Receiving Environment Monitoring Program for New Acland Mine

Confidential

New Acland Coal Pty Ltd

Level 8, 200 Creek Street, Brisbane Qld 4000

Prepared by:

SLR Consulting Australia

Level 16, 175 Eagle Street, Brisbane QLD 4000, Australia

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1.0	1 November 2023	Diana Bedder	Sarah Kill	Sarah Kill

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with New Acland Coal Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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1.0 Introduction

New Acland Coal Pty Ltd (NAC), a subsidiary of New Hope Group (NHG) engaged SLR Consulting Australia Pty Ltd (SLR) to review and update the existing Receiving Management Plan (REMP) (BMT, 2019) for New Acland (NAC) mine.

The REMP review and updates (this document) includes amendments relating to updated legislation, additional sampling, monitoring, and reporting requirements specified in the latest version of Environmental Authority (EA) (EPML00335713) for NAC mine which was recently been amended (21 July 2023) and includes updated trigger values. A copy of the EA is provided in **Appendix A**. The new conditions relevant to the REMP amendment (i.e., C-35 to C-38) are further discussed in **Section 1.4**.

This REMP provides a basis for evaluating whether the discharge limits or other conditions imposed upon NAC's activity have been successful in maintaining or protecting receiving environment values over time.

1.1 Background

The NAC mine is an open cut thermal coal mine located on the Darling Downs, adjacent to the township of Acland and approximately 14 kilometres (km) north-west of Oakey, Queensland. NAC operations are located on mining lease (ML) 50170, ML 50216, ML50232 and ML700002, under the approval of the EA. The EA includes conditions associated with the development of three (3) new resource areas, Manning Vale East, Manning Vale West and Willeroo, within ML50232.

The current mining activity has the required licences to discharge into two (2) ephemeral catchments; Spring Creek, a tributary of Myall Creek and Lagoon Creek, a tributary of Oakey Creek, where the majority of mine affected water (MAW) from natural flow is discharged. Both creeks ultimately form part of the Condamine River Catchment, which is at the headwaters of the Murray-Darling Basin in Southern Queensland. Further information is provided in **Section 3.0**.

The REMP review and updates do not include significant changes to description of activity and associated Contaminants of Potential Concern, existing receiving waters descriptions or monitoring program design established in the original REMP (BMT, 2019).

1.2 Aims and Objectives

The overall aim of this REMP is to quantify the potential impact of controlled releases of mine-affected discharge water and associated contaminants from the Environmental Dams (EDs) on the mine site on the receiving environments of Lagoon Creek and Spring Creek.

The specific objectives and aims are to:

- Characterise the baseline aquatic environmental values, including water quality conditions at Lagoon and Spring Creek prior to any influence of the revised Project's activities.
- Develop the objectives of water quality monitoring in accordance with the ANZG (2018) water quality guidelines.
- Identify the locations of the upstream control (reference) and downstream test monitoring sites, in addition to the licenced discharge points.
- Describe the sampling methods that will be implemented during the REMP.

- Develop a monitoring program that allows for the detection of any changes in the receiving environment and is able to determine (as far as practicable) whether these are natural variation or potential impacts from mining activities.

1.3 Linkages to the Environmental Impact Statement and Commonwealth Conditions

The original REMP (BMT, 2019) was designed to address the commitments made by NHG in the environmental approval process, including.

- Environmental Impact Statement (EIS).
- Commonwealth conditions under the *Environment and Biodiversity Conservation Act 1999*.

Further information relating to these commitments is provided in **Appendix B**.

1.4 Environmental Authority Conditions

The EA conditions relevant to this REMP are outlined in **Table 1-1**, which includes a summary of how the conditions are met and the location within this document.

Table 1-1 EA Conditions

Condition	Condition fulfilment	Section
Schedule C: Water		
C1 Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.	N/A to this REMP document – these conditions are addressed in New Hope Group's Water Management Plan.	N/A
C2 Unless otherwise permitted under the conditions of the environmental authority, the release of mine affected water must only occur from the release points specified in **Table C1 – Mine affected water release points, sources and receiving waters** and depicted in **Figure C1 – Surface water monitoring points** attached to this environmental authority.		
C3 The release of mine affected water to water in accordance with **C2** must not exceed the release limits stated in **Table C2 – Mine-affected water release limits** when measured at the monitoring points specified in **Table C1 – Mine-affect water release points, sources and receiving waters** for each quality characteristic.		
C4 The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table C1: Mine-affected water release points, sources and receiving waters** for each quality characteristic and at the frequency specified in **Table C2: Mine-affected water release limits**.	All release points (i.e., EDs) as specified in **Table C1: Mine-affected water release points, sources and receiving waters** will be monitored in accordance with **Section 4.2** of this REMP.	4.2
Mine-affected water release events		
C5 The holder must ensure a stream flow gauging station(s) is installed, operated and maintained to determine and record stream flows in Lagoon and Spring Creek upstream of the discharge sites.	Stream flow gauges are included in Lagoon and Spring Creek upstream of the discharge sites.	4.2.3
C6 Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition **C2** must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table C2 – Mine-affected water release limits** for the release point(s) specified in **Table C1 – Mine-affected water release points, sources and receiving waters**.	N/A to this REMP document – these conditions are addressed in New Hope Group's Water Management Plan	N/A

Condition	Condition fulfilment	Section
C7 The release of mine affected water to waters in accordance with condition **C6** must not exceed the Maximum Release Rate (for all combined release point flows) for each receiving water flow criterion for discharge specified in **Table C3 – Mine-affected water release during flow events** when measured at the monitoring points specified in **Table C1 – Mine-affected water release points, sources and receiving waters**.	N/A to this REMP document – these conditions are addressed in New Hope Group's Water Management Plan	N/A
C8 The daily quantity of mine affected water released from each release point must be measured and recorded.		
C9 Release to waters must be undertaken so not as to cause erosion of the bed and banks of the receiving waters or cause material build-up of sediment in such waters.		
C10 The environmental authority holder must notify the administering authority as soon as practicable and no later than **1 Business day** after commencing to release mine affected water to the receiving environment. Notification must include the submission of written advice to the administering authority of the following information: a) release commencement date/time; b) details regarding the compliance of the release with the conditions of Schedule C: Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume); c) release point(s); d) release rate; e) release salinity; and f) receiving water(s) including the natural flow rate. NOTE: Notification to the administering authority must be made via WaTERS.		
C11 The environmental authority holder must notify the administering authority as soon as practicable and nominally no later than **1 Business day** after cessation of a release event of the cessation of a release notified under condition **C10** and within **twenty-eight (28) days** provide the following information in writing: a) release cessation date/ and time; b) natural flow rate in receiving water; c) volume of water released;		

Condition	Condition fulfilment	Section
d) details regarding the compliance of the release with the conditions of Agency Interest; Water of this environmental authority (i.e. contaminant limits, natural flow, discharge volume); e) all in-situ water quality monitoring results; and f) any other matters pertinent to the water release event. NOTE: Successive or intermittent releases occurring within twenty-four (24) hours of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions C10 and C11, provided the relevant details of the release are included within the notification provided in accordance with conditions C10 and C11.		
C12 If the release limits defined in **Table C2: Mine-affected water release limits** are exceeded, the holder of the environmental authority must notify the administering authority within **1 Business day** of receiving the results.	N/A to this REMP document – these conditions are addressed in New Hope Group's Water Management Plan	N/A
C13 Compliant with the conditions of this environmental authority, provide a report to the administering authority detailing: a) the reason for the release; b) the location of the release; c) the total volume of the release and which (if any) part of this volume was non-compliant; d) the total duration of the release and which (if any) part of this period was non-compliant; e) all water quality monitoring results (including all laboratory analyses); f) identification of any environmental harm as a result of the non-compliance; g) all calculations; and h) any other matters pertinent to the water release event.		
Receiving Environmental Monitoring and Contaminant Trigger Levels		
C14 The quality of the receiving waters must be monitored at the locations specified in **Table C5: Receiving water upstream background sites and downstream monitoring points** for each quality characteristic and at the monitoring frequency stated in **Table C4: Receiving waters contaminant trigger levels**.	Receiving waters are monitored at sites listed in **Section 4.0** of this REMP. The monitoring parameters are specified in **Table 3-8** located in **Section 3.5**.	3.4, 4.1

Condition	Condition fulfilment	Section
C15 If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table C4: Receiving waters contaminant trigger levels** during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no additional monitoring and reporting action is required; or b) where the downstream results exceed the upstream results complete an investigation into the potential for environmental harm and provide a written report to the administering authority within ninety (90) days of receiving the results and in the next annual return, outlining: (1) details of the investigations carried out; and (2) actions taken to prevent environmental harm. NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with (b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.	Management actions are included in **Section 7.0** of this REMP.	7.0
C16 If an exceedance in accordance with condition **C15(b)** is identified, the holder of the environmental authority must notify the administering authority in writing within **1 Business day** of receiving the result.	Identified in **Section 7.0** of this REMP.	7.0
C17 All determinations of water quality must be performed by an appropriately qualified person.	Identified in **Section 5.1** of this REMP	5.1
Annual water monitoring reporting		
C18 The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken;	Some of these conditions are addressed in **Section 5.2** and the remainder is covered in New Hope Group's Water Management Plan.	7.0

Condition	Condition fulfilment	Section
d) the measured or estimated daily quantity of mine affected water released from all release points; e) the release flow rate at the time of sampling for each release point; f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request; and h) water level monitoring data must be provided in the specified electronic format upon request.		
Storm water and water sediment controls		
C19 An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.	N/A to this REMP document – these conditions are addressed in New Hope Group's Water Management Plan.	7.0
C20 Stormwater, other than mine affected water, is permitted to be released to waters from: a) Erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition C19; and b) Water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with conditions C21 and C22, for the purpose of ensuring water does not become mine affected water.		
Water Management Plan		
C21 Water Management Plan must be developed by an appropriately qualified person and implemented for all stages of mining. The Water Management Plan must be submitted to the administering authority for review and comment within **three (3) months** upon the grant of ML50232 and ML700002.	N/A to this REMP document – these conditions are addressed in New Hope Group's Water Management Plan.	7.0
C22 The Water Management Plan must identify methods to:		

Condition	Condition fulfilment	Section
a) identify the environmental values of the receiving waters, including Lagoon and Spring Creeks, and water quality objectives and how they will be protected; b) incorporate a risk management approach to how changing levels of flood, drought and water quality risks should be addressed; c) manage stormwater discharge; d) develop and implement a system for emergency spills or discharges including procedures to minimise extent and duration of release, staff training, investigation and reporting procedures; e) manage the environmental impacts of any release of wastewater to the environment so that any impacts are minimised including restricting any discharge to waters to occasions where there is flow in receiving waters to provide considerable dilution; f) separate clean water from undisturbed areas and water from disturbed areas; g) manage site water quality and quantity during the (3) phases of mining: development, operation and decommissioning and include a site water balance including groundwater generated through mine dewatering; h) safeguard against the potential for soil erosion and acid drainage; and i) provide details of operational monitoring and monitoring of hydrological processes including associated performance indicators.		
C23 Within **twenty (20) business days** of receiving comments from the administering authority as required by **condition C21**, the Water Management Plan must be updated by a suitably qualified and experienced person having regard to the comments and submitted to the administering authority.		
C24 A copy of the Water Management Plan and any subsequent amendment of the Water Management Plan must be kept at the place to which this environmentally relevant activity relates and be available for examination by Emergency Services Personnel or an authorised person on request.		
C25 Mine affected water (MAW) that has been treated in the Reverse Osmosis Water Treatment Plant (ROWTP) is authorised to be released to Environmental Dam 4 for controlled discharge to the receiving waters of Lagoon Creek when there is no natural	The ROWTP has not yet been constructed and as such, conditions for treated MAW have not been incorporated into this REMP. Provision has been	8.0

Condition	Condition fulfilment	Section
flow on a continuous basis for a period of 18 months from when written notification is given to the administering authority*, subject to conditions C25 to C38 of this environmental authority. *NOTE: *This notification relates to the initial commencement of ERA64 not the notification of the commencement of individual releases within this period as required by condition C29.*	included in **Section 8.0** for these conditions to be addressed in the REMP prior to commissioning of the ROWTP.	
C26 The release of treated MAW to waters must only take place in accordance with the criteria in Table C6: Treated MAW Release Criteria and Monitoring Point and subject to the contaminant release limits specified in Table C7: Treated MAW Release Limits.	The ROWTP has not yet been constructed and as such, conditions for treated MAW have not been incorporated into this REMP. Provision has been included in **Section 8.0** for these conditions to be addressed in the REMP prior to commissioning of the ROWTP.	8.0
C27 The quality of contaminants released from the release point in **Table C6: Treated MAW Release Criteria and Monitoring Point** must be measured and recorded at the monitoring point and at the frequency specified in **Table C6: Treated MAW Release Criteria and Monitoring Point.**		
C28 The release of treated MAW to waters must not: a) cause erosion to the bed and banks of the receiving waters; b) cause a build-up of sediment in the receiving waters; c) cause an adverse impact to aquatic biota; and d) adversely impact on downstream water users.		
C29 Notification of Treated MAW Release Event The environmental authority holder must notify the administering authority as soon as practicable and no later than **twenty-four (24) hours** after commencing to release treated MAW to the receiving environment in accordance with **condition C25**. Notification must include the submission of written advice to the administering authority via WaTERS of the following information: a) release commencement date/time; b) expected release cessation date/time; c) release point/s; d) release volume (estimated);		

Condition	Condition fulfilment	Section
e) receiving water/s including the natural flow rate; and f) any details (including available data) regarding likely impacts on the receiving water(s).		
C30 The environmental authority holder must notify the administering authority via WaTERS as soon as practicable (nominally within **twenty-four (24) hours** after cessation of a release event) of the cessation of a release of treated MAW notified under **Condition C29** and within **twenty-eight (28) days** provide the following information in writing: a) release cessation date/time; b) natural flow volume in receiving water; c) volume of water released; d) details regarding the compliance of the release with the relevant conditions of this environmental authority (i.e. contamination limits, discharge rate); e) all in-situ water quality monitoring results; and f) any other matters pertinent to the water release event. NOTE: *Successive or intermittent releases occurring within **forty-eight (48) hours** of the cessation of any individual release of treated MAW for the purpose of maintenance activities can be considered part of a single release event and do not require individual notification for the purpose of compliance with Conditions **C29 and C30**, provided the relevant details of the release are included within the notification provided in accordance with **Conditions C29 and C30**.*		
C31 Notification of Treated MAW Release Event Exceedance If the release limits in **Table C6: Treated MAW Release Limits** are exceeded at the monitoring point specified within **Table C7: Treated MAW Release Criteria and Monitoring Point**, the holder of the environmental authority must immediately cease the release and notify the administering authority via WaTERS within **twenty-four (24) hours** of receiving the results.	The ROWTP has not yet been constructed and as such, conditions for treated MAW have not been incorporated into this REMP. Provision has been included in **Section 8.0** for these conditions to be addressed in the REMP prior to commissioning of the ROWTP.	8.0
C32 The authority holder must, within **twenty-eight (28) days** of a release of treated MAW that exceeds the conditions of this authority, provide a report to the administering authority via WaTERS detailing: a) the location of the release; b) volume of water released;		

Condition	Condition fulfilment	Section
c) the quality of the water released; d) the quality of the water in the receiving environment; e) any impacts on aquatic biota; f) the cause of the exceedance; and g) any other matters pertinent to the water release event.		
C33 Brine produced by the ROWTP must be disposed of within an in-pit tailings storage facility.		
C34 The environmental authority holder must develop and implement a Brine and Waste Management Plan, which includes the following details: a) Identification and characterisation of all solid and liquid waste generated by the ROWTP including volumes; b) A program for the safe disposal of all waste generated, including control strategies and methods and an investigation into beneficial uses for the waste products generated; and c) Monitoring and reporting on matters relevant to the brine and waste to ensure compliance with the conditions of this environmental authority, including monitoring of groundwater.	The ROWTP has not yet been constructed and as such, conditions for treated MAW have not been incorporated into this REMP. Provision has been included in **Section 8.0** for these conditions to be addressed in the REMP prior to commissioning of the ROWTP.	8.0
C35 Receiving Environmental Monitoring Program (REMP) A REMP must be developed and implemented by an appropriately qualified person by 1 November 2023 to monitor, identify, and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised resource activity. This must include monitoring of the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water and/or treated MAW is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of Spring Creek and Lagoon Creek and connected or surrounding waterways. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised resource activity that will potentially be directly affected by an authorised release of mine affected water or treated MAW.	This Document and subsequent bi-annual review and reporting of the data.	5.1 and 7.4

