

Boundary Creek, Big Swamp and surrounding environment Remediation and Environmental Protection Plan

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Acknowledgements

Barwon Water wishes to acknowledge the contribution of the Boundary Creek and Big Swamp Remediation Working Group whose valuable insights, local knowledge and passion for the environment helped shape the Remediation and Environmental Protection Plan.

Representatives included Traditional Owners, Land and Water Resources Otway Catchment (LAWROC), Corangamite Catchment Management Authority, Colac Otway Shire Council, Environment Victoria, Upper Barwon Landcare Network, Boundary Creek landowners, and other interested community members.

Barwon Water also wishes to recognise the technical expertise of Dr. Darren Baldwin, Dr. Vanessa Wong and Professor. Richard Bush who provided independent support to the Remediation Working Group.

Executive Summary

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 the ineffective regulation of passing flow conditions 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 develop 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.

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 March 2020.

This document addresses the requirements of the s78 notice to submit the REPP following 18 months of scientific studies, advice from independent technical experts and valuable community feedback.

Eight key principles underpin the REPP (see overleaf) including continuing an open and transparent relationship with Traditional Owners, the community and key stakeholders. Through this relationship, the desire to allow groundwater levels to recover in the Lower Tertiary Aquifer was clearly expressed. Barwon Water fully supports this aquifer recovery and incorporated this into the principles.

Remedial works aims to improve water quality in Big Swamp, stabilise the acidification process that takes place due to the drying and wetting of the acid sulfate soils in the area, and reduce the risk of acid flush events from Boundary Creek in the long-term.

This will occur through the continual wetting of Big Swamp through controlled release of water to Boundary Creek and the installation of hydraulic barriers to maintain surface water flows and groundwater levels within Big Swamp.

The REPP also outlines how possible impacts in other areas within the regional groundwater system will be investigated and determine if further remediation work is necessary.

The REPP employs an adaptive approach to allow continued environmental monitoring to inform requirements for remediation.

As remedial works are implemented, it is anticipated that low pH events will diminish over the next decade and that ecological values of the swamp will improve.

1 Response to Southern Rural Water's feedback

1.1 Introduction

Barwon Water welcomes the feedback¹ from Southern Rural Water on the Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan (REPP), which took into consideration a review undertaken by the Independent Technical Review Panel and recommendations from their Community Leaders Group.

The feedback endorsed the preferred remediation option for Boundary Creek and Big Swamp and confirmed the need for an adaptive management approach so that the Plan can be responsive to new data and information as it becomes available.

The REPP is a clear statement of Barwon Water's unwavering commitment to delivering successful environmental outcomes and demonstrates the significant progress made since July 2019 in determining the preferred remediation option, and proposed actions and controls for improved environmental outcomes for Boundary Creek and Big Swamp.

It also outlines a robust process to undertake investigations to verify if other areas within the regional groundwater system have been impacted by historical management of groundwater extraction.

Barwon Water will begin implementation of the REPP by 01 March 2020 as soon as it is accepted. This will include continuing the release of supplementary flow and collection of more data to refine the design of the preferred remediation option and installation of new monitoring equipment in the surrounding environment. This will occur in parallel to addressing feedback from Southern Rural Water.

1.2 Addressing the feedback

The adaptive approach outlined in the REPP is acknowledgment that remediation is complex, with the proposed remediation option for Boundary Creek and Big Swamp developed using a time limited dataset available at the time of submission of the REPP on 20 December 2019.

In providing their feedback, Southern Rural Water has acknowledged that considerable work and time is required to address particular questions that they have raised, including a longer period for data collection and assessment. While addressing some of these questions already aligns with the further technical work proposed in the REPP, Barwon Water will work on all of the items in the feedback prior to preparing responses to ensure that they are understood and are adequately addressed.

In response to Southern Rural Water's feedback and in acknowledging the technical nature of the work, Barwon Water proposes to incorporate in the REPP a meeting with Southern Rural Water to outline the items of feedback that are not already addressed by the REPP, including work plans, timeframe and prioritisation of actions.

¹ Specifically, feedback from Southern Rural Water dated 20 February 2020 and subsequent email clarification dated 25 February 2020.

As part of this process, Barwon Water will also consider the feedback provided by the Independent Technical Review Panel and Community Leaders Group as context.

In some cases, the feedback relates to matters that are beyond Barwon Water's control. Recovery of groundwater levels in the aquifer is understandably complex and susceptible to fluctuations through use by third parties and the future impact of a drier climate. Success measures and targets relating to objectives must reflect what is *practicably achievable* by the actions and controls being implemented by Barwon Water. This is consistent with the intent of SMART principles.

The targets currently in the REPP were developed with input from our community and stakeholder Remediation Working Group and their independent nominated experts.

In some cases, the refinement of success targets may be required based on what is being observed and how the environment is responding to remediation works. This will enable the setting, monitoring and adapting of meaningful and realistic targets linked to proposed actions and controls for remediation. A register of the feedback received from Southern Rural Water that Barwon Water will address through this process is provided below.

Barwon Water proposes the following process and the development of a work plan for addressing feedback and progressing implementation of the REPP that will require acceptance from Southern Rural Water.

Table 1: Proposed work plan to address feedback

Milestone	Timeframe
Meeting with SRW to be held at the Barwon Water office to develop work plan towards confirming priority actions relating to feedback provided. SRW to accept outcomes of the workshop whereby a register of feedback is confirmed for Barwon Water's response.	By 30 April 2020
Submission of a work plan detailing how Barwon Water will respond to the register of feedback, including prioritisation of actions, the timeframe for responding to each item and the process for reporting and closing out each item. SRW to accept the work plan.	By 31 July 2020

1.3 Governance

A crucial element for successful remediation is the development of a governance framework so that:

- responsibilities are clear, and
- that it is clear when acceptance of revisions to the REPP may be sought by Barwon Water from Southern Rural Water.

Barwon Water will propose any changes or improvements to the REPP and seek acceptance of these changes from Southern Rural Water based on evaluating the effectiveness of actions and controls, outcomes of the monitoring and assessment program, scientific data and expert advice and/or feedback from stakeholder and community engagement.

Barwon Water's commitment to continuing an open and transparent relationship with the community and key stakeholders including local environmental groups during the implementation of the REPP will also be a key component throughout the implementation of the REPP.

A communications and engagement plan will be developed in 2020. This will be informed by input from Barwon Water's existing Remediation Working Group with regard to the appropriate level of engagement, and method of engaging in their community. This may include the establishment of a new Remediation Working Group.

Barwon Water will invite Southern Rural Water to observe stakeholder and community engagement undertaken by Barwon Water. This will be important to ensure both Southern Rural Water and the community remain informed through every step of the remediation process.

In line with the accepted governance and approvals framework, as a minimum, Barwon Water proposes that the following key milestones would require acceptance from Southern Rural Water. It should be noted that ad-hoc requests to amend the REPP may also require acceptance from Southern Rural Water outside the proposed timetable below as new data or information is obtained.

Table 2: Proposed milestones and timeframes for implementation of the REPP

Milestone	Timeframe
<p>Endorsement of a governance framework clearly outlining roles and responsibilities of stakeholders involved in the REPP, a decision making process to determine how revisions to the REPP in the form of controls or actions are accepted or rejected and how controls and actions are implemented.</p> <p>SRW to accept the governance framework.</p>	By 31 July 2020
<p>Submission of detailed design of the hydraulic barriers outlining proposed controls or actions and any revisions to success measures/targets.</p> <p>SRW to accept the detailed design, including proposed actions, controls, and success measures/targets.</p>	01 July 2021
<p>Outcomes of the Surrounding Environment investigation to be progressively provided to Southern Rural Water as they come to hand.</p> <p>SRW to decide if further action is required.</p>	31 July 2023
Barwon Water to provide progress updates against annual work plan on a quarterly basis.	Quarterly
<p>Barwon Water to submit annual work plan as part of the Annual Report.</p> <p>SRW to accept annual work plan.</p>	Annually

1.4 Feedback register

Feedback	
SRW Cover Letter	
01	Definition of remediation does not match what is in the notice. The definition in the plan should not limit the intent or extent of the S78 notice. Risks and limitations around achieving remediation are appropriate within the plan.
02	Principles need to be consistent and align to the definition of 'principle'. See attachment 1 for further guidance.
03	Prioritising Boundary Creek and Big Swamp over surrounding areas is an acceptable approach, however more detail is required as to what will be done for surrounding areas.
04	The 2ML per day supplementary flow into Boundary creek is the same as the historic licence condition. The REPP should identify what the objective of the flow is, why 2ML is the appropriate flow to achieve the objective, and how higher flows have been considered and not adopted.
05	All remediation and investigative options explored need to be presented and analysis or commentary provided with regard to why they were or were not pursued.
06	Works and timetable contain 10 year objectives which are very general. The REPP should be specific on the actions to be taken and their timeframe for completion ie what the action will be, who will do it, when it will happen etc
07	The success targets presented are general and aspirational. It is entirely appropriate to include aspirations and goals, however the targets themselves should be described using the SMART principles. As an example, "recovery trend for groundwater levels in the LTA" is an aspiration. As a SMART target it needs to express each of the principles, including what the measurable is (a specific groundwater level or range), relevance in relation to stream gaining conditions, the timeframe it is expected to be achieved. There are no targets for groundwater levels in the observation bores listed or a timeframe within which they should be met.
08	To support the adaptive approach and the considerable timeframes proposed in the REPP, a framework for governance and decision making, including how the community and their Expert Panel will be involved should be included.

Feedback	
09	Consistent with Section 78, the footnote on page 45 flags the need for ongoing improvements of the REPP in line with the adaptive approach. The REPP should propose a more specific process and work plan for monitoring, for determining what constitutes the need for an improvement to the REPP and how this will be proposed to SRW and implemented. The matters raised in this correspondence should be identified within the REPP as part of this point.
SRW feedback attachment 1: Principles	
10	Principle 1 - A remediation principle regarding full recovery of the aquifer has been discounted, this needs to be further explored, and more information is required to evidence whether or not this should be a principle/objective. This could include scenario modelling of filling under different scenarios.
11	Principle 6 – It is unclear how this aligns with the evidence which suggest that both passive and active remediation actions are likely required. SRW suggests that the principle is the focus on remedying the “cause of the issue ...” is an appropriate principle statement, however ruling in or out engineering or passive intervention is appropriate for analysis and conclusion within the plan itself.
12	Principle 2 – This should be more explicit in describing the circumstances in which a qualification of rights may be sought.
13	Principle 3 – This principle states that remediation actions must relate directly to ‘confirmed environmentally significant adverse impacts’. How is ‘environmentally significant’ defined?

Feedback	
14	<p>Principle 8 – The REPP makes a number of assertions that are not supported with data or technical analysis; indeed the Jacobs review does not raise this issue to the level that the REPP does. Whilst SRW agree and support any notion that the dam owner must operate in compliance with their license, the statements in the REPP appear to overstate the impact of previous practices with respect to the dam. Without diminishing the importance of compliance it is not clear how this matter should sit at a principle level given the focus and nature of the other principles. The REPP identifies 2ML as the relevant flow required at McDonalds dam in order to meet 0.5ML per day at the Yeodene gauge. It is not clear in the REPP what the purpose of the flow is, and basis for arriving at these volumes as preferable to any other volume.</p> <p>In this regard REPP should:</p> <ul style="list-style-type: none"> - Describe the purpose of the release into Boundary Creek. - Clarify the scientific basis of 2ML/day as the proposed volume that is required to be released into Boundary Creek. Revise and provide evidence supporting the extent of impact of the operation of “McDonald’s dam” - In the success target for flows in Boundary Creek (page 36 of the REPP) includes an assumption about operation of the dam. It is acceptable to raise assumptions and risks in the text, however these would generally not be highlighted within the success target. We note that the other success targets do not contain commentary around risks and assumptions. - In light of the above, reconsider the matter as a principle as opposed to text within the plan. The principle may more appropriately address risk management and mitigation to any number of events that could impact the progress and success of the plan.
SRW feedback attachment 1: Modelling	
15	<p>The conceptual and numerical models they are critical for ensuring a shared understanding and informing decisions. The REPP should;</p> <ul style="list-style-type: none"> - be informed by the most up-to-date data and information, i.e data from newly installed bores. The current conceptual model presented does not take this new information into account; - prioritise the action to update and refine both the conceptual and numerical models and develop a clearly defined work plan that describes the methodology and timeframes;
16	The impact of modelling uncertainty on broader investigations should be more clearly articulated throughout the document
17	The impact of depressurisation on direct discharge and vertical flows into Big Swamp, particularly at the western boundary is a fundamental conceptual question that requires specific attention

Feedback	
18	Figure 6 - The conceptual diagram indicates losses between McDonalds Dam and Big Swamp are between 1.5 - 2.0ML/d, this suggests that in dry weather (when inflows to McDonalds dam are 0, then a release of 2ML/d is unlikely to make it to Big Swamp. Are these losses included in the SW/GW modelling and the options assessment? Reach 2c (Big Swamp) is identified as neutral in regards to water balance. What is the estimated volume of Evapotranspiration/evaporation/drainage from the swamp and how does this compare to other water balance components?
19	Based on the evidence presented in the Jacobs SW/GW modelling report that acknowledges <i>'the available groundwater level records for bores in the swamp (June to September 2019) is of insufficient duration to allow a robust transient calibration that tests the model over a range of climatic and surface water hydrological conditions'</i> and concludes that <i>'a continuous release of water and installation of hydraulic barriers can be expected to increase groundwater levels throughout the swamp and to maintain flow in Boundary Creek, however this would need to be confirmed with further modelling...'</i> It is important to highlight that the flow and barrier option is unconfirmed and further modelling and site trials are required before confidence in this option can be improved.
SRW feedback attachment 1: Success targets and measures	
20	SRW acknowledges use of an adaptive management approach and the reasons BWC have proposed to use that model. Where clear, measurable success targets exist, actions can be taken, the response observed and the actions adjusted as dictated by the data. The current success measures generally are not described specifically enough to show when the target will be met or on what basis the mitigation options will be changed. For example "an increasing trend" is not a "SMART" goal and would be better expressed in terms of lower and upper range limits of the trend;
21	Further, a time period of 2 years is stated for recovery; is this 2 consecutive years, or 2 cumulative years? And what is the target after 2 years?
22	The targets around acid generation propose 10 year timeframes. The plan should include options analysis detailing why 10 years and not something less is appropriate. Including options analysis of potential intermediate targets and timeframes for pH in Boundary Creek, noting the Jacobs report says 1/2 have met targets already.
23	In general, success measures, targets and timelines should be more explicit, consistent and transparent.
SRW feedback attachment 1: Options analysis and the plan	

