

About Big Swamp and Boundary Creek

Boundary Creek is a tributary of the Barwon River. About 19 kilometres long, it flows from Barongarook to Yeodene where it joins the Barwon River, approximately 16 kilometers south-east of Colac.

Big Swamp (also known as Yeodene Swamp) is a naturally acidic wetland located adjacent to the lower reaches of Boundary Creek, approximately 4 kilometers upstream from the confluence of Boundary Creek and the Barwon River. Big Swamp is primarily fed by inflows from Boundary Creek.



Why the need for remediation?

The Boundary Creek catchment has undergone significant changes since European/Australian colonisation, with land clearing and development for agriculture and farming, use of groundwater and surface water resources, occurrence of fires, and a drier climate leading to changes in the condition and function of Boundary Creek and Big Swamp.

In June 2017, Barwon Water acknowledged that the historic management of groundwater pumping activities at the Barwon Downs borefield had led to a reduction in groundwater contribution from the Lower Tertiary Aquifer into Reach 2 of Boundary Creek. This reduction, in conjunction with other changes in the catchment, resulted in the increased severity of wet-dry cycling processes within Boundary Creek and Big Swamp.

Technical studies to date have identified that this subsequently led to the following impacts to the lower reaches of Boundary Creek and Big Swamp:

- Occurrence of extended 'cease to flow' events and the increased mobilisation of acidity and metals;
- A reduction in the water quality
- The occurrence of fish kill events;
- A loss of wetland species and stream ecology; and
- Change / loss of soil structure and/or properties.

Ultimately this has resulted in environmentally significant adverse impacts to Boundary Creek and Big Swamp that requires management intervention.

About the Remediation and Environmental Protection Plan (REPP)

Our Remediation and Environmental Protection Plan (REPP) was developed based on the outcomes of scientific studies and advice from independent technical experts and community and stakeholder Remediation Reference Group and has been designed to achieve improved environmental outcomes for Boundary Creek, Big Swamp and the Surrounding Environment.

Following its initial development in 2018, the REPP was formally implemented following its acceptance by Southern Rural Water in March 2020 pending the outcomes of further technical works.

The REPP is a clear statement of Barwon Water's commitment to improving environmental outcomes and addressing the impacts caused by the historic management of groundwater pumping activities at the Barwon Downs borefield. It also outlines a robust process to undertake further investigations to verify if other areas within the regional groundwater system have been impacted by these activities, and whether any further remediation actions are required. Noting that the actions and controls implemented as part of the Boundary Creek and Big Swamp Remediation Plan do not aim to address the factors beyond Barwon Water's control and that these will continue to impact on the overarching resilience of the system.

The REPP also responds to the requirements of a Ministerial Notice issued to Barwon Water under Section 78 of the *Water Act 1989* that requires the implementation of *'controls and actions that could be practicably carried out to achieve improved environmental outcomes for Boundary Creek, Big Swamp and the surrounding environment'*.

Today, the REPP continues to be updated in consultation with the community and stakeholder Remediation Reference Group in line with our adaptive management approach to guide and inform our efforts to address the impacts caused by Barwon Water's activities and achieve the desired outcomes.

The REPP was most recently updated in July 2023 and is currently pending review by Southern Rural Water.

The REPP comprises of two parallel work packages:

- **The Boundary Creek and Big Swamp Remediation Plan** - That outlines the controls and actions that have and will be implemented within the confirmed areas of impact to:
 - **Ensure** no further harm from Barwon Water's historic groundwater pumping or remediation actions
 - **Protect** the water quality and ecological values of the Barwon River
 - **Improve** the water quality and streamflows within Boundary Creek, and
 - **Improve** the ecological values of Big Swamp
- **The Surrounding Environment Investigation** - To investigate whether other areas within the regional groundwater system have been impacted by historical management of groundwater extraction at the Barwon Downs borefield.

The plan is adaptive and will involve direct action and constant monitoring and adjustment to ensure improvements to water flows and quality, vegetation and ecology in Boundary Creek and Big Swamp.

