SOUTH32
Worsley Alumina

BUSINESS BLUEPRINT

SOUTH32 WORSLEY ALUMINA
(ABN 58 008 905 155)

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1 DECLARATION OF ACCURACY

I declare that:

1. I am aware that:
    a. *Section 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth).*
    b. *Section 112 of the EP Act makes it an offense to give or cause to be given information that to the person's knowledge is false or misleading to the Minister, the Authority, the CEO, a police officer, an inspector or an authorised person.*
    c. *The above offences are punishable on conviction by imprisonment or a fine or both.*
2. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed

Full name (please print)

Michelle Elvy

Organisation (please print)

Date: 15 / 01 / 2025

2 EXECUTIVE SUMMARY

South32 Worsley Alumina Pty Ltd (Worsley Alumina) operates the Worsley Bauxite-Alumina Project (the Proposal; the Project) in the southwest of Western Australia (WA) under *Environmental Protection Act 1986* (EP Act) Part IV Ministerial Statement (MS) 719 and Part V of EP Act operating licences L4504/1981/17 (Worsley Alumina Refinery) and L5960/1983/11 (Boddington Bauxite Mine). The Project includes the Boddington Bauxite Mine (BBM), an existing conveyor, the Worsley Alumina Refinery (the Refinery) near Collie and port operations at Bunbury Port. The Project location is shown on Figure 1.

In April 2006, Worsley Alumina was granted approval under Part IV of the EP Act via MS719 for the "Worsley Alumina Production to Maximum Capacity of 4.4 million tonnes per annum (Mtpa) Alumina and Associated Mining" (the Proposal).

Worsley Alumina proposes to implement an expansion project to facilitate the ongoing operation of the Project. The expansion project is the Worsley Mine Expansion – Revised Proposal (Revised Proposal). Key elements of the Revised Proposal include:

- expansion of the existing mining envelope at the BBM (to become the Worsley Mining Development Envelope – WMDE),
- establishment of a Bauxite Transport Corridor (BTC) at the BBM, and
- establishment of a Contingency Bauxite Mining Envelope (CBME) and support infrastructure / facilities at the Worsley Refinery (the Refinery).

The alumina refinery production rate remains at 4.7 million tonnes per annum. The full details of the Revised Proposal are detailed in the Worsley Environmental Review Document (Worsley, 2022) and subsequent Response to Submissions document (Worsley, 2024).

The Revised Proposal is described in its entirety in the referral for the Revised Proposal and the referral supporting document (Worsley, 2019) and the Response to Submissions document (Worsley, 2024).

This Construction Environmental Management Plan (CEMP) details the expected impacts, management, monitoring and mitigation measures for the Environment associated with all Worsley operations. This plan will be updated in accordance with adaptive management principles as the operation progresses into new mining areas.

This CEMP has been prepared in accordance with the Instructions: How to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans' published by the Western Australian Environment Protection Authority (EPA) (EPA, 2024) and the 'Environmental Management Plan Guidelines' published by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) (DCCEEW, 2024).

Table 1: CEMP Executive Summary Table

Proposal name	**Worsley Mine Expansion – Revised Proposal**
Proponent name	South32 Worsley Alumina Pty Ltd
Ministerial Statement number	Ministerial Statement 1237
Purpose of the CEMP	To outline Worsley's management and monitoring approach to ensure the environmental objectives and outcomes are achieved in accordance with conditions B17-1 and B17-2 of MS1237 to maintain the quality of land and soils so that environmental values are protected.
Key environmental factors, outcomes and objectives	The key environmental factors for the Revised Proposal include: • Terrestrial Environmental Quality **Environmental Outcomes** • Ensure no acid sulfate soil contamination within the PAA or elsewhere attributable to the proposal; • Ensure no secondary salinity occurs within the **PAA** or elsewhere attributable to the proposal; • Ensure soil compaction and soil quality is remediated as part of rehabilitation and mine closure activities, in line with timing requirements outlined in condition B14 and B2. **The Environmental Objective is:** 1. Maintain the quality of land and soils so that environmental values are protected

Proposal name	**Worsley Mine Expansion – Revised Proposal**
Condition Clauses	**B17-1** The proponent must ensure the implementation of the proposal achieves the following environmental objective: • maintain the quality of land and soils so that environmental values are protected. **B17-2** The proponent must ensure the implementation of the proposal achieves the following outcomes: 1) ensure no acid sulfate soil contamination within the PAA or elsewhere attributable to the proposal; 2) ensure no secondary salinity occurs within the PAA or elsewhere attributable to the proposal; and 3) ensure soil compaction and soil quality is remediated as part of rehabilitation and mine closure activities, in line with timing requirements outlined in condition B14 and B2. **B17-3** The proponent must review and update the Construction Environmental Management Plan (South 32 Worsley Alumina Version 0, WOR-71183-FS-PM-PLN-0004), that satisfies the requirements of condition C4 and demonstrates how achievement of terrestrial environmental quality outcomes in condition B17- 2 will be monitored and substantiated and how the environmental objective in condition B17-1 will be achieved, and submit for approval to the CEO prior to implementation of the proposal.
Key components in the CEMP	Refer to Table 7 and Table 8 for Outcome-based and objective-based Provisions
Proposed Construction Date	February 2025
CEMP required pre-construction?	Yes

3 CONTEXT, SCOPE & RATIONALE

3.1 PROPOSAL

South32 Worsley Alumina Pty Ltd (Worsley) operates the Worsley Bauxite-Alumina Project on behalf of the Joint Venture parties. Worsley sought approval for the Worsley Mine Expansion Revised Proposal (the Revised Proposal) to continue existing mining operations and access additional ore resources to maintain the continuity of the Boddington Bauxite Mine (BBM), which has been in operation for over 40 years.

Key elements of the Revised Proposal include:

- expansion of the existing mining envelope at the BBM (to become the Worsley Mining Development Envelope – WMDE),
- establishment of a Bauxite Transport Corridor (BTC) at the BBM, and
- establishment of a Contingency Bauxite Mining Envelope (CBME) and support infrastructure / facilities at the Worsley Refinery (the Refinery).

The alumina refinery production rate remains at 4.7 million tonnes per annum. The full details of the Revised Proposal (as conditionally approved) are detailed in the Worsley Environmental Review Document (Worsley, 2022) and subsequent Response to Submissions document (Worsley, 2024).

3.1.1 Purpose and Scope

The purpose of this CEMP is to provide an overarching environmental management framework to adequately demonstrate and substantiate how environmental outcomes can be monitored, managed and achieved, as required by Condition B17-2 of MS1237 and how the environmental objective in condition B17-1 will be achieved. The CEMP presents outcome based and objective based approaches to environmental management.

The scope of this document includes operations within the Primary Assessment Area, impacts, monitoring and management activities associated with the Extended Mining Areas, managed under Part B(B) of MS1237, are excluded from this CEMP.

The CEPM has been written to be consistent with the requirements of conditions C4-1 and C5-1 of MS1237. In accordance with condition C1-1 no ground disturbing activities may take place until the CEO has confirmed in writing that this CEMP meets the

requirements of condition B17-3 of MS1237.

This CEMP has been prepared in accordance with the EPA guideline Instructions: How to prepare EP Act Part IV Environmental Management Plans 2024. The EPA 2024 notes that the purpose of a Part IV Environmental Management Plan is:

'to describe how the environmental impacts of activities related to the implementation of a proposal will be:

- Adequately monitored, reported on and subject to adaptive management; and/ or
- Adequately managed where those impacts are not likely to be able to be managed by an outcome- based condition or limitation on the extent of a proposal.

A management plan required for an implementation condition is a legally enforceable document. Proponents must comply with the components set out in the management plan.'

The objectives of this CEMP are to:

- Ensure MS1237, and other approvals/agreements are adhered to by Worsley Alumina and its Contractors.
- Provide details for the management and mitigation measures to be implemented, including timing and responsibilities.
- Provide a process for implementation of the CEMP, and subplans (topic specific and project specific CEMPs), including roles and responsibilities, monitoring, reporting, and auditing.
- Provide a commitment to continue meeting the requirements of Worsley Alumina's Document Management Systems, including the need for continual improvement / adaptive management.

The scope of the CEMP includes all operations with the Primary Assessment Area (see Figure 1) and is separated as follows:

- Condition B17-1: Entire PAA
- Condition B17-2 (1): construction of the bridge over the Hotham River as described in section 1.3.1.7 and 1.4.2.3.1 of the ERD (Worsley, 2022).
- Condition B17-2 (2): Entire PAA with objectives, outcomes, monitoring, and control strategies outlined in the Water Management Plan required by condition B16 (noting that secondary salinity will only be realized as an impact for the proposal in relation to the management of inland waters).
- Condition B17-3 (3): Entire PAA with management undertaken in accordance with the outcomes outlined in condition B14 – this will be addressed in the Annual Rehabilitation Management Plan required by condition B14-3 and within the Closure Plan required by Condition B3-1.

In accordance with Condition C2-6 of MS1237 this CEMP will be published on the South32 website and provided to the CEO in electronic form suitable for on-line publication by the Department of Water and Environmental Regulation within twenty (20) business days of being implemented, or being required to be implemented (whichever is earlier).

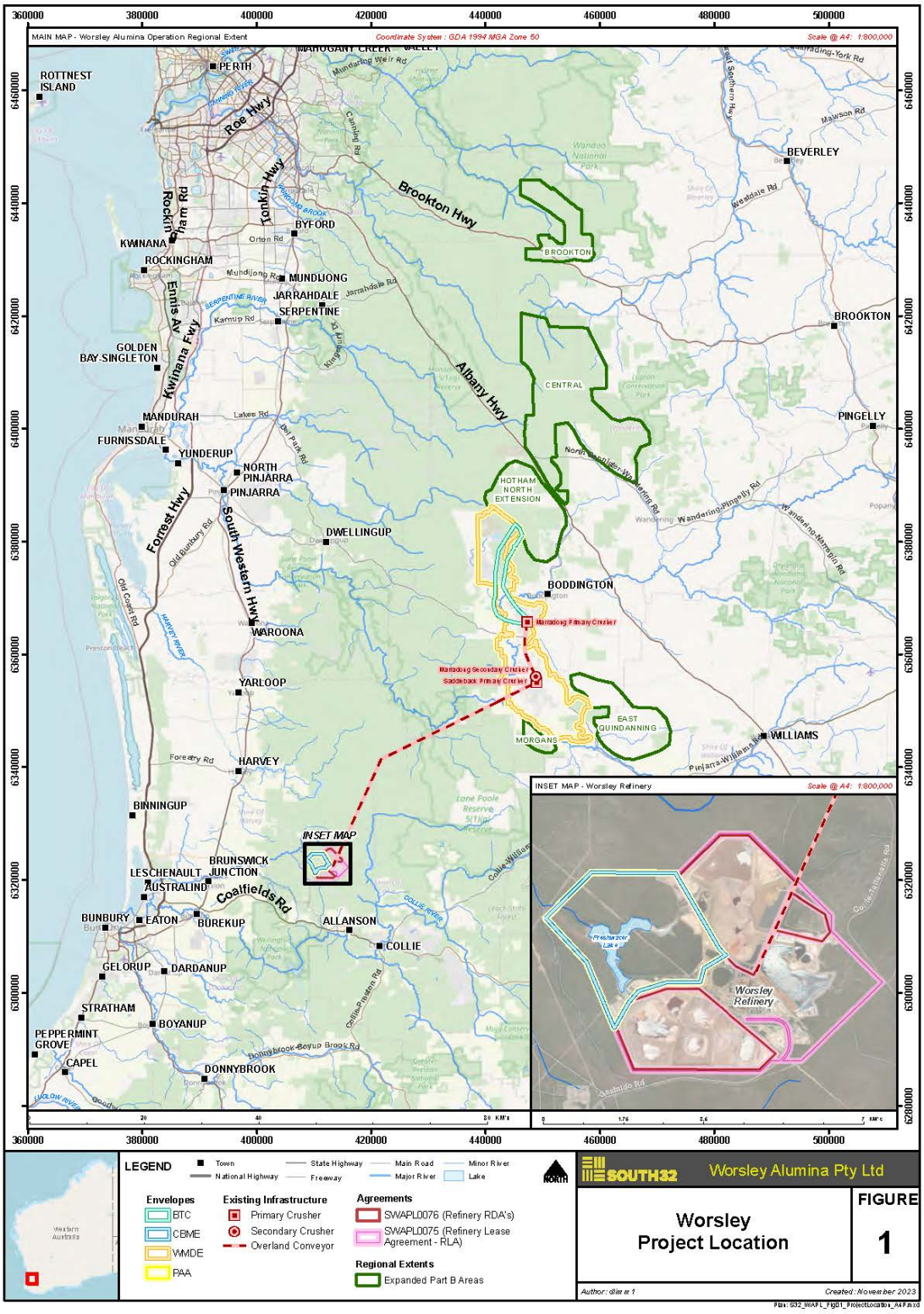

Figure 1: Worsley Project Location

3.2 KEY ENVIRONMENTAL FACTORS

MS1237 has identified the following key environmental factors relevant to the CEMP:

1) Terrestrial Environmental Quality, specifically:

- Acid sulfate soils
- Secondary salinity
- Soil compaction and soil quality (as part of rehabilitation and mine closure activities).

3.2.1 Proposal Activities Potentially Affecting Terrestrial Environmental Quality

Activities associated with the Project have the potential to either directly or indirectly impact on the key environmental factor of Terrestrial Environmental Quality. Potential impacts to the environment (direct and indirect) that may result from Project activities such as vegetation clearing, water abstraction, vehicle and machinery movements, and construction and other mining activities, include:

- Contamination of groundwater and / or surface water from Potential Acid Sulfate Soils (PASS) material and contaminants during removal of soils and sediment at river crossings;
- Deterioration or change in background water quality, such as salinity, due to indirect impact of mining activities;
- Compaction and loss of soil quality as a result of mining activities.

Sensitive components which may be affected by the operation include:

- GDEs; and
- Conservation significant flora, fauna and ecological communities.

Further details relating to potential impacts are outlined below.

3.2.1.1 Acid Sulfate Soils

Most soils within the PAA were identified through a desktop assessment as having ‘extremely low’ to ‘low’ probability of acid sulfate soil occurrence. There are some isolated areas within the PAA as having ‘high’ probability of occurrence aligning with inland water bodies and watercourses, such as Freshwater Lake in the CBME and along the Hotham River and 34 Mile Brook in the WMDE. Earthwork activities are proposed to occur over portions of the WMDE, such as for the construction of haul routes, water crossings, and the proposed crusher location at Hotham North. These have the potential to disturb ASS within lower lying areas of the PAA and major water crossings.

GHD conducted a desktop study reviewing the Atlas of Australian Acid Sulfate Soils (CSIRO 2020), characterising soil across the PAA. The study found a high probability (but low confidence) risk of ASS occurring on the banks of the Hotham River and 34 Mile Brook, in the northern portion of the WMDE (GHD 2020a). Mining voids and infrastructure in the Hotham North, Marradong and Saddleback areas of the WMDE are located within low risk areas of ASS occurring. Should ASS be exposed, the sulfide has the potential to change soil and water acidity beyond the natural buffering capacities, which may impact biological receptors. Mine pit operations and other infrastructure are not expected to disturb ASS. The risk of ASS occurring, is associated with river crossing construction activities.

Within the CMBE, Freshwater Lake, as a modified water body, has a high probability (but low confidence) of ASS presence. ASS soils are naturally occurring generally under waterlogged conditions in coastal or low-lying areas. Construction in the BTC has the potential to disturb ASS within lower lying regions and major water crossings for bridges. Modifications (or disturbance) to the Freshwater Lake within the CBME may pose a significant oxidation and acidification risk to the water body and associated environmental receptors.

To avoid water contamination impacts from ASS exposure, mining in low-lying topographical areas in the vicinity of creeks and rivers will be avoided, construction of bridges will be undertaken in the drier months, and there will be management buffers implemented around water courses to prevent water exposure. Worsley has committed to implement the Acid Sulfate Soil Management Plan (ASSMP), to outline identification, sampling, monitoring, and management of any ASS encountered. The ASSMP is provided in Appendix A.

3.2.1.2 Salinity

Dryland salinity is the accumulation of salt within the soil of a non-irrigated area, with the potential to affect a range of environmental values including soil health, flora and vegetation, terrestrial fauna, aquatic and terrestrial ecosystems. Dryland salinity has the potential to develop where the water balance in a landscape is changed and salt is mobilised by groundwater as it rises and

accumulates on the land surface.

The EPA considers that the proposal has the potential to impact soil health from an increase in dryland salinity due to removal of vegetation and groundwater table increases, particularly in low-lying areas where the groundwater table is closer to the surface. The EPA's assessment of salinity impacts from changes to the groundwater table resulting in mounding is discussed in the inland waters section 4.3.8 of EPA Report 1768 with recommended conditions, and is addressed in the Water Management Plan required by Condition B16-2.

Worsley has undertaken a Soil Characterisation Study, indicating that the risk of increased topsoil salinisation due to soil disturbance is low due to published mapping, recorded geological profile and that proposed mining activities would predominantly occur in lateritic soils above the groundwater table. The Soil Characterisation Study noted that there is the potential for secondary salinisation of soils in the event of a rising water table due to vegetation clearing in low-lying areas and near water courses.

To counteract potential impacts from dryland salinity, the Worsley has committed to reducing unnecessary clearing of native vegetation, preferencing previously cleared areas for infrastructure placement, including roads haulage corridors and conveyor routes. Worsley also committed to undertake detailed salinity risk evaluation for new mining areas using techniques developed over the past 20 years in identification of potential salinity hazard 'hot spots'. Where these salinity 'hot spots' are identified, a commitment has been made to undertake further evaluation of soil-salt storage via drilling and sampling monitoring. Progressive rehabilitation is also undertaken at Worsley which counters the impact of clearing and stabilizes the groundwater levels over time, reducing the risk of secondary salinity. The rehabilitation process if further described in section 4.5.4 and outcome and objective based provisions to reduce the risk of secondary salinity are included in the Water Management Plan required by condition B16-2.

Management measures for salinity impacts, including site specific triggers for groundwater levels, are contained within the Water Management Plan (required by Condition B16-2).

3.2.1.3 Soil Compaction and Quality

Most soils within the PAA were identified to be at a high risk (50-70%) of structure decline due to subsurface compaction. Within the CBME, the risk of subsurface compaction rises to greater than 70%. Higher risk soils are generally associated with upland areas, whereby soil profiles consist of clay rich lateritic duricrust over granite bedrock (weather saprolite). Upon the removal of overburden and bauxite ore, it is expected that the saprolite horizon would be susceptible to compaction. Soil compaction of bauxite mine pit floors will be alleviated by deep ripping prior to large rock, overburden and topsoil return as per standard mining operations. Soils occurring in low-lying areas (such as those adjacent to water courses) have lower risks of subsurface compaction (30-50%). Nevertheless, the risk of compaction is expected to vary depending on the proportion of clay particles present.

The EPA considers that compaction is likely to occur in cleared areas subject to mining and vehicle movement, and as such remediation activities undertaken as part of rehabilitation is likely to mitigate compaction impacts.

Reporting in accordance with condition B14-3, which requires the preparation and submission of an annual Rehabilitation Plan to ensure the outcomes of condition B14-1 are achieved will be undertaken. See section 4.5.4.8 for details on what is included in this annual plan.

3.2.2 Proposal Activities that Affect Terrestrial Environmental Quality

The activities associated with the proposal that have the potential to either directly or indirectly impact on the key environmental factor of Terrestrial environment are described below, including the two initial projects that form part of the overall proposal.

The Revised Proposal, including the Nullaga and Hotham North Projects, that may specifically affect terrestrial environmental quality include:

- Clearing of vegetation from construction areas.
- Removal and storage of topsoil from construction areas.
- Bulk earthworks.
- Disturbance and compaction of land from vehicles, equipment and machinery.
- Excavation works and disturbance of Acid Sulphate Soils.
- Excavation and dewatering of construction areas near surface water drainage / high water table areas.
- Use and storage of fuels and chemicals.
- Construction works in the beds and banks of watercourses.

Ancillary works and infrastructure include services relocation and removal, combined office, ablution and crib facilities, water infrastructure (bores, storage, and distribution), heavy vehicle park up, fencing, refuelling facility, explosives storage, overhead power, and telecommunication towers.

3.2.2.1 Description Of Construction Methods

Typical construction phase methodologies are outlined below. These methodologies would be adapted and developed in more detail as part of pre-construction planning processes and will be provided in detail in the Construction Contractor's Project-Specific CEMPs, where applicable.

3.2.2.2 Haul Roads, Access Roads, Bridges, And Culverts

Construction of the haul roads, access roads, bridges and culverts will generally involve the following:

1) Completion of topographic survey and marking out construction areas.
2) Installation of pre-construction environmental protection measures.
3) Upgrade and maintenance of selected existing exploration roads / access roads to allow access to the construction sites.
4) Pre-clearing surveys as per Worsley Alumina's internal procedures.
5) Vegetation clearing and topsoil removal as per Worsley Alumina's internal procedures:
    - Hygiene assessments: Prior to clearing, forest disease assessments are undertaken by qualified personnel. If disease is not found, clearing operations may proceed. In areas where disease is found a disease management plan for the area is initiated. Clearing (or any other activity) must not proceed until the disease management plan for the area is approved and implemented.
    - Salvage of forest products: This is managed by the Forest Products Commission in State Forest. The salvage operation involves harvesting of merchantable timber, fencing timber and firewood. On private land, timber salvage is arranged, if required, by the landholder which has a pre-agreed notice and removal period.
    - Clearing of vegetation: After timber salvage, the remaining vegetation is cleared and suitable hollow logs, stumps and other large residues are salvaged for future use as fauna habitat. Remaining forest residue may be burned (weather permitting), used as biomass to reduce carbon emissions or used in rehabilitation research trials.
    - Topsoil stripping and overburden removal: Topsoil and gravel are removed using the most appropriate equipment. This process is typically completed with scrapers, bulldozers, front- end loaders or excavators and trucks. Overburden is then directly replaced on nearby mine pits undergoing rehabilitation or stockpiled for future use in rehabilitation.
6) Establishment of site construction compounds.
7) Bulk earthworks.
8) Construction of permanent drainage basins, channels, berms, culverts and other drainage controls.
9) Construction of access road foundation including ripping and compaction of in-situ material, importation, levelling and compaction of sub-base material and base material, followed by importation, spreading and grading the wearing course material (the new road surface).
10) Excavation of foundations for bridge abutments including piling and dewatering (if required), installation of formwork and reinforcing, installation of pre-cast, or cast in-situ concrete foundations.
11) Construction of bridge abutments and pier with concrete piles and steel reinforced cast in-situ concrete Installation of prefabricated steel beams sections (via crane), concrete bridge deck, safety barriers and other associated facilities.
12) Installation of safety barriers, berms and signage.
13) Rehabilitation of construction areas and other post-construction environmental management

Construction materials and equipment, inputs for the haul roads will likely include civil engineering fleet of excavators, graders, dozers, roller compactors, cranes and dump trucks. The mining fleet may also be used in bulk earthworks for the road.