Feedback	
24	SRW believe it is critical to the process and transparency to have insight into the rationale behind the position presented in the REPP. The plan should provide reference to the suite of remediation options assessed and an analysis that supports the conclusion to rule them in or out. As an example; was artificial recharge of the aquifers considered and assessed, and what were the outcomes of this assessment?
25	Technical evidence suggest that the preferred remediation option carries a risk that acidity and iron discharges will increase in the short term. More information is required on the potential effects of this risk downstream, and also the level of confidence in potential mitigation measures.
26	Section 3.2.1 – It was not clear how the boundaries of the area of confirmed impact in Figure 1 were defined. Please provide the rationale that informed either the inclusion of exclusion of areas
27	Section 3.3 - The Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems (GDEs) (DELWP, 2015) have been used in the risk assessment. The guidelines refer to High Value GDEs. The REPP should make it clear how it has defined 'High Value' and how the definition of remediation relates to ecological value
28	Figure 4 – The diagram should include other impacts, loss of stream ecology, loss of stock access, impacts in upper Boundary creek etc
29	5.2.2 – reference to maintenance of 'minimum flows' in Reach 3 of Boundary creek all year round. It is unclear what 'minimum flows' means.
30	5.2.3 – The text above Figure 10 that refers to 'reduced releases from McDonald's Dam' is incorrect
31	5.3 - It is not clear from the map or the text why the areas for investigation have been chosen and how these relate to the broad areas of high and medium risk across the map. The report states ' <i>This process was detailed in the revised scope of works submitted to and approved by Southern Rural Water.</i> ' This statement should be caveated by the comments provided by SRW and the Independent Review Technical Panel on the Scope of Works and the risk assessment process, the model calibration, and the need to refine the risk assessment process as the model is improved. It would be useful to specifically address the sites/areas identified by the local community and to explain why these are not included.
32	Figure 36 – Is this figure correct? Where are the locations of ASS sampling?
33	6.1.8 – There is no target related to the Barwon River, so as it reads it is unclear how sampling of chemistry and macroinvertebrates in the Barwon River relates to the REPP

Feedback	
34	6.5.2 - Vegetation in Big Swamp is assessed as "current" with no further changes proposed. This does not alter the system "back" to any former condition or species type in the swamp. Saturation of parts of the swamp is assumed to cause alteration to species tolerant to wetter soils. The plan should include options analysis to demonstrate this is acceptable within the context of remediation. (S6.5.2 Table 23)
35	Contingency measures should be linked to specific triggers. At present it is not clear when contingency measures will be initiated.
36	There is very little detail around the costings provided, and they seem optimistic. More detail around these would be beneficial.
SRW feedback attachment 1: Supporting technical reports	
37	The Prof. Perran Cook report concludes that inundation 'still produces mobile potential acidity in the form of dissolved iron (II), and any release of this from groundwater would regenerate acidity upon contact with oxygen. Longer term immobilisation of acidity also requires sulfate reduction to take place and present indications suggest this process would not occur for several years and even then, there is unlikely to be enough sulfate present in the soil to lead to the complete immobilisation of dissolved iron.' This aspect appears to be crucial to the design of the remediation options, and it appears to merit further work. How will this question be confirmed, in order to enable a robust remediation approach?
38	The GHD report concludes ... 'The geochemical processes associated with each management and remediation option under consideration suggest that no single management and remediation option under consideration is capable of mitigating acid generating processes associated with the primary acid source minerals, primary acidification reactions and secondary acidification reactions. Therefore, a combination of management and remediation processes is likely to be required.' and 'the results of the geochemical assessment are subject to considerable uncertainty and should be used with an appropriate amount of caution in the design of the management and remediation options...' The REPP should be clearer on how it will reduce this uncertainty, and which recommendations will be addressed.
SRW feedback attachment 1: Previous feedback	
39	The ITRP identified previously, and in the current review, that misconceptions regarding the conceptual model have been presented repeatedly and need to be corrected to "avoid further promulgation of false understanding and to avoid inappropriate remedial action."
40	The report states 'Monitoring Data used to validate risk and determine level of impact'. The ITRP provided previous feedback on the Scoping Document to the effect that monitoring per se will not inform the level of impact, this will be informed by modelling historic and future scenarios (data will be used to refine the conceptual and numerical model)

Feedback	
41	The delineation of the reaches within Boundary Creek has been raised previously as a point to requiring attention. We do not accept the justification presented in the REPP. The position taken is inconsistent with scientific principles and with Barwon Waters own applied to the 3 sub-reaches within Reach 2. We believe the community have the ability to understand the scientific reasoning.
SRW feedback attachment 1: Future process and requirements	
42	Given the adaptive approach presented and the timeframes indicated (10 years) it is expected that more clarity is provided around the future process and framework that will guide Barwon Water, particularly around decision making, community engagement and approvals.

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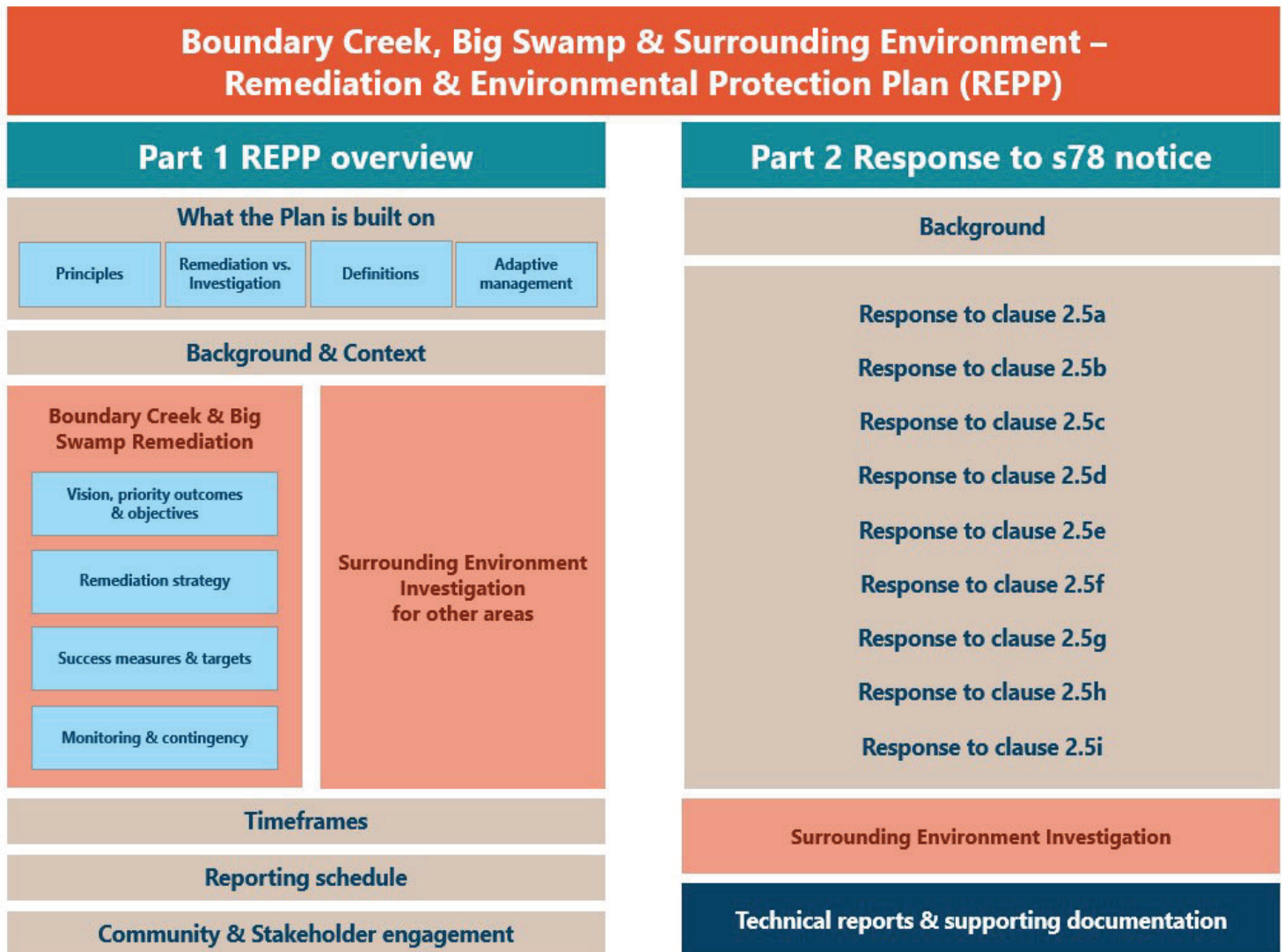
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2 How to navigate this document

The Boundary Creek, Big Swamp and Surrounding Environment – Remediation and Environmental Protection Plan (REPP) is separated into two sections:

- Part 1 provides an overview of the REPP, and
- Part 2 contains the technical responses to meet the requirements of the section 78 Ministerial Notice.



Part 1

Remediation & Environmental Protection Plan Overview

3 What the Plan is built on

This section outlines the fundamental principles upon which the Boundary Creek, Big Swamp and Surrounding Environment - Remediation and Environmental Protection Plan (REPP) has been developed in response to the requirements of the section 78 Ministerial Notice (s78 notice).

3.1 Principles

The eight principles that underpin the REPP can be found in Table 3.

Table 3: Principles of the REPP

Principle	Why is this a principle?
<p>1. Barwon Water supports the recovery of groundwater levels in the Lower Tertiary Aquifer (LTA) and its surrounding environment and ecosystems as intended under the current Permissive Consumptive Volume (PCV) set for the Gerangamete and Gellibrand Groundwater Management Areas.</p> <p>Barwon Water will not undertake actions in relation to the Barwon Downs borefield that could jeopardise this recovery.</p>	<p>Barwon Water fully supports the Victorian Government's reduction in the PCV limits which will allow for the recovery of this resource and its surrounding environment and ecosystems. These PCVs place a cap on the volume that can be allocated for extraction from the system (not just by Barwon Water) and therefore provides greater protection for this system.</p> <p>Barwon Water will not – and cannot – consider any future use of the borefield or applying for another licence as the PCV limit has been set by the Victorian Government to a very low level to enable the aquifer to recover.</p> <p>Barwon Water fully supports this aquifer recovery.</p> <p>The Remediation Working Group's independent nominated experts have advised that the recovery of the LTA to pre-pumping groundwater levels is not a suitable target as it is dependent on factors such as third party users and climate. Positively, the effect of the current PCV limit will be a recovering trend in groundwater levels. As such a target reflecting this has been incorporated into the REPP.</p> <p>The only potential exception to this principle, is if the Barwon region faces an 'emergency' water shortage. In such a highly unlikely scenario, Barwon Water would be required to go through the qualification of rights process as per Section s33AAA of the Water Act, 1989. This is a rigorous process that is overseen by DELWP with the final decision to be made by the Minister for Water.</p>

Principle	Why is this a principle?
<p>2. No groundwater extraction from the Barwon Downs Borefield by Barwon Water during remediation.</p>	<p>Barwon Water does not have a licence to use the borefield, and therefore, there will be no groundwater extraction from the Barwon Downs Borefield by Barwon Water during the REPP. Our previous licence expired on 30 June 2019.</p> <p>The PCV and the s78 notice prevents any groundwater pumping occurring in the Gerangamete Groundwater Management Area other than by three other licensees for dairy wash and irrigation purposes or for maintenance/testing purposes.</p> <p>Barwon Water will not – and cannot – consider any future use of the borefield or applying for another licence as the PCV limit has been set by the Victorian Government to a very low level to enable the aquifer to recover.</p> <p>Barwon Water is also currently preparing for the next 'Urban Water Strategy' to explore other long-term water supply opportunities with the community, as part of Barwon Water's Water for our Future Program.</p>
<p>3. Remediation actions which may be required to be carried out by Barwon Water must directly relate to confirmed environmentally significant adverse impacts caused by the historical management of groundwater extraction at Barwon Downs Borefield by Barwon Water in order meet the requirement of the s78 notice.</p>	<p>Barwon Water will consider remediation actions and controls in the area which surround Boundary Creek and Big Swamp if measurable and evidence-based scientific methodologies conclude that historical groundwater pumping by Barwon Water at Barwon Downs Borefield has caused an environmentally significant adverse impact in that area.</p> <p>Remediation actions and controls in the area will be considered if they are reasonably practicable and proportionate and will achieve environmental improvements.</p>
<p>4. Barwon Water highly values its partnerships with Traditional Owners and is committed to working with, and learning from them to ensure that cultural history and values are considered during the implementation of the REPP.</p>	<p>Waterways are the lifeblood of our land and Aboriginal and Torres Strait Islander peoples have been managing the waterways we all have relied upon for thousands of years.</p> <p>By respecting and understanding the cultures and histories of Aboriginal and Torres Strait Islander peoples within the region, Barwon Water can learn to look at the environment through the eyes of an Aboriginal and Torres Strait Islander person.</p>

Principle	Why is this a principle?
<p>5. Barwon Water is committed to continuing an open and transparent relationship with the community and key stakeholders including local environmental groups during the implementation of the REPP.</p>	<p>We want to ensure insights and knowledge of the community, local environmental groups and stakeholders are considered and help to inform the implementation of the REPP.</p> <p>We also want to build community and stakeholder confidence in the implementation of the REPP.</p> <p>Like the REPP itself, the long-term approach to engagement with the community and stakeholders will adapt as outcomes from the REPP come to hand.</p>
<p>6. The Boundary Creek and Big Swamp Remediation Plan will prioritise actions and controls that have minimal engineered intervention (unless necessary) and target the source of the issue to enable the system and its ecological values to improve progressively over time.</p>	<p>Actions that address the source of poor quality water are considered to be more resilient in the long term and in line with the vision and objectives set out in the Remediation Plan.</p> <p>Barwon Water acknowledges that it may take a decade to realise improvements from remedial works, particularly an increase in median pH values.</p> <p>However, this needs to be balanced with practicality as required by the s78 notice, along with the environmental implications, costs, risks and trade-offs associated with implementing ongoing artificial treatment.</p>
<p>7. The REPP is based on an adaptive management approach.</p>	<p>Barwon Water has adopted the following definition for adaptive management of the REPP:</p> <p>‘a continuous cycle of improvement based on setting goals and priorities, developing strategies, taking action and measuring results, and then feeding the results of monitoring back into new goals, priorities, strategies and actions’ (Mackay, 2016).</p> <p>An adaptive approach to remediation is considered best practice, where adaptation occurs continuously to improve the REPP’s ability to deliver on the vision and objectives.</p> <p>Barwon Water proposes that any improvements made to the REPP in light of the adaptive management approach is put forward and approved by SRW as part of the annual reporting process for the s78 notice.</p>

Principle	Why is this a principle?
8. Successful remediation of Boundary Creek and Big Swamp is dependent on passing flow conditions being enforced at 'McDonald's Dam' in accordance with its licence conditions (dam licence no. WLE043336).	<p>Critical to the success of the REPP will be consistency with the powers and responsibilities of respective parties under the Water Act, 1989.</p> <p>Southern Rural Water is responsible and accountable for effectively regulating compliance with the passing flow conditions, including Barwon Water's supplementary flows, with the holder of the dam licence.</p>

3.2 Confirmed impact and other areas of investigation

The Boundary Creek, Big Swamp and Surrounding Environment – Remediation and Environmental Protection Plan (REPP) will be delivered under two parallel work packages:

- I. 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.
- II. The **Surrounding Environment Investigation** to investigate whether other areas within the regional groundwater system have been impacted by historical management of groundwater extraction.