Condition	Condition fulfilment	Section
C36 The REMP required by Condition C35 must address, but not be limited to, the following: a) a description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal variation (e.g. seasonality); b) a description of applicable environmental values, including but not limited to: i) hydrology (flow, duration, periodicity connectivity with groundwater systems); ii) physiochemical properties; iii) aquatic ecosystem parameters including flow and fauna habitat; and iv) geomorphological features; c) a description of water quality objectives to be achieved pursuant to the Environmental Protection (Water and Wetland Biodiversity) Policy 2019); d) any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed; e) water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during the REMP; f) monitoring for any potential and adverse environmental impacts caused by the release including impacts to bank stability and erosion; g) monitoring of stream flow hydrology; h) an assessment of bank stability and an evaluation of water course bank slumping; i) monitoring of physical chemical parameters including, as a minimum, those specified in Table C4: Receiving waters contaminant trigger levels and Table C7: Treated MAW Release Limits of this environmental authority and dissolved oxygen saturation to assess the extent of the compliance of concentrations with water quality objectives and/or the ANZG (2018) guidelines for slightly to moderately disturbed ecosystems;	This Document. The ROWTP has not yet been constructed and as such, conditions for treated MAW have not been incorporated into this REMP. Provision has been included in **Section 8.0** for these conditions to be addressed in the REMP prior to commissioning of the ROWTP.	All

Condition	Condition fulfilment	Section
j) monitoring of contaminants should consider the limits specified in Table C4: Receiving waters contaminant trigger levels and Table C7: Treated MAW Release Limits of this environmental authority to assess the extent of the compliance of concentrations with water quality objectives and/or the ANZG (2018) guidelines for slightly to moderately disturbed ecosystems; k) monitoring of metals/metalloids in sediments with consideration of ANZG (2018) guidelines, BATLEY and the most recent version of AS5667.4 Guidance on Sampling of Bottom Sediments; l) monitoring biological indicators (including but not limited to vertebrate and invertebrate species) for permanent, semi-permanent water holes and water storages using sampling techniques sufficient to reliably detect significant differences between impacts (test) and unimpacted sites; m) monitoring of a selection of zooplankton species to assess health (e.g. exoskeleton density) in respect to the availability of calcium and magnesium; n) the methods for analysis and interpretation of all monitoring results; o) the locations of monitoring points (including the locations of proposed background and downstream impacted sites for each release point); p) the frequency of scheduling of sampling and analysis sufficient to determine water quality objectives and to derive site specific reference values within two (2) years (depending on wet season flows) in accordance with the Queensland Water Quality Guidelines 2009. For ephemeral streams, this should include periods of flow irrespective of mine or other discharges; q) specify sampling and analysis methods and quality assurance and control; r) any historical data sets to be relied upon; s) description of the statistical basis on which conclusions are drawn; t) any control or reference sites; and u) record of planned and unplanned releases to watercourses, procedures for event monitoring, monitoring methodology used and procedure to establish background surface water quality.		
C37 The REMP Design Document must be updated and resubmitted to the administering authority whenever the release activities change, or the program is	**Section 8.0** of this document.	8.0

Condition	Condition fulfilment	Section
modified. The REMP Design Document must describe how the REMP will address the criterion in Conditions C35 and C36 of this environmental authority. Due consideration must be given to any comments made by the administering authority on the amended REMP Design Document and subsequent implementation of the program. NOTE: For guidance in preparing a REMP Design Document, please refer to the latest version of the Receiving environment monitoring program guideline – for use with environmentally relevant activities under the Environmental Protection Act 1994 (ESR/2016/2399), which is available on the department's website at www.ehp.qld.gov.au.		
C38 An Annual REMP Report must be prepared and submitted to the administering authority by 1 November each year reporting on compliance with Conditions C35 and C36.	**Section 7.0** of this document.	8.0

2.0 Description of Activity

2.1 Location of Activity

NAC mine is an open cut thermal coal mine owned by the NHG. It is located on the Darling Downs, adjacent to the township of Acland and approximately 18 km north- west of Oakey, Queensland.

2.2 Contaminants of Potential Concern

The main mine-derived contaminants of potential concern are (NHG 2014):

- Total suspended sediments – associated with mobilisation of soil particles in runoff from the mine site.
- Salinity – waste rock (especially weathered mine waste), soils and coal are a source of salts (particularly sulphate, sodium and chloride). Most waste rock samples were considered sodic.
- Acid-forming substances – most mine waste is non-acid forming, although a small proportion of waste (principally inter-burden) have slightly acidic pH. There have been no incidences of acid drainage to date, with mine affected waters having circum-neutral to base pH.
- Trace metals and metalloids - contained within waste rock and soils. Multi-element scans of solids found slight enrichment (relative to median crustal values) of antimony, arsenic, bismuth, cadmium, caesium, gallium, lithium, lead, selenium, mercury, silver, tungsten and zinc, although differences were not statistically significant. Manganese was the only metal to exceed Queensland EPA (1998) soil guideline value (in weathered and fresh overburden).
- Nutrients - nitrate is the main nutrient in waste rock, whereas other forms of nitrogen and phosphorus occur at low concentrations.
- Hydrocarbons – from machinery used in the mining process (spills, leaks etc.).

2.3 Mine Water Management, Discharge Location and Release Criteria

NHG (2018) assessed sources of various contaminant sources and mitigation measures to avoid or minimise impacts to water quality and aquatic ecosystems. In summary, the mitigation measures involve the following:

- Measures to minimise soil disturbance (exposed areas) on site. All areas of disturbance on site are kept to an operational minimum and are controlled by strict clearance protocols, involving detailed mine planning within pit areas and a ‘permit to disturb’ system for the rest of the site. Progressive rehabilitation is conducted to help keep exposed areas to an operational minimum. A 50 m conservation zone (no mining zone) is also maintained around natural waterways.
- As required, water management structures are appropriately protected to prevent scouring, particularly in areas of potential high or concentrated flow (e.g. drains, spillways, etc.). Sediment and erosion control strategies from the Best Practice Erosion and Sediment Control Guideline (BPESC Guideline) (IECA 2008) may be applied as required to specific issues as they arise (e.g. during construction near water courses).

- Stormwater runoff from undisturbed areas is diverted away from disturbed areas to waterways. Flow paths are maintained in a grassed state, reducing the potential for sediment transport off site. A flood levees also redirects mine-affected runoff from discharging directly to Lagoon Creek.
- Assessments of the integrity and effectiveness of erosion control measures are undertaken at regular periods and following significant rainfall event.
- Mine affected waters are diverted to sediment or environment dams, where sediments (and bound contaminants) are allowed to settle, and waters are treated if required. Sediment from sediment dams is periodically removed to maintain design capacity. Waters captured in sediment and environmental dams are used preferentially for dust suppression or as process water in the CHPP. Excess water is released (controlled discharges) to receiving environments only occur during certain (high) flow events and where it meets water quality criteria set out in license conditions.
- Runoff from industrial areas is managed through several water management measures including bunding in accordance with the applicable provisions of AS1940-2004, the use of oil and water separators and appropriate emergency controls. Spill capture and retention devices are installed in applicable areas as required (e.g. fuelling stations, etc.). All machinery is stored, refuelled and maintained outside the high banks of watercourses. Surface water runoff from these areas is be directed to a sediment dam / trap for treatment and then follow a grassed waterway to an environmental dam before release off site under discharge criteria outlined in the Mine's EA.
- Pit waters is used for make-up water and dust suppression, and runoff is captured as above.

Currently, mine waters are stored in three (3) environmental dams (ED1, ED3 and ED4) prior to release. ED2 was mined out in 2018 (currently no release).

Discharge of mine-affected water into Spring Creek occurs from ED1. Discharge into Lagoon Creek occurs from ED3 and ED4. The discharge locations of mine-affected water into the Lagoon Creek and Spring Creek are presented in **Table 2-1**, and shown in **Section 4.1**.

Three (3) additional environmental dams (ED5 – ED7) have been proposed. These new EDs will be located on the downstream edge of the pits. The EDs provide additional storage and treatment for water in significant rainfall events and mitigate against uncontrolled releases to the downstream environment. The additional environmental dams (ED5, ED6 and ED7) will discharge into Lagoon Creek.

Table 2-1 Location of discharge release points at New Acland Mine

Release Point	Latitude (decimal degrees)	Longitude (decimal degrees)	Size (mL)	Location	Monitoring Location	Monitoring Frequency	Receiving Waters
Existing Water Management Infrastructure							
ED1	27°15’40.5603” S	151°41’48.32659” E	126	Northwest mining lease boundary area (ML50170)	Overflow point from ED1	As soon as practical prior to, at least daily during and immediately after any release to waters from this point.	Spring Creek
ED2[1]	27°16’54.96167” S	151°41’36.83113” E	232	Downstream of the tailings dam, southwest mining lease boundary area (ML50170)	Overflow point from ED2	As soon as practical prior to, at least daily during and immediately after any release to waters from this point.	Lagoon Creek
ED3	27° 18’ 29.86677” S	151° 43’ 03.04606” E	45	Southern mining lease boundary (ML50216)	Overflow point from ED3	As soon as practical prior to, at least daily during and immediately after any release to waters from this point.	Lagoon Creek
ED4	27° 17’ 38.43301” S	151° 41’ 29.26048” E	TBA	Western mining lease boundary (ML50416)	Overflow point from ED4	Real-time data to be monitored during active release for pH and EC. If real-time data is unavailable, daily monitoring of pH and EC must occur as soon as possible after commencement, when safe access permits. Water samples for laboratory analysis to be taken weekly during active release only.	Lagoon Creek

Release Point	Latitude (decimal degrees)	Longitude (decimal degrees)	Size (mL)	Location	Monitoring Location	Monitoring Frequency	Receiving Waters
ED5	TBA	TBA	250	Southwest of Manning Vale West final pit extent	TBA	TBA	Lagoon Creek
ED6	TBA	TBA	250	South of Manning Vale East final pit extent	TBA	TBA	Lagoon Creek
ED7	TBA	TBA	350	Southeast of Willeroo final pit extent	TBA	TBA	Lagoon Creek

[1] Environmental Dam 2 was mined out in 2018, the overflow point will be reconstructed if the dam is reinstated.

TBA = To be announced

The EDs will receive pit water and thus may contain contaminant concentrations, most notably high levels of salinity. A controlled release system proposed for the new EDs will be based on specific water quality targets to allow water from a significant rainfall event to be removed from the site. As indicated in the EA conditions (**Appendix A**), the release of mine-affected water from the listed discharge location must comply with strict physio-chemical characteristics (**Section 3.2.2.1**).

Table 2-2 Mine-affected water quality release limits

Parameter	Minimum	Maximum	Monitoring frequency
EC (µs/cm)	325	510	Real time telemetry.
pH	6.0	9.0	Daily grab samples, within 2 hours of commencement of release if telemetry unavailable.
TSS (mg/L)	-	100	Daily during release, within 2 hours of commencement of release.

The EA also states that release of waters must only occur where there is an existing minimum flow in receiving waters upstream of the discharge point to provide adequate dilution such that 1,500 µs/cm is not exceeded outsider of the 50 m mixing zone. Due to the ephemeral nature of Spring Creek and Lagoon Creek, the opportunity for release of large volumes of mine-affected water is heavily restricted. The electrical conductivity (EC) release limits for mine-affected water release during flow events are presented in **Table 2-3** over-page.

Table 2-3 Mine-affected water release during flow events

Receiving waters	Release Point (RP)	Gauging station Latitude (GDA94)	Gauging station Longitude (GDA94)	Receiving Water Flow Criteria for Discharge (m^3/s)	Maximum release rate (for all combined RP flows)	Electrical Conductivity Release Limits
Lagoon Creek	ED2	27º 16' 54.96167" S	151º 41' 36.83113" E	**Low flow** <46.3 L/sec for a period of 28 days after natural flow events that exceed 4 ML/d	<17.4 L/sec	700
	ED3	-27° 18' 29.86677" S	151° 43' 03.04606			
	ED4	27° 17' 38.43301" S	151° 41' 29.26048" E			
	ED5	TBA	TBA	**Medium Flow (low)** >46.3 L/sec	<17.4 L/sec	1,500
	ED6	TBA	TBA		<8 L/sec	2,500
	ED7	TBA	TBA		5.8 L/sec	3,500
				Medium flow (high) >133 L/sec	< 48.6 L/sec	1,500
					< 23 L/sec	2,500
					< 15 L/sec	3,500
				High Flow >405 L/sec	< 144.7 L/sec	1,500
					< 92.6 L/sec	2,500
					<69.4 L/sec	3,500
Spring Creek	ED1	27º 15' 40.56603"S	151º 41' 48.32659" E	**Low flow** < 46.3 L/sec for a period of 28 days after natural flow events that exceed 46.3 L/sec	<17.4 L/sec	700

3.0 Description of the Receiving Waters

3.1 Background

For this REMP, the receiving waters are defined as the waters of Spring Creek and Lagoon Creek, downstream of some, or all, of the current and proposed New Acland mine EDs and mine infrastructure.

Spring Creek and Lagoon Creek are ephemeral creeks with shallow, narrow poorly defined channels and wide floodplains. Lagoon Creek has a relatively small upstream catchment area of approximately 200 km^2, and for the majority of the year it is restricted to a series of disconnected pools in the form of artificially constructed farm dams. Spring Creek is a tributary of Myall Creek, which merges into the Condamine River. Lagoon Creek merges with Oakey Creek south of the site and ultimately forms part of the Condamine River.

The receiving environment is part of the Condamine-Balonne River Catchment, which is located in southern Queensland and northern New South Wales, covering about 14% of the Murray−Darling Basin. The catchment is bordered by the Great Dividing Range to the east, the Warrego region to the west, and by the Border Rivers, Moonie and Barwon-Darling regions to the south and is one of the largest catchments in the Murray–Darling Basin.

The climate in the Condamine River catchment is variable, ranging from sub-tropical in the east to semi-arid in the west. Rainfall varies between years and seasons, with the majority occurring between October and March (CBWC 2002). Stream flow is almost restricted to rainfall run-off during storm events, thus the flow regime is unpredictable and intermittent.

The region is one of the most intensively farmed landscapes in eastern Australia, supporting grazing and dryland crops. As a consequence of increasing population, changing land use, construction of weirs and dams and extraction of water, the catchment's ecology and hydrology has been greatly altered (MDBA 2015).

The specific land use within the area of the receiving waters includes a combination of grazing and cropping on small farms, in addition to limited areas of urban settlement. Most of the remnant vegetation has been cleared for agriculture production. Limited vegetation remains along Lagoon Creek, with contour banks across much of the arable land surrounding the receiving waters, to manage runoff and reduce erosion across the cleared landscape (EIS, 2014). There are several in- stream dams within both Lagoon and Spring Creek.

Spring Creek and Lagoon Creek have been moderately disturbed through past and current agricultural practices. For the purposes of this assessment, waterways are considered to represent 'slightly to moderately' disturbed (SMD) aquatic ecosystems, based on ANZG (2018) definition due to the following:

- Riparian zone is in poor condition and has been moderately disturbed by surrounding land-use, predominately cattle damage.
- The vegetation within the riparian zone of the receiving environment has been mostly cleared with only small sections of native riparian vegetation remaining.
- Cleared catchment.
- The receiving environment supporting a poor community of non-threatened aquatic macroinvertebrates and fish indicated by previous surveys.

