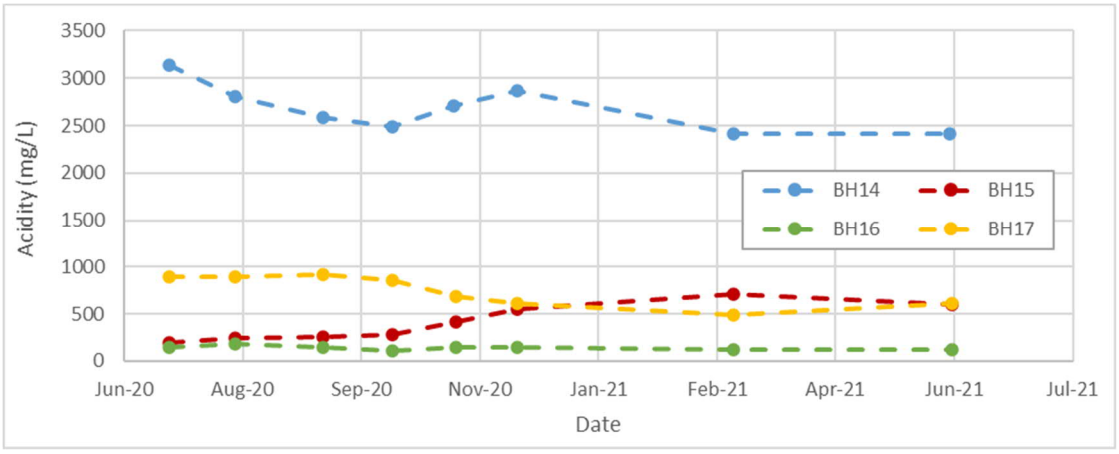


Figure 59: Groundwater acidity concentrations along Transect 5

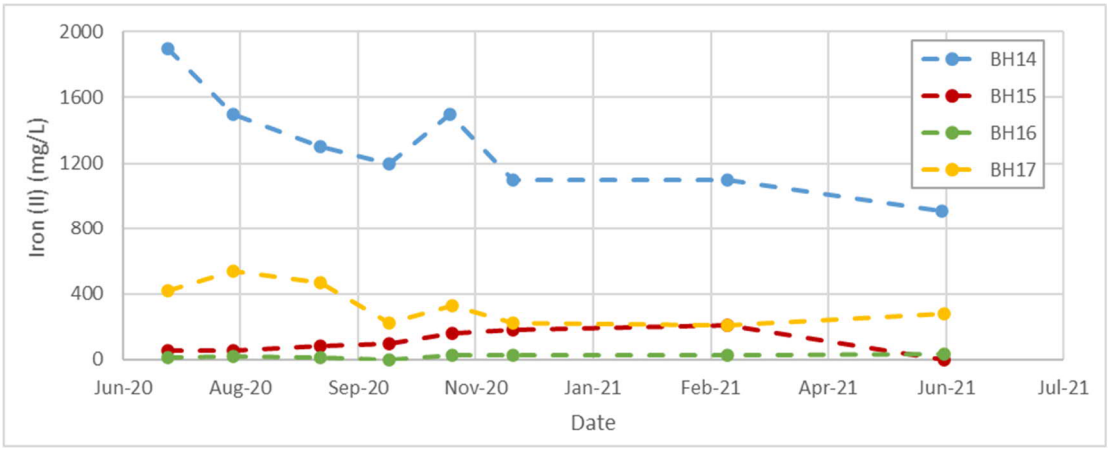


Figure 60: Groundwater iron (II) concentrations along Transect 5

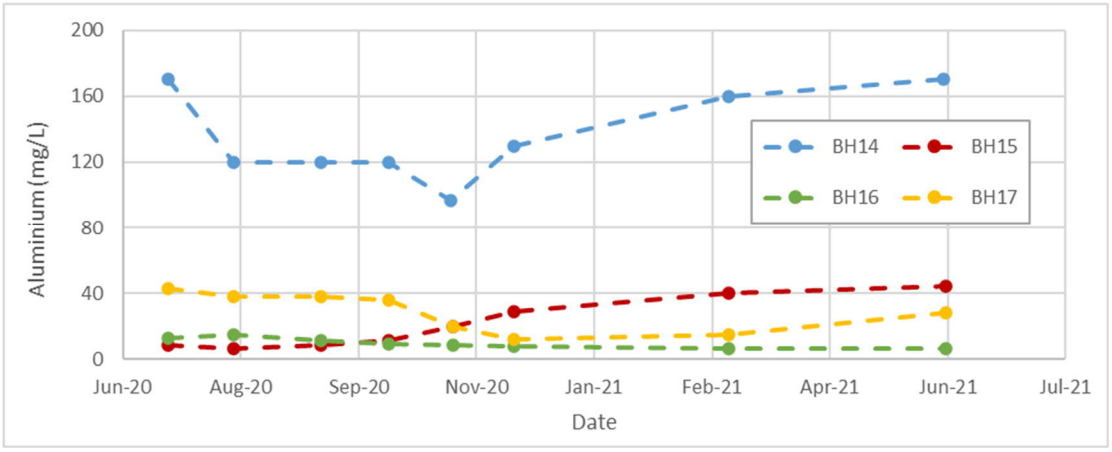


Figure 61: Groundwater aluminium concentrations along Transect 5

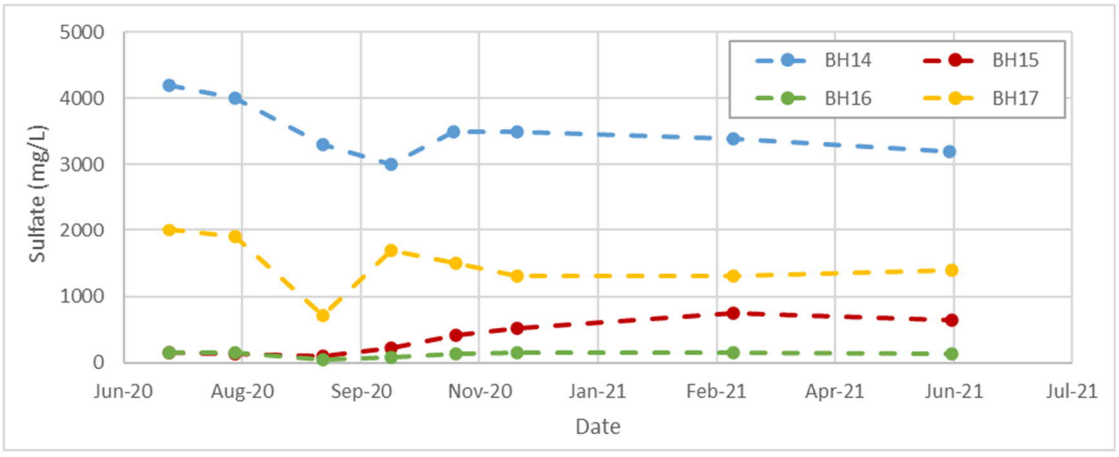


Figure 62: Groundwater sulfate concentrations along Transect 5

6.3 Barwon River macroinvertebrate survey

Austral Research and Consulting were engaged by Barwon Water to investigate the extent of impacts from Big Swamp on surface water, sediments and the macroinvertebrate community structure in Boundary Creek and the upper Barwon River in Spring 2020 and Autumn 2021. Water samples were collected for analysis with a specific focus on metals and the impacts of pH on these analytes from the East and West Barwon Rivers, Boundary Creek downstream of Big Swamp, and the Barwon River down to Winchelsea. Sampling locations are shown on the map provided in Figure 63 below.

Figure 63: Boundary Creek and Barwon River water quality and macroinvertebrate sampling locations

Water quality results have indicated that although pH values in Boundary Creek remain low, the pH value in the mainstem of the Barwon River appear unaffected reflecting the Barwon's good buffering capacity and the River's greater flow (typically 3 or more times that of Boundary Creek). The Barwon River pH values lie predominantly within the ecologically optimum range of 6.5 to 8.5. Dissolved oxygen concentrations in Boundary Creek remain low inline with long term trends since 2000.

Austral observed Lower DO concentrations along the length of the Barwon River in the Autumn 2020 survey, a time of very low flow. In addition, high concentrations of aluminium and iron have the potential to form insoluble flocs which can smother vegetation and clog gills of aquatic organisms. Zinc also continues to exceed the ANZECC guidelines and is mobilised within the catchment probably in response to acidic conditions. These issues should continue to be monitored as remediation action progress. Predictably, macroinvertebrate community composition continues to be poor at the only site on Boundary Creek (Site 5) with no families from the pollution sensitive Ephemoptera, Plecoptera and Trichoptera orders collected during the last four sampling events and consistently low number of families present.

Austral believe the effects on Barwon's water quality from Boundary Creek inflows are of very limited downstream effect. The buffering capacity of the river combined with its larger discharge mean pH and conductivity show little difference at sites above and below the confluence of the two streams (ie mixing and dilution are efficient). Overall, stream health as measured by macroinvertebrate community composition is good downstream of the confluence, with sites identified as reference condition (AusRivAS Band A) at most downstream sites at least once in the last two years.

During the Autumn 2021 survey, the presence of iron flocs at Site 6 immediately downstream of Boundary Creek show the potential for iron rich waters to enter the Barwon River from Boundary Creek – either as groundwater or surface flows. This floc most likely

contributed to the reduction in the quality and quantity of macroinvertebrates present at Site 6 but the impact was not evident at Site 7, 1.8km further downstream.

Elsewhere along the Barwon River conductivity rises abruptly downstream of Site 8 indicating a salt source in regional groundwater and/ or surface runoff. Lower pH and DO concentrations have been observed at different sites on various surveys. Austral has not been able to determine the reasons for them as they're outside the scope of the study.

Austral have concluded that whilst sites along the Barwon River do not consistently meet environmental quality objectives, overall indicator scores such as AusRivAS have been met over the last two years at sites downstream of the Boundary Creek confluence, reflecting the ability of the River to absorb catchment impacts on water quality or habitat condition.

6.5 Flow in the Barwon River

Flows in the East Barwon River have been manually measured at six-monthly intervals in three locations (refer Figure 64) since 2005. The three locations are:

1. East Barwon gauge (old Monitoring site 233253A)
2. Approximately 1km downstream of the East Barwon gauge
3. Approximately 250m upstream of the Kings Creek junction.

The data collected and presented in Table 14 below is for the final two manual measurements that were undertaken as part of this monitoring as they are no longer required following the installation of the new stream gauge 233254 East Barwon River @ U/S Kings Creek Junction.

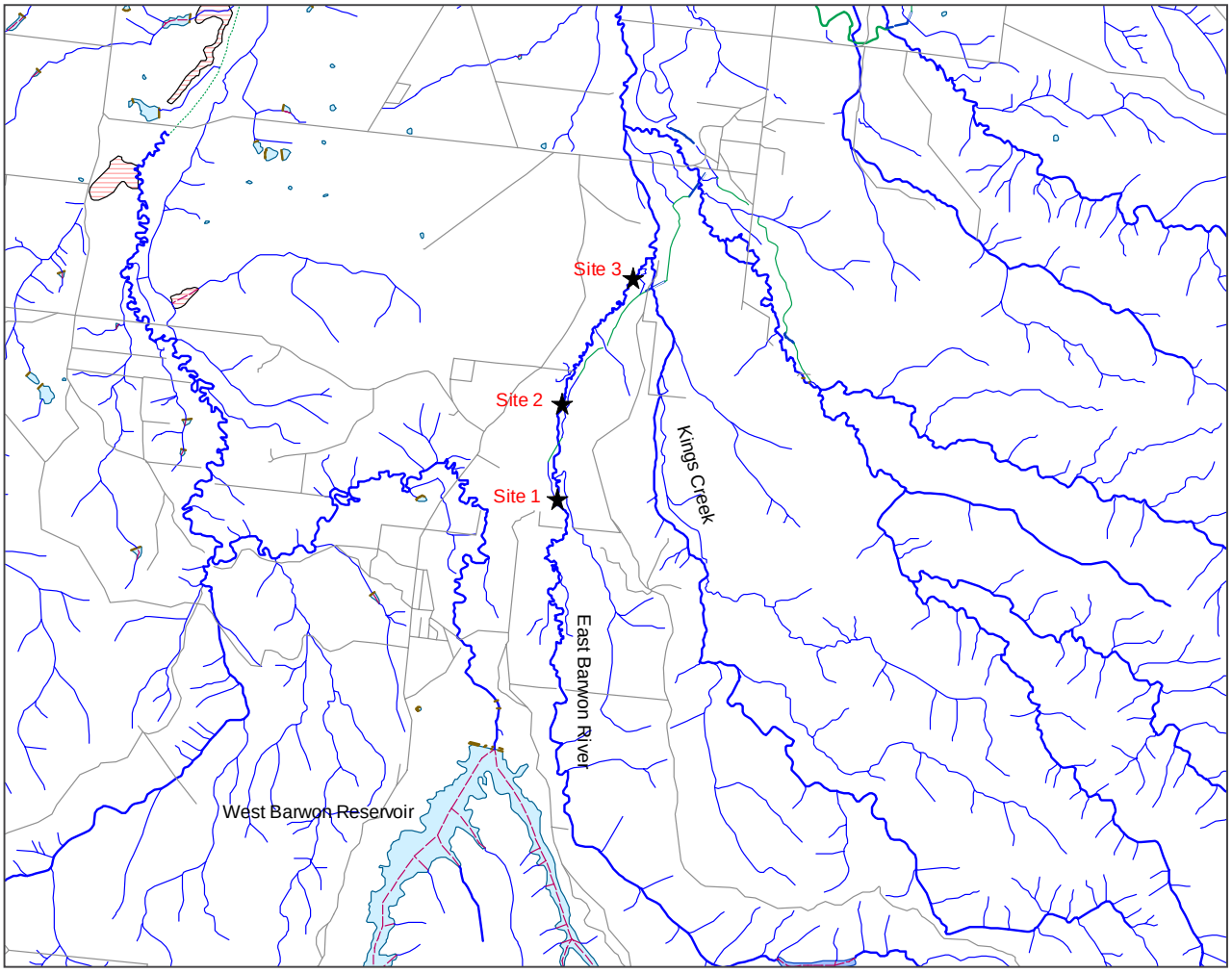


Figure 64: Stream flow spot measurement locations on the East Barwon River

Table 14: East Barwon flow measurements 2020-2021

Date	Flow at site (ML/d)		
	Site 1	Site 2	Site 3
27/07/2020	1.35	1.41	2.66
27/10/2020	4.40	2.89	0.65

Surface water flow gauging for the East Barwon River at Flume (233268) and East Barwon River upstream of Kings Creek Junction (233254) are shown on Figure 65. A limited record exists for the East Baron River upstream of King Creek Junction with records beginning in December 2020 following installation of the new gauge. Going forward the continuous flow data collected from these stream gauge sites will replace the spot gauging previously undertaken at sites 1 and 3 above, and no further spot gauging will be undertaken at site 2.

Surface water flow gauging for the Barwon River at Rickets Marsh is shown in Figure 66 while flow gauging for the West Barwon River at Boundary Road is shown in Figure 67, with the record commencing in February 2021 following installation of the new gauge as part of the surrounding environment investigation.