This approach was supported by the Remediation Working Group as it recognises the need for immediate action to remediate confirmed impacts within the Boundary Creek catchment and the need to investigate for impacts in an expanded area.

This two pronged approach was outlined in the revised scope of works which was approved in October 2019 by Southern Rural Water and its Independent Technical Review Panel subject to addressing any recommendations and feedback in the REPP.

3.2.1 Boundary Creek and Big Swamp Remediation Plan overview

The area of confirmed impact is approximately 0.42 km² in size, from immediately upstream of Big Swamp to the confluence of Boundary Creek and the Barwon River (refer to Figure 1) which is the basis of the Boundary Creek and Big Swamp Remediation Plan.

While the area of confirmed impact is constrained to the Boundary Creek catchment, it is recognised that the Barwon River is also impacted from discharge from the swamp and that it is a major asset that requires protection.

Historically, groundwater from the regional aquifer helped maintain flows in Boundary Creek, especially during dry periods.

Recognising that summer base flow in the creek was reliant on groundwater, a supplementary flow condition was written into the Barwon Downs groundwater licence in 2004 with the intent of offsetting the loss of flows due to groundwater pumping.

As predicted, groundwater pumping reduced groundwater contributions to flows into Boundary Creek. Technical studies in 2017 confirmed that the historical management of groundwater extraction from the Barwon Downs borefield over the past 30 years was responsible for two thirds of the reduction of groundwater base flow into Boundary Creek, increasing the frequency and duration of no flow periods in the lower reaches of Boundary Creek. The dry climate experienced during the same period accounts for the remaining one third reduction.

Although Barwon Water complied with licence conditions, investigations confirmed that the ineffective regulation of passing flow conditions, including the supplementary flow released by Barwon Water to counter the expected losses in the creek, was not effectively reaching downstream reaches of Boundary Creek.

The reduction in flows was the main contributor that caused drying of Big Swamp, leading to the oxidation of naturally occurring acid sulfate soils and poor environmental outcomes downstream.

Monitoring data has enabled potential impacts to be confirmed for Boundary Creek and Big Swamp.

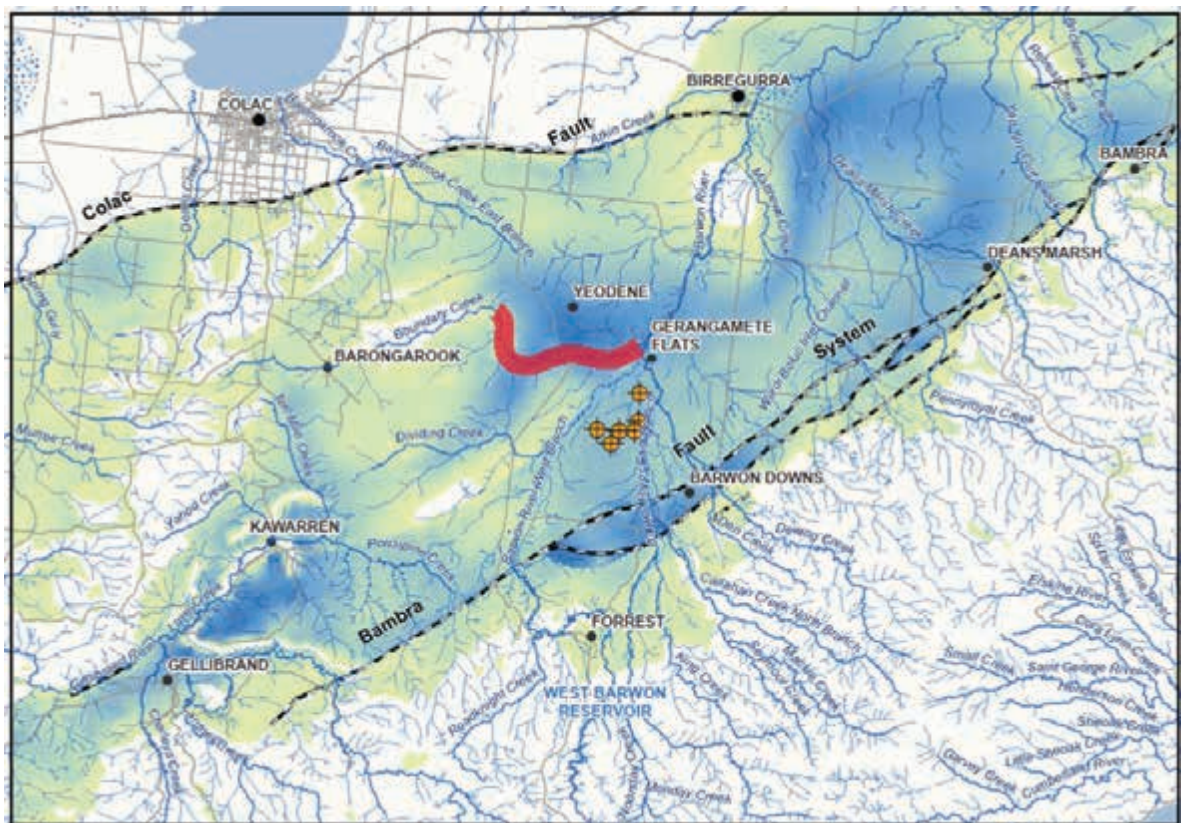


Figure 1: Area of confirmed impact (red area)

3.2.2 Surrounding environment investigation overview

The Surrounding Environment Investigation considers an extent of 480 km² (refer to Figure 2) as the starting point to identify other potentially impacted areas based on a systematic risk assessment framework (published in the revised scope of works submitted to Southern Rural Water in July, 2019).

This area was based on a whole of aquifer approach taking into consideration that the Barwon Downs Graben extends from the township of Gellibrand in the south-west to the Birregurra Monocline in the north-east (Blake, 1974). However, the Gellibrand Saddle to the east of Kwarren has been reported to act as a hydraulic barrier (Petrides and Cartwright, 2006), which may limit the connectivity of the far south-west of the graben from other areas.

This process resulted in the identification and prioritisation of areas ranked as 'high' risk using the regional groundwater model. These areas include:

- Barwon River (East branch)
- Barwon River (downstream of the confluence)
- Gellibrand River
- Ten Mile Creek
- Yahoo Creek
- Groundwater dependent ecosystems west of the graben (near Yeodene)
- Groundwater dependent ecosystems east of the graben (Barwon Downs-Dean Marsh)
- Groundwater dependent ecosystems south of the graben (along the Gellibrand River)

While the groundwater model was able to narrow down sites at risk and give them a risk ranking, areas will require site specific investigations to 'ground-truth' and confirm if historical management of groundwater extraction from the Barwon Downs Borefield has had a measurable and environmentally significant adverse impact in that area. This will be the focus of the Surrounding Environment Investigation.

The Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems (GDEs) (DELWP, 2015) were used to identify areas of potential risk that may require further investigations to validate the model results and confirm the presence of high value groundwater dependent ecosystems.

Where there is insufficient data to confirm the potential risk identified by the groundwater model, a site-specific study is recommended to investigate impacts and ground-truth the model predictions.

There is currently insufficient monitoring data to identify if historical groundwater pumping at Barwon Downs has caused any measurable impact to sensitive environmental receptors other than Boundary Creek and Big Swamp.

The additional data collected will also be used to update and refine the regional groundwater model prior to reassessing the risk to groundwater dependent ecosystems to confirm results from the initial risk assessment.

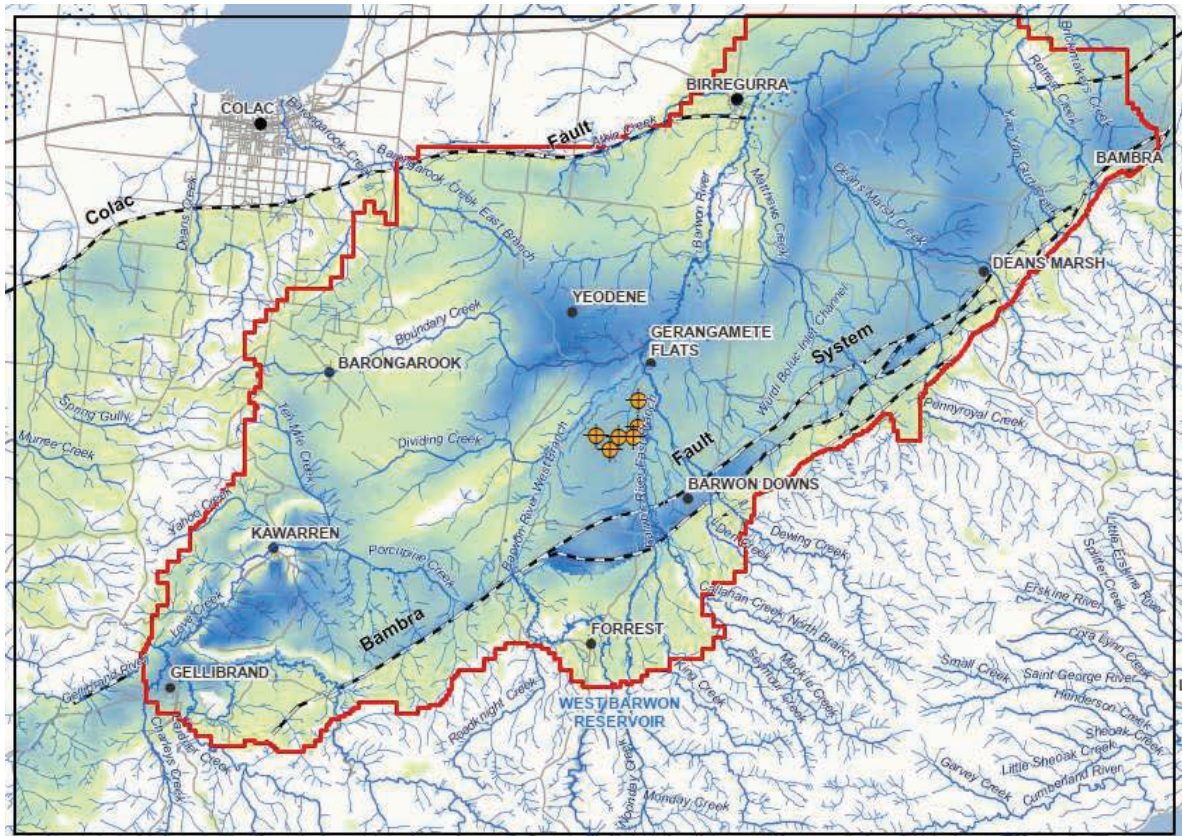


Figure 2: Area considered for further investigation

3.3 Definition of Remediation

The words river 'restoration', 'rehabilitation' and 'remediation' are often used interchangeably but have very different definitions with regard to environmental projects.

'Restoration'

The ideal restoration project will restore a degraded river to its original condition. This includes restoring the natural range of water quality, sediment and flow regime, channel geometry, native aquatic plants and animals, and adjoining riparian lands. The goal of restoration is an admirable one, but it is important to acknowledge that it is often something to be aspired to, as it will seldom be possible to achieve.

This is because it is often impossible to establish what the 'original' condition was and, secondly, such restoration would mean replicating pre-European inputs and outputs into the system (e.g. water quality and quantity, animals and plants) from upstream, downstream and the riparian zone.

Rehabilitation

Although restoration may be impossible, this does not leave a degraded system without hope. By improving the most important aspects of the stream environment, you may create a stream that, although only resembling its original condition, is nevertheless an improvement on the degraded system and often a valuable environment in its own right.

Since restoration is usually impossible, rehabilitation is the more common goal for undertaking projects along rivers.

Remediation

In some cases, even rehabilitation is not possible because of irretrievable changes. In such a situation, the original state is no longer an appropriate aim for the stream because inputs from the catchment will never support that condition. **The aim of remediation is to improve the ecological condition of the stream, but the endpoint of that improvement will not necessarily resemble the original state of the stream.** In fact, it may not be possible to predict what that endpoint will be like.

Understanding that some of the changes in the catchment cannot be reversed (e.g. climate change, land clearing, channelisation and soil chemistry), rehabilitation and restoration are not reasonable and practicable conditions to aim for because inputs from the catchment will never support that original condition.'

(Edgar & Lovett, 2002)

Remediation has been defined in the s78 notice as the controls and actions that could be practicably carried out to achieve improved environmental outcomes.

Therefore, in order to address the requirements of the s78 notice and scientifically accepted definitions of remediation, the following has been adopted as the definition of remediation for the purposes of the REPP:

Remediation refers to 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.

3.4 Adaptive management approach

Barwon Water has adopted the following definition of adaptive management for the REPP:

‘a continuous cycle of improvement based on setting goals and priorities, developing strategies, taking action and measuring results, and then feeding the results of monitoring back into new goals, priorities, strategies and actions’

(Mackay, 2016).

An adaptive approach to remediation is considered best practice, whereby the REPP can be adapted in response to ongoing monitoring and measured changes. This approach allows Barwon Water to evaluate how systems are responding to interventions and take further action, such as implementation of contingency measures, if required.