Remedial objectives

To assist in realising the project vision, the following remedial objectives have been developed in collaboration with the Remediation Reference Group:

1. Facilitate groundwater level recovery and enable groundwater-surface water interaction to return.
2. Reduce the severity of wet-dry cycling processes and the occurrence of 'acid flush' events in Boundary Creek.
3. Control/manage the risks associated with the oxidation of naturally occurring acid sulfate soils.
4. Preserve/improve the ecological values of Big Swamp and Boundary Creek, and
5. Reduce the fire risk in Big Swamp

Adopted remedial actions

Following a comprehensive review of the potential remedial actions, the following remedial actions have been adopted to address the objectives outlined above. Noting that these will continue to be informed by the ongoing environmental monitoring activities.

Progress against the remediation success targets

The remediation actions that have been undertaken as part of the REPP to facilitate the natural recovery process to date, have resulted in the following:

- Ongoing recovery of the Lower Tertiary Aquifer, with groundwater levels in the central portions of the aquifer nearing pre-pumping levels;
- Recovery and maintenance of soil moisture within Big Swamp's upper aquifer system and subsequent decrease in the severity of wet-dry cycling processes and the potential for acid flush / fish kill events in the Barwon River;
- Improvements in the water quality within the lower reaches of Boundary Creek and Big Swamp compared to worst case conditions. Noting that these have and will continue to be impacted by the naturally occurring acid sulfate soils into the future;
- Improvements in the ability for Barwon Water to ensure that our supplementary flows are passed through the private on-stream dam; and
- Continued recolonisation of the wetland with desired species since the 2010 fires and ongoing stabilisation of these species towards a 'new normal'.

Environmental monitoring

A routine environmental monitoring program has been established to inform and evaluate how the system is responding to the adopted remedial actions and trigger additional actions, such as the implementation of contingency measures, if and when required.

The data obtained from these works are used to inform the Quarterly Updates and Annual Reports (due 30 September each year) that are submitted to Southern Rural Water and published on the dedicated Your Say website.

The future of the Barwon Downs borefield

Barwon Water through its 2022 Urban Water Strategy: Water for our Future has **ruled out** any future use of the Barwon Downs borefield as a water supply source.

This was also reflected in Barwon Water's 2023-2028 Price Submission through Barwon Water's commitment to decommissioning the Barwon Downs borefield extraction bores.

About the decommissioning plan

In March 2023, we commenced the development of a decommissioning plan that outlines the decommissioning specifications (i.e., backfill/perforation/sealing requirements) for each of the Barwon Downs production bores.

This was subsequently submitted to Southern Rural Water as part of an application for a licence to decommission the Barwon Downs borefield on 17 July 2023. We're currently waiting to hear back from Southern Rural Water on this application. Once approved, Barwon Water will look to engage a suitably qualified driller.

When will the bores be decommissioned?

At this stage, we anticipate on-ground decommissioning works to commence in 2024-2025, this is earlier than the date identified in the 2023-2028 Price Submission (2026-2027).

We will continue to share updates on the progress and timing of the decommissioning works as we progress through the planning phase.



Contingency measures

The development of contingency measures focuses on minimising the potential for high-risk events, should these persist following the implementation of the primary remedial actions.

As such, these are **last resort controls** and in line with feedback provided by the Remediation Reference Group should only be implemented if the benefits outweigh the risks associated with more intrusive actions.

Noting that the remediation actions may take time for improvements to be realised. As such, contingency measures are designed to support the primary remedial actions and focus on managing the short-term, rather than long-term risks.

As a minimum, the implementation of contingency measures will be assessed as part of the annual reporting process, with routine reviews of monitoring data and SCADA/telemetry alarms used, where possible, to prompt the need for a detailed assessment of conditions.

Contingency approach	Contingency measure
Minimise the potential for acid-related fish kill events in the Barwon River	Mobile downstream treatment system (pending acceptance by SRW)
Reduce the severity of wet-dry cycling processes	Tier 1: Water diversion barriers (e.g., straw bales or similar)
	Tier 2: Adjustment of existing drainage lines / channels
Improve the condition and function of Big Swamp	Tier 1: Removal of dry vegetation classes and/or undesired species from the swamp plain
	Tier 1: Removal of dry vegetation classes and/or undesired species from the swamp plain