3.2 Previous Surveys

Previous surveys of receiving waters were compiled by BMT during development of the original REMP (BMT, 2019) for NAC Stage 3 Project EIS. A summary of the compiled information is provided below.

Desktop Review

Database searches were conducted within a 25 km radius of the aquatic ecology study area, which included larger watercourses with permanent surface water. Reviews of literature were conducted to determine the distribution of aquatic fauna and flora, Endangered, Vulnerable and Near Threatened (EVNT) species, special least-concern species, and protected areas including wetlands and sensitive environments. A range of resources were used included EPBC Act Online Protected Matters database, EHP Wildlife Online database and Queensland Museum database.

January 2008 Aquatic Ecology Survey

An aquatic ecology survey was performed during a period of no-flow between the 23rd and 24th January 2008. Four sites along Lagoon Creek (**Table 3-1**) were selected based on available water and were surveyed for water quality, aquatic habitat, flora and fauna.

March 2013 Aquatic Ecology Survey

A wet season aquatic habitat surveys was conducted on 7th March 2013 at four sites along Lagoon Creek area to assess aquatic habitat (**Table 3-1**).

Long-term Water Quality Monitoring (NAC)

NAC, as a requirement of their EA, has routinely conducted water quality measurements for the basic suite of parameters at three sites along Lagoon Creek (**Table 3-1**).

Table 3-1 Survey site locations

Survey	Site Code	Site Location on Lagoon Creek
January 2008 Aquatic Ecology Survey	AE1	Upstream of the Manning Vale East Pit and Willeroo
	AE2	Mine Pit
	AE3	Downstream of the Willeroo Mine Pit
	AE4	Upstream of the Manning Vale East Pit and Willeroo
March 2013 Aquatic Ecology Survey	AH4	Adjacent to Manning Vale East Pit and Willeroo Mine Pit
	AH6	Downstream of Willeroo Mine Pit
	LCU1	Upstream of the mine discharge points
	LCD1	Downstream of the mine discharge points.
Long-term Water Quality Monitoring (NAC)	LCU1	Upstream of the mine discharge points
	LCD1	Downstream of the mine discharge points.
	LCD2	In the approximate location of the proposed Manning Vale East pit

3.2.1 Water Level

Water level loggers were installed by NHG in September 2010 at two sites on Lagoon Creek – one upstream of the mine and one downstream of the mine (refer to for locations). The water level data from both sites is presented in **Figure 3-1** and **Figure 3-2**.

Figure 3-1 Upstream Water Level Logger

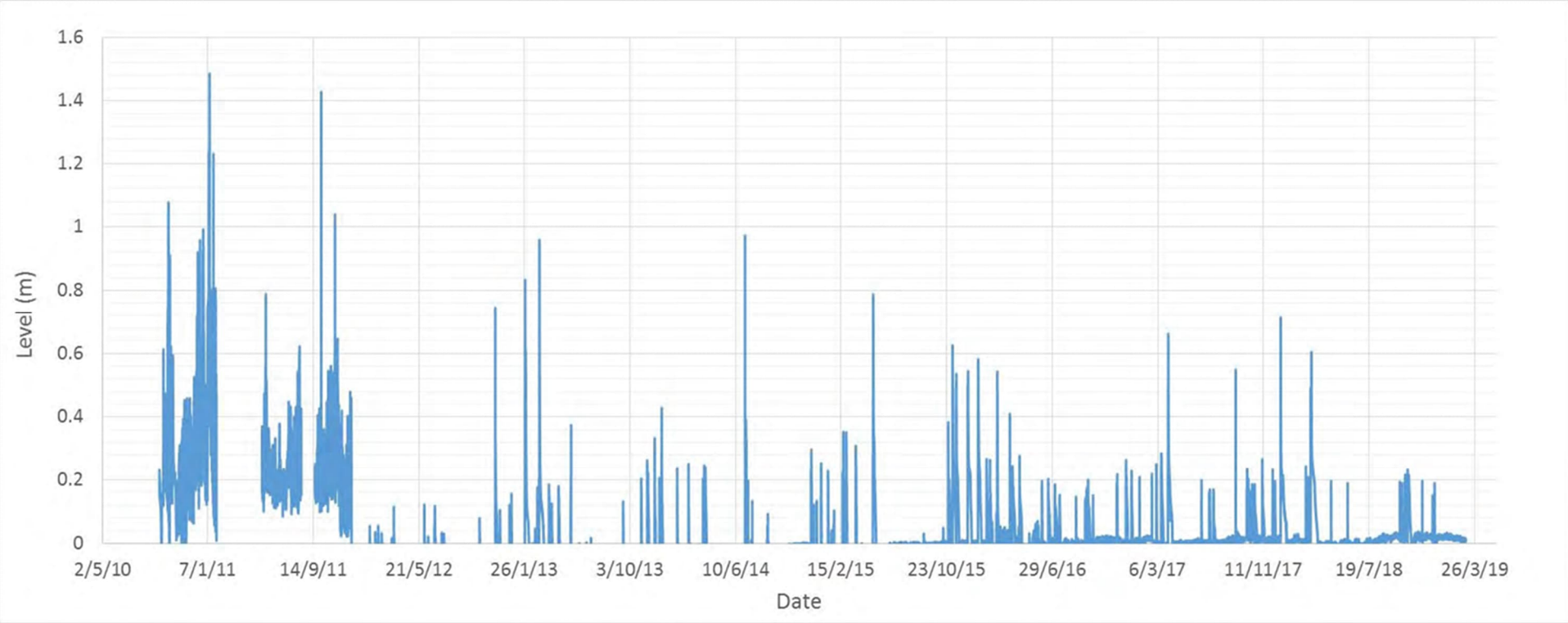
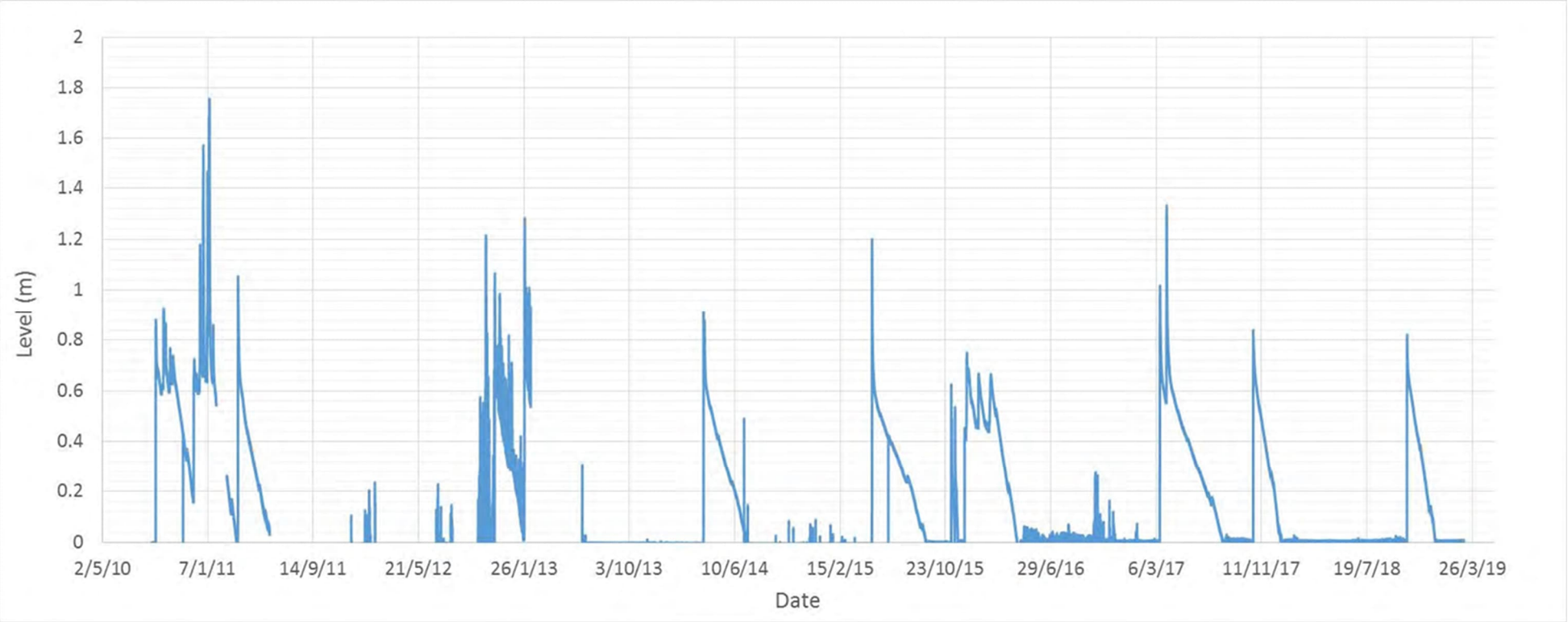


Figure 3-2 Downstream Water Level Logger



3.2.2 Water Quality

Relevant historical water quality monitoring for Lagoon Creek is limited. The Department of Natural Resources, Mines and Energy (DNRME) operates a water quality gauge on Oakey Creek at Fairview downstream of the confluence with Lagoon Creek. However, it is unlikely to be representative of that in Lagoon Creek as it is influenced by other factors including releases from the Toowoomba Water Treatment Facility.

There have been several water quality monitoring events conducted within the receiving waters at various times and sites, as listed in **Table 3-1**. The most consistent water quality monitoring has been performed by NAC for the basic suite of parameters, which has been conducted under NAC's EA.

The following summarises trends in water quality data compared to default ANZECC / ARMCANZ (2000) guideline values (DGV) for the protection of aquatic ecosystems (BMT, 2019).

3.2.2.1 Physio-chemical Stressors

Long-term monitoring conducted by NAC found that median pH and EC values were higher at downstream test sites than those upstream. pH and EC values exceeded the DGV at both test sites (**Table 3-2**). During the 2013 flow event (**Table 3-3**), EC at all sites was below DGV, however the EC recorded during the 2008 no-flow event exceeded the DGV at all but one site. pH recorded in the 2008 survey was higher than DGVs recorded in 2013, although all measurements were within the range recorded in NAC's long-term monitoring program (**Table 3-2**, **Table 3-3**).

Dissolved oxygen did not meet DGVs at two of the sites during the 2008 no-flow event. DO levels were lower during the 2013 flow period, with all sites below DGVs. The low concentrations of DO during streamflow were suggested to be due to the decomposition of suspended and dissolved organic matter in the rainfall run-off (EIS, 2014) (**Table 3-2**, **Table 3-3**).

Turbidity was variable among sites during periods of both flow and no-flow and exceeded DGVs at three sites (**Table 3-2**, **Table 3-3**).

3.2.2.2 Nutrients and Major Ions

Total and filterable fractions of nitrogen and phosphorus exceeded DGVs at all sites monitored during the 2013 flow event. Total nitrogen was similar between sites and ammonia concentrations were high at the upstream site (**Table 3-3**). High total phosphorus levels are common within the waters of the Condamine Catchment have been attributed to the impacts of agriculture (CBWC 1999). Furthermore, the high concentrations of nutrients in Lagoon Creek during streamflow indicate mobilisation nitrogen and phosphorus from agricultural catchment run-off.

Concentrations of major ions were similar among sites with no spatial trend evident (**Table 3-3**).

3.2.2.3 Dissolved Metals and Toxicants

Dissolved concentrations of most metals and metalloids were below DGVs, the exception being copper, which exceeded the DGV at all sites.

Pesticides and hydrocarbons were below detection laboratory limits at all sites (**Table 3-3**).

Table 3-2 Long-term water quality data (Source NAC unpublished)

Site	Date	Temp (˚C)	Suspended Solids (mg/L)	Turbidity (NTU)	pH	DO (% sat.)	Sulphate (mg/L)	EC (µS/cm)
ANZECC Default Guideline Value		**N/A**	**N/A**	**<25**	**6.5-7.5**	**90-110%**	**<250***	**<350**
Environmental Authority Monitoring								
LCU1	2008-2013	22.4 (15.5-30.5)	18 (2-179)	N/A	7.46 (6.6-8.4)	N/A	2 (1-190)	210.0 (97-590)
LCD1	2008-2013	3.8 (17.9-29.6)	11 (1-335)	N/A	**7.80 (7.3-8.9)**	N/A	25 (3-220)	**418.5** (176-**3,900**)
LCD2	2008-2013	23.4 (19.3-29.6)	10 (2-353)	N/A	**7.80 (7.4-8.9)**	N/A	30 (1-200)	**596.0** (136-**1,700**)
In-situ sampling No Flow Event (January 2008)								
Lagoon Creek (Site 1)	23/1/2008	31.4	N/A	**94.9**	**8.90**	**111.7**	N/A	**596.4**
Lagoon Creek (Site 2)	23/1/2008	26.3	N/A	**33.3**	**8.91**	95.2	N/A	**463.1**
Lagoon Creek (Site 3)	23/1/2008	26.0	N/A	3.1	**8.03**	94.7	N/A	**8,089.6**
Lagoon Creek (Site 4)	24/1/2008	26.9	N/A	20.4	**8.52**	**65.6**	N/A	**642.1**
Lagoon Creek (Site 5)	24/1/2008	30.9	N/A	16.9	**8.69**	92.1	N/A	**636.9**

Note: Bold indicates exceedance of guideline values, shaded cells indicate median exceeds guideline values. * sulfate guideline value from EA adopted as no default ANZG, 2018 guideline value

Table 3-3 Water quality monitoring during a period of flow (March 2013)

Water quality variable	Unit	Guideline Value	LCU1	LCD1	AE4	DS1
Flow*	N/A	None	Yes	Yes	Yes	Yes
Temperature*	°C	N/A	23.9	25.9	21.9	21.6
Dissolved oxygen	%	90-110%	**15**	**51.8**	**44.3**	**46**
pH	pH Units	6.5-7.5	7	7.5	7.6	7.4
Electrical conductivity	µS/cm	<350	240	310	240	280
Turbidity	NTU	<25	8.6	55	19	10
Total nitrogen	mg/L	<0.25	**1.4**	**0.84**	**1.2**	**0.97**
Ammonia	mg/L	<0.010	**0.35**	**0.037**	**0.061**	**0.04**
Total phosphorus	mg/L	<0.030	**0.15**	**0.12**	**0.31**	**0.26**
Filterable reactive phosphorus	mg/L	<0.015	**0.052**	**0.059**	**0.18**	**0.17**
DIN	mg/L	None	**0.02**	**0.29**	**0.02**	<0.02
Sodium#	mg/L	None	12	32	15	15
Sulphate#	mg/L	None	1	20	4	5
Total hardness# mg/L	mg/L	Level 1 >150 Level2 > 200	95	84	98	110
Calcium*	mg/L	None	20	15	23	22
Magnesium*	mg/L	None	5.9	8.4	7.7	8
Potassium*	mg/L	None	10	6	12	11
Fluoride*	mg/L	None	<0.1	0.6	0.2	0.1
Chloride*	mg/L	None	9	26	10	13
Dissolved metals						
Arsenic (As)	mg/L	<0.013	0.002	0.001	0.002	0.002
Chromium (Cr)	mg/L	<0.0027	BDL	BDL	BDL	BDL
Copper (Cu)	mg/L	<0.0014	0.002	0.003	0.004	0.003
Manganese (Mn)	mg/L	1.9	0.001	BDL	0.022	0.001
Mercury (Hg)	mg/L	<0.00006	BDL	BDL	BDL	BDL
Nickel (Ni)	mg/L	<0.011	0.005	0.002	0.004	0.004
Zinc (Zn)	mg/L	<0.008	BDL	BDL	0.006	BDL
Barium (Ba)*	mg/L	None	0.039	0.028	0.069	0.061
Beryllium (Be)*	mg/L	None	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)*	mg/L	None	<0.001	<0.001	<0.001	<0.001
Vanadium (V)*	mg/L	None	0.002	0.004	0.008	0.005

* indicates no guidelines currently available

shows water quality indicator values used for protection of drinking water supply, all other guideline values are DGVs for the protection of aquatic ecosystems

Below detection limits (BDL) indicates the variable was below detection limits of the laboratory analysis. Shaded and bold values indicate exceedance of the relevant guideline

3.2.3 Aquatic Flora

Previous field and desktop surveys have indicated that 24 aquatic flora species have been identified to be distributed within the receiving waters and broader Condamine Catchment area. Of these, five are introduced species, 21 are emergent form species and three are submerged forms. There were no identified species listed as Endangered, Vulnerable and Near Threatened (EVNT) species or special concern species (**Table 3-4**).

