Boundary Creek Mobile Downstream Treatment Contingency Measure

Boundary Creek and Big Swamp Remediation Plan

Submitted: 31 July 2023

Table of contents

Introduction

Background

As outlined in the Remediation and Environmental Protection Plan (REPP) (Barwon Water 2020 and Barwon Water 2023), a key requirement of the section 78 notice is the development of appropriate contingency measures that are designed to address any issues identified from the monitoring results. While the remedial actions focus on addressing the environmentally significant adverse impacts resulting from the historical management of Barwon Water's groundwater pumping activities at the Barwon Downs borefield, 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.

Based on a review of the potential remedial options (CDM Smith, 2019, CDM Smith, 2022 and Barwon Water, 2021), two potential contingency approaches were identified to address the potential for fish kill events that can occur following an extended period of flow cessation in Boundary Creek. These were:

Downstream treatment where a water treatment system is located along Boundary Creek downstream of Big Swamp to manage the metal and acidity loads emanating from Big Swamp, and

Upstream treatment where a water treatment system is located within Big Swamp to address the metal and acidity loads at the source

On 31 July 2021, an initial design of a permanent downstream chemical dosing plant was completed and submitted to Southern Rural Water. However, this was not accepted by Southern Rural Water due to the potential ecological risks associated with operating a sodium hydroxide dosing plant in a natural setting. Similar concerns were also raised by the community and stakeholder Remediation Reference Group (RRG), who's preference was to prioritise actions and controls that minimise the need for active and/or intrusive interventions. As such, this was put on hold while the upstream treatment measure was further investigated.

However, following the outcomes of the Upstream Treatment Investigation (Barwon Water, 2022), Barwon Water has since ruled out the use of an upstream treatment system. As such, in order to overcome a number of the risks and challenges associated with the permanent downstream dosing plant and help address community and stakeholder feedback, Barwon Water have now revised the design of the downstream contingency measure to focus on a mobile treatment system that can be deployed as a last resort, in the unlikely event it is required.

Objectives of this report

The objective of this report is to outline the design of a mobile downstream treatment system that could be deployed, if and when required, to mitigate against potential acid-related fish kill events that may occur following an extended period of flow cessation in Boundary Creek.

It is noted that while acceptance is required from Southern Rural Water before this could be trialled and implemented, additional permits and/or approvals are likely required from other agencies (e.g., CCMA, Colac Otway Shire, EMAC and EPA Victoria) before this could proceed. However, these approvals cannot be progressed until Southern Rural Water, as the regulator of the section 78 notice, is satisfied that this would be an appropriate contingency measure.

Similarly, if additional permits and/or approvals cannot be obtained, this option will be removed from the REPP as a potential contingency measure.

Implementation roadmap

As outlined above, there are a number of hold points before this contingency measure can be adopted, as outlined in Figure 1.

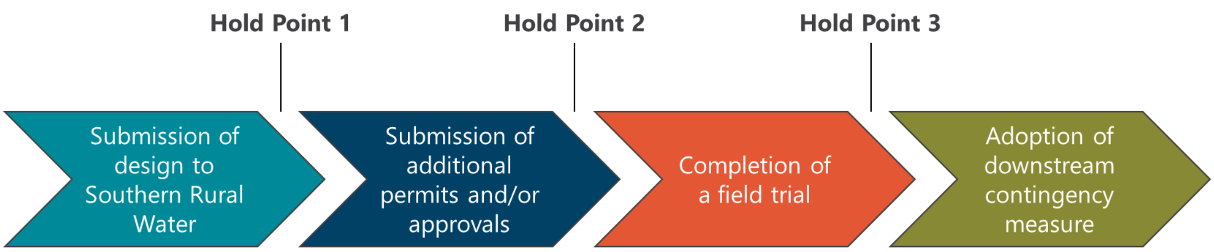

Figure 1 Downstream Treatment Implementation Roadmap

Noting that the term adoption in this instance, refers to this being available to implement as a last resort in the unlikely event it is required, rather than being deployed for use.

What has informed this process

This report has been informed by the following documents:

- Jacobs, 2018, 2016-2017 Technical Works Program - Yeodene Swamp Study
- CDM Smith, 2019, Boundary Creek and Big Swamp remediation: Options Assessment
- Barwon Water, 2020, Boundary Creek, Big Swamp and Surrounding Environment Remediation & Environmental Protection Plan (REPP)
- Barwon Water, 2021, Hydro-Geochemical Modelling - Design of Contingency Measure
- Barwon Water, 2022, Outcomes and Implications of the Upstream Treatment Investigation, amended November 2022

- Barwon Water, 2022, Revised Interim Draft of the Boundary Creek, Big Swamp and Surrounding Environment Remediation & Environmental Protection Plan (REPP)
- CDM Smith, 2022, PRB Assessment
- La Trobe University, 2023, Big Swamp Paleoenvironmental Study
- Nation Partners, 2023, Ecological Risk Assessment Boundary Creek, Big Swamp and the Barwon River

Overview of the mobile downstream treatment contingency measure

The sections below provide an overview of the design of the mobile downstream contingency measure. Refer to Appendix A for further detail.

Design principles

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. Because of this, 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.

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

- Challenges in providing a power supply
- Access and supply of fuel and reagent required for plant operation
- Potential for fuel or chemical spills or overdosing
- Whether the potential costs and/or risks outweigh the benefits of implementing the system
- Land ownership
- System maintenance and vandalism
- Accuracy of automation, and
- Potential for increased flocculant/sludge build up

While some of these are unable to be resolved entirely, the mobile treatment system provides a less intrusive approach that minimises the potential frequency and duration of potential risks whilst meeting the contingency planning requirements of the section 78 notice.

pH target

A pH target of 5.5-6.0 pH units has been adopted for this system in accordance with the Tier 2 guidelines developed as part of the Ecological Risk Assessment (Nation Partners, 2023). This also acknowledges that acidic conditions have prevailed at Big Swamp for over a millennia (La Trobe University, 2023).

Reagent selection

Based on a review of potential reagents, caustic soda 30 per cent has been selected as the most appropriate neutralising agent for the proposed application. This limits the volume of reagent required to meet the target pH range of 5.5-6.0 pH units whilst minimising the risk of freezing, clogging or other operational issues that would prevent the system achieving its intended purpose.

Treatment location

The proposed chemical dosing point is within the drainage channel downstream of Big Swamp, before the confluence with Boundary Creek, upstream of the V notch weir. This provides direct contact with acidic water discharging from Big Swamp and allows for a degree of mixing prior to entry into Boundary Creek. The V notch weir located downstream of this confluence will also provide additional mixing.

Dosing Rate

While the exact dosing rate would be based on a field titration prior to treatment, the estimated upper dosing rate is expected to be 0.7 L/min depending on the pH and stream flow.

Dosing system

As outlined in Appendix A, two potential mobile dosing systems have been proposed. Based on the preliminary costing, the IBC mounted chemical trailer option that uses an 8″ x 5″ tandem trailer (refer Figure 2) that can then be used by Barwon Water's operational teams when not required for treatment is considered to be the most appropriate solution. Given this would also need to be purchased prior to completion of a trial, if adoption is not feasible, the trailer could still be used for other operational purposes.

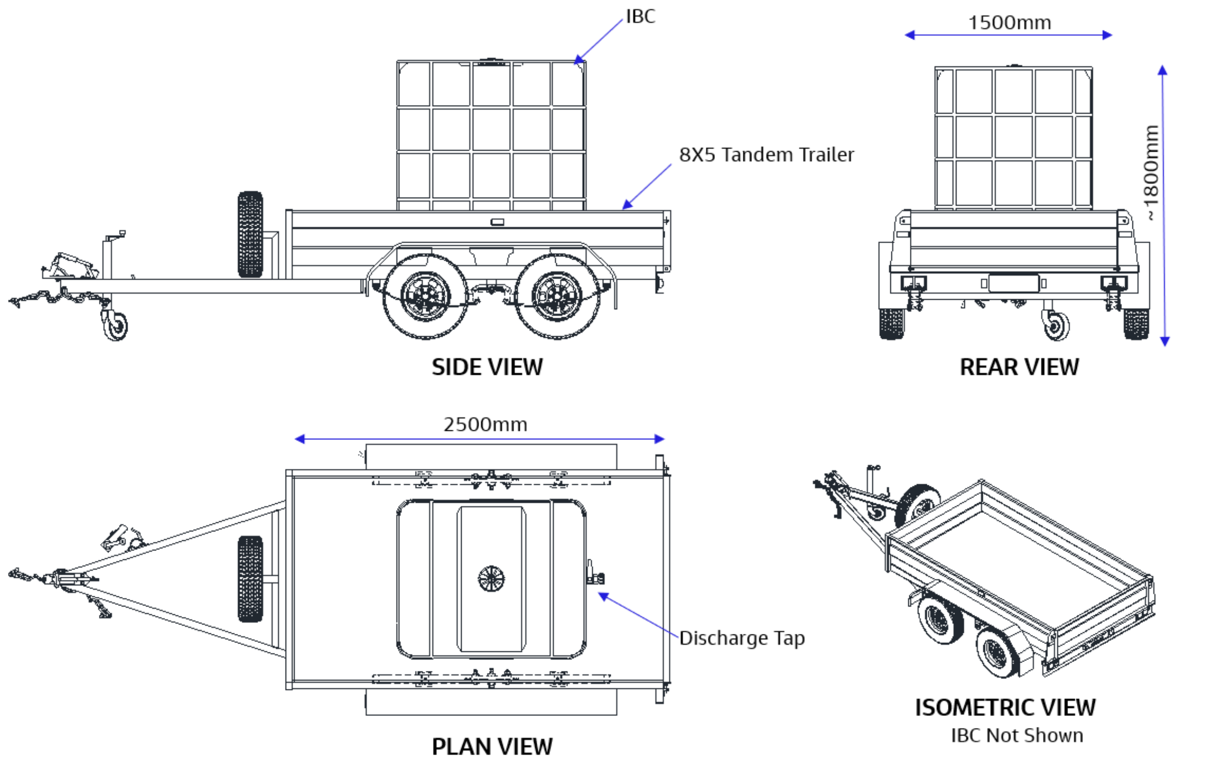

Figure 2 IBC chemical mounted trailer

Trigger(s)

To ensure that the system could be deployed in time to treat an acid flush event, a tiered preparatory and alert response is proposed, as follows:

1. **Planning trigger**: Streamflows at gauge site 233228 are less than 0.1 ML/day for greater than 6 weeks → staff notified to verify flows, conduct pre-operational checks and liaise with chemical supplier.

2. **Mobilisation trigger**: Streamflows at gauge site 233228 have been less than 0.1 ML/day for greater than 3 months, **and** greater than 40mm rainfall is forecast within 5 days **or** streamflows at gauge site 233228 have since increased above 0.5 ML/day.

3. **Dosing trigger**: pH readings are less than 5 at gauge site 233276 **and** less than 4 at gauges site 233228 are confirmed via field readings **and** Boundary Creek is contributing greater than 35% of flows into the Barwon River (based on flow measurements from gauge sites 233228 and 233233)

4. **Cease treatment trigger**: pH readings upstream of the dosing plant are greater than 5 **or** Boundary Creek is contributing less than 35% of flows into the Barwon River

Monitoring and risk mitigation measures

While a field trial is proposed to be undertaken to confirm the operation and monitoring requirements during treatment, the following monitoring and management activities are anticipated to be required to monitor progress and minimise the risks identified in Appendix A to the extent practicable:

- Construction of an access track and turn around point to provide suitable ingress and egress to the treatment location
- Use of bunding and carrying of mobile spill kits during transport
- Placarding in accordance with Dangerous Goods (Storage and Handling) Regulations
- Use of bunding and temporary fencing around the dosing system to restrict access and mitigate against any off-site contamination in the event of a spill
- Portable safety shower and eye wash station
- Limits on the dosing pump and maric valve to mitigate the potential for over-dosing to occur
- Replacement of hoses and cam locks seasonally to reduce the risk of leakages from hosing or fittings
- Use of motion and video sensors to prevent and/or notify staff of any unauthorised access
- Automated water quality monitoring using the existing stream gauges along Boundary Creek and the Barwon River (i.e., gauge sites 233276, 233228 and 233233)
- Spot pH measurements upstream and downstream of the dosing point
- Daily site inspections and field titrations on grab samples taken upstream of the dosing point
- Use of SCADA alarms to flag any shut off triggers (i.e., pH overshoot) or potential leaks via the pressure sensor within the IBC. Should these be triggered, Barwon Water staff can mobilise to site within 30 minutes to check and, if required, rectify the issue
- Use of a security system to alert staff of any unauthorised access or vandalism

Next steps

Based on the findings from this investigation, Barwon Water propose to undertake the following actions.

Item	Action	Deliverable	Timeframe
1	Submission of the mobile downstream treatment contingency measure to Southern Rural Water for acceptance	This report	31 July 2023
2	Once accepted by Southern Rural Water, seek additional permits and/or approvals from other agencies (e.g., CCMA, Colac Otway Shire, EMAC and EPA Victoria)	N/A	TBA pending feedback
3	Purchase of the mobile downstream treatment system	N/A	TBA pending feedback
4	Completion of a field trial – pending relevant permits and/or approvals	Downstream Treatment Trial Report	TBA pending feedback
5	Development of standard operating procedures for the successful operation of the mobile downstream treatment system	Standard Operating Procedure (SOP)	TBA pending feedback
6	Routine review of monitoring data and SCADA/telemetry alarms against the trigger(s)	Implementation notification, as required **or** Annual Report	Ongoing

References

Barwon Water, 2020, Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan (REPP), February 2020

Barwon Water, 2021, Hydro-Geochemical Modelling, Design of Contingency Measure. July 2021

Barwon Water, 2022, Outcomes and Implications of the Upstream Treatment Investigation, amended November 2022

Barwon Water, 2023, Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan (REPP), July 2023

CDM Smith, 2019, Boundary Creek and Big Swamp remediation: Options Assessment, 19 December 2019

CDM Smith, 2022, PRB Assessment, 13 September 2022

Jacobs, 2018, 2016-2017 Technical Works Program - Yeodene Swamp Study, 10 August 2018

La Trobe University, 2023, Big Swamp Paleoenvironmental Study, July 2023

Nation Partners, 2023, Ecological Risk Assessment Boundary Creek, Big Swamp and the Barwon River, July 2023

Appendix A – Boundary Creek Mobile Downstream Treatment System (Jacobs, 2023)

Boundary Creek Mobile Downstream Treatment System

Version: Final

Barwon Water

Boundary Creek and Big Swamp Remediation Plan
27 July 2023

Boundary Creek Mobile Downstream Treatment System

Client name: Barwon Water

Project name: Boundary Creek and Big Swamp Remediation Plan

Project no: IA296600

Project manager: Nicolaas Unland

Version: Draft

Prepared by: Tyson Fehring, Christeen Thamashi

Date: 27 July 2023

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Document history and status

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Draft A	8/6/23	First Draft Issued	NU/TF	NU/AC	GH	GH
Draft B	5/7/23	Second Draft	NU/TF	NU/AC	GH	GH
Final	27/7/23	Third Draft	NU/TF	NU/AC	GH	GH

Distribution of copies

Version	Issue approved	Date issued	Issued to	Comments
Draft A	Draft A	8/6/23	Barwon Water	
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Executive summary

In May 2018 Barwon Water commenced the development of the Boundary Creek and Big Swamp Remediation Plan that outlines the practicable controls and actions that have and will be implemented to achieve improved environmental outcomes for the areas along Boundary Creek where historical management of groundwater pumping activities resulted in material harm to the environment. This was subsequently implemented as part of the Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan (REPP) in February 2020 which flagged the need to develop a series of contingency measures to support the primary remedial actions, and mitigate against the potential high-risk events, should these persist following the implementation of the primary remedial actions.