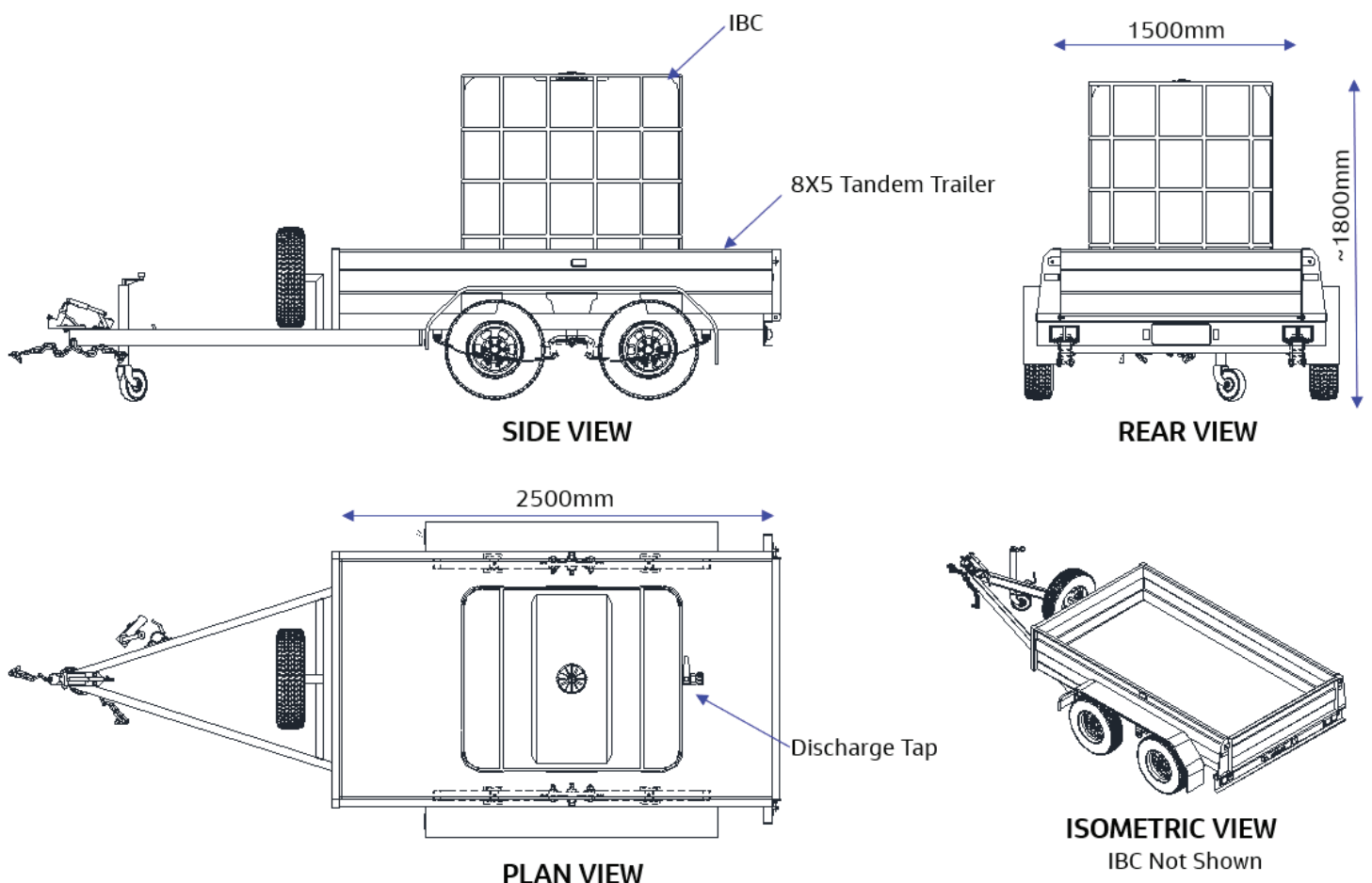
The proposed contingency measure(s) will require approval from Southern Rural Water with additional licences and/or approvals likely required by other agencies prior to implementation. With recent improvements in conditions, these engineered contingency measures may not be required if the risks can be appropriately managed.

Mobile downstream treatment contingency measure

The mobile downstream treatment system has been designed to neutralise acidity in Boundary Creek during high-risk acid discharge events that may lead to potential fish kill events in the Barwon River.