The Condamine Catchment generally supports low macrophyte richness and abundance (Hydrobiology 2010). Ephemeral creeks are typically dominated by emergent species, as submerged macrophytes are sensitive to desiccation when creeks run dry, and generally support a lower diversity and coverage of macrophytes compared to perennial creeks (Hydrobiology 2010). Furthermore, ephemeral creeks within the Condamine Catchment are typically highly turbid (CBWC 2002) which further reduces submerged macrophyte growth due to insufficient light penetration.

Despite the small catchment area and ephemeral nature of Lagoon Creek, the in-stream dams have provided surface water environments that support emergent macrophyte communities.

Table 3-4 Aquatic Flora recorded from previous field and desktop surveys (EIS, 2014)

Species	Common Name	Status, form	Recorded from the Study Area	Source
Bolboschoenus fluviatilis	Marsh clubrush	Native, emergent	No	WO, GC
Cyperus eragrostis	Umbrella sedge	Introduced, emergent	No	WO
Cyperus exaltus	Giant sedge	Native, emergent	No	GC
Damasonium minus	Starfruit	Native, emergent	No	GC
Eleocharis acuta	Common spike-rush	Native, emergent	Yes	WO, LC
Eleocharis cylindrostachys	Unknown	Native, emergent	No	WO
Eleocharis sphacelata	Tail spike-rush	Native, emergent	Yes	LC
Fimbristylis dichotoma	Common fringe-rush	Native, emergent	No	WO
Juncus bufonius	Toad rush	Introduced, emergent	No	WO
Juncus flavidus	Rush	Native, emergent	No	WO
Juncus polyanthemus	Unknown	Native, emergent	No	WO
Juncus subglaucus	Unknown	Native, emergent	No	WO
Juncus subsecundus	Finger rush	Native, emergent	No	WO
Juncus usitatus	Common rush	Native, emergent	Yes	WO, LC
Leptochloa digitata	Umbrella canegrass	Native, emergent	No	GC
Ludwigia spp.	Water primrose	Native, emergent	Yes	WO, LC, CC
Persicaria attenuata	Unknown	Native, emergent	No	GC
Phragmites australis	Common reed	Native, emergent	No	

Species	Common Name	Status, form	Recorded from the Study Area	Source
Pontederia cordata	Pickerel weed	Introduced, emergent	Yes	LC
Potamogeton crispus	Curly pondweed	Native, submerged	No	WO
Potamogeton perfoliatus	Perfoliate pondweed	Native, submerged	No	WO
Ruellia simplex, R. tweediana	Ruellia, Mexican bluebell	Introduced, emergent	No	WO
Rumex crispus	Curled dock	Introduced, emergent	No	GC
Vallisneria nana	Ribbon weed	Native, submerged	No	WO

WO indicates record sourced from Wildlife online database search. LC refers to Lagoon Creek field survey, CC refers to Charleys Creek (Hydrobiology 2010), GC refers to Gowrie Creek (Aquateco 2011).

3.2.4 Aquatic Macroinvertebrates

Aquatic macroinvertebrates are commonly used as indicators of the health of a water body. There is large diversity of aquatic macroinvertebrates, with different taxa reacting differentially to environmental stressors. These responses allow for a range of indices to be calculated (e.g. Stream Invertebrate Grade Number Average Level (SIGNAL) from each sample of macroinvertebrates collected and then applied for assessments of different stressors (Negus et al. 2014).

The macroinvertebrate community within the receiving environment is not well known. A dry season study in 2008 recorded a total of 31 families/higher level taxa, of which none had local or regional significance. The average signal scores at all four sites were less than 3.5 (Table 3-5), which is indicative of environmental degradation. The low SIGNAL scores of the Condamine basin have been attributed to a range of stressors including river regulation, agriculture, clearing of vegetation and urban development (Hydrobiology 2010).

3.2.5 Macro-crustaceans

The dry season survey in 2008 recorded the freshwater crayfish (*Cherax spp*.) at sites AE1 and AE3, and the Australian freshwater prawn (*Macrobrachium australiense*) at site AE4. Both groups are common and widely distributed in the Condamine catchment, including disturbed aquatic habitats (Hydrobiology 2010).

Table 3-5 Macroinvertebrate presence/ absence and SIGNAL-2 Scores at surveyed sites

Family Name	Site AE1	Site AE2	Site AE3	Site AE4
Hydridae (2)			3	30+
Bithyniidae (3)		2		
Thiaridae (4)	30+			30+
Physidae (1)	1			4
Planorbidae (2)		25		
Lymnaeidae (1)			1	2
Ancylidae (4)				4

Family Name	Site AE1	Site AE2	Site AE3	Site AE4
Sphaeriidae (5)	3			16
Corbiculidae (5)				1
Atyidae (3)				30+
Parastacidae (4)			4	1
Acarina (6)	1	14		
Baetidae (5)	1	1	15	30+
Caenidae (4)		2		1
Aeschnidae (4)			13	2
Libellulidae (4)		4	2	5
Coenagrionidae (2)		2	30+	30+
Nepidae (3)		2		
Notonectidae (1)	15		30+	30+
Corixidae (2)	30+	7	30+	30+
Pleidae (2)		1		
Psephenidae (6)	1			
Curculionidae (2)		1		
Dytiscidae (2)	3	22	3	1
Haliplidae (2)		2		
Hydrophilidae (2)	1		2	6
Tipulidae (5)		1		
Culicidae (1)			7	1
Chironomidae (3)	13	13	30+	30+
Ceratopogonidae (4)	1		3	
Leptoceridae (6)		30+	30+	30+
No. of Taxa	12	15	16	21
Total Signal Score	41	50	46	65
Av. Signal Score	3.42	3.33	2.88	3.1

3.2.6 Fish

A total of 18 fish species are known or likely to occur within the study area and/or the catchment (Table 3-6). Two of these species, common carp (*Cyprinus carpio*) and eastern gambusia (*Gambusia holbrooki*) were introduced species and are declared pest species under the Fisheries Act 1994. The remaining 16 species are native to the Condamine catchment. One species, the Murray cod (*Maccullochella peelii*), is listed as vulnerable and may occur or may have habitat that occurs within the aquatic ecology study area.

A field survey undertaken during January 2008 recorded two native fish species (spangled perch *Leiopotherapon* unicolor and gudgeon *Hypseleotris* spp.) and one exotic fish species (*Gambusia holbrooki*) in Lagoon Creek. Lagoon Creek fish assemblages would need to tolerant of degraded physical habitat (instream barriers, degraded bed and banks) and water quality conditions, and/or have the capacity to recolonise following creek drying.

Table 3-6 Fish recorded from desktop and field surveys within the study area and the broader catchment

Species	Common NaME	Status	Recorded from Study Area	Likelihood of Occurrences	Sources
Ambassis agassizii	Agassiz's glassfish	Native	No	Unlikely	WO
Carassius auratus	Goldfish	Introduced	No	Likely	CC, WC
Craterocephalus stercusmuscarum	Flyspecked hardyhead	Native	No	Possible	WO, QM, GC
Cyprinus carpio	Common Carp	Introduced	No	Observed	WO, CC, WC, GC
Gambusia holbrooki	Mosquitofish	Introduced	Yes	Observed	WO, LC, CC, GC
Gadopsis marmoratus	River blackfish	Native	No	Unlikely	WO, GC
Hypseleotris spp.	Gudgeon species	Native	Yes	Observed	LC, CC
Hypseleotris sp. 1	Midgley's carp gudgeon	Native	No	Unlikely	WO
Hypseleotris klunzingeri	Western carp gudgeon	Native	No	Unlikely	WO, QM, WC
Leiopotherapon unicolor	Spangled perch	Native	Yes	Observed	WO, LC, GC
Maccullochella peelii	Murray cod	Native, Vulnerable	No	Unlikely	WO
Macquaria ambigua	Golden perch	Native	No	Unlikely	WO
Melanotaenia duboulayi	Crimson spotted rainbowfish	Native	No	Unlikely	WO
Melanotaenia fluviatilis	Murray River rainbowfish	Native	No	Possible	WO, QM
Mogurnda adspersa	Purple-spotted gudgeon	Native	No	Unlikely	
Nematalosa erebi	Bony beam	Native	No	Unlikely	
Retropinna semoni	Australian smelt	Native	No	Possible	
Tandanus tandanus	Eel-tailed catfish	Native	No	Unlikely	

Note: WO indicates record sourced from Wildlife online database search, LC refers to the 2008 Lagoon Creek field survey, CC refers to Charleys Creek (Hydrobiology 2010), GC refers to Gowrie Creek (Aquateco 2011)

3.3 Environmental Values

An Environmental Value (EV) is the value placed on the waterbody by the community, as outlined in the Environmental Protection (Water) Policy 2009 (EPP Water). EVs are essentially the goals that the community wants to achieve for their waterways. In 2020, the EVs for surface waters of the Condamine River basin were released (Newham et al. 2017). The receiving environment covered two sub-regions: Central Condamine River (Lagoon Creek) and Upper Myall Creek (Spring Creek). The EVs for the receiving environment are shown in **Table 3-7**.

Table 3-7 Condamine River Basin Surface Water Environmental Values

Condamine River Basin Sub-Region	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial values
Lagoon Creek												
Central Condamine River	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Spring Creek												
Upper Myall Creek	✓	✓	✓	✓		✓			✓			✓

✓ means the Environmental Value is selected for protection. Blank indicates that the Environmental Value is not selected for protection.

3.4 Water Quality Objectives

The Central Condamine River (Lagoon Creek) and Upper Myall Creek (Spring Creek) EVs provide water quality objectives (WQOs) to ensure it is suitable for supporting aquatic ecosystems and human water uses. These EVs need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use.

There are no WQOs provided for Upper Myall Creek. The WQOs provided for the Central Condamine River are as follows: ammonium nitrogen (ammo N), oxidised nitrogen (N), total N, filterable reactive phosphorus (FRP), total phosphorous (P), chlorophyll-a (Chl-a), dissolved oxygen (DO), turbidity (T), total suspended solids (SS), pH, conductivity, sulfate and alkalinity. It is noted, however, the creek systems listed do not relate to mine site. Listed creeks include Hodgson Creek at Balgownie and Kings Creek at Aides Bridge.

3.5 Water Quality Guidelines

Surface water quality guidelines are derived to protect a specific EV of a waterway. They are based on the condition of aquatic ecosystems and the levels of protection provided to those ecosystems. For the aquatic ecosystem EV, the EPP Water identifies four levels of protection per the current condition of waters: high ecological value, slightly disturbed, moderately disturbed and highly disturbed. In the context of the receiving environments relevant to the REMP, all are classified as moderately disturbed ecosystems. Moderately disturbed ecosystems are defined as waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree. Guidelines have been derived for annual application for base (low) and event (high) flow conditions.

The receiving waters contaminant trigger levels as outlined in the EA and ANZG (2018) are provided in **Table 3-8**. The EA trigger levels have been adopted until Site specific criteria can be established using a minimum of 4 data sets. In the interim, Default guideline values (DGVs) from ANZG (2018) have also been provided for context.

Table 3-8 Water quality guideline values for the receiving environment

Parameter	Units	EA[1]	ANZG (2018)
		Trigger Levels	DGV - 95% species protection (toxicity)
pH	-	6.5-9.0	**6.5-7.5**
Electrical Conductivity	µS/cm	700	**350**
Total Suspended Solids	mg/L	65	-
Aluminium	µg/L	55	55 (if pH>6.5)
Arsenic	µg/L	13	13
Cadmium	µg/L	0.2	0.2
Chromium	µg/L	1	1
Copper	µg/L	2	**1.4**
Iron	µg/L	300	-
Lead	µg/L	4	**3.4**
Mercury	µg/L	0.2	**0.06^**
Nickel	µg/L	11	11
Zinc	µg/L	8	8
Boron	µg/L	370	**940**
Cobalt	µg/L	90	**1.4**
Manganese	µg/L	1,900	1,900
Molybdenum	µg/L	34	34
Selenium	µg/L	10	**5^**
Silver	µg/L	1	**0.05**
Uranium	µg/L	1	**0.5**
Vanadium	µg/L	10	**6**
Ammonium N	µg/L	-	-
Ammonia	µg/L	900	900
Nitrate	µg/L	1,100	**2,400***
Oxidised N	µg/L	-	-
Total N	µg/L	-	-
Filterable Reactive P	µg/L	-	-
Total P	µg/L	-	-
Chlorophyll-a	µg/L	-	-

Parameter	Units	EA[1]	ANZG (2018)
		Trigger Levels	DGV - 95% species protection (toxicity)
Dissolved Oxygen	% saturation	-	-
	mg/L	-	-
Turbidity	NTU	-	-
Alkalinity	mg/L $CaCO_3$	-	-
Sodium	µg/L	To be determined	-
Petroleum hydrocarbons (C_6-C_9)	µg/L	20	-
Petroleum hydrocarbons (C_{10}-C_{36})	µg/L	100	-
Fluoride	µg/L	2,000	-
Sulfate	mg/L	250	-

[1] Limits as per Table C4: Receiving waters contaminant trigger levels of the EA.

^ ANZG (2018) default guideline values for 95% species protection, except for mercury and selenium which are 99% species protection as recommended in Section 8.3.5.7 of the ANZECC/ARMCANZ (2000) if there are no data to allow for adjustment for bioaccumulation at the specific site.

* ANZG (2018) states that the ANZECC/ARMCANZ (2000) default guideline value for nitrate was erroneous and recommends reference to the "Grading" guideline values published in the report *Updating nitrate toxicity effects on freshwater aquatic species*, used to inform the current New Zealand nitrate toxicity attribute.

Bolded values indicate ANZG DGVs which are more conservative than the EA Trigger Levels.

3.6 In-Stream Sediment Quality Guideline Values

Sediment monitoring will be undertaken as part of the REMP, with sampling locations corresponding with the water quality monitoring locations. **Table 3-9** summarises the metal and metalloids to be measured at each sampling site together with the Sediment Quality Guideline Values (SQGV) outlined in the Simpson et al. (2013).

In accordance with the Simpson et al. (2013), concentrations below the corresponding SQGV are considered low risk with no further action required. Concentrations between the SQGV and SQG-High value require background concentrations to be examined. Concentrations above the SQG-High require further investigation into the factors affecting bioavailability.

In addition, distribution of sediment grain size (PSD analyses) will be investigated. Fine sediments (<64 µm in size, such as silts) typically display higher concentrations of metals and metalloids than sediment with larger sized grains (such as sand). This reflects the tendency of most metals and metalloids to blind more readily with finer sediment fractions.