In 2021 Jacobs designed a permanent downstream treatment system that could treat the water discharging from Big Swamp during periods of high acid load and in doing so, reduce the risk of fish kills in the Barwon River associated with this. The permanent system provided a somewhat conventional option for managing water quality, but also presented a number of risks and challenges including, but not limited to:

- Challenges in providing power supply
- Access and supply of fuel and reagent for plant operation
- Potential for unintended consequences associated with fuel or chemical spills or overdosing
- Commensurateness of the system in contrast to the risk profile
- Land ownership
- System maintenance and vandalism
- Accurately automating treatment
- Management of large volumes of flocculant/sludge build up over time

To overcome such challenges and risks, a mobile downstream treatment system that can be deployed for short periods of time when the Barwon River is at an increased risk of being impacted by acidic discharge from Boundary Creek has been designed, based on a trailer mounted system.

Following a review of acidic and metalliferous discharge from Boundary Creek, a series of hydrogeochemical simulations were undertaken. These indicated that during an acid flush event, treatment to a pH of 6.0 could reduce concentrations of dissolved aluminium from up to 10 mg/L to <1.2mg/L, while dissolved iron concentrations could be reduced from 110 mg/L to 2.5 mg/L. A subsequent workshop with Barwon Water operational staff and a review of potential treatment reagents, a series of design inputs were agreed including:

- The use of 30% NaOH to prevent on site freezing
- Dosing/storage volumes capable of providing between <50L a day to up to 1,000L a day to meet water quality objectives
- The ability to mobilise to site readily during high-risk periods at acceptable levels of risk to health, safety and the environment

In response to this, an 8" x 5" tandem trailer lined with a collapsible chemical bund, holding a 1 KL Intermediate Bulk Container (IBC) has been designed. The chemical trailer would arrive at site and discharge controlled NaOH via a Grundfos dosing pump. As a secondary control a Maric valve would be fitted to prevent an overdosing in Boundary creek. The peak flow rate is estimated to be 0.7 L/min (~1KL/day) and the creek treated over a 24 hour period. A small generator is required for the dosing pump and possible site lighting for night works.

At the completion of the discharge of the IBC, a self-priming pump would rinse the IBC, dosing pump and line to clear residual chemical in the system. A second chemical trailer with a full IBC would arrive on site to transfer over the dosing pump and continue treatment. The two trailers are proposed to alternate until the high risk period has ended.

A risk review was undertaken with Barwon Water to document risk and control measures.

During the review process an Ixom Cube trailer product was identified as an alternative chemical dosing trailer arrangement. This provides many common benefits, however, does require the IBC to be lifted into position on site, adding craneage process to the operational activities.

Important Note About Your Report

The sole purpose of this report and the associated services performed by Jacobs is to develop a concept design for a water dosing system to manage water quality in Boundary Creek in accordance with the scope of services set out in the contract between Jacobs and Barwon Water ('the Client'). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

The concepts developed here have been developed in workshops with the client and considering the stated client operational requirements.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Contents

Appendices

1. Introduction

1.1 Background

The Barwon Downs borefield was used intermittently to supplement conventional water supplies during dry periods between 1982 and 2016 in accordance with groundwater extraction licence(s). In June 2017, Barwon Water acknowledged that the historic management of these groundwater pumping activities had led to a reduction in groundwater contribution from the Lower Tertiary Aquifer into Boundary Creek, a tributary of the Barwon River. This reduction, in conjunction with the changes in land use, the Millennium Drought, and complexities associated with management and regulation of a private on-stream dam that controls flows into the lower reaches of Boundary Creek, resulted in the increased frequency and duration of 'cease to flow' and 'acid flush' events along Boundary Creek and Big Swamp – a wetland that is primary fed by inflows from Boundary Creek. This was despite meeting the provisions set out in the groundwater extraction licence(s) that were intended to offset the potential impacts from Barwon Water's groundwater pumping activities on Boundary Creek.

In May 2018 Barwon Water commenced the development of a Remediation and Environmental Protection Plan (REPP) which was subsequently implemented in February 2020, outlining the actions Barwon Water have and will implement 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 water quality and streamflow within Boundary Creek; and
- Improve the ecological values of Big Swamp

To help achieve this vision, potential risk-based contingency measures to minimise the potential for high-risk events (i.e. for acid flush events to negatively impact the Barwon River) were assessed by Barwon Water, including reducing the wet-drying cycles in Big Swamp and improving the condition and function of the swamp. In addition to this, an assessment was made as to the conditions under which the Barwon River may be at the greatest risk of negative impacts from acidic discharge from Boundary Creek. Subsequently, a permanent water quality treatment plant was designed to automatically adjust and maintain the pH of water discharging from Boundary Creek at times of high risk.

While the system provided a somewhat conventional option for managing water quality, a number of risks and challenges with a permanent treatment system were raised by key stakeholders, including, but not limited to:

- Challenges in providing power supply
- Access and supply of fuel and reagent for plant operation
- Potential for unintended consequences associated with fuel or chemical spills or overdosing
- Commensurateness of the system in contrast to the risk profile
- Land ownership
- System maintenance and vandalism
- Accurately automating treatment
- Management of large volumes of flocculant/sludge build up

To overcome such challenges and risks, Barwon Water are currently considering a mobile downstream treatment system that can be deployed for short periods of time when the Barwon River is at an increased risk of being impacted by acidic discharge from Boundary Creek.

1.2 Scope

The objective of this report is to provide a functional design for a mobile water quality dosing (treatment) system that is capable of being deployed temporarily on Boundary Creek during high-risk periods, to reduce the risk of fish kills in the Barwon River, by neutralising acidity in Boundary Creek during acid discharge events. It does so by:

- Assessing the requirements of the system to enable it to meet its objectives as well as considering any associated risks
- Providing a series of potential controls that could help to manage and mitigate such risks
- Using the above to develop a design basis for the system
- Presenting functional level design for such a system
- Considering any residual risks associated with such a system

2. Elements, risks and controls

This section documents the principles, assumptions, risks, and controls that a temporary dosing system needs to consider to meet its objective in way that is safe for both Barwon Water operational staff and the receiving environment. To do so, the section draws on previous work that has been completed to date, ongoing water quality monitoring, hydrogeochemical modelling simulations using the modelling package PHREEQC and the outcomes of an interactive two-hour workshop held between Barwon Water stakeholders and Jacobs staff. The purpose of the section is to provide sufficient detail to develop a design basis and subsequently, functional design for a temporary dosing system. The section considers six key elements/risks of the system including:

- Adequate treatment
- Overtreatment
- Timely mobilisation
- Flocculant formation
- Chemical spills
- Vandalism

2.1.1 Adequate treatment

2.1.1.1 Reagent selection

There are a variety of technical, environmental, commercial and operational factors (including occupational health and safety) to be considered when selecting the appropriate neutralants for a mobile downstream treatment system.

While a variety of neutralants are available for treating acidic and metalliferous drainage, the most common used for the active treatment of high loads of acidity and metals such as those associated with acidic discharge events from Boundary Creek (which monitoring indicates is typically 300-500 kg $CaCO_3$ equivalent per day following summer low flow conditions, see Appendix A) include:

1. Limestone – $CaCO_3$
2. Caustic Magnesia – MgO and/or $Mg(OH)_2$
3. Quicklime - CaO
4. Hydrated lime – $Ca(OH)_2$
5. Soda ash – Na_2CO_3
6. Caustic Soda - $NaOH$

Further details summarising these six neutralants is provided in Appendix B and below based on Earth Systems (2022), Jacobs et al. (2014) and Trumm (2010).

The soluble alkalinity of limestone and caustic magnesia (15-30 mg/L $CaCO_3$ equivalent for limestone and up to 500 mg/L $CaCO_3$ equivalent for caustic magnesia) exhibit practical limitations at the site. Use of these neutralants would require the additional supply of 1.5 to 30 ML/day of water to a treatment plant to meet peak acidity load demands. This is currently not considered feasible as the supply of such volumes of water to the site is impractical and would take potable water from townships such as Colac (which is not preferable). As such, limestone and caustic magnesia are not considered to be suitable for the proposed application.

The soluble alkalinity of quicklime is higher (1,750-2,500 mg/L $CaCO_3$ equivalent) and hence, water demands to meet peak acidity loads are more modest (~0.3 ML/day). However, the hydration process during the mixing of quicklime with water is highly exothermic and is sufficient to boil water under some circumstances, making it particularly difficult and dangerous to handle. As such, quicklime is not considered a suitable reagent.

Hydrated lime has a similar soluble alkalinity to quicklime (~1,750-2,500 mg/L $CaCO_3$ equivalent) and hence, similar water demands (~0.3 ML/day). However, contact between hydrated lime and atmospheric moisture can result in clogging in the dispensing mechanisms and lead to complete system failure. This could be particularly problematic during high-risk events when the delivery of neutralant is critical. The use of hydrated lime has been minimised by Barwon Water due to ongoing operational issues and as such, hydrated lime is not considered a suitable reagent.

Soda ash is often dispensed directly into water streams as either powder or briquettes via a gravity fed hopper. It has a soluble alkalinity of 425,000 mg/L $CaCO_3$ equivalent and hence, doesn't have any water demands to meet peak acidity loads. However, as soda ash absorbs moisture it can cause the powder or briquettes to expand and/or stick and clog the hopper leading to similar operational issues at hydrated lime. There is also risk of sodium toxicity associated with the use of soda ash which could impact upon the flora and fauna that the system is trying to protect.

Caustic soda has a similar soluble alkalinity to soda ash (~560,000 mg/L $CaCO_3$ equivalent) and is also dispensed directly into water streams (as a liquid) and hence does not have any water demands to meet peak acidity loads. It is recognised that due to its high soluble alkalinity, treatment using caustic soda can result in overtreatment, high pH values in the resulting waterway and elevated dissolved aluminium concentrations. As such, appropriate controls, failsafe's and operating philosophies need to be considered to mitigate these risks (these are discussed further in section 2.1.2).

Regardless, based on a review of the potential neutralants, caustic soda is considered to be the most suitable neutralant for the proposed treatment system. Noting that as with any alternate neutralant, appropriate risk mitigation measures need to be in place to manage the potential risks. One of these such considerations is the concentration of NaOH to be used. Barwon Water operational staff have indicated that storage of 30% wt NaOH under site conditions in the Barwon Downs region has successfully avoided increased viscosity and potential flow/clogging issues.

Given the above, 30% wt NaOH is considered to be the most suitable neutralant for the treatment system.

2.1.1.2 Dosing rates and storage

As discussed by Jacobs (2021), the greatest risk of a fish kill event in the Barwon River occurs:

1. Following an extended period of flow cessation in Boundary Creek (>4 months) when acidity and metals have accumulated in Big Swamp
2. Flows in Boundary Creek represent a relatively high portion of flow in the Barwon River (modelling suggests this is when greater than 40% of the total flow at the confluence between Boundary Creek and the Barwon River is derived from Boundary Creek).

Detailed monitoring of water quality was not undertaken along Boundary Creek or the Barwon River in 2016 during the only confirmed fish kill event. However, such monitoring was undertaken downstream of Big Swamp during April and May 2020 following a period of ~1 month of effective flow cessation (when discharge from Big Swamp was ≤0.1 ML/day). During this period, surface water pH was 3.3, dissolved aluminium concentrations ranged from 6-10 mg/L and dissolved iron concentrations ranged from 7 to 110 mg/L. Accordingly, based on the available monitoring data set, these conditions most closely represent an acid flush event under which the Barwon River would be at risk of a fish kill event and thus, provides the best basis for assessing potential treatment rates. Flows have been maintained through Big Swamp since 2020 resulting in a general increase in pH and decrease in dissolved aluminium concentrations and as such, subsequent water quality monitoring is unlikely to represent those similar to acid flush events (see Appendix A).

It is envisaged that the specific pH target adopted for treatment would need to balance its objective (of mitigating the risk of a potential fish kill events) against the risk of overtreating, and driving potential negative environmental effects associated with high pH values and elevated dissolved aluminium concentrations (discussed further in section 2.1.2 below). In this sense, a target treatment pH range of 5.5-6.0 would both significantly mitigate the risk of a fish kill event (which haven't been recorded in this pH range) while limiting the risk of over treating.

Accordingly, trends in surface water pH in Boundary Creek following the addition of NaOH, based on the surface water quality monitored in April and May 2020 at gauge 233276 have been illustrated in Figure 2-1 and Figure 2-2 below. The surface water pH was modelled in PHREEQC and is based on the same assumptions adopted in Jacobs (2021). The exception to this is the concentration of NaOH adopted in the model simulations below, were assumed to be 30% by weight, whereas the Jacobs (2021) modelling assumed a concentration of 40% by weight. This modification has been made following feedback from Barwon Water operation staff discussed in section 2.1.1.1 above.