3.2.2.3 Non-Process Infrastructure Areas And Support Areas

The general sequence of construction for non-process infrastructure and support areas will comprise completion of surveys and marking out, installation of environmental protection measures, removal of vegetation, topsoil and unsuitable sub-soils, earthworks, construction of foundations, hardstands and concrete slabs, construction / installation of infrastructure (buildings, machinery, worker facilities, refuelling facilities, workshops and stores etc.).

3.2.2.4 Piling

The bridge will be constructed in an area underlain by soft or compressible material. The bridge abutments and pier will be constructed

on piled foundations.

The piling method associated with bridge construction will be subject to consideration of geotechnical information and detailed structural civil engineering design and construction limitations. For example, the results of existing geotechnical studies and calculations of expected pile bearing loads will be used to inform the type and design of foundations, and optimal piling method.

For the purposes of this CEMP, piling will generally be as follows:

1) Completion of topographic survey and marking out the construction areas.
2) Pre-clearing surveys as per Worsley Alumina's internal procedures.
3) Installation of pre-construction environmental protection measures.
4) Removal of vegetation, topsoil and unsuitable sub-soils and transport to stockpiles (as per mine haul road).
5) Construction of a stable work platform, such as geotextile mattress and clean dumped rock (piling platform may remain as engineered fill (behind abutments) or scour protection (at pier)).
6) The most suitable piling methods will be determined following geotechnical, engineering and constructability analyses.
7) Stabilising polymers and bentonite may be used in the piling process to ensure stabilisation of hole walls in the presence of water table and/or unstable ground conditions.
8) Piles will be tested for design compliance and structural integrity.

3.3 DOCUMENT STRUCTURE

The structure of this CEMP seeks to address the EPA's instructions and template for the preparation of a Part IV Environmental Management Plan. The EPA's template requirements addressed in this document is shown in Table 2.

Additional sections have been developed to allow the document to be a 'stand-alone' management plan, and to show how the plan should be implemented in conjunction with Worsley Alumina's Document Management System.

Table 2: EPA EMP Template Structure and Sections Addressed

EPA EMP Template Structure	Section where addressed in this document
1. Executive Summary	Section 2 – Executive Summary
2. Context, scope and rationale	Section 3 – Context, Scope & Rationale
2.1. Proposal	Section 3.1 – Proposal
2.2. Key environmental factor/s	Section 3.2 – Key Environmental Factors
2.3. Condition requirements	Section 3.4 – Condition Requirements
2.4. Rationale and approach	Section 4 – Rationale and Approach
· Environmental outcome or management objective/s	Section 4.1 – Environmental Outcomes
· Survey and study findings	Section 4.2 – Survey and Study Findings
· Key assumptions and uncertainties	Section 4.3 – Key assumptions and Uncertainties
· Objective-based EMP – risk-based approach	Section 4.6 – EMP Components
· Rationale for choice of indicators and/or management actions	Section 4.4 – Rationale for Choice of Indicators
3. EMP Components	Section 5 – CEMP Components
4. Adaptive Management & review of the EMP	Section 6 – Reporting, Adaptive Management & Review
4.1. Early response indicators, criteria & actions	Section 5.1 – Outcome based provisions

EPA EMP Template Structure	Section where addressed in this document
4.2 Stakeholder consultation	Section 7 – Stakeholder Consultation
4.3 Changes to the EMP	Section 10 – Document Control

3.4 CONDITION REQUIREMENTS

Implementation and management of the Revised Proposal must be accordance with the conditions of MS1237. Conditions addressed by the CEMP are included in Table 3.

Table 3: EP Act Approval Conditions Addressed by the CEMP

Ref	Cond.	Condition Requirement	Plan Ref	Key commitments and activities
MS1237	B17-1	The proponent must ensure the implementation of the proposal achieves the following environmental objective: (1) Maintain the quality of land and soils so that **environmental values** are protected.	Acid Sulfate Soil Management Plan (Appendix A) Water Management Plan (Required by Condition B16-2) BBM Mine Closure Plan (required by Condition B3-1) Rehabilitation Plan required by condition B14-3 Section 4.2 Section 4.5 Section 4.5.4.8 Section 5	Targeted GDE Groundwater Monitoring Program Regional Surface Water Monitoring Program ASSMP excavation and dewatering management BBM Mine Closure activities as outlined in the BBM Mine Closure Plan (required by Condition B3-1) Rehabilitation activities as outlined in the Rehabilitation Plan required by Condition B14-3.
MS1237	B17-2	The proponent must ensure the implementation of the proposal achieves the following outcomes: (1) Ensure no acid sulfate soil contamination with the **PAA** or elsewhere attributable to the proposal; (2) Ensure no secondary salinity occurs within the **PAA** or elsewhere attributable to the proposal; and (3) Ensure soil compaction and soil quality is remediated as part of rehabilitation and mine closure activities, in line with timing requirements outlined in condition B14 and B2.	Water Management Plan (Required by condition B16-2) Appendix A: Acid Sulfate Soil Management Plan BBM Mine Closure Plan (required by Condition B3-1) Rehabilitation Plan Section 4.2 Section 4.5 Section 5	Targeted dewatering management & monitoring ASS Soil excavation management Targeted GDE Groundwater Monitoring Program Targeted GDE Vegetation Condition Assessment Regional Vegetation Condition Assessment Regional Surface Water Monitoring Program Regional Groundwater Monitoring Program
MS1237	B17-3	The proponent must review and update the Construction Environmental Management Plan (South32 Worsley Alumina Version 0, WOR-71183-FS-PM-PLN-0004), that satisfies the requirements of condition C4 and demonstrates how achievement of terrestrial environmental quality outcomes in condition B17-2 will be monitored and substantiated and how the environmental objective in condition B17-1 will be achieved, and submit for approval to the **CEO** prior to implementation of the proposal.	This CEMP Table 6 Table 7 Table 8 Water Management Plan (required by condition B16-2) Appendix A: Acid Sulfate Soil Management Plan BBM Mine Closure Plan (required by Condition B3-1) Rehabilitation Plan (as required by Condition B14-3)	Targeted dewatering management & monitoring ASS Soil excavation management Targeted GDE Groundwater Monitoring Program Targeted GDE Vegetation Condition Assessment Regional Vegetation Condition Assessment Regional Surface Water Monitoring Program Regional Groundwater Monitoring Program
MS1237	C4-1	The plans required under conditions B3-1, B12-6, B13-7, B14-3, B15-4, B15-7, B15-9, B15-11, B16-2 and B17-3 must contain provisions which enable the substantiation of whether the relevant outcomes of those conditions are met, and must include: (1) threshold criteria that provide a limit beyond which the environmental outcomes are not achieved; (2) trigger criteria that will provide an early warning that the environmental outcomes are not likely to be met; (3) monitoring parameters, sites, control/reference sites, methodology, timing and frequencies which will be used to measure threshold criteria and trigger criteria. Include methodology for determining alternate monitoring sites as a contingency if proposed sites are not suitable in the future; (4) baseline data; (5) data collection and analysis methodologies; (6) adaptive management methodology; (7) contingency measures which will be implemented if threshold criteria or trigger criteria are not met; and (8) reporting requirements.	Table 7 Table 8 Section 4.2 Section 4.5.4.8 Section 6.3 Section 6.2 Water Management Plan (Required by Condition B16-2) Acid Sulfate Soil Management Plan (Appendix A) Rehabilitation Plan (Required by condition B14-3) BBM Mine Closure Plan (Required by condition B 3-1)	Targeted dewatering management & monitoring ASS Soil excavation management Targeted GDE Groundwater Monitoring Program Targeted GDE Vegetation Condition Assessment Regional Vegetation Condition Assessment Regional Surface Water Monitoring Program Regional Groundwater Monitoring Program

3.5 SUMMARY OF INITIAL PROJECTS

This CEMP applies to the entire Revised Proposal area, Worsley is planning two initial project construction phases located within the Worsley Mining Development Envelope (WMDE) to support ongoing operations. Initially, the Nullaga project (Phase 1) will be developed with ore transported to the existing Marradong facility via a haul road. Following Nullaga, the Hotham North project (Phase 2) will be developed. Nullaga is expected to commence construction in 2025, and Hotham in 2027 with mining activities commencing concurrently. A summary is provided below of the two major construction phases.

3.5.1 Summary of the Nullaga Project (Phase 1)

The Nullaga Project (Phase 1 of the Worsley Mine Expansion) comprises construction of a haul road including a bridge, culvert crossings of drainage lines and tributaries, construction access and laydown areas. The proposed transport corridor comprises a corridor for the construction of long-term infrastructure to transport bauxite ore to Marradong from the Nullaga Project and Hotham North Project (future stage) mining areas and provides a link to the extended mining areas.

The haul road will cross the Hotham River and tributaries to access the Nullaga Project mining areas, and bridges or culvert crossings are required to be constructed at these crossing locations. The bridge including the haul road over the Hotham River is proposed to have a dual span of approximately 70 m and require piles to be bored more than 40 m deep. The piles will be installed adjacent to the riverbanks. No piles to be installed within the normal flow course of the river. Excavations will be required to construct bridge abutments composed of concrete piles with reinforced concrete abutment wall to contain the earthen backfill. Dewatering of the excavations may also be required.

Culvert crossings over the tributaries, e.g. 34 Mile Brook, will be low level crossings with culverts placed directly in the stream path. Rock material will also be installed on the riverbed, embankments and at the ends of the culverts to provide scour protection.

3.5.2 Summary of the Hotham North Project (Phase 2)

The Hotham North Project (Phase 2 of the Worsley Mine Expansion) provides the enabling infrastructure and equipment to Boddington Bauxite Mine (BBM) required to continue the supply of bauxite feed to the Worsley Refinery. Hotham North is located approximately 12 km north of the Marradong operations and adjacent to the Nullaga project, providing access to the remaining resource.

The Hotham North deposit will be mined by traditional truck and shovel method with run of mine material transferred to the existing Crushing Hub at Marradong. The Hotham North project components include:

1) Installation of public road overpass over Gold Mine Road and heavy vehicle by-pass road
2) The construction of haul roads suitable from the Nullaga haul road to the Hotham North Mining area Intermediate Run of Mine Stockpiles (I-ROMs)
3) Intermediate Run of Mine Stockpiles (IROM) areas and supporting infrastructure
4) Non-process Infrastructure (NPI), including heavy equipment workshop, administration offices emergency services facilities, diesel storage, site access and car parks
5) Construction of a Bauxite Transport Corridor to transfer mine material from Hotham North to the Crushing Hub at Marradong.
6) Expansion of the sites existing Optus Long Term Evolution (LTE) including additional towers associated hardware and P25 two-way radio equipment
7) Water bores, storage, standpipe and pipeline connection to the Nullaga water storage facility
8) Construction of an Ammonium Nitrate (AN) storage facility and explosives magazine.

4 RATIONALE AND APPROACH

The CEMP addresses the Terrestrial Environmental Quality environmental factor and the EPA's objective to maintain the quality of land and soils so that environmental values are protected. The CEMP addresses the required outcomes within MS1237 and other legal requirements and identified risks related to terrestrial environmental quality.

Worsley has operated in the region for over 40 years and, in this time, has conducted three detailed environmental impact

assessments under Part IV of the *Environmental Protection Act 1986* (WA) to support the expansion of its operations. Worsley has a thorough understanding of the potential impacts to terrestrial environmental quality that could occur because of its proposed operations.

4.1 ENVIRONMENTAL OUTCOMES

Required environmental outcomes have been defined within MS1237 and are contained within the management plans provided in Appendix A: Acid Sulfate Soil Management Plan, the Water Management Plan (as required by condition B16-2 of MS1237 and the Rehabilitation plan as required by condition B14-3 of MS1237. Whilst environmental outcomes from the relevant management plans is provided below, this is not an exhaustive list as the plans may be required to be updated as the project progresses. Condition B17-1 defines the outcomes as:

1) ensure no acid sulfate soil contamination within the PAA or elsewhere attributable to the proposal;
2) ensure no secondary salinity occurs within the PAA or elsewhere attributable to the proposal; and
3) ensure soil compaction and soil quality is remediated as part of rehabilitation and mine closure activities, in line with timing requirements outlined in condition B14 and B2.

4.1.1 Environmental Objectives

Additional environmental objectives have been determined by the business to manage potential impacts to the Terrestrial Environment identified through risk assessment that are not addressed within MS1237.

1) Minimise the risk of riverbank erosion and sedimentation.
2) Minimise risk of Worsley's mining operations impacting on water quality (salinity).
3) Minimise risk of adverse impacts to hydrological regimes of the Hotham River, Marradong Brook, Murray River, Williams River and 34 Mile Brook attributable to the proposal.
4) Minimise the risk of exposure of PASS.
5) Minimise the risk of over or under compacted soils and poor drainage.

4.2 SURVEY AND STUDY FINDINGS

4.2.1 Overview

Worsley has undertaken numerous studies to understand the potential impacts of bauxite mining on the Terrestrial Environment, as detailed in the ERD. These studies have supported the development of appropriate monitoring programs to ensure operational impacts are understood and minimised to prevent environmental impacts. Detailed reviews of monitoring programs and associated data are completed on a regular basis applying an adaptive management approach to the monitoring and management of Inland Waters. These studies and reviews are contained within the ASSMP, Water Management Plan, BBM Mine Closure Plan and Rehabilitation Plan, and are summarized below in Table 4.

Table 4: Studies and Reviews Relevant to the CEMP

Mining Area	Description/Purpose	Reference
Primary Assessment Area	Desktop baseline soil quality assessment to provide additional information and assessment of all available data provided for the PAA.	Worsley Mine Expansion – Revised Proposal – Soil Characterisation Study (GHD, 2020a)
Marradong	Description of lithology encountered during groundwater drilling programs in Marradong.	Boddington Bauxite Mine 2018 Groundwater Program – Bore completion report – Marradong Drilling (Global Groundwater 2018)
Rehabilitation	Investigating Landform related erosion triggers, comparison of topsoils from three bauxite mines, rates of gully growth and erosion modelling	Erosion-resistant landform design for steep slopes in rehabilitated bauxite mines ((Mengler, et al., 2006))

Mining Area	Description/Purpose	Reference
Primary Assessment Area	Salinity risk assessment for the Worsley Alumina proposal to increase bauxite mining in support of expanded alumina production.	Worsley Alumina's Bauxite Mining Lease Area 258SA Salinity Assessment (Golder, 2004)
Rehabilitation	Investigation into the stability and potential erodibility of rehabilitated and unmined topsoils in the Fawcett rehabilitation area	Assessment of Topsoil Stability on Fawcett's Rehabilitation Area at the Boddington Bauxite Mine (Braimbridge and Hinz, 2004)
Saddleback	Flux Density Analysis to determine high salinity risk areas and revise the surface and groundwater monitoring program as appropriate.	WEC 2003, Salinity Risk Assessment for the Boddington Bauxite Mine Using FDA
Marradong	Flux Density Analysis to determine high salinity risk areas and revise the surface and groundwater monitoring program as appropriate.	Croton and Dalton 2008, Proposed Groundwater Monitoring for the Marradong Timber Reserve Mine Area
Hotham North	Flux Density Analysis to determine high salinity risk areas and revise the surface and groundwater monitoring program as appropriate.	Green et. al 2023a, Salinity Risk Assessment for the Hotham North Mining Area Using Flux Density Analysis
Saddleback and Marradong	Triennial Aquifer Reviews: These have been completed for operations occurring from 2004 onwards. The purpose of the triennial review is to assess the effectiveness of controls in managing impacts to the aquifers within the active areas of BBM.	Most recent: Green et al 2021, Boddington Bauxite Mine Triennial Aquifer Review July 2017 – June 2020 Green et al 2024, Boddington Bauxite Mine Triennial Aquifer Review July 2020 – June 2023
Primary Assessment Area (BBM)	Numerical Groundwater Model: quantify potential groundwater related effects of the proposed mining activities, specifically changes to groundwater levels and fluxes, to inform the assessment of groundwater impacts	GHD 2022b, Groundwater Supporting Studies, Numerical Groundwater Modelling
Primary Assessment Area (BBM)	Assessment of bauxite mining impacts on the groundwater and surface water systems consisting of a desktop review and predictive groundwater flow modelling.	GHD 2022b, Groundwater and surface water studies
Primary Assessment Area (BBM)	Additional Groundwater Model Uncertainty Analysis	GHD 2023, Technical Memorandum: Groundwater uncertainty analysis to support addressing comments provided by the Office of Water Science
Primary Assessment Area	Desktop baseline soil quality assessment to provide additional information and assessment of all available data provided for the PAA.	GHD. 2020a. Worsley Mine Expansion Revised Proposal – Soil Characterisation Study.
Saddleback	A targeted study to understand the effects of Worsley Alumina's Boddington Bauxite Mine (BBM) on stream flows, stream salinities and groundwater levels.	WEC 2004, Review of the Bee Farm and Tunnel Rd Catchment Study
Saddleback and Marradong	Detailed groundwater monitoring program review for the BBM.	Croton, J.T, Mauger, G.W. & Dalton, J.A., 2020. Review of the Piezometer Network at the Boddington Bauxite Mining

Mining Area	Description/Purpose	Reference
Hotham North	Hydrology and hydraulics study to understand hydrological risks and support design of Hotham River Crossing and associated haul road alignment.	Egis 2023, Dilyan's Crossing Hydrology and Hydraulics Report
CBME	Hydrogeological assessment and groundwater model development for the proposed contingency bauxite mining at the CBME	GRM 2023, Contingency Bauxite Mining Envelope (CBME) Hydrogeological Assessment and Groundwater Model
Quindanning Timber Reserve	Detailed review of potential indirect impacts to *C. hopperiana* in the Quindanning Timber Reserve associated with the Revised Proposal providing recommended monitoring and management measures.	Green et al 2023b Review of the Indirect Impacts in the Quindanning Mining Area
BBM	Investigating Landform related erosion triggers, comparison of topsoils from three bauxite mines, rates of gully growth and erosion modelling.	Mengler et al. 2006. Erosion-resistant landform design for steep slopes in rehabilitated bauxite mines
BBM	Investigate adequacy of historical ripping techniques used in rehabilitation and soil properties associated with variation observed in tree growth in rehabilitation	Braimbridge MF & Gilkes RJ (2007). Effect of Past Ripping Practices on Pit Floor Regolith Material, Root Growth and Rehabilitation Success.
BBM	To investigate the immediate effects of deep ripping on soil physical properties.	Worthington, T et al (2007). Assessment of the Effect of Deep Ripping Practices on Soil Physical Properties at BBM.

4.2.2 Acid Sulfate Soils

A baseline soil quality assessment was undertaken to support the environmental Impact Assessment for the Worsley Revised Proposal. (GHD 2020). This is with reference to soil quality including the chemical, physical, biological and aesthetic characteristics, with regard to potential for acid sulfate soils, salinisation (dryland salinity) and contamination (mining activities), compaction, erosion and acidification of soils. This assessment included the assessment of potential issues in relation to soil and rock disturbance. The following conclusions related to ASS and acidification and/or metalliferous drainage were reached by the study:

Acid Sulfate Soil (ASS): Published mapping, visual observations and a review of the Proposal information provided indicates that sulfidic material (material with a reduced inorganic sulfur content greater than 18.0 mol H+/tonne) is unlikely to be intersected during mining operations (mining voids within indicative disturbance footprint) and general mining activities above the groundwater table. Site specific investigations (intrusive investigations) prior to ground disturbance works should focus on low lying areas (includes infrastructure crossing water courses) and areas defined as Groundwater Dependent Ecosystems (Mattiske 2020), where disturbance is greater than 100 m^3 and / or where groundwater modelling predicts groundwater level alterations above or below seasonal fluctuations within ASS risk areas.

Acidification and/ or metalliferous drainage: The presence of elemental sulfur (as sulfate or sulfide) is not anticipated to occur within the highly weathered laterite (bauxite ore) due to the leaching that has occurred during the weathering process. The weathering process has resulted in the absence of significant sulfides and metals and as such metalliferous drainage is not likely to occur within the weathered profile and disturbed bauxite ore. It is further noted that metals and sulfate or sulfides are not expected to be present within naturally forming and un-altered topsoil formations. Minor concentrations of sulfate through atmospheric fall out and deposition may occur within concentrated seeps and low lying areas.

4.2.3 Dryland Salinity

Section 4.3 of the Water Management Plan (required by condition B16-2) includes a summary of the findings from studies related to the hydrology / catchment at the BBM.

4.2.4 Soil Compaction and Soil Quality

The baseline assessment undertaken by GHD (GHD, 2020a) to support the Revised Proposal included a summary of findings in

relation to soil compaction as follows:

Published mapping for the PAA indicates that soils are at a high risk of compaction and structural decline through subsurface compaction. In the CBME, the risk of subsurface compaction is greater than 70%. The higher risk soils are associated with upland areas, where the soil profile comprises laterite duricrust over deeply weathered saprolite (granitic bedrock), that is clay-rich. It is therefore expected that the saprolite horizon would be susceptible to compaction, upon removal of the overburden and bauxite ore. Soils occurring in low-lying areas immediately adjacent to watercourses intersecting the PAA (i.e. Hotham River, Williams River and 34 Mile Brook), have the lowest risk (30- 50%) of subsurface compaction. These sedimentary soils, deposited through colluvial and alluvial processes, comprise a mix of clay, silt and sand. Nevertheless, the risk of compaction is expected to vary depending on the proportion of clay particles present.

Studies conducted by Worsley (eg Braimbridge et al 2007) to assess the potential impact mining and rehabilitation may be having on plant growth as a result of compaction with a primary focus on assessing the ripping techniques and resulting effects on soil profile structure and subsequent root growth. Rehabilitation of the sites ranged in age from 8 to 16 years. Soil pits were excavated to a minimum of 2.5 metres depth and detailed descriptions of soil profile morphology, soil structure and root growth were conducted for each site. Samples were also collected from each profile for analyses of physical, chemical and mineralogical characteristics. The study found that although no direct effects of ripping were identified, there were various amounts of root penetration throughout all profiles to the base of each of the pits and there was no matting of roots at the overburden/pit floor boundary and in all profiles roots extended to below the base of the pits (>3m).

4.3 KEY ASSUMPTIONS AND UNCERTAINTIES

The key assumption underpinning this CEMP is that acid sulfate soils are absent throughout the entire project area, except for the river crossings. This assumption is based on comprehensive soil testing and the 35 years of experience conducting earthworks in the region, which indicate that the presence of acid sulfate soils is confined to the river crossing locations. Consequently, the management strategies and mitigation measures outlined in this plan are tailored to address potential risks and impacts associated with acid sulfate soils exclusively at the river crossings, ensuring that the rest of the project area remains unaffected by these conditions.

The primary uncertainty in this CEMP is the extent to which earthworks will interact with potentially acid sulfate soils (PASS) at the river crossings. While initial assessments and soil testing have provided a general understanding of the locations and concentrations of PASS, the dynamic nature of earthworks and the variability of soil conditions introduce a level of unpredictability. To mitigate these uncertainties, a robust monitoring program has been established. This program includes regular soil testing, real-time monitoring during earthworks, and adaptive management strategies to promptly address any unexpected encounters with PASS. These measures are provided in Section 4.5.4.8 and Section 5, and are designed to minimize environmental impacts and ensure that any interaction with PASS is effectively managed, thereby safeguarding the integrity of the project and the surrounding environment.