An adaptive approach also aligns with feedback received from Southern Rural Water and its Independent Technical Review Panel which highlighted that the setting of indicators and measures of success would be dependent on the periods and seasonality of monitoring, and therefore a full seasonal cycle of data should be collected as a minimum to better inform long-term remediation. This approach allows for ongoing monitoring and collection of data to inform further actions.

The effectiveness of an adaptive management approach relies on appropriately designed management interventions and related monitoring and assessment programs. Adaptive management requires periodic review and if needed, the adjustment of the:

- **conceptual understanding**
Constantly evolving improvements to the understanding of the system, its drivers and relationships based on collection of longer periods of monitoring data and the update of supporting models;
- **vision and objectives**
If management strategies cannot achieve the vision and objectives against SMART success measures or targets, then the vision and objectives may need to be modified as more information becomes available as to what is achievable;
- **management strategies**
Using the monitoring program to determine if the management strategies are working as expected and embrace innovation as newer technologies develop, and
- **monitoring**
Based on observed ‘on-ground’ changes revisions to the monitoring program may be required.

Barwon Water proposes that any changes made to the REPP in light of the adaptive management approach would need to be considered and subsequently, approved by SRW.

4 Background & Context

Table 4 summarises the key regulatory mechanisms, technical inputs and community and stakeholder engagement activities that led to the development of the REPP.

An overview of the timeline in relation to the s78 notice is captured in Figure 3.

Table 4: Inputs that informed the development of the REPP

Time	Event
June 2017	Environmental impact caused by historical management of groundwater pumping acknowledged Barwon Water acknowledged publicly that the historic management of groundwater pumping from the Barwon Downs Borefield had environmentally significant impacts in the Boundary Creek catchment.
December 2017	Yeodene (Big) Swamp Study drafted A draft technical report was prepared to improve the understanding of chemical and physical processes in and around Big Swamp and on this basis, six possible remediation strategies for Boundary Creek and Big Swamp. This draft report was shared publicly.
May 2018	Remediation Working Group established The Remediation Working Group nominated three independent technical experts to provide input into the development of the Boundary Creek and Big Swamp Remediation Plan.
July 2018	Nominated technical experts appointed The Remediation Working Group established their independent expert panel to provide technical support in the development of the Boundary Creek and Big Swamp Remediation Plan.
September 2018	Section 78 Ministerial Notice issued Barwon Water was issued with a Ministerial Notice under Section 78 of the Water Act 1989. The purpose of the Notice is to ensure that Barwon Water successfully remediates impacts caused by historic groundwater extraction. The section 78 Notice directs Barwon Water to undertake the following requirements: <ul style="list-style-type: none"> • Discontinue extraction, other than for maintenance and emergency response purposes while the assessment is being completed and until all remediation work required under the remediation plan has been completed, and • Prepare and implement a remediation and environmental protection plan for Boundary Creek, Big Swamp and the surrounding environment. The preparation and implementation of the plan requires the: <ul style="list-style-type: none"> • Submission of a scope of works for developing the Remediation Plan by December 2018; • Submission of the Remediation Plan by 20 December 2019; and • Implementation of the Remediation Plan by 01 March 2020

Time	Event
December 2018	<p>Scope of works submitted</p> <p>Barwon Water submitted the scope of works which outlined the area covered by the Plan, the environmental values to be included, and the necessary environmental assessments and methodology for how Barwon Water proposed to develop the Plan.</p>
February 2019	<p>Southern Rural Water feedback on scope of works received</p> <p>In early 2019, Southern Rural Water and its Independent Technical Reference Panel reviewed the 'scope of works'. Feedback included:</p> <ul style="list-style-type: none"> • The use of a risk assessment framework to identify and confirm areas for remediation; • Broadening out the geographical extent beyond the Boundary Creek catchment; and • Broadening the ecological values beyond the emphasis on acid sulfate soils to address all beneficial uses under the State Environmental Protection Policy (Victorian Waters). • Data collected will be seasonally variable and vary between years depending on climatic conditions and therefore the setting of indicators and measures of success will be dependent on the periods and seasonality of monitoring <p>Feedback was also received from the Remediation Working Group and their nominated expert panel and was consistent with what was provided from Southern Rural Water.</p>
March 2019	<p>Field program and environmental assessments commenced</p> <p>With approval from Southern Rural Water and support from the Remediation Working Group, Barwon Water initiated:</p> <ul style="list-style-type: none"> • a field program and site specific environmental assessments to inform the development of the REPP, and • subsequently undertook additional monitoring as described in the scope of works to improve the conceptual understanding of current system conditions.
April 2019	<p>Community information sessions held</p> <p>Community information sessions were held at Winchelsea, Birregurra and Colac to provide an update on the Remediation Plan to the broader community.</p> <p>Around forty people attended the information sessions with discussion centering on the process for developing the remediation plan, investigating whether there have been impacts in other areas and plans to secure future water supplies.</p>
April 2019	<p>Soil testing and analysis commenced</p> <p>A specialist consultant was engaged to undertake static and kinetic (incubation) soils testing to subject soils to a variety of treatments to assess the dominant hydro-geochemical processes occurring within the swamp and how these might respond to changing hydro-geochemical conditions.</p> <p>Static testing was complete and five soil types were categorized, including: burned, unburned, wet and dry sediment. These soil types underwent further analysis using</p>

Time	Event
	<p>standard methods according to the national acid sulfate soils identification and laboratory methods manual.</p> <p>Results of the static testing informed the incubation testing by ensuring that the soils used in the incubation tests are representative of Big Swamp. Incubation test samples were sacrificed in a times series of 1,2,4,8,16,32,64 and 128 days (note, the final time step of 200 days won't be completed until after submission of this REPP) to determine if neutralisation of actual and potential acidity is viable via different treatment methods.</p>
July 2019	<p>Revised scope of works submitted</p> <p>Barwon Water submitted a revised scope of works on 31 July 2019 that addressed all feedback received from Southern Rural Water and its Independent Technical Review Panel, as well as the Remediation Working Group and their nominated experts.</p>
October 2019	<p>Southern Rural Water feedback on revised scope of works received</p> <p>After review, Southern Rural Water and its Independent Technical Review Panel considered the scope of works complete conditional to addressing recommendations and feedback through the submission of the Remediation Plan.</p>
October 2019	<p>Community information sessions held</p> <p>Community information sessions were held at Winchelsea and Colac to provide another update on the Remediation Plan to the broader community.</p> <p>Fifteen people attended the information sessions with focus on what would be included in the Remediation Plan and how the field program and environmental assessments were progressing.</p>

s78 timeline

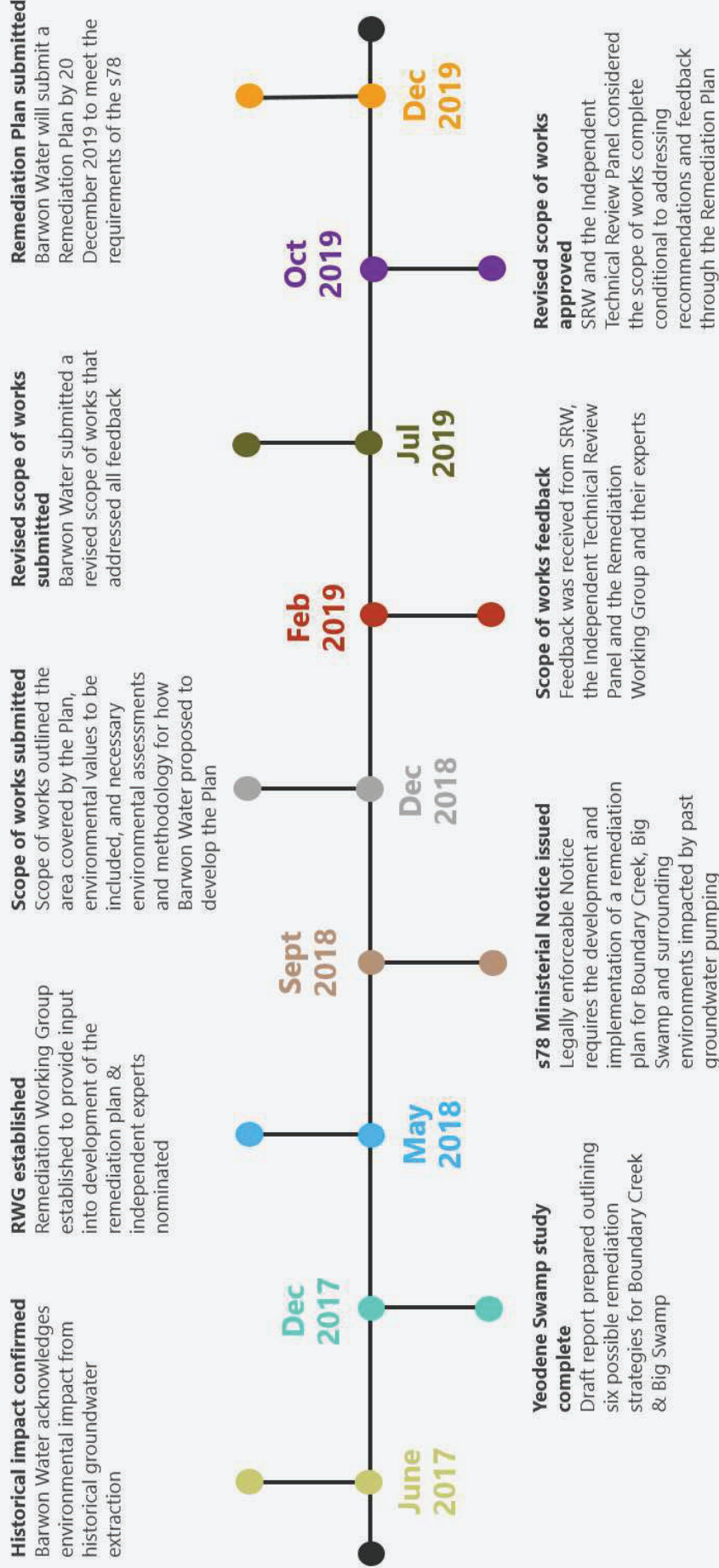


Figure 3: Summary of s78 notice and requirements

4.1 Why is remediation necessary?

Although many factors (described in section 6.1.2) have contributed to changes in the Boundary Creek Catchment, the two variables that have had the greatest influence are the management of historical groundwater extraction and climate due to their impact on flows.

Hydrogeological investigations found that “operation of the borefield over the past 30 years is responsible for two thirds of the reduction of base flow into Boundary Creek” (Jacobs, 2018a). Furthermore, the investigation concluded that “pumping had increased the frequency and duration of no flow periods in the lower reaches of Boundary Creek” (Jacobs, 2018a).

Compounding this, was the ineffective management of the supplementary flow condition. This was confirmed by investigations (Jacobs, 2018b) which showed that passing flows including the release of 2 ML/day in supplementary flows to counter expected streamflow losses in the lower reach of Boundary Creek were not passed in full in accordance with dam licence WLE043336.

This has resulted in several environmental impacts, including:

- Oxidation of acid sulfate soils in Big Swamp, leading to release of acidic water (i.e. water with low pH, low alkalinity, high acidity and elevated concentration of metals) into Boundary Creek and Barwon River;
- Encroachment of plant species relying on deeper groundwater levels within Big Swamp, and
- Increased occurrence of days with ‘no flow’ (i.e. flow rate below detection at the Yeodene stream gauge) in Boundary Creek downstream of Big Swamp (Reach 3).

Refer to Figure 4 and Figure 5.