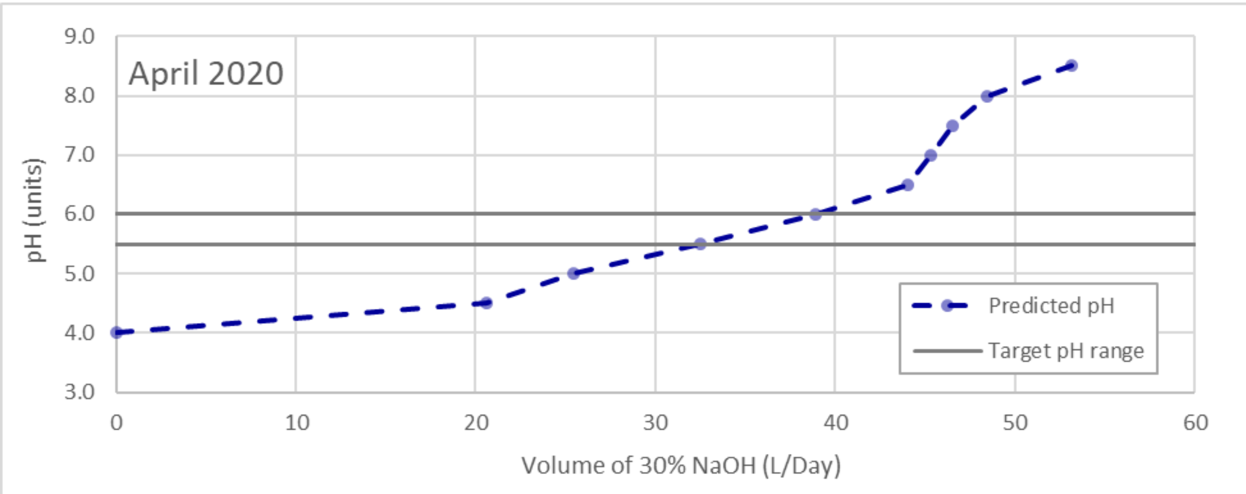


Figure 2-1 Resulting surface water pH following addition of 30% NaOH to surface water discharging from Boundary Creek (based on water quality monitoring in April 2020 at 233276)

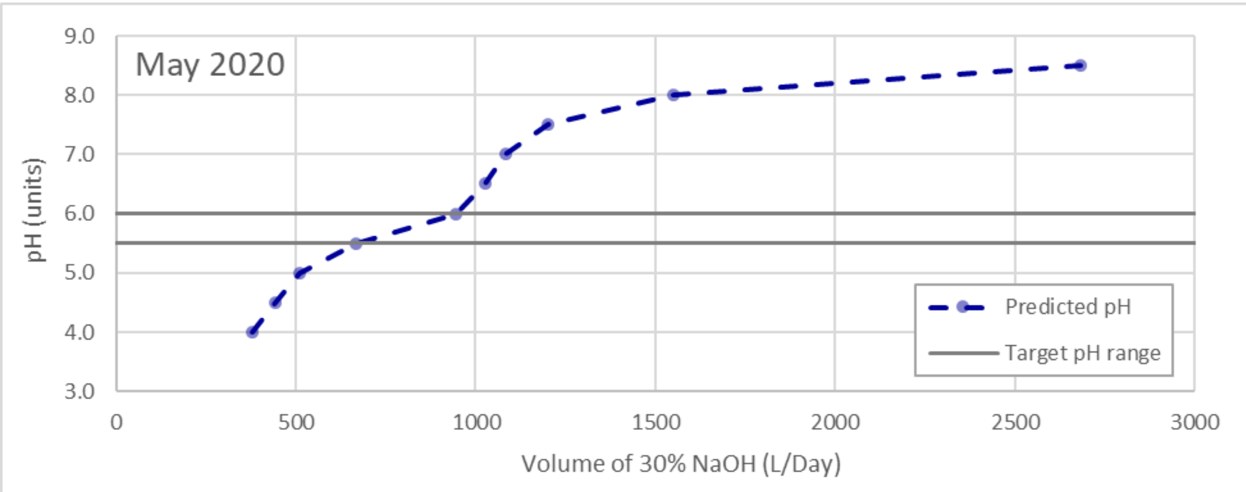


Figure 2-2 Resulting surface water pH following addition of 30% NaOH to surface water discharging from Boundary Creek (based on water quality monitoring in May 2020 at 233276)

The modelling indicates that under conditions such as those observed in April 2020 (0.06 ML/day immediately following flow cessation), the addition of <50 L/day of 30% NaOH would be capable of achieving target water quality objectives, while up to 945 L/day of NaOH would be required to meet target objectives under conditions like May 2020 (when flows increased to 5.3 ML/day).

Following the modelling described above, treatment to a pH of 6.0 is predicted to reduce the concentration of aluminium in surface water from 10 mg/L to 1.2 mg/L assuming conditions similar to April 2020, and from 6.3 mg/L to 2.0 mg/L assuming conditions similar to May 2020. Likewise, the predicted concentration of iron is predicted to fall from 110 mg/L to 2.5 mg/L assuming conditions similar to April 2020, and from 7.5 mg/L to 4.0 mg/L assuming conditions similar to May 2020.

In summary, to achieve the water quality outcomes described above:

- the system would need to be capable of storing 945 L of 30% NaOH for each day of operation
- the system would need to be capable of regulating treatment rates to manage both lower loads of acidity (<50 L/day of 30% NaOH) and higher loads of acidity (~945 /day of 30% NaOH)

Given the above, the supply of up to 945 L of 30% NaOH per day could be provided by a single Intermediate Bulk Container (IBC) with a 1,000 L capacity provided it was able to be replaced on a daily frequency. These would be pre-packaged and delivered by chemical suppliers to a nominated Barwon Water location to enable timely mobilisation to site (this is discussed further in section 2.1.3).

2.1.1.3 Monitoring and management

While the above modelling provides the current best estimate of the storage volume and treatment rates required for the system to meet its objective, it is also likely that the specific conditions during any actual event in Boundary Creek (i.e. flow, water quality and the load of acidity) will be variable. As such, there is a need for monitoring, in addition to the existing network, to evaluate the required treatment rates and the water quality outcomes during treatment.

Following a workshop including Barwon Water operational, environmental, and occupational health and safety staff, a monitoring program consisting of a combination of automated pH monitoring, spot pH monitoring, field titrations and detailed water quality sampling and analysis by a NATA accredited lab was considered to provide sufficiently rigorous monitoring to mitigate the risks associated with treatment rates.

Prior to treatment, a field titration of water collected downstream of Big Swamp (gauge 233276) would be undertaken by field staff and multiplied by the real time measured discharge rate at gauge 233276 to calculate the current load of acidity being discharged to Boundary Creek. This would be used to estimate the initial maximum treatment rate. Subsequently, 30% NaOH would be added to the constructed drain at the eastern end of Big Swamp (to achieve a degree of mixing prior to entry into Boundary Creek – see further discussion in section 2.1.2 below). The dosing rate would then be increased towards the estimated maximum rate until a pH of 5.5-6.0 is achieved at gauge 233276. This would be monitored by the automated pH logger at gauge 233276 and verified by operational staff on site using a portable calibrated pH probe.

Once the treatment rate has been established and the target pH has been achieved, additional sampling downstream of gauge 233276 is to be undertaken by operational staff 2 to 3 times daily ideally, but at least once daily during the dosing (treatment) activity and subject to field titration to assess the resulting acidity/alkalinity of the surface water following treatment. This would be used to inform any necessary adjustments to treatment rates. The sample would be collected across the water column, mixed, and rested to (1) ensure the sample was representative of the water column as a whole; (2) to allow acid base reactions to proceed; and (3) ensure the sample was well mixed prior to titration.

Automated pH monitoring will continue at Yeodene (gauge 233228) and at the Barwon River downstream of its confluence with Boundary Creek (gauge 233233). These monitoring points will provide feedback as to the water quality responses downstream of the treatment location as mixing and acid-base reactions proceed in stream. Automated pH monitoring at all gauges will be spot checked by Barwon Water operational staff prior to treatment and, if found to be out of calibration, Australian Laboratory Services (ALS) will be notified and the automated probes re-calibrated. It should be noted that Barwon Water haver a direct data feed from the automated monitoring stations and are not reliant on other websites such as the Water Measurement Information System.

In addition to the above, a field trial would be undertaken prior to the mobilisation of the system during a high-risk event. The trial would be undertaken for three key reasons. Firstly, to train operational staff in the use and implementation of the system. Secondly, to ensure that the system is functioning as intended, such that modifications can be made as required for it to meet its objective. Thirdly, it will allow the above approach to be tested and if necessary re-calibrated (for example, if water quality outcomes are being met at the dosing location but not further downstream, or vice versa). It is recognised that all acid flush events will be in some way unique, however a trial would in the least provide additional information and help guide expectations on water quality responses downstream of the treatment location.

During the field trial, daily sampling and detailed water quality analysis (major ions, total and dissolved metals, nutrients, field water quality parameters, acidity/alkalinity) would also be undertaken at gauging locations by a NATA approved laboratory during treatment to enable a full assessment of water quality outcomes following treatment.

The proposed treatment and monitoring locations have been illustrated in Figure 2-3 below.

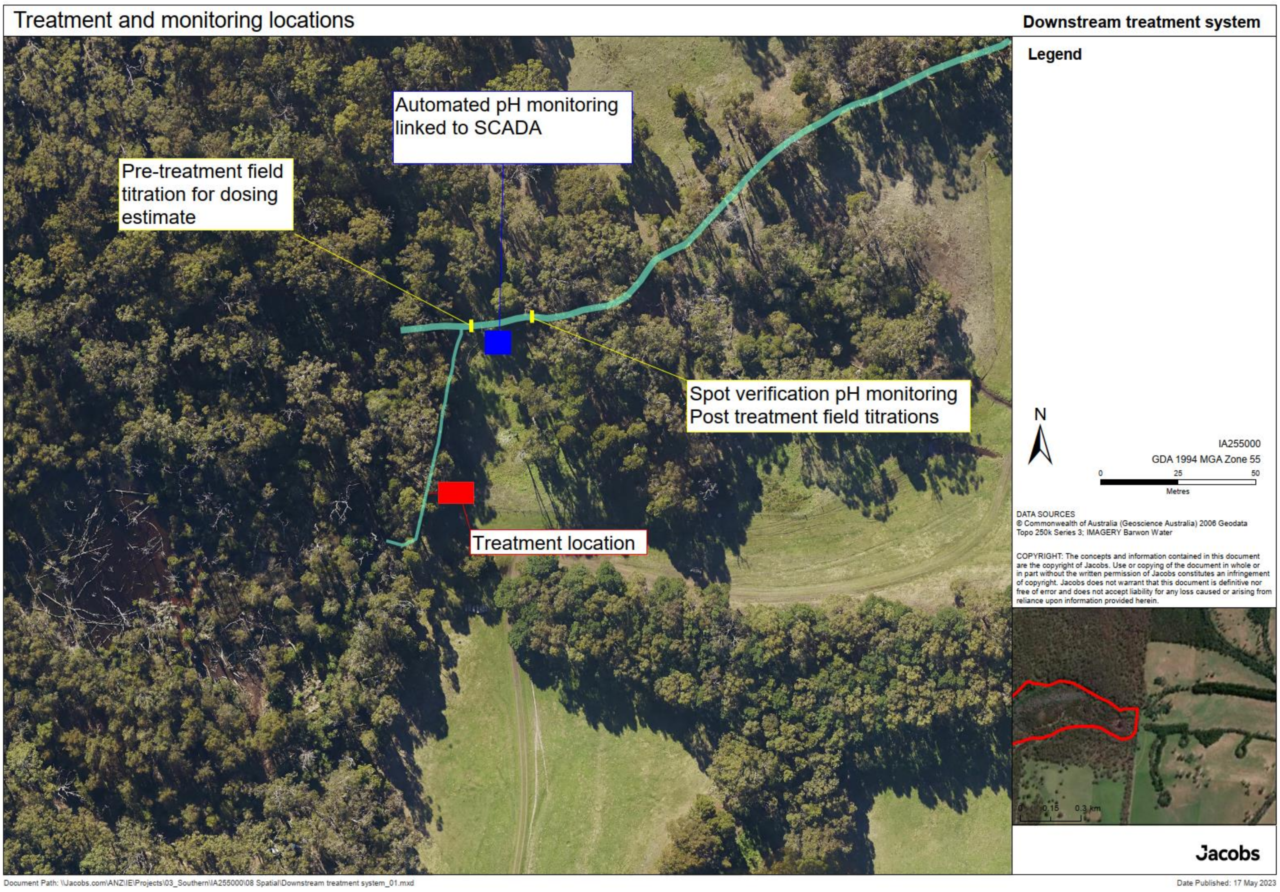


Figure 2-3 Location of treatment and monitoring locations

As water quality, flow and acid loads in Boundary Creek will vary over time, it is important to be able to adjust dosing rates to meet water quality outcomes. Barwon Water have staff on call who can mobilise to site within 30 minutes to adjust dosing rates as required to achieve desired water quality outcomes. To achieve this, SCADA systems can be alarmed to notify operational staff when the system is not achieving its intended objective, such that staff could mobilise to site. The SCADA triggered alerts could be linked to all three automated pH loggers (at gauges 233276, 233228 and 233233) as well as a pressure sensor installed within the NaOH storage container (to indicate if blockages were apparent) so that staff could mobilise to site and adjust rates or clear blockages if the system was not achieving its objective.

2.1.2 Over treatment

As discussed above, there is a potential for over treatment to result in negative environmental effects associated with high pH values and increased dissolved aluminium concentrations in receiving waterways (which occur at pH values greater than 8.5). A primary mechanism to help mitigate this risk is the target pH proposed (5.5-6.0) which inherently mitigates against over treating (i.e. even if mixing and acid base reactions have not proceeded to completion downstream of the dosing point, at gauge 233276, the target pH of 5.5-6.0 will mitigate the potential for reaching a pH end point of >8.5 further downstream).

In addition, the proposed storage volume and treatment capacity (~1000 L/day) are estimated to reach a maximum pH of <7 under conditions similar to May 2020 and therefore, provide an additional control for over treatment. In this sense, the risk of over treating is likely to be greatest in the early stages of treatment. As discussed above, the maximum initial treatment rates could be estimated via field titration and flow monitoring, which would mitigate against over treating during the initial stages of treatment. Further, given staff would be on site and actively monitoring water quality responses during the initial stages of treatment, this risk would be further mitigated.

The monitoring and management activities described in section 2.1.1.3 would also mitigate the risk of over treating via a combination of:

- Automated pH monitoring at gauge D/S of Big Swamp (233276), Yeodene (233228) and Barwon River D/S Boundary Creek (233233).
- Spot pH probe measurements at gauge D/S of Big Swamp (233276) to confirm automated measurements.
- Field titrations on grab samples D/S of Big Swamp (gauge 233276) at least once daily
- Daily sampling and detailed water quality analysis during a field trial (major ions, total and dissolved metals, nutrients, field water quality parameters, acidity/alkalinity) at Yeodene (233228) and the Barwon River D/S Boundary Creek (233233)

The completion of a field trial prior to the mobilisation of the system during a high-risk event will also allow the above approach to be tested and if necessary re-calibrated (for example, if water quality outcomes are being met at the dosing location but result in elevated pH outcomes further downstream). Again, it is recognised that all acid flush events will be in some way unique, however a trial would in the least provide additional information and help guide expectations on water quality responses downstream of the treatment location.

As water quality, flow and acid loads in Boundary Creek will vary over time, it is important to be able to adjust dosing rates to meet water quality outcomes. Barwon Water have staff on call who can mobilise to site within 30 minutes to adjust dosing rates as required to achieve desired water quality outcomes. To achieve this, SCADA systems can be alarmed to notify operational staff when the system is not achieving its intended objective, such that staff could mobilise to site. The SCADA triggered alerts could be linked to all three automated pH loggers (at gauges 233276, 233228 and 233233) as well as a pressure sensor installed within the NaOH storage container (to indicate if dosing rates were being exceeded) so that staff could mobilise to site and adjust in the event that the system was exceeding its target pH outcome.

While the above provides a series of controls for overtreating the water moving through Boundary Creek as a whole, there remains a potential risk that treatment will result in highly alkaline conditions in the zone immediately downstream of the treatment location. To mitigate this risk, the dosing location proposed is the man-made drain to the east of Big Swamp, to allow a degree of mixing prior to the discharge of alkalinity to the main section of Boundary Creek. In addition, a spreader hose system has been proposed to diffusely discharge 30% NaOH across the drains width and increase mixing at the point of treatment. It should be noted that this risk may not manifest and as such, will be re-evaluated following a field trial. If it is manifest, appropriate triggers for dosing cessation or reduction will be put in place at SCADA linked gauges once the alkaline mixing zone is established during a field trial.

2.1.3 Timely mobilisation

This section considers the need for the system to be mobile, for it to be ready and deployed in time to treat an acid flush event and for site conditions to be suitable for deployment. For each of these aspects, considerations are given below to both the safety of workers during the transport of the system as well as the receiving environment.