4.4 RATIONALE FOR CHOICE OF INDICATORS

4.4.1 Potential Impacts

The environmental outcomes addressed by the CEMP are largely interconnected and reflect potential direct and indirect impacts associated with ground disturbance activities and disturbance of soils. Given this, selected indicators and associated trigger levels can often be applied to multiple environmental outcomes.

The environmental impact assessment process identified the following potential direct and indirect impacts to the environment for terrestrial environment:

1) Impacts to soil quality through erosion
2) Potential increase in dryland soil salinity due to groundwater table changes
3) Impacts to soil quality through contamination (acid sulfate soils, hydrocarbons and other chemicals).
4) Impacts to soil quality through compaction.

These impacts are interconnected and have a limited duration associated with the temporary change in land use during mining activities. The expected duration of the identified potential impacts represents the period from initial clearing within a given area until the reestablishment of deep-rooted vegetation.

The proposed outcomes, mitigation measures and management actions are presented in Section 5.

4.4.1.1 Outline Construction Methodology

Construction works will involve clearing and preparatory earthworks for access, equipment and material laydown areas. Access

roads will be required along the alignment to allow construction crews access to work locations. To avoid areas unnecessary exposure to erosion by wind and rain, areas will only be opened immediately in advance of construction with erosion and sediment controls, where practicable. There may be instances where this is not possible as some larger areas may be cleared in a single campaign.

Clearing activities will remove ground cover to enable construction access and sufficient vehicular movement. Clearing of vegetation within the bed and banks will be necessary to facilitate construction of instream structures required for traversing of streams for site access.

Initial earthworks will establish the entry and exit points into creeks or riverbeds. Scour protection will to be incorporated into the design of each structure.

4.4.2 External Contributing Factors

The region within which Worsley operates are large with many contributing factors that must be factored into an assessment of impacts. Of highest relevance are:

- Drying Climate: the drying climate has led to a regional decline in groundwater levels and reduced surface water flows. An increase in the frequency of extreme weather events must also be considered.
- Historic land use: areas surrounding the Worsley operation are largely used for agricultural purposes with most native vegetation historically removed. Some areas are also utilised for plantation and the harvesting of these plantation crops are likely to influence groundwater and surface water.
- Dryland salinity: The Hotham River and Williams River are known to be impacted by salinity associated with historic land clearing in the upper catchments.
- Newmont Boddington Gold (NBG): Worsley's operations will be adjacent to the existing NBG facility. Potential cumulative impacts have been considered in the EIA process to ensure that required environmental outcomes are achieved.

4.5 MANAGEMENT AND CONTROL STRATEGIES

4.5.1 Water Management Plan

The Worsley Water Management Plan (WMP) has been prepared to outline Worsley's management and monitoring approach to ensure outcomes are achieved in accordance with conditions B16-1 and B12-1(2) of MS1237 and to minimise impacts on inland waters. In addition these outcomes are applicable to this CEMP.

Management measures relate to achieving the following environmental outcomes:

- Ensure no secondary salinity occurs within the PAA or elsewhere attributable to the proposal;
- Management of riverbank erosion and sedimentation (section 4.6.9); and
- Hazardous Materials and Spill Management (section 4.6.8).

Specific considerations included in section 5.2.1 of the WMP (Outcome Based Provisions), table 5-1 include:

- Secondary salinity (Table 5-1, Outcome 1, 2, 3, 4 & 5)
  - Groundwater monitoring; including trigger and threshold criteria, response actions and reporting (including groundwater level, EC / TDS and pH);
  - Surface water monitoring; including trigger and threshold criteria, response actions and reporting (including Turbidity, TSS, EC / TDS)

Specific considerations included in section 5.2.1 of the WMP (Objective Based Provisions), table 5-2 include:

- Secondary salinity (table 5-2, Outcome 1, 2, 4,)
  - Conduct landscape assessment and baseline flora monitoring to identify potential locations of GDEs and SWDEs.
  - Conduct baseline groundwater and surface water monitoring and ground truthing to verify location and boundaries of GDEs and SWDEs within highest risk impact areas as identified through modelling and FDA (i.e. potential groundwater mounding risk or salinity hotspot identified).
  - Define Protected Areas and associated buffers in accordance with the Protected Areas Plan.

  - Complete investigations into the sensitivities and tolerances of any conservation significant GDE vegetation structures vulnerable to groundwater mounding predictions.
  - Review and revise the water monitoring program to ensure the monitoring program intent is met for any newly identified GDEs and / or SWDEs
  - Minimise native vegetation disturbance and utilise existing cleared areas or areas that will be disturbed for future mining pits where possible.
  - Complete FDA for new mining areas to determine salinity risks. Additional salt storage investigations to be completed for high-risk areas.
  - Progressive rehabilitation of disturbed land.
  - No ground disturbance within PDWSAs until working arrangements are developed and agreed upon with regulators and the Water Corporation.
- Riverbank erosion and sedimentation (table 5-2 Outcome 3)
  - Apply stream buffers in accordance with the FMP (CPCWA, 2023) and Water Quality Protection Note 6: (Department of Water, 2006).
  - Manage stream buffers.
  - Installation of water management infrastructure (sumps, drainage lines etc.) for all operational areas including haul roads in accordance with site procedures and standards.
  - Obtain Bed and Banks permits under the RIWI Act for any disturbance required to stream beds and banks.
  - Reshape disturbed areas to match surrounding contours during progressive rehabilitation to minimise impacts on surface water drainage patterns.
- Contamination of groundwater and surface water from chemicals and hydrocarbons (table 5-2, Outcome 8)
  - Avoid storage of chemicals and hydrocarbons in PDWSAs.
  - Chemicals, hydrocarbons and other environmentally hazardous materials stored and handled in accordance with Dangerous Goods Safety Act 2004 and associated regulations.
  - Construction of fuel containment infrastructure in accordance with Australian Standards.
  - All spills will be managed in accordance with site procedures and standards.
  - Collection and treatment of potentially contaminated stormwater run-off from workshops and hydrocarbon storage areas.
  - Contaminated soils at BBM to be placed in lined hydrocarbon storage area until removal from site by a licensed contractor.

4.5.2 Mine Planning

The Ten Year Mine Plan is developed annually and submitted to the WEMLG in the last quarter of the calendar year. The Ten Year Mine Plan includes the anticipated clearing for both State Forest and private land, including pasture disturbance and clearing of rehabilitation for both mining and infrastructure. The Ten Year Mine Plan also maps and advises on any changes to Protected Areas and Protection Commitments. The WEMLG reviews the clearing areas within the Ten Year Mine Plan and provides feedback and acceptance on behalf of the Minister.

In addition to clearing areas, the Ten Year Mine Plan outlines the proposed exploration, resource definition and grade control drilling programs for the next available ten years.

4.5.3 DBCA Working Arrangements

The DBCA - WAPL Working Arrangements (Working Arrangements; Worsley 2018) outline the procedures mutually agreed upon by the DBCA and Worsley for bauxite / alumina activities undertaken by Worsley on State lands managed by DBCA (currently Saddleback, Marradong and Quindanning Timber Reserves), as outlined in the Worsley State Agreement.

The document sets out the responsibilities of each party and provides a framework from which detailed working arrangements for specific aspects of mining and rehabilitation related activities can be prepared or reviewed. The framework intends that full

advantage can be taken of the resources and experiences of both organisations and that the arrangements are responsive to new information from operational experience, trials and research.

Arrangements outlined in the documents include:

1) Exploration drilling activities;
2) Forest clearing;
3) Forest rehabilitation;
4) Hygiene management;
5) Forest burning;
6) Forest vermin control;
7) Fauna management; and
8) Additional arrangements.

The rehabilitation program formulated under the Working Arrangements (Rehabilitation Prescription) for bauxite mining in Timber Reserves (described in Section4.5.4) is guided by the Working Arrangements document. Under the terms of the current Working Arrangements:

1) Worsley is required to rehabilitate all areas of Timber Reserve disturbed by its activities according to a prescription agreed with DBCA. Worsley will assume responsibility for the progressive graphic and descriptive documentation of rehabilitation efforts and for providing DBCA with data for its internal recording.
2) The development of the annual Rehabilitation Prescription consists of two steps:
3) A generalised prescription is jointly prepared and includes rehabilitation works common to all pits and identifies where options exist to modify particular rehabilitation treatments (part one is reviewed in detail every second year); and
4) An outline of the proposed BBM rehabilitation plan for that year.

Worsley provides an Annual Environmental Report (AER) outlining the rehabilitation treatments, prescription, vegetation description and the areas rehabilitated.

As part of rehabilitation responsibilities, Worsley is required, in consultation with DBCA, to reinstate the forest track network upon completion of mining. This includes maintenance of a proposed post-rehabilitation 'Forest Track Plan' which will identify proposed permanent and temporary tracks. Forest tracks are typically re-established near pre-existing track locations, depending on slope and access restrictions, and tie into any boundary or fire access tracks or gates. For large rehabilitation areas, rehabilitation monitoring tracks may be established with the intent that these will have restricted access once monitoring has been completed.

The Working Arrangements also provide for Worsley to develop and implement research programs into rehabilitation burning, in consultation with DBCA. Operational burning of rehabilitated areas is also to be based on this research and where possible, integrated into the annual forest burning program and demonstrated to be sustainable prior to handing back to the State. This operational burning is to be self-sustaining and robust to DBCA forest burning practices.

In parallel with the Working Arrangements review, Worsley is undertaking a documented review of rehabilitation outcomes in previously rehabilitated areas to support joint development of appropriate agreed completion criteria for the State forest areas, based on the framework generated by the Western Australian Biodiversity and Science Institute (WABSI). This will form the basis for agreed future handback of rehabilitated areas. It is likely that performance criteria will need to be established for different aged areas of rehabilitation to address the progressive variation in rehabilitation establishment techniques used since the commencement of mining operations. Any criteria established for rehabilitation will also need to be reviewed at regular intervals to recognise improvements in rehabilitation technology and performance and other new information.

Upon finalisation of the completion criteria with DBCA, the Working Arrangements will be reviewed to ensure they are consistent and support the required outcomes for rehabilitation. Worsley's rehabilitation prescriptions will then become subsidiary and separate to the completion criteria and Working Arrangements but will continue to be made available to the DBCA and WEMLG to provide information on processes and procedures being used by Worsley to rehabilitate areas and meet the completion criteria.

There are no set agreed rehabilitation prescriptions for the CBME area. Any planned rehabilitation program will be discussed with DBCA and a joint understanding of outcomes will be agreed prior to any rehabilitation activities occurring.

4.5.4 Forest Rehabilitation

Rehabilitation forms an important component of the mitigation hierarchy as a mitigation measure associated with the impacts of clearing native vegetation. The current primary objective of rehabilitation undertaken by Worsley on Timber Reserve land is to: "regenerate a stable productive forest ecosystem planned to maintain recreation, conservation and nominated forest values." The reestablishment of native vegetation through rehabilitation counters the impact of clearing and stabilises the groundwater levels over time.

The following section of the plan describes rehabilitation objectives, processes, adaptive management, completion criteria and monitoring practices.

4.5.4.1 Summary

Future rehabilitation in the Project Area will be based on the current rehabilitation program. This program involves an existing adaptive management approach to alter the program where needed, recognising there are likely to be variations required as operations move into new areas. Worsley has established a comprehensive research program that allows refinement of the current program based on improved methods and requirements of specific areas.

Current rehabilitation prescriptions for the Saddleback, Marradong and Quindanning Timber Reserves are agreed with DBCA during the revision of the Rehabilitation Prescription. During the biennial review process all amendments are made in consultation with the DBCA based on operational needs, research and monitoring results.

All rehabilitation planned for areas within the RLA will be subjected to an agreed specific rehabilitation prescription with DBCA (depending on the target outcome).

Where mining occurs on agricultural land, the Private Land Rehabilitation Management Procedure (01020410) is followed. This Procedure outlines requirements for Restoration Agreements between Worsley and the landowners prior to the commencement of rehabilitation. These agreements are generally based on pre-existing land use as identified during baseline botanical surveys prior to disturbance. The agreement is mutually agreed and signed off by both parties.

Worsley is confident that the current rehabilitation program and the adaptive management approach used to keep the program up to date will continue to provide a suitable basis for a comprehensive and appropriate rehabilitation program.

4.5.4.2 Rehabilitation Planning

Rehabilitation is prioritised during the planning process to ensure that the rehabilitation program:

- Supports Ecological Linkages and fauna corridors;
- Maximises availability of direct return topsoil placement;
- Provides additional vegetated buffer for Protected Areas; and
- Reduces fragmentation across the landscape.

4.5.4.3 Protection of Rehabilitation

Completed rehabilitation may on occasion be prioritised for clearing over remnant vegetation (for activities such as establishment of haul roads or other infrastructure). However, planning will be undertaken to designate areas as "Protected Rehabilitation" where it is known to provide specific function (such as ecological linkage or to buffer existing Protected Areas) or it is confirmed future access will not be required.

Worsley will not re-clear areas of Protected Rehabilitation to ensure it is maintained and protected as an ecological resource supporting ecological values including State and federally listed values (i.e. Black Cockatoo foraging habitat) for the time period it remains within Worsley's management and control (noting once areas are handed back to the original landowner, Worsley has no right to influence protection measures). Worsley will, on an annual basis, report any areas of rehabilitation designated for protection in the 10 Year Mine Plan. These areas will be incorporated into the Protected Areas layer.

4.5.4.4 Rehabilitation Process

For mining activities in State Forest, the obligations under the Worsley State Agreement are met through a rehabilitation program currently guided by the Rehabilitation Prescription, the Working Arrangements and Worsley's internal procedures and standards. The Rehabilitation Prescription details the application of rehabilitation objectives, methodology, and success criteria. Worsley reviews and revises the Working Arrangements every 5 years, and associated Rehabilitation Prescription every 2 years and submits these to the DBCA for comment. Agreed completion criteria are currently under development. Upon finalisation the Working Arrangements will be reviewed, and the Rehabilitation Prescription will become a subsidiary and separate document to the completion criteria and working arrangements. The adaptive management regime, incorporating the agreed completion criteria adopted by Worsley, aims to ensure rehabilitation of Timber Reserves is kept up to date.

4.5.4.5 Rehabilitation Objectives

Rehabilitation of Timber Reserves mined by Worsley is subject to a range of objectives that originate from various sources, including:

1) Worsley State Agreement;
2) Working Arrangements;
3) MS719:M12 & MS1237 Condition B14;
4) Forest Management Plan 2024–2033 (Conservation & Parks Commission, 2023); and
5) EPA (2006) Guidance of the Assessment of Environmental Factors – Rehabilitation of Terrestrial Ecosystems.

The current objectives, as set out in the Rehabilitation Prescription, guide daily rehabilitation operations by Worsley in State Forest, and have been retained as the key objectives until agreed completion criteria are developed. The objectives of the other sources noted above are closely aligned with the objectives of the Working Arrangements, and thus, where applicable, are also addressed by this Plan.

The current primary objective of rehabilitation undertaken by Worsley on Timber Reserve land is to: "regenerate a stable productive forest ecosystem planned to maintain recreation, conservation and nominated forest values."

Specific goals are:

1) Recreation - where practicable, to provide or maintain recreational and heritage values in accordance with approved DBCA plans
2) Conservation - to regenerate, in the long-term, floral and faunal characteristics compatible and consistent with the surrounding Eastern Jarrah Forest biodiversity
3) Landscape - to create a rehabilitated landscape compatible with the general landform and physiography
4) Landform - ensure the resulting landforms and soils are safe, stable and resilient
5) Hydrology - to restore the hydrological balance through the establishment of deep-rooted vegetation in rehabilitated areas
6) Protection - to minimise impacts on non-mined areas, to conserve the residual soils, to minimise dieback spread, and ensure that unacceptable fire hazards do not accumulate.

In seeking to meet these goals, the desired result is a safe multiple-use forest in which rehabilitated and undisturbed stands are integrated to the maximum practical extent.

In implementing the objectives of the Working Arrangements, in terms of forest ecosystem sustainability, the following characteristics (adapted from Hobbs & Harris 2001) are considered as they are fundamental components of functioning forest ecosystems:

1) Composition: range of species present and their relative abundances;
2) Structure: the vertical arrangement of vegetation and soil components;
3) Pattern: the horizontal arrangement of system components;
4) Heterogeneity: the relationship and arrangement of composition, structure and patterns;
5) Function: the performance of basic ecological processes such as energy, water and nutrient transfers;
6) Species interaction: for example, the role of pollinators and seed dispersers; and
7) Dynamics and resilience: such as succession and state-transition processes and recovery from disturbance.

Figure 2 shows reinstatement of landscape and surface hydrological management with typical establishment of dominant mid and overstorey species within rehabilitation of forest areas.

Figure 2: 7-year-old rehabilitation

4.5.4.6 Current Forest Rehabilitation Prescription

The Rehabilitation Prescription is applied to the rehabilitation of forested areas within the BBM and involves the following key stages:

Pre-mining

1) Areas for mining and clearing are identified and forest clearing notices are submitted to DBCA and Forest Products Commission (FPC) six months prior to clearing operations commencing;
2) Impending clearing areas are assessed for forest disease (dieback and Australian honey fungus) and where required, hygiene management plans are established. On Timber Reserve, harvesting for timber and firewood is coordinated through FPC. Other plant material (cuttings, seed, transplants) may be collected for rehabilitation operations;
3) Remnant vegetation to be used for habitat material is stockpiled for use in rehabilitation; remaining forest residue from clearing may be chipped or burnt; and
4) Topsoil and gravel overburden materials are removed in separate operations and where practicable, are used on other rehabilitation (direct return) or stockpiled for later use.

Post-mining

1) Following completion of mining operations, mine pit floors and haulage routes are deep ripped to the maximum available depth (approximately 1.2 m). Ripping line spacing must be no more than 3 m. Ripping aims to relieve induced compaction. The pits are then landscaped and contoured to blend in with surrounding forest topography and to control surface water flows. If required, sumps designed to withstand run-off from a 10-day, 15-year ARI (average reoccurrence interval) storm event are constructed; as are contour banks which are designed to comply with criteria for erosion control and controlled discharge;
2) Overburden materials and topsoil are respread (often direct return from nearby new mining areas);
3) Salvaged timber, hollow logs and rocks are returned as fauna habitat;
4) Topsoil is scarified and a seed mix of local provenance tree and understorey species is broadcast onto the freshly tilled topsoil at a rate which aims to produce on average, at establishment monitoring, 1 legume and 1 non-legume per square metre and 600 trees/hectare for the mine site. Seeding generally occurs between January and May;
5) Seedlings of selected recalcitrant species are planted following opening rains when soil moisture conditions are appropriate (usually around June). Tree seedlings may also be planted at this time if required;
6) An application of fertiliser (225 kg/ha of Superphosphate with Copper, Molybdenum and Zinc trace elements) occurs through ground-based application at the time of seeding;
7) Monitoring occurs in the spring of the following year (October / November) to measure the establishment success; and
8) Where agreed success criteria are not met, a remediation plan agreed with DBCA is implemented.

4.5.4.7 Review of Forest Rehabilitation Prescription

The Working Arrangements specify rehabilitation works common to all pits within the currently mined areas of the WMDE. The

Rehabilitation Prescription currently forms an appendix to the Working Arrangements and is reviewed biennially. The review examines the results of trials and monitoring and, where appropriate, includes them into operational practice through incorporation into planning and into the prescription's guiding operations. This process will change upon the finalisation of agreed completion criteria. The Rehabilitation Prescription will then become a subsidiary and separate document to the Working Arrangements.

An appended Rehabilitation Prescription containing detailed information of each year's rehabilitation works is submitted annually to the DBCA. This process will continue upon finalisation of completion criteria. Once agreed, it is scheduled that the completion criteria will be reviewed in consultation with DBCA on a five-yearly basis.

Worsley has documented a series of procedures, specifications and work instructions which detail the methods on-ground personnel are required to follow in order to implement the Working Arrangements and undertake rehabilitation within the WMDE. These are revised and updated as required to incorporate new information or changes as a result of research or monitoring results or improvements in industry best practice.

Any rehabilitation planned for areas within the RLA will be subjected to an agreed specific rehabilitation prescription and seed source provenance range with DBCA (depending on the target outcome).

The key components of the Rehabilitation Prescription are summarised in Table 5 and the method for rehabilitation is presented in Figure 3.

Table 5: Issues prescribed by the Agreed Working Arrangements

Issue	Prescription Components
Preparation of areas for rehabilitation	Pit preparation for planting (including landscaping, topsoil / overburden management and ripping)
	Water management options
	Placement of temporary access tracks
	Artificial fauna habitat construction and layout
Revegetation aspects (Specified in Worsley BBM Revegetation Management Procedure (00111496))	Vegetation community types
	Revegetation method
	Seed mixes
	Tree planting guidelines, including: • Planting layout and design • Species selection • Success criteria
	Understorey establishment, including: • Species selection and establishment • Recalcitrant species • Success criteria
	Fertiliser application

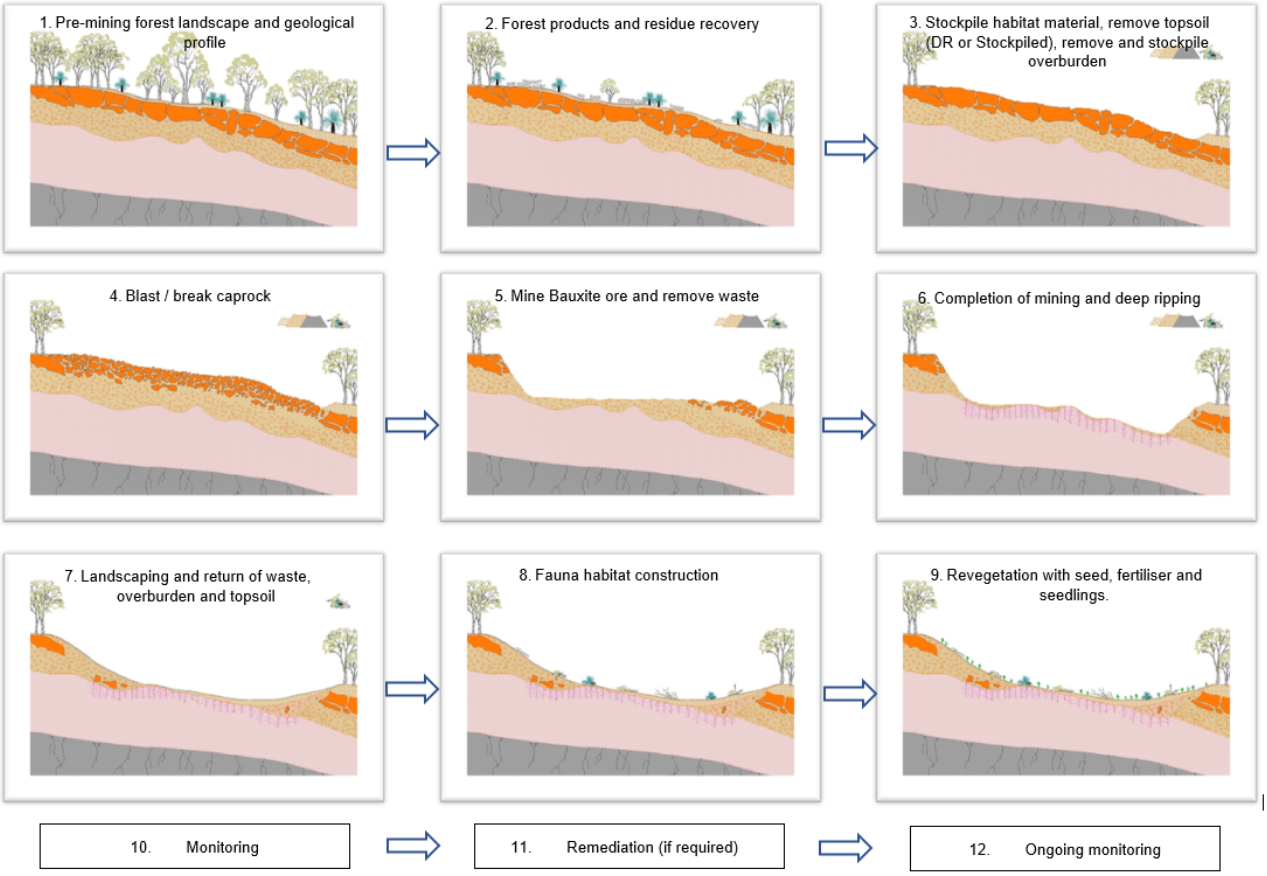

Figure 3: Rehabilitation Sequence

4.5.4.8 Worsley Rehabilitation Performance Report & Annual Rehabilitation Plan

In accordance with MS1237 condition B14-2 Worsley will submit a Rehabilitation Performance Report which will include proposed biodiversity indicators and completion criteria (condition B14-2(2)). These completion criteria and biodiversity indicators include the trajectory towards and outcomes of successful rehabilitation, which includes monitoring and reporting.