Table 3-9 Sediment monitoring parameters and guideline values

Parameter	Unit	SQGV	SQG- High
Basic characteristics			
Particle Size Distribution (sieve and hydrometer)	µm	-	-
Moisture Content (%)	%	-	-
Metals and Metalloids			
Aluminium	mg/kg	-	-
Arsenic	mg/kg	20	70
Cadmium	mg/kg	1.5	10
Chromium	mg/kg	80	370
Copper	mg/kg	65	270
Lead	mg/kg	50	220
Mercury	mg/kg	0.15	1
Nickel	mg/kg	21	52
Silver	mg/kg	1	4
Zinc	mg/kg	200	410
Boron	mg/kg	-	-
Iron	mg/kg	-	-
Cobalt	mg/kg	-	-
Manganese	mg/kg	-	-
Molybdenum	mg/kg	-	-
Selenium	mg/kg	-	-
Uranium	mg/kg	-	-
Vanadium	mg/kg	-	-
Organics			
Total PAHs	µg/kg	10,000	50,000
TPHs	mg/kg	280	550
BTEX			
Benzene	mg/kg	-	-
Toluene	mg/kg	-	-
Ethylbenzene	mg/kg	-	-
Xylene	mg/kg	-	-

4.0 Monitoring Program Design

4.1 Sampling Locations

Lagoon Creek and Spring Creek are intermittent headwater streams that have a 'flashy' flow regime, experiencing short duration flow events lasting for hours to days (**Section 3.2.1**). Temporary pools form in the channel during non-flow periods, many of which are artificial habitats created by the construction of low earthen 'bunds' within the waterway (i.e., in-channel farm dams).

There are three (3) different sample sites referred to as reference (background) sites, test (downstream) sites and control (upstream) sites, which are described in the following subsections.

Monitoring will be undertaken at ten (10) locations within Lagoon Creek and two (2) sites within Spring Creek (**Figure 4-3)**.

4.1.1 Reference (Background) Sites

Reference sites are typically defined as sites that are considered to relatively undisturbed conditions and are used to develop site-specific water quality objectives. It should be noted that the nominated reference sites are not in 'pristine' condition and are influenced by surrounding and upstream catchment users. As outlined in the Queensland Water Quality Guidelines (DES, 2018), good control (reference) sites are difficult to locate and a least disturbed site can be used as an alternative.

For the purpose of this document, sites LCU1 and SCCU1 will serve as the adopted 'reference' sites (refer to **Figure 4-3** and Table C5 of the EA). These reference sites:

- Are representative of aquatic habitat (i.e., high order ephemeral streams with a sandy substrate) and flow conditions found with Lagoon Creek and Spring Creek.
- Are located outside the influences of mine waters.
- Are lotic features rather than impounded (lentic) waters (i.e., outside farm dams).
- Are relatively undisturbed compared to other sites on these waterways.

The selected reference sites will enable spatial and temporal trends to be separated from those that may have been caused of the release of mine-affected water. A description of these reference sites is provided below.

LCU1

Site LCU1 is located on Lagoon Creek and is an intermittent, first order stream. The aquatic ecosystem is representative of control and test sites further downstream. The surrounding land use is dry land grazing. This site occurs upstream (but outside the impoundment) of a small in-stream farm dam. The site has semi-continuous riparian vegetation with some shading of the waterbody. Emergent macrophytes are present along the banks of the waterway, and macrophyte cover is typically limited to the littoral margins. The bed substrate is comprised of clays and silts.

Where possible, sampling will be undertaken in the main channel of the site when sufficient water is present. **Figure 4-2** provides a view of upstream (left column) and downstream (right column) habitat from November 2015 to October 2018 (BMT, 2019).

SSCU1

Site SSCU1 is an intermittent (first order) stream on the main channel of Spring Creek. The aquatic ecosystem is representative of the test site on Spring Creek but is unaffected by mine waters. This site occurs upstream (but outside the impoundment) of a small in-stream

farm dam. The surrounding land use is predominantly low intensity dry land grazing. The site has limited riparian vegetation and patches of emergent macrophytes are present. Bed sediments are comprised of sandy silts and clays.

4.1.1.1 Alternative Reference Sites Not Adopted

There are no available reference sites upstream of LCU1 and SSCU1 on Lagoon and Spring creeks due to lack of pool habitat and/or access constraints.

There is a lack of suitable reference sites in surrounding catchments due to the intensive nature of agricultural activities and associated with this, lack of undisturbed waterways. The Queensland Water Quality Guidelines (DES, 2018) identifies two (2) reference sites exist within a 100 km radius of the mine, the closest occurring some 50 from the mine site (**Figure 4-1**, **Table 4-1**). Both reference sites have different aquatic ecosystem types to those occurring in Lagoon and Spring Creek (e.g., rocky substrates), and being remote from the mine site, experience different flow conditions. These sites were therefore inappropriate for use as reference sites for the REMP (BMT, 2019).

4.1.2 Test (Downstream) Sites

The downstream sites represent ‘test’ sites due to mine water discharge activities. Within Lagoon Creek there are seven (7) test sites (i.e., LCD1, LCD2, L-DS3, L-DS4, LT-1, LT-2 and DS1). Within Spring Creek there is one (1) test site (i.e., SCD1). These sites are depicted on **Figure 4-3** and in Table C5 of the EA.

Note that two (2) test sites in Lagoon Creek Tributary (i.e., LT-1 and LT-2) have been included to satisfy conditions of approval but will be difficult to reliably sample as it is dry most of the time (BMT, 2019). The inclusion of these sites will be subject to future review of this REMP document as described in **Section 8.0**.

4.1.3 Control (Upstream) Sites

The upstream sites represent ‘control’ sites as they are located upstream of the NAC mine ED discharge sites and have not been previously affected by mine water discharges. Within Lagoon Creek there are two (2) control sites (i.e., L-US2 and L-US3). There are no control sites in Spring Creek.

As noted, most pools on the subject waterways are artificial habitats created by the construction of earthen bunds by farmers. As these are artificial waterbodies, they do not represent reference sites. For the purposes of this REMP, sites upstream of mine water discharges within impounded waters are considered control sites (BMT, 2019).

Figure 4-1 QWGC Reference Sites (mine in yellow)

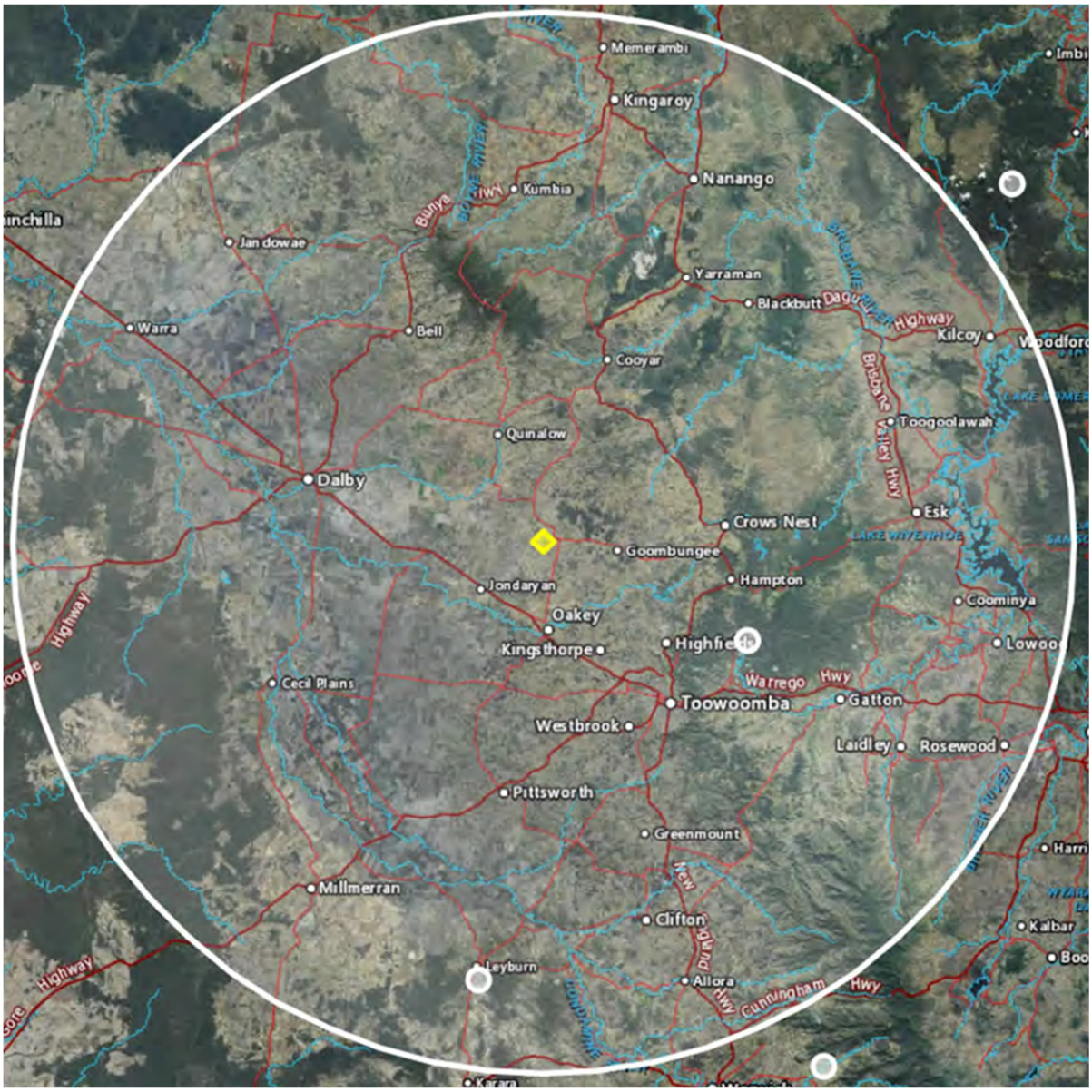


Table 4-1 QWGC Reference Site Details

Site Name	Region	Distance From Mine (km)	Latitude	Longitude
Acland Mine	Murray Darling	-	-27.2906	151.7103
Fifteen Mile Creek at Murphys Creek	Southeast	43	-27.4586	152.0994
Canal Creek at Leyburn	Murray Darling	80	-28.0321	151.5856

Figure 4-2 Site L-US1: Upstream (L column) and downstream (R column) between 2015 - 2018

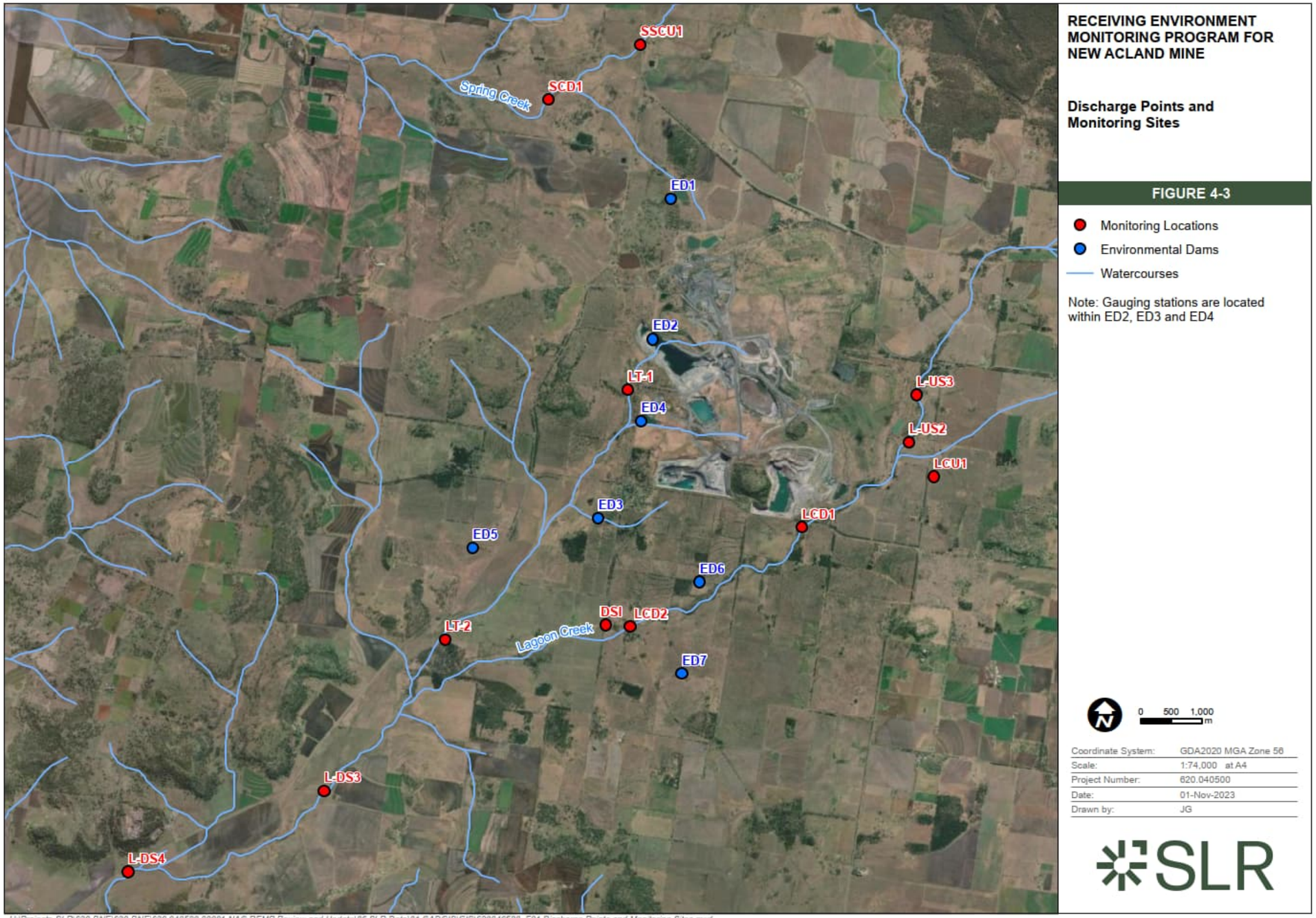
Table 4-2 Location of sites to be monitored during the REMP (WGS84). Parameter group sampled at the site shown as green shading (✓)

Site No.	Latitude	Longitude	Treatment	Parameter group:		Invertebrates incl. crustaceans	Fish	Descriptors:				Other human disturbance
				Water quality (grab, in-situ) and sediment quality	Water quality (auto-sampler)			Mine affected	Stream order	Hydraulic habitat / Aquatic ecosystem type	Land use	
Lagoon Creek												
LCU1	-27° 18' 9.773"	151° 44' 23.136"	Reference (background)	✓	✓	✓	✓	>2km u/s of mine discharges and runoff	1st order (headwater)	Main channel Lotic: ephemeral stream	Agriculture – predominantly cleared (grazing)	No upstream extractive industries, urban areas, point source discharges, water infrastructure
L-US2	-27° 17' 51.230"	151° 44' 8.550"	Control (upstream)	✓		✓	✓	>500 m u/s of mine discharges and runoff	1st order (headwater)	Main channel Lotic/lentic: ephemeral stream/ permanent waterbody created by earthen bund	Agriculture (grazing) – predominantly cleared	No upstream extractive industries, urban areas, point source discharges, water infrastructure
L-US3	-27° 17' 26.057"	151° 44' 13.491"	Control (upstream)	✓		✓	✓	>2km u/s of mine discharges and runoff	1st order (headwater)	Main channel Lotic/lentic: ephemeral stream/ permanent waterbody created by earthen bund	Agriculture (grazing) – predominantly cleared	No upstream extractive industries, urban areas, point source discharges, water infrastructure
DSI	-27° 19' 26.680"	151° 41' 7.020"	Test (downstream)	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA
LCD1	-27° 18' 35.880"	151° 43' 4.270"	Test (downstream)	✓		✓	✓	Receiving environment of ED3	2nd order (headwater)	Main channel Lotic: ephemeral stream	Agriculture (grazing), mining – predominantly cleared	No other upstream extractive industries, urban areas, point source discharges, water infrastructure
LCD2	-27° 19' 27.767"	151° 41' 21.579"	Test (downstream)	✓		✓	✓	Receiving environment of ED3	1st order (headwater)	Main channel Lotic/lentic: ephemeral stream/ permanent waterbody created by earthen bund	Agriculture (grazing) – predominantly cleared	No other upstream extractive industries, urban areas, point source discharges, water infrastructure
L-DS3	-27° 20' 53.331"	151° 38' 18.213"	Test (downstream)	✓	✓	✓	✓	Receiving environment of ED2, ED3 and ED4	3rd order	Main channel	Agriculture (grazing) – predominantly cleared	No other upstream extractive industries, urban areas, point source discharges, water infrastructure
L-DS4	-27° 21' 35.135"	151° 36' 21.165"	Test (downstream)	✓		✓	✓	Receiving environment of ED2, ED3 and ED4	3rd order	Lotic: ephemeral stream	Agriculture (grazing) – predominantly cleared	No other upstream extractive industries, urban areas, point source discharges, water infrastructure
Lagoon Creek Tributary												
LT-1	-27° 17' 21.746"	151° 41' 21.568"	Test (downstream)	✓		✓	✓	Receiving environment of ED2 and ED4	1st order (headwater)	Main channel Ephemeral stream	Agriculture (grazing) – predominantly cleared	No other upstream extractive industries, urban areas, point source discharges, water infrastructure