2.1.3.1 System transport

As indicated above, the system needs to be mobile and safe to transport to site. To achieve this, a dual axle trailer would improve the stability of a 1,000 L capacity (internally bunded) container of 30% NaOH during transport. Staff would need to be trained in the use of 4x4 (4WD) vehicles off sealed roads and tandem trailer towing at a maximum of 3 tonne capacity. The container would need to be easily mounted and fixed to the trailer for stability and limit movement or sliding of the container on the trailer. This could be further improved by relocating the trailer tie-down points closer to the IBC to improve stability and security during transport.

The potential for liquid displacement within the container during transport would need to be considered and a baffle may be needed to be considered for safe transport of a partially full container. Prior to demobilisation of the system, the container would be fully discharged to the creek to prevent driving hazards associated with liquid displacement in a partially full container during demobilisation. If necessary, this could be done at a reduced rate over a period of time to match the recession of the flush event following peak loads.

Given the system capacity is estimated to be ~1,000 L and that treatment rates may be up to 1,000 L/day, two trailer mounted systems would be required and interchanged (potentially daily) to ensure near constant treatment during a flush event.

The trailer would be fitted with collapsible bunding to mitigate the risk of NaOH spills to the receiving environment during transport, with additional bunding surrounding the dosing location to limit potential spills during treatment. In addition, prior to demobilisation, any hosing used during treatment would be flushed into the creek with a small volume of water stored on site or via a self priming pump, to limit spills during demobilisation and subsequent transport. Chemical spill kits would also be transported in vehicles to help manage chemical spills in the event that they were to occur.

The condition of the trailer and treatment system would need to be regularly checked and maintained to ensure that they are safe to transport in the occurrence of an acid flush event. All staff would need appropriate materials handling training and PPE to ensure staff safety during transport and treatment. In addition, 30% NaOH is regarded as a Hazard Class – 8, Un Number – UN1824, Packing Group – II, which for 1,000 L volumes requires placarding under the Dangerous Goods (Storage and Handling) Regulations. However, these would already likely to be attached to the IBC provided by the supplier. A dangerous goods drivers licence is not required to transport 1,000 L of dangerous goods, however may be required for the loading/unloading and discharge to the creek.

2.1.3.2 Site access

A suitable treatment location needs to be established and maintained to enable timely treatment in the occurrence of an acid flush event. An indicative treatment location has been illustrated in Figure 2-3 above and on this basis, would require:

- An agreement with the landowner
- The establishment and maintenance of access tracks suitable for a trailer mounted treatment system
- The establishment of a treatment location (such as a crushed rock pad) with a sufficient turning circle for a vehicle and trailer, that is accessible during a high rainfall event

It is also noted that once track and treatment locations are determined, the need for approvals (such as planning, environmental and cultural heritage) as well as any offsets for any vegetation removal will require assessment.

2.1.3.3 Mobilisation process

To ensure that the system could be deployed in time to treat an acid flush event, a tiered preparatory and alert response is proposed. A review of rainfall at gauge 233250 (approximately 6 km south of Boundary Creek) and flows in Boundary Creek at gauge 233228 between 2000 and 2020 indicates that on average, an accumulative rainfall of ~40 mm over 5 days is sufficient to return flows to the creek following a period of extended cessation. On this basis and that described above, an indicative outline of a tiered preparatory and alert response has been provided below:

1. **Planning Trigger**: Streamflows at 233228 <0.1 ML/day for greater than 6 weeks → staff notified to verify flows, conduct pre-operational checks and liaise with chemical supplier.

2. **Mobilisation Trigger**: Streamflows at 233228 <0.1 ML/day for greater than 3 months, **and** >40mm rainfall is forecast within 5 days **or** flows >0.5 ML/day recorded at 233228.

3. **Dosing Trigger**: pH readings <4 recorded at 233228 are confirmed via field readings **and** Boundary Creek is contributing >35% flows into the Barwon River (based on flow measurements from 233228 and 233233)

In addition to the above, there would need to be a trigger point at which it becomes reasonable to de-mobilise from site. Based on the above discussion, an indicative outline of this has been provided below:

4. **Cease treatment trigger:** pH readings upstream of the dosing plant are >5 or Boundary Creek is contributing <35% of flows into the Barwon River.

A review of streamflow monitoring and the relative proportion of flow from Boundary Creek to that in the Barwon River at their confluence since 2020 has been undertaken following the process outlined in Jacobs (2021). This indicates that when flows from Boundary Creek exceed 35% of those in the Barwon River, such conditions persist for 6 days on average, with 95% of such events lasting 16 days. This indicates that a typical treatment duration would last 6 days, thought significant events at the 95th percentile may last 16 days.

2.1.4 Flocculant formation

During treatment, there is a risk of enhanced floc formation in the water column. While this occurs currently via passive neutralisation along the Barwon River, there is a risk that treatment will result in a more concentrated plume of floc in Boundary Creek prior to discharge into the Barwon River. This could result in negative impacts on aquatic species in the Barwon River related to the clogging of fish gills and reduced photosynthesis (though it is worth noting that there is likely to be a net benefit when compared to the acute toxicity of highly acidic water discharging to the Barwon River).

Regardless, this remains a risk worth both considering and controlling. Firstly, the potential for enhanced floc formation could be assessed during a trial prior to the deployment of the system during an acid flush event. Following this, in the event that this risk appears to manifest, a silt curtain could be deployed in Boundary Creek during treatment to limit the capacity for floc to impact on the Barwon River.

In addition, if floc formation does appear significant, then there is a potential for the floc to settle along the streambed of Boundary Creek (both naturally along the creek and at the location of the sit curtain if it is deployed). This may then represent a source of aluminium and iron which could re-dissolve into the water column if acidic discharge from Big Swamp returns after a flush event once treatment has ceased. To mitigate this, a vacuum truck or excavator could be deployed to areas of key floc deposition (most likely concentrated at the silt curtain or the weir at the Yeodene flow gauge) to remove the floc for disposal at a suitable premises.

2.1.5 Chemical spills

There is a risk of the leakage of reagent from the system during treatment and system changeover which could result in negative impacts on the local soils, vegetation and waterways (i.e. Boundary Creek). These risks would range from low for minor leakages and local soil contamination to medium for greater leakages that could drain into Boundary Creek (this is discussed further in section 6).

To mitigate this risk, the trailer will be bunded so that any leakages from the container or hosing connections inside the trailer would be retained in the trailer. Additional bunding could be erected around the treatment area and turn-around as a failsafe in the event that leakages were not contained within the trailers bunding. In addition, the treatment area and turn-around could be underlain by geofabric to limit potential contamination of natural soils at the treatment site. Hosing and cam locks would also be replaced seasonally to reduce the risk of leakages from hosing or fittings.

Closing both the containers lid and hosing values would reduce the risk of spillage during system swap over. In addition, the hosing would remain fixed during the changeover of trailers to limit the potential of soil contamination associated with hosing roll out. The system would be monitored daily for potential leakages and hosing and cam locks could be replaced if required.

In the event of a spill, the treatment location and turn-around materials would be tested for NaOH contamination prior to decommissioning and return of site to the landholder to inform appropriate disposal of material, and the hosing would be flushed with a small volume of water (~20 L) prior to demobilisation to remove any residue from the system and prevent any leakage during transport.

The spillage of 30% NaOH also presents a risk to worker health and safety. As such, workers would need to be appropriately trained in chemical handling and wear appropriate PPE. Additionally, in accordance with the Globally Harmonised System/Australian Dangerous Goods (GHS/ADG) guidelines and safety data sheet for 30% NaOH, an eyewash station and safety shower must be close to the workstation location. This would necessitate the transport of a portable safety shower and eye wash station compliant with AS4775 to site at the beginning of treatment. In addition, a trailer mounted water cart would need to be hired and transported to supply the safety shower at the beginning of treatment.

2.1.6 Vandalism

There is a risk that vandalism of the chemical storage or hosing could result in the spill of NaOH into the surrounding environment or waterway. Temporary lockable fencing could be erected around the site and locked during non-daylight ours to restrict access to the treatment system, as could access gates along tracks leading to the site. In addition, motion and video sensors could be set up on site to alarm operational staff of unauthorised access, which would allow police and operational staff to mobilise to site if trespassers are present. Further, the SCADA linked pressure sensors in the container would notify operational staff of a leakage and allow mobilisation to site to manage the leakage on site.

Further to the above, additional on-site controls could be put in place to mitigate against spills in the event that vandalism did occur, including:

- Bunding around the system to prevent off site contamination if the chemical storage was vandalised
- Bunding around hose line to prevent off site contamination if the hosing line is vandalised
- Limitations on dosing pump and maric valve to mitigate over-dosing in the event of vandalism to flow controls

3. Design Basis

Following from the above, the basis of design for the mobile dosing trailer includes the following aspects. This aligns with Barwon Water's operational requirements and site conditions to pH adjust expected flows. These aspects are listed in Table 3-1.

Table 3-1 - Basis of Design Summary

Item	Value	Reference
Volume	1,000L	1,000L align with Intermediate Bulk Container (IBC) volumes that are easily supply from Barwon Water
Dosing Rate	0.7 L/minute 1KL/day	The estimated dosing rate may vary with an upper flow rate of 0.7 L/min subject to pH level and stream flow. Needs to be capable of ceasing dosing once pH >5 or proportion of flow (<35%) triggers reached.
Chemical Reagent	Caustic Soda 30% Sodium Hydroxide (NaOH)	Caustic Soda (AKA - Sodium Hydroxide) (NaOH) is the proposed pH correction chemical to be used due to is common use with Barwon Water. The concentration is proposed to be 30% W/W to minimum risk of freezing, if used during cold periods.
Trailer Size	5"x8" Tandem Trailer	5"x8" (1500mm x 2400mm) Tandem Trailer is to provide to provide suitable site for the IBC and stability for transport to site of the required volume.
Dosing Location	Big Swamp upstream of V Weir	The chemical dosing point is proposed to be the drainage channel downstream of Big Swamp, before the confluence with Boundary Creek, upstream of the V notch weir. This provides a direct contact with expected low pH flows with an existing mixing location with the weir.
Access Path	Newly constructed Gravel Road	Refer to drawing set to indicate the extent of the proposed new access road to the dosing location. This provides for forward delivery to site without need for reversing.
Access Road Standard	Gravel access road	Refer – Typical Road Profiles Rural - IDM SD 600 – Gravel Road
Operational Duration	24 hours a day for a period of up to 16 days	The 1,000 L volume is estimated to provide a 24 hours chemical dosing supply per day. Typical events may require 6 containers but up to 16 containers may be required for a significant event. Need to account for 16 containers changed over daily.
Flow Control	0.7 L/min	A maric valve is proposed in addition to the dosing pump to prevent overdosing and discharge.

Further to the design basis information listed in Table 3-1, the following standards, act and codes are thought to be relevant to this project.

- Victorian Dangerous Goods Act 1985
- Victorian Dangerous Goods (Storage and Handling) Regulations 2022
- Victorian Road Vehicles Standards Act 2018
- VicRoads – Vehicle Standards Bulletin VSB1 – Revision 5
- Victorian Occupational Health and Safety Act & regulations
- Barwon Water – Polices and Procedures.

4. Design Summary

The initial design assessment of the chemical dosing trailer is to provide a, safe, robust and cost effective solution to mitigate against the potential for fish kill events to occur as a result of first flush events in Boundary Creek. The preliminary design shown in Figure 4-1, provides for the normal use of a 5" x 8" tandem trailer with the Barwon water operational team (further drawings are shown in Appendix C). It should be noted that the feasibility of the system is subject to assessment (taking into account technical, logistical, financial, stakeholder, timing and sustainability factors) which may preclude the commissioning of the system even if technically capable of meeting requirements.

In the event of a call out for pH correction, a flexible portable spill containment bund would be placed within the trailer, an IBC with caustic soda would be loaded and tied down for transport. The dosing would be via fitted pipework using a Grundfos dosing pump to provide a control constant flow of reagent. To further prevent an overdose risk a Maric flow control valve would be fitting to avoid a flow greater than 0.7 L/minute from entering the Boundary creek.

The dosing pump would be powered via a small generator on site that would further aid in operation site needs that may include lighting.

This modular approach is to provide an appropriate balance with infrequency of events, with having the equipment able to be used for secondary purposes.

At the completion of the discharge of the IBC, a self-priming pump would rinse the IBC, dosing pump and line to remove residual chemical from the system. The self-priming pump is not shown in the drawings. This is assumed to be a flexi drive pump or similar that could be provided by the operational team or hired as required. A second chemical trailer with a full IBC of sodium hydroxide would arrive on site if necessary to transfer over the dosing pump, assemble, and continue treatment flows. The two trailers are proposed to alternate until the acid discharge conditions return to acceptable conditions.

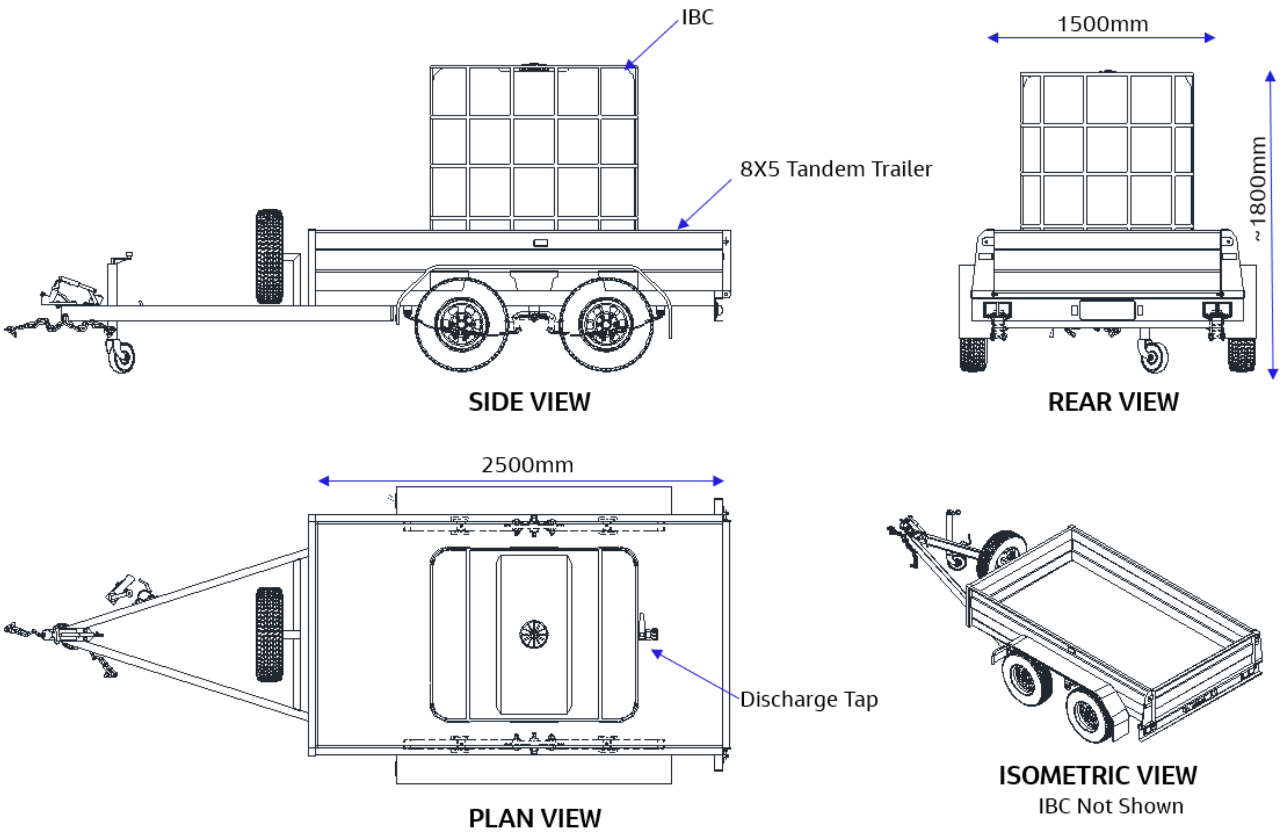


Figure 4-1 - Dosing Trailer General Arrangement

During the review process of the dosing trailer, the IXOM Trailer Cube was identified as an off the shelf alternative solution to the preliminary trailer design. The Trailer Cube™ is an innovative product developed by Ixom for the safe, reliable and mobile dosing of IBC packaged chemicals. The Cube™ is fully mobile and includes a sealed containment bund, day tank and dosing pump skid assembly. Ixom's Trailer Cube™ is designed and manufactured in Australia using components from industry leading brands such as Grundfos, Georg Fischer and Endress+Hauser.