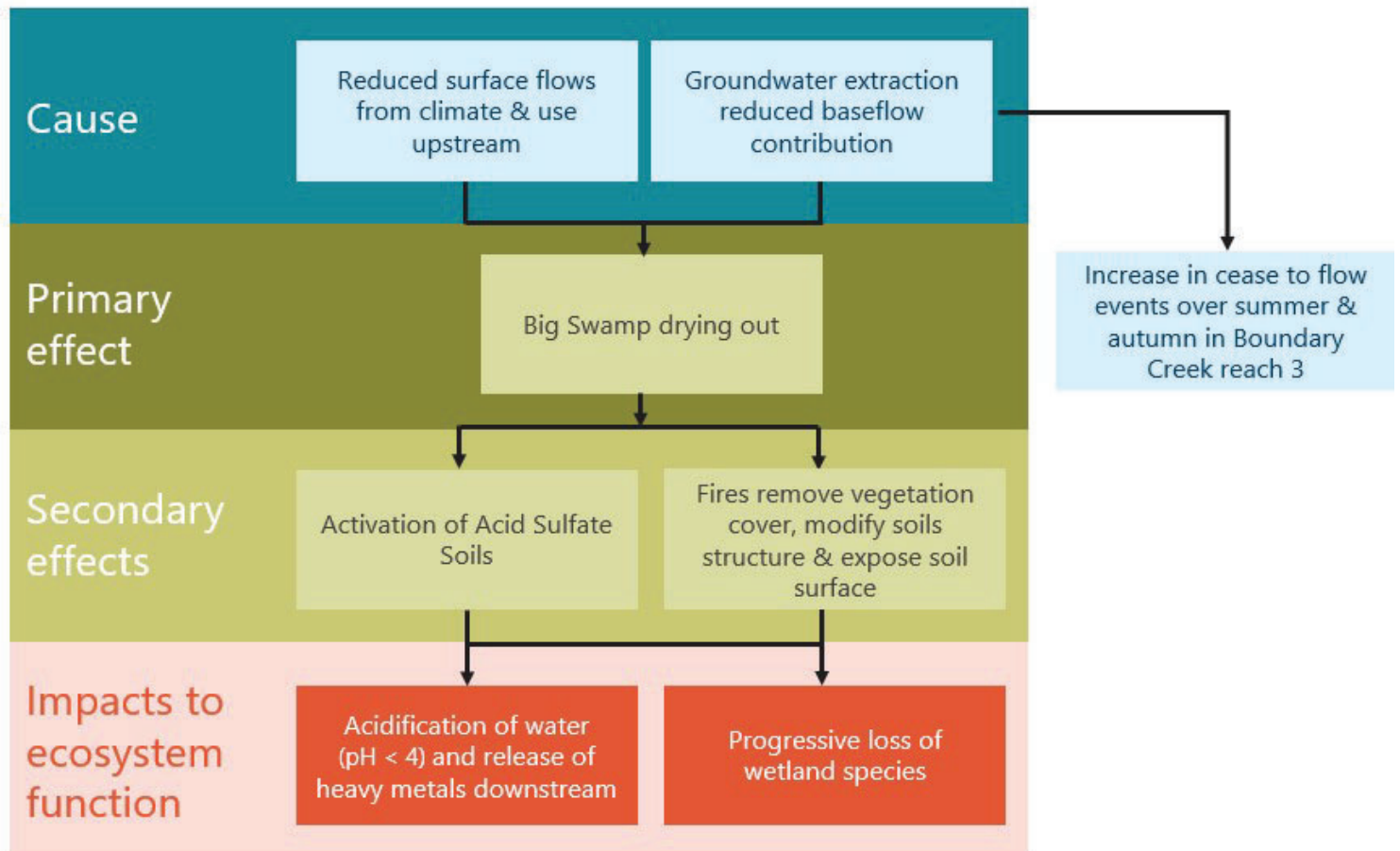


Figure 4: Cause and effect relationship in the Boundary Creek catchment

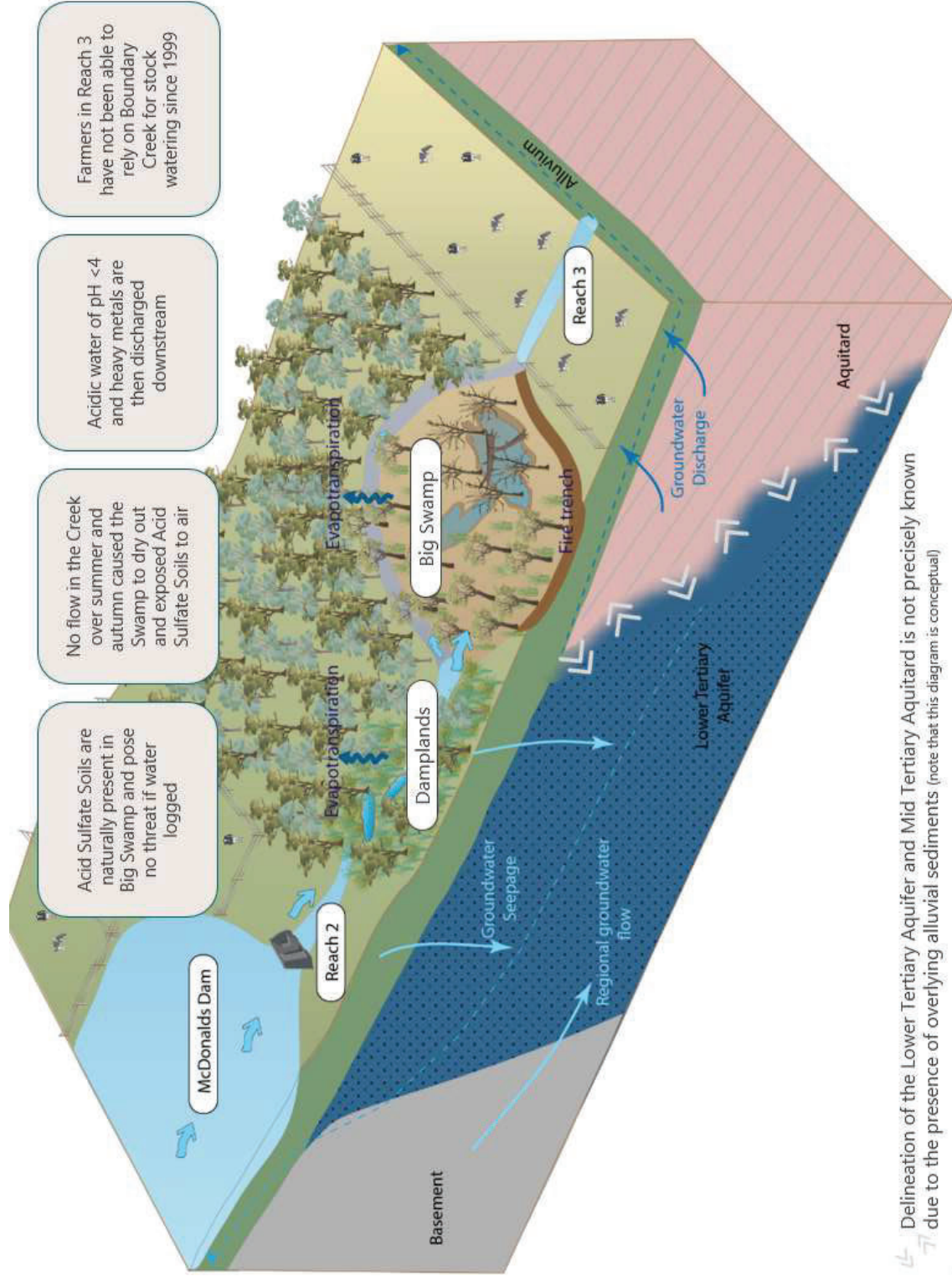


Figure 5: Changes in water quality in Boundary Creek

Figure 6 provides a simplified conceptual illustration of the water balance for Boundary Creek, including the release of supplementary flows, reduced releases from 'McDonalds Dam' and surface water-groundwater interactions along each reach of Boundary Creek.

Figure 7 provides a simplified conceptual illustration of the chemical processes occurring at Big Swamp leading to the oxidation of acid sulfate soils and subsequently causing the discharge of low pH water downstream.

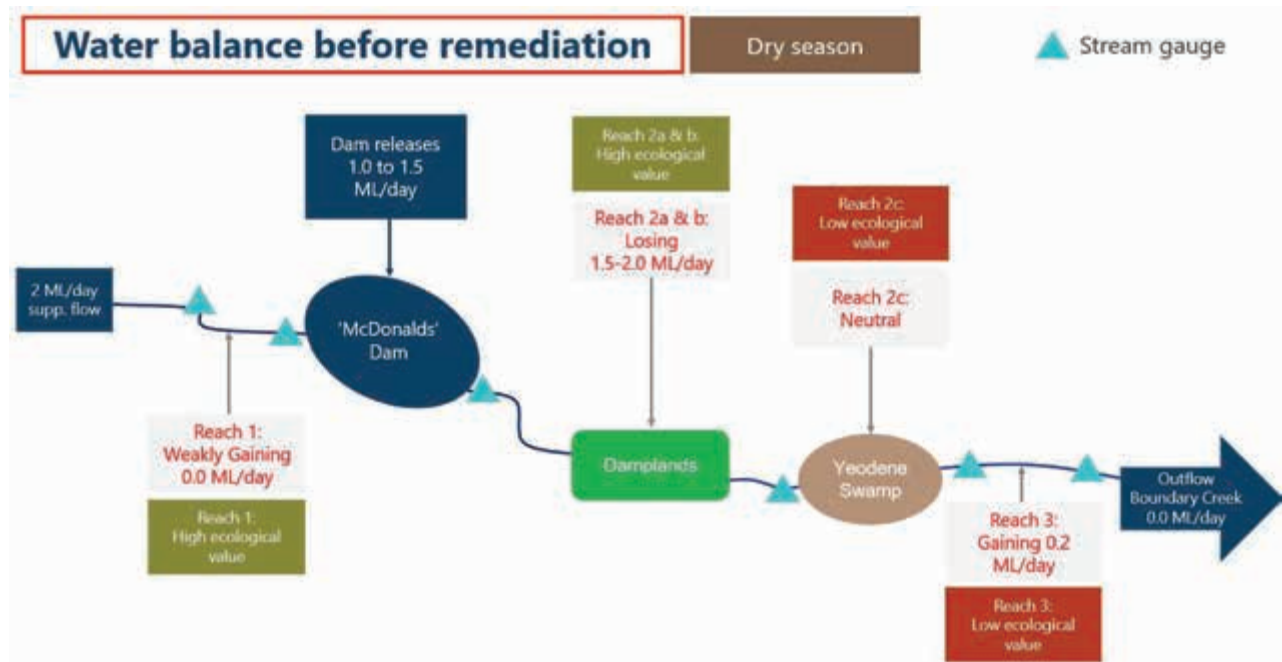


Figure 6: Conceptual water balance of Boundary Creek during the summer dry period prior to remediation

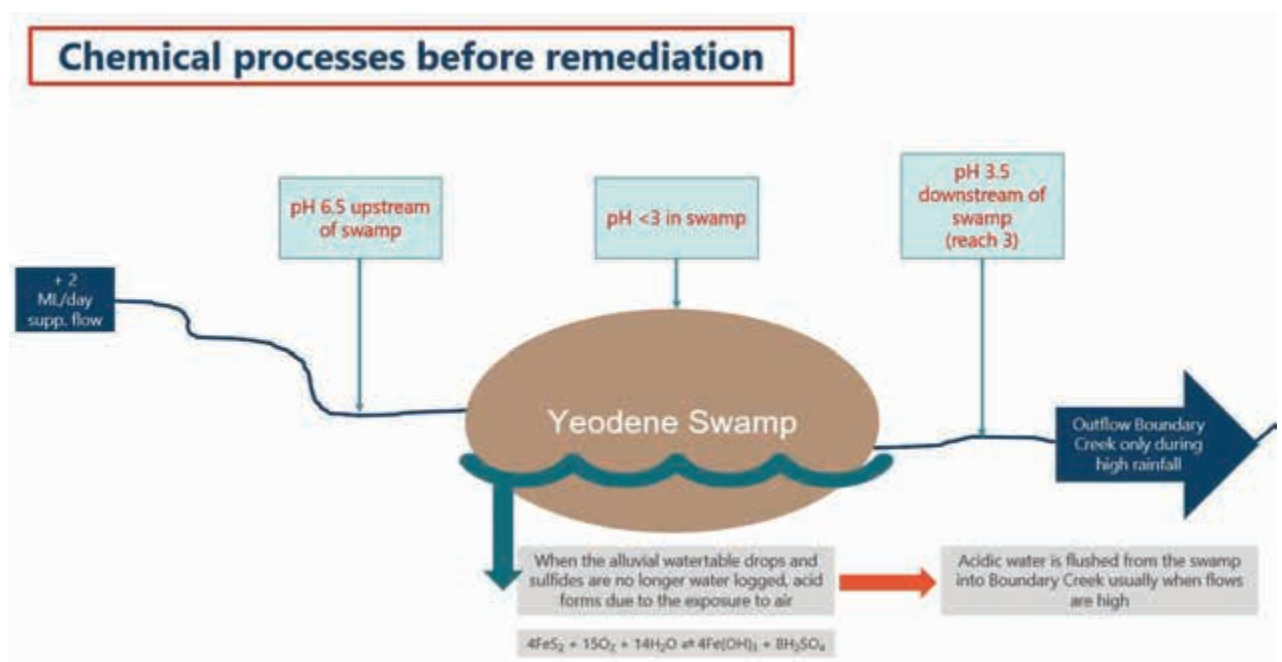


Figure 7: Conceptual chemical process occurring in Yeodene (Big Swamp) without remediation

4.2 What informed the development of the Remediation Plan

4.2.1 Community & stakeholder engagement

In May 2018, the Boundary Creek and Big Swamp Remediation Working Group was established to actively engage with Barwon Water in the design of a remediation plan for Boundary Creek and Big Swamp.

The working group is made up of representatives from the Corangamite Catchment Management Authority, Colac Otway Shire Council, Traditional Owners, Land and Water Resources Otway Catchment, Environment Victoria, Upper Barwon Landcare Group, Boundary Creek landowners and other interested community members.

The working group nominated their own independent technical experts to provide specialist advice and support. The experts are:

- **Dr. Vanessa Wong** (Monash University, Senior Lecturer, School of Earth Atmosphere and Environment)
- **Prof. Richard Bush** (Monash Sustainable Development Institute) (Global Innovation Chair, International Centre for Balanced Land Use Office)
- **Dr. Darren Baldwin** (Independent Consultant) (Charles Sturt University, Visiting Adjunct Professor, School of Environmental Sciences)

Ten meetings were held to consider how best to incorporate the community's vision and values for remediation as well as address any concerns they had about the remediation option. An eleventh and final meeting will be held with the group in early 2020 to provide the group with Southern Rural Water's feedback on the REPP.

A summary of meetings is provided in section 9.

Subject to the following considerations, the REPP was supported by the Remediation Working Group and their nominated technical experts:

- Desire to see Barwon Water's support for recovery of groundwater levels in the Lower Tertiary Aquifer articulated as a principle;
- Success measures for remediation need to be specific and measurable;
- Preference for minimal active treatment interventions unless required to be implemented as a contingency;
- Appropriate contingency measures developed to mitigate any unforeseen impact from the implementation of remedial works for Boundary Creek and Big Swamp, and
- Confirmation of impacts associated with the Surrounding Environment Investigation needs to be based on observable data and field studies to validate the predictions of the regional groundwater model.

4.2.2 Field program and environmental assessments

The revised scope of works that Barwon Water submitted in July, 2019 outlined a range of monitoring and environmental assessments to improve the understanding of the current system conditions of the Boundary Creek catchment. Activities under the scope of works have informed the development of the REPP.

The scope of works, of which some activities are still in progress, has included:

- Installation of 17 groundwater monitoring bores and data loggers within Big Swamp;
- Monitoring of groundwater levels in the 17 bores within Big Swamp;
- Monitoring of groundwater quality in the 17 bores in Big Swamp;
- Installation of two new stream gauges upstream and downstream of Big Swamp to monitor surface water flows in and out of the swamp, as well as monitor pH and EC;
- Light Detection and Ranging (LIDAR) Survey captured for Boundary Creek and Big Swamp
- 181 soil samples collected to depths of six metres from Big Swamp with cores logged for grainsize, colour, moisture content, organic material, odour, plasticity, cohesion, peat and burnt condition;
- 250 kg soil samples from Big Swamp sent for static laboratory analysis of acidity, potential acidity, acid neutralising capacity, net acidity, organic matter, and moisture content;
- Commencement of soil incubation testing of five soil types at the Monash University soils laboratory, including treatment with:
 1. No addition (anoxia)
 2. Bioavailable carbon
 3. Lime
 4. Lime and bioavailable carbon
 5. Sulfate

A total of 675 analytical points will be collected over a sampling period of 1, 2, 4, 8, 16, 32, 64, 128, 200 days (underway with completion due early 2020);



Figure 8: Soils incubating in lab

- Vegetation survey undertaken within Big Swamp, and
- Water quality, sediment and macroinvertebrate sampling along Boundary Creek and the Barwon River.

4.2.3 Modelling to inform the Remediation of Boundary Creek and Big Swamp

Modelling to inform the feasibility assessment of remediation options, potential risks and other issues was informed by data collected through the field program and associated environmental assessments.