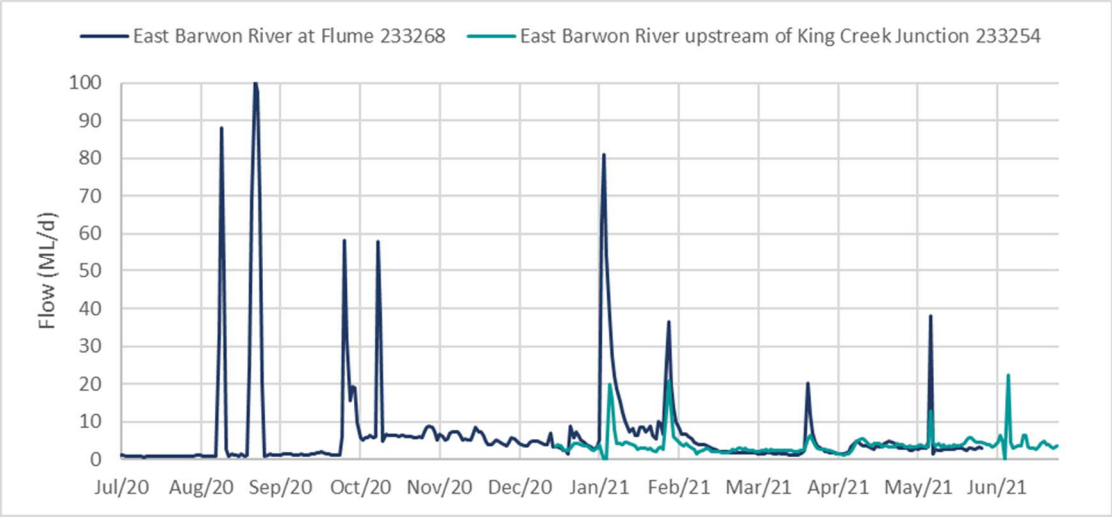


Figure 65: Flows for East Barwon River for 2020/21

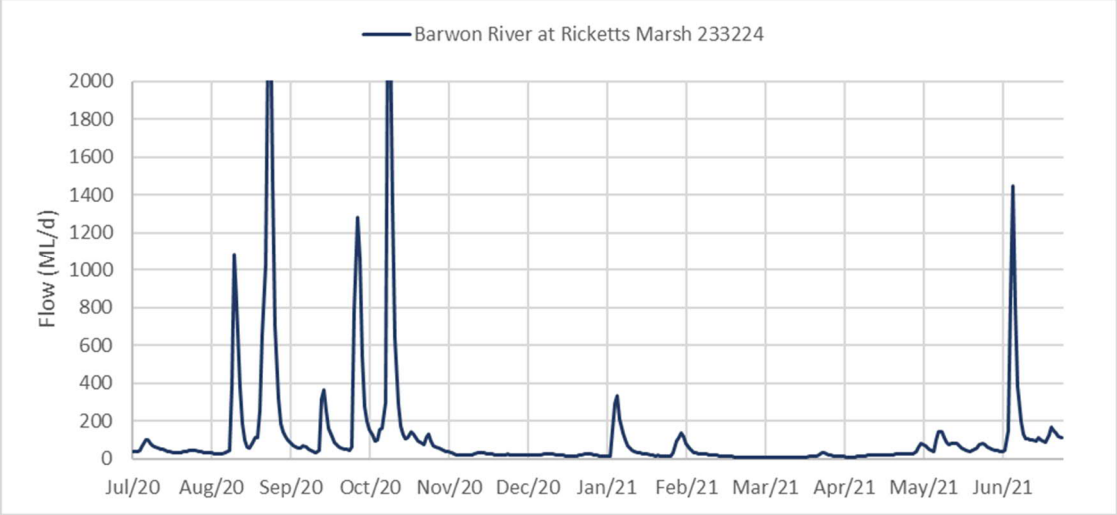


Figure 66: Flows for Barwon River at Ricketts Marsh

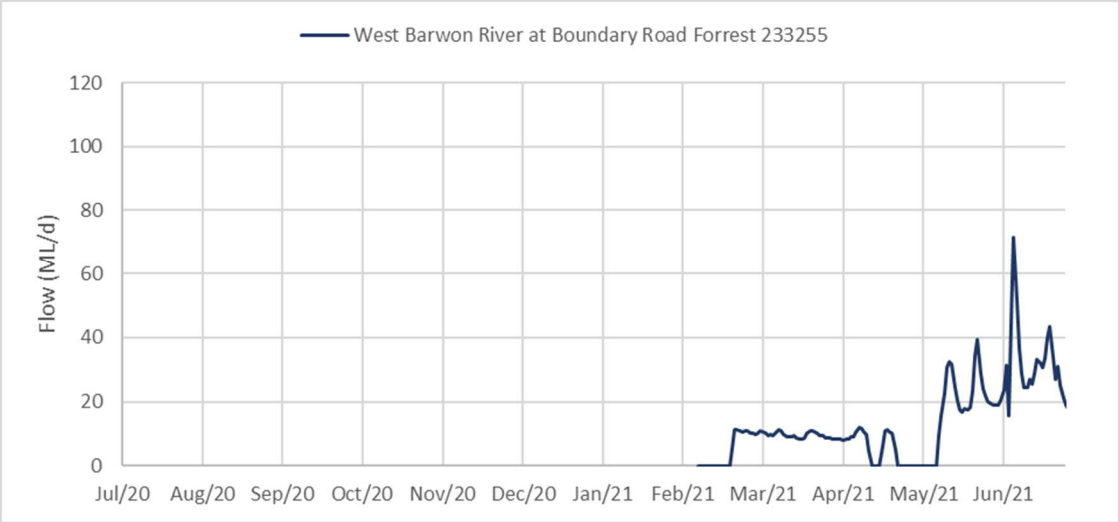


Figure 67: Flows for West Barwon River at Boundary Road Forrest

6.6 Regional groundwater monitoring

This sections covers some of the groundwater monitoring that was previuosly provided in the Gernagamete groundwater annual report.

6.6.1 Metering

No groundwater was extracted from the Barwon Downs borefield in 2020-2021 as Barwon Water no longer holds a groundwater licence for the Barwon Downs Borefield. Barwon Water's groundwater licence expired 30 June 2019 and the bore pumps were removed in 2017-18.

6.6.2 Monitored area

The monitoring network for the Gerangamete groundwater management area takes in the areas of Barongarook, Yeodene, Birregurra, Gerangamete, Barwon Downs, Deans Marsh and Bambra. Table 15 below indicates the bores that are monitored for each aquifer formation across the management area.

Table 15: Observation Bore number and aquifer monitored

Model layer	Aquifer/Aquitard	Active Monitoring Bores	Inactive Monitoring Bores
Layer 1	Gellibrand Marl		
Layer 2	Clifton Formation	G18, G19, M22	
Layer 3	Narrawatuk Marl		
Layer 4	Mepunga/Dilwyn Formation	BA54, BA56, BA57, BA58, BD3, G11, G14, G17, G20, G22, G24, G28, M25, M27, M28, M29, M30, M31, W7, W9, YYG217, YYG218, YYG221, Y40, Y41, YEO20, YEO21, YEO37, YEO39, YEO40, YEO42, YEO44	G12, G25, W4, YEO38
Layer 5	Pember Mudstone		
Layer 6	Pebble Point Formation	BK69, E68, G11, G13, G14, G21, G23, M24, YEO19, YEO22, YEO23, YEO41	
Layer 7	Basement		

6.6.3 Regional groundwater levels & hydrographs

Monitoring of the regional observation bore network continued during 2020-21. The locations of the observations bores have been included in the map in Appendix C – Regional groundwater bore locations. Groundwater levels have been recorded at each of the observation bores quarterly and provided in the table in Appendix D – Regional groundwater bore levels.

The hydrographs for the observation bores in close proximity to the Barwon Downs Borefield indicate that groundwater levels in this area have demonstrated a quick but expected drawdown and recovery in response to historical groundwater pumping. Observation bores that are further from the borefield show a slower drawdown in response to groundwater extraction and then take longer to recover. Hydrographs have been prepared for each bore and are presented in Appendix E – Regional groundwater hydrographs. Comments have been provided for observation bores where recorded levels weren't consistent with the expected levels.

Overall, regional groundwater levels in the LTA continue to display a recovering trend in the majority of observation bores.

6.6.4 Residual drawdown

Figure 68 below shows that overall, groundwater levels are continuing to recover post groundwater extraction at Barwon Downs Borefield in 2016/17. Of the 51 observation bores monitored during the 2020-21 year the majority of bores showed recovery with only five bores not recording positive groundwater level change from the previous year. In 2016-17 only 17 bores were indicating a positive change in groundwater level. Readings were taken in May 2021 and are compared to the April 2020 levels.

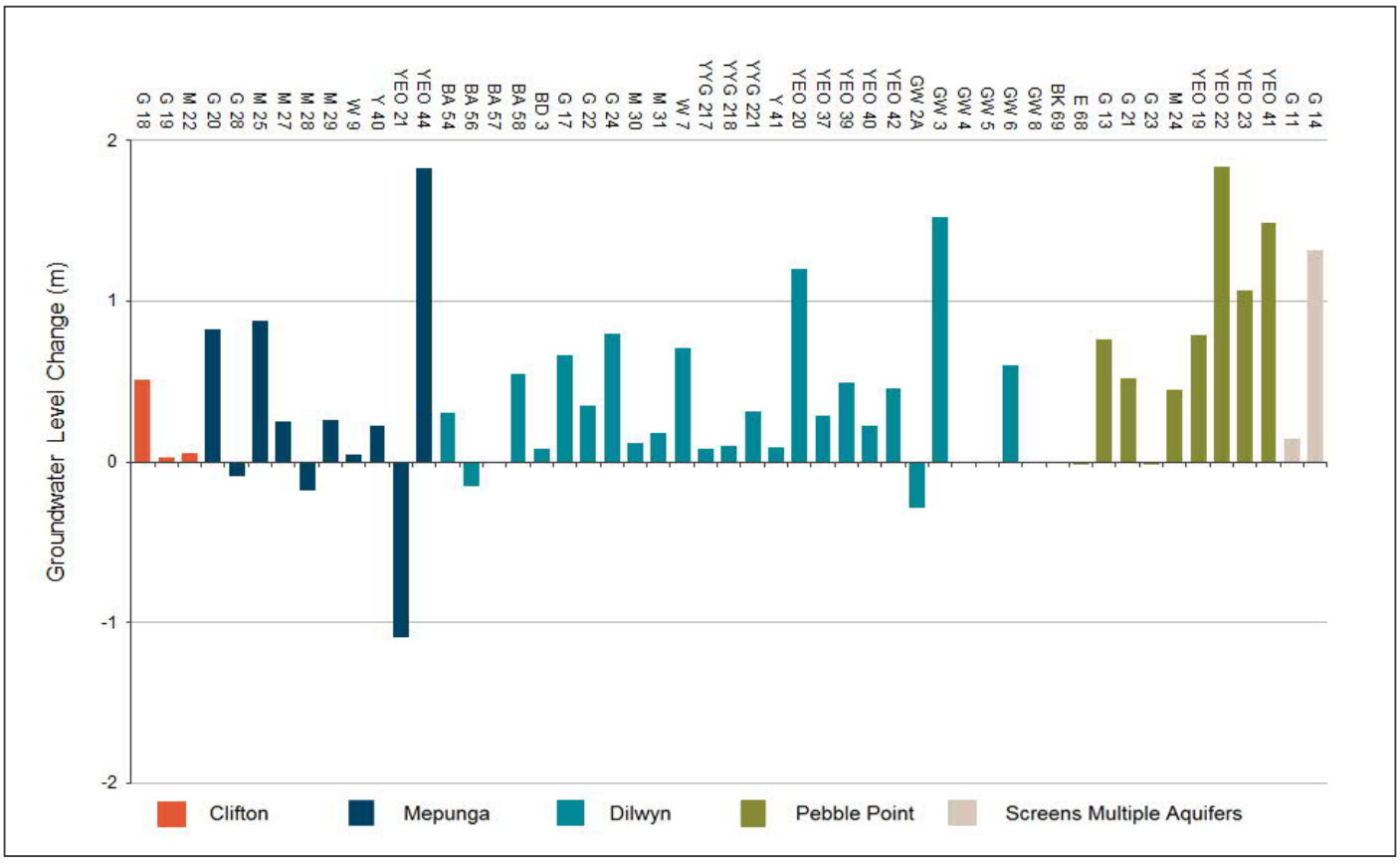


Figure 68: Change in groundwater levels between April 2020 and May 2021

The contour maps provided in Appendix F – Contour Maps illustrate the residual drawdown in groundwater levels since June, 1997. The contours are based on the difference in the groundwater levels measured in May 2020 compared to those levels recorded in 1997.

The baseline used for determining residual drawdown was June 1997 because it represents the end of an extended period of no groundwater extraction and because it is prior to extended periods of groundwater extraction during September 1997 - July 2001, and May 2006 - August 2010. Prior to September 1997, groundwater extraction had occurred intermittently from 1982 – 1990 with a total extraction volume during that time of 25,858 ML. The majority of groundwater extraction during that period was undertaken March 1987 – February 1990, with a total of 20,559 ML.

For this 2020-21 report, the residual drawdown contours have been plotted for each groundwater formation separately. Each aquifer has been observed to have varying rates of recovery and different cones of depression, and so plotting the contours for each aquifer individually is considered the most accurate method of representing the drawdown within each formation. However, the ability to accurately represent drawdown contours within each formation is highly dependent on the number and distribution of the observation bores within each formation. Evenly distributed observation bores across the whole formation would provide greater confidence in the drawdown contour map.

As per previous years, bore Y41 has been excluded from the residual drawdown map for the Dilwyn formation as it was only constructed in 2006 and provides no comparative data back to 1997.

6.6.5 Land subsidence

Measurements were carried out and compared to 2003 readings for the subsidence-monitoring network previously monitored in accordance with the now expired Gerangamete groundwater licence. Surveying was conducted by Barwon Water's spatial services team and the results are presented below. Positive values indicate an increase in ground levels compared to the readings taken in 2003, while a negative value indicates subsidence. The results indicate a slight subsidence in ground levels up until May, 2010. After 2010, the ground levels at most observation points have shown a small recovery, while some levels have been observed to stabilise.

Table 16: Land Subsidence Monitoring – Variation from 2003 Readings

Ellipsoid Height Differences as compared to 2003 data (mm)																			
Primary Control Station ID	June 2004	May 2005	May 2006	June 2007	Dec. 2007	June 2008	July 2009	May 2010	July 2011	June 2012	June 2013	June 2014	June 2015	June 2016	June 2017	June 2018	July 2019	July 2020	Aug 2021
20790040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20880024	-8	-2	-8	-18	-16	-8	-21	-25	-25	-12	-23	-20	-21	-11	-19	-19	-19	-15	-22
20590052	-6	0	6	-3	-12	7	8	8	15	8	14	1	3	13	27	11	-1	-26	-12
39780106	-1	0	3	-27	-9	-15	-16	-30	-14	-16	-30	-24	-25	-11	-19	-15	-17	-20	-18
Monitoring Station ID																			
32390045	-6	1	-11	-42	-42	-36	-66	-75	-47	-42	-54	-42	-42	-47	-35	-39	-30	-15	-68
32390046	3	1	-8	-20	-19	-20	-47	-50	-32	-25	-46	-32	-28	-37	-25	-27	-10	-3	-18
26470027	-6	2	-2	6	-11	-22	-37	-45	-36	-39	-43	-42	-35	-32	-37	-36	-21	-23	-30
26470032	-5	5	-1	-43	-30	-36	-63	-63	-35	-40	-45	-42	-37	-42	-39	-40	-15	-17	-24
26470033	-8	3	-13	-40	-35	-36	-65	-76	-38	-39	-44	-38	-35	-46	-39	-36	-21	-22	-25
26470036	5	10	1	-32	-23	-30	-48	-63	-42	-38	-39	-33	-23	-33	-33	-24	-12	-11	-20
39870025	-1	-4	-5	-15	-11	-17	-23	-34	-37	-31	-25	-29	-33	-27	-27	-21	-17	-27	-27
39870026	-3	0	2	-9	-6	-15	-22	-38	-37	-33	-31	-31	-35	-21	-28	-23	-10	-5	-5
38090024	-4	-3	12	8	NA	0	-26	-25	-18	-30	-15	-36	-36	-81	-74	-89	-65	-85	-91
38090025	-5	-5	9	-12	NA	-5	-30	-33	-28	-48	-23	-33	-35	-27	-27	-34	-18	-31	-35
38090026	-5	0	6	-15	NA	-6	-33	-31	-30	-41	-30	-33	-28	-31	-31	-33	-19	-31	-35

7.0 Contingency measures

Table 17 outlines contingency measures identified during the detailed design or implementation of the REPP. No contingency measures have been implemented

Table 17: Contingency measures identified

Contingency measure	Status
Downstream treatment	designed

8.0 REPP amendments

Table 18 outlines any REPP amendments current as of the time of this report.