In addition, Worsley will provide an Annual Rehabilitation Plan (MS1237 condition B14-3) detailing but not limited to whether the environmental outcomes specified in condition B14-1 were achieved. This includes:

- that rehabilitated landforms are stable and do not cause pollution or environmental harm (B14-1(1)),
- rehabilitated draining lines are stable, not prone to erosion and support ecological processes (B14-1(3)) and
- monitoring of agreed biodiversity indicators and agreed completion criteria (B14-1(10)) and annual reporting (B14-1(11)) on agreed biodiversity indicators to ensure they are evidence based, effective and achievable.

Biodiversity indicators also include monitoring related to dryland salinity, acid sulphate impacts to surface waters or soils, and landform stability.

4.6 MONITORING AND REPORTING

A summary of environmental monitoring requirements, auditing and incident reporting is provided below. Additionally, the ASSMP provided in Appendix A, the Water Management Plan required by condition B16-2, and the Rehabilitation Plan (as required by condition B14-3) provide further detail on management and control strategies.

4.6.1 Monitoring Requirements

General environmental monitoring requirements are set out in Table 6 below.

The monitoring requirements set out in this CEMP will utilise and build on existing monitoring programs where practical, such as those programs in place to address the existing BBM operating licence (L5960/1983/11). Where required, these monitoring programs will be supplemented by project and activity specific monitoring programs.

Monitoring programs in relation to secondary salinity are detailed and outlined in Appendix A of the Water Management Plan, required by condition B16-2.

ASS management conditions are detailed and outlined in Sections 6 and 7 of the ASSMP, provided in Appendix A: Acid Sulfate Soil Management Plan.

Soil compaction management actions requirements are detailed and outlined in the Rehabilitation Plan required by Condition B14 and B2.

Table 6: Environmental Monitoring Requirements

Monitoring Frequency	Monitoring Actions
Daily	• Inspection of clearing extents to ensure no clearing outside of the approved clearing boundaries. • Walkover inspection for fauna ahead of and during vegetation clearing activities (such that further fauna relocation can be undertaken where appropriate using qualified personnel as per pre-clearing management action). • Daily inspection of excavations in the morning and afternoon to identify any trapped fauna and to enable capture and relocation. • Record and report any known injuries or mortalities of fauna. • Visual monitoring of airborne dust in relation to dust generation beyond the perimeter of the construction area to ensure no offsite impacts and efficacy of dust control measures. • Visual monitoring during construction to identify and manage any potential disturbed contamination or heritage objects. • Report and provide management guidance for any hydrocarbon or chemical spills. • Noise monitoring for works outside of standard construction hours (if applicable and if required under Environmental Protection (Noise) Regulations 1997). • Visual inspection of erosion and sediment controls to maintain functionality and report any releases of material. • Report any required alterations to management infrastructure.
Weekly	• Visual inspection for evidence of unauthorised access to areas of native vegetation surrounding the development area, attributable to construction. • Conduct required water / soil monitoring (up/ downstream) • Visual inspection of any water management infrastructure (i.e., booms or silt curtains) for integrity and suitability. • Spot checks of compliance with vehicle clean on entry/exit procedures at each entry and exit point. • Visual inspection of identified heritage sites or other Projected Areas to ensure no disturbance by contractor outside of the approved development envelope. • Visual inspection for evidence of erosion. • Produce a report on monitoring results. • Inspections of chemical and hydrocarbon storage infrastructure • Inspections of rehabilitation and land management
Monthly	• Visual inspection and coordinate management for weeds within the disturbance footprint. • Visual inspection of hazardous material storage, handling and disposal. In the event of a major spill, undertake groundwater and/or surface water monitoring. • Visual inspection of riverbanks for signs of scouring or erosion. • Visual monitoring of culvert infrastructure (once established) to ensure potential fauna passage is maintained. • Undertaking routine GHG emissions monitoring in accordance with the *National Greenhouse and Energy Reporting Act 2007* and National Greenhouse and Energy Reporting Regulations 2008. • Produce a report on monitoring results.

Monitoring Frequency	Monitoring Actions
Annually	• Assessment and monitoring of dieback and Australian honey fungus free (un-infested) areas of native vegetation within and adjacent to the development area. • Produce a report on monitoring results.
As required	• Monitoring as required by any additional CEMP, ASSMP or other relevant management plans.
	• Visual inspection of offsite discharges and downstream environments following rainfall events. • Visual inspection for evidence of erosion in the lead up to and following inclement weather events. • Aboriginal monitors to be present when initial ground disturbance is undertaken near registered or potential Aboriginal site, as per the Aboriginal Heritage Site Management Procedure (Worsley 2014).

4.6.2 Non-Compliances and Incident Response

All events with an environmental consequence (actual or potential) must be promptly reported to South32 and recorded in G360. Significant environmental events are investigated (by appropriately trained personnel), actions identified, and learnings shared.

The management and reporting of environmental incidents shall be undertaken by the appropriate person as detailed in Worsley Alumina Event and Hazard Reporting Procedure (00100891).

4.6.3 Environmental Incident Reporting

Worsley Alumina will report environmental incidents in accordance with the requirements of legislation, regulation and approval requirements relevant to the Revised Proposal / construction projects.

If impact is caused by personnel, or if personnel become aware of impact caused by Worsley Alumina's activities, to any Aboriginal Site or Place, the Managing Heritage Incidents Procedure (200000493) must be followed.

Each Contractor will develop and implement an Environmental Incident and Emergency Plan/Procedure, in accordance with the requirements of this CEMP.

The Contractor will make all personnel aware of the plan and their responsibilities.

Following formal notification of an incident to South32, an incident report detailing the cause of the incident and demonstrating corrective and preventative actions will be provided by the Contractor. A summary of the incident will be provided in the Contractor monthly report (e.g., provision of a spill register).

5 EMP COMPONENTS

5.1 OUTCOME-BASED PROVISIONS

Outcomes based provisions provided below in Table 7 in relation to management of Potential Acid Sulfate Soils – in accordance with Condition B17-2(1). Provisions in relation to condition B17-2(2) are provided in section 5 of the Water Management Plan, required by condition 16-2. No further replication has been incorporated within this plan.

Table 7: Outcome-based Provisions

EPA factor/s and objective/s: Terrestrial Environmental Quality

Outcome/s:

1. Ensure no acid sulfate soil contamination within the PAA or elsewhere attributable to the proposal;
2. Ensure no secondary salinity occurs within the PAA or elsewhere attributable to the proposal;
3. Ensure soil compaction and soil quality is remediated as part of rehabilitation and mine closure activities, in line with timing requirements outlined in condition B14 & B2.

Key impacts and risks: Acid sulfate soil contamination, secondary salinity, soil compaction leading to not meeting completion criteria, contamination of soils

Relevant outcome(s)	Trigger & Threshold Criteria	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
Dewatering to support construction activities where PASS present					
Outcome 1	Trigger Criteria: During dewatering activities Total titratable acidity <40mg/L, pH>6	Continue daily dewatering water quality monitoring.	**Field measurement:** pH, Eh, DO, EC, TTA, TAlk **Laboratory analysis:** TTA, TAlk, pH	Daily Fortnightly	Post dewatering closure report submitted to DWER
	Trigger Criteria: During dewatering activities, Total titratable acidity <40mg/L, pH in range 4 to 6	1. Undertake neutralisation treatment (liming) on extracted water. 2. Continue dewatering water quality monitoring	**Field measurement:** pH, Eh, DO, EC, TTA, TAlk **Laboratory analysis:** TTA, TAlk, pH	Daily Weekly	Post dewatering closure report submitted to DWER
	Trigger Criteria: During dewatering activities, Total titratable acidity 40mg/L to 100mg/L, pH >6	1. Undertake neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. 2. Continue dewatering water quality monitoring	**Field measurement:** pH, Eh, DO, EC, TTA, TAlk **Laboratory analysis:** TTA, TAlk, pH	Daily Weekly	Post dewatering closure report submitted to DWER

Relevant outcome(s)	Trigger & Threshold Criteria	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
	Trigger Criteria: During dewatering activities, Total titratable acidity 40mg/L to 100mg/L, pH in range 4 to 6	1. Undertake neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. 2. Continue dewatering water quality monitoring	**Field measurement:** pH, Eh, DO, EC, TTA, TAlk **Laboratory analysis**: TTA, TAlk, pH **Laboratory analysis**: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide, EC, total suspended solids (TSS), total dissolved salts (TDS), total nitrogen (TN), total phosphorus (TP)	Daily Weekly Fortnightly	Post dewatering closure report submitted to DWER
	Threshold Criteria Total titratable acidity >100mg/L or pH<4 or total alkalinity <30mg/L	1. Increase neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. 2. CEASE DEWATERING AND ADVISE DWER IMMEDIATELY. 3. Continue dewatering water quality monitoring	**Field measurement:** pH, Eh, DO, EC, TTA, Talk **Laboratory analysis:** total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide, EC, TSS, TDS, TN, TP	Twice Daily Weekly	Report using DWER's 24 hour pollution watch hotline or the online reporting form Post dewatering closure report submitted to DWER
Outcome 2	Trigger & Threshold Criteria: Comply with the actions in the Water Management Plan (Table 5-1, outcomes 1, 2, 3, 4, & 5)	Trigger & Threshold Actions Undertake actions as outlined in accordance with WMP Table 5-1	Indicator In accordance with Table 5-1 of the WMP	In accordance with Table 5-1 of the WMP	In accordance with Table 5-1 of the WMP

Relevant outcome(s)	Trigger & Threshold Criteria	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
Outcome 3	Trigger Criteria: Rehabilitation of areas cleared for infrastructure, roads or access is not scheduled for rehabilitation within 12 months of that infrastructure road or access no longer being required	Trigger Level Actions: 1. Notify EH&A Manager & Production Planning Manager 2. Determine if infrastructure, road or access is required for future use 3. If not required schedule commencement of rehabilitation			Rehabilitation forecast included in 10YP
	Threshold Criteria: Rehabilitation of areas cleared for infrastructure, roads or access has not commenced rehabilitation within 18 months of that infrastructure road or access no longer being required	Threshold Contingency Actions: 1. Notify EH&A Manager & Production Planning Manager 2. Commence rehabilitation as soon as practicable			Reporting in accordance with MS1237

5.2 OBJECTIVE-BASED PROVISIONS

Table 8 provides a summary of the Management objectives and management provisions for Terrestrial Environmental Quality for the Revised Proposal.

Table 8: Outcome-based Provisions

EPA factor/s and objective/s: Terrestrial Environmental Quality, Inland Waters, Flora & Vegetation

Objectives:

1. Minimise the risk of exposure of PASS;
2. Minimise the risk of secondary salinity attributable to the proposal;
3. Minimise the risk of soil compaction and soil quality attributable to the proposal.

Key environmental values: Surface Water Dependant Ecosystems, Water Quality, soil quality, flora

Key risks: impacts to SWDEs, impacts on water quality, water contamination (PASS), flora establishment, impacts on soil compaction & quality.

Management Targets	Management Actions	Monitoring	Timing/frequency of monitoring	Reporting
Potential Acid Sulfate Soil				
Minimise the risk of exposure of PASS	• Mining footprint to avoid low-lying topographical areas in the vicinity of rivers and creeks. • Stream buffers must be applied to all rivers in accordance with the FMP (CPCWA, 2023) and *Water Quality Protection Note 6*: *Vegetation Buffers to Sensitive Water Resources* (Department of Water, 2006). • Acid Sulphate / Potentially Acid Sulphate soil monitoring as part of risk management in disturbance areas • ASSMP in place to outline the identification, sampling and management of any PASS expected to be encountered for the construction of river crossings.	• Ongoing monitoring in accordance with the water monitoring program including application of Trigger Action Response Plan (TARP) requirements. • Monitoring in accordance with the ASSMP.		• Summary of water monitoring data provided within AER. • Reporting of incidents and associated corre actions in accordance with applicable TARP

Management Targets	Management Actions	Monitoring	Timing/frequency of monitoring	Reporting
Minimise PASS disturbance	• All confirmed and suspected ASS materials (i.e. grey to dark grey soils containing organic matter below the water table) encountered during excavations will be transported by truck to the onsite ASS treatment facility or an offsite facility licensed to accept ASS. • Any ASS materials that cannot be transported within the short-term period detailed above must be stockpiled on a suitably prepared storage area and the following additional management measures shall be followed: • Stockpiles are to be contained by bunds with stormwater run-off directed to a collection sump. Bunds are to be constructed from low permeability materials that are not ASS; • A guard layer of fine ground agricultural lime of at least 10 kg/m2 will be spread across the soil surface prior to placement of the stockpile; • The surface area of the stockpile will be minimised by shaping and possibly capping or covering to prevent moisture loss and rainfall entry; and • Temporary or bunded, short term stockpiling will not be permitted within 100 m of a waterway.	• Audit stockpile area for compliance to construction requirements outlined in section 6.1.3.1 of the ASSMP • Monitoring of collected runoff in accordance with section 6.1.3.2 of the ASSMP		• Summary of findings reported within the AE
Minimise impacts to surface water systems	• Given the close proximity of the Hotham River monitoring of surface water quality shall be conducted during excavation in ASS areas.	• Undertake surface water quality monitoring in accordance with ASSMP section 6.3.2		• On completion of dewatering activities in AS areas, the results of surface water quality ar water level monitoring program will be repor within an initial closure report along with a discussion of any environmental impacts observed. This initial closure report will be submitted to DWER as part of the Worsley Annual Environmental Report. • The results of any post-dewatering surface w quality will be reported within a post-dewate monitoring closure report submitted to DWE part of the Worsley Annual Environmental R

Management Targets	Management Actions	Monitoring	Timing/frequency of monitoring	Reporting
Secondary Salinity				
Objective based provisions (management objectives and management provisions) to manage the risk of secondary salinity as a result of the Revised Proposal are included in table 7 of the Water Management Pl required by MS1237 condition B16-2. Further detail is also provided in section 4.5.1 of this CEMP.				
Soil Compaction & Quality				
Minimise the risk of soil compaction	• Following completion of mining operations, rehabilitation activities are planned and implemented and checked in accordance with site specific procedures and standards for each area	• Rehabilitation monitoring • Biodiversity indicators and completion criteria monitoring	• 1, 5, 10, and every subsequent 10 year period	• Annual Environmental Report in regard to completion criteria reporting
Management of Erosion	• Comply with the requirements of the Rehabilitation Performance Report (condition B14-2) Annual Rehabilitation Management Plan (Condition 14-3) for final landform structure	• Rehabilitation monitoring	• 1, 5, 10, and every subsequent 10 year period	• In accordance with MS1237 (condition D2-1
Minimise the risk of soil contamination (other than PASS)	• Chemicals, hydrocarbons and other environmentally hazardous materials stored and handled in accordance with Dangerous Goods Safety Act 2004 and associated regulations. • Construction of fuel containment infrastructure in accordance with Australian Standards. • All spills will be managed in accordance with site procedures. • Collection and treatment of potentially contaminated stormwater run-off from workshops and hydrocarbon storage areas. • Contaminated soils at BBM to be placed in lined hydrocarbon storage area until removal from site by a licensed contractor.	• Incident reporting procedures	• As needed	• BBM Licence compliance reporting.

Management Targets	Management Actions	Monitoring	Timing/frequency of monitoring	Reporting
Management of Sedimentation	• Apply stream buffers in accordance with the FMP (CPCWA, 2023) and Water Quality Protection Note 6: (Department of Water, 2006). • Manage stream buffers. • Installation of water management infrastructure (sumps, drainage lines etc.) for all operational areas including haul roads in accordance with site procedures and standards. • Obtain Bed and Banks permits under the RIWI Act for any disturbance required to stream beds and banks. • Reshape disturbed areas to match surrounding contours during progressive rehabilitation to minimise impacts on surface water drainage patterns.	• Ongoing monitoring in accordance with the water monitoring program outlined in the WMP, including application of TARP requirements. • Regular inspection and maintenance of sumps.	• As outlined in the WMP	• Reporting of incidents and associated corre actions in accordance with applicable TARP outlined in the WMP

6 REPORTING, ADAPTIVE MANAGEMENT & REVIEW

6.1 COMPLIANCE AUDITING

Compliance to this CEMP will be audited annually under MS1237 condition D2-1. Any non-compliances of the provisions set out in the CEMP will be identified and registered within the internal incident, risk reporting and management system (G360) and will be reported within the AER and Compliance Assessment Report (CAR). Audit findings will be communicated internally, and actions will be assigned to relevant areas through G360. The CAR will be provided in a form suitable for publication on the South32 website and online by DWER, as required by MS1237 Condition D2-4(5).

6.2 REPORTING

6.2.1 Reporting Under Ministerial Conditions

Reporting under condition D-2 (1):

"The proponent must provide an annual Compliance Assessment Report to the CEO for the purpose of determining whether the implementation conditions are being complied with."

Reporting under condition C3-2:

"The proponent must submit as part of the Compliance Assessment Report required by condition D2, a compliance monitoring report that:

1) outlines the monitoring that was undertaken during the implementation of the proposal;
2) identifies why the monitoring was capable of substantiating whether the proposal limitation and extents in Part A are exceeded;
3) for any environmental outcomes to which condition C3-1(2) applies, identifies why the monitoring was scientifically robust and capable of detecting whether the environmental outcomes in Part B are met;
4) outlines the results of the monitoring;
5) reports whether the proposal limitations and extents in Part A were exceeded and (for any environmental outcomes to which condition C3-1 (2) applies) whether the environmental outcomes in Part B were achieved, based on analysis of the results of the monitoring; and
6) reports any actions taken by the proponent to remediate any potential non-compliance."

6.2.2 Annual Environmental Report

Worsley is required to provide an annual summary of monitoring activities by 30 September each year as part of its environmental licences. The Annual Environmental Report contains a summary of data collected over the previous financial year (1 July to 30 June). This includes a discussion of the monitoring data and other collected data against historical data (trend analysis), known standards and targets set in the licences.

6.3 ADAPTIVE MANAGEMENT & REVIEW

Worsley commits to maintaining a process of adaptive controls that provide the best outcome for management of terrestrial environmental quality with regards to PASS. This Plan will be reviewed by Worsley on a triennial basis to assess effectiveness, ongoing relevance and incorporate improved management strategies derived from assessment of monitoring, research and positive corrective actions from incident investigations. Revised versions of this plan must be submitted to EPA Services for approval. The review of this Plan will consider:

- Effectiveness of monitoring controls / systems;
- Monitoring report outcomes;
- Relevance to current monitoring and analysis systems and performance indicators;
- Technology improvements;
- Changes to operational activities leading to changes in the risk;

- Best practice monitoring processes;
- Actions from incident and audit outcomes;
- Changes to relevant legislation, policy, guidelines and guidance material; and
- Benchmarking against other similar operations.

Secondary salinity management conditions are detailed and outlined in Section 5 of the Water Management Plan, required by condition B16-2.

7 STAKEHOLDER CONSULTATION

Stakeholder consultation has progressed as part of the development of the Revised Proposal, as part of the publication and assessment of the ERD. The stakeholder consultation work completed as part of the ERD can be found in ERD Section 3 and is not repeated here. Identification and consultation of additional stakeholders specific to the Worsley Revised Proposal is ongoing and will occur prior to commencement works.

Table 9 provides information relating to consultation for the drafting and revision of this CEMP.

Table 9: Stakeholder Engagement Summary

Stakeholders	Comments Received	Worsley Alumina Response
DWER	• As summarised within the Response to submissions. • Further amendments required in line with draft conditions received in EPA Report 1768.	• Key recommendations incorporated into this WMP. • Changes incorporated to meet new requirements.