Groundwater, surface water and geochemical models were used to simulate the Boundary Creek system and predict responses to physical processes such as groundwater and surface water flows, soil chemistry and water quality changes. Key outcomes included the quantification of acid in Big Swamp, the water balance within the swamp and understanding of changes in geochemistry that could result as a consequence of implementing various remediation options.

A surface water model (including a flood model) and a groundwater model were developed and 'loosely' coupled to enable prediction of the impact of surface water flows and influences of localised groundwater levels within Big Swamp. Various scenarios were assessed, including different flow rates, timeframes and the feasibility of a hydraulic barrier to maintain water levels and re-wet the swamp. The models were limited by a short period of data collection and therefore further refinement and calibration will be required as ongoing monitoring continues. The collection of a full seasonal cycle of data was a recommendation provided by Southern Rural Water and its Independent Technical Review Panel on review of the revised scope of works.

A conceptual level hydro-geochemical model for Big Swamp was also developed to identify the key chemical processes responsible for the generation of acid, and estimate the current load and concentration of key analytes discharging from the swamp under different flow conditions and how analytes are likely to change over time.

Note that the geochemical model is thermodynamic, not kinetic in nature due to the recent installation of monitoring assets that haven't yet captured a low flow period. Development of a kinetic model will require a longer period of data to allow refinement of the model.

4.2.4 Approach adopted to develop the Boundary Creek and Big Swamp Remediation Plan

The approach adopted for development of the Boundary Creek and Big Swamp Remediation Plan was adapted from a nationally recognised 12 step stream rehabilitation planning process developed by the Cooperative Research Centre for Catchment Hydrology that provides guidance on how to conduct a stream rehabilitation – or in this case – a remediation project (LWRRDC & CRCCH, 2000).

Figure 9 summarises the 12 step planning process with more detail provided in section 9.

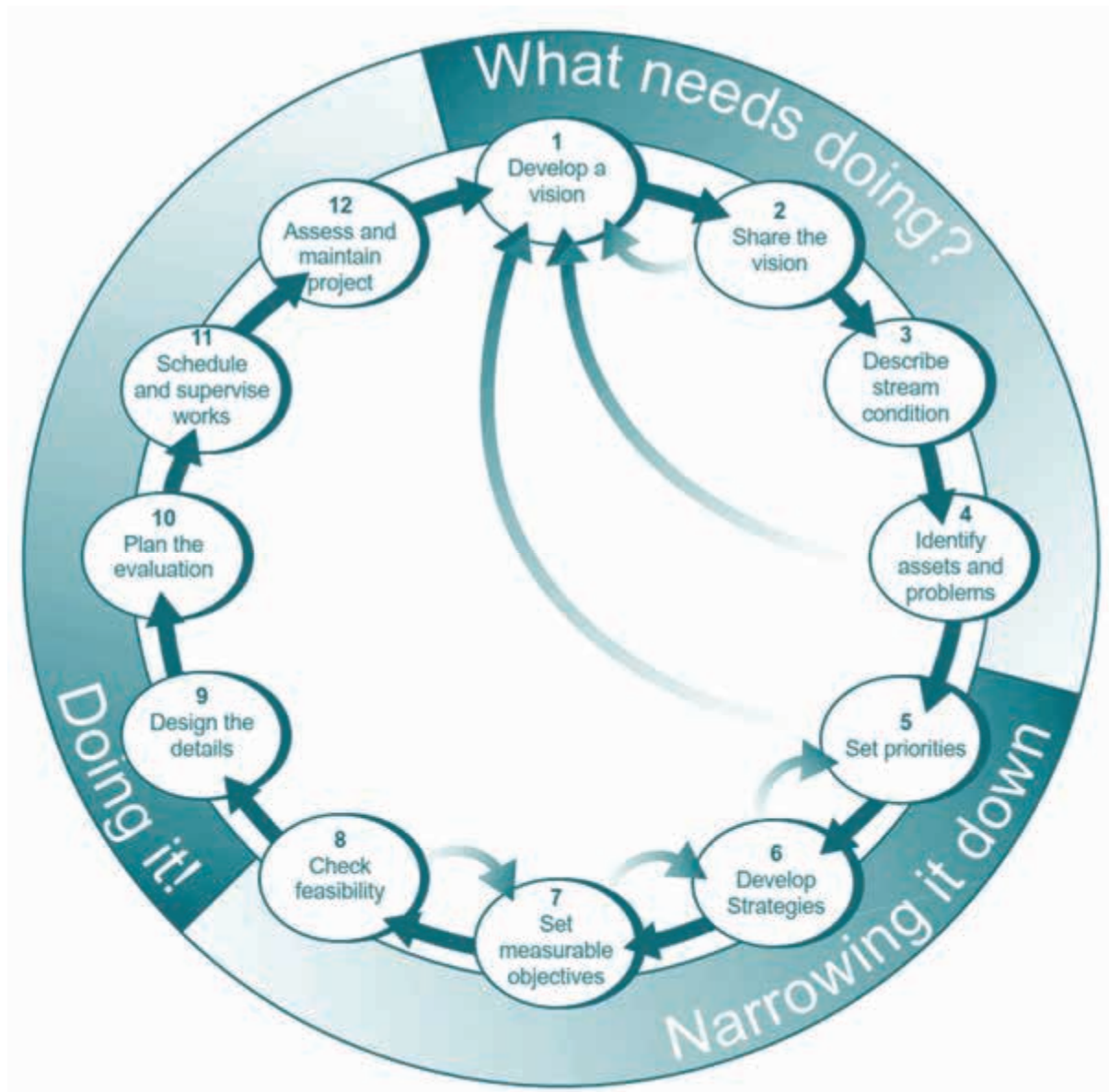


Figure 9: 12 step stream rehabilitation/remediation planning process (LWRRDC & CRCCH, 2000).

5 Remediation and Environmental Protection Plan summary

5.1 REPP Vision

Implementation of practical remediation actions and controls that achieve an improvement to the environment and the community, where measurable and evidence-based scientific methodologies conclude that historical groundwater pumping by Barwon Water at Barwon Downs Borefield has caused an environmentally significant adverse impact in that area.

5.2 Remediation of Boundary Creek and Big Swamp

5.2.1 Vision for Remediation of Boundary Creek and Big Swamp

Implementation of a practical remediation strategy that achieves an improvement to the environment and the community, so that:

- Big Swamp and Boundary Creek have healthy and sustained ecological systems;
- The impacts to the Barwon River are minimised and monitored, and
- Fire risks/threats are mitigated.

5.2.2 Priority outcomes for remediation of Boundary Creek and Big Swamp

Priorities were based on the protection of assets with the highest ecological values as well as consideration of the level of effort required to not only remediate damaged reaches but realise the benefits of remediation.

Priorities agreed to by the Remediation Working Group and experts involved are:

- **Protect** Barwon River (major asset) water quality and ecological values.
- **Improve** Boundary Creek stream flow and water quality.
- **Improve** Big Swamp ecological values.

To assist in realising the project vision, the following **six project objectives** were developed and agreed with the Remediation Working Group and experts involved:

1. Maintain groundwater levels above the top of the non-oxidised sediments in Big Swamp (to prevent oxidisation of deeper sediments within the swamp).
2. Control of the acid discharge (i.e. pH, sulfate and metals) from Big Swamp into Boundary Creek.
3. Maintain at least minimum flows in Reach 3 of Boundary Creek all year round.
4. Manage potential formation of acidity downstream of Big Swamp, which may be triggered as a result of implementation of some remediation options (i.e. swamp inundation).
5. Preserve/improve the ecological values of Big Swamp and Boundary Creek.
This objective is focused around addressing the changes to the vegetation assemblages within the swamp post the initial acidic event and fire. The result is a drying of the swamp, creating a more terrestrial soil environment that has enabled the encroachment of Swamp Ovata, reducing the density of existing Melaleuca communities.
6. Reduce the peat fire risk in Big Swamp.

5.2.3 Remedial actions for Boundary Creek and Big Swamp

The Boundary Creek and Big Swamp Remediation Plan outlines an adaptive approach to improve flows and water quality, as well as vegetation and ecology in Boundary Creek and Big Swamp so that downstream impacts to the Barwon River are minimised.

An adaptive approach was recommended by all the experts and specialists involved in the remediation options assessment and they concluded that a combination of remediation options will be required to meet the vision and priorities.

Actions to be implemented for rewetting the swamp include the:

- **continued delivery of a supplementary flow** to meet the objective of maintaining minimum flows in Reach 3 of Boundary Creek all year round (recording a flow of at least 0.5 ML/day at the Yeodene stream gauge).
- **construction of a series of hydraulic barriers** to effectively distribute flows across the swamp to allow for a greater area to be inundated, increasing surface water flow connectivity across Big Swamp and preventing progressive water table decline in the perched alluvial aquifer.
- **infilling the existing fire trenches and agricultural drain** at the eastern end of the swamp to allow the swamp to retain more water over the winter months.
- **preventing the encroachment of dry vegetation classes** (e.g. Swamp Gum) in Big Swamp to provide suitable conditions for wetland species to recolonise disturbed areas.
- **ongoing data collection to inform the adaptive monitoring approach** including monitoring or surface water flow, groundwater levels, water quality for both groundwater and surface water, vegetation monitoring, macroinvertebrate survey, etc.

- **additional data collection and testing to inform the feasibility of the other contingency options ('aerial liming', 'in-stream treatment' and 'limestone sand')** which is particularly important for the 'in-stream treatment' option in consideration of its higher complexity and financial implications. Subsequent refinement of the geochemical model will inform the feasibility, risks and trade-offs associated with the need for additional treatment as a contingency to manage low pH events while the re-wetting strategy takes effect.

Table 5 highlights the remediation objectives the proposed remediation strategy will meet when considered over the long-term, i.e. 10 years.

Table 5: Meeting the objectives

	Maintain minimum groundwater levels in Big Swamp	Protect Barwon River water quality & ecological values	Improve water quality in Boundary Creek	Maintain Boundary Creek Minimum Flow	Increase Melaleuca/ Swamp Ovata ratio	Reduce Peat Fire Risk	Estimated Costs over 10 years
Remediation Strategy	✓	✓*	✓*	✓	✓	✓	\$5M

**subject to further data collection, additional modelling and detailed design; contingencies may be required in the short to medium-term*

Costs include initial constructions and ongoing monitoring

Figure 10 provides a simplified conceptual illustration of the water balance for Boundary Creek, including the release of supplementary flows, reduced releases from 'McDonalds Dam' and surface water-groundwater interactions along each reach of Boundary Creek following remediation with the most important change being that minimum flows are maintained all year round in reach 3.

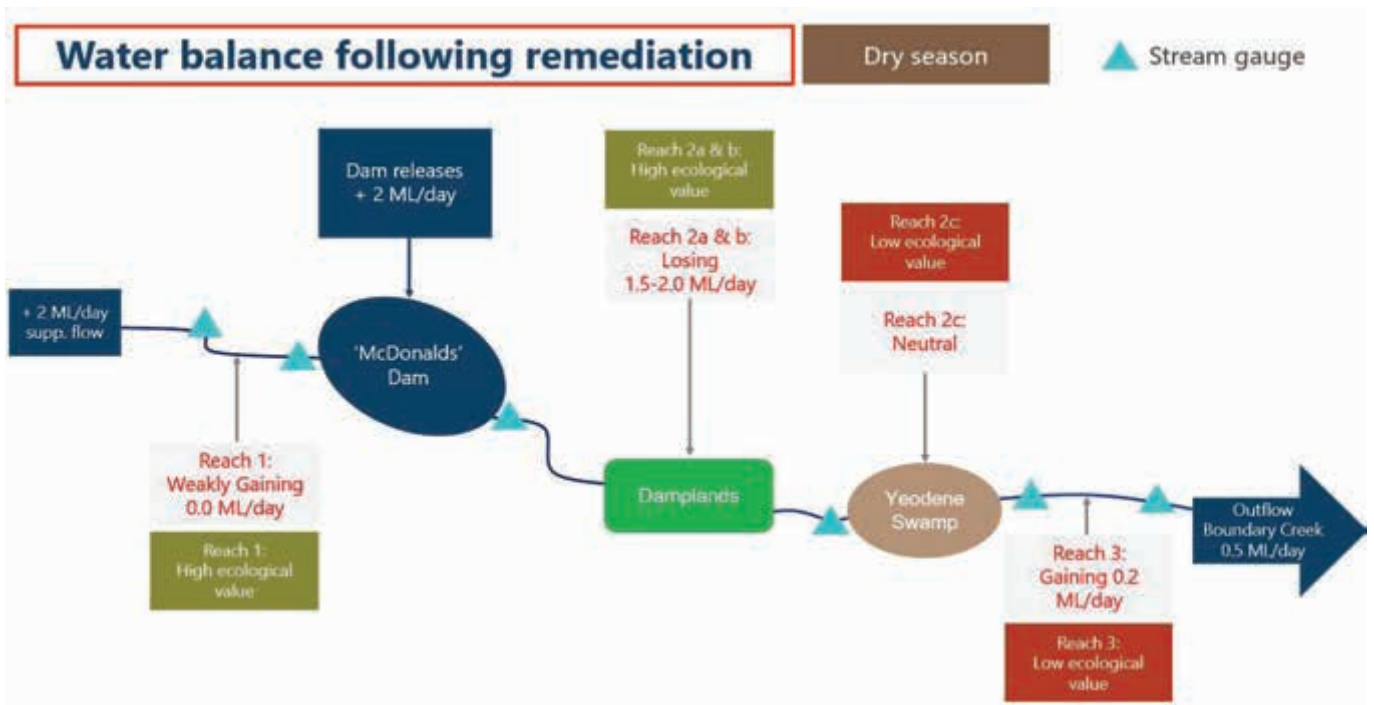


Figure 10: Conceptual water balance of Boundary Creek during the summer dry period following remediation

Figure 11 provides a simplified conceptual illustration of the chemical processes expected to occur following remediation which will see an increase in pH exiting the swamp.