Table 18: Amendments to the REPP

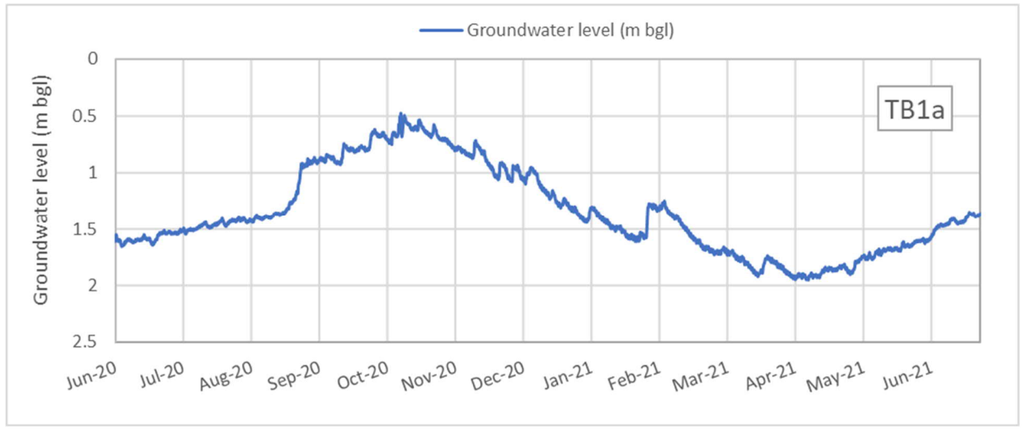
No.	REPP amendments	Status
1	REPP updated 27th February 2020 to include new section capturing Southern Rural Water feedback on the REPP	Complete

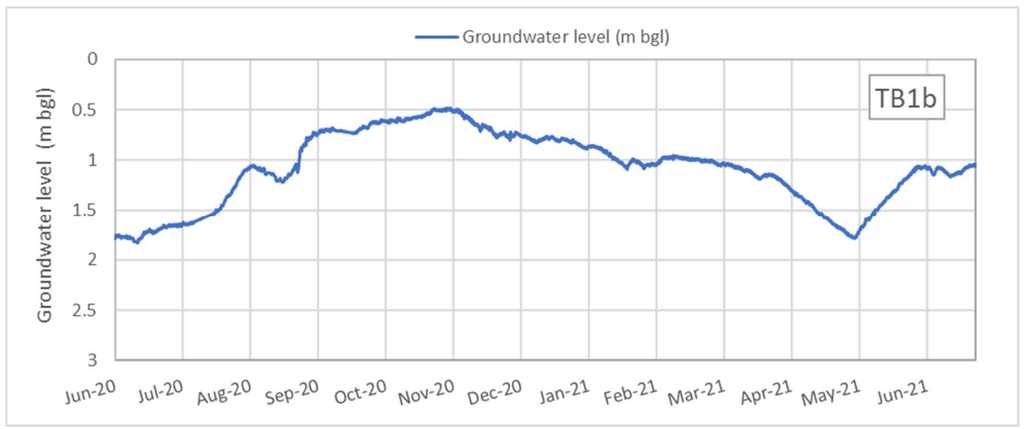
9.0 Progress report

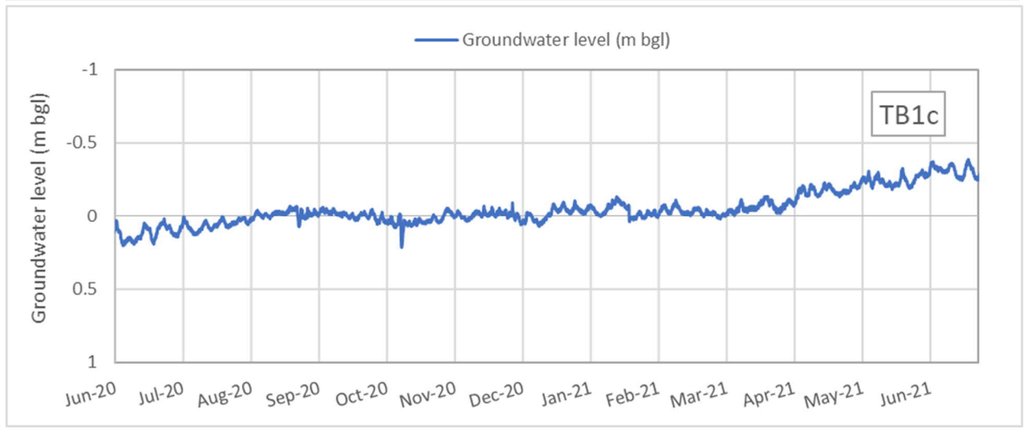
Appendix G – Progress Report presents actions that have been completed, are currently in progress, or are yet to commence as part of implementation of the REPP. It is important to note that additional tasks may be added or updated as they are identified during implementation of the REPP.

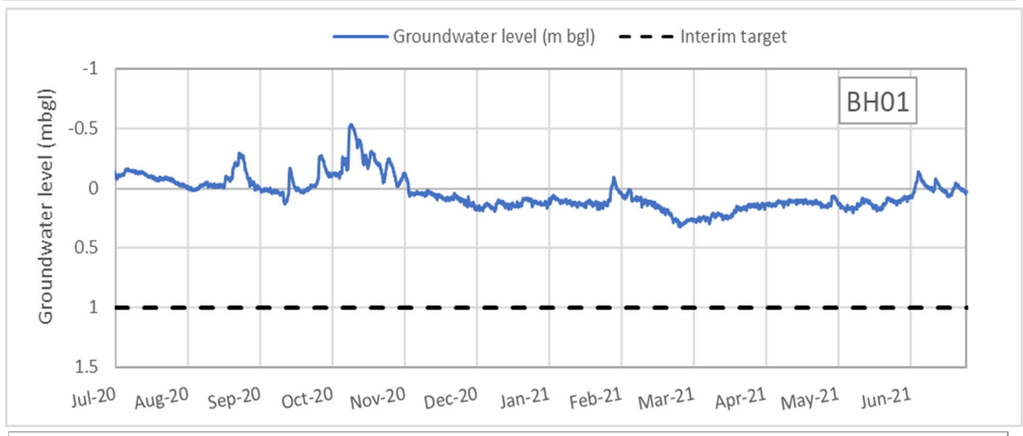
10.0 Appendices

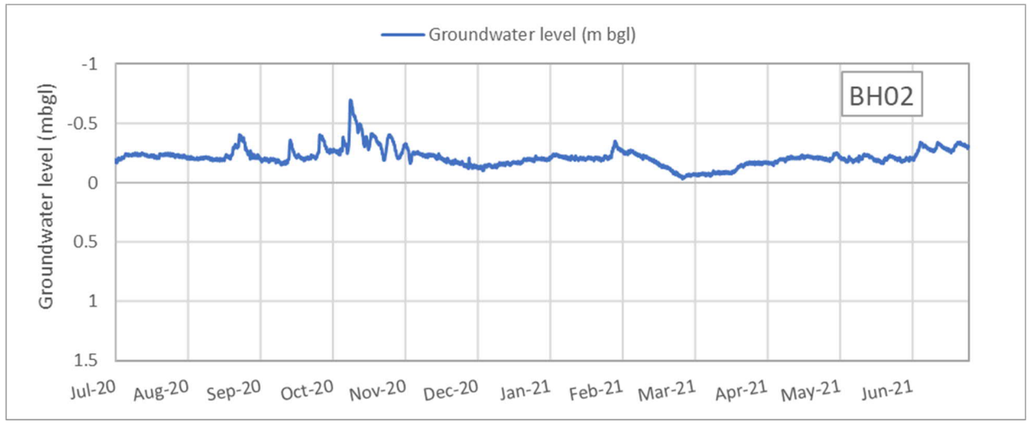
Appendix A – Big Swamp Groundwater Hydrographs

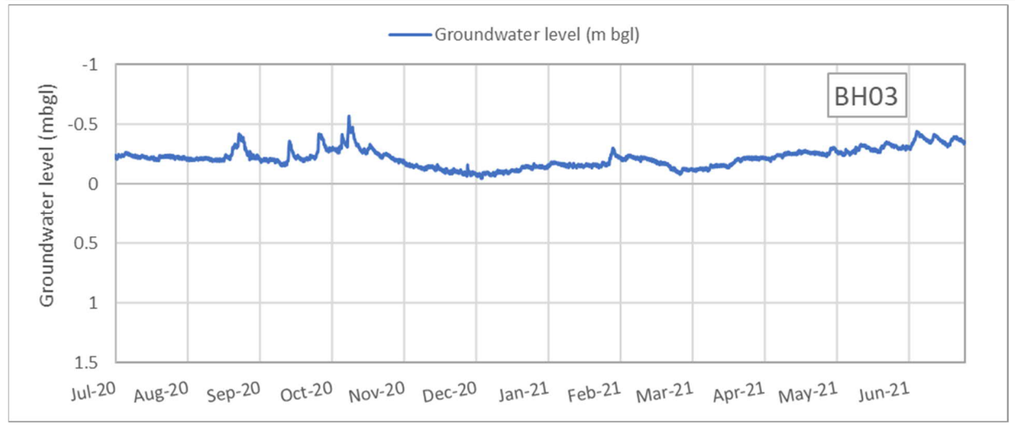


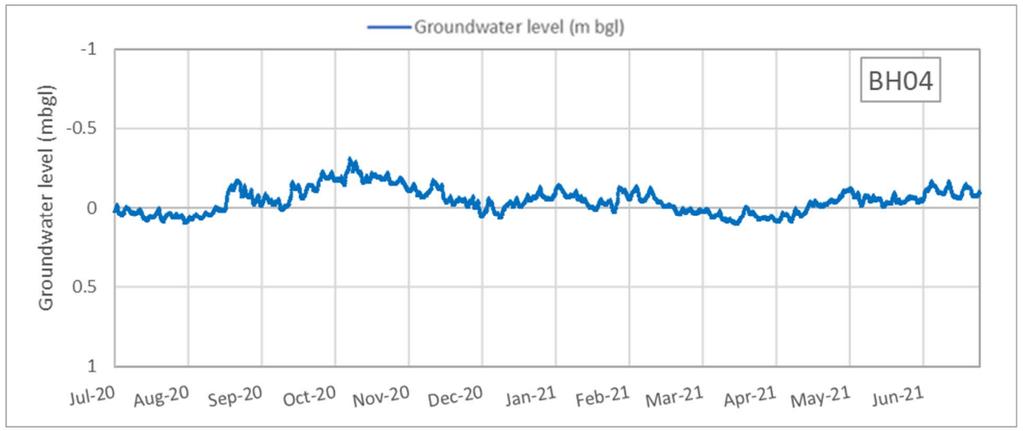








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Mar-21
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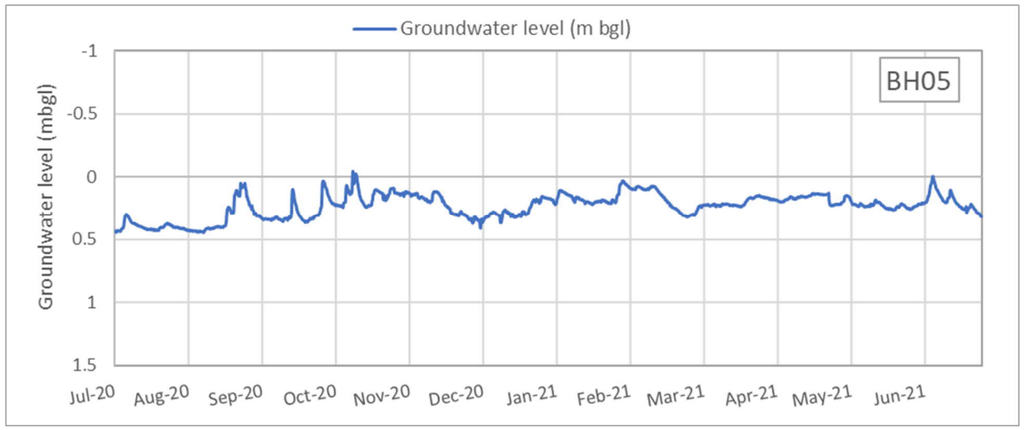
May-21
Jun-21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Oct-20
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Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21