The Cube trailer however is unable to be transported with an IBC. The IBC needs to be loaded into the trailer once positioned on site. This could be done with a crane truck of forklift. This additional lifting required does add additional equipment to the site, along with risk of lifting the IBC into the trailer for ongoing dosing activities, though means that a second trailer would not be required. In addition, the Ixom cube trailer may not be suitable for a gravel

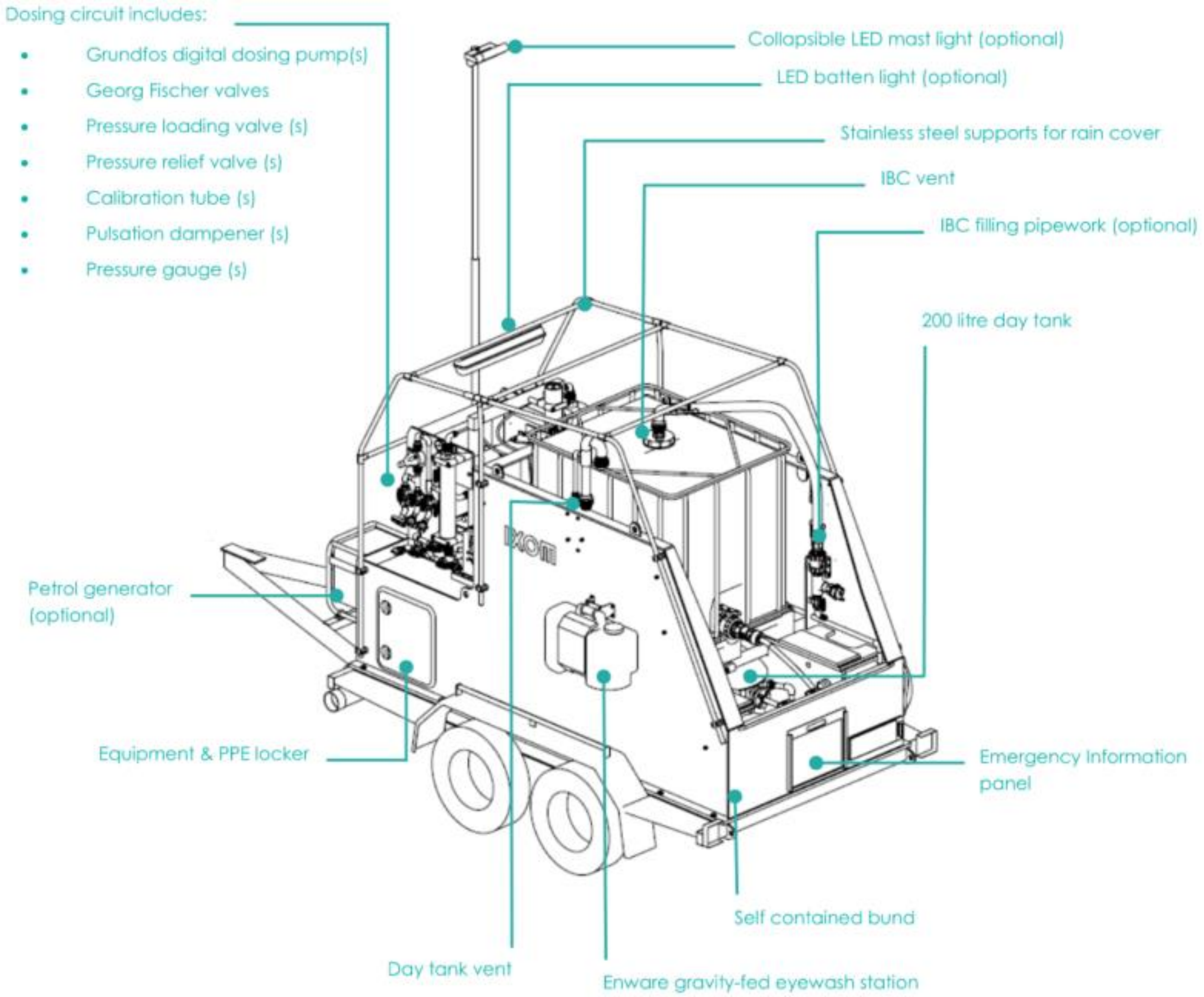


Figure 4-2 - IXOM Trailer Cube General Arrangement

Figure 4-3 - Photographs of IXOM Trailer Cube

The IXOM trailer cube has been designed to use Sodium Hydroxide chemical and provides a comprehensive solution with the capacity to tailor aspects to Barwon Water's needs.

Refer to Appendix D for IXOM trailer cube information.

4.1 Site Works and Preparation

The access for the chemical trailer does require an all-weather access road. Shown in Figure 4-4 is the proposed extension of the access road to the Big Swamp, Boundary Creek junction. The proposed road loop provides a turnaround point and eliminates the need for reversing trailers into position for discharge or change over. The establishment of the access road is required well in advance of the use of the chemical trailer.

Following chemical dosing, enhanced flocculation may occur in Boundary Creek. As shown in Appendix C design drawings. A floating silt curtain may be required to retain sludge for removal with a vacuum truck, as required.

Figure 4-4 - Big Swamp Access Road for Chemical Dosing

4.2 Preliminary Costing

The estimate project cost of the IBC mounted chemical trailers and safety shower, excluding the access road, are $75,000.00 excluding GST. A full breakdown of these costs is summarised in Table 4-1 below. This may vary depending on the suppliers used and if additional features are required to meet Barwon Water requirements. It is noted that the cost to hire a safety shower and transport it to/from site for a 14 day period is approximately $5,250.00 an may provided a cheaper alternative for Barwon Water if the safety shower would not be used on other sites and only infrequently as part of the treatment program.

The proposed access road has not been included in the cost estimate below as the volumes, type and materials to be used are not known.

At the time of reporting, cost estimates were not available for the IXOM trailer cube, but they are understood to cost approximately $80,000 each for the trailer only, subject to selected options and final agreed arrangement.

Table 4-1 - Preliminary Cost Estimate for two 5 x 8 Tandem Trailers

Item	Description	Comment	Cost
1	2 x 8" x 5" Tandem box trailer	All materials, spare wheel and registration ($7,060.00)	$14,120.00
2	2 x Collapsible Sidewall Portable Bunding	$1,500.00 each	$3,000.00
3	2 x IBC	Sourced from chemical supplier, replaced as required	$2,000
4	Grundfos DDE 60-10 Dosing Pump		$4,649.00
5	DeWalt 8.2kVA Petrol Generator		$2,985.00
6	Pipeline, valves and fit out materials	Allowance (may require replacing seasonally)	$2,500.00
7	Silt Curtain Class 1 (Non Tidal) 1m Skirt (20m section)	May require replacing seasonally	$1,028.50
8	Labour Allowance for Equipment Assemble, fitting and testing	This may be done by Barwon Water Ops team	$5,000.00
9	Portable safety shower[1]	Transport and filling costs not included	$26,000.00
10		Sub Total	$61,282.50
11		Contingency 20%	$12,256.50
12		Budget Estimate	$73,539.00
13		Rounded	$75,000.00

[1]Portable safety shower hire has been quoted at $75/day, + $280 for cleaning and $1,950 per delivery/return (~$5,350 for a 14 day treatment period)

5. Safety in Design

5.1 Introduction

Eliminating hazards at the design or planning stage is often easier and cheaper to achieve than making changes later when the hazards become real risks in the workplace.

Safe design can result in many benefits, including:

- more effective prevention of injury and illness
- improved useability of structures
- improved productivity and reduced costs
- better prediction and management of production and operational costs over the lifecycle of a structure
- innovation, in that safe design can demand new thinking to resolve hazards that occur in the construction phase and in end use.

Design, in relation to a structure, includes the design of all or part of the structure and the redesign or modification of a design. Design output includes any hard copy or electronic drawing, design detail, design instruction, scope of works document or specification relating to the structure.

5.2 What is safe design

Safe design means the integration of control measures early in the design process to eliminate or, if this is not reasonably practicable, minimise risks to health and safety throughout the life of the structure being designed. The safe design of a structure will always be part of a wider set of design objectives, including practicability, aesthetics, cost and functionality. These sometimes competing objectives need to be balanced in a manner that does not compromise the health and safety of those who work on or use the structure over its life.

- Safe design begins at the concept development phase of a structure when making decisions about:
- the design and its intended purpose
- materials to be used
- possible methods of construction, maintenance, operation, demolition or dismantling and disposal
- what legislation, codes of practice and standards need to be considered and complied with.

From the risks identified, the chemical dosing trailer have documented with potential controls. The residual risks are noted in section 6 to inform the Barwon Water operational team of residual risks that could not be eliminated during the design process.

6. Residual risks

Table 6-2 below summarises risks that were identified during the design process but have not been able to be addressed by the design. In the table below, those risks that are either not addressed by the design or only partially addressed are listed. A set of indicative controls based on discussion with Barwon Water operational staff have been listed with the revised residual risks also outlined. The risks have been based on the matrix described in Table 6-1. Accordingly, based on the discussion presented in section 2, all residual risks can be mitigated to low except for vehicle accidents and under dosing, which remain medium.

With regards to the former, this is because a vehicle accident carries the potential for a fatal collision, even if rare. With respect to the latter, this is due to uncertainty in the chemical composition of water discharging from Big Swamp following extended flow cessation, which has yet to be characterised in detail. Given this, there is an unlikely chance of the dosing system being able to meet peak acid loads during an acid flush event (though this likelihood is significantly reduced from current conditions).

Table 6-1 Risk assessment matrix for determining residual risks

Risk Matrix							
			Consequence				
	HSE		1 - First aid treatment; minor environmental impact with localised effects, immediate remediation	2 - Medical treatment required; Moderate environmental impact with local effects, short term remediation	3 - Serious injury requiring urgent treatment. Significant environmental impact and remediation	4 - Permanent and serious disablement; significant offsite impact. Major environmental impact and long-term remediation	5 - Fatality. Major environmental impact, full remediation not possible
	Environment/Community		1 - Onsite release, containable with minimal damage. Localised impact on energy usage. 1- Workforce concern	2 - Major onsite release with some damage, no offsite damage. Numerous and/or widespread but small-scale impacts on energy and waste. Remediation in terms of days. 2 - Local community concern	3 - Offsite release, no significant environmental damage. Remediation in terms of weeks. 3 - Regional concern	4 - Major offsite release, short to medium term environmental damage. Remediation in terms of months. 4 - Widespread reputation loss to single business unit, widespread community outcry.	5 - Major offsite release, long term environmental damage. Remediation in terms of years. 5 - Widespread reputation loss to more than one business unit, extreme community outcry nationally.
	Reputation		1 - No media coverage; localised community concern involving landholders or residents	2 - Local media coverage; local community concern with collective action	3 - Regional media coverage; Regional community concern	4 - National media coverage; NGO intervention, national community concern	5 - International media coverage; significant NGO or government intervention, international community concern
			1	**2**	**3**	**4**	**5**
Determine the Likelihood (L)	1 – Rare	Once every 50-100 years	1	2	3	4	5
	2 – Unlikely	Every 10-50 years	2	4	6	8	10
	3 – Possible	Every 3-10 years	3	6	9	12	15
	4 – Likely	Every 1-3 years	4	8	12	16	20
	5 – Almost certain	At least once a year	5	10	15	20	25

15-25 Extreme	Unacceptable level of risk - Controls must be implemented to reduce the risk. Seek HSE team input and EDO approval before proceeding
9-14 High	Unacceptable level of risk - Controls must be implemented to reduce the risk. Seek HSE team input and EDO approval before proceeding
5-8 Medium	Implement controls to reduce risk ALARP. If risk is still Medium after implementation - Line Management must approve before proceeding.
1-4 Low	Requires monitoring

Table 6-2 Indicative controls and residual risks associated with dosing system

Work stage	Hazard	Impact on	Consequence	Likelihood	Risk	Indicative controls	Revised Consequence	Revised Likelihood	Revised Risk
Mobilisation	Unable to access site during an acid flush event	Environment	4 – Major offsite impact, short to medium term environmental damage	4- Likely	16 - Extreme	- Tiered response system - Landowner agreement in place - Construction and maintenance of suitable access tracks - Staff trained in trailer use - Use of alternate dosing location (i.e. Yeodene gauge)	4 – Major offsite impact, short to medium term environmental damage	1- Rare	4-Low
Mobilisation	Vehicle accident or crash whilst on highway to site	Health Environment	5 – Fatality, major environmental impact, full remediation not possible	3- Possible	15 - Extreme	- Light vehicle training - Towing training - Fatigue management	5 – Fatality, major environmental impact, full remediation not possible	1- Rare	5-Medium
Mobilisation	Chemical spills during transport	Health Environment	3 – Serious injury requiring urgent treatment, significant environmental impact and remediation	3- Possible	9 - High	- Trailer internally bunded - Placarding in accordance with dangerous good handling - Dangerous goods handling training and licencing - Appropriate PPE - Mobile spilt kits	3 – Serious injury requiring urgent treatment, significant environmental impact and remediation	1 - Rare	3 - Low
Treatment	Chemical Spill	Health Environment	4 – Permanent and serious disablement, major offsite impact, short to medium term environmental damage	4- Likely	16 - Extreme	- Dangerous goods handling training and licencing - Personal protective equipment - Portable safety shower and eye wash station on site - Appropriate bunding - Seasonal changing of hosing and valves	1- Onsite release, containable with minimal damage	2-Unlikely	2- Low

Work stage	Hazard	Impact on	Consequence	Likelihood	Risk	Indicative controls	Revised Consequence	Revised Likelihood	Revised Risk
Treatment	Over-dosing	Environment	4 – Major offsite impact, short to medium term environmental damage	3- Possible	12 - High	- Completion of a trial - Target pH ≤6 - On site and laboratory testing - Alerts on water quality in stream	4 – Major offsite impact, short to medium term environmental damage	1- Rare	4-Low
Treatment	Under-dosing	Environment	4 – Major offsite impact, short to medium term environmental damage	2-Unlikely	8 - Medium	- Completion of a trial - On site and laboratory testing - Alerts on water quality in stream	4 – Major offsite impact, short to medium term environmental damage	1-Rare	4-Low
Treatment	Destruction of property by vandals	Equipment Environment	4 – Major offsite impact, short to medium term environmental damage	3- Possible	12 - High	- Security system alerting staff who can mobilise to site in 30 minutes - Monitoring of dosing with SCADA alerts to staff - Lockable fencing and gates	4 – Major offsite impact, short to medium term environmental damage	1- Rare	4- Low
Loading / Unloading	Chemical spill at works yard	Health Environment	2 – Controlled release, limited spill, contact with worker	3 -Possible	6- Medium	- Appropriate bunding and PPE during handling - Dangerous goods handling training and licencing - Mobile spilt kits	2 – Controlled release, limited spill, contact with worker	2-Unlikely	4- Low

7. Summary and Conclusions

A trailer mounted chemical dosing system has been designed that would allow safe dosing of Boundary Creek to reduce the risk of fish kills in the Barwon River downstream of Boundary Creek during an acid flush event. The system takes into account a series of elements, risks and controls including:

- Adequate treatment
- Over treatment
- Timely mobilisation
- Flocculant formation
- Chemical spills
- Vandalism

The proposed arrangement allows for the removal of mobile treatment systems from the site when the contingency measure is no longer required and avoids a number of risks and challenges associated with a permanent treatment plant.