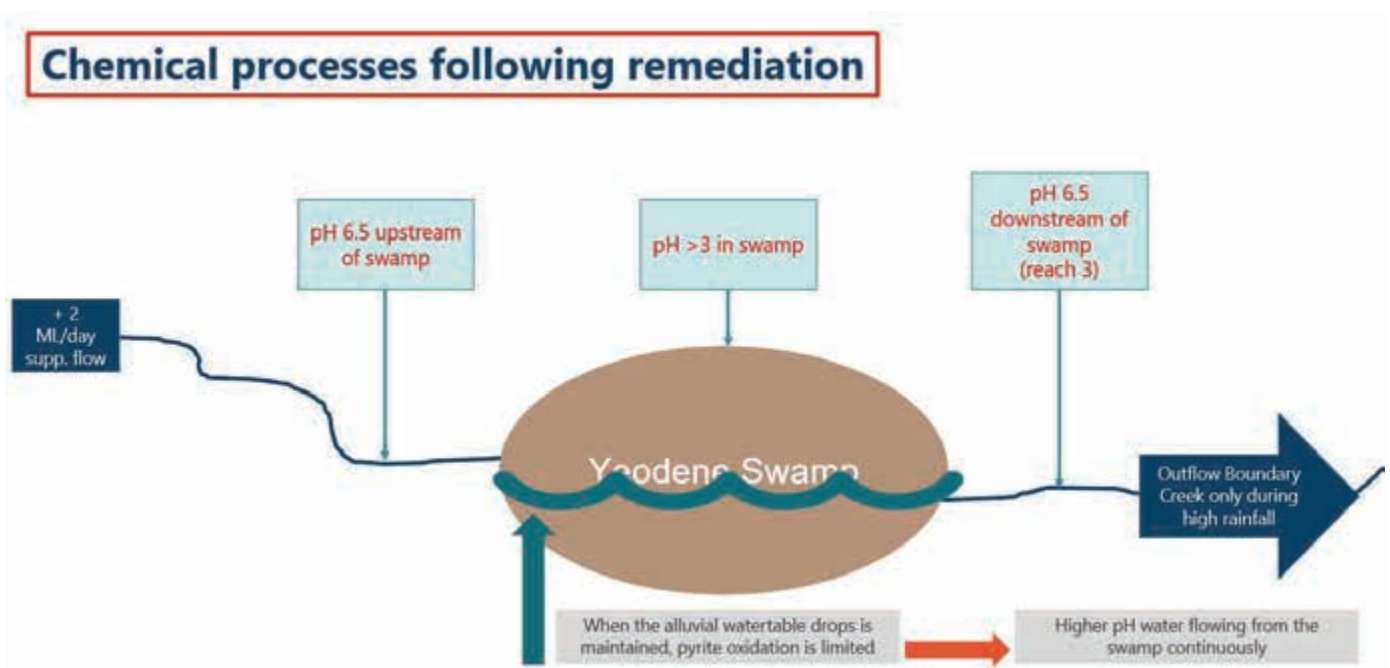


Figure 11: Conceptual chemical process occurring in Big Swamp following remediation

5.2.4 What does success look like for remediation of Boundary Creek and Big Swamp?

The development of success targets was informed by technical work and the vision, priorities and objectives for remediation.

They are based on SMART principles and are specific, measurable, achievable, relevant and time limited.

Consistent with these SMART principles, it is important that the success targets are set at a level that is achievable by the controls and actions being implemented.

Success targets are outlined in

Table 6 with further detail on how they were developed provided in section 6.5.1.

Table 6: Success targets for remediation of Boundary Creek and Big Swamp

Success Target	Measurement	Timeframe
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
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
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.	
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.	
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	

Success Target	Measurement	Timeframe
	to form the baseline for assessment of change along with condition scores.	
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
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
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
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
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
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
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*

**Additional data is 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.*

5.2.5 Boundary Creek and Big Swamp monitoring

An adaptive approach to remediation is considered best practice, whereby the Remediation Plan can be adapted in response to ongoing monitoring and measured changes. This approach allows Barwon Water to evaluate how systems are responding to interventions and take further action, such as implementation of contingency measures, if required.

Fundamental to an adaptive management approach is establishing an effective monitoring and assessment program to enable ongoing assessment of:

- Compliance with the requirements set out in the s78 notice;
- Progress towards meeting the vision, objectives and success targets;
- Monitoring environmental conditions, and
- Any unexpected high-risk conditions that require immediate management through a contingency action.

The monitoring and assessment program will follow the process of:

- Where needed, installation and construction of new monitoring assets and/or undertake appropriate environmental assessments;
- Collecting monitoring data;
- Refining models based on monitoring data to determine if action is required;
- Implementing action, and
- Evaluating the effectiveness of action.

Monitoring for the Boundary Creek and Big Swamp Remediation Plan will include:

- Standing water levels and groundwater quality at 17 monitoring bores within Big Swamp;
- Stream flow at six gauging sites along Boundary Creek;
- Vegetation assessments at five established transects every two years or as recommended based on monitoring results;
- Water quality monitoring along the Barwon River at 12 established sites quarterly or as recommended based on monitoring results;
- Sediment sampling along the Barwon River at 12 established sites every two years or as recommended based on monitoring results, and
- Macro-invertebrate sampling along the Barwon River at 12 established sites every two years (autumn and spring surveys) or as recommended based on monitoring results.

5.2.6 Boundary Creek and Big Swamp Remediation contingency planning

Contingency measures were identified should high-risk events be identified which may adversely impact environmental receptors. Detailed requirements for contingency measures will need to be informed by the final soil incubation test results anticipated to be available in early 2020, and the collection of additional geochemical data to obtain a full seasonal cycle.

This information will also inform establishment of triggers for implementation of contingency measures.

The implementation of contingency measures may be triggered by outcomes of the monitoring and assessment program to minimise or contain prolonged events like acid flushes or mobilisation of metals that may require additional management through intervention.

The Remediation Working Group supported the need for contingency options to be incorporated as part of remedial works for Boundary Creek and Big Swamp.

Subject to the outcomes of further geochemical modelling, final detailed design of hydraulic barriers and the refinement of assessment of risks, contingency measures may include:

- Increasing or reducing supplementary flows;
- Use of neutralising agents (either via aerial liming or placement of limestone sand) along established surface water flow paths to mitigate potential spikes in acidity promoted by increases in surface water and groundwater levels;
- Installation of a settling pond to protect Boundary Creek and the Barwon River from metal oxidation and precipitation;
- Installation of silt traps/barriers to protect Boundary Creek and the Barwon River from metal oxidation and precipitation;
- Instream treatment to control acid release and manage potential secondary precipitates being released into Boundary Creek and the Barwon River, and/or
- Use of treatment to supplement sulfate deficit in Big Swamp.

Progressive implementation of hydraulic barriers within Big Swamp will also provide an opportunity to calibrate the models (surface water, groundwater and geochemical) and reassess the potential occurrence and magnitude of any risks associated with increasing surface water flows and groundwater levels.

5.3 Surrounding Environment Investigation

The Surrounding Environment Investigation considers an extent of 480 km² (refer to Figure 2) as the starting point to identify other potentially impacted areas based on a systematic risk assessment framework (published in the revised scope of works approved by Southern Rural Water in October 2019).

The Surrounding Environment Investigation considers the whole extent of the Lower Tertiary Aquifer (LTA) and will focus on eight '**high**' risk areas identified through a risk assessment process adapted from the Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems (DELWP, 2015). This process was detailed in the revised scope of works submitted to and approved by Southern Rural Water.

The initial areas of further investigation include the following and are illustrated in Figure 12:

- Barwon River (East branch);
- Barwon River (West branch);
- Barwon River (downstream of the confluence of the east and west branches);
- Gellibrand River;
- Ten Mile Creek²;
- Yahoo Creek³;
- Groundwater dependent ecosystems near Yeodene;
- Groundwater dependent ecosystems near Deans Marsh, and
- Groundwater dependent ecosystems adjacent to the Gellibrand River.

^{2 2} Ten Mile and Yahoo Creeks feed into Loves Creek therefore outcomes for these creeks will also inform requirements for any further assessment of Loves Creek.

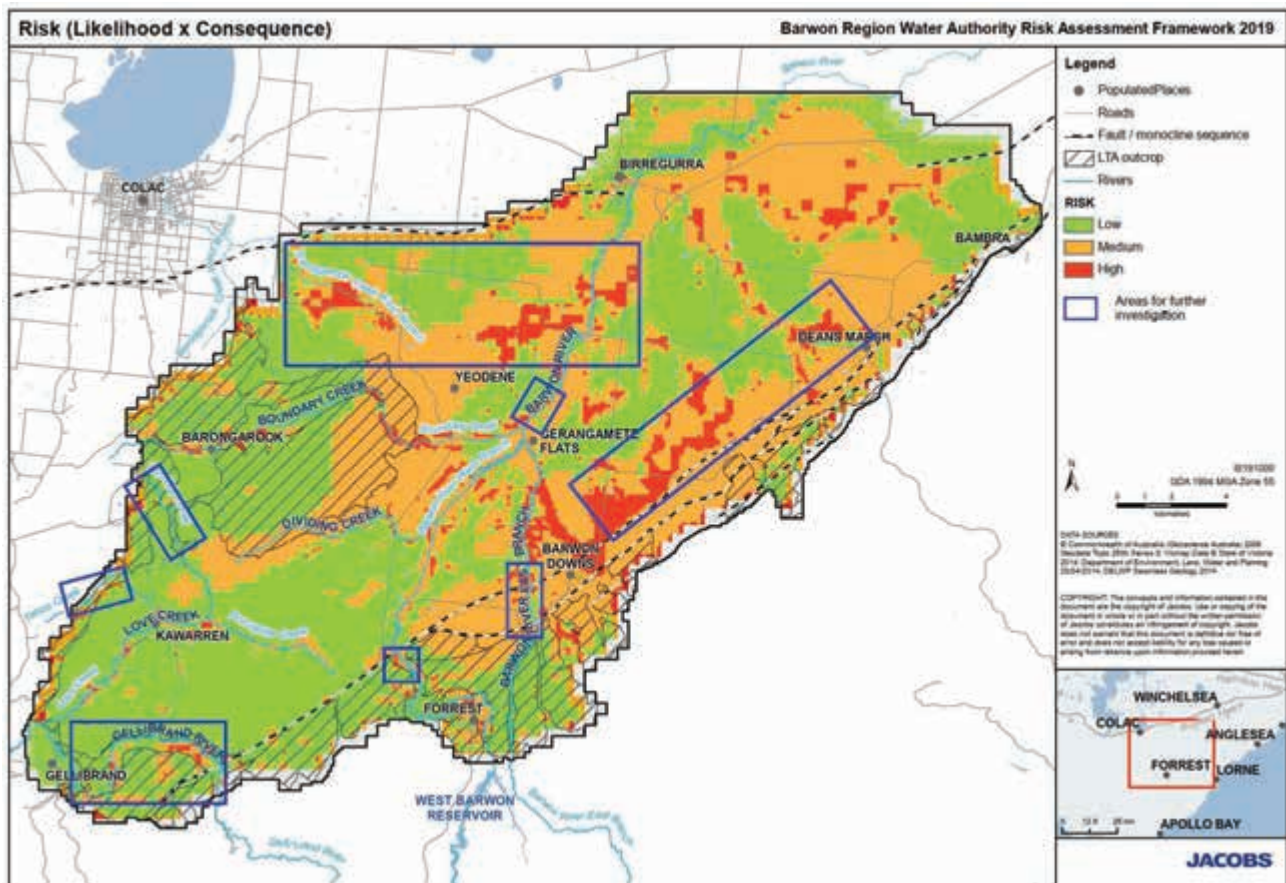


Figure 12: High risk area for further investigation

The regional groundwater model was used as the basis for informing a local scale conceptualisation of each of the eight **'high'** risk areas. Each conceptualisation seeks to represent current thinking (although in most cases, based on limited data-sets) in terms of hydrogeological setting (i.e. groundwater characteristics like recharge, discharge and flow) and processes like groundwater surface water interactions.

While the eight sites at risk are spread across the whole extent of the LTA, information gaps common to them all relate to answering the following questions:

- Has historic groundwater pumping caused a reduction in baseflow to rivers from the LTA (either directly or indirectly) in areas identified as high risk? If so, how much and is it significant?
- Has historic groundwater pumping caused a decline in watertable in areas where there a high value GDEs? And if so, how much and is it significant?

By answering these questions, the Surrounding Environment Investigation will be better placed to identify if there have been environmentally significant impacts in the surrounding environment which have been caused by historic management of groundwater pumping.

To resolve these questions, more data is required to validate the regional groundwater model and in turn, verify that the current risk ranking of **'high'** allocated to the eight areas are accurate. If the

regional groundwater model is deemed unfit for purpose, Barwon Water will consider developing localised groundwater models to better represent site specific conditions.

Data-sets for these eight **‘high’** risk areas are currently limited (either they don’t exist, or the data is insufficient), therefore the recommended actions are to install the following monitoring assets:

- 22 groundwater monitoring bores;
- 5 surface water stream gauges, and
- 6 new vegetation monitoring sites (to confirm existence of groundwater dependent ecosystems).

The investigation has the potential to result in identifying additional areas that may need to be investigated further, or conversely the removal of areas where environmental indicators are not shown to have been impacted by the historic management of groundwater pumping.

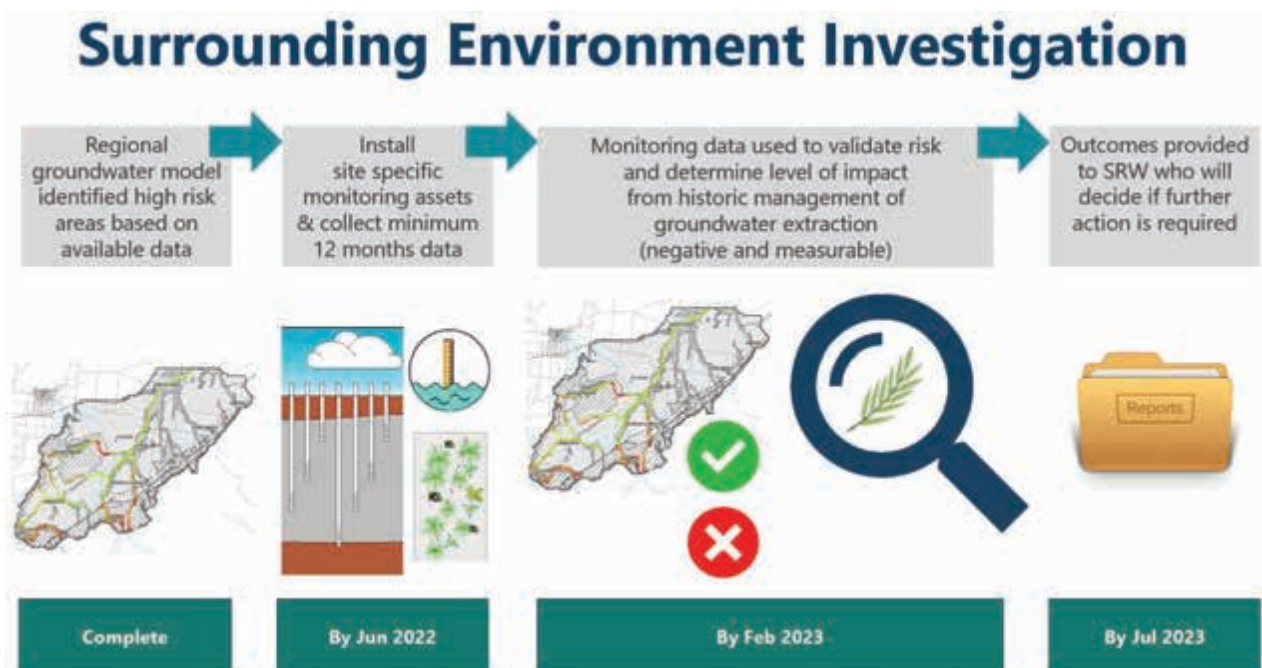


Figure 13: Process overview for the Surrounding Environment Investigation

Figure 13 highlights the time contingency built into the installation and data collection phase due to the fact that some monitoring assets may not be installed until the summer of 2020/21. This allows for approval of the REPP, permits to be obtained and accessibility requirements to install assets (i.e. stream gauges need to be installed during low flow periods).