Groundwater level (m bgl)
Interim target
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Groundwater level (mbgl)
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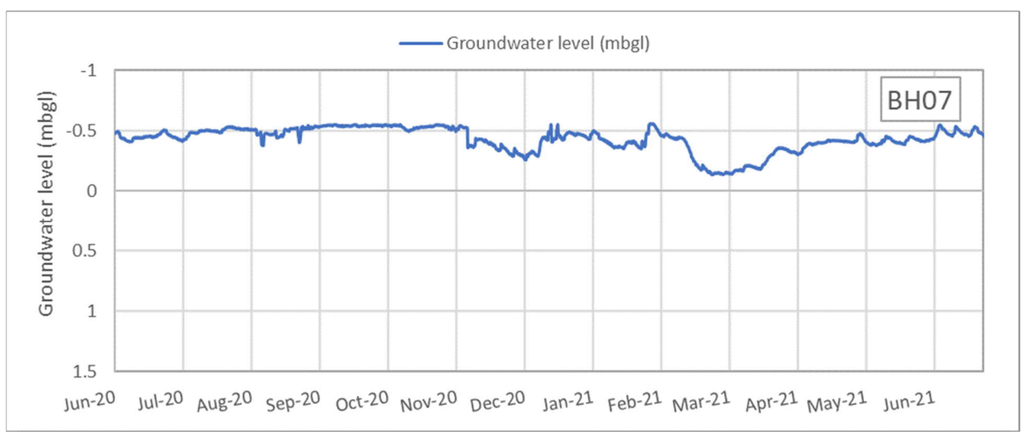
Feb-21
Mar-21
Apr-21
May-21
Jun-21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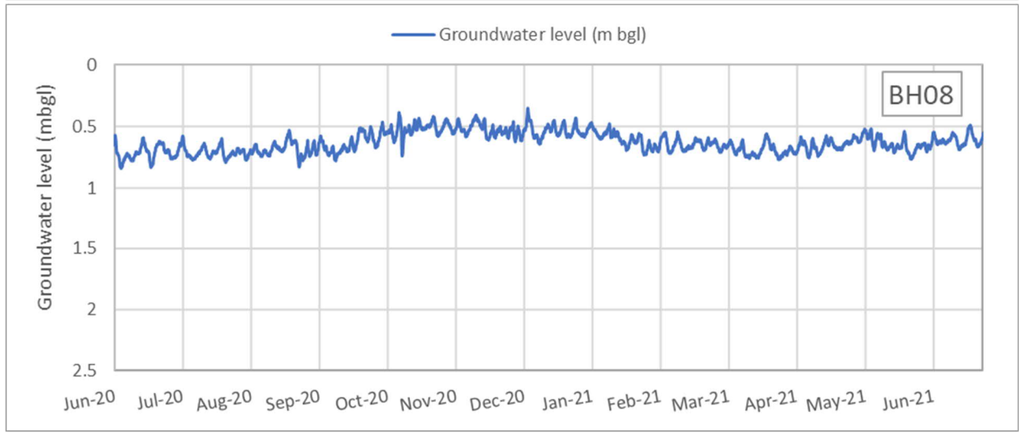
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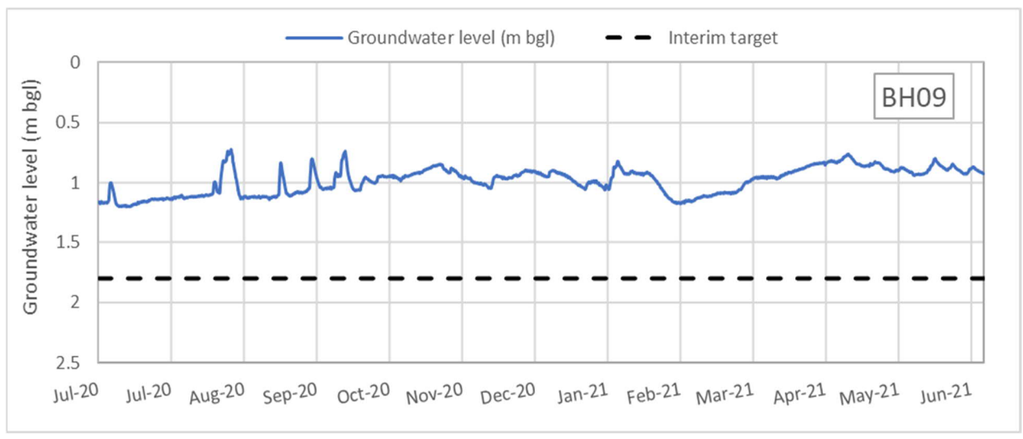
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Mar-21
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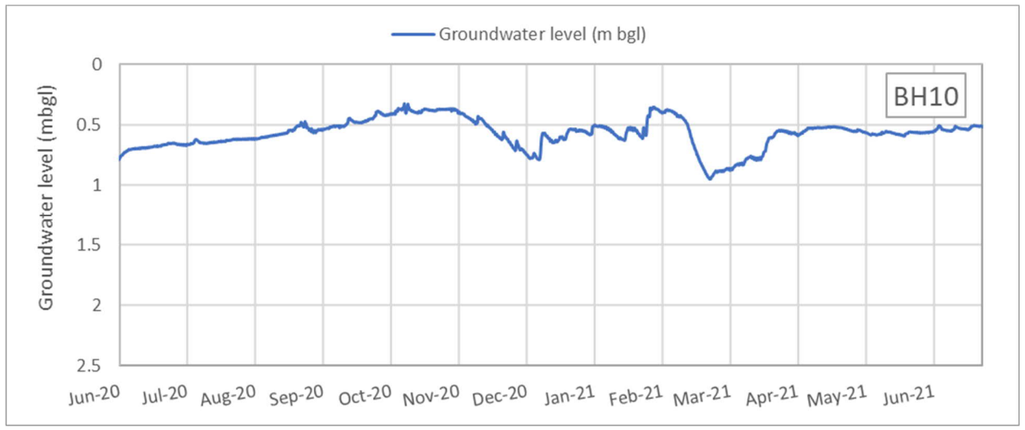
Jun-21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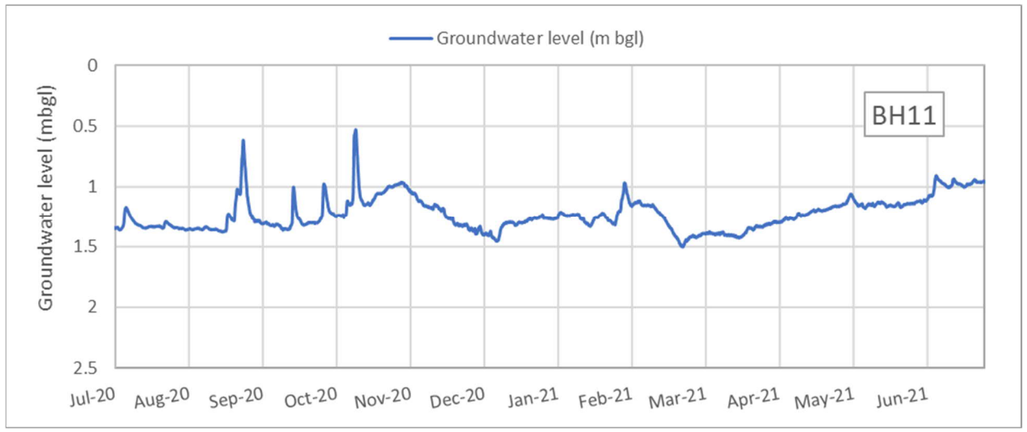
Mar-21
Apr-21
May-21
Jun-21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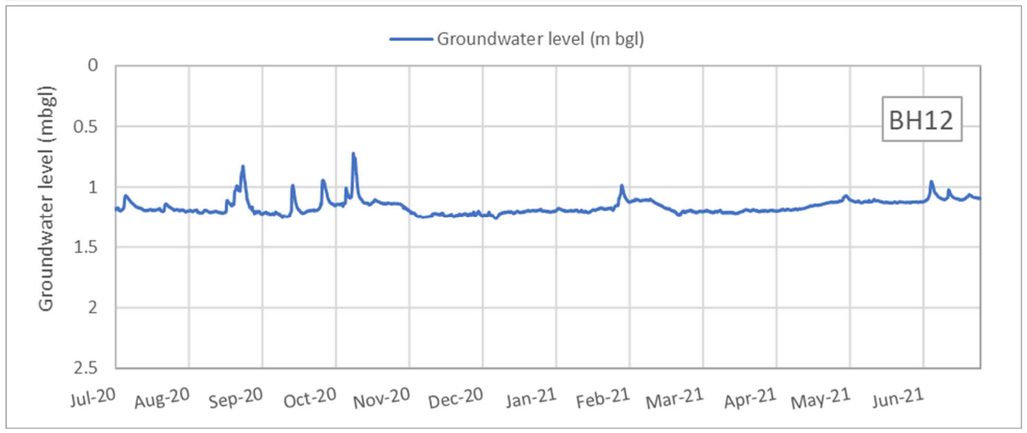
Jun-21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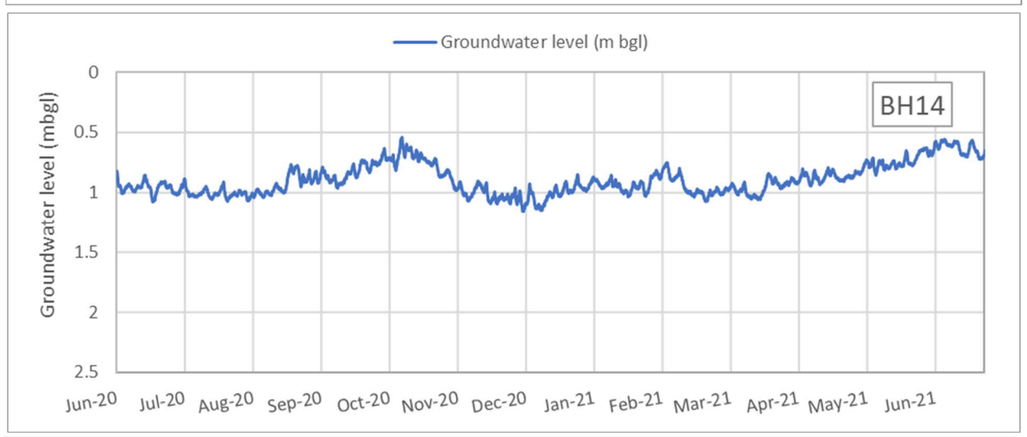
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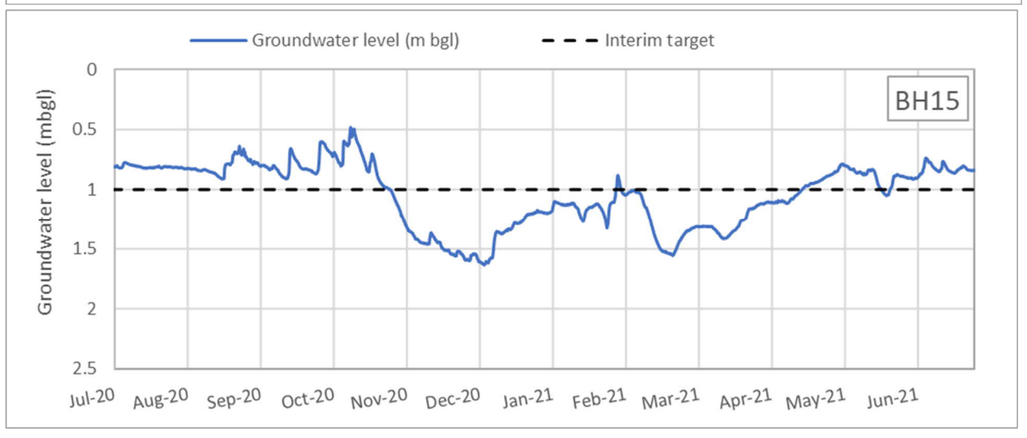
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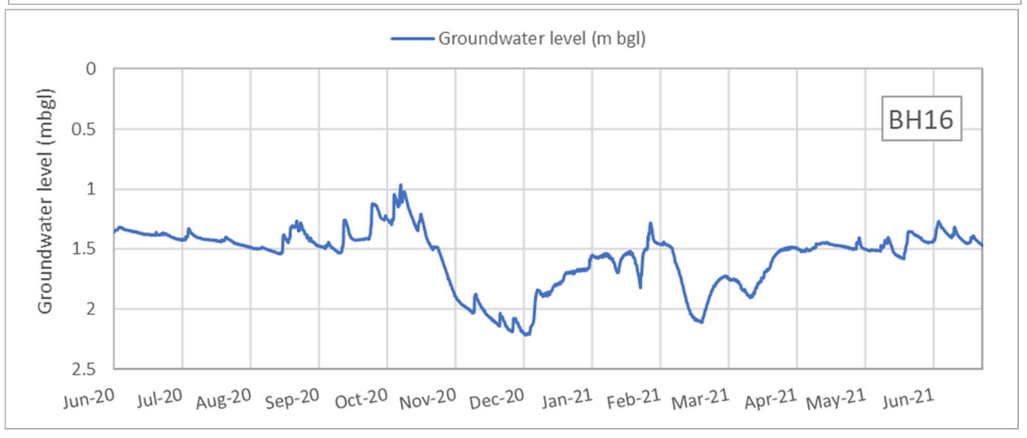
Apr-21
May-21
Jun-21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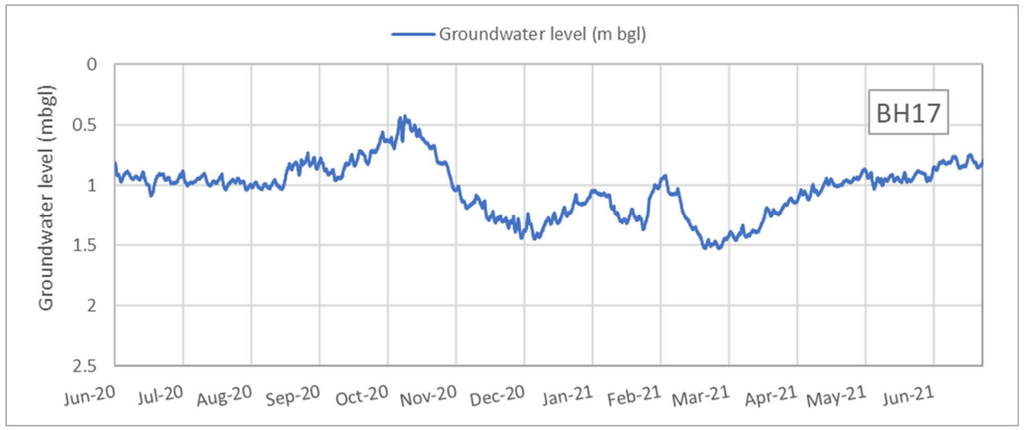
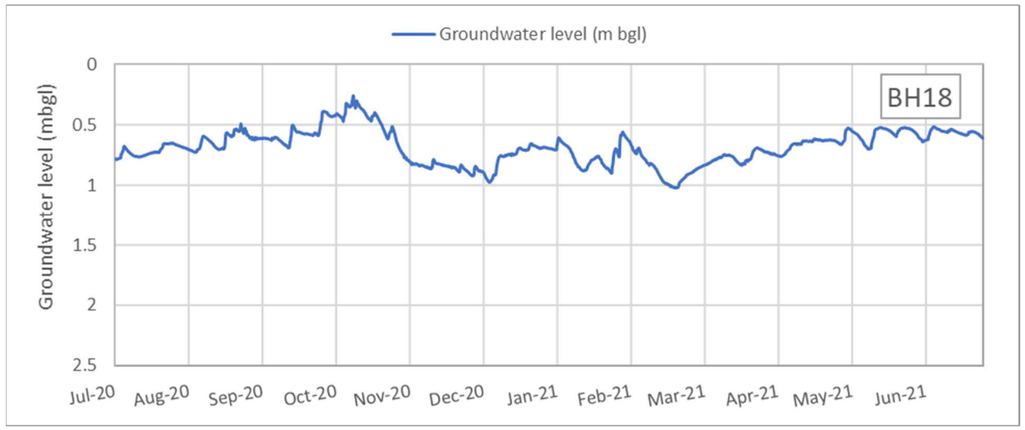
BH16
Groundwater level (mbgl)
0
0.5
1
1.5
2
2.5
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21


Groundwater level (m bgl)
Groundwater level (mbgl)
0
0.5
1
1.5
2
2.5
BH17
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21


Groundwater level (m bgl)
Groundwater level (mbgl)
0
0.5
1
1.5
2
2.5
BH18
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21

Appendix B – Surface Water flow in Boundary Creek

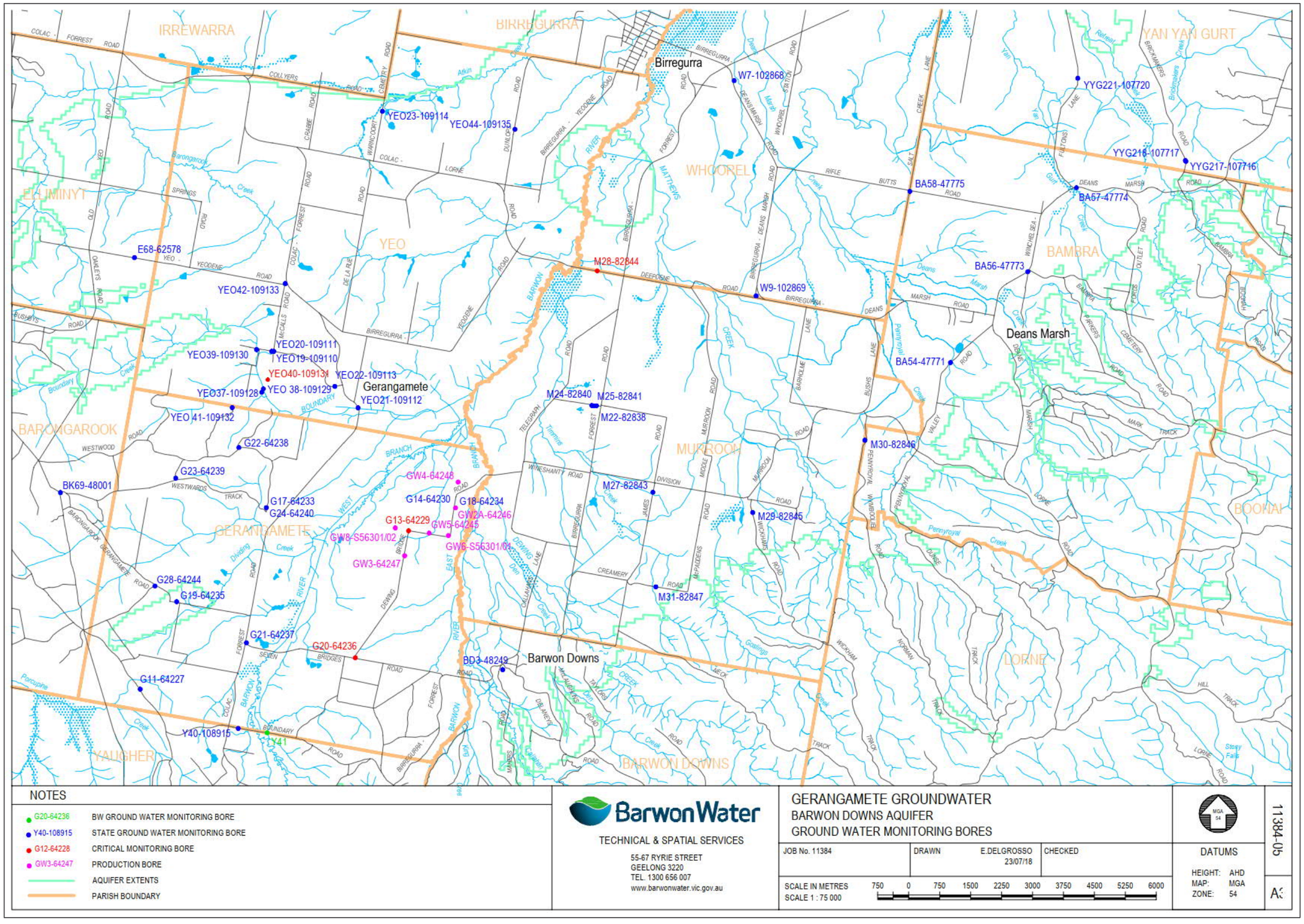
Flows in Boundary Creek at Yeodene Stream Gauge 233228 (ML/day)