This means it is only intended to be mobilised if, and when, conditions flag a potential risk and provide short-term treatment until these risks are minimised to the extent practicable, **and only as a last resort.**

The mobile downstream treatment system also addresses several risks and challenges that were raised with regard to the permanent downstream dosing plant that was proposed in 2021 (Barwon Water, 2021).



Surrounding Environment Investigation

The Surrounding Environment Investigation considers the whole extent of the Lower Tertiary Aquifer (480 km²) and aims to determine whether the historical management of Barwon Water's groundwater pumping activities resulted in any unintended environmentally significant adverse impacts within the broader environment, in addition to those already confirmed within Big Swamp and the lower reaches of Boundary Creek.

A key element of this work was the development of a conceptual site model that consolidates the abundance of work completed within the region since investigations commenced in the 1960/1970s. This conceptual site model was then used in conjunction with groundwater levels, surface water flows, surface water and groundwater extraction licences, land use and climate related factors to:

- Test the underlying assumptions of the regional groundwater model that was used to identify the initial focus areas for this investigation. Noting that recent investigations considered sub-catchments rather than attempting to look at these areas in isolation;
- 'Ground truth' the findings of the model and the potential for hydraulic influences, and
- Determine if Barwon Water's historical management of groundwater pumping activities at the Barwon Downs borefield resulted in any environmentally significant adverse impacts.

Impacts on remedial actions

In line with the s78 notice, no further remedial actions are required based on the outcomes of this work. The actions that have already been committed to as part of the Boundary Creek and Big Swamp Remediation Plan will continue to facilitate the recovery of the Lower Tertiary Aquifer. This approach has been supported by our Remediation Reference Group and their nominated experts. Barwon Water no longer has a groundwater extraction licence and has already committed to decommissioning the Barwon Downs extraction bores.

Impacts on future management of surface water and groundwater resources

The outcomes of this work have also highlighted the importance of considering the following elements when making future management decisions:

- Climate related impacts of recharge/discharge and rainfall-runoff processes;
- The interconnection between groundwater and surface water resources and competing demands; and
- The potential impacts of land use change on rainfall-runoff processes.

Understanding these factors will help protect these resources into the future.

Key findings

The outcomes of this work identified hydraulic influences from Barwon Water's historic management of groundwater pumping activities at Barwon Downs borefield on Loves Creek, Yahoo Creek and to a lesser extent in the Barwon River and Gellibrand River.

These influences have been attributed to reductions of up to 26, 23, 9 and 6% in low flow conditions, respectively. Despite this, there is no evidence to suggest that these have resulted in any environmentally significant adverse impacts.

The work also identified that climate related factors can be attributed to reductions of between 20-56%, while licenced surface water extraction activities and potential influences from forestry and logging activities may also play an important role and confound the overarching impacts.

The need for further work was identified in the upper reaches of Deans Marsh, Matthews and Pennyroyal Creeks to better understand the potential hydraulic influences and establish if there is any evidence of environmentally significant impacts that could be attributed to the historical management of groundwater pumping at Barwon Downs. This work will be progressed following the receipt of feedback from SRW on our July 2023 submissions.

Commonly asked questions

What will successful remediation of the Boundary Creek catchment look like?

Successful remediation of the Boundary Creek catchment will be based on meeting the success targets outlined in the REPP. The success targets reflect the point at which the environmental outcomes have been improved to the extent practicable (i.e., the point at which further intervention by Barwon Water is no longer practicable or the potential benefits of additional actions do not outweigh the risks). This acknowledges that the natural recovery processes that we are trying to facilitate take a much longer timeframe (i.e. 10 years or more) and may be impacted by factors beyond Barwon Water's control.

While no timelines have been provided for these success targets to be achieved due to the number of variables at play, the time-bound element of these success targets aims to ensure that success is not short-lived. Hence this requires the targets to be met for two-consecutive years. Noting that this takes some seasonal variation into account, without attempting to control climatic factors beyond Barwon Water's control.

How long will it take for successful remediation of the Boundary Creek catchment?