Some sites such as the East Barwon River are scheduled to have assets installed this summer (2019/2020).

Barwon Water will progressively present outcomes from these investigations to Southern Rural Water as data becomes available to validate risk and determine level of environmental impact from historic management of groundwater extraction. The entire process to confirm if further remediation action is required is expected to conclude by July 2023.

Barwon Water will continue to monitor the regional network of groundwater monitoring bores and stream flow gauges within the Gerangamete and Gellibrand Groundwater Management Areas to refine and update existing surface water, groundwater and geochemical models as required.

Data from new monitoring assets will also be fed back into the regional groundwater model to reassess risks and ensure any new at risk areas are captured for investigation or alternately deemed low risk with no further remediation action required.

In carrying out the Surrounding Environment Investigation, Barwon Water will engage with community and stakeholders to consider insights and other available technical or scientific information so that there is a robust process (for example, that the investigation is well resourced, that data is quality controlled and appropriate project management protocols are followed) for implementing the Surrounding Environment Investigation.

Costs for the Surrounding Environment Investigation are estimated to be in the order of \$1.6M.

5.4 Timeframes

High level timeframes for implementation of the Boundary Creek and Big Swamp Remediation Plan are outlined in Figure 14 (over-leaf).

Ongoing activities will include the continued delivery of supplementary flow to meet the objective of maintaining minimum flows in Reach 3 of Boundary Creek all year round (minimum flows means recording a flow of at least 0.5 ML/day at the Yeodene stream gauge) and monitoring and environmental assessments which will be refined based on monitoring outcomes.

Monitoring data will inform the update of the surface water, groundwater and geochemical models, which in turn will feed into the detailed design of the hydraulic barriers. Additional monitoring is necessary for collection of a full seasonal cycle to inform the setting of indicators and measures of success as recommended by Southern Rural Water and its Independent Technical Review Panel in review of the scope of works.

Detailed design is expected to be complete in 2021 to allow adequate time for approvals of permits. During this time, it is expected that the fire trenches will be infilled to enable more water to be retained in the swamp.

Further work will be undertaken in parallel to inform the feasibility and requirements for 'last resort' instream treatment contingency options.

The progressive installation of hydraulic barriers is anticipated to commence early 2022. Trigger levels for contingency measures will be reassessed based on how the system is responding to the hydraulic barriers taking into consideration any potential side effects associated with increasing surface water flows and groundwater levels within Big Swamp.

Barwon Water acknowledges that it may take a decade to realise improvements from remedial works for Boundary Creek and Big Swamp, particularly an increase in median pH values. However, this needs to be balanced with practicality as is required under the s78 notice, along with the environmental implications, costs, risks and trade-offs associated with implementing ongoing artificial treatment.

Beyond implementation, regular assessment of monitoring results, controls and trigger levels will continue to assess if progress is being made towards achieving success targets.

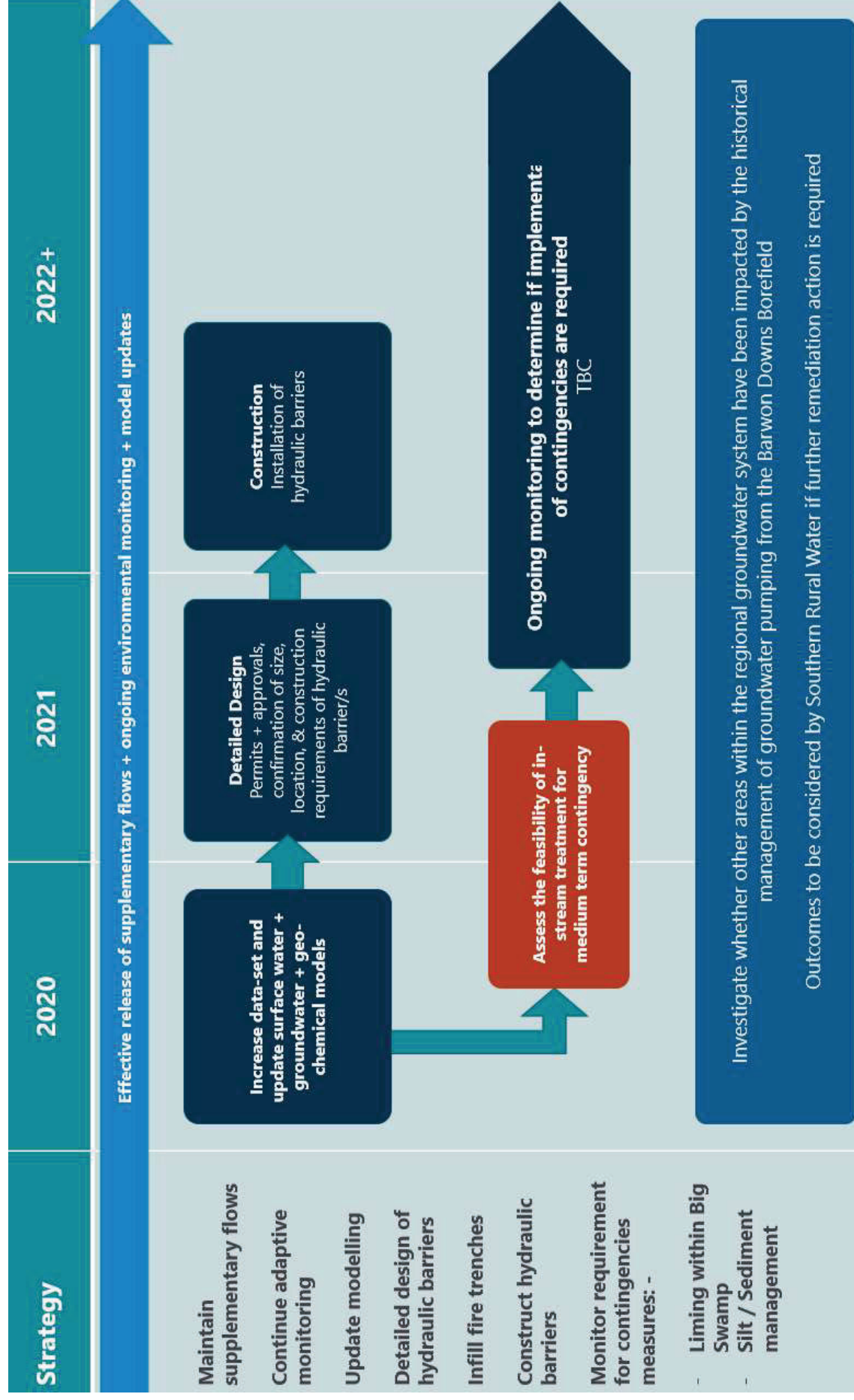


Figure 14: Timeframes for implementation of the REPP

5.5 Reporting Schedule

The schedule outlined in Table 7 proposes that Barwon Water provide a quarterly update and an annual report to Southern Rural Water to meet the requirements of the s78 notice.

The reporting schedule will be reviewed and if necessary, readjusted, at the conclusion of the implementation of the REPP, anticipated for 2023.

Table 7: Reporting schedule for the REPP

Date	Reporting requirement
30 June 2020	Quarter 1 update
30 September 2020	Quarter 2 update + Annual Report*
31 December 2020	Quarter 3 update
31 March 2021	Quarter 4 update
30 June 2021	Quarter 1 update
30 September 2021	Quarter 2 update + Annual Report*
31 December 2021	Quarter 3 update
31 March 2022	Quarter 4 update
30 June 2022	Quarter 1 update
30 September 2022	Quarter 2 update + Annual Report*
31 December 2022	Quarter 3 update
31 March 2023	Quarter 4 update
30 June 2023 +	Quarter 1 update

**Barwon Water proposes that any improvements made to the REPP in light of the adaptive management approach is put forward and approved by SRW as part of the annual reporting process for the s78.*

5.6 Community & Stakeholder Engagement

Recognising the important role the community, local environmental groups, technical experts and key stakeholders played in the development of the REPP, Barwon Water remains committed to continuing an open and transparent relationship during the upcoming implementation of the REPP.

Barwon Water wants to ensure that local insights and knowledge that the community and stakeholders bring are considered as progress is made in delivering the outcomes of the REPP for both remediation of Boundary Creek and Big Swamp, and the Surrounding Environment Investigation.

Barwon Water has designed a high level engagement approach that is aligned with the International Association for Public Participation (IAP2) public participation spectrum.

Figure 15 provides an overview of Barwon Water's proposed approach to the continued involvement of community and stakeholders following approval of the REPP.

Barwon Water anticipates that the Remediation Working Group will reconvene in March 2020 so that feedback on the REPP from Southern Rural Water and its Independent Technical Review Panel can be shared, and if updates to the REPP are required that the Remediation Working Group is involved prior to a resubmission.

Post approval of the REPP, Barwon Water will continue to share progress updates with key stakeholders, interested community groups and the broader community while implementation is underway.

Like the REPP itself, the approach to engagement will be adaptive to suit the needs of the community and stakeholders.

A dedicated communications and engagement strategy will be developed following approval of the REPP. Barwon Water will share community insights as well as outcomes from its communication and engagement activities through the quarterly and annual reporting requirements with Southern Rural Water.

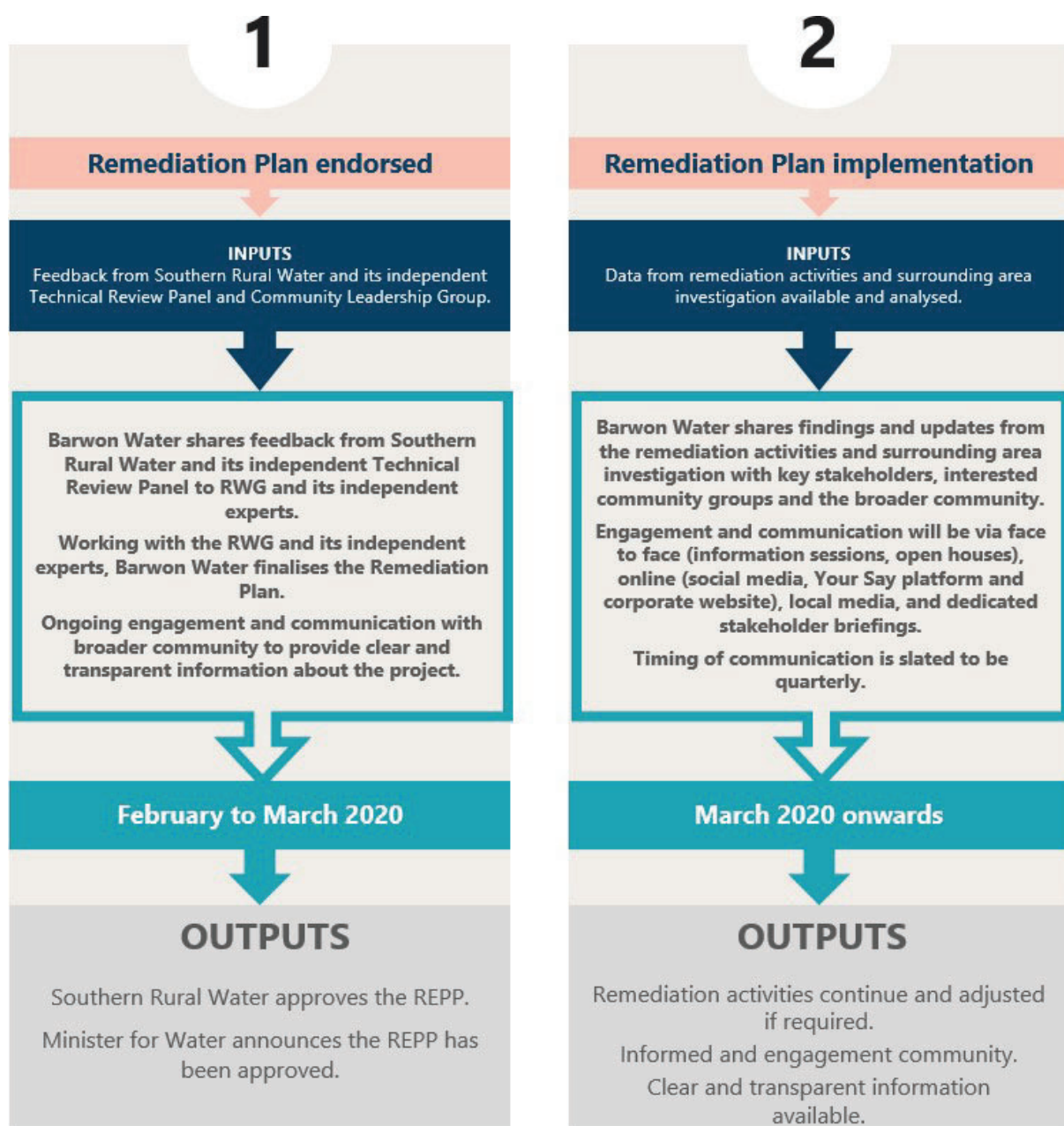


Figure 15: Overview of community and stakeholder engagement