Date	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021
1	5.37	4.36	16.24	23.57	3.36	10.59	18.30	37.38	9.43	1.15	2.03	2.26
2	4.52	3.94	13.88	25.20	2.55	10.28	19.31	32.03	9.47	1.14	1.99	1.95
3	4.62	3.61	12.93	21.86	2.05	9.76	23.37	29.46	9.45	1.12	2.12	1.81
4	6.59	3.63	11.13	15.65	1.98	9.23	26.38	27.92	9.49	1.10	3.76	1.76
5	11.02	4.28	12.95	17.16	1.93	9.87	26.08	28.27	9.19	1.07	8.27	1.72
6	22.32	4.84	17.23	72.38	1.95	11.42	24.42	29.52	8.88	1.10	6.12	1.77
7	20.79	6.51	15.50	55.96	2.03	12.46	23.00	28.65	8.55	1.08	3.69	1.82
8	17.15	9.53	10.45	62.16	2.01	11.97	22.25	27.74	9.26	1.11	2.57	3.70
9	14.08	10.27	7.68	59.48	1.83	11.40	21.59	26.77	9.71	1.23	2.02	10.57
10	11.82	9.49	5.73	0.00	1.54	10.61	20.76	25.60	9.57	1.30	1.89	34.16
11	10.19	8.50	4.70	0.00	4.88	12.77	20.02	24.85	5.16	1.52	1.91	22.76
12	8.75	7.93	8.18	0.00	7.26	15.33	19.85	24.77	0.45	1.64	1.87	15.72
13	7.51	7.65	75.83	15.75	7.20	15.56	18.83	23.99	0.50	1.71	1.88	10.84
14	6.60	7.47	88.28	25.48	7.28	15.42	17.87	22.93	0.52	1.73	1.97	8.21
15	5.73	7.39	40.10	17.45	6.58	15.03	18.26	21.75	0.53	1.85	2.78	7.00
16	5.07	8.07	19.80	15.30	6.55	16.18	18.34	20.36	0.52	1.96	3.94	7.02
17	4.50	11.20	13.27	22.46	6.27	16.69	17.11	18.74	0.51	2.03	7.08	15.22
18	4.19	34.26	11.18	47.54	5.97	16.55	16.44	16.87	0.48	2.03	6.47	15.94
19	3.90	30.63	7.77	42.13	5.18	17.33	17.32	15.06	0.47	2.16	5.02	13.66
20	3.92	31.03	6.68	31.23	5.21	17.67	18.35	13.86	0.48	2.50	3.33	13.66
21	5.64	74.70	6.41	23.99	5.35	17.96	18.56	13.60	0.54	2.79	2.53	13.66
22	8.71	94.34	6.24	16.38	5.70	20.37	18.55	13.15	0.57	2.81	2.11	13.66
23	13.00	97.67	6.84	12.06	9.75	21.92	17.86	12.70	0.72	2.83	1.85	13.66
24	12.18	146.39	7.23	11.46	9.32	23.67	17.09	11.87	0.80	2.74	1.61	13.66
25	11.10	158.11	17.83	12.61	8.37	21.25	16.54	11.04	0.84	2.72	1.62	11.39
26	9.78	87.84	108.42	19.62	7.45	20.33	20.33	10.60	0.83	2.54	1.81	13.15
27	8.30	52.87	112.53	23.99	7.25	19.54	18.73	9.91	0.86	2.42	3.35	10.77
28	6.83	35.29	76.07	18.41	7.79	19.64	20.50	9.34	0.97	2.48	5.03	8.71
29	5.70	28.72	43.59	8.69	11.49	19.34	33.95		1.07	2.39	4.97	7.61
30	5.18	28.96	28.24	6.42	10.76	19.08	50.58		1.12	2.21	3.65	6.36
31	4.80	21.72	0.00	4.70	0.00	18.55	49.75		1.15		2.71	
Total	269.86	1041.16	812.90	729.06	166.85	487.76	690.28	588.69	112.08	56.47	101.96	304.17

Release to Boundary Creek (ML/day)

Date	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021
1	0.01	0.01	0.01	0.00	0.00	2.08	2.08	2.08	2.09	2.25	2.13	2.12
2	0.01	0.01	0.01	0.00	0.00	2.10	2.13	2.07	2.09	2.17	2.14	2.12
3	0.01	0.01	0.01	0.00	0.00	2.10	2.12	2.08	2.10	2.09	2.16	2.11
4	0.01	0.02	0.01	0.00	0.00	2.09	2.13	2.09	2.10	2.08	2.14	1.03
5	0.01	0.00	0.00	0.00	0.00	2.09	2.10	2.09	2.09	2.10	2.14	0.02
6	0.01	0.01	0.00	0.00	0.00	2.09	1.97	2.09	2.09	2.11	2.13	0.03
7	0.01	0.01	0.00	0.00	0.00	2.08	2.02	2.09	2.10	2.10	2.13	0.03
8	0.01	0.02	0.00	0.00	0.00	2.07	2.15	2.09	2.10	2.10	2.12	0.02
9	0.01	0.02	0.00	0.00	0.00	2.06	2.13	2.08	2.10	2.09	2.13	0.03
10	0.01	0.01	0.00	0.00	0.00	2.06	2.06	2.08	2.10	2.09	2.14	0.03
11	0.01	0.01	0.00	0.00	0.00	2.06	2.05	2.08	2.10	2.09	2.15	0.02
12	0.01	0.01	0.00	0.00	0.00	2.06	2.06	2.08	2.09	2.11	2.14	0.02
13	0.01	0.01	0.00	0.00	0.00	2.06	2.06	2.08	2.08	2.11	2.14	0.02
14	0.01	0.02	0.00	0.00	0.00	2.10	2.06	2.08	2.08	2.10	2.14	0.02
15	0.01	0.01	0.00	0.00	0.00	2.11	2.06	2.08	2.11	2.09	2.14	0.02
16	0.01	0.01	0.00	0.00	0.00	2.10	2.05	2.09	2.11	2.08	2.13	0.03
17	0.00	0.02	0.00	0.00	0.00	2.09	2.02	2.09	2.10	2.09	2.13	0.02
18	0.01	0.01	0.00	0.00	0.00	2.08	2.07	2.09	2.09	2.10	2.14	0.03
19	0.01	0.01	0.00	0.00	0.00	2.08	2.06	2.09	2.08	2.10	2.13	0.03
20	0.01	0.01	0.00	0.00	0.00	2.09	2.01	2.09	2.08	2.10	2.12	0.03
21	0.02	0.01	0.00	0.00	0.00	2.19	2.07	2.10	2.10	2.09	2.12	0.03
22	0.02	0.01	0.00	0.00	0.00	2.20	2.10	2.09	2.10	2.10	2.13	0.03
23	0.02	0.00	0.00	0.00	0.00	2.19	2.10	2.10	2.10	2.09	2.11	0.03
24	0.01	0.01	0.00	0.00	0.00	2.13	2.11	2.10	2.11	2.09	2.12	0.03
25	0.01	0.01	0.00	0.00	0.00	2.09	2.10	2.09	2.11	2.09	2.12	0.01
26	0.01	0.01	0.00	0.00	0.00	2.15	2.09	2.08	2.12	2.09	2.13	0.01
27	0.01	0.01	0.00	0.00	0.62	2.14	2.09	2.09	2.11	2.09	2.12	0.01
28	0.01	0.01	0.00	0.00	1.46	2.10	2.10	2.10	2.10	2.10	2.12	0.01
29	0.01	0.01	0.00	0.00	1.34	2.08	2.09		2.14	2.11	2.12	0.00
30	0.01	0.01	0.00	0.00	1.69	2.07	2.09		2.16	2.13	2.12	0.00
31	0.01	0.02		0.00		2.04	2.09		2.21		2.11	
Total	0.33	0.33	0.05	0.00	5.11	65.01	64.42	58.44	65.23	63.10	66.04	7.95

Appendix C – Regional groundwater bore locations



Appendix D – Regional groundwater bore levels

Clifton Formation

	State/WMIS ID	64234	64235	82838
	Barwon Water ID	G 18	G 19	M 22
	Point of Reference	TOV	TOC	TOC
Date	16-Jul-20	0.00	-23.48	-17.05
	12-Oct-20	1.86	-28.32	-17.00
	28-Jan-21	2.04	-28.35	-16.98
	13-May-21	2.14	-28.39	-17.00

Mepunga Formation

	State/WMIS ID	64236	64244	82841	82843	82844	82845	102869	108915	109112	109135
	Barwon Water ID	G 20	G 28	M 25	M 27	M 28	M 29	W 9	Y 40	YEO 21	YEO 44
	Point of Reference	TOC	TOC	TOV	TOC	TOV	TOC	TOC	TOC	TOV	TOC
Date	16-Jul-20	-19.41	-37.90	-11.72	5.51	16.26	-25.64	0.00	-35.92	5.36	0.00
	12-Oct-20	-19.27	-37.81	-11.75	5.40	16.32	-25.61	0.00	-35.90	5.30	-29.14
	28-Jan-21	-19.10	-37.94	-11.70	5.45	16.32	-25.47	0.00	-35.80	5.10	-29.80
	13-May-21	-19.00	-37.92	-11.15	5.45	16.42	-25.30	0.00	-35.73	5.10	-29.35

Dilwyn Formation

	State/WMIS ID	47771	47773	47774	47775	48249	64227	64230	64233	64238	64240	82846
	Barwon Water ID	BA 54	BA 56	BA 57	BA 58	BD 3	G 11	G 14	G 17	G 22	G 24	M 30
	Point of Reference	TOC[1]	TOC	TOP[2]	TOP	TOC	TOP	TOV[3]	TOP	TOC	TOC	TOC
Date	16-Jul-20	-11.94	-25.28	-14.63	-12.66	-34.86	-47.03	5.10	-27.48	-86.53	-27.50	-28.53
	12-Oct-20	-11.90	-25.26	-14.60	-12.62	-34.76	-46.89	5.61	-27.78	-86.52	-27.32	-28.50
	28-Jan-21	-11.34	-25.30	-14.60	-12.40	-34.80	-47.00	6.61	-27.08	-86.31	-27.05	-28.52
	13-May-21	-11.70	-25.43	-14.60	-12.30	-34.76	-46.93	5.91	-27.02	-86.20	-26.85	-28.48

	State/WMIS ID	82847	102868	107716	107717	107720		109111	109128	109130	109131	109133
	Barwon Water ID	M 31	W 7	YYG 217	YYG 218	YYG 221	Y41	YEO 20	YEO 37	YEO 39	YEO 40	YEO 42
	Point of Reference	TOC	TOV	TOP	TOP	TOV	TOC	TOC	TOC	TOC	TOC	TOC
Date	16-Jul-20	-22.42	32.74	-52.36	-33.99	0.00	-8.44	-23.65	-8.80	-7.73	-15.25	-60.45
	12-Oct-20	-22.44	32.74	-52.40	-33.96	8.16	-15.46	-23.55	-8.68	-7.58	-15.22	-60.85
	28-Jan-21	-22.38	32.74	-52.44	-33.98	8.16	-15.42	-26.64	-8.60	-7.27	-15.15	-60.63
	13-May-21	-22.33	32.84	-52.42	-33.94	8.26	-15.41	-22.56	-8.48	-7.26	-15.11	-60.50

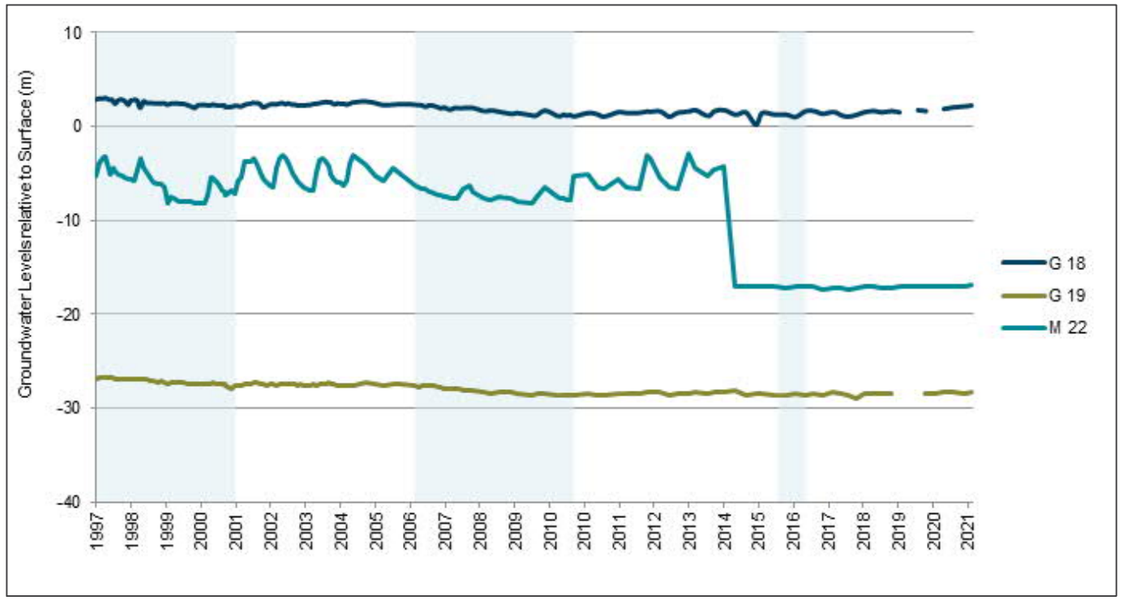
	WMIS ID	WRK040900	WRK040901	WRK040902	WRK040899	WRK040903	WRK040904
	State ID	64246	64247	64248	64245	56301/01	56301/02
	Barwon Water ID	GW2A	GW3	GW4	GW5	GW6	GW8
	Point of Reference	TOV	TOV	TOV	TOV	TOV	TOV
Date	16-Jul-20	4.59	-1.35	18.67	6.23	0.00	0.29
	12-Oct-20	4.89	-1.14	18.97	6.32	0.00	0.30
	28-Jan-21	5.10	-0.90	19.17	6.32	1.02	0.30
	13-May-21	4.30	0.00	18.56	6.42	N/A	0.30

Pebble Point Formation

	State/WMIS ID	48001	62578	64229	64237	64239	82840	109110	109113	109114	109132
	Barwon Water ID	BK 69	E 68	G 13	G 21	G 23	M 24	YEO 19	YEO 22	YEO 23	YEO 41
	Point of Reference	TOC	TOC	TOV	TOV	TOC	TOV	TOC	TOC	TOC	TOC
Date	16-Jul-20	-25.60	-24.96	-1.82	-0.70	-71.29	-8.57	-27.10	-31.15	-14.08	0.00
	12-Oct-20	-25.57	-24.90	-1.75	-0.65	-71.21	-8.50	-26.85	-30.90	-13.56	-59.10
	28-Jan-21	-25.60	-24.77	-1.43	-0.41	-71.28	-8.38	-26.60	-30.68	-13.30	-58.82
	13-May-21	-25.55	-24.84	-1.28	-0.44	-71.23	-8.35	-26.48	-30.48	-13.23	-58.51