There is no certainty about the time it will take for successful remediation to occur. Rather, the REPP aims to establish what can be achieved by addressing Barwon Water's contribution to the identified impacts and monitoring the progress against these targets to determine when remediation efforts have been successful. The timeframes are dependent on the overarching resilience of the system and the extent to which factors beyond Barwon Water's control provide a barrier to remedial efforts.

This also acknowledges that climate related impacts are anticipated to occur during future droughts and the anticipated climatic shifts. Despite this, significant progress has been made to date. Barwon Water – in accordance with the Section 78 Notice – continues to submit quarterly updates to Southern Rural Water on the progress of the plan's implementation. In addition, an Annual Report is prepared and submitted every September.

Barwon Water commits to ongoing communication and sharing of data (including all progress and annual reports) and information with the community to update them on the progress of implementation.

Is Barwon Water allowed to extract groundwater from the Barwon Downs borefield?

No, Barwon Water no longer holds a licence to extract water from the Barwon Downs borefield and have committed to decommissioning the Barwon Downs extraction bores as part of the 2023-2028 Price Submission. Further to this, Barwon Water has made a commitment as part of the Water for our Future Strategy (a 50 year plan for the region's water security and resources) to deliver a sustainable, affordable and reliable water future. This includes reducing our reliance on rivers and groundwater as we transition to more climate-independent sources of supply and increase the resilience of our water supplies, such as expanding the reach of the Melbourne to Geelong pipeline to service more customers in our region.

Will Barwon Water submit a new licence application for the Barwon Downs borefield and extract groundwater from this site in the future?

No, Barwon Water has ruled out any future use of the Barwon Downs borefield as part of the Water for our Future Strategy (a 50-year plan for the region's water security and resources) and committed to decommissioning the Barwon Downs extraction bores as part of the 2023-2028 Price Submission. Works are currently underway to develop the Barwon Downs Borefield Decommissioning Plan, with on ground works expected to occur in the 2024/2025 financial year.

What is involved in delivering the REPP for Boundary Creek, Big Swamp and surrounding environment?

The remediation of Big Swamp and Boundary Creek will involve the continual wetting of the swamp through a controlled release of water from Colac's water supply system to Boundary Creek and the installation of hydraulic barriers to maintain surface water and groundwater levels within Big Swamp. The aim of this work is 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 and occurrences of acid being flushed into Boundary Creek in the long-term. The surrounding environment investigation considers an extent of 480 km² as the starting point to identify other potentially impacted areas. This includes some reaches along the Barwon River, Gellibrand River, Ten Mile Creek, Yahoo Creek and other groundwater dependent features, such as vegetation near Yeodene and Deans Marsh.

What signs will indicate that remediation action is having a positive impact?

Signs that remediation actions are having a positive effect will include: recovery of groundwater levels within Big Swamp and the Lower Tertiary Aquifer system, improved water quality within Boundary Creek downstream of Big Swamp and the recolonisation of the swamp with wetland vegetation types, such as melaleuca and macrophytes (reeds and sedges).

Where do supplementary flows come from?

Barwon Water releases supplementary flows into the headwaters of Boundary Creek above the private on-stream dam, as required, to maintain flows in the lower reaches of Boundary Creek. The timing and volume of supplementary flow releases is based on the data obtained from stream gauges along Boundary Creek.

The water for the supplementary flows is supplied via the Barwon-Colac transfer pipeline. Predominately the supplementary flows are untreated water sourced from the Colac water supply system. However, when water is being transferred from the Barwon system to supplement water supplies for Colac the supplementary flows would be untreated water supplied from the Barwon system.

The water for supplementary flows is sourced in accordance with the conditions and limits stipulated in Barwon Water's existing Bulk Entitlements for the Colac and Upper Barwon systems.

There's a private on-stream dam on Boundary Creek. How can Barwon Water ensure the passing flows stipulated in the REPP are being met?

Barwon Water has been manually managing the passing of the supplementary flows since 2018 in agreement with the owner of the dam. The meeting of the passing flow requirements is the responsibility of the dam owner, with Southern Rural Water being responsible for the regulation of these requirements.

To reduce the complexities associated with the management and regulation of these flows, in March 2023 Barwon Water installed an automated flow valve on the dam's outlet pipe to assist in managing the passing of both the supplementary flows and passing flows as much as possible.