8 DEFINITIONS, TERMS AND ABBREVIATIONS

Term	Description
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soils Management Plan
BBM	Boddington Bauxite Mine
BTC	Bauxite Transport Corridor
CBME	Contingency Bauxite Mining Envelope
CEMP	Construction Environmental Management Plan
DAWE	Department of Agriculture, Water and the Environment (now DCCEEW)
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DWER	Department of Water and Environment Regulation
WEMLG	Worsley Environmental Management Liaison Group
EMP	Environmental Management Plan
EP Act	*Environmental Protection Act 1986* (WA)
EPA	Environmental Protection Authority
ERD	Environmental Review Document
GDE	Groundwater Dependent Ecosystem
GHD	GHD Pty Ltd
ha	Hectares
km	Kilometre
MNES	Matters of National Environmental Significance
MS 719	Ministerial Statement 719
Nullaga Project	Nullaga Mine Development Project
OBC	Overland Bauxite Conveyor
PAA	Primary Assessment Area
PASS	Potential Acid Sulfate Soils
PDWSA	Public Drinking Water Source Area
PEC	Priority Ecological Community
PM10	Particulate matter which is 10 micrometres or less in diameter
Project	Worsley Bauxite-Alumina Project
RLA	Refinery Lease Area (Crown Lease I150306)
RIWI Act	*Rights in Water and Irrigation Act 1914* (WA)
TARP	Trigger Action Response Plan
TEC	Threatened Ecological Community
tpa	Tonnes per annum
WA	Western Australia
WAPL	Worsley Alumina Pty Ltd

WJV	Worsley Alumina Joint Venture. The WJV includes South32 Aluminum (RAA) Pty Ltd, South32 Aluminium (Worsley) Pty Ltd, Japan Alumina Associates (Australia) Pty Ltd and Sojitz Alumina Pty Ltd
WMDE	Worsley Mining Development Envelope
Worsley Alumina	South32 Worsley Alumina Pty Ltd

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	———2024 Boddington Bauxite Mine Triennial Aquifer Review July 2020 – June 2023
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10 DOCUMENT CONTROL

Version Control

Version	Change	Date
0	Initial version prepared for submission following Worsley Mine Expansion Revised Proposal ERD EPA Assessment #2216	27/10/2021
0.1	Incorporate Recommended Conditions received in EPA Report 1768.	27/9/2024
1.1	Incorporate feedback from EPA-Services on draft management plan	07/11/2024
1.2	Finalise document for submission to EPA-Services, for CEO Approval following issue of MS1237	08/01/2025
2.0	Final internally approved version as submitted to EPA-Services, for CEO Approval.	15/01/2025

Reviewer Circulation

Role	Name	Endorsed	Date
Manager EH&A	Claire Reid	✓	15.01.2025
Construction Manager	St John Mc Swiney	✓	15.01.2025

Approval Circulation

Role	Name	Approved	Date
General Manager Mine and Materials	Trever Stockil	✓	15.01.2025

11 APPENDICES

11.1 APPENDIX A: ACID SULFATE SOIL MANAGEMENT PLAN

WORSLEY MINE EXPANSION

Operation:	Worsley Mine Expansion
Project Number:	A700.C.71183
Document Number:	WOR-71183-FS-PM-PLN-0005
Document title:	Acid Sulfate Soil Management Plan

Document Control

	Name	Signature	Date
Author			
Approvals Specialist	Rebekka Kavanagh		
Reviewed by			
Approvals Lead	Renae Srdarev		
Approved by			
Study Manager	Danny De Vries		

Revision	Date	Revision Description
Revision Log		
0	13/12/2023	Issued for Use
1	06/03/2024	Update to Section 6.7

Contents

1 EXECUTIVE SUMMARY

This Acid Sulfate Soil Management Plan (ASSMP) identifies areas within the Nullaga Project Area where acid sulfate soils (ASS) are likely to be disturbed by construction works and provides management measures to avoid and/or mitigate potential environmental impacts. The Nullaga Project Area forms Stage 1 of the Worsley Mine Expansion Revised Proposal (the Revised Proposal).

Relevant summary information is provided in Table 1-1.

Table 1-1: ASSMP summary information

Proposal name	**Worsley Mine Expansion – Revised Proposal**
Proponent name	South32 Worsley Alumina Pty Ltd (ACN: 008 905 155) Level 37, 108 St Georges Terrace PERTH WA 6000
Ministerial Statement number	Ministerial Statement 719
Purpose of the ASSMP	The purpose of this ASSMP is to meet the commitments of the ERD and to provide Worsley Alumina and its contractors with the information required to address potential risk associated with the disturbance of ASS.
Key environmental factor/s, outcome/s and objective/s	The objective of the ASSMP is to prevent any acid generation from in situ materials due to ground disturbing activities and to manage any disturbance to minimise the environmental impacts. The risk of encountering ASS across the Nullaga Project Area is generally very low. ASS has been identified at the Hotham River and may be disturbed by excavation and dewatering during the construction of the bridge at this location. With the implementation of avoidance, management and monitoring measures, ASS disturbances are expected to result in minimal ecological impact.
Proposed construction date	April 2025 to June 2028
ASSMP required pre-construction?	Yes

2. INTRODUCTION

2.1 PROJECT BACKGROUND

South32 Worsley Alumina Pty Ltd (Worsley Alumina; the Proponent) operates the Worsley Bauxite-Alumina Project (the Proposal; the Project) in the southwest of Western Australia (WA) under *Environmental Protection Act 1986* (EP Act) Part IV Ministerial Statement (MS) 719 and EP Act Part V operating licences L4504/1981/17 (Worsley Alumina Refinery) and L5960/1983/11 (Boddington Bauxite Mine). The Project is one of the largest bauxite mining and alumina refining operations in the world, comprising the Boddington Bauxite Mine (BBM), an existing conveyor, the Worsley Alumina Refinery (the Refinery) near Collie and port operations at Bunbury Port.

In April 2006, Worsley Alumina was granted approval under Part IV of the EP Act via MS719 for the "Worsley Alumina Production to Maximum Capacity of 4.4 million tonnes per annum (Mtpa) Alumina and Associated Mining" (the Proposal).

Worsley Alumina proposes to continue operations by expanding existing activities with the next phase of bauxite mining, providing access to future bauxite reserves and resources to sustain production at the Refinery. This expansion is referred to as the Worsley Alumina Mine Expansion Revised Proposal (the Revised Proposal).

A Draft Environmental Review Document (ERD) has been submitted to the Environmental Protection Authority (EPA) for the Worsley Mine Expansion. The Revised Proposal ERD has undergone a public comment period, as a consultative step to achieve a consolidated, contemporised Ministerial Statement.

A critical component of the mine expansion is the development of haul roads to access new resources at the Nullaga mining area. The preferred haul road route is contained within the Nullaga Project area (Figure 1) which forms Stage 1 of the Worsley Mine Expansion. The haul road will require a bridge and culvert crossing at the Hotham River, and culvert crossings of drainage lines and tributaries along the route (Figure 2). Previous desktop studies for the Mine Expansion (GHD 2020) identified haul road construction in low lying areas and specifically water course crossings as having the potential to disturb Acid Sulfate Soils (ASS) if present.

2.2 SCOPE OF THE ASSMP

Within the ERD is a commitment to develop a Construction Environmental Management Plan (CEMP) with an associated Acid Sulfate Soil Management Plan (ASSMP) for the haul road and specific to construction of river and stream crossings.

The scope of this ASSMP includes:

- Identification of areas within the Nullaga Project area where construction activities may disturb ASS and therefore contribute to potential environmental impacts.
- Description of the potential environmental impacts associated with ASS disturbance and dewatering operations (if required);
- Definition of the appropriate controls required for the handling of ASS if encountered during scheduled site works, to minimise potential impacts; and
- Definition of the systematic processes to manage potential environmental impacts associated with ASS during the term of the Project.

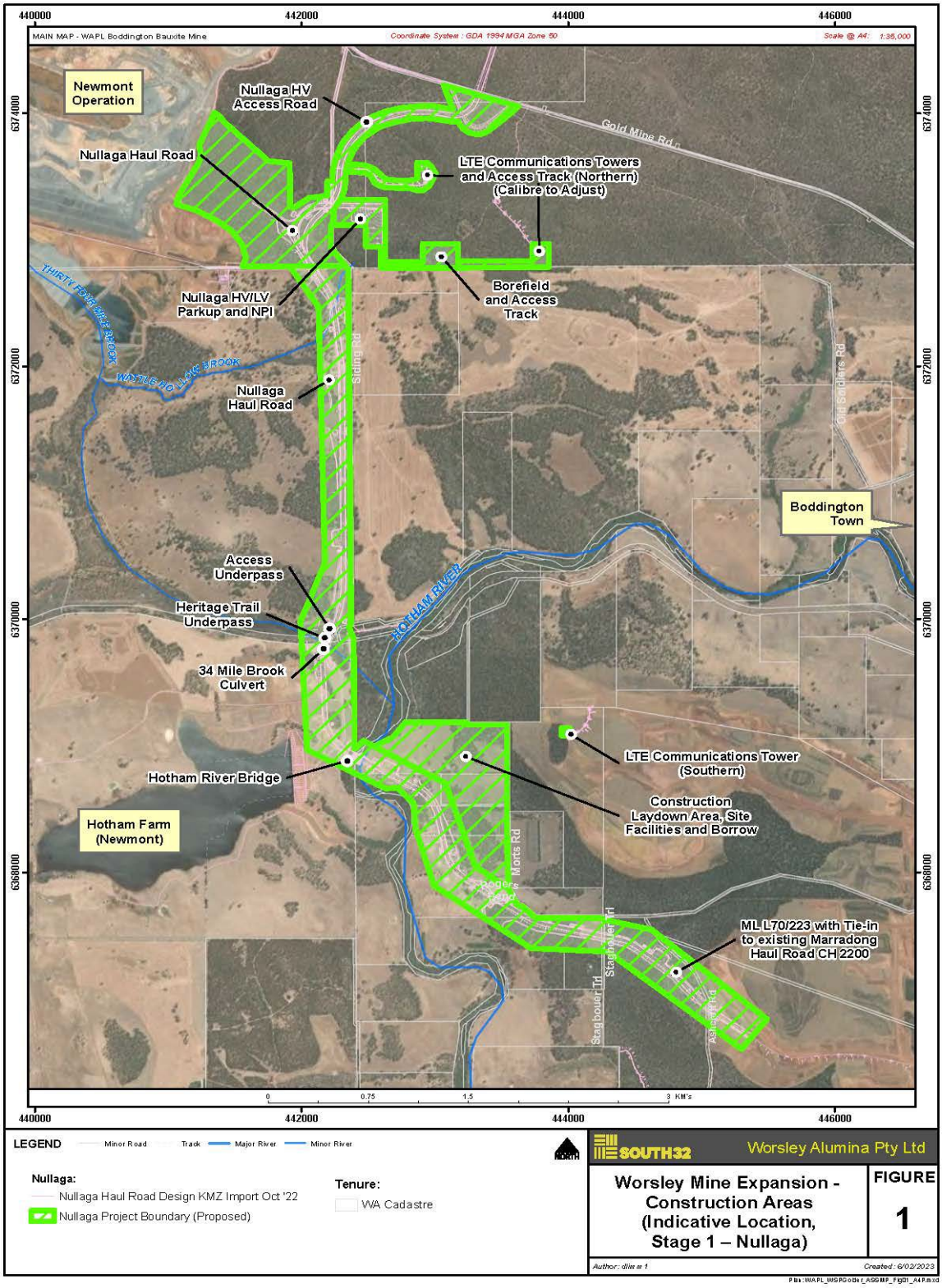

Figure 1: Nullaga Project Are

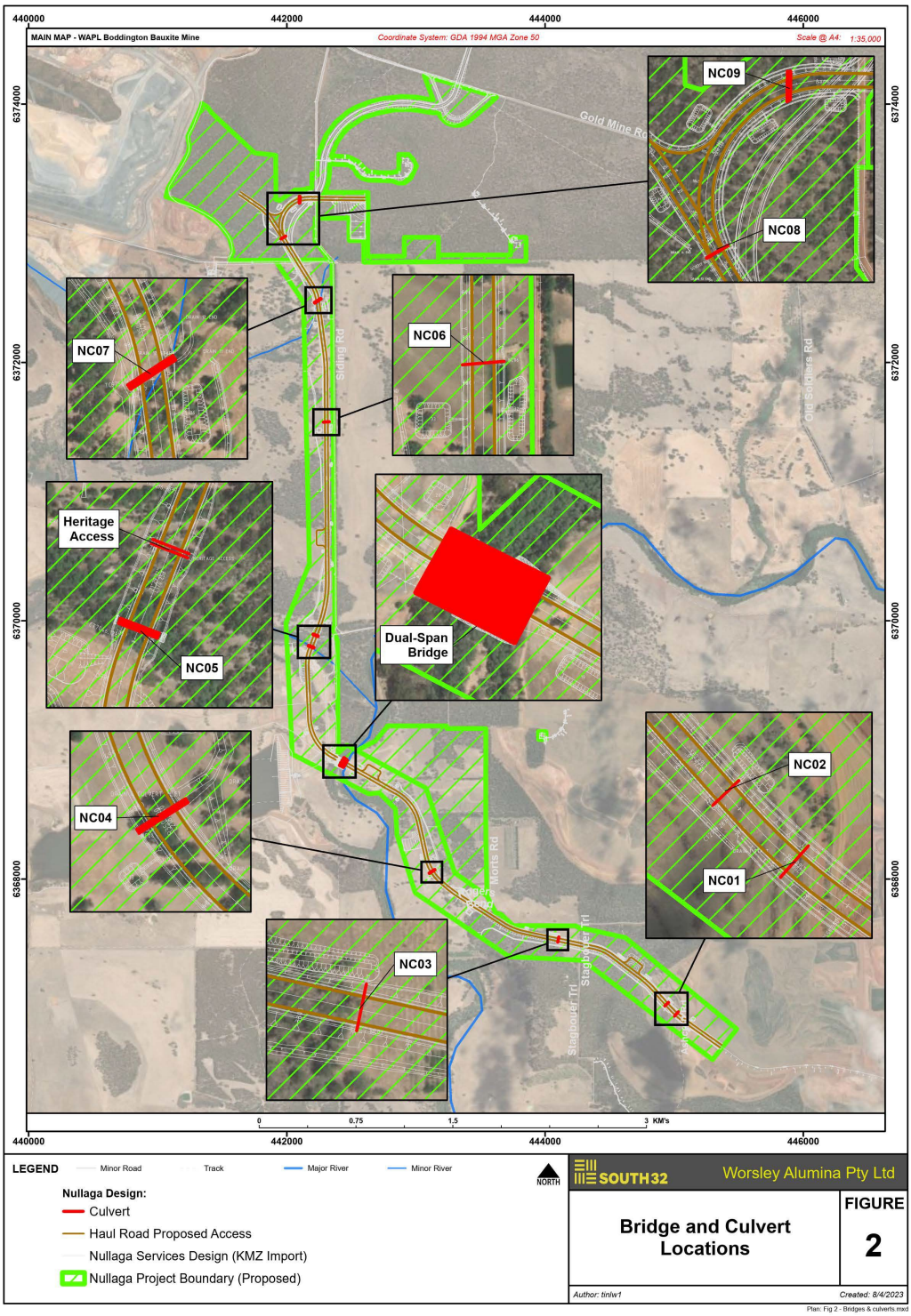

Figure 2: Bridge and Culvert Locations

2.3 PURPOSE AND OBJECTIVE

The purpose of this ASSMP is to meet the commitments of the ERD and to provide Worsley Alumina and

its contractors with the information required to address potential risk associated with the disturbance of ASS.

The objective of the ASSMP is to prevent any acid generation from in situ materials due to ground disturbing activities and to manage any disturbance to minimise the environmental impacts. The main mechanisms in the ASSMP to achieve this objective include:

- Provide an operational methodology, including contingency planning, for the sampling, interpretation, reporting and mitigation measures to determine:
    - Presence or absence of ASS in the construction areas for infrastructure crossings over the Hotham River and other high-risk drainage lines;
    - Lateral and vertical extent of any ASS identified;
    - Maximum expected net acidity; and
    - ASS management/remediation options, including operational monitoring.

2.4 ENVIRONMENTAL MANAGEMENT FRAMEWORK

The CEMP provides the environmental management framework corresponding to this ASSMP. The CEMP shall be referenced for the overarching obligations associated with:

- Roles and responsibilities.
- Performance outcomes and indicators.
- Training, competency, and awareness; and
- Communication and reporting.

Additionally, South32's Global Environmental Standard will apply to environmental management measures implemented under this ASSMP. A copy of this standards is presented in Appendix A. Statutory and permitting requirements will take precedence over South32 standards, except in those cases where the South32 standards are more stringent.

2.5 NULLAGA PROJECT AREA DETAILS

The Nullaga Project Area (Stage 1 of the Worsley Mine Expansion) comprises construction of the haul road including a road bridge, culvert crossings of drainage lines and tributaries, construction access and laydown areas. Ancillary works include Western Power relocations, Telstra removals and creation of bore water pump stations and pipework.

The bridge over the Hotham River is proposed to have a dual span of approximately 70m with the bridge deck supported on piled abutments on each riverbank and on the pier. Piles will be cast to depths of more than 30m below the current ground level and will extend above the current ground surface to a design level of about RL199 m (i.e., top of piles will be about 5 to 6 m above the current ground surfaces). The piled abutments will also support filled approaches to the bridge. No piles will be installed within the normal flow course of the river. Minor shallow excavations may be required on each riverbank behind the piled abutments. The depth of such excavations is not known at this time and dewatering in these excavations may be required. Rip Rap will be installed in the river channel and on the approach and departure sides of the bridge, this will require localised excavation of materials to allow placement of the rock and any other stabilisation treatments required.

Other haul road crossings are also planned over Thirty-Four Mile Brook, Wattle Hollow Brook, and other minor drainage lines. These crossings will be achieved by installing corrugated steel pipe culverts directly in the stream/drainage path. Scour protection primarily in the form of loose dumped rock and grouted or cement stabilised rock will be installed on the bed and banks and at the ends of the culverts. Construction of these crossings will be limited as much as practicable, to drier months of the year to prevent excessive erosion and sedimentation, as well as to minimise impacts on water flows.

2.6 REGULATORY FRAMEWORK

Legislative and other requirements (relevant to ASS), their application, and administrating authority are listed and described in Table 1.1.

Legislation or Other Requirement (Australian Standards, Codes of Practice, Licences, Approvals)	Application	Responsible Department / Administrator
National Acts		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The purpose of the EPBC Act is to provide a framework for the protection of matters of national environmental significance (MNES), which includes threatened species and communities. Unmanaged disturbance of ASS may cause a significant impact on a MNES.	Australian Government – Department of Agriculture, Water and Environment
National Guidelines/Manuals/Resources		
National Environmental Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM) as amended 2013	The purpose of this guidelines to provide a national approach to the assessment of site contamination and protect human health and the environment where contamination has occurred.	Australian Government – Department of Agriculture, Water and Environment (DAWE)
Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018	The Water Quality Guidelines provide authoritative guidance on the management of water quality for natural and semi-natural water resources in Australia and New Zealand. These guidelines have replaced the ANZECC and ARMCANZ (2000) guidelines.	National Water Quality Management Strategy (NWQMS), an Australian Government initiative in partnership with state and territory governments
Australian Soil Resource Information System (ASRIS) (http://www.asris.csiro.au/)	ASRIS provides access to the best available soil and land resource information (spatial and temporal databases) in a consistent format across Australia. It provides a scientific information infrastructure for assessing and monitoring the condition of Australia's soil and land resources	Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018*, National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual,* Department of Agriculture and Water Resources, Canberra ACT. CC BY 4.0.	This manual provides technical and practical advice on the identification and sampling of acid sulfate soil materials. Guidance is also provided on the sampling requirements necessary to define the extent of acid sulfate soil materials in the landscape.	Australian Government – Department of Agriculture, Water and Environment
Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual,* Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.	The purpose of this manual is to set out the current good practice acid sulfate soils laboratory analytical methods for soil samples.	Australian Government – Department of Agriculture, Water and Environment

Legislation or Other Requirement (Australian Standards, Codes of Practice, Licences, Approvals)	Application	Responsible Department / Administrator
Shand, P, Appleyard, S, Simpson, SL, Degens, B, Mosley, LM 2018, *National Acid Sulfate Soils Guidance: Guidance for the dewatering of acid sulfate soils in shallow groundwater environments*, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.	The purpose of this guidance material on groundwater dewatering in ASS landscapes is to provide technical and practical advice on managing ASS to help prevent or minimize harm to the environment	Australian Government – Department of Agriculture, Water and Environment
State Acts (Western Australia - WA)		
Environmental Protection Act 1986	An Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement, and management of the environment and for matters incidental to or connected with the foregoing.	Department of Water and Environmental Regulation (DWER)
Contaminated Sites Act 2003	An Act providing for the identification, recording, management, and remediation of contaminated sites, to consequentially amend certain other Acts and for related purposes.	Department of Water and Environmental Regulation
State Guidelines/Regulations/Policies (Western Australia - WA)		
Identification and investigation of acid sulfate soils and acidic landscapes 2015	The purpose of this guideline is to provide practical guidance in relation to the minimum level of investigation required to: • Identify the presence or the absence of acid sulfate soil (ASS) in areas likely to be disturbed by a proposed development or other project; and, if present • Define the nature and extent of ASS and the amount of existing and potential acidity it contains in order to determine appropriate management measures. This document provides information on the identification and investigation of ASS.	Department of Environment Regulation (current DWER)
Treatment and management of soils and water in acid sulfate soil landscapes 2015	The purpose of this guideline is to provide technical and procedural advice to avoid environmental harm and to assist in achieving best practice environmental	Department of Environment Regulation (current DWER)

Legislation or Other Requirement (Australian Standards, Codes of Practice, Licences, Approvals)	Application	Responsible Department / Administrator
	management in areas underlain by ASS. The guideline has also been designed to assist decision-making and provide greater certainty to the development, construction and agricultural industries, state and local government and the community when planning for activities that may disturb ASS. This guideline is applicable to Western Australian sites and has been developed on the basis of experience in both Western Australia and in other States.	

Table 1.1: Legal And Other Requirements

2.7 ACID SULFATE SOILS

ASS are naturally occurring sediments that contain iron sulfides (mostly pyrite with typically smaller quantities of iron monosulphides (FeS)). When the pyrites within ASS oxidise (i.e., when they are exposed to air, and then combined with water), sulfuric acid leachate can be generated. Where the pH of the surrounding ground/surface water decreases, the solubility of aluminium, iron and other heavy metals can increase, leading to chemical mobilisation. The mobilisation of sulfuric acid and/or heavy metals has the potential to cause significant environmental harm to the receiving environment.

Oxidisation of ASS normally occurs when soils are changed from anaerobic to aerobic by for example, being removed from below the groundwater table (excavated) or when the groundwater table is lowered.

ASS includes Actual ASS (AASS) and potential ASS (PASS). AASS are soils in which the pyrite content present within the soil has already been fully or partially oxidised potentially generating sulfuric acid and creating acidic soil layers. PASS are soils where there is pyrite present in the soil, but the soil has not been oxidised. If disturbed, the PASS has the potential to oxidise and form sulfuric acid. AASS is generally found overlaying PASS, however both have the potential to cause environmental harm.

Acid sulfate soils are typically found in low-lying coastal areas and are referred to as “coastal ASS”. However, the conditions for forming ASS can also exist in bottom sediments of drains, dams, constructed and natural waterways, swamps and billabongs, periodically stagnant creeks, places with perched water tables and saline inland areas. These types of environments are not restricted to coastal areas. Acid sulfate soils in non-coastal areas are commonly referred to as “inland ASS” or “upland ASS”. The occurrence of inland ASS is not limited by stratigraphy or sediment age.

3. ASSESSMENT OF ASS LANDSCAPES

3.1 ACID SULFATE SOILS

National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual (DAWE, 2018a) provides a staged approach to determine the likely presence and distribution of ASS materials. This national guidance approach has been used to identify possible ASS landscapes that

may be encountered by Nullaga Project Area disturbances.

This approach is also consistent with Step 1 of the investigation process outlined in *Identification and investigation of acid sulfate soils and acidic landscapes* (GoWA 2015a)

3.2 DESKTOP ASSESSMENT

3.2.1 SITE CONDITIONS AND SURROUNDING ENVIRONMENT

3.2.1.1 TOPOGRAPHY

The Nullaga Project area is characterised by a moderate to gently undulating landscape with elevations typically ranging from approximately 194 to 330 m Australian Height Datum (AHD).