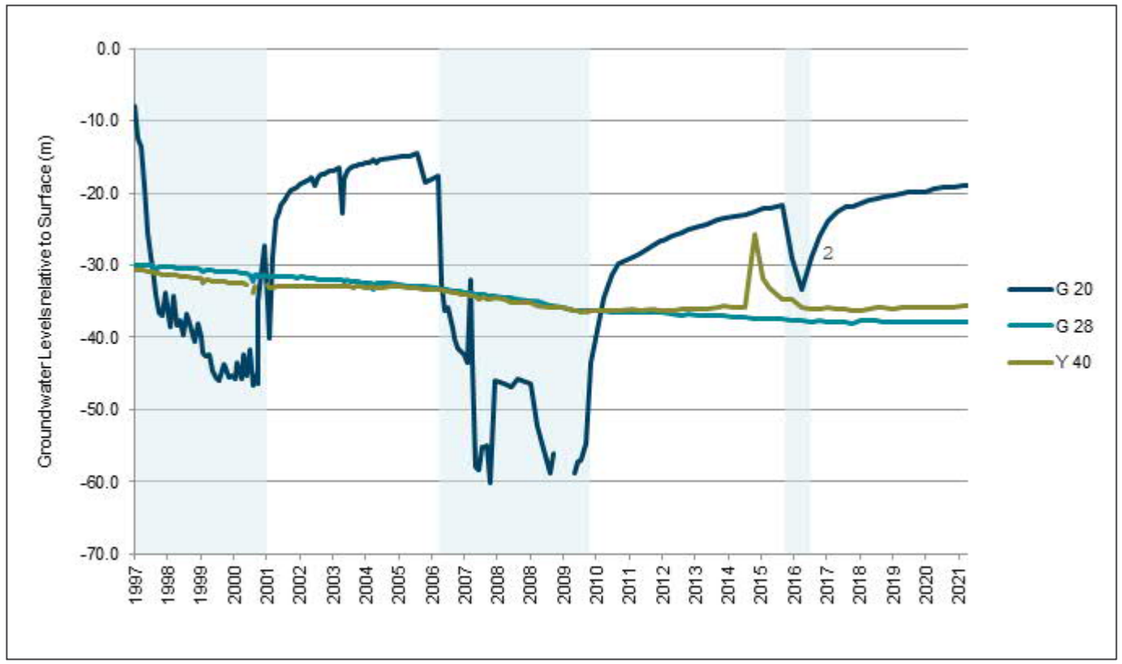
Appendix E – Regional groundwater hydrographs

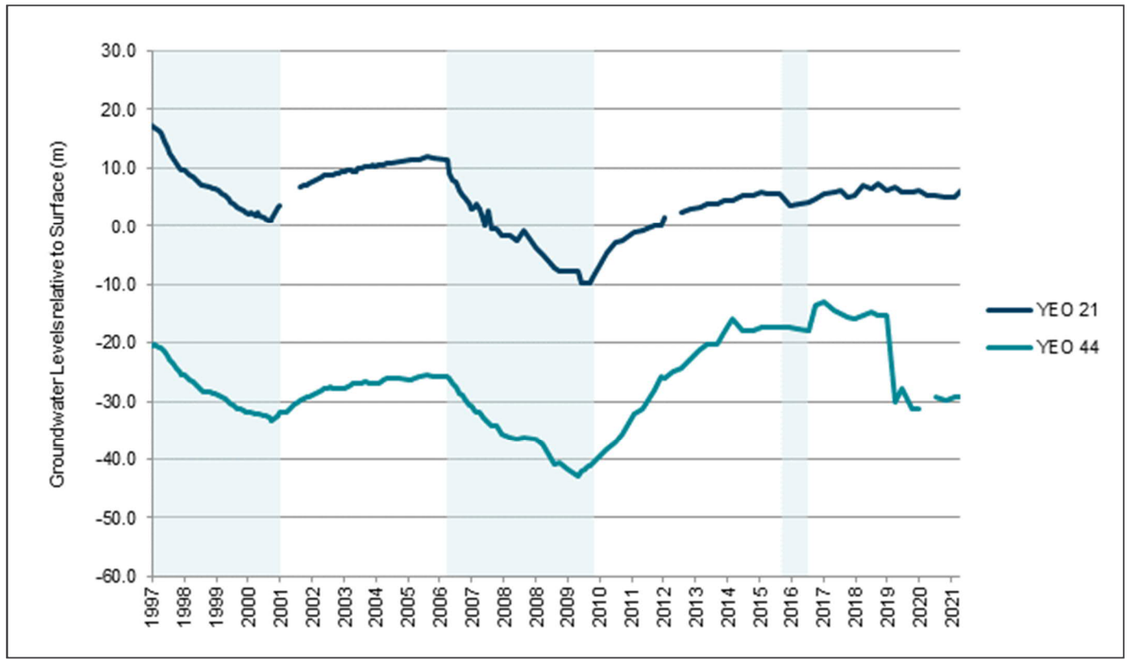
Clifton

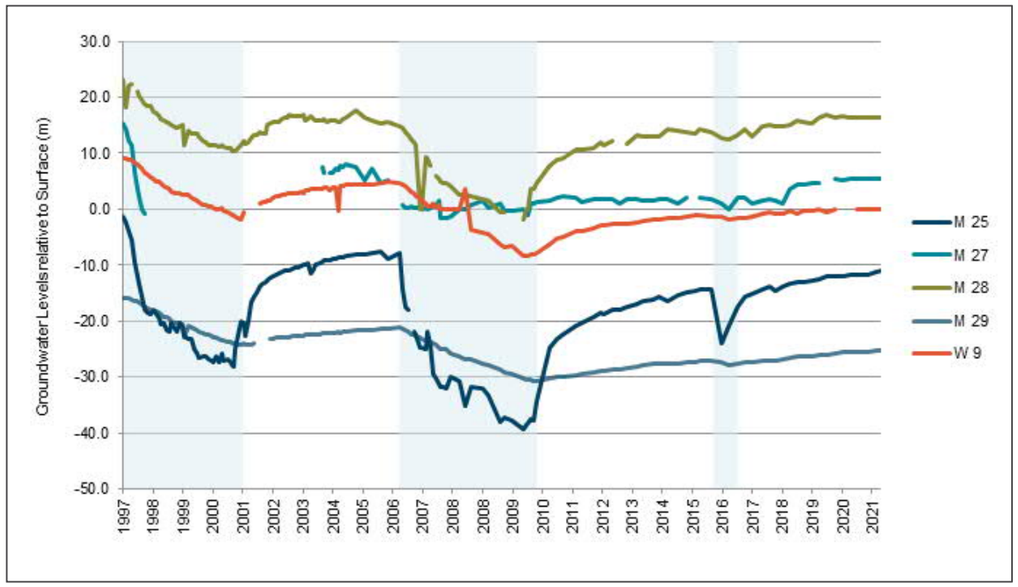


Notes:
1. Light blue shading denotes periods of groundwater extraction
2. M22 was refurbished by DELWP in 2014-2015. The drop in groundwater levels observed in 2014-2015 are due to the refurbishment and this bore is now recording accurate levels.

Mepunga



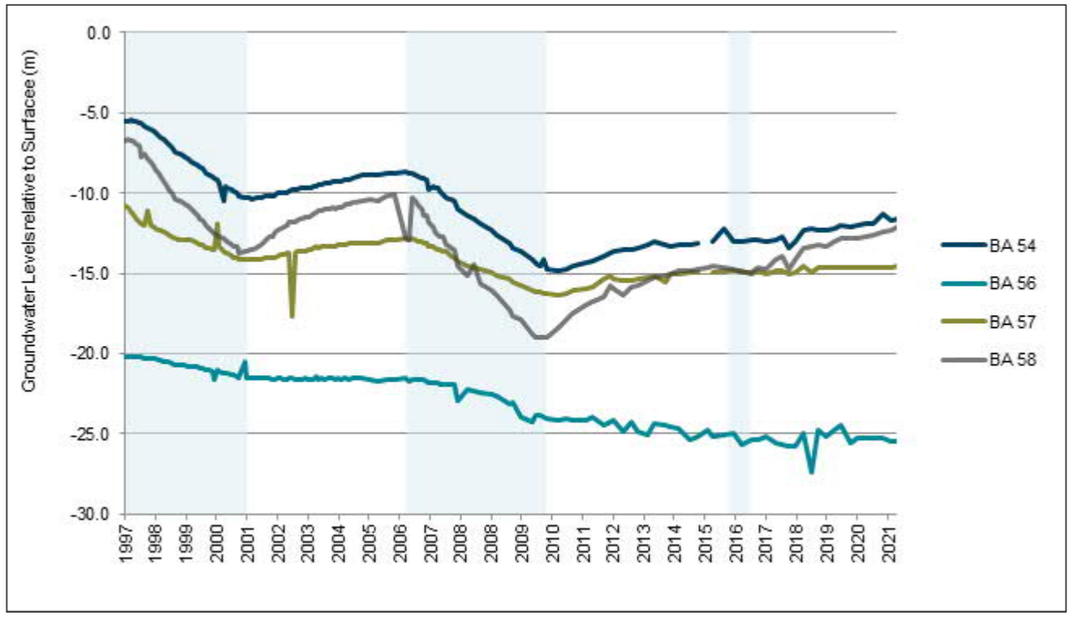


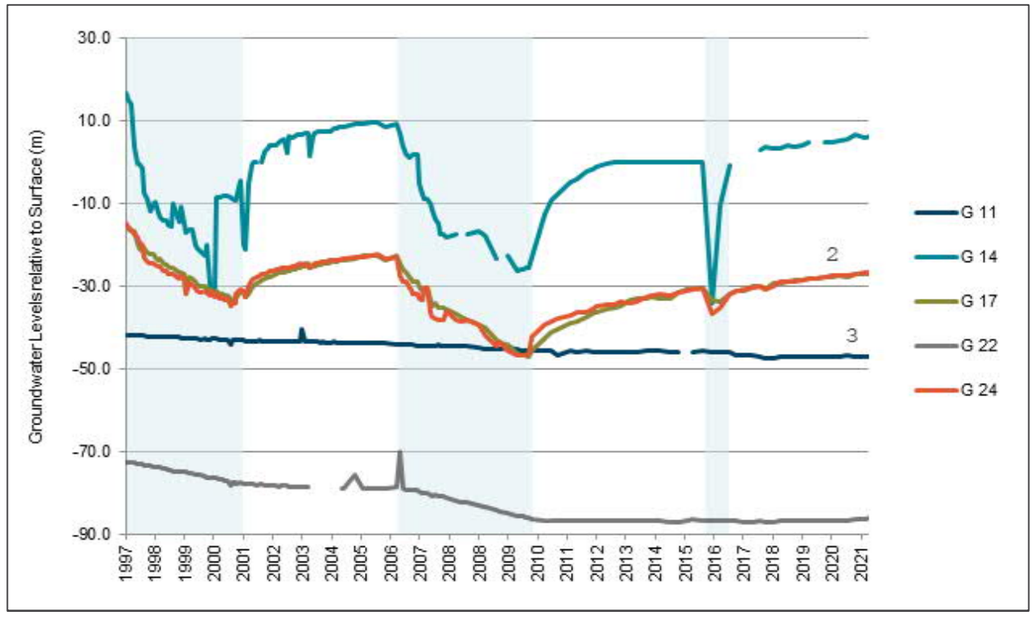


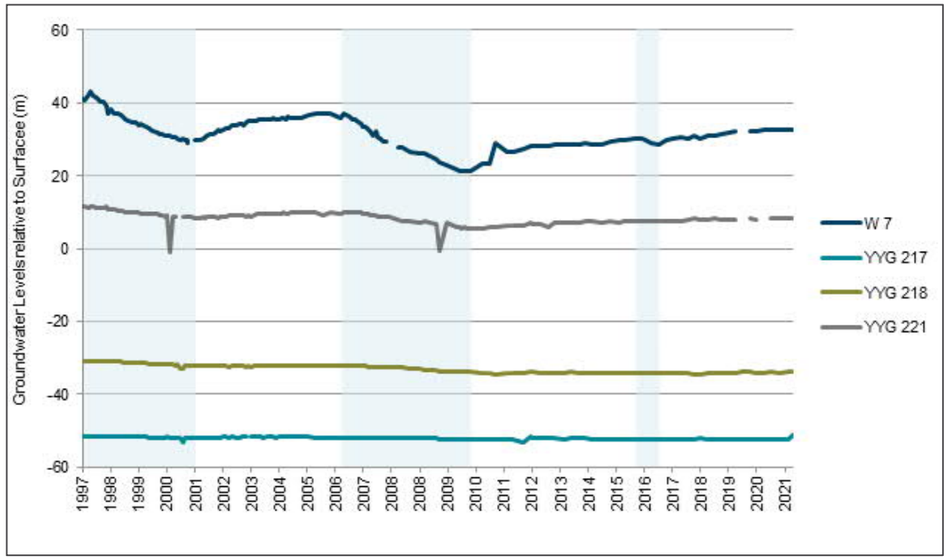
Notes:

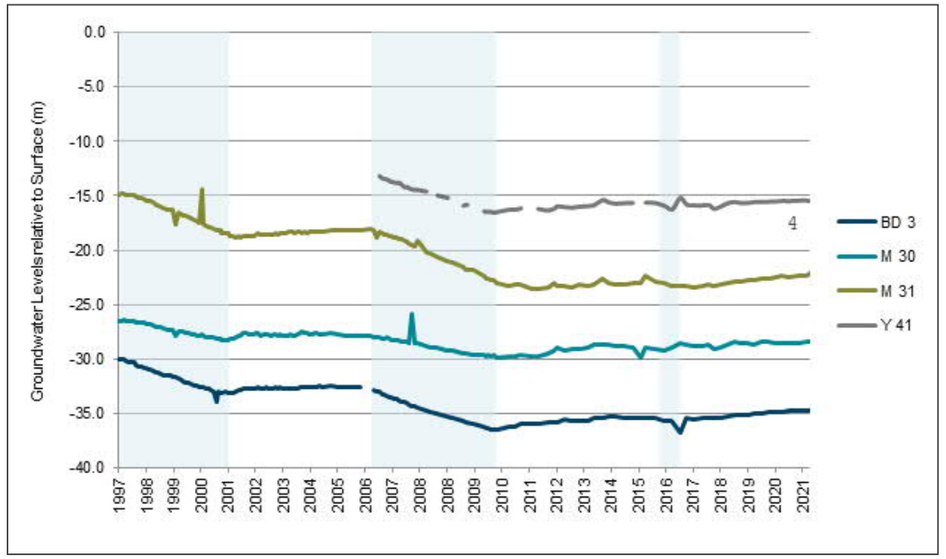
1. Light blue shading denotes periods of groundwater extraction
2. A condition assessment was conducted on Y40 in 2015/16. This indicated that the screens were blocked causing erroneous readings. Y40 was refurbished in 2016/17 and is now providing representative results.
3. Yeo44 (SOBN 109135) was refurbished post May 2019

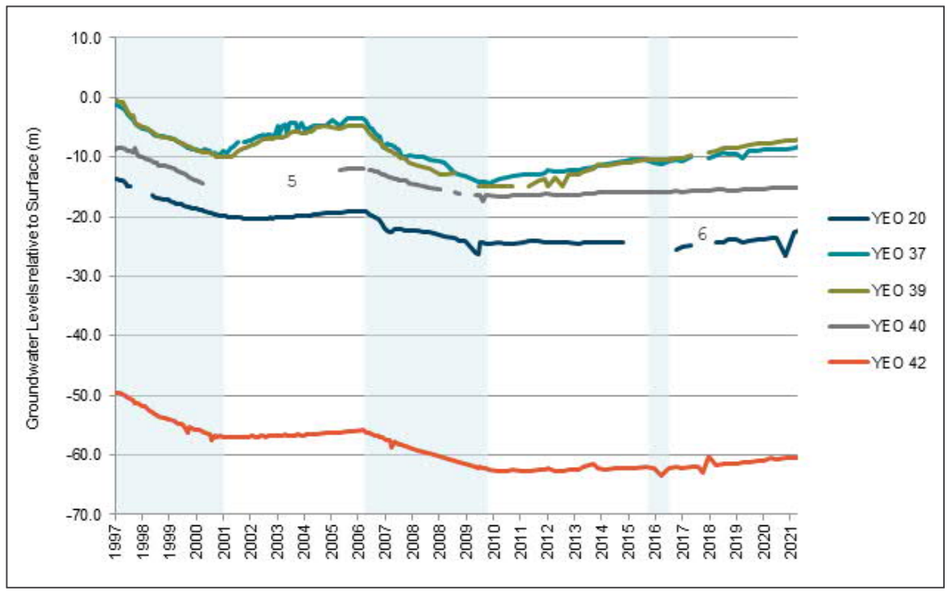
Dilwyn

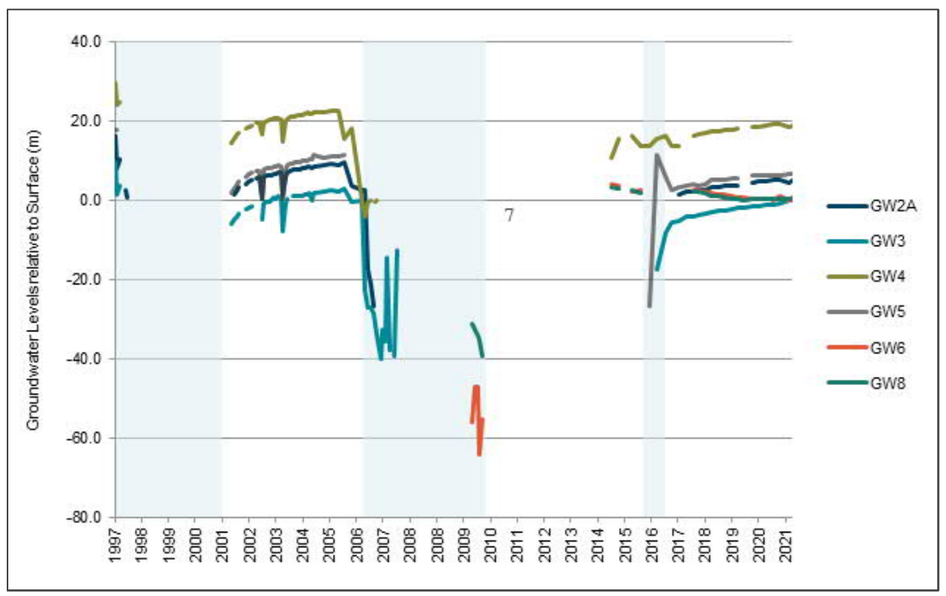












Notes:

1. Light blue shading denotes periods of groundwater extraction

2. G14 was artesian for a period of time in 2017 and did not have the correct fittings to enable pressure readings to be taken. Fittings have now been installed to enable pressure readings to be taken.