Site No.	Latitude	Longitude	Treatment	Parameter group:		Invertebrates incl. crustaceans	Fish	Descriptors:				Other human disturbance
				Water quality (grab, in-situ) and sediment quality	Water quality (auto-sampler)			Mine affected	Stream order	Hydraulic habitat / Aquatic ecosystem type	Land use	
LT-2	-27° 19' 33.644"	151° 39' 31.447"	Test (downstream)	✓		✓	✓	Receiving environment of ED2 and ED4	1st order (headwater)	Main channel Ephemeral stream	Agriculture (grazing) – predominantly cleared	No other upstream extractive industries, urban areas, point source discharges, water infrastructure
Spring Creek												
SSCU1	-27° 14' 18.773"	151° 41' 31.286"	Reference (background)	✓	✓	✓	✓	>4km u/s of mine discharges and runoff	2nd order (headwater)	Main channel Lotic: ephemeral stream	Agriculture (grazing) – predominantly cleared	No upstream extractive industries, urban areas, point source discharges, water infrastructure
SCD1	-27° 14' 47.364"	151° 40' 36.203"	Test (downstream)	✓	✓	✓	✓	Receiving environment of ED1	2nd order (headwater)	Main channel Lotic: ephemeral stream	Agriculture (grazing) – predominantly cleared	No upstream extractive industries, urban areas, point source discharges, water infrastructure

1 L_US3 was replaced by L_US3-A as previous REMP surveys showed site L_US3 was not a reliable monitoring location due to a lack of water at time of sampling. Site L_US3-A is upstream of sites L_US2 andL_US1, however it was chosen as it has similar site features representative of L_US3. 2 Sites LT-1 and LT-2 have been included to satisfy conditions of approval but may be difficult to sample as the tributary is dry most of the time. The inclusion of these sites will be subject to future review of this REMP document.

Figure 4-3 Discharge Points and Monitoring Sites



4.2 Monitoring Programs

Given the ephemeral and disconnected nature of the receiving environment, water quality has the potential to change temporally and spatially within pools. Ephemeral streams exhibit a high level of natural variability in water quality, due to the irregularity and intensity of flow/rainfall events (DES, 2018). As the stream flow decreases, streams become a series of disconnected water bodies, as typified in Lagoon and Spring Creek. Thus, the water quality at each monitoring site may become less dependent on the upstream water quality and more dependent on local effects. The smaller the water body, the more significant these effects may be. Different water quality parameters are affected more than others, with dissolved oxygen and pH much more variable during stagnant conditions (DES, 2018).

Therefore, due to the ephemeral nature of the receiving environment water quality monitoring will be undertaken at each of the nine (9) sites within Lagoon Creek and at the two (2) sites within Spring Creek on a bi-annual basis only during the pre-release and post-wet season when there is water available for monitoring. The pre-release sampling will take place at the start of the wet- season prior to any discharges from the mine, typically around October/November. The post-wet season sampling will take place once all mine-affected water releases have ceased at the end of the wet season, typically around May.

4.2.1 Bi-annual Biological Monitoring

Biological sampling (fish and macroinvertebrates) will occur on a bi-annual basis: pre-release and post-wet season. The exact timing of the sampling is dependent on the timing of the wet and dry seasons which can vary annually. The pre-release sampling will take place at the start of the wet- season prior to any discharges from the mine, typically around October/November. The post-wet season sampling will take place once all mine-affected water releases have ceased at the end of the wet season, typically around May.

Monitoring will take place at control and reference sites (LCU1, L-US2, L-US3 and SSCU1) and test sites (LCD1, LCD2, LCD3, LCD4, LT-1, LT-2 and SCD1).

4.2.2 Bi-annual Water Quality and Sediment Quality Monitoring

Water quality and sediment quality monitoring will be performed bi-annually at the same 11 sites as the pre-release and post-wet season biological monitoring. In addition, field observations such as nature of flow (i.e. low, medium, high), weather conditions and other notable observations will be recorded. In addition to the biological monitoring sites, water quality monitoring will also take place at the existing environmental dams (ED1, ED2, ED3 and ED4) during pre-release and post-wet season REMP surveys, noting ED2 is currently mined out. The proposed EDs (ED5, ED6 and ED7) will be monitored similarly once constructed.

During collection of sediment samples, the bank stability and erosion potential and erosion occurence will be assessed and documented.

4.2.3 Stream Flow Monitoring

The Queensland Government does not operate stream gauges near the New Acland Mine site. There are four gauges in current operation in the vicinity of the catchment on Oakey and Gowrie Creek (**Table 4-3**). All four flow gauges either have significantly larger catchment areas or have upstream catchments significantly different to that of Lagoon Creek and Spring Creek.

Since 2007, NAC has operated two surface water level loggers on Lagoon Creek, enabling flows to be estimated (**Table 4-4**). Due to the ephemeral nature of the creek with long periods of zero depth records, Lagoon Creek has only recorded stream flow approximately once per year.

In addition to the historic water level data measured and recorded from the NAC water loggers, flow gauging stations will be installed in Spring Creek and Lagoon Creek at sites upstream of the mine water discharges. These locations are included in **Table 4-5**.

Stream flow data will be used in the interpretation of the water quality, sediment quality and biological indicators results.

Table 4-3 Qld Government stream flow gauge details

Gauge Number	River Name	Catchment Area (km^2)	Open- Closed	Location (degrees S)	Location (degrees W)
422326A	Gowrie Creek at Cranley	47	1969 - present	27.52	151.94
422332B	Gowrie Creek at Oakey	142	1992 - present	27.47	151.74
422350A	Oakey Creek at Fairview	1,970	1980 - present	27.30	151.28
422333A	Condamine at Loudoun Bridge	12,380	1969 - present	27.22	151.18

Table 4-4 Historic water level logger locations at Lagoon Creek

Flow Gauge	Location	
	Latitude	Longitude
Upstream Lagoon Creek	27º16’12.78” S	151º44’45.46” E
Downstream Lagoon Creek	27º20’53.85” S	151º38’18.91” E

Table 4-5 NHG flow gauge stations at Lagoon Creek and Spring Creek

Flow Gauge	Location	
	Latitude	Longitude
Upstream Lagoon Creek	27º16’12.78” S	151º44’45.46” E
Upstream Spring Creek	27º14’18.22” S	151º41’32.76” E

4.2.4 Event-Based Water Quality Sampling

Event-based water quality monitoring stations (automatic samplers) are planned for installation at two (2) reference (background) sites and two (2) test (downstream) sites (refer to **Figure 4-3**):

- Reference site SSCU1 on Spring Creek.
- Reference site LCU1 on Lagoon Creek.
- The downstream reaches of Lagoon Creek near site L-DS3. This location is downstream of all mine water discharge locations in the Lagoon Creek catchment.
- The downstream reaches of Spring Creek near site SCD1. This location is downstream of all mine water discharge locations in the Spring Creek catchment.

Note that the event-based water quality monitoring stations may be difficult to install due to landowner access issues and lack of water flow in the ephemeral creeks and the inclusion of these stations may not be feasible and their installation will be subject to future review of this REMP document as described in **Section 8.0**.

The stations will consist of an automatic sampler interfaced with a flow meter. The automatic samplers will be set to begin sample collection once flow is detected following a rainfall event and will continue to collect samples at regular intervals throughout the flow event hydrograph.

To ensure sample integrity (i.e. holding times met), samples will be collected by from the auto- sampler device environment personnel within two days of the commencement of the flow event, where safe to do so. If the flow event extends for greater than two days, samples will be collected at two-day intervals. Samples collected will be homogenised in a single composite sample (for each two-day period) and transferred to relevant laboratory sample bottles. Samples will be sent to a NATA accredited laboratory for analysis of the parameters listed in **Table 3-2**.

Weather Monitoring

The Oakey Aero (041359) monitoring station is located approximately 14 km south of the mine. Daily minimum and maximum temperature can be sourced from this station, along with wind data. In the event of an unexplained anomaly in water quality (after comparison with stream flow, rainfall, discharges etc.), temperature and wind data will be sourced and analysed to aid in the interpretation of the anomaly in water quality data.

4.2.5 Summary of REMP Monitoring Program

A summary of the REMP monitoring program is outlined in **Table 4-6**.

Table 4-6 Summary of the proposed REMP monitoring

Parameter		Sampling site	Sampling Frequency
Water Quality			
Physio-chemical	Temperature, pH, EC, DO, Turbidity, pH, salinity	• Existing EDs (ED1, ED2, ED3 and ED4) • Proposed EDs once constructed (ED5, ED6, ED7) • Control / Reference sites: LCU1, L-US2, L-US3, SSCU1 • Receiving Environment / Test sites: LCD1, LCD2, DS1, L-DS3, L-DS4, LT-1, LT-2, SCD1.	• Pre-release and post-wet season at all sites
Nutrients	Total nitrogen, ammonia, nitrate, nitrite, Total phosphorus, Filterable reactive phosphorus		
Major Cations and Anions	Cations: calcium, potassium, magnesium, sodium, anions, chlorine, sulphate, carbonate, bicarbonate		
Contaminants	Total and dissolved (filtered) metals (Al, Cd, Cr, Cu, Fe, Hg, Pb, Ni, Zn, B, Co, Mn, Mo, Se, Ag, U, V) and metalloids (As), total fluoride, TPH, TRH, BTEX, PAH		
Biological	Chlorophyll-a		
Other	TSS, water hardness		
Event-Based Water Quality (Autosamplers)			

Parameter		Sampling site	Sampling Frequency
As per the list of parameters listed in **Table 3-2**		LCU1, L-DS3, SCD1 and SSUC1	During flow events in Lagoon Creek and Spring Creek
Sediment Quality			
Contaminants	Total metals (Al, Cd, Cr, Cu, Fe, Hg, Pb, Ni, Zn, B, Co, Mn, Mo, Se, Ag, U, V) and metalloids (As), petroleum hydrocarbons (C6-C9) (C10-C36), recoverable hydrocarbons, BTEX, polycyclic aromatic hydrocarbons (PAH)	• Control / Reference sites: LCU1, L-US2, L-US3, SSCU1 • Receiving Environment / Test sites: LCD1, LCD2, DS1, L-DS3, L-DS4, LT-1, LT-2, SCD1.	Pre-release and post-wet season
Physical	Particle Size Distribution (PSD)		
Biological Indicators			
Fish, macro-crustaceans	Richness and abundance of fish and macro-crustaceans	• Control / Reference sites: LCU1, L-US2, L-US3, SSCU1 • Receiving Environment / Test sites: LCD1, LCD2, DS1, L-DS3, L-DS4, LT-1, LT-2, SCD1.	• Pre-release and post-wet season
Macro-invertebrates	Aquatic macroinvertebrates identified to the lowest practical taxonomic level (family or order)	• Control / Reference sites: LCU1, L-US2, L-US3, SSCU1 • Receiving Environment / Test sites: LCD1, LCD2, DS1, L-DS3, L-DS4, LT-1, LT-2, SCD1.	Pre-release and post-wet season
Zooplankton	Zooplankton identifying the first 200-300 individuals encountered	• Control / Reference sites: LCU1, L-US2, L-US3, SSCU1 • Receiving Environment / Test sites: LCD1, LCD2, DS1, L-DS3, L-DS4, LT-1, LT-2, SCD1.	Pre-release and post-wet season

5.0 Sampling Methodology

5.1 Sampling Personnel

All sampling will be conducted by a suitably qualified and experienced person/s.

5.2 Water Quality Sampling Methods

All in-situ water quality measurements will be performed in accordance with DES (2018) and/or relevant Australian standards (AS/NZS 5667.1:1998 Water Quality Sampling). At each site for each sampling event, in-situ measurements of physio-chemical characteristics of the water column will be collected using a calibrated water quality instrument. Samples will also be collected for laboratory analysis for a range of parameters. The parameters that will be recorded at each sampling site are shown in **Table 5-1**.

Water samples will be collected at an approximate depth of 30 cm in a representative area of each site by hand or by a sampling pole with clamp if required for safety reasons. Samples requiring field filtration (e.g., dissolved metals) will be filtered through a 0.45 µm filter on-site, and the supernatant will be retained for analysis.

Table 5-1 Summary of the surface water quality sampling parameters

Water Quality Type	Parameter	Units
In-situ parameters		
Physio-chemical	Temperature	(°C)
	Electrical conductivity	µS/cm and mS/cm
	Salinity	ppt
	Dissolved oxygen	(% saturation
	Dissolved oxygen	mg/L
	Turbidity	NTU
	pH	(°C)
Analytical parameters		
Major Ions	Cations: calcium, potassium, magnesium, sodium	mg/L
	Anions: chlorine, sulphate, carbonate, bicarbonate	mg/L
Nutrients	Total nitrogen	mg/L
	Ammonia	mg/L
	Nitrate	mg/L
	Nitrite	mg/L
	Total phosphorus	mg/L
	Filterable reactive phosphorus	mg/L
Metals (total and dissolved)	Aluminium	µg/L
	Arsenic	µg/L
	Boron	µg/L
	Cadmium	µg/L

Water Quality Type	Parameter	Units
	Chromium	µg/L
	Cobalt	µg/L
	Copper	µg/L
	Iron	µg/L
	Lead	µg/L
	Manganese	µg/L
	Mercury	µg/L
	Molybdenum	µg/L
	Nickel	µg/L
	Selenium	µg/L
	Silver	µg/L
	Uranium	µg/L
	Vanadium	µg/L
	Zinc	µg/L
Others (analytical)	Total suspended solids (TSS)	mg/L
	Total fluoride	mg/L
	Water hardness	mg/L
	Total Petroleum Hydrocarbons	µg/L
	Total Recoverable Hydrocarbons	µg/L
	BTEXN	µg/L
	Polycyclic aromatic hydrocarbons (PAH)	µg/L

5.2.1 Sample Handling and Storage

Samples will be collected and transported in appropriately pre-treated samples bottles supplied by the analytical laboratory. Correct sample volumes for each parameter with be collected using the appropriate sampling bottle. Sample containers will be labelled with a waterproof xylene-free marker pen on the containers label and lid. The site number, unique sample ID, name of the collector, time and date will be included on the label.

Furthermore, field replicate and laboratory split samples will be labelled with numbers/ names that do not relate to the sampling location names.

Clean, power free gloves will be used for samples collection and discarded after collection of each sample. All storage containers will be chilled on ice (4°C) immediately following collection and during transport to the chosen laboratory (same day, otherwise transferred to refrigerator). The samples requiring freezing will be placed in the freezer at the completion of the day's sampling. Storage requirements and holding times are specified in the Queensland Monitoring and Sampling Manual (DES, 2018).

Accurate chain of custody forms will be maintained for samples. The form will identify all sample numbers, the respective analyses and limits of reporting (LORs) required for analysis. All samples will be submitted to the analytical laboratory as a single batch to minimise the chance for misplaced or misdirected freight.