In the central and western portions of the Project area the valleys are generally shallow and broad, steepening where watercourses have incised the landscape.

3.2.1.2 VEGETATION

Remnant native vegetation covers approximately 60% of the total Expansion Project area. Upland areas support tall open forests of Jarrah and other Eucalypt species, with patches of closed heath consisting of Myrtaceae-Proteaceae species.

Valley areas comprise open Wandoo woodland, which transitions to Sheoak and Eucalyptus woodlands (and tall Melaleuca shrubland) in the valley floors. Understorey, where present in the Wandoo woodland, typically comprises Acacia species.

Depressions and swamps in upland areas support a mosaic of low open woodland of Melaleuca and Banksia species, closed Myrtaceae shrubland, and sedgelands.

Review of 'Vegetation Complexes – South-West forest region of Western Australia' dataset, confirms that the following vegetation complexes occur within the Project area: Cooke, Coolakin, Dwellingup, Michibin, Murray 1, Pillenorup, Swamp, Williams, Yalanbee, and Yarragil 1.

3.2.1.3 DRAINAGE AND HYDROLOGY

The Nullaga Project Area is located in the Murray River basin and is subject to the Murray River and Tributaries Surface Water Management Area in the Hotham River sub-area. The area is proclaimed as a RIWI Act Surface Water Area (Murray River System).

The Project area is broadly to moderately dissected by valleys incised by rivers and tributaries. Watercourses intersecting the Project area comprise the Hotham River, Thirty-four Mile Brook and Wattle Hollow Brook as shown on Figure 1. Hotham River is a mainstream water course with perennial flow. Thirty-four Mile Brook is a Hotham River tributary and is designated as a significant stream although it is largely ephemeral. Wattle Hollow Brook is a tributary of Thirty-four Mile Brook and is an ephemeral drainage line.

Historical surface water monitoring programs in the Hotham River by Worsley Alumina have indicated generally neutral to alkaline conditions with electrical conductivity readings ranging between 6,500 to 21,000 µS/cm. Historical sampling programs were not designed with the objective of defining pre-construction baseline conditions upstream and downstream of the Project bridge site.

3.2.1.4 LOCAL SENSITIVE ENVIRONMENT

The receiving environment of the Project area includes various species of native flora, terrestrial fauna and aquatic species and receiving water/ aquatic environments as mentioned above.

The Hotham River, its tributaries and remnant feeder creek systems provide an important fauna

movement corridor system within the current landscape of the project area. The Hotham River and tributaries traverse the Project area, travelling through areas of State managed forests, private bush and agricultural lands.

The waterways are mostly fringed by narrow disturbed native riparian and associated communities, providing important habitat for aquatic and semi-aquatic species and numerous wetland bird and frog species. These corridors also allow for the movement of ground dwelling and arboreal species.

3.2.1.5 GEOLOGY

The 1:250,000 geological map indicates that the Nullaga Project Area is predominantly located on Ferruginous duricrust (Laterite) including massive to pisolitic ferruginous subsoil, mottled clays, magnesite, reworked products of ferruginous and siliceous duricrusts, calcrete, gossan and residual ferruginous saprolite.

Quaternary age channel and flood plain alluvium (comprised of gravels, sands, silts and clays) is indicated along the key drainage paths of the Hotham River and Thirty-four Mile Brook.

To the north of the Hotham River zones of Wells Formation felsic volcanics (including lavas and tuff) are present. These deposits are largely obscured by residual soils and colluvium.

3.2.1.6 SOILS

Review of Government of Western Australia (GoWA) Soil Landscape Mapping Units has identified four soil units within the Nullaga Project Area as described in Table 3.1.

WA Soil Groups are attributed to each Soil Landscape Mapping Unit as defined by Schoknecht and Pathan (2013) which use the following criteria to differentiate Soil Groups: presence of carbonates, colour, depth to soil horizons, pH and soil structure.

Soil Landscape Mapping Unit	Name	Description	WA Soil Group	
253MuDW	Dwellingup Subsystem (Marradong)	Divides, lower to upper slopes and hillcrests. Duplex sandy gravels and loamy gravels with minor areas of shallow gravels, deep sandy gravels, yellow deep sands and yellow and pale deep sands, often gravelly.	302	Duplex sandy gravel
253QdMN	Michibin Subsystem (Quindanning)	Hillslopes containing soils formed by the weathering of fresh rock. Rock outcrop is common.	505	Brown deep loamy duplex
255DpDW	Dwellingup Subsystem	Divides, lower to upper slopes and hillcrests. Duplex sandy gravels and loamy gravels with minor areas of shallow gravels, deep sandy gravels, yellow deep sands and yellow and pale deep sands, often gravelly.	302	Duplex sandy gravel
255DpPN	Pindalup Subsystem	Shallow minor valleys (5-20 m) with gentle side slopes (3-10%) and broad swampy floors. Soils are loamy gravels, and deep sands and non-saline wet soils on the valley floors.	302	Duplex sandy gravel

Table 3.1: Soil Landscape And Soil Mapping Units Along Haul Road

3.2.1.7 GEOMORPHOLOGY

The northern extent of the Project occurs within the Western Darling Range Zone and the southern extent within the Eastern Darling Range Zone. These geomorphological zones belong to the Avon Province and are considered relevant to the occurrence of salinity and dryland salinity issues (GHD 2020).

The Project is broadly to moderately dissected by valleys incised by rivers and tributaries. Watercourses intersecting the Project include the Hotham River and its tributary Thirty-four Mile Brook. Soils occurring in low-lying areas represent sedimentary material (clay, silt, and sand) deposited through colluvial and alluvial processes (that have infilled depressions and palaeovalleys) and are typically preserved in low-lying areas, sometimes in association with modern rivers and flow paths.

3.2.1.8 HYRDOGEOLOGY

The groundwater host rocks of the Hotham region predominantly comprise the weathered and fresh Archaean basement crystalline rocks. In addition, more recent sediments are incised into the basement rocks, coincident with existing drainage or paleo drainage lines.

The generalised hydrogeology of the Hotham area comprises three main aquifer units (GHD, 2020):

- Shallow weathered zone aquifer: comprising lateritic cap rock and shallow gravely to sandy sediments with represents a seasonal aquifer with significant storage, infiltration and flow capability;
- Deep weathered zone aquifer (lower saprolite). An aquifer of high storage potential, but limited bulk permeability (comprising clays); and
- Fractured bedrock aquifer- permeability and yields are dependent on facture development and connectivity of the fractures, which may be significant in brittle rocks (felsic intrusive) but absent in more ductile basement rocks (e.g., shales).

In addition to the above, where drainage lines are sufficiently developed, and have eroded the basement material, sediments, typically alluvial, have accumulated in the lower lying areas. The permeability of the sediments is variably distributed and related to lithology.

Broadly, groundwater levels within all aquifers appear to follow the topography, such that groundwater level is highest in areas of highest topography and lowest in areas of lowest topography. Groundwater is recognised as providing baseflow to the major rivers and creeks of the area.

3.3 ASS RISK MAPS

The Atlas of Australian Acid Sulfate Soils was compiled by CSIRO in 2013 to provide a consistent national collation of Australia's acid sulfate soils. The atlas includes mapping of inland ASS with risk criteria derived from soils, hydrography and landscape coverages. Risk mapping from the Atlas indicates an Extremely Low Probability of ASS Occurrence (based on a low confidence level of 6-70%) across Project disturbance area. An area mapped as having high probability of ASS (based on a low confidence level) coincides with the Hotham Farm Dam located about 450m to the south-west of the proposed Hotham River bridge site, as shown in Figure 3. This high probability area coincides with a dammed water storage and does not fall within the Project disturbance area.

3.4 PREVIOUS INVESTIGATIONS

Limited investigations by the DWER between 2003 and 2005 identified PASS (with 6.73% sulfide-S) in surface peat within a saline seep at a location approximately 1.3 km outside of the Worsley Alumina Mine Expansion. This provides evidence that favourable conditions for PASS formation are present within permanent water courses and wetlands (including those fed by saline seeps) in this region.

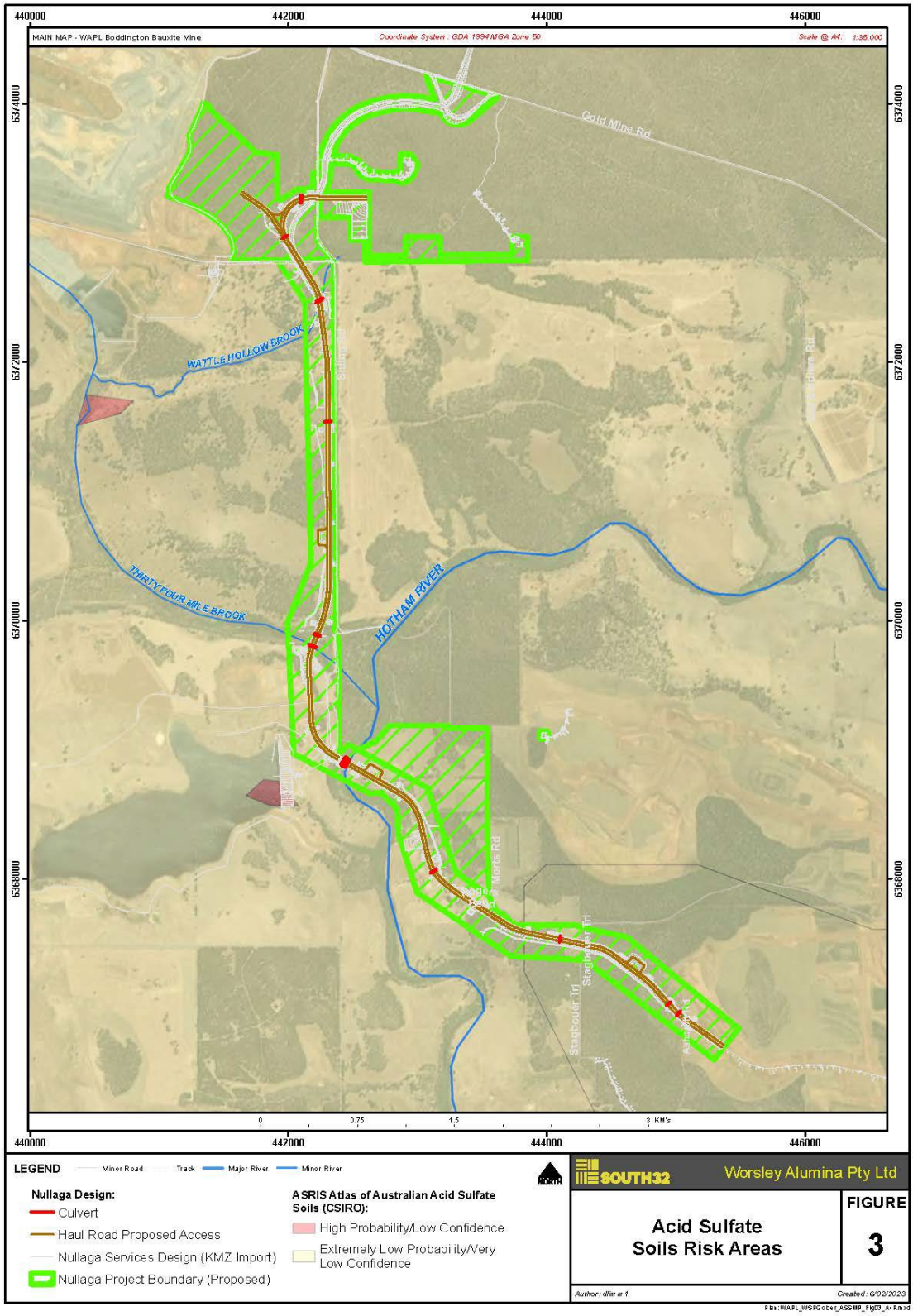

Figure 3: ASS Risk Map

3.5 SITE INSPECTION

An inspection of the proposed bridge and culvert locations was conducted for possible indicators of acid sulfate soils. Relevant observations are summarised below:

- Hotham River – Paperbarks were observed near the toe of the western riverbank and across the overflow area between the river and the eastern river bank (see Photographs 1 and 2). Paperbarks can be indicative of waterlogged conditions conducive to possible ASS formation.
- Thirty-four Mile Brook – Shallow surface water was present at the proposed culvert crossing location in November 2022 (see Photograph 3). A thin layer of organic matter was present in places within the base of the Brook suggesting seasonal flushing prevents ongoing build-up of organic matter. No other possible indicators of acid sulfate soils were observed.
- Wattle Hollow Brook and other culvert locations – These drainage lines are ephemeral and were dry in November 2022. Conditions conducive for possible ASS formation were not present at these locations.

Photograph 1: Paperbarks at Toe of Western Bank

Photograph 2: Paperbarks on Eastern Floodplain Looking Across Hotham River

Photograph 3: Thirty-Four Mile Brook Culvert Location Looking Northeast Towards Existing Crossing

3.6 IDENTIFIED AREAS OF CONCERN

Based upon the findings from the desktop review and site inspection:

- Conditions at the Hotham River are considered to have a high potential for the formation of ASS in the bed, lower banks and overflow areas. Investigation of disturbance areas at the Hotham River was recommended.
- Ephemeral conditions at the Thirty-four Mile Brook culvert crossing are less conducive to the formation of ASS. However, given the observations of surface water at this location in November and the presence of some organic matter over portions of the creek bed, limited investigation of bed sediment was recommended to confirm the absence of ASS.
- There is negligible risk of ASS formation/presence at Wattle Hollow Brook and other culvert locations. No investigations at these locations were considered to be warranted.

4. ASS INVESTIGATIONS

4.1 HOTHAM RIVER INVESTIGATION

4.1.1 INVESTIGATION SCOPE

ASS sampling and analysis was conducted by Calibre Professional Services (Calibre) as part of the geotechnical investigation at Hotham River. The scope of the ASS investigation was developed to target

proposed disturbances and meet requirements of *National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual* (DAWE, 2018a). The investigation comprised the following:

Western Bank

- Three window sampler boreholes (NUL-WS59, NUL-WS60 and NUL-WS61) to depths of 2m targeting shallow disturbances at the proposed piled abutment. Samples collected at 0.25 m depth intervals for field screening tests. On the basis to the field screening tests, samples were selected for Chromium Suite tests.
- At one of the geotechnical boreholes (NUL-BH17) located at the proposed piled abutment, samples were collected at 1m depth intervals in alluvial deposits extending below 2m. This sampling was aimed at evaluating deeper conditions should longer pile lengths is required as the design progresses. Field screening tests were conducted on recovered samples and selected samples were analysed for Chromium Suite tests.
- Two hand auger holes (ASS HA01 and ASS HA02) to depths ranging between 0.3m and 0.9m were conducted to the east of the piled abutment location following observations of wet, organic soils during formation of drilling rig access. The depth of sampling was limited by hand auger recovery. Samples were collected at 0.25 m depth intervals for field screening tests and Chromium Suite tests. ASS HA01 was converted into a temporary monitoring well to allow collection of a groundwater sample. The groundwater was tested for the analysis suite described in *Identification and investigation of acid sulfate soils and acidic landscapes* (GoWA 2015a).
- Three test pits (NUL-TP57, NUL-TP56 and NUL-TP58) to 3m depth were located near the crest of the western bank, 30m west of the crest and 70 m west of the crest, respectively. These test pits targeted conditions in the approach to the river, outside expected higher risk ASS areas. Samples were collected at 0.25 m depth intervals for field screening tests and selected samples were analysed for Chromium Suite tests.

Eastern Bank

- Three window sampler boreholes (NUL-WS62, NUL-WS63 and NUL-WS64) to depths of 1m to 2m targeting shallow disturbances at the proposed piled pier and the western extent of proposed pile. Samples were collected at 0.25 m depth intervals for field screening tests. On the basis to the field screening tests, samples were selected for Chromium Suite tests.
- One window sampler borehole (NUL-WS65) to a depth of 2m targeting the eastern extent of the proposed pier. Samples were collected at 0.25 m depth intervals for field screening tests. On the basis to the field screening tests, samples were selected for Chromium Suite tests.

- At one of the geotechnical boreholes (NUL-BH18) located at the proposed piled abutment, samples were collected at about 1m depth intervals in alluvial deposits extending below 2m. Whilst concrete bored and CFA piles are proposed, this sampling was aimed at evaluating deeper conditions should other piling methods be considered in the future. Field screening tests were conducted on recovered samples and selected samples were analysed for Chromium Suite tests.
- Two test pits (NUL-TP66 and NUL-TP67) to 3m depth were located about 20m and 40 m east of the bank crest, respectively. These test pits targeted conditions in the approach to the river outside expected higher risk ASS areas. Samples were collected at 0.25 m depth intervals for field screening tests and selected samples were analysed for Chromium Suite tests.

Investigation locations are shown on Figure 4 and factual results are presented in Appendix B.

4.1.2 INVESTIGATION FINDINGS

Western Bank

The proposed piled abutment on the western bank is located on the bank slope where surface levels range from about RL 192.7 m to RL194.3 m. Screening tests on soil samples from NUL-BH17 indicated the possible presence of PASS at a depth of about 6.3m below the ground surface. Laboratory test results confirmed the presence of PASS in a 4 m thick layer from about RL189.5 m to RL 185.6 m with a

maximum net acidity of 0.038% S.

Surface levels in the area between the toe of the western bank and the flowing river (immediately east of the proposed piled abutment and where paperbarks were observed) range from about RL192.4 m to RL 192 m. Field screening and laboratory testing of soils from this area confirmed the presence of PASS from the surface to about 1.5 m (RL 190.5 m) with maximum net acidity of 0.072% S. Laboratory results on a groundwater sample collected from this area indicated a pH of 6.6, acidity of 33 mg/L and total alkalinity of 150 mg/L. These results suggest the presence of high alkalinity groundwater with a buffering capacity generally adequate to maintain acceptable pH level in the future. More detailed groundwater investigation will be conducted to confirm baseline water quality.

Figure 4 provides an interpretation of the area where ASS has been identified.

Screening tests and laboratory tests on soil samples from investigation locations west of the crest indicated the presence of non-sulfidic acidic soils but did not indicate the presence of PASS.

Eastern Bank

Surface levels at investigation locations in the overflow area on the eastern side of the Hotham River range from about RL192.7 to RL193.6 m. Screening tests intermittently indicated the possible presence of PASS in wet alluvial soils (typically grey hued soils with a trace of organic matter and about 0.5m below the ground surface) across this area. Laboratory test results confirmed the presence of PASS in these wet alluvial soils with net acidities generally marginally above the action criteria of 0.03% S. The maximum net acidity of 0.1% S was detected at 5.6 m below the surface (i.e. at about RL 187.7 m) at NUL-BH18.

The confirmed PASS layer across the overflow area ranges in thickness from about 0.3 m (RL 193 m to RL192.7 m) at NUL-HR-WS65 near the toe of the eastern bank to about 6.5 m (RL 191.7 m to RL 185.3 m) at NUL-BH18 at the proposed piled abutment location.

Figure 4 provides an interpretation of the area where ASS has been identified.

Screening tests and laboratory test results in the upper 3m of the soil profile east of the eastern riverbank crest did not indicate the presence of PASS.

Figure 4: Hotham River Investigation Locations

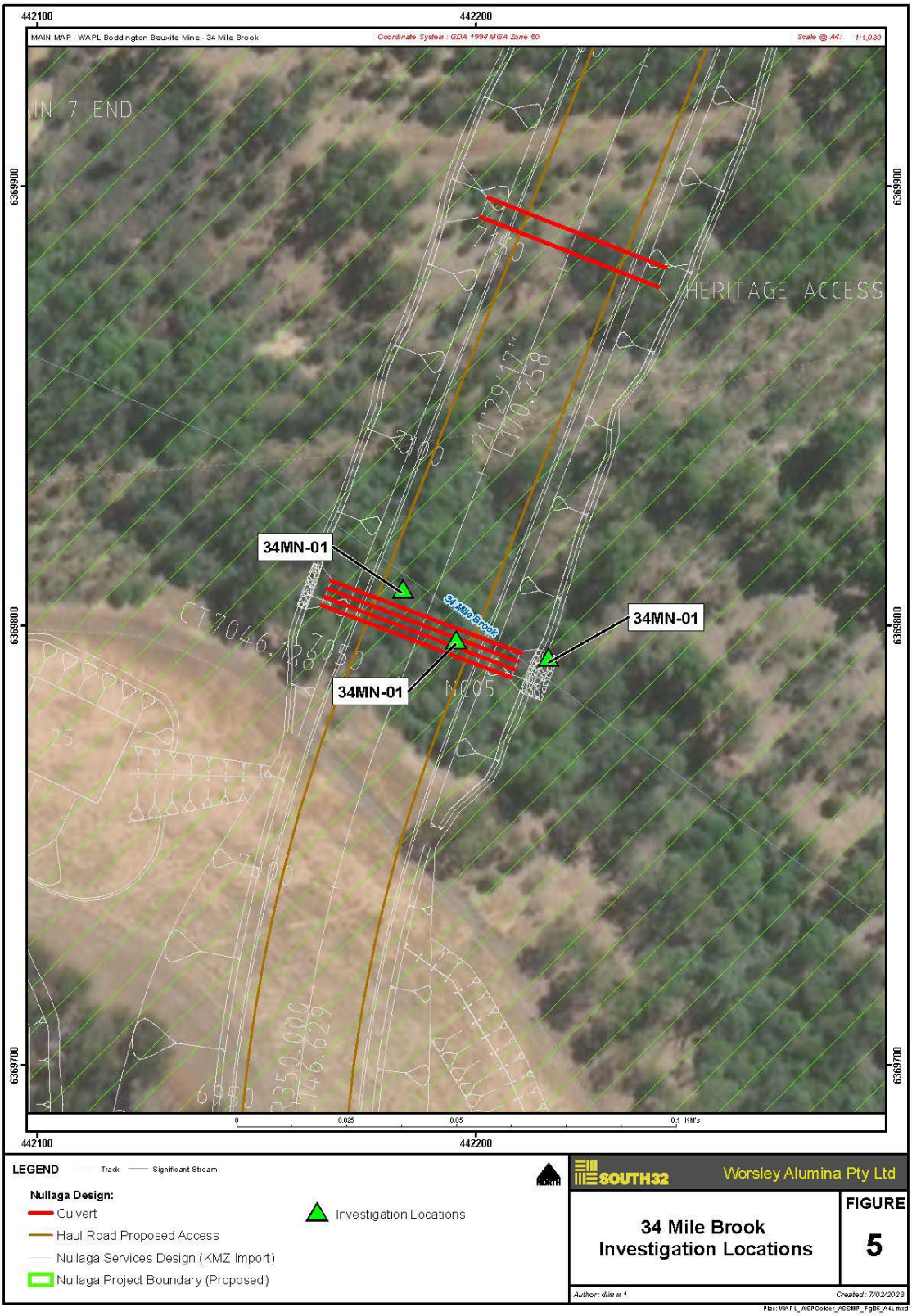

Figure 5: 34 Mile Brook Investigation Locations

4.2 THIRTY-FOUR MILE BROOK INVESTIGATION

4.2.1 INVESTIGATION SCOPE

ASS sampling and analysis was conducted by Calibre at Thirty-four Mile Brook. Given the lower risk of encountering ASS at this location, the investigation was limited to collection of sediment samples to depths of 0.1m in the bed of the brook at the proposed culvert crossing. Field screening tests and Chromium Suite tests were conducted on the recovered samples.