3. G11 has recorded a consistent decline in the groundwater levels over the whole reporting period. A condition assessment was conducted on this bore in 2015-2016 which indicated that it needed refurbishment. The refurbishment on G11 was completed in 2016-2017 and it is now providing reliable data.

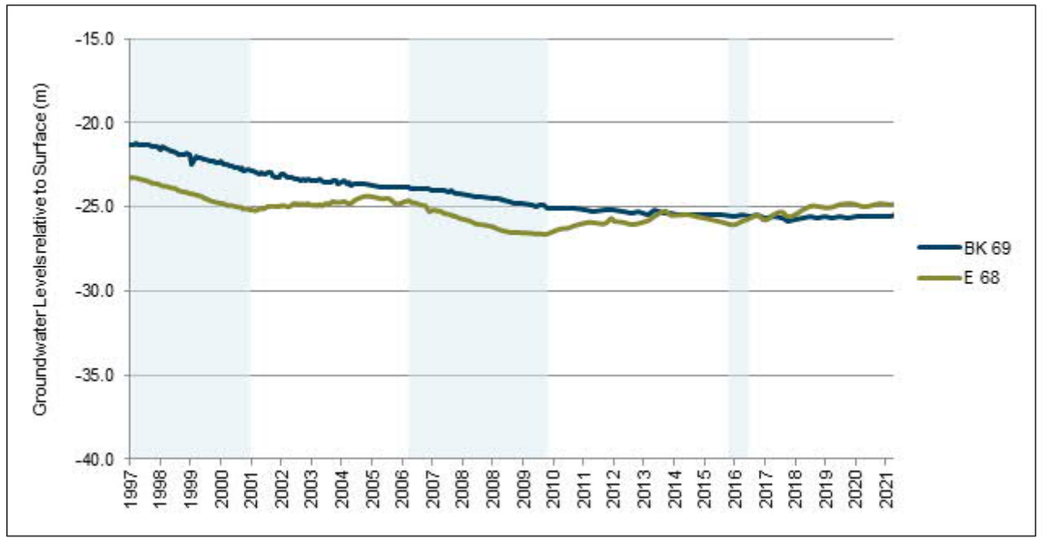
4. Y41 was constructed in 2006 and therefore no data exists for this bore prior to then.

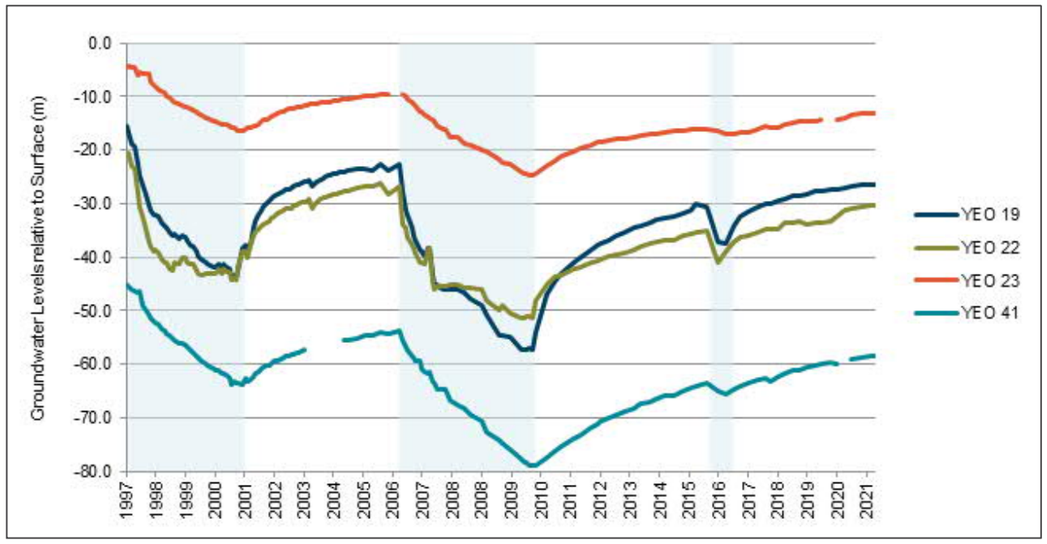
5. YEO40 has an extended period of missing data from October 2000 – June 2006. YEO40 was part of the DELWP State Observation Bore Network and was decommissioned in October 2000. A new observation bore was constructed by Barwon Water in June 2006 to replace YEO40.

6. YEO20 had a condition assessment conducted in 2015-2016 that showed it was completely blocked by tree roots. This bore has been decommissioned and a new bore has been redrilled in the same location. Readings on the new YEO20 bore commenced in June 2017. Site access prohibited some readings from being taken during 2017-2018 as operations staff were denied access to the landowner's property.

7. Data collected for the groundwater production bores varies with well head access, infrastructure arrangements and extraction. Groundwater levels are now being recorded at all production bores.

Pebble Point





Notes:

1. Light blue shading denotes periods of groundwater extraction

2. BK69 has demonstrated a declining trend in groundwater levels. A condition assessment was conducted on this bore in 2015-2016 that confirmed that these readings were representative of the actual groundwater levels.

Appendix F – Contour Maps

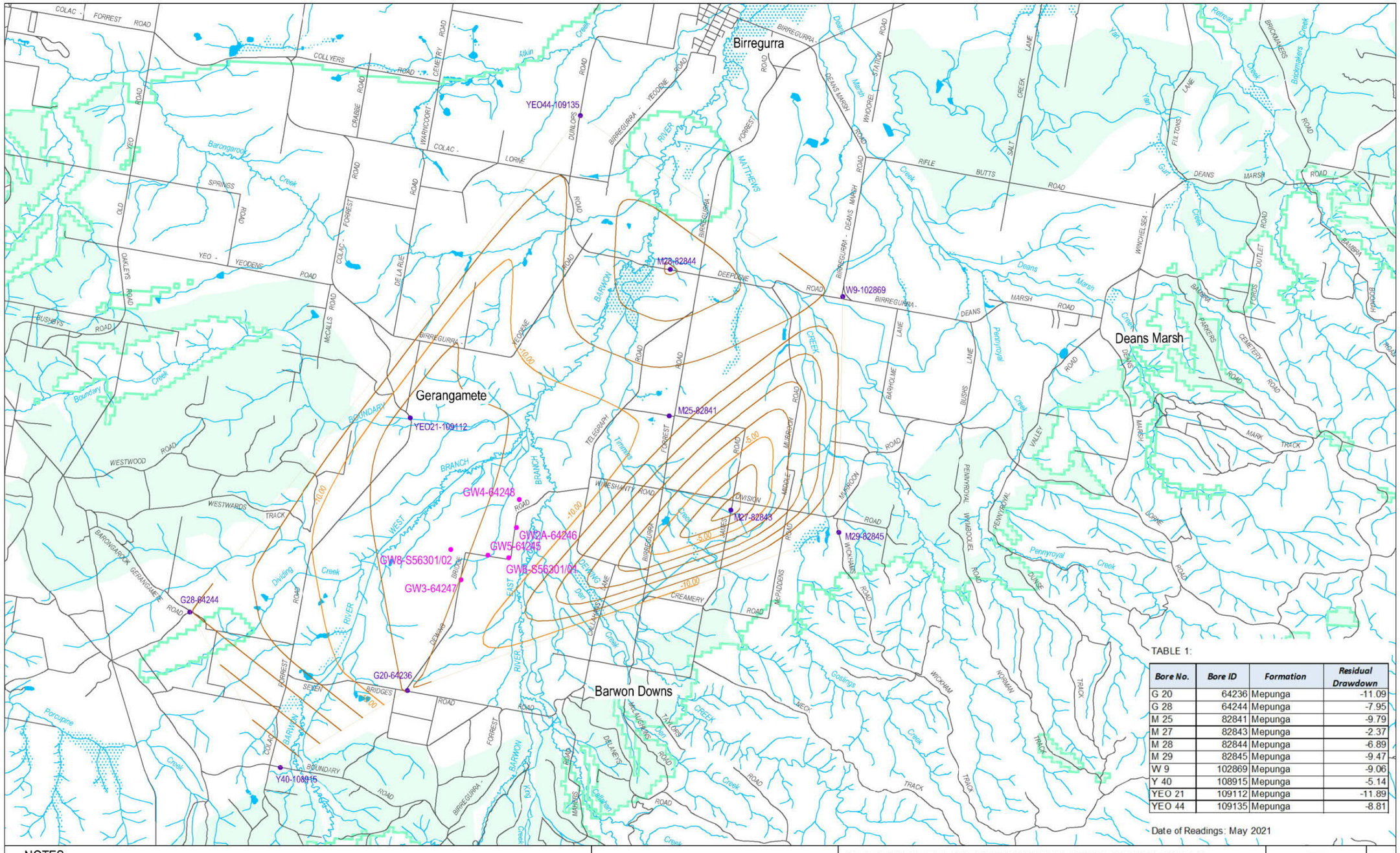


TABLE 1:

Bore No.	Bore ID	Formation	Residual Drawdown
G 20	64236	Mepunga	-11.09
G 28	64244	Mepunga	-7.95
M 25	82841	Mepunga	-9.79
M 27	82843	Mepunga	-2.37
M 28	82844	Mepunga	-6.89
M 29	82845	Mepunga	-9.47
W 9	102869	Mepunga	-9.06
Y 40	108915	Mepunga	-5.14
YEO 21	109112	Mepunga	-11.89
YEO 44	109135	Mepunga	-8.81

Date of Readings: May 2021

NOTES

RELATIVE RESIDUAL DRAWDOWN CONTOURS 1m
RELATIVE RESIDUAL DRAWDOWN INDEX CONTOURS 5m
AQUIFER EXTENTS
GROUND WATER MONITORING BORE Y40-108915
PRODUCTION BORE GW3-64247
AQUIFER AT SURFACE

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THE RESIDUAL DRAWDOWN MAPS REPRESENT THE DRAWDOWN IN DEEP, CONFINED AQUIFERS. THIS IS NOT THE LOCAL WATER TABLE LEVEL.

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GERANGAMETE GROUNDWATER MONITORING BORES
BARWON DOWNS AQUIFER - MEPUNGA FORMATION
RELATIVE RESIDUAL DRAWDOWN - 2021 COMPARED TO PRE-PUMPING (1997)

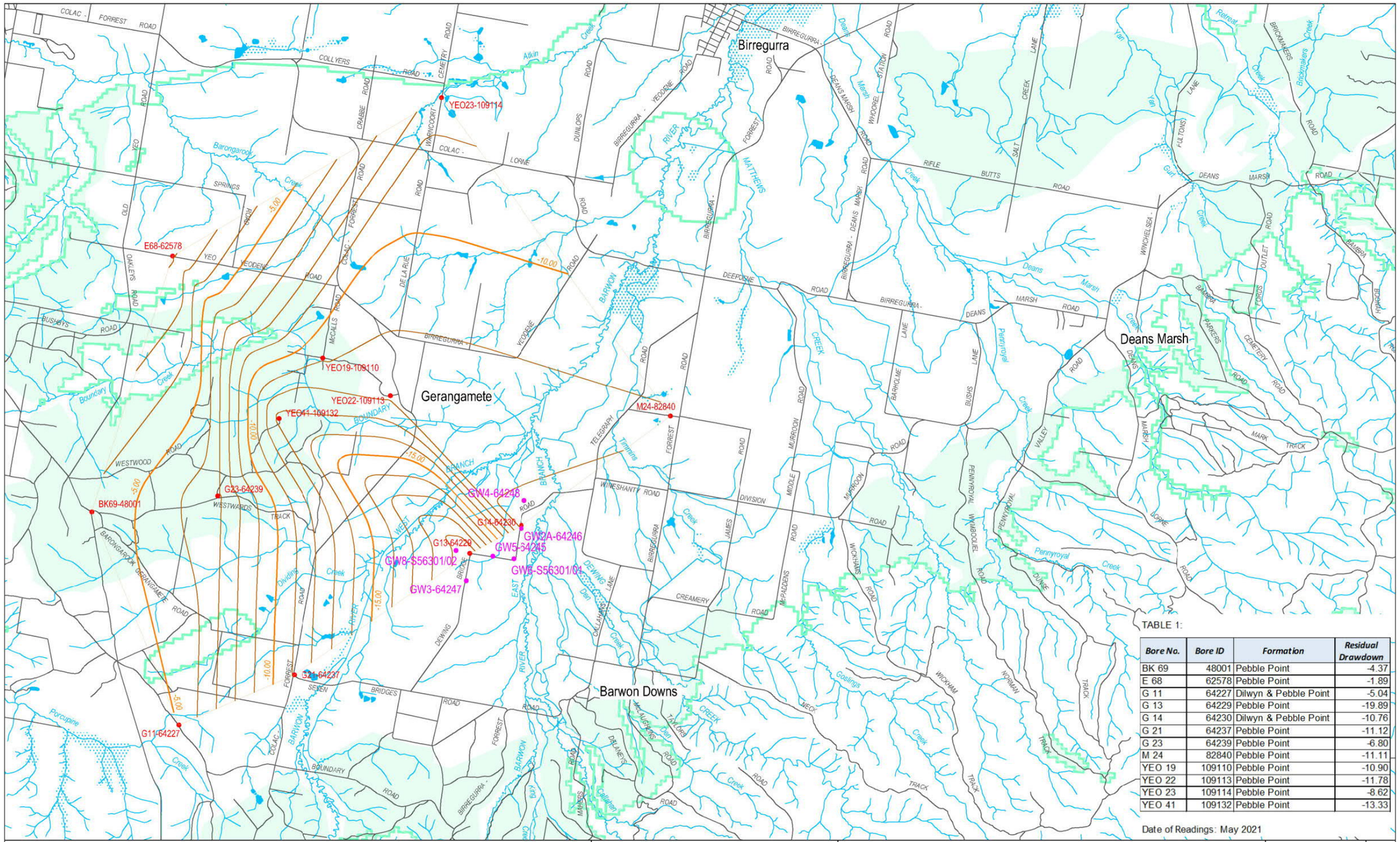
JOB No. 12106 | DRAWN E.DELGROSSO 21/09/21 | CHECKED