How is Barwon Water ensuring water for Boundary Creek landowners?

Barwon Water has constructed a dedicated stock pipeline and access to piped water at no additional cost to Boundary Creek landowners impacted by low quality water in the creek. This arrangement will be in place until flows and water quality in the affected reach of Boundary Creek are suitable for stock consumption.

How does the Barwon Downs borefield differ to the Anglesea borefield?

Barwon Water operates the Anglesea borefield under a bulk entitlement issued by the Victorian Government. This includes environmental triggers and an extensive monitoring and assessment program designed to protect groundwater dependent ecosystems, which is overseen by the community through the Anglesea River Working Group. The management of the Anglesea borefield is very different to the Barwon Downs borefield, which was operated and managed under a groundwater licence, fixed for 15 years, and did not include the same level of environmental monitoring or the adaptive management approach for protection of the environment. The triggers for Anglesea borefield are conservative and designed to prevent impacts on groundwater dependent ecosystems before they occur. The below table details the different approach to both borefields.

Anglesea borefield	Past management of Barwon Downs borefield
Bulk entitlement, issued by Victorian Government	Fixed 15 year licence issued by regulator, SRW
Adaptive management approach	Non adaptive management approach
Extensive Monitoring and Assessment Program (MAP) to protect the environment	Groundwater levels, surface water flows and 5-yearly vegetation studies
MAP triggers are conservative and designed to prevent impacts on groundwater dependent ecosystems before they occur	Fixed licence had triggers to offset impacts (i.e: reduced flow in Boundary Creek), rather than triggers to prevent impacts. Provision of supplementary flow to Boundary Creek as a licence condition did not adequately protect the downstream environment
10 years of data on groundwater, surface water, acidic sulphate soils, subsidence and ecological values	Additional monitoring undertaken to better inform remediation.

Working together

Barwon Water's Remediation and Environmental Protection Plan has had significant input from community members, stakeholders and community nominated technical experts.

Remediation Reference Group (RRG)

A dedicated Remediation Working Group was established during the development of the remediation plan and is continuing to provide community oversight and feedback as the Remediation Reference Group (RRG) while the plan is implemented.

The RRG is comprised of members from Corangamite Catchment Management Authority (CCMA), Colac Otway Shire Council, Upper Barwon Landcare Group, Geelong Environment Council, Friends of the Barwon River, local landowners and other interested community members.

RRG members continue to meet on a quarterly basis along with their nominated technical experts (Dr Darren Baldwin, Dr Vanessa Wong and Professor Richard Bush) to discuss progress, opportunities and challenges and provide input on new directions for the remediation plan.



Findings from the Paleoenvironmental Study

In 2022, Barwon Water engaged La Trobe Universities Archaeology Research Partnerships team to conduct a paleoenvironmental study of Big Swamp to better understand the past environmental conditions within the swamp and how these have changed in response to anthropogenic impacts over time. This work has also been informed by feedback from the Remediation Reference Group's nominated independent experts.

To do this, two soil cores were collected from within Big Swamp, with samples from the Eastern Portion of Big Swamp being suitable for multiproxy analysis of the following elements to reconstruct the past environment:

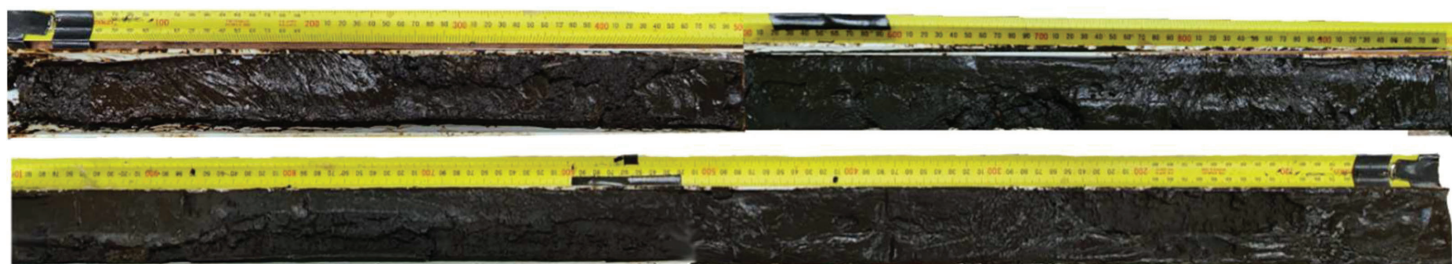
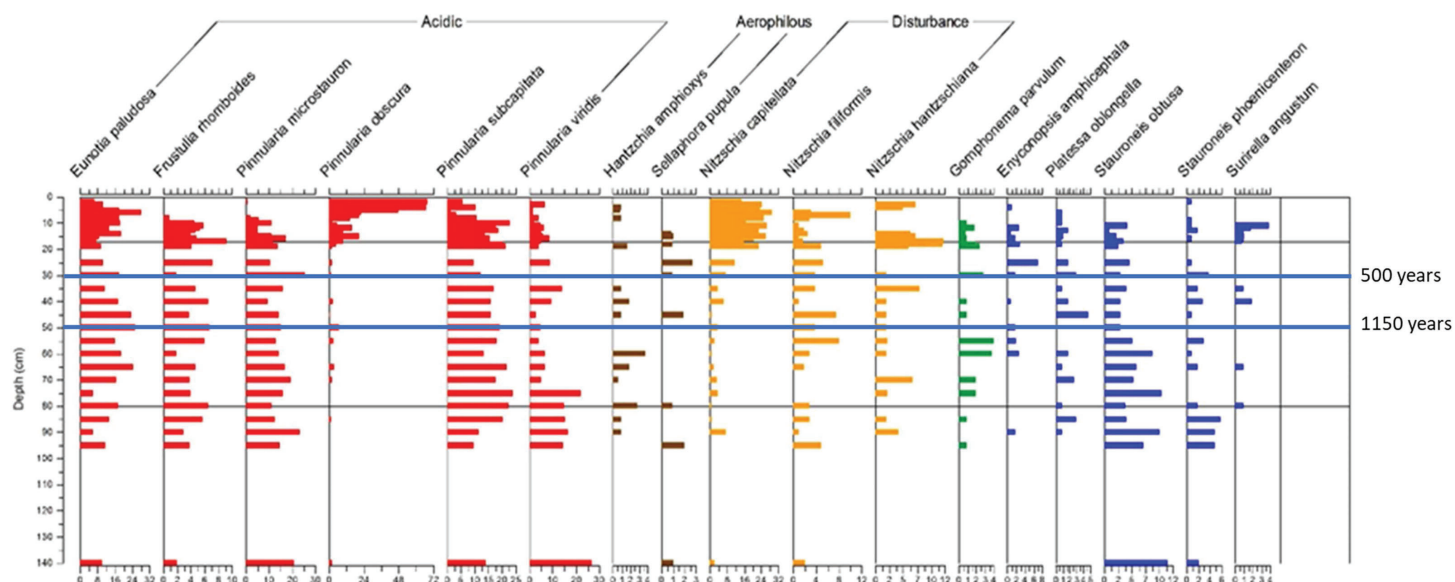
- Pollen – to reconstruct past vegetation
- Diatoms – to reconstruct the waterways conditions, and
- Charcoal – to reconstruct past burning within the landscape

To support this, radiocarbon dating was used to date the core and provide insight into the age of the sediments and the elements contained within.

High level findings

Based on the dating, the samples collected as part of these works were able to provide insight into the conditions and communities within Big Swamp over the past 10,000 years. Key findings relating to the response of the system to anthropogenic impacts include:

- Prior to European/Australian colonisation Big Swamp was a stable environment for at least the past 1,000 years, being a swampy environment surrounded by established forest.
- While European/Australian colonisation has significantly impacted the catchment, particularly from a sedimentation and vegetation community standpoint, Big Swamp appears to have retained much of its character with established forest and sedge still dominant features in the local landscape.
- Acidic conditions and acid tolerant species have prevailed at Big Swamp for over a millenia. This is consistent with the presence of naturally occurring acid sulfate soils.
- The long-term stability of Big Swamp has been punctuated by fire. There are two instances of large-scale fires, dated to more than 1,000 years ago, interrupting the vegetation communities.



Composite image of core: 0-100 cm (top) 100-200 cm (bottom)