Investigation locations are shown on Figure 5 and factual results are presented in Appendix C.

4.2.2 INVESTIGATION FINDINGS

Field screening and laboratory test results did not indicate the presence of ASS in the sediment samples. This is considered suitable to confirm the absence of ASS at this location. No ASS management measures are required for disturbances at this location.

5. PROJECT ACTIVITIES AND POTENTIAL IMPACTS

Inappropriately managed ASS can have negative impacts on the environment and the life span of infrastructure built within areas containing ASS. Construction activities that may cause potential impacts include excavation and dewatering at Hotham River construction sites. Potential impacts are detailed below.

5.1 EXCAVATIONS/DISPLACEMENT OF ASS

During construction works ASS may be disturbed by excavation or displacement (i.e. by uplifting ground movements caused filling over ASS materials). Displacement can be avoided by appropriate geotechnical design.

ASS has been identified at abutment locations where piling is proposed. ASS materials will not be excavated by the installation of bored piles. Minor excavation/disturbance of identified ASS may occur in soft/wet spots exposed during the formation of access for the piling rig and during preparation works for fill placement immediately behind the piled abutments. Disturbance will be minimised by the use of a bridging layer rather than an excavate and replace strategy.

Potential impacts resulting from excavating or displacing identified ASS include:

- Disturbance of acid sulfate soils, as a result of Hotham River works, leading to contamination of land and soils;
- Oxidation of excavated or dewatered PASS producing sulfuric acid and leaching of metals (principally iron and aluminium) from the soil matrix;
- If disturbed ASS soil is not appropriately managed, contamination of soils and waters could potentially occur downstream as water within the Hotham River and its tributaries becomes acidified; and
- The shortening of the lifespan of built infrastructure due to corrosion of metal and calcium substitution in concrete.

5.2 DEWATERING OF ASS

The need for and possible extent of excavation dewatering at the Hotham River work sites is not fully known at this time. Although it is expected that dewatering of seepage entering culvert excavations on the eastern overflow area will be required.

If dewatering during construction is required, potential impacts associated with dewatering of ASS materials include:

- Alteration of the receiving waters physio-chemical parameters i.e., lowering pH, lowering dissolved oxygen levels, increasing of sediment loadings;

- Water table drawdown resulting in oxidation of PASS in areas surrounding excavations and subsequent leaching of acidic groundwater with elevated metals concentrations;
- Discharge/recharge of acidic water or groundwater with elevated metals concentrations;
- Contamination of receiving waters through the introduction of dissolved metals and or discolouration of water;
- Degradation or mortality of flora and fauna; and
- Potential drawdown of the groundwater table and associated settlement impacts to footings and neighbouring infrastructure.

6. MITIGATION AND MANAGEMENT MEASURES

ASS management will be in accordance with the *Treatment and management of soil and water in acid sulfate soil landscapes* guideline (GoWA 2015b). ASS mitigation and management measures are provided below.

6.1 SOIL MANAGEMENT

6.1.1 MINIMISATION OF ASS DISTURBANCE

Construction techniques will be adopted which minimise ground disturbance in identified ASS areas.

6.1.2 HANDLING AND STORAGE MEASURES

6.1.2.1 EXCAVATION AND STOCKPILING OF ASS

All confirmed and suspected ASS materials (i.e. grey to dark grey soils containing organic matter below the water table) encountered during excavations will be transported by truck to the onsite ASS treatment facility or an offsite facility licenced to accept ASS.

Where practical, excavated ASS materials will be transported directly to the offsite facility or onsite treatment facility as excavation occurs. Temporary stockpiling of untreated ASS should be avoided, where practicable. Where stockpiling is unavoidable, the recommended maximum short term period for which ASS can be temporarily stockpiled without treatment is 18 hours for coarse textured soil (less than 5% clay content), 70 hours for medium textured soil (more than 5% but less than 40% clay content) and fine textured soil (more than 40% clay content).

Any ASS materials that cannot be transported within the short-term period detailed above must be stockpiled on a suitably prepared storage area and the following additional management measures shall be followed:

- Stockpiles are to be contained by bunds with stormwater run-off directed to a collection sump. Bunds are to be constructed from low permeability materials that are not ASS;
- A guard layer of fine ground agricultural lime of at least 10 kg/m^2 will be spread across the soil surface prior to placement of the stockpile;
- The surface area of the stockpile will be minimised by shaping and possibly capping or covering to prevent moisture loss and rainfall entry; and
- Temporary or bunded, short term stockpiling will not be permitted within 100 m of a waterway.

6.1.2.2 TRANSPORT AND MATERIALS TRACKING

Accurate records of material movements shall be kept including volumes, origin, material type, and destination. ASS materials shall be transported in suitable trucks to prevent spillage of soil and leakage of water.

The contractor will be responsible for maintaining transport route free of spilled and sloughed ASS sediments. All such spilled sediments are to be regularly (daily) collected and managed as ASS.

6.1.3 TREATMENT MEASURES

6.1.3.1 TREATMENT AREAS

The size of the treatment area(s) will depend on the amount of ASS encountered and time required for treatment and verification. ASS treatment area(s) will be developed and located on site by the contractor in consultation with the HSEC Manager and will be based on availability of sufficient and suitable area(s).

Treatment areas shall meet the following requirements:

- Treatment areas will not to be located within 100 m of a waterway.
- Treatment areas shall be contained by compacted earthen bund walls of at least 0.15m height to contain potential leachate runoff within the treatment pad area and prevent surface water runoff from entering the treatment pad area. An area of at least 2 m width shall be left between the treatment areas and bunds to allow collection of run-off and direction to sumps.
- Treatment areas shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. If sandy materials are exposed in the stripped surface, a layer of low permeability material shall be placed over the stripped surface.
- A guard layer of at least 0.3m thickness of compacted crushed limestone or 10 kg/m^2 of fine ground agricultural lime shall be applied to the prepared surface of the treatment area prior to placement of ASS materials.
- Excavated ASS materials shall be placed in layers at identifiable earthworks “lots” (not more than 100 m^3) within the treatment area and following a materials tracking plan.
- The overall layer thickness shall not exceed 250 mm thickness unless effective treatment over a greater thickness can be demonstrated.
- Where required, drying shall be enhanced by mechanical methods (rotary hoe, disc plough, etc.) to create a relatively homogenous, friable material prior to addition of lime for neutralisation.
- Fine ground agricultural lime (or other neutralising agent approved by the HSEC Manager) shall be applied to the surface of the placed material at the applicable rate (see Section 6.1.3.3) using a spreader truck or other method (approved by the HSEC Manager). Following lime application, the lime shall be mixed into the ASS layer using mechanical methods (disc plough, rotary hoe, etc.).
- Following collection of verification samples (see Section 6.1.3.4) and confirmation of suitable treatment, the layer of treated material will be removed from the treatment area and placed at a Project location approved by the HSEC Manager.
- Once ground disturbance works have been completed at the Hotham River bridge site and soil treatment is no longer required, the treatment area shall be decommissioned. Decommissioning will include remediation and validation of the treatment area ground surface.

6.1.3.2 MONITORING AND DISPOSAL OF COLLECTED RUNOFF

Where water is collected in ASS stockpile or treatment areas, pH monitoring shall be conducted as follows:

- Daily pH measurements will be conducted using a calibrated meter, where accumulated water is present.
- Where pH of less than 5.5 is detected, the water shall be treated to achieve a pH between 6 and 8.5 by addition of agricultural lime. Where large volumes of low pH water are generated the use of other neutralising agents such as hydrated lime and/or liquid caustic will be allowed. Treatment of the water will be conducted by a suitably qualified person to avoid pH overshooting.

Treated or untreated waters with a pH of 5.5 or greater shall be disposed of by application over stockpiled or treated materials. Treated waters or untreated waters shall not be directly or indirectly discharged into waterways.

6.1.3.3 LIMING RATES

Where the terms lime or agricultural lime occur in this management plan, these shall be interpreted as meeting the following definition – fine ground agricultural lime with a grading predominantly <1mm (and greater than 60% <0.5mm) and with an Effective Neutralising Value of at least 97%. Other proposed neutralising agents must be approved by the HSEC Manager prior to use.

The recommended ASS treatment rates using fine ground agricultural lime are presented in Table 6.1. These treatment rates were derived from the highest net acidities detected during investigations at Hotham River and assume an excavated soil bulk density of 1.6 t/m^3.

WORKS AREA	TREATMENT RATE
Eastern Bank	6.3 kg lime/m³
Western Bank	5.5 kg lime/m³

Figure 6.1: Lime Treatment Rates

These recommended rates may be adopted or, alternatively, lime neutralisation rates for each treatment lot may be determined by sampling and Chromium Suite analysis of each treatment batch of excavated material. The liming rate required to neutralise the Net Acidity (Existing Acidity + Potential Acidity) shall be calculated by:

- Multiplying Net Acidity (calculated in kg/tonne) by a safety factor of 1.5 to allow for mixing deficiencies and poor reactivity of the lime.
- Multiplying the above result by the bulk density of the soil to arrive at the liming rate (kg/m3).
- Multiplying the above result by 1.03 (to account for an agricultural lime neutralising value of 97%).
- Calculating surface application rate (kg/m^2) by multiplying the above result by the thickness of soil being treated.

Treatment rates for alternative neutralising agents must be determined based on a laboratory derived neutralising value.

6.1.3.4 VERIFICATION TESTING

Verification testing shall be undertaken using field testing (pH_F and pH_{FOX}) at a sampling intensity reflective of *Landfill Waste Classification and Waste Definitions 1996* (As amended 2019) (DWER 2019). This will require 4 verification samples to be collected and field tested per earthworks lot.

Samples shall be collected over the full thickness of the treated soil.

The accuracy of the field-testing program shall be 'calibrated' by sending 25 per cent of samples to a laboratory for confirmatory analysis of pH_{KCl}, pH_{OX} and Chromium Suite.

Where there is poor correlation between laboratory results and field test results then the verification laboratory analyses will be increased to 50% of samples.

The verification sampling process shall include a quality assurance/quality control (QA/QC) program to ensure the quality and reproducibility of sampling methods used at the site. The minimum QA/QC program requirements are:

- Field QA/QC
    - Collection of field duplicates (one field duplicate for every 20 verification sample) as quality control samples;
    - Use of standardised field sampling forms (including Chains of Custody) and methods; and
    - Documenting calibration and use of field instruments.
- Laboratory QA/QC

- Analysis of samples will be completed by laboratories which hold National Association of Testing Authorities (NATA) accreditation for the particular parameters and methodologies needed. Information on QA/QC methods will be obtained from the designated laboratory before sampling to ensure that they meet acceptable standards; and
- The laboratory report shall be a NATA endorsed report and include the results of the analysis, sample numbers, laboratory numbers, a statement about the condition of the samples when they were received (e.g. on ice, cold, ambient, etc.), date and time of receipt, dates and times of extraction and analysis of samples, quality control results and a report on sampling and extraction holding times.

- Following receipt of field and/or laboratory data, a detailed review of the data will be completed to determine their accuracy and validity.

6.1.3.5 PERFORMANCE CRITERIA

The following performance criteria must be met to confirm effective neutralisation of treated soils:

- The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil, (e.g. pH_{FOX} must be >5 and/or net acidity <0);
- The neutralising material has been thoroughly mixed with the soil; and
- Soil pH must be in the range 6.0 to 8.5.

Where treated soils fail to meet these performance criteria, additional lime treatment neutralisation will be implemented until results comply with performance criteria.

6.2 MANAGEMENT OF DEWATERING ACTIVITIES

6.2.1 DEWATERING MANAGEMENT

A dewatering program has not been designed at the time of issuing this ASSMP. A hydrogeological assessment and establishment of baseline groundwater quality will be completed once design and construction methodologies, relevant to the specific excavations/dewatering, have been advanced. The ASSMP will be then amended to present management requirements relevant to the proposed dewatering.

The following sections outline appropriate groundwater management measures to be adopted for short term or longer-term dewatering of ASS.

6.2.2 MINIMISATION OF ASS DEWATERING

Dewatering techniques (including staged excavations) which minimise both the period and extent of planned dewatering will be adopted in identified ASS areas.

6.2.3 DEWATERING PERIOD <7 DAYS WITH A RADIUS OF INFLUENCE <50M

The risk of significant acidification at the Hotham River site is low providing the dewatering period is less than 7 days and the extent of dewatering of the ASS materials is less than a 50 m radius of influence. The following measures will apply for dewatering under these conditions:

- Walls and base of dewatered excavations in ASS shall be dusted (application rate of about 0.5kg/m^2) with fine ground agricultural lime prior to backfilling.
- Untreated water within each excavation shall be monitored and managed as outlined in Table 6.2. Based on current investigation findings, the monitoring regime for Trigger Action 1 shall be initially adopted. The monitoring regime and management actions shall be varied in line with Table 6.2 where increases in total acidity and/or decreases in pH are detected.
- DWER's 24 hour Pollution Watch hotline – 1300 784 782 or the Online reporting form (https://www.der.wa.gov.au/your-environment/reporting-pollution/report-pollution-form) will be

utilised where the management action in Table 6.2 requires advising DWER.

- Treated or untreated waters with a pH of 6 or greater may be reused for dust suppression or disposed of by irrigation to ground surfaces more than 100 m from water bodies. Treated waters or untreated waters shall not be directly or indirectly discharged into waterways.
- Water treatment shall occur in a settlement basin or holding tank to allow post-treatment precipitation of iron and other metals.
- Dewatering will not be allowed to cause any lowering of the water level in the Hotham River.
- The groundwater level immediately next to the Hotham River shall be monitored during dewatering works. Dewatering shall cease if groundwater immediately next to the river falls more than 100mm below the river level.

Groundwater levels outside of the excavation shall be monitored to ensure that the actual radial extent of the groundwater cone of depression is not more than predicted.

	TRIGGER	MANAGEMENT ACTION	MONITORING
1	**Total titratable acidity <40mg/L**, pH>6	Continue daily dewatering water quality monitoring.	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Fortnightly**—laboratory analysis: TTA, TAlk, pH
2	**Total titratable acidity <40mg/L**, pH in range 4 to 6	Undertake neutralisation treatment (liming) on extracted water. Continue dewatering water quality monitoring.	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: TTA, TAlk, pH
3	**Total titratable acidity in range 40mg/L to 100mg/L**, pH>6	Undertake neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. Continue dewatering water quality monitoring .	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: TTA, TAlk, pH
4	**Total titratable acidity in range 40mg/L to 100mg/L**, pH in range 4 to 6	Undertake neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. Continue dewatering water quality monitoring.	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: TTA, TAlk, pH **Fortnightly**—laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide, EC, total suspended solids (TSS), total dissolved salts (TDS), total nitrogen (TN), total phosphorus (TP)
5	**Total titratable acidity >100mg/L** or pH<4 or **total alkalinity <30mg/L**	Increase neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. Cease dewatering and advise DWER immediately. Continue dewatering water quality monitoring	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide, EC, TSS, TDS, TN, TP
6	**Total titratable acidity >100mg/L and 25% higher than baseline values**	Change to Dewatering Measures in Section 6.2.4.	Change to Monitoring Requirements in Table 6.3.
7	pH decrease >1 pH unit from baseline values	Change to Dewatering Measures in Section 6.2.4.	Change to Monitoring Requirements in Table 6.3.

Table 6.2: Monitoring and Management Actions - Radius of Influence of Dewatering <50m and Duration of Groundwater Pumping <7Days

6.2.4 DEWATERING PERIOD >7 DAYS AND/OR RADIUS OF INFLUENCE >50M

The following measures will apply for dewatering for periods > 7days and/or with a radius of influence >50 m:

- The dewatering and excavation staging adopted must limit the radius of the groundwater cone of depression to less than 100 m.
- Baseline groundwater quality data must be collected before the commencement of dewatering operations.
- The ASSMP must be approved by DWER before commencement of site works.
- Untreated water within each excavation shall be monitored and managed as outlined in Table 6.3. Based on investigation findings, the groundwater monitoring regime for Trigger Action 1 shall be initially adopted. The monitoring regime and management actions shall be varied in line with Table 6.3 for increases in total acidity and/or decreases in pH are detected.
- Treated or untreated waters with a pH of 6 or greater shall be reused for dust suppression or disposed of by irrigation to ground surfaces more than 100 m from water bodies. Treated waters or untreated waters shall not be directly or indirectly discharged into waterways.
- Water treatment shall occur in a settlement basin or holding tank to allow post-treatment precipitation of iron and other metals.
- Dewatering will not be allowed to cause any lowering of the water level in the Hotham River.
- The groundwater level monitoring during dewatering works shall be conducted immediately next to the Hotham River and at a distance of 100 m elsewhere. Dewatering shall cease if groundwater level falls more than 100mm below the river level at adjacent monitoring locations or 100 mm at monitoring locations 100 m from the dewatering location.
- Groundwater quality monitoring:
    - Groundwater monitoring wells shall be installed up-gradient and down-gradient of dewatering location (wells will be appropriately positioned to enable them to be used to assess any impacts of dewatering on groundwater level and quality).
    - Groundwater monitoring of pH, standing water levels, EC, redox, DO, total titratable acidity and total alkalinity will be conducted in the field every second day during the dewatering operations and continued until it can be shown that groundwater quality and levels have returned to normal elevations.
    - Groundwater samples will be collected for laboratory analysis at fortnightly intervals during the dewatering operations and analysed for total acidity, total alkalinity, sulfate, chloride, dissolved aluminium (filtered), dissolved arsenic (filtered), dissolved chromium (filtered), dissolved cadmium (filtered), dissolved iron (filtered), dissolved manganese (filtered), dissolved nickel (filtered), dissolved zinc (filtered), dissolved selenium (filtered), ammoniacal nitrogen, TDS, total nitrogen, total phosphorus, filterable reactive phosphorus (FRP).
    - Groundwater samples will be collected from all groundwater monitoring wells and tested for the above listed laboratory analysis at two monthly intervals for a period of at least six months (including at least one groundwater monitoring event taken at the time of highest seasonal groundwater levels) following completion of the dewatering operations.
- Dewatering operations will be ceased if the results of groundwater monitoring indicate any deterioration in groundwater quality (i.e. change in trigger levels listed in Table 6.3). An assessment of the monitoring results will be conducted by an appropriately qualified person to confirm any required alteration to dewatering operations and the need for remedial works.
- DWER's 24 hour Pollution Watch hotline – 1300 784 782 or the Online reporting form (https://www.der.wa.gov.au/your-environment/reporting-pollution/report-pollution-form) will be utilised where the management action in Table 6.3 requires advising DWER.
- Groundwater remediation will be conducted if the results of the groundwater quality monitoring

program indicate that any environmental impact has occurred as a result of project works.

- On completion of dewatering activities, the results of the groundwater and effluent water quality and water level monitoring program will be reported within an initial closure report for the project along with a discussion of any environmental impacts observed. This initial closure report will be submitted to DWER.
- The results from any post-dewatering groundwater quality monitoring program will be reported within a post-dewatering monitoring closure report for the project along with a discussion of any environmental impacts observed. This post-dewatering closure report will be submitted to DWER.

	TRIGGER	MANAGEMENT ACTION	MONITORING
1	**Total titratable acidity <40mg/L**, pH>6	Continue daily dewatering water quality monitoring.	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Fortnightly**—laboratory analysis: TTA, TAlk, pH
2	**Total titratable acidity <40mg/L**, pH in range 4 to 6	Undertake neutralisation treatment (liming) on extracted water. Continue dewatering water quality monitoring	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: TTA, TAlk, pH
3	**Total titratable acidity in range 40mg/L to 100mg/L**, pH>6	Undertake neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. Continue dewatering water quality monitoring	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: TTA, TAlk, pH
4	**Total titratable acidity in range 40mg/L to 100mg/L**, pH in range 4 to 6	Undertake neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals Continue dewatering water quality monitoring	**Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: TTA, TAlk, pH **Fortnightly**—laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide, EC, total suspended solids (TSS), total dissolved salts (TDS), total nitrogen (TN), total phosphorus (TP)
5	**Total titratable acidity >100mg/L** or pH<4 or **total alkalinity <30mg/L**	Increase neutralisation treatment (liming) on extracted water and aeration of treated water to precipitate dissolved iron in settlement basin or other treatment system to allow removal of iron and other metals. Cease dewatering and advise DWER immediately. Continue dewatering water quality monitoring	**Twice Daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide, EC, TSS, TDS, TN, TP

Table 6.3: Monitoring and Management Actions - Radius of Influence of Dewatering >50m and Duration of Groundwater Pumping > 7 Days

6.3 OTHER MONITORING

6.3.1 VISUAL MONITORING

Regular visual monitoring of work areas at Hotham River shall be undertaken to identity signs of possible ASS oxidation. This monitoring will include looking for signs of:

- Unexplained scalding, degradation or death of vegetation;
- Unexplained death or disease of aquatic organisms;
- Areas of green-blue water or extremely clear water indicating high concentrations of aluminium;
- Formation of the mineral jarosite and other acidic salts in exposed or excavated soils;
- Rust coloured deposits on plants and on the banks of drains, water bodies and watercourses indicating iron precipitates;
- Excessive corrosion of concrete and / or steel structures in contact with soil or water;
- Black to very coloured waters indicating de-oxygenation; and
- Any sulphurous smells, e.g., hydrogen sulphide or rotten egg gas.

A record of visual monitoring (including photographs) and observations of possible ASS oxidation shall be kept. Any potential or confirmed environmental impact must be dealt with as an incident (see Section 6.6).

6.3.2 SURFACE WATER QUALITY MONITORING

Given the close proximity of the Hotham River monitoring of surface water quality shall be conducted during excavation in ASS areas. Establishment of baseline surface water quality and monitoring locations will be as per the Nullaga Project Area CEMP.

Surface water monitoring for ASS shall comprise:

- Field measurements at upstream and downstream monitoring locations of pH, redox, total titratable acidity and total alkalinity every second day during excavation works.
- Where monitoring indicates pH levels downstream lower than 1 pH unit of that upstream, works shall be ceased, a review works operations will be conducted by an appropriate qualified person and operations will be amended to minimise the risk of impact to surface water.

Where excavation dewatering of ASS occurs and a deterioration in groundwater quality (i.e. change in trigger levels listed in Table 6.2 or Table 6.3) has been detected in excavation groundwater monitoring bores, the surface water monitoring program shall be increased to:

- pH, EC, DO, Eh, total titratable acidity and total alkalinity in upstream and downstream surface water locations shall be monitored in the field every second day during dewatering operations.
- Laboratory water quality data shall be collected from upstream and downstream surface water locations at fortnightly intervals during dewatering operations. Laboratory surface water quality data shall be collected at intervals of two months for six months following completion of the dewatering operation. The laboratory analytical suite for surface water quality monitoring will comprise: total titratable acidity (TTA), total alkalinity, pH, sulfate, chloride, dissolved aluminium (filtered), total aluminium, dissolved arsenic (filtered), dissolved chromium (filtered), dissolved cadmium (filtered), total iron, dissolved iron (filtered), dissolved manganese (filtered), dissolved nickel (filtered), dissolved zinc (filtered), dissolved selenium (filtered), ammoniacal nitrogen, EC, TDS, total nitrogen, total phosphorus, filterable reactive phosphorus (FRP).
- Measurement of river water levels shall be carried out before the commencement of dewatering operations and at twice weekly intervals throughout the duration of the dewatering operation (to

ensure that water levels are not lowered as a result of the groundwater disturbance). Dewatering operations must cease immediately if monitoring results show any decline in water levels within the river or a decrease of more than 100mm in groundwater levels immediately adjacent to the river.