SCALE IN METRES 750 0 750 1500 2250 3000 3750 4500 5250 6000
SCALE 1 : 75 000

MGA 54

DATUMS
HEIGHT: AHD
MAP: MGA
ZONE: 54

12106-03
A3


Birregurra
Deans Marsh
Gerangamete
Barwon Downs
YEO23-109114
E68-62578
YEO19-109110
YEO22-109113
YEO41-109132
M24-82840
G23-64239
BK69-48001
GW4-64248
G14-64230
GW2A-64246
G13-64229
GW5-64245
GW8-S56301/02
GW6-S56301/01
GW3-64247
G21-64237
G11-64227
-5.00
-10.00
-15.00
COLAC - FORREST ROAD
COLLYERS ROAD
CRABBE ROAD
CEMETERY ROAD
WARNCOORT ROAD
LORNE ROAD
DUNLOPS ROAD
BIRREGURRA - YEODENE ROAD
RIVER ROAD
FORREST ROAD
MATTHEWS ROAD
BIRREGURRA - DEANS MARSH ROAD
WHOOREL ROAD
SALT CREEK LANE
RIFLE BUTTS ROAD
DEANS MARSH ROAD
WINCHELSEA - BIRREGURRA ROAD
DEEPDENE ROAD
BARWON ROAD
YEODENE ROAD
OLD YEO ROAD
OAKLEYS ROAD
BUSHEYS ROAD
McCALLS ROAD
DE LA RUE ROAD
VEDDERE ROAD
TELEGRAPH ROAD
MURROON ROAD
BARHOLME LANE
BUSHS LANE
PENNYROYAL VALLEY ROAD
PARKERS CEMETERY ROAD
MARK TRACK
WESTWOOD ROAD
WESTWARDS TRACK
BARONGAROOK ROAD
BARONGAROOK CREEK
DIVIDING ROAD
WINESHANTY ROAD
DIVISION ROAD
MIDDLE ROAD
McPADDENS ROAD
WICKHAMS ROAD
CREAMERY ROAD
DEWING LANE
JAMES ROAD
SEVEN BRIDGES ROAD
BOUNDARY ROAD
TAYLORS ROAD
DELANEYS ROAD
WICKHAM TRACK
NORMAN TRACK
GOSLINGS TRACK
PENNYROYAL CREEK
DEANS MARSH CREEK
BARONGAROOK CREEK
DIVIDING CREEK
BOUNDARY CREEK
PORCUPINE CREEK
GELLIBRAND RIVER
BARWON RIVER
WEST BARWON BRANCH
EAST BARWON BRANCH
TABLE 1:
Bore No. | Bore ID | Formation | Residual Drawdown
BK 69 | 48001 | Pebble Point | -4.37
E 68 | 62578 | Pebble Point | -1.89
G 11 | 64227 | Dilwyn & Pebble Point | -5.04
G 13 | 64229 | Pebble Point | -19.89
G 14 | 64230 | Dilwyn & Pebble Point | -10.76
G 21 | 64237 | Pebble Point | -11.12
G 23 | 64239 | Pebble Point | -6.80
M 24 | 82840 | Pebble Point | -11.11
YEO 19 | 109110 | Pebble Point | -10.90
YEO 22 | 109113 | Pebble Point | -11.78
YEO 23 | 109114 | Pebble Point | -8.62
YEO 41 | 109132 | Pebble Point | -13.33
Date of Readings: May 2021
NOTES
RELATIVE RESIDUAL DRAWDOWN CONTOURS 1m
RELATIVE RESIDUAL DRAWDOWN INDEX CONTOURS 5m
AQUIFER EXTENTS
GROUND WATER MONITORING BORE Y40-108915
PRODUCTION BORE GW3-64247
AQUIFER AT SURFACE
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GERANGAMETE GROUNDWATER MONITORING BORES
BARWON DOWNS AQUIFER - PEBBLE POINT FORMATION
RELATIVE RESIDUAL DRAWDOWN - 2021 COMPARED TO PRE-PJMPING (1997)
JOB No. 12106
DRAWN E.DELGROSSO 21/09/21
CHECKED
SCALE IN METRES
SCALE 1 : 75 000
750 0 750 1500 2250 3000 3750 4500 5250 6000
MGA 54
DATUMS
HEIGHT: AHD
MAP: MGA
ZONE: 54
12106-02
A3

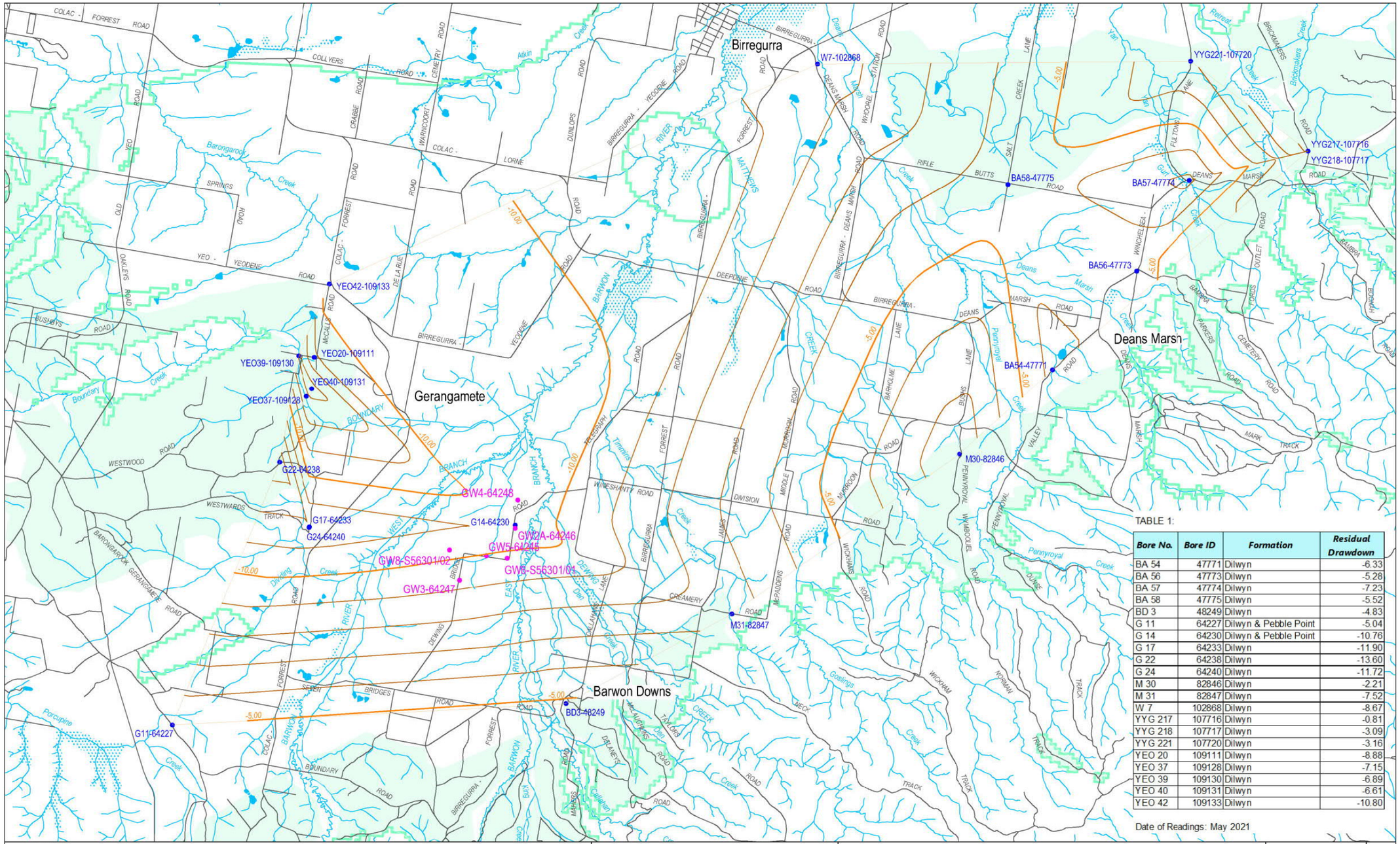

TABLE 1:

Bore No.	Bore ID	Formation	Residual Drawdown
BA 54	47771	Dilwyn	-6.33
BA 56	47773	Dilwyn	-5.28
BA 57	47774	Dilwyn	-7.23
BA 58	47775	Dilwyn	-5.52
BD 3	48249	Dilwyn	-4.83
G 11	64227	Dilwyn & Pebble Point	-5.04
G 14	64230	Dilwyn & Pebble Point	-10.76
G 17	64233	Dilwyn	-11.90
G 22	64238	Dilwyn	-13.60
G 24	64240	Dilwyn	-11.72
M 30	82846	Dilwyn	-2.21
M 31	82847	Dilwyn	-7.52
W 7	102868	Dilwyn	-8.67
YYG 217	107716	Dilwyn	-0.81
YYG 218	107717	Dilwyn	-3.09
YYG 221	107720	Dilwyn	-3.16
YEO 20	109111	Dilwyn	-8.88
YEO 37	109128	Dilwyn	-7.15
YEO 39	109130	Dilwyn	-6.89
YEO 40	109131	Dilwyn	-6.61
YEO 42	109133	Dilwyn	-10.80

Date of Readings: May 2021

NOTES

RELATIVE RESIDUAL DRAWDOWN CONTOURS 1m
RELATIVE RESIDUAL DRAWDOWN INDEX CONTOURS 5m
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GERANGAMETE GROUNDWATER MONITORING BORES
BARWON DOWNS AQUIFER - DILWYN FORMATION
RELATIVE RESIDUAL DRAWDOWN - 2021 COMPARED TO PRE-PUMPING (1997)

JOB No. 12106 | DRAWN E.DELGROSSO 21/09/21 | CHECKED

SCALE IN METRES 750 0 750 1500 2250 3000 3750 4500 5250 6000
SCALE 1 : 75 000

MGA 54

DATUMS
HEIGHT: AHD
MAP: MGA
ZONE: 54

12106-01

A3

Appendix G – Progress Report

#	Activity	Due Date	Status	Health Indicator	Comments
1.0	Meeting with SRW to be held at the Barwon Water office to develop work plan towards confirming priority actions relating to feedback provided.	30-Apr-20	Complete	Complete	Complete
2.0	Complete autumn macro-invertebrates survey	30-Jun-20	Complete	Complete	Report now complete and is now uploaded on web page
3.0	Complete soil incubation testing	31-May-20	Complete	Complete	Report has been finalised and is now uploaded on web page
4.0	Submit Quarterly Update to SRW and publish to web page	30-Jun-20	Complete	Complete	SRW review of template complete. Quarterly Update uploaded to web page on 30th June.
5.0	Scoping of SW-GW technical work packages required to inform detailed design and address feedback register	30-Nov-20	Complete	Complete	Complete
6.0	Complete installation of additional monitoring assets for the following sites identified as 'high risk' in the surrounding environment investigation	31-May-22	In progress	On track	19 of 23 bores are installed - remaining 4 to be completed once condition permit and appropriate drill rig is available 2 of 5 Stream Gauges installed, the wet weather and high flows over summer prevented installation of 2 gauges. 1 stream gauge is still awaiting permit approval.
7.0	Conclusion of monitoring period enabling the capture of a full seasonal cycle of data to inform updates to the groundwater-surface water model and geochemical model.	31-Jul-20	Complete	Complete	1 year of monitoring completed. Monitoring of GW levels, stream flows and water quality continues in Big Swamp and Boundary Creek.
8.0	REPP Feedback Work plan - Submission and Acceptance	31-Jul-20	Complete	Complete	Completed
9.0	Governance Framework - Submission and Acceptance	31-Jul-20	Complete	Complete	Completed
10.0	Barwon Water Comms and Engagement Plan	Ongoing	In progress	On track	Remediation Reference Group meeting continue to be held quarterly. Work being completed with SRW and DELWP on updating the joint comms plan
11.0	Submit updated REPP to capture the work plan for addressing the feedback register. SRW to accept the updated REPP.	TBA	In progress	On track	Barwon Water submitted changes to SRW on 30th September. SRW has provided feedback, and discused on 10th March. BW has submitted proposed updates including any which were contingent on detailed design on the 31st July
12.0	Submit annual report to SRW and publish to web page	30-Sep-20	Complete	Complete	Completed
13.0	Remediation Reference Group Meeting	2-Dec-20	Complete	Complete	Completed
14.0	Establish vegetation baseline monitoring for Boundary Creek and Big Swamp Remediation Plan:	31-Dec-20	Complete	Complete	Baseline Monitoring undertaken 25th of November - Further monitoring to be completed in 2022
15.0	Update groundwater-surface water model	31-Dec-20	Complete	Complete	Final report uploaded to web page
16.0	Submit quarterly report to SRW and publish to web page	31-Dec-20	Complete	Complete	Completed
17.0	Remediation Reference Group Meeting	17-Mar-21	Complete	Complete	Completed
18.0	Submit quarterly report to SRW and publish to web page	31-Mar-21	Complete	Complete	Completed
19.0	Remediation Reference Group Meeting	23-Jun-21	Complete	Complete	Completed
20.0	Submit quarterly report to SRW and publish to web page	30-Jun-21	Complete	Complete	Completed and uploaded to web page
21.0	Submission of detailed design of the hydraulic barriers outlining proposed controls or actions and any revisions to success measures/targets.	1-Jul-21	Complete	Complete	Complete. Submitted to SRW on 1 July 2021
22.0	Update Hydrogeochemical model	31-Jul-21	Complete	Complete	Completed and uploaded to web page
23.0	Complete detailed design of contingency measure and feasibility assessment for up-stream for new upstream treatment method	31-Jul-21	Complete	Complete	Detailed design submitted to SRW 30 July 2021. Limited information available indicates upstream treatment could be feasible subject further investigation and completion of lab and field trials
24.0	Remediation Reference Group Meeting	8-Sep-21	Complete	Complete	Barwon Water presented on the key aspects of the hydraulic barrier and contingency measure submissions, inlcuding the proposed further investigation of upstream treatment.
25.0	Submit annual report to SRW and publish to web page	30-Sep-21	Complete	Complete	Report currently being drafted
26.0	Remediation Reference Group Meeting	Dec-21	Not started		

27.0	Scoping and completion of Upstream Treatment desktop investigation and development of trial plan	31-Dec-21	In progress	On track	High level scope currently being developed to allow further engagement with relevant technical experts
28.0	Submit quarterly report to SRW and publish to web page	31-Dec-21	Not started		
29.0	If trial plan is approved undertake upstream treatment trial	31-Mar-22	Not started		
30.0	Submit quarterly report to SRW and publish to web page	31-Mar-22	Not started		
31.0	Decision on full scale upstream treatment, hydraulic barriers and downstream treatment	30-Apr-22	Not started		
32.0	Submit quarterly report to SRW and publish to web page	30-Jun-22	Not started		
33.0	Submit quarterly report to SRW and publish to web page	30-Sep-22	Not started		
34.0	Hydraulic Barriers - seek relevant approvals/permits if barriers are confirmed to be required following the upstream treatment investigations and trial	31-Dec-22	Not started		
35.0	Infill the existing fire trenches and the agricultural drain at the eastern end of the swamp to allow the swamp to retain more water over the winter months:	Summer 22/23	Not started		Rescheduled to integrate with hydraulic barriers installation.
36.0	Conclusion of monitoring period for surrounding environment investigation enabling the capture of a full seasonal cycle of data (12 month minimum) to inform updates to the regional groundwater model	31-Dec-22	Not started		
37.0	Update regional groundwater model or build new local scale groundwater models for the surrounding environment investigation 'high' risk sites to assess magnitude of impact as a result of historic groundwater management.	30-Apr-23	Not started		
38.0	Submit quarterly report to SRW and publish to web page	31-Dec-22	Not started		
39.0	Review risk assessment for 'high' risk areas for the surrounding environment Investigation to confirm risk rankings based on updated groundwater model/s	31-Jul-23	Not started		
40.0	Submit quarterly report to SRW and publish to web page	31-Mar-23	Not started		
41.0	Submit quarterly report to SRW and publish to web page	30-Jun-23	Not started		
42.0	Outcomes of the surrounding environment investigation to be provided to Southern Rural Water to determine if further remedial works is required.	31-Jul-23	Not started		
43.0	Submit annual report to SRW and publish to web page	30-Sep-23	Not started		
44.0	Submit quarterly report to SRW and publish to web page	31-Dec-23	Not started		