5.2.2 Quality Assurance and Quality Control

Sampling will be undertaken in accordance with AS5667 Water Quality Sampling and in accordance with the Queensland Monitoring and Sampling Guidelines (DES, 2018). In summary, quality control during the sampling will be ensured by:

- Using suitably qualified and competent staff experienced in water quality sampling.
- Calibrating water quality probes prior to the commencement of sampling with calibration records kept.
- Cleaning water quality probes between sites, with the instrument stored within appropriate case and probe kept moist.
- Collecting water samples straight into the sample jar whenever possible and not rinsing bottle prior to sample collection.
- Ensuring staff wear nitrile gloves while processing samples with gloves changed between samples to avoid cross-contamination.
- Using a container thoroughly rinsed with ambient site water to reduce contamination risk if the sample cannot be collected straight into the sample jar.
- Following specific sampling procedures, including the provision of field trip blanks, field replicates and field duplicates.
- Storing samples in appropriately cleaned, pre-treated and labelled sample containers.
- Chilling samples (4°C) after sampling and during transport, storing in eskies with pre-frozen ice bricks and ice. Samples to be delivered to the laboratory within the appropriate holding times in accordance with the security and transport protocols outlined in the Queensland Monitoring and Sampling Manual (DES, 2018).
- Maintaining an accurate chain of custody form for sediment samples collected from the project area. The form would identify all sample numbers and the respective analysis and practical quantitation limits required for analysis.
- Analysing samples at a NATA accredited laboratory. The laboratory practical quantitation limits (PQLs) should be sufficient to enable any exceedances of the established trigger levels (refer to **Section 3.5**).

The Queensland Monitoring and Sampling Guidelines (DES, 2018) provide details on the number of recommended field and laboratory blanks and replicate samples for monitoring programs. **Table 5-2** provides a summary of the quality assurance samples that have been adopted for the REMP.

Table 5-2 QA/QC requirements

Sample type	Description	Action in the field	Number of samples
Trip / Transport blanks	Contamination during transport of samples when analysing for volatile substances (such as hydrocarbons)	Transport blank to be carried in the cooler with other samples. No actions required in the field, return to laboratory for analysis	Once per cooler box
Field blanks	Sample contamination from sampling personnel, equipment, or the atmosphere	Samples taken in the field using laboratory supplied solution which is placed into sample containers the same way as normal samples (i.e.	Once per monitoring event

Sample type	Description	Action in the field	Number of samples
		using sampling equipment such as the sample pole, syringes and filters)	
Rinsate blanks	Equipment decontamination and sample handling procedures	Wash sampling equipment as required. Collect final rinse water as the blank	One per monitoring event per re-usable equipment
Intra-laboratory duplicates	Variability of analysis within laboratory	Samples split into two sub-subsamples and tested as separate (blind) samples by the primary laboratory	One per 10 primary samples (water)
Inter-laboratory duplicates	Variability of analysis between laboratories	Samples split into two duplicate sub-samples and tested as separate (blind) samples by the primary and second independent laboratory	One per 20 primary samples (water) (or one per program if less than 20 primary samples)

5.3 Sediment Quality Sampling Methods

Sediment monitoring will be undertaken in conjunction with water quality monitoring, with stream sediments analysed for the parameters provided in **Table 3-9** and particle size distribution.

Samples will be provided to a NATA registered laboratory and the laboratory practical quantitation limits (PQLs) set out in ANZG (2018) should be at least lower than sediment quality (SQG-Low) guideline values (Simpson et al. 2016).

Surface sediment samples (upper 30 cm of the sediment column) will be collected using a plastic trowel from several representative locations at each sampling site. Each sample will initially be emptied into a plastic tray to allow photography of the sample. Details of the field texture (sandy, silty, gravel etc.), sediment colour and sediment odours will be recorded.

All sampling equipment will be thoroughly cleaned using decontaminating solution and rinsed in freshwater prior to use. The trowel and tray will be thoroughly cleaned and rinsed with site water between samples to prevent sample cross contamination.

Samples will be thoroughly homogenised and transferred to appropriately cleaned, pre-treated and labelled sample containers provided by an accredited laboratory. The quantity of sediment material removed at each location will be sufficient to ensure that sediment is available for further testing or analysis (i.e. above SQG-Low which triggers further investigations). The analytical laboratory is required to provide sample storage (in appropriate containers) for at least three months following the receipt of samples. The sample labels will include location, site and sample number as well as the time of sample collection.

All samples will be chilled on ice (4°C) immediately following sample collection and during transport. Samples will then be couriered to the analytical laboratories within holding times. Interim refrigerated storage will be provided for all samples whilst waiting to be transported to the laboratory.

5.3.1 Quality Control and Assurance

Sediment sampling will be undertaken by a qualified and competent person in accordance with the most recent version of AS5667.4 (1998) Guidance on Sampling of Bottom Sediments and Simpson et al. (2016) and following the Queensland Monitoring and Sampling Guidelines (DES, 2018). In summary, quality control and assurance measures will include:

- Using sampling equipment that is thoroughly inspected and washed down, prior to the beginning each survey.
- Following specific sampling procedures, including the provision of the following quality control/assurance samples:
  - Trip/Transport blanks.
  - Field blanks.
  - Rinsate blanks.
  - Intra- laboratory duplicates.
  - Inter- laboratory duplicates.
- Ensuring staff wear nitrile gloves while processing samples with gloves changed between samples to avoid cross-contamination.
- Storing samples in appropriately cleaned, pre-treated and labelled sample containers.
- Chilling samples (4°C) after sampling and during transport, storing in eskies with pre-frozen ice bricks and ice. Samples to be delivered to the laboratory within the appropriate holding times in accordance with the security and transport protocols outlined in DES (2018).
- Maintaining an accurate chain of custody form for sediment samples collected from the project area. The form would identify all sample numbers and the respective analysis and practical quantitation limits required for analysis.
- Analysing samples by a NATA accredited laboratory.
- Collecting QA/QC samples at each sampling event as per **Table 5-2** in **Section 5.2.2**:

5.4 Biological Indicator Sampling Methods

5.4.1 Aquatic Macroinvertebrates

5.4.1.1 Sampling Methods

Aquatic macroinvertebrate sampling procedures will be undertaken in accordance with the Queensland AusRivAS (Australian Rivers Assessment) sampling protocol (DES, 2019). Three (3) replicate macroinvertebrate samples will be collected from the edge habitat type at each site. This level of replication has been found to provide a robust means for assessing intra-site spatial variability in aquatic macroinvertebrate communities in intermittent streams (WBM 2005).

Macroinvertebrate samples should only be compared between sites if they are collected from the same aquatic habitat type, as each habitat supports unique macroinvertebrate assemblages (Humphries et al. 1996). Comparing assemblages from different habitat types may be confounded by the differences between habitats (Parsons and Norris 1996). Due to insufficient pool/riffle habitat within the study area, only edge habitat will be sampled. Edge

habitat is defined as an area along the bank with minimal or no current, with trailing terrestrial vegetation and/or exposed tree roots.

Samples will be collected using a triangular sweep-net (250 x 250 x 250 mm; 25 µm mesh). The sweep net will be thoroughly cleaned and rinsed between samples. Macroinvertebrates communities will be surveyed during the pre-release and post-wet season, in conjunction with water and sediment quality and fish sampling. For safety and data integrity, surveys will not be undertaken during or within two weeks following flood events.

5.4.1.2 Field Sampling Handling and Storage

The material collected will be retained and placed into a 600 ml plastic screw-top container. All remaining material on the sieve will be carefully washed using ambient creek water into the container. In cases when retained sample cannot fit in to a single container, two (or more) containers may be used.

Containers will be labelled on the lid and the side of the container using a waterproof permanent maker. A water-proof label will also be placed inside each sample container. The sample labels will contain the following details:

- Location, site and replicate sample number.
- Job name and number.
- Date and time of sample collection.

The sample will be preserved in 70% ethanol solution and transferred to an appropriate storage container.

5.4.1.3 Laboratory Sorting and Identifications

Samples will be passed through a 25 µm sieve. The retained material will be spread over a shallow tray and animals will be picked from detrital and inorganic material for a standard 60-minute period. An illuminated Magilamp or similar will be used to assist with sample picking.

All picked animals (including parts of animals) will be placed in a sample vial containing 70% ethanol solution. In cases where all organisms cannot fit into a single vial, two (or more) vials may be used. A label will be placed inside each sample vial and will contain the following details (as taken from the label containing the unsorted sample):

- Location, site and replicate sample number.
- Job name and number.
- Date and time of sample collection.
- Number of vials used for each sample, using a sequential numbering system (i.e. 1 of 1, 1 of 3 etc.).

The field sample and field collections logs will be consulted to ensure that all collected samples listed in the log are accounted for.

Binocular and/or dissecting microscope techniques will be used to identify fauna to the lowest practical taxonomic level outlined by DNRM (2001) and Chessman (2003). In most cases, this should be to sub-family (chironomid larvae) or family level, although higher taxonomic levels may be used for taxa that are difficult to identify (e.g. Oligochaeta worms).

All taxa will be counted in each sample. In some cases, particularly fragile organisms like worms may break. Only the head of broken animals will be counted.

5.4.1.4 Quality Control and Quality Assurance

Quality control during sampling will be ensured by:

- Using suitably qualified (AusRivAS trained) and competent staff experienced in macroinvertebrate sampling.
- Following specific sampling procedures outlined in the Qld AusRivAS guidelines (DES, 2019).
- Using appropriately cleaned, pre-treated and labelled containers to store samples.
- Completing a check list to ensure all samples are collected.
- Retaining 10% of the sorted sample residue to assess sorting efficiency.
- Compiling and storing a reference collection of each taxon identified.
- Comparing and cross-referencing voucher specimens with specimen with confirmed identifications.
- Retaining and storing all samples in ethanol solution for at least five years.
- Entering all data into a database. The database will have a set of standard operating procedures, and should contain, as a minimum, the following fields:
    - Sample data (site and location details, data type, etc.).
    - Ambient environment data (water depth, sediment characteristics, other data).
    - Fauna data (number of individuals in each sample).
    - Taxonomic data (standard taxa codes for each taxa, family, class, order and phylum of each taxon)

5.4.1.5 Sampling Methods

Fish community structure will be sampled using the following sampling apparatus:

- Backpack electro-fisher - Output power will be standardised to electrical conductivity of waters to ensure that only enough power will be used to temporarily stun fish. Pulsed DC current will be fixed at a pulse rate of 60 Hz and a duty cycle of 25%. Samples will be collected in pools and other suitable habitat types for 600 seconds of pulse time. Backpack electro-fishing will be undertaken in shallow areas (<1m deep) due to safety issues of operating equipment in deeper waters. Fish will be collected using a dip net and will be retained in temporary storage buckets until all electro-fishing is completed to avoid potential recapture.
- Baited box traps (0.5 mm mesh) - baited box traps will be used at all sampling sites and represent a key technique for capturing small bodied species. Ten collapsible, baited fish traps will be deployed across a range of microhabitats types present, with traps deployed for approximately two hours.
- Push seine (3m long, 2m high, 5mm stretched mesh) - a push seine net will be used to sample small bodied fish. Numerous hauls will be undertaken within each microhabitat types present, depending on channel dimensions and the number of snags present.
- Scissor seine net (2m long, 2 m drop, 0.5 mm mesh) - a scissor seine net will be used to sample small fish. Three 10 m hauls will be conducted in each microhabitat at each site where waterway dimensions permit.
- Beach seine net (70 m long, 2 m high and 18mm mesh) – techniques will be used to sample large open areas of water, targeting larger bodies species. Numerous hauls will be undertaken, which would be dependent on the waterbody dimensions.

Note, backpack electrofishing and baited traps are the preferred methods for targeting fish and macro crustaceans and should be attempted at all sites. Nets should be used at sites where electrofishing returns on fish are low or is not considered possible or appropriate. At sites where nets are required three replicated hauls should be undertaken in representative habitats using a variety of net types.

5.4.1.6 Sample Handling and Storage

The catch from each sampling method will be placed into plastic tubs, identified to species and counted, and later released. The following will be recorded in each sample:

- Number of species caught.
- Abundance of each species in the catch.
- Size distribution, as lengths.
- % of external lesions, abnormalities and parasites.

All data (counts of each species for each method) will be transcribed onto pre-printed pro-forma sheets. Identifications and nomenclature will follow Allen et al. (2002). Species that cannot be identified in the field will be euthanized and returned to the laboratory for identification. Any exotic species captured will be euthanized in accordance with appropriate animal ethics procedures.

5.4.1.7 Quality Control and Quality Assurance

All fish monitoring will be undertaken in accordance with regulator permits (i.e., General Fisheries Permit, Animal Ethics Approval and Scientific Purpose Permit) and under the requirement of the Australian Code of Electrofishing Practice. Quality Control during sampling will be ensured by:

- Using suitably qualified and competent staff experienced in fish sampling.
- Following specific sampling procedures outlined in the Queensland Monitoring and Sampling Manual (DES, 2018) and any condition under the operators fisheries and ethnics permits.
- Using appropriately cleaned, pre-treated and labelled sample containers to collect and store samples.
- Compiling a list of collected reference specimens.

5.5 Zooplankton

5.5.1 Sampling Methods

Zooplankton (freshwater microfauna) will be collected by gently sweeping through the water column with a 53 µm mesh long-handled plankton net, with the operator holding the net in front of the body and wading forward. Zooplankton is thereby filtered into the cup at the end of the net. Care must be taken to not disturb the benthos (bottom sediment), patches of algae and macrophyte, so as not to collect large amounts of sediment, algae and other debris. Samples will be taken over a distance of approximately 15 m of clear, open water habitat. After collection, the sample is to be concentrated down to less than half the volume of the cup by holding the net out of the water and gently shaking the cup, allowing water to spill through the net whilst retaining sample material in the cup. The initial net rinsing process should be repeated again after sampling to avoid cross-contamination of the next sample.

Zooplankton communities will be surveyed during the pre-release and post-wet season, in conjunction with water and sediment quality and fish sampling. For safety and data integrity, surveys will not be undertaken during or within two weeks following flood events.

5.5.2 Field Sampling Handling and Storage

The material collected will be retained and placed into a clear 200 ml PET jar with a wadded lid.

Containers will be labelled on the lid and the side of the container using a waterproof permanent maker. A water-proof label will also be placed inside each sample container. The sample labels will contain the following details:

- Location, site and replicate sample number.
- Job name and number.
- Date and time of sample collection.

The sample will be preserved in 70% ethanol solution and transferred to an appropriate storage container. Samples should be stored upright and out of direct sunlight until ready to be sorted under laboratory conditions.

5.5.3 Laboratory Sorting and Identifications

Zooplankton samples will be processed by identifying the first 200-300 individuals encountered in an agitated sample decanted into a 125 mm^2 gridded plastic tray, with the tray then scanned for additional missed taxa also taken to species and recorded as ‘present’. Binocular and/or dissecting microscope techniques will be used to identify fauna to the lowest practical taxonomic level.

All picked animals (including parts of animals) will be placed in a sample vial containing 70% ethanol solution. A label will be placed inside each sample vial and will contain the following details (as taken from the label containing the unsorted sample):

- Location, site and replicate sample number.
- Job name and number.
- Date and time of sample collection.

It is assumed that this is sufficient to meet C-35 of the EA which states that “monitoring of a selection of zooplankton species to assess health (e.g., exoskeleton density) in respect to the availability of calcium and magnesium” (refer to **Section 1.4**). It is noted that analysis of exoskeleton densities is not mentioned in the monitoring and sampling manual (DES, 2018) and that if the zooplankton population of the receiving environment were sensitive to changes in calcium and magnesium, these changes would be evident a community-level response in the zooplankton fauna.

5.5.4 Quality Control and Quality Assurance

Quality control during sampling will be ensured by:

- Using suitably qualified and competent staff experienced in zooplankton sampling.
- Using appropriately cleaned, pre-treated and labelled containers to store samples.
- Completing a check list to ensure all samples are collected.
- Retaining 10% of the sorted sample residue to assess sorting efficiency.
- Compiling and storing a reference collection of each taxon identified.