The use of caustic soda provides for an alkali agent that can correct low pH. The use of 30% NaOH is the most suitable reagent as it avoids water supply issues, system clogging and other operational challenges. However, it does have residual risk with overdosing into the water, which can be managed with existing pH sensors and appropriate chemical dosing, commissioning, and operational supervision. Given this, risks can be mitigated to low following the appropriate design and management.

The location of the contingency measure on the drain on the Eastern end of the Big Swamp provides opportunity to treat acidity from Big Swamp, prior to entering Boundary Creek. The extension of the access road is required to provide suitable all weather access. A floating silt curtain may be required to capture flocculant that may form in response to chemical dosing.

Risks were identified during the design process that have not been able to be addressed by the design. All residual risks can be mitigated to low following a series of indicative controls within Barwon Waters operational capacity except for vehicle accidents. This is because a vehicle accident carries the potential for a fatal collision, even if rare.

The estimate project cost of the two IBC mounted chemical trailers and safety shower, excluding the access road, are $75,000.00 excluding GST. This cost may vary depending on the suppliers used and if additional features are required to meet Barwon Water requirements.

A significant benefit of this proposed arrangement is that the trailers are able to be used by the Barwon Water operational teams for general purposes. The expected frequency of use of the chemical dosing trailer is low and, not expected to be used every year. This provides additional trailers for operational duties.

In addition to the two IBC mounted chemical trailers, an Ixom cube trailer was identified that could be considered for this application, however, the need to crane in the IBC on site adds to the operational complexity. The Ixom cube trailer may not be suitable for transport on a gravel track (depending on the track condition) and remote site IBC craneage is likely to be difficult. At the time of reporting, cost estimates were not available, but understood to cost approximately $80,000 for the trailer only, subject to selected options and final agreed arrangement.

8. References

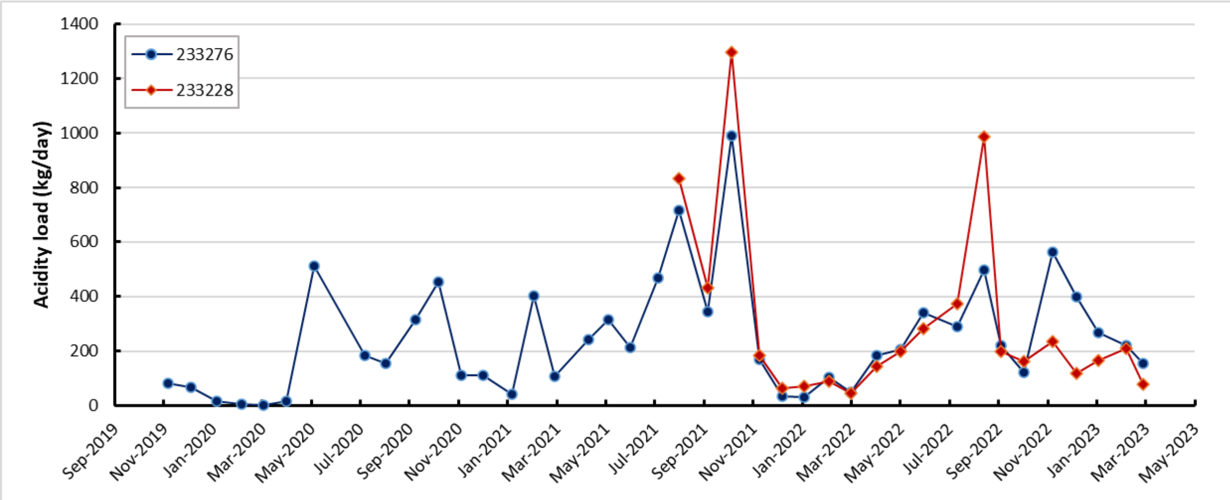
Barwon Water (2021) Hydro-Geochemical Modelling, Design of Contingency Measure. 31 July 2021

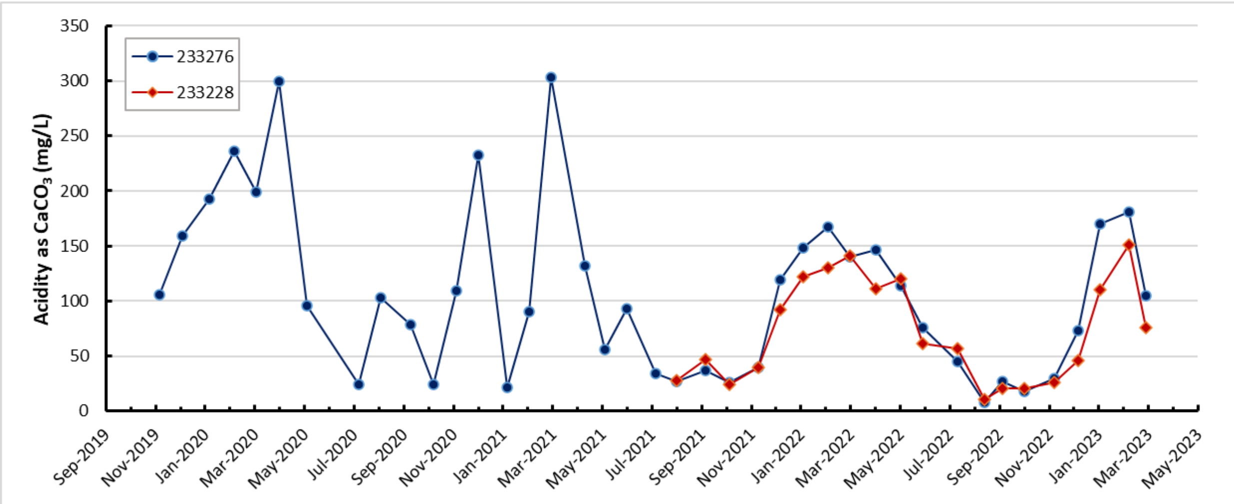
Earth Systems (2022) Semi-Passive Treatment of Big Swamp, Desktop Review and Trial Treatment Plan. Prepared for Barwon Water by Earth Systems. 14 January 2022.

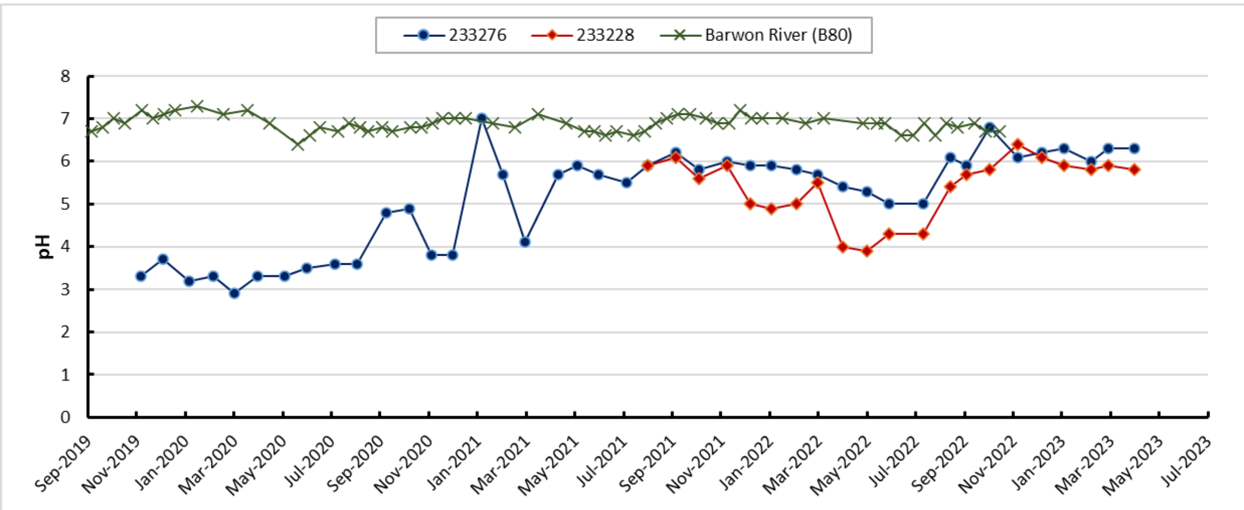
Jacobs, J.A, Lehr, J.H., and Testa, S.M. (2014). Acid Mine Drainage, Rock Drainage, and Acid Sulfate Soils (Causes, Assessment, Prediction, Prevention, and Remediation) || Overview of Acid Mine Drainage Treatment with Chemicals. doi:10.1002/9781118749197.ch29

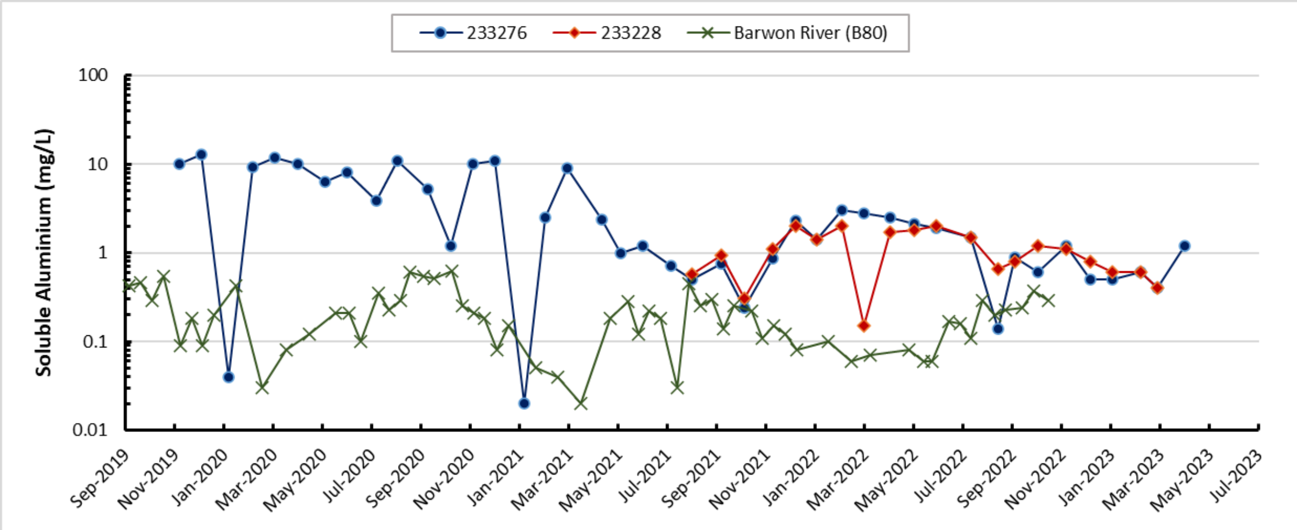
Trumm, D. (2010) Selection of active and passive treatment systems for AMD—flow charts for New Zealand conditions, New Zealand Journal of Geology and Geophysics, 53:2-3, 195-210, doi: 10.1080/00288306.2010.500715

Appendix A. Summary of surface water quality monitoring





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233228
Barwon River (B80)
Soluble Aluminium (mg/L)
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10
1
0.1
0.01
Sep-2019
Nov-2019
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Mar-2020
May-2020
Jul-2020
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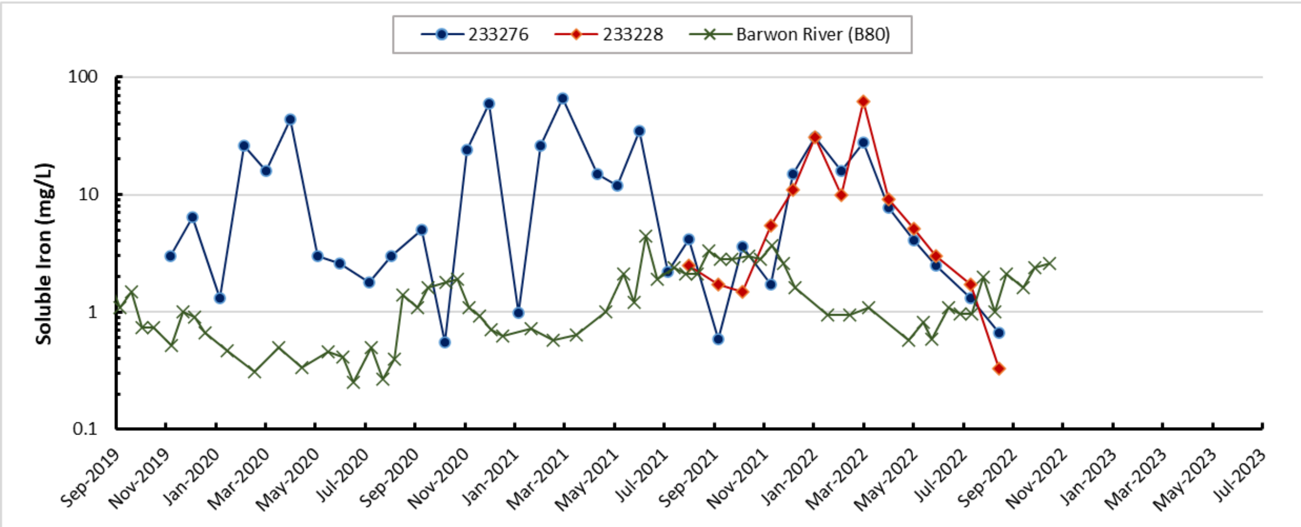
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0.1
Sep-2019
Nov-2019
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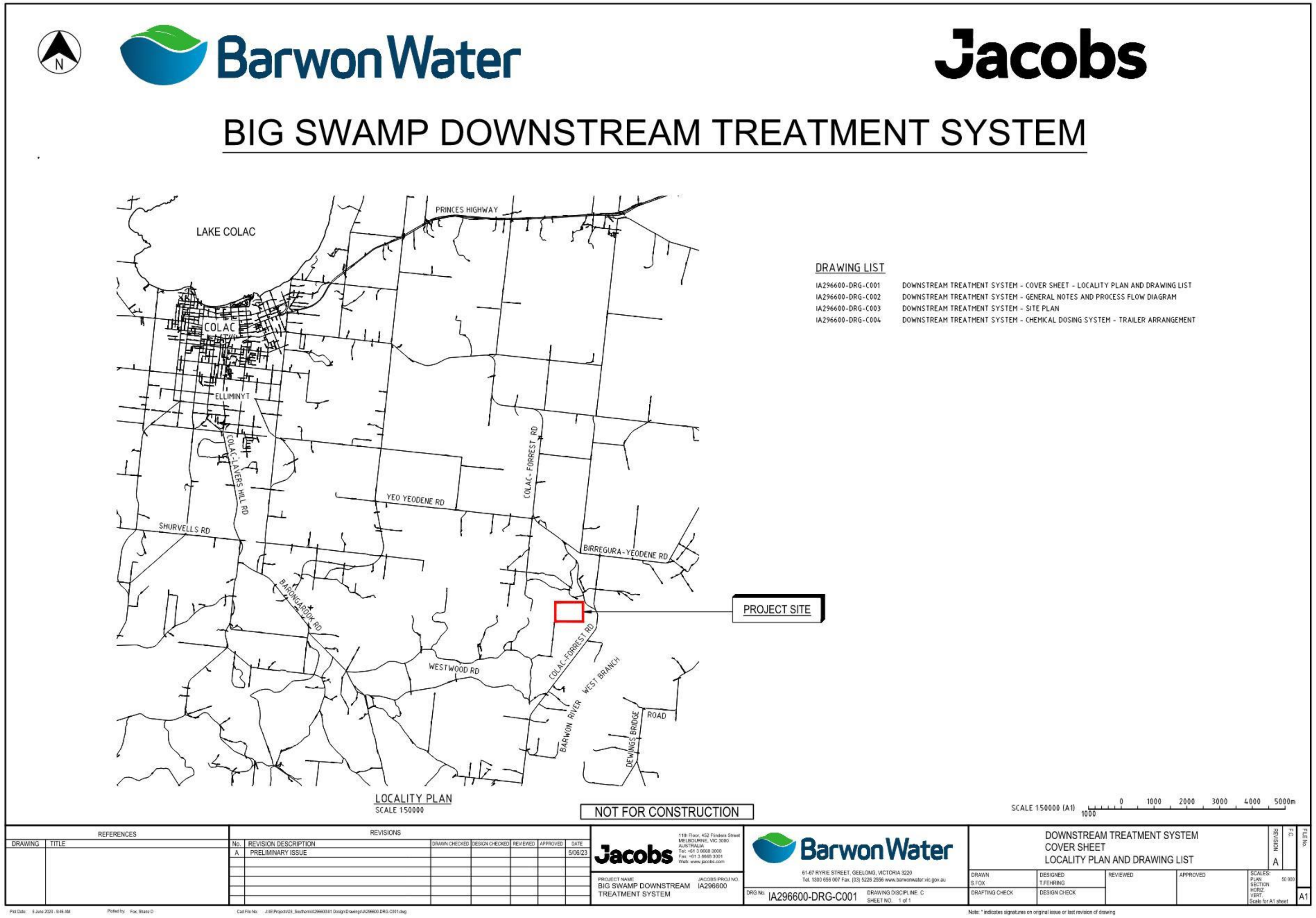
May-2023
Jul-2023

Appendix B. Summary of different neutralants considered

Material	Formula	Saturation pH	Alkalinity	Cost / t acid neutralised	Operation	OHS	Precipitation and sludge settling	Environmental risks
Quicklime	CaO	12.4	1,750-2,500 mg/L $CaCO_3$ equivalent in near neutral water	$180-300	Dissolution of powdered quicklime in water and added as slurry. Storage required to prevent contact with moisture. Poor maintenance can result in plugged dispensing mechanism and complete failure.	Hydration process is highly exothermic and can boil water, particularly difficult and dangerous to handle.	Most metals precipitate, although at higher pH's some metals (eg. Al) may begin to redissolve.	Plugging and failure at high risk period may result in untreated acidic discharge.
Hydrated lime	$Ca(OH)_2$	12.4	1,750-2,500 mg/L $CaCO_3$ equivalent in near neutral water	$300-400	Silo or hopper with mechanical feed screw to dispense powder. Batching tank to mix powder with water. Can use aqueous slurry. Poor maintenance can result in plugged dispensing mechanism and complete failure.	Specialist storage and handling equipment is required to prevent contact with moisture and to minimise contact with skin.	Most metals can be precipitated from solution, although at higher pH's some metals (eg. Al) may begin to redissolve.	Plugging and failure at high risk period may result in untreated acidic discharge.
Limestone	$CaCO_3$	6.5-8.0 (effective)	15-30 mg/L $CaCO_3$ equivalent in near neutral water	$40-80	Silo or hopper with mechanical feed screw to dispense powder. Batching tank to mix powder with water.	Safe to use, lower handling requirements than other reagents.	Not all metals removed (ineffective for Mn).	Cannot overtreat.

Material	Formula	Saturation pH	Alkalinity	Cost / t acid neutralised	Operation	OHS	Precipitation and sludge settling	Environmental risks
Caustic Magnesia and Mg Hydroxide	MgO $Mg(OH)_2$	9.5-10.8	Approximately 500 mg/L $CaCO_3$ equivalent in near neutral water	$330-450	Silo or hopper with mechanical feed screw to dispense powder. Batching tank to mix powder with water.	Safer and easier to handle and dispense than Ca-bearing reagents and is weakly exothermic on hydration. Some health and safety issues.	Most metals precipitate, low sludge volumes.	
Soda Ash	Na_2CO_3	10.9-11.6	~425,000 mg/L $CaCO_3$ equivalent in near neutral water	$530-700	Briquettes/powder placed in acid and metalliferous stream.	Direct skin or eye contact, or inhalation of powder or crystals can produce irritation, rash and sometimes burns.	Most metals precipitate. Poor sludge settling rates. At higher pH's some metals (eg. Al) may begin to redissolve.	High risk of under and over pH correction.
Caustic Soda	NaOH	14	~560,000 mg/L $CaCO_3$ equivalent in near neutral water at a concentration of ~46 wt.%	$1,500-2,000	Stored as a liquid in tank, dispense through metering pump or valve and feeder hose . No mixing required. Low freezing temperature.	Can cause severe burns to the eyes, skin, digestive system or lungs.	Most metals precipitate. Poor sludge Settling rates. At higher pH's some metals (eg. Al) may begin to redissolve.	High risk of over pH correction.

Appendix C. Mobile Downstream Treatment System Drawings



GENERAL:

G1. UNLESS NOTED OTHERWISE ALL DIMENSIONS ARE IN MILLIMETRES. ALL RUNNING DISTANCES ARE IN METRES AND ALL LEVELS ARE TO A.H.D. ALL CO-ORDINATES ARE TO MGA ZONE 54.

G2. ALL PROPRIETARY PRODUCTS SHALL BE INSTALLED STRICTLY IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.

G3. THE DISTURBANCE OF ACID SULFATE SOILS AND POTENTIALLY ACID SULFATE SOILS SHALL BE MINIMISED. SOILS ARE TO REMAIN INSITU WHEREVER POSSIBLE. CONSTRUCTION TRAFFIC SHALL BE ON APPROVED PATHWAYS TREATED TO PREVENT DISTURBANCE OF THE UNDERLYING SOIL.

G4. CONTRACTOR SHALL NOT REMOVE ANY EXISTING FENCING WITHOUT APPROVAL OF THE CONTRACT ADMINISTRATOR.

G5. CONTRACTOR SHALL KEEP ALL GATES CLOSED OR OPEN AS FOUND ON THE DAY OF WORK.

G6. ALL LOCKED GATES SHALL BE ACCESSED BY THE CONTRACTOR USING APPROVED BARWON WATER PADLOCKS ONLY AND THESE SHALL AT NO TIME REPLACE THE LANDOWNERS LOCKS BUT BE USED "IN SERIES" WITH THESE.

G7. THE CONTRACTOR SHALL ONLY ACCESS PRIVATE LAND USING AGREED AND APPROVED VEHICLE TRACKS AND SHALL NOT MAKE NEW TRACKS WITHOUT THE APPROVAL OF THE CONTRACT ADMINISTRATOR.

G8. THE CONTRACTOR SHALL CONFINE ALL CONSTRUCTION ACTIVITIES TO WITHIN THE CONSTRUCTION CORRIDOR DEFINED BY BARWON WATER. THIS SHALL NOT BE VARIED WITHOUT THE PERMISSION OF THE CONTRACT ADMINISTRATOR.

SURVEY AND SET OUT

SV1. THE CONTRACTOR SHALL CONDUCT A FEATURE SURVEY ALONG ALL ALIGNMENTS AND WITHIN 3 M OF ANY PROPOSED CONSTRUCTION; AND ESTABLISH TEMPORARY BENCH MARKS.

SV2. THE CONSTRUCTION CORRIDOR SHALL BE CONFIRMED AND MARKED ON THE FIELD PRIOR TO COMMENCING CONSTRUCTION

SV3. SETTING OUT DIMENSIONS AND ALIGNMENTS SHALL BE CONFIRMED ON THE GROUND BEFORE CONSTRUCTION COMMENCES

SV3. THE CONTRACTOR IS RESPONSIBLE FOR ENSURING THE PROJECT SET OUT AND ANY REVISED ALIGNMENTS ARE CONSISTENT WITH THE DESIGN. SHOULD ACTUAL SITE CONDITIONS CONFLICT WITH THAT DOCUMENTED, THE CONTRACTOR SHALL CONTACT THE SUPERINTENDENT FOR CLARIFICATION BEFORE PROCEEDING.

SV4. CONTRACTOR SHALL PREPARE AS CONSTRUCTED DRAWINGS OF ALL WORKS.

SITE PREPARATION:

SP1. THE CONTRACTOR SHALL NOT UNDERTAKE ANY CLEARING WORK OR ANY TYPE OF DISTURBANCE OUTSIDE THE SPECIFIED LIMITS OF WORK UNLESS APPROVED BY THE SUPERINTENDENT.

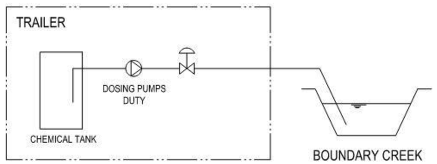
SP2. PRIOR TO COMMENCEMENT OF ANY WORK, THE CONTRACTOR AND THE SUPERINTENDENT SHALL CONDUCT A JOINT INSPECTION OF THE SITE TO IDENTIFY AREAS TO BE CLEARED AND VEGETATION TO BE RETAINED AND PROTECTED.

ENVIRONMENTAL MANAGEMENT PLAN:

EMP1. THE CONTRACTOR SHALL CARRY OUT ALL WORKS IN ACCORDANCE WITH THE ENVIRONMENT MANAGEMENT PLAN.

ABBREVIATIONS:

ASS	ACID SULFATE SOIL
PASS	POTENTIAL ACID SULFATE SOIL
DWL	DESIGN WATER LEVEL
NSL	NATURAL SURFACE LEVEL



PROCESS FLOW DIAGRAM

LEGEND:

FLOW CONTROL VALVE

NOT FOR CONSTRUCTION

REFERENCES	
DRAWING	TITLE

No.	REVISION DESCRIPTION	DRAWN CHECKED	DESIGN CHECKED	REVIEWED	APPROVED	DATE
A	PRELIMINARY ISSUE					5/06/23

Jacobs — 11th Floor, 452 Flinders Street, MELBOURNE, VIC 3000, AUSTRALIA. Tel: +61 3 8668 3000 Fax: +61 3 8668 3001 Web: www.jacobs.com

PROJECT NAME: BIG SWAMP DOWNSTREAM TREATMENT SYSTEM — JACOBS PROJ NO. IA296600

Barwon Water — 61-67 RYRIE STREET, GEELONG, VICTORIA 3220. Tel. 1300 656 007 Fax. (03) 5226 2556 www.barwonwater.vic.gov.au

DRG No. IA296600-DRG-C001 — DRAWING DISCIPLINE: G — SHEET NO. 1 of 1

DOWNSTREAM TREATMENT SYSTEM
GENERAL NOTES AND
PROCESS FLOW DIAGRAM

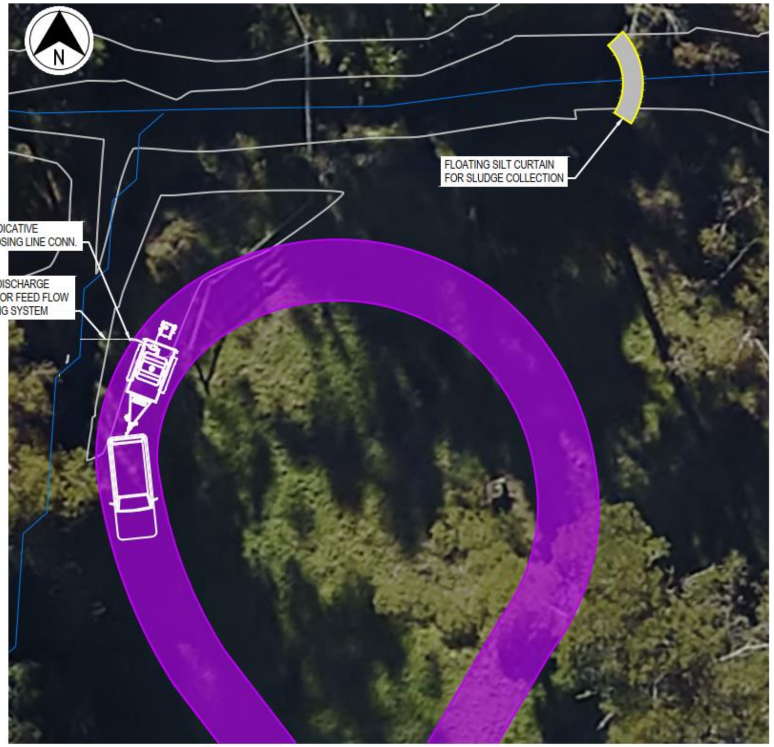
REVISION A

DRAWN	DESIGNED	REVIEWED	APPROVED	SCALES: PLAN N/A, SECTION, HORIZ., VERT. Scale for A1 sheet
S.FOX	T.FEHRING			
DRAFTING CHECK	DESIGN CHECK			A1

Plot Date: 5 June 2023 - 9:47 AM Plotted by: Fox, Shane D Cad File No. J:\IE\Projects\03_Southern\IA296600\01 Design\Drawings\IA296600-DRG-C002.dwg

Note: * indicates signatures on original issue or last revision of drawing

LOCALITY PLAN
SCALE 1:200



SITE PLAN
SCALE 1:100

NOTES

1. ACCESS ROAD AND AREA FOR CHEMICAL DOSING TRAILER SHALL BE IN ACCORDANCE WITH INFRASTRUCTURE DESIGN MANUAL (IDM) STANDARD DRAWINGS SD600, TYPICAL CROSS SECTION FOR GRAVEL ROAD.

   STRIP TOP SOIL AND PROOF ROLL IN ACCORDANCE WITH CLAUSE 12.7.13 OF IDM.