- Comparing and cross-referencing voucher specimens with specimen with confirmed identifications.
- Retaining and storing all samples in ethanol solution for at least five years.
- Entering all data into a database. The database will have a set of standard operating procedures, and should contain, as a minimum, the following fields:
    - Sample data (site and location details, data type, etc.).
    - Ambient environment data (water depth, sediment characteristics, other data).
    - Fauna data (number of individuals in each sample).
    - Taxonomic data (standard taxa codes for each taxa, family, class, order and phylum of each taxon).

6.0 Data Analysis

6.1 Stream Flow Monitoring

Due to the absence of gauging stations within the proximity of the New Acland Mine site, data regarding the stream flow will be gathered from NAC's flow gauging stations on Lagoon Creek and Spring Creek. The annual and seasonal patterns in the flow in the receiving environment will be identified and discussed. Rainfall data from the closest BoM station will also be incorporated and discussed.

6.2 Bi-annual Water Quality

Water quality data collected from each monitoring site will be compared between sites (i.e. test sites compared to control sites) and to the water quality guidelines presented in **Table 3-8**. Water quality data will also be compared to data collected during previous REMP surveys.

Standard descriptive statistics for water quality monitoring points will be summarised in tables once a minimum of four (4) data sets have been collected. Piper diagrams should be used, where appropriate, to infer potential impacts of discharge mine-affected water. A discussion on the water quality data relating to the sediment quality and biological data will also be presented.

6.3 Bi-annual Sediment Quality

Sediment quality data collected from each monitoring site will be compared between sites and to the sediment quality guideline values presented in **Table 3-9**. Sediment quality data will also be compared to data from previous REMP surveys.

Standard descriptive statistics for sediment quality monitoring points will be summarised in tables. A discussion on the sediment quality data relating to the water quality and biological data will also be presented.

6.4 Bi-annual Biological Parameters and Indicators

6.4.1 Aquatic Macroinvertebrates

The following stream condition parameters will be generated for each sample:

Taxa Richness

Taxa richness is a measure of the number of types of organisms within a sample. Generally, the more favourable the ecological conditions the more taxa will be present (Hannaford and Resh 1995; Sorvell and Vondracek 1999). Samples with high taxa richness are typically indicative of a healthier aquatic ecosystem than samples with few taxa.

SIGNAL Index

The taxonomic composition of macro-invertebrate communities is often used to determine the 'health' of waterbodies. The SIGNAL (Stream Invertebrate Grade Number Average Level) index was developed by Chessman (1995) as a rapid bio-assessment method for water pollution. Most macro- invertebrate families have been assigned a SIGNAL grade number (Chessman 1995, Chessman 2001, Chessman et al. 1997), based on the known tolerance of the taxa to water pollution. The SIGNAL grade numbers range from 1 (most tolerant of pollution) to 10 (most sensitive to pollution). Waterways with a high proportion of taxa with high SIGNAL grade numbers are generally indicative of a 'healthy' waterbody,

whereas the dominance of a site by taxa with low SIGNAL grade numbers is typically indicative of a stressed waterbody.

PET Richness

The PET Richness is another measure based on the pollution sensitivity of macroinvertebrates, which can be used to assess changes in environmental conditions. Three particular groups (orders) of insects are known to be highly sensitive to disturbance (particularly pollutants): *Plecoptera* (Stoneflies), *Ephemeroptera* (Mayflies) and *Trichoptera* (Caddisflies), these three groups being the PET. It has been demonstrated that sites with good habitat and water quality typically often contain higher number of PET families than degraded sites (Plafkin et al. 1989).

Multivariate Analysis

Patterns of similarity in macroinvertebrate communities among sites will be quantified using multivariate statistical techniques. The following analyses will be undertaken:

- Non-metric multidimensional scaling (n-MDS) ordinations (graphs) of community structure, which provide a two-dimensional visual representation of the similarity among samples (i.e., the closer together two samples are, the more similar the community is structured). Similarity groupings produced by hierarchical cluster analysis will be superimposed to determine the group membership of samples/sites.
- One-way analysis of similarity (ANOSIM) will be performed to for differences in assemblages among treatments.
- SIMPER analysis will be undertaken to determine the taxa contributing most to the differences between sites and times.

6.4.2 Macro-crustaceans

Species richness and total abundance of macro-crustacean species will be compared between sites and sampling events. Macro-crustacean data will also be compared with the previous desktop and field studies conducted within the study area.

The multivariate statistical measures described above can also be used to assess spatial and temporal changes in macro-crustacean communities.

6.4.3 Fish

Species richness and total abundance of fish species will be compared between sites and sampling events. Fish health (including wounds, lesions or deformities) and length data will also be compared between sites and sampling events. Fish data will also be compared with the previous desktop and field studies conducted within the study area.

The multivariate statistical measures described above can also be used to assess spatial and temporal changes in fish communities.

6.4.4 Zooplankton

Zooplankton (freshwater microfauna) will be processed by identifying the first 200-300 individuals encountered in an agitated sample decanted into a 125 mm^2 gridded plastic tray, with the tray then scanned for additional missed taxa also taken to species and recorded as ‘present’. Binocular and/or dissecting microscope techniques will be used to identify fauna to the lowest practical taxonomic level.

7.0 Reporting and Management Actions

7.1 Annual REMP Report

An Annual REMP Report must be prepared and submitted to the administering authority by 1 November each year reporting on compliance with Conditions C35 and C36 of the EA.

The bi-annual monitoring data will be used to assess whether there are any discernible impacts from the mine discharges. This will be undertaken by comparing the water quality, sediment quality and biological data between upstream and downstream sites to determine whether there is a difference at the downstream sites that may be attributable to mine water releases.

If an impact is identified through this assessment, the findings will be included in the Annual REMP report for submission to the relevant authorities. Appropriate management actions will then be discussed and negotiated with the administering authorities to ensure further impacts are minimised.

7.2 Exceedance of Trigger Levels

As per the EA, in the event of exceedance of the water quality trigger levels specified in **Table 3-8** at the downstream monitoring points, the following management measures must be followed:

- The downstream results are to be compared to the upstream results in the receiving waters and:
  a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic, then no additional monitoring and reporting action is required; or
  b) As per C15 of the EA, where the downstream results exceed the upstream results complete an investigation into the potential for environmental harm and provide a written report to the administering authority within **ninety (90) days** of receiving the results and in the next annual return, outlining:
     1 Details of the investigations carried out, and
     2 Actions taken to prevent environmental harm.

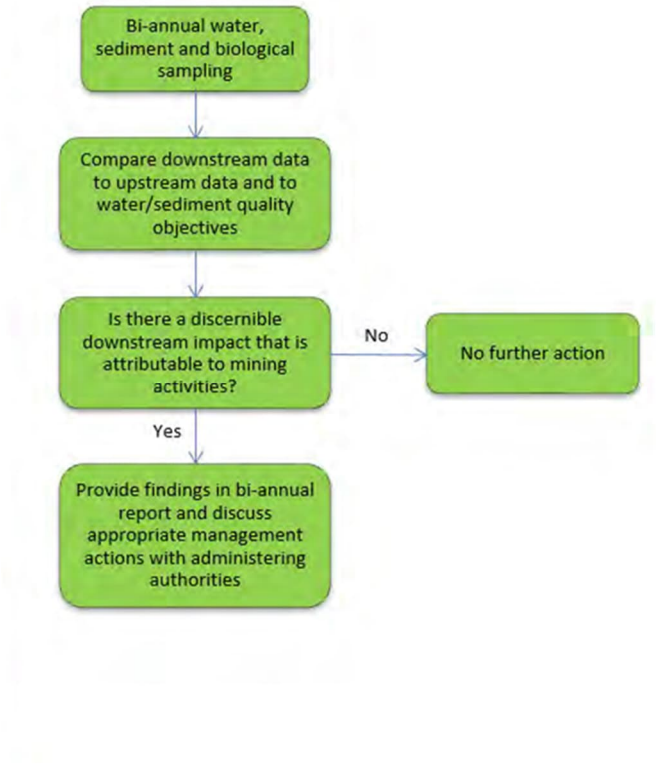
If an exceedance in accordance with condition C15(b) of the EA is identified, the holder of the environmental authority must notify the administering authority in writing within **1 Business day** of receiving the result.

Any exceedance notification will include raw data from the sampling event, a comparison against the relevant criteria and likely cause of the exceedance.

A summary of any exceedances will be provided in the EA Annual Report.

A flowchart of management actions to be implemented should there be an exceedance of EA trigger levels is provided in **Figure 7-1**.

Figure 7-1 Management Action Flowchart



7.3 Further Investigations and Potential Management Actions

7.3.1 Investigation Steps

Further investigations will be carried out by NHG should water quality parameters at test sites exceed the guideline values stipulated in **Table 3-8**, and the upstream control sites. The specific scope of investigations will depend on the parameter/s exceeding guideline values and spatial patterns in exceedances (e.g., number of sites, location of sites). The investigation steps are as follows:

- Review incident reports to determine potential mine-related causes (e.g., spills, inappropriate water diversions etc.).
- Review dam water quality monitoring data to identify potential contaminant sources.
- Review spatial and temporal receiving environment water quality and sediment quality monitoring to determine potential causes of guideline value exceedances, including mine water discharges or due to physical disturbance or physio-chemical stressors operating at a highly localised scale (e.g., cattle disturbance of bed sediments, inputs of nutrients etc. occurring at a local waterbody scale).
- Review biological indicator data from the REMP to determine whether there is any evidence that water quality parameters exceeding guideline values caused ecological impairment.

7.3.2 Management Responses

Section 2.3 outlines pro-active water management strategies implemented by NHG to minimise the potential for mine-associated contaminants entering and impacting on environmental (including human use) values[1] of adjacent receiving environments.

Where it is demonstrated or suspected that mine-related activities were the cause of guideline value exceedances, a strategy and/or standard procedures will be developed and implemented to minimise the likelihood of a recurrence. Actions may include the following (where applicable – see **Table 7-1**):

- Spills/uncontrolled release:
  - contaminant spills occurring on site will be cleaned up in accordance with standard measures.
  - repair of damaged areas and re-establishing the banks or scoured areas, if excessive erosion has occurred.
  - removal of chemical contaminants, where practicable.
- Dam waters of unacceptable quality. Management measures will be developed and implemented to improve the quality of water in dams. This could include:
  - modifications to water management practices (e.g. flow paths) to minimise contaminant exposure
  - operational controls to improve sediment settlement in dams (e.g. flocculation), maximise salinity dilution prior to discharge (e.g. pumping of clean water into dams), measures to maintain appropriate pH (e.g. liming)
- Optimise the water release management strategy to ensure adequate dilution and dispersion in receiving environments.
- Removing excessive sediment built up from sensitive areas or where it may be causing problems.

[1] Referred to as community values in ANZG (2018)

Table 7-1 Potential water quality impact scenarios and management actions

Issue	How detected	Management actions
Hydrocarbon or toxicant spill to environment dam or sediment dam released to receiving environments	• Incident observation at mine site	• No water release to receiving environments until cleaned-up to appropriate standards
	• Hydrocarbons in receiving environments > EA trigger level and upstream sites	• Assess extent of contamination and potential causes • Inform downstream land owners • Carry out risk assessment to inform management response • Undertake clean-up and rehabilitate waterway, if required
Salinity, pH and total suspended solids (TSS) in site runoff entering environment dam or sediment dam released to receiving environments	• In situ monitoring in dams • Salinity, pH or TSS2[2] in receiving environments > EA trigger level and upstream sites • Biological monitoring in REMP	• Release of mine affected waters in accordance with EA release limits • Should salinity, pH or TSS in receiving environments exceed EA trigger levels and upstream sites, and REMP results indicate no impairment of biological communities as a result of these exceedances: o Consider modification of water quality guideline values, either in accordance with process in ANZG (2018), or adoption of default regional guideline values o Develop and implement measures to improve the quality of water in dams. This could include (i) source identification; (ii) modifications to water management practices (e.g. flow paths) to minimise contaminant exposure; (iii) operational controls to improve sediment settlement in dams, maximise salinity dilution prior to discharge, maintain appropriate pH); or o Refine the water release management strategy to ensure adequate dilution and dispersion in receiving environments. • Should salinity, pH or TSS in receiving environments exceed EA trigger level and upstream sites, and REMP results indicate impairment of biological communities as a result of mine activities:

[2] And associated parameters such as major ions and alkalinity (salinity) and turbidity (TSS)

Issue	How detected	Management actions
		o Undertake measures to improve the quality of water in dams as above; or o Refine water release management strategy to ensure adequate dilution and dispersion in receiving environments.
Nutrients and metals/metalloids in site runoff entering environment dam or sediment dam released to receiving environments	• In situ monitoring in dams • Nutrient/metals/metalloid concentrations > EA trigger level and upstream sites • Biological monitoring in REMP	• Release of mine affected waters in accordance with EA release limits • Should nutrient/metals/metalloids concentrations in receiving environments exceed EA trigger levels and upstream sites, and REMP results indicate no impairment of biological communities as a result of these exceedances: o Consider modification of water quality guideline values, either in accordance with process in ANZG (2018) for metals/metalloids and nutrients, or adoption of default regional guideline values (applicable to nutrients only); o Develop and implement measures to improve the quality of water in dams (e.g. source identification, changes to water flows to minimise contaminant exposure, operational controls to improve sediment (and bound nutrient/metal) settlement; or o Refine water release management strategy to ensure adequate dilution and dispersion in receiving environments. • Should concentrations in receiving environments exceed EA trigger level and upstream sites, and REMP results indicate impairment of biological communities as a result of mine activities: o For metals/metalloids, undertake studies to assess their bioavailability and potential to cause impacts to biotic receptors; o Undertake measures to improve the quality of water in dams as above; or o Refine water release management strategy to ensure adequate dilution and dispersion in receiving environments.

Figure 7-2 Steps to implement the Water Quality Management Framework (Source: ANZG 2018)

7.4 Bi-Annual Reporting

A report will be prepared following the pre-release and post-wet season sampling events which will outline key findings of the respective REMP sampling event. The report will compare results against relevant guidelines and previous surveys to determine whether a potential mine impact has been detected within the receiving environments.

The report will identify all methods employed and assumptions made, the location and survey effort undertaken, the distribution of aquatic biota within the study area, the relative abundance of each species/taxa within each surveyed habitat type, a description of significant and notable findings, and survey constraints (if any). Field observations such as nature of flow and weather conditions will also be reported. The report will:

- Describe the water quality and sediment quality within the study area.
- Provide full details of exceedances of water quality and sediment quality triggers.
- Summarise the existing information on the aquatic biota of the study area.

- Provide a list of taxa encountered and the location of these species.
- Describe any potential ecological impacts on the receiving environment associated with the release of mine affected water.
- Provide recommendations for the need or otherwise for additional work or future monitoring programs.
- Provide full referencing and a bibliography of relevant information sources. Where appropriate, tables and figures will be used to present and summarise data.

8.0 Review of REMP

A regular review of this REMP should be undertaken once every two years as follows:

- At the first review (i.e., after two years), site-specific water quality objectives (WQOs) should be developed as per Queensland Water Quality Guidelines 2009 (DEHP, 2013). Due to the limitation of water through out the year in the receiving environments for sampling, a minimum of 4 data set will be used for the development of site specific WQOs. These site-specific WQOs will be reviewed against the current EA trigger levels and an EA amendment should be sought to amend EA trigger levels as necessary.
- At each review, the monitoring design should be assessed to determine its suitability and whether the REMP objectives are being met, and if not, the REMP should be amended accordingly.

The REMP should also be reviewed and updated as necessary, when:

- Continuing breach of EA release trigger levels.
- Changes to release points, change in release activities or the program is modified.
- Changes to Water Management Plan (WMP) or Mine Affected Water Plan (MAWP).
- Prior to release from the proposed Reverse Osmosis Water Treatment Plant (ROWTP), once constructed.
- Significant observed changes to receiving environment (i.e. death of flora/fauna, visual/olfactory change in water quality).
- Upon request from a regulatory authority.

The resulting revised REMP is to be submitted to the administering authority and due consideration must be given to any comments made by the administering authority on the amended REMP and subsequent implementation of the program.

9.0 References

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