   BASE MATERIAL TO BE MINIMUM 100mm DEPTH, 20mm CLASS 3 FIND CRUSHED ROCK.

SCALE 1:100 (A1) 2000 0 2000 4000 6000 8000 10000mm

SCALE 1:200 (A1) 4000 0 4000 8000 12000 16000 20000mm

NOT FOR CONSTRUCTION

REFERENCES

DRAWING	TITLE

REVISIONS

No.	REVISION DESCRIPTION	DRAWN CHECKED	DESIGN CHECKED	REVIEWED	APPROVED	DATE
A	PRELIMINARY ISSUE					5/06/23
B	REVISED WITH BARWON WATER COMMENTS					14/07/23

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DRG No. IA296600-DRG-C003
DRAWING DISCIPLINE: C
SHEET NO. 1 of 1

DOWNSTREAM TREATMENT SYSTEM
CHEMICAL DOSING
SITE PLAN

REVISION: B
F.C.
FILE No.

DRAWN	DESIGNED	REVIEWED	APPROVED	SCALES:
S.FOX	T.FEHRING			PLAN SECTION HORIZ. VERT. Scale for A1 sheet
DRAFTING CHECK	DESIGN CHECK			

A1

Plot Date: 18 July 2023 - 10:59 AM
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Cad File No: J:\IE\Projects\03_Southern\IA296600\01 Design\Drawings\IA296600-DRG-C003 - Rev B.dwg

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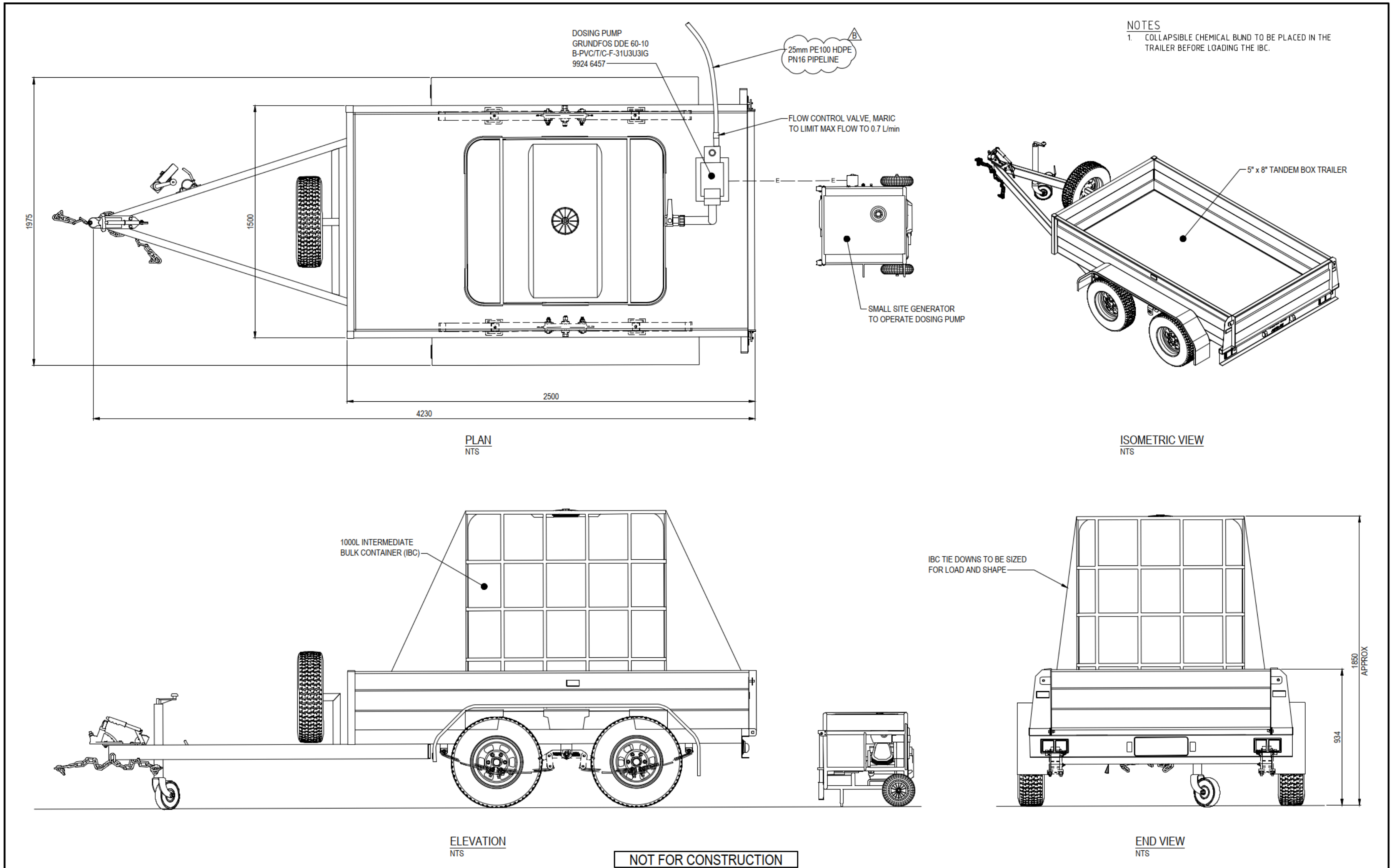
Boundary Creek Mobile Downstream Treatment System



NOT FOR CONSTRUCTION

REFERENCES	
DRAWING	TITLE

REVISIONS

No.	REVISION DESCRIPTION	DRAWN CHECKED	DESIGN CHECKED	REVIEWED	APPROVED	DATE
A	PRELIMINARY ISSUE					5/06/23
B	REVISED WITH BARWAON WATER COMMENTS					14/07/23

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PROJECT NAME: BIG SWAMP DOWNSTREAM TREATMENT SYSTEM
JACOBS PROJ NO. IA296600

Barwon Water
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DRG No. IA296600-DRG-C004
DRAWING DISCIPLINE: C
SHEET NO. 1 of 1

DOWNSTREAM TREATMENT SYSTEM
CHEMICAL DOSING SYSTEM
TRAILER ARRANGEMENT

REVISION B | F.C. | FILE No.

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DRAFTING CHECK	DESIGN CHECK			

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Note: * indicates signatures on original issue or last revision of drawing

Appendix D. Ancillary materials for dosing trailer

Figure D-1 Collapsible sidewall portable bunding (www.stratex.com.au)

Figure D-2 Grundfos DDE 60-10 Dosing Pump

Figure D-3 DeWalt 8.2kVA Petrol Generator

Figure D-4 Maric valve flow limiter

Figure D-5 25 mm diameter PE tubing

Figure D-6 Silt Curtain Class 1 (Non Tidal) 1m Skirt (20m section)

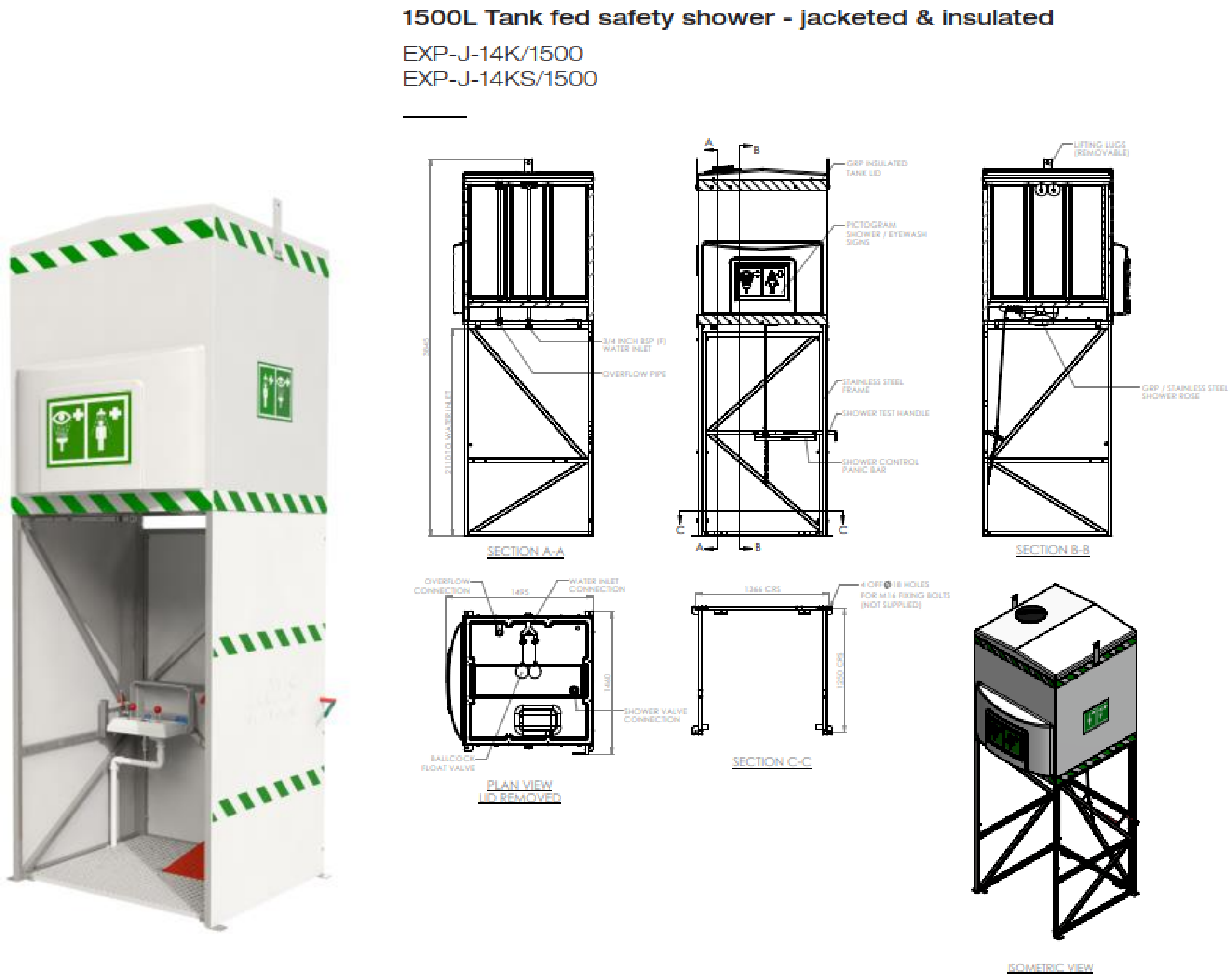


Figure D-7 Jacketed & Insulated 1500 Litre Emergency Tank Shower and eye wash station

Appendix E. Additional information – IXOM Trailer Cube

Product Guide | **Solving Our Customers' Challenges**

IXOM

IXOM TRAILER CUBE™

Key Product Features:

- Accommodates standard 1,000 litre IBC
- 200 litre day tank facilitates continual dosing during IBC change over
- Dosing rate up to 375 litres by hour
- Self-bunded
- Local design and build allowing customisation to suit your application
- Provides hassle-free mobile dosing

Suitable For Common Water Treatment Chemicals Including:

- Aluminium Sulphate
- Antiscalants, Biocides, Dispersants and other specialty chemicals
- Ferrous Chloride
- Magnesium Hydroxide Liquid (MHL)
- Sodium Hypochlorite (Hypo)
- Sodium Hydroxide (Caustic)
- Sodium Bisulphite (SBS)
- Sulphuric Acid

What is a Trailer Cube™?

The Trailer Cube™ is an innovative product developed by Ixom for the safe, reliable and mobile dosing of IBC packaged chemicals. The Cube™ is fully mobile and includes a sealed containment bund, day tank and dosing pump skid assembly. The benefit the Trailer Cube™ has over its stationary rivals is its ability to dose chemicals all around site, delivering crucial dosing without the need for a permanent structure.

Ixom's Trailer Cube™ is designed and manufactured in Australia using components from industry leading brands such as Grundfos, Georg Fischer and Endress+Hauser.

Ixom Water Treatment Systems

1 Nicholson St
East Melbourne VIC 3002
Australia

T **Australia**
1300 559 262
New Zealand
0800 222 277
All other locations
61 3 9906 3000
E **water.treatment@ixom.com**

Ixomwatercare.com/ixomwts

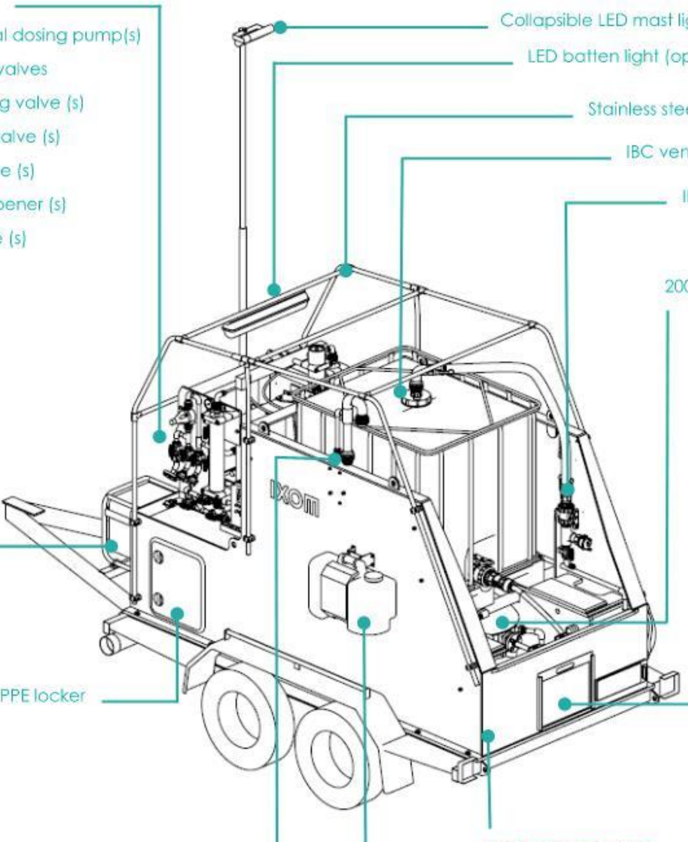
For specialist advice in an emergency, call Ixom's **24 HOUR EMERGENCY RESPONSE SERVICE**

Australia
1800 033 111

New Zealand
0800 734 607

International
+61 3 9663 2130

Product Guide | **Solving Our Customers' Challenges**



Safety in Design

Each Trailer Cube™ has been designed to incorporate Ixom's extensive knowledge and best practice in chemical storage and handling. The Trailer Cube ™ is designed in accordance with ANZ standards and developed using the IXOM HAZOP process to minimise operational and safety risks.

Configurable Product To Suit Your Application

- Dosing pumps such as AODD, peristaltic, mag drive and progressive cavity
- Types/brands of equipment
- Variable material of construction
- Dilution circuits
- Rain cover
- IBC filling spool

What's your challenge?

Ixom Water Treatment Systems

1 Nicholson St
East Melbourne VIC 3002
Australia

T **Australia**
1300 559 262
New Zealand
0800 222 277
All other locations
61 3 9906 3000
E **water.treatment@ixom.com**

Ixomwatercare.com/ixomwts

For specialist advice in an emergency, call Ixom's **24 HOUR EMERGENCY RESPONSE SERVICE**

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0800 734 607

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+61 3 9663 2130