- Dewatering operations must cease immediately if surface water results and adjacent groundwater indicate a deterioration in water quality.
- On completion of dewatering activities in ASS areas, the results of surface water quality and water level monitoring program will be reported within an initial closure report along with a discussion of any environmental impacts observed. This initial closure report will be submitted to DWER.
- The results of any post-dewatering surface water quality will be reported within a post-dewatering monitoring closure report submitted to DWER.

6.4 TRAINING

Training for all staff involved in the excavation, transport, handling or dewatering of ASS will be included in Contractor Project Site Inductions and Contractor Environmental Awareness Training under the CEMP. Training sessions are to be designed to ensure that all staff are aware of the ASS issues involved on the site and that they understand their responsibilities in managing the treatment of ASS to minimise potential environmental impacts. This training should be delivered by an ASS specialist/ suitably qualified and experienced person and be completed prior to the commencement of works.

6.5 REPORTING AND RECORDS

All records of soil testing will be provided by the contractor to the HSEC Manager. These records will include the in-field and laboratory analyses of all samples, the pH prior to and after testing, the volume of material treated, and the volume of lime added.

An ASS Closure Report will be prepared at the completion of the construction activities, including finalising the treatment of any remaining ASS. The ASS Closure Report will be retained onsite as evidence of the management methodologies implemented during construction. The ASS Closure Report shall include the following:

- The soil and water management measures undertaken at the construction area.
- The volume of soil and groundwater treated at the ASS treatment area.
- The amount of neutralising agent used during works.
- The results of soil validation and monitoring programs.
- The results of dewatering effluent monitoring programs.
- The results of the groundwater and surface water monitoring program, including trends in water quality.
- A discussion of the effectiveness of management strategies employed at the site.
- A discussion of any potential risks to human health or the environment.
- A discussion and action plan if any remedial measures are needed.

6.6 INCIDENTS

Incidents related to the management of ASS must be promptly reported to Worsley Alumina and recorded in G360. Significant environmental events must be investigated (by appropriately trained personnel), actions identified, and learnings shared.

The management and reporting of environmental incidents shall be undertaken by the appropriate person as detailed in South32 Worsley Alumina Event Investigation and Action Management Procedure (01015997).

For additional information on incident reporting please see the Worsley Mine Expansion Framework

Construction Environmental Management Plan (WOR-71183-FS-DWER-MPL-0001).

6.7 RESIDUAL IMPACTS

Should any discharge to the environment be identified during construction, the following will be undertaken:

- Immediate clean-up of the impacted site (removal of contaminated material or other appropriate actions).
- Verification sampling to ensure all contaminated material has been removed from the site.
- Investigation into the extent of environmental impact to MNES species and habitat, followed by implementation of any appropriate response actions as per Section 6.0 - Mitigation and Management Measures.
- Assessment of the effectiveness of response actions and reporting through the Annual Environmental Report.
- If the implementation of response actions does not successfully remediate and restore the area, South32 Worsley will engage with DWER regarding further actions which may be required such as offsets.

7. ENVIRONMENTAL MANAGEMENT AND MONITORING

A summary of Environmental Management Measures, Monitoring, Inspection and Reporting requirements is provided in Table 7.1.

ID	Control Measures / Actions	Timing	Performed By	Activity / Record	Timing (minimum)	Performed by
1.	**General**					
1a	Adopt construction techniques that minimise ground disturbance in identified ASS areas.	Prior to Construction	Contractor	-	-	-
1b	Adopt dewatering techniques which minimise both the period and extent of planned dewatering in identified ASS areas	Prior to Construction	Contractor	-	-	-
1c	Induction and training of all personnel involved in the excavation, transport, handling or dewatering in identified ASS areas.	Prior to Construction	Contractor	Training Records	As Required	Contractor
1d	ASS Closure Report	Completion of all ASS disturbance works	Worsley	All Monitoring and Materials Tracking Records	Completion of all ASS disturbance works	Worsley
2.	**Excavated ASS**					
2a	Limit stockpile period for untreated ASS outside of designated treatment areas	During Construction	Contractor	Materials Tracking Register	As Required	Contractor
2b	Set up and maintain designated ASS treatment areas.	During Construction	Contractor	Inspection Checklist	Weekly	Contractor
2c	Treatment and validation of ASS	During Construction	Contractor	Materials Tracking Register, Lime Register, Monitoring Records	Each Earthworks Lot	Contractor
2d	Reuse of verified treated ASS within the Project site.	During Construction	Worsley	Materials Tracking Register,	Each Earthworks Lot	Contractor
2e	Capture, analyse and treat (if necessary) runoff from the designated ASS treatment areas and record results.	During Construction	Contractor	Monitoring Records	As Required	Contractor
2f	Release/reuse of captured runoff (treated or untreated) from designated ASS treatment areas.	During Construction	Contractor	Monitoring Records	As Required	Contractor
3.	**Dewatering ASS**					
3a	Dust walls and base of dewatered excavations in ASS with lime prior to backfilling.	During Construction	Contractor	Lime Register, Monitoring Records	On completion of dewatering	Contractor

ID	Control Measures / Actions	Timing	Performed By	Activity / Record	Timing (minimum)	Performed by
3b	Monitor untreated water quality within each excavation and treat (if necessary) and record results.	During Construction	Contractor	Monitoring Records	Daily	Contractor
3c	Release of untreated/treated water from excavations (pH >5.5) for dust suppression or disposed of by irrigation to ground surfaces more than 100 m from water bodies	During Construction	Worsley	Monitoring Records	As Required	Contractor
3d	Groundwater level monitoring (requirements dependent upon dewatering period/cone of depression) around excavations and between excavation and Hotham River.	During Dewatering	Worsley	Groundwater Monitoring Records	Twice Weekly	worsley
3e	Groundwater quality monitoring (requirements dependent upon dewatering period/cone of depression) around excavations.	During Dewatering	Worsley	Groundwater Monitoring Records	Dependent on pH and Total Titratable Acidity Levels	Worsley
3f	Groundwater quality monitoring post-dewatering	Post Dewatering	Worsley	Groundwater Monitoring Records	Monthly for 6 Months	Worsley
3g	Post-dewatering Closure Reporting	Post Dewatering	Worsley	Groundwater Monitoring Records, Closure Report	Initial Report on completion of dewatering. Final report on completion of post-dewatering monitoring.	Worsley
4.	**Visual Monitoring**					
4a	Visually monitoring for signs of ASS oxidisation.	During Construction	Contractor	Inspection Checklist	Weekly	Contractor
5.	**Surface Water Monitoring**					
5a	Field measurements at upstream and downstream monitoring locations of pH, redox, total titratable acidity and total alkalinity.	During Excavations in ASS areas	Contractor	Surface Water Monitoring Records	Every Second Day	Contractor

ID	Control Measures / Actions	Timing	Performed By	Activity / Record	Timing (minimum)	Performed by
5b	Increased monitoring of water quality (field and laboratory testing) and river levels where excavation dewatering of ASS occurs and a deterioration in groundwater quality is detected.	During Dewatering in ASS areas	Worsley	Surface Water Monitoring Records	Field Measurement Every Second Day. Laboratory Testing Fortnightly	Worsley
6.	**Environmental Incidents**					
6a	Investigate and report possible and actual environmental incidents related to the management of ASS.	During Construction	Worsley	Incident Record	As Required	Contractor

Table 7.1: Draft Management, Monitoring, Inspection and Reporting

* Draft Roles and Responsibilities are provided and are subject to change.

8. TERMS AND DEFINITIONS

For the purposes of this document, the following terms and definitions apply:

Abbreviation / Acronym / Term	Meaning
AASS	Actual Acid Sulfate Soils
ACT	Australian Capital Territory
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASC - NEPM	National Environmental Protection (Assessment of Site Contamination) Measure 1999 as amended 2013
ASRIS	Australian Soil Resource Information System
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soil Management Plan
BBM	Boddington Bauxite Mine
CEMP	Construction Environmental Management Plan
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DAWE	Department of Agriculture, Water and the Environment (Cth)
DER	Department of Environment Regulation (now DWER)
DO	Dissolved Oxygen
DWER	Department of Water and Environment Regulation
EC	Electrical Conductivity
Eh	Redox potential
EP Act	*Environmental Protection Act 1986* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPA	Environmental Protection Authority
ERD	Environmental Review Document
FRP	Filterable Reactive Phosphorus
GHD	GHD Pty Ltd
GoWA	Government of Western Australia
ha	Hectares
km	Kilometer
MNES	Matters of National Environmental Significance
MS 719	Ministerial Statement 719
NATA	National Association of Testing Authorities
NWQMS	National Water Quality Management Strategy
PASS	Potential Acid Sulfate Soils
pH	pH units

QA/QC	Quality Assurance/Quality Control
RIWI Act	*Rights in Water and Irrigation Act 1914* (WA)
RL	Relative Level
TAA	Total Titratable Acidity
TAlk	Total Alkalinity
TN	Total Nitrogen
TP	Total Phosphorous
tpa	Tonnes per annum
TSS	Total Suspended Solids
WA	Western Australia
Worsley Alumina	South32 Worsley Alumina Pty Ltd

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Appendix A -South32's Environmental Standard

ENVIRONMENT STANDARD

Type	**Standard**
Effective from:	25 May 2015
Document owner:	Chief Sustainability Officer
Date approved:	23 October 2020
Approved by:	Chief Executive Officer
Next review date:	23 October 2022
Version no:	04
Related documents:	Sustainability Policy Health Standard Community Standard Social Performance Framework Dam Management Standard Closure Standard Material Risk Management Standard HSEC Reporting Standard Supply Standard Asset Management Standard Training Standard Assurance Standard [Governance] Document Structure Standard Sustainable Development Framework: ICMM Principles

CONTENTS

1. PURPOSE

In line with the South32 Purpose, our Code of Business Conduct and our Breakthrough # 6 we commit to creating value for our owners through our environmental and social leadership. The Environment Standard is a key foundation to enable the business to deliver on these strategic objectives.

2. SCOPE AND APPLICATION

All exploration, major projects and operations under the operational control of South32 must implement, or demonstrate conformance aligned to the requirements of this Standard. Refer to Environment Standard performance requirement mapping matrix to understand which requirements apply relevant to the business cycle phase (i.e. Exploration through to Closure).

Statutory and permitting requirements will take precedence over South32 standards, except in those cases where the South32 standards are more stringent.

If approvals are required for a environment-related activity outside of this document, approvals as outlined in Appendix 1 must be obtained.

The specified period for implementation of this Standard is two years from date of published approval.

3. KEY CONTACT

Scott Coleman, Group Manager Environment

4. REVIEW OF THIS DOCUMENT

This document is scheduled to be reviewed on a two-yearly basis.

5. GENERAL REQUIREMENTS

The following requirements provide an environmental management framework that ensures appropriate focus and accountability, continuous improvement and a standardised process is in place that prevents environmental harm. The general requirements section is modelled on the International Organisation for Standardisation (ISO) 14001 Environmental Management System Standard and complements the ICMM Sustainable Development Principles and Performance Expectations.

5.1 Leadership and Accountability

The South32 Senior Leadership Team demonstrate leadership and accountability by ensuring that:

- A Sustainability policy that details the commitment to the management and improvement of environment is established, communicated and periodically reviewed;
- Plans, objectives and targets for the improvement of environmental performance are established, communicated and implemented; and
- Resources necessary to achieve key environmental improvement targets have been identified and adequately provisioned for.

South32 Leaders demonstrate leadership and accountability by ensuring that:

- Clear roles and responsibilities for environmental management are established;
- Action is taken to address breaches or non-compliance with external and internal environmental requirements.

5.2 Hazard Identification and Risk Management

Complementing the Material Risk Management Standard, processes shall be in place that ensure:

- All relevant personnel are involved in hazard and risk assessment processes, including environmental subject matter experts and operational personnel who interact with and/or influence environmental performance outcomes.
- A risk register is managed in G360 that includes all relevant environmental hazards and risks, with the risk profile informed through:
    - understanding local and regional context (refer to performance requirements 6.2.1 & 6.2.2)
    - application of the source-pathway-receptor model (refer to Appendix 3);
- Risk controls are identified and implemented using the hierarchy of controls to reduce risk as low as reasonably practicable (ALARP); and
- Controls are implemented and verified as effective.

5.3 Improvement Planning

Processes shall be in place to enable and drive continuous improvement relevant to environmental performance, at both Group and Operational level. This includes ensuring:

- Key environmental performance targets and objectives are incorporated into (where relevant):
    - Business Scorecard / Key Performance Indicators (KPIs)
    - Life of Operations Planning (LoOP) activities
    - Annual Business Plans
    - Local Environment Improvement Plans (EIPs)
- Processes to track and monitor progress against the agreed plans are in place and occur at regular and planned intervals or whenever there is a change to activities or operating conditions; and
- Reward and incentive schemes (where in place) are designed such that health, safety, environment, communities and social performance are not compromised in order to maximise the financial reward.

5.4 Legal and Other Requirements

Processes shall be in place to ensure that all applicable environmental legal and other obligations are met. Obligations are to be identified and evaluated for compliance and documented in a register.

- At a Group level, the register must:
    - List all relevant external commitments associated with environmental performance (e.g. ICMM performance expectations), and the South32 policies, standards and/or processes that address the commitment/s; and
    - Be checked regularly for currency.
- At an Operational level, the register must:
    - List all environmental licences, permits, authorisations and approval documents issued to the Operation by an external authority, including expiry/renewal dates;
    - Define the approach and accountability for maintaining compliance with each requirement, commitment and/or obligation associated with the above documents;
    - Be checked regularly for currency;
    - Include or provide reference to records that show periodic evaluation of compliance which includes managing of actions in G360 to address identified gaps; and
    - Be accessible to relevant personnel, with changes or updates communicated as appropriate.

5.5 Communication and Consultation

Processes shall be in place to ensure:

- Environmental management and performance information is communicated effectively;
- The workforce is engaged in understanding their role in the effective management of relevant environmental aspects; and
- The workforce is involved in environmental hazard identification, risk assessment, workplace inspections and event investigations.

5.6 Document Control and Record Management

- Documents and procedures related to environmental management shall be:
  - Reviewed and approved by authorised and competent personnel;
  - Current, dated, controlled by revision and readily available to relevant stakeholders; and
  - Maintained in accordance with local regulatory requirements.
- EQuIS is to be used to manage all environmental data collected to inform and report on performance and compliance. Authorisations must be in place for the use of an alternate data management system (refer to authorisations table in Appendix 1).

5.7 Training and Competency

In accordance with the Training Standard, training frameworks focussed on key environmental management aspects shall be developed and periodically reviewed. At a minimum, a training framework will cover:

- Training needs or skills analysis including competencies required by legislation;
- Processes for the verification of training and competency; and
- Processes for ensuring training records are maintained and are current.

5.8 Change Management

Processes shall be in place to manage change ensuring all associated risk is managed, including processes that:

- Identify any change relating to people, plant, procedures, products, services or processes that could impact the environment;
- Assess new hazards and/or increased risks of existing hazards to the environment resulting from a change and develop appropriate controls.

5.9 Contractor and Supplier Management

In addition to the Supply Standard, processes shall be in place for the onboarding and management of contractors engaged in work with potential to impact the environment, including:

- Risk-based selection (tiers) and evaluation of suppliers and contractors, including supplier risk assessment and prequalification where appropriate;
- Establishing accountabilities for the management of contractors, including provision of appropriate supervision;
- Training, competency and induction requirements; and
- Requirements for contractors to provide work procedures and HSE plans including KPIs.

5.10 Assurance

In accordance with the Assurance Standard and supporting the three lines of defence assurance model, processes shall be in place to ensure:

- First and Second line assurance programs are in place to enable effective implementation of environmental performance requirements and processes, as outlined by this Standard.

5.11 Event Reporting and Investigation

In accordance with the HSEC Reporting Standard, processes shall be in place to ensure:

- All events with an environmental consequence (actual or potential) are promptly reported and recorded in G360; and
- Significant environmental events are investigated (by appropriately trained personnel), actions identified, and learnings shared.

5.12 Management Review

The South32 leadership team shall review environmental performance annually to ensure their continued suitability, adequacy and effectiveness. The management review shall be a part of the business planning and prioritisation process and should include consideration of:

- Changes in internal and external legislative and other requirements relevant to the business' environmental performance;
- The extent to which the current plan, objectives and targets have been met;
- Information on environmental performance and trends taking into consideration data from events, monitoring programs including compliance, and audit/assurance results;
- Adequacy of resources; and
- Opportunities for continual improvement.

6. ENVIRONMENTAL PERFORMANCE REQUIREMENTS

6.1 Environmental Commitments

We protect the environment in a way that demonstrates our values and are aligned with the ICMM commitments for mining and protected areas.

6.1.1 Exploration and extraction of resources must not occur within the boundaries of World Heritage listed properties.

6.1.2 Exploration and extraction of resources must not occur adjacent to World Heritage listed properties unless internal (Appendix 1) and external approvals are obtained.

6.1.3 Exploration and extraction of resources must not occur within or adjacent to the boundaries of International Union for Conservation of Nature (IUCN) Protected Areas Categories I to IV unless internal approvals (Appendix 1) and external approvals are obtained.

6.1.4 Exploration and extraction of resources must not occur within or adjacent to the boundaries of any protected area defined under legislation unless internal (Appendix 1) and external approvals are obtained.

6.2 Environmental Management

We understand our local and regional context and have processes in place to ensure we minimise adverse environmental impacts.

6.2.1 Identify and map key features within the area of influence in accordance with Appendix 2.

6.2.2 Establish the baseline or reference conditions for land, biodiversity, water resources and air within the area of influence.

6.2.3 Use the suite of minimum performance requirement documents to inform management of common environment risk exposures (as relevant to the operation/project, based on risk profile):

- Air Emissions Management (Appendix 4)
- Contamination Prediction and Management (Appendix 5)
- Rehabilitation and Biodiversity Management (Appendix 6)
- Water Management (Appendix 7)
- Waste Management (Appendix 8)

6.3 Energy Efficiency and Climate Change

We actively reduce our emissions through the efficient use of energy resources, adoption of emission reduction technologies

6.3.1 Consider energy use and emissions within the optimisation of the integrated business planning process, and identify and implement energy efficiency and emission reduction initiatives that:

- are aligned with the South32 Our Approach to Climate Change;
- are evaluated using the internal carbon pricing protocols; and
- are approved through the planning process.

6.3.2 Maintain a GHG emissions forecast for the life of operation that:

- is inclusive of Scope 1, 2 and 3 emissions;
- is aligned with operational performance and external supply contracts;
- includes all approved energy efficiency and emission reduction projects; and
- is incorporated into the planning process.

6.4 Water Stewardship

We manage water resources using a holistic approach to promote better water use, effective catchment management and contribute to improved water security and sanitation.

6.4.1 Maintain a water resource forecast (supply/demand) that is incorporated into the Life of Operations Plans.

6.4.2 Undertake a water resource risk and opportunity analysis (template):

- for operational locations on a five-yearly basis;
- for exploration areas on an as-required basis; and
- incorporate the outcomes into the planning process.

For Operations with a water-resource related Material Risk

6.4.3 Identify and implement controls that must:

- use the 'water management' performance requirement document to inform control design, implementation and verification (noting application will vary depending on local context); and
- where relevant, consider the potential socio-environmental impacts within the catchment area (including future climate risks) and how this will likely influence the catchment over the life of the operation.

6.4.4 Develop site specific contextual water targets or objectives that:

- considers and supports the management of the water-resource related Material Risk and the broader stakeholders and catchment needs.
- is authorised in accordance with Appendix 1.

6.5 Biodiversity and Land Stewardship

We manage Biodiversity and Land through an integrated land use planning process designed to protect ecosystem services and biodiversity values for future generations.

6.5.1 For new projects and major expansions, during the planning cycle, apply and implement the Biodiversity Mitigation Hierarchy for managing biodiversity values and ecosystem services across the project/operations lifecycle, aimed at achieving no net loss.

6.5.2 Undertake a biodiversity risk and opportunity analysis (template):

- for operational locations on a five-yearly basis;
- for exploration areas on an as required basis; and
- incorporate outcomes into the planning process and rehabilitation performance criteria.

For Operations with a biodiversity related Material Risk

6.5.3 Identify and implement controls that must:

- use the 'rehabilitation and biodiversity management' performance requirement document to inform control design (consistent with the Biodiversity Mitigation Hierarchy), implementation and verification (noting application will vary depending on local context); and
- where relevant, consider the potential cumulative impacts from land use in the surrounding area, including projected changes associated with climate and regional development and how these may likely influence the surrounding land use over the life of the Operation.

6.6 Waste Stewardship

We manage our waste streams to minimise environmental impact and realise value.

6.6.1 Identify, classify and record wastes generated and/or managed on site.

6.6.2 Implement governance processes (risk-based) to verify the treatment, handling and disposal of waste is being undertaken in accordance with local jurisdiction and/or specific company requirements where stipulated (inclusive of on and off-site waste management).

APPENDIX 1: ENVIRONMENTAL AUTHORITIES

Authority Description and Role		Endorse	Approve	Inform
Activities requiring internal approval (as outlined in Section 6.1)				
	COO	✓▪		
OR	CDO	✓▪		
	CEO		✓▪	
Environment Data managed outside of EQuIS				
	HSE Lead/Manager	✓▪		
	VP Operation		✓▪	
	GM Environment			✓▪
Contextual Water Targets approval				
	GM Environment and VP Operation	✓▪		
	COO		✓▪	
	CEO			✓▪

APPENDIX 2: ENVIRONMENTAL MANAGEMENT REQUIREMENTS

Requirement	Scope
Area of influence	The boundary that takes into account South32's business activities, and their potential direct, indirect and/or cumulative impacts on the environment. The area of influence may vary depending on the type and severity of environmental impact being considered within the regional context (e.g. air shed, water catchment, bio-region) and if relevant based on the risk profile, consider other 'outside of the gate' factors such as shipping or transportation through highly sensitive areas. These must align to the *HSEC Reporting Standard, Appendix 4: Decision tree for reporting boundary*. As a minimum, the area of influence should include: • South32 operational footprints including land owned, managed and leased • Extent of potential impacts associated with executing activities associated with the operation (inclusive of potential cumulative impacts) • Water catchments that the operation interacts with (i.e. extracts from or discharges into) • External waste disposal facilities used by the operation (including port facilities) • The extent of the airshed that the operations interacts with
Identify and map key features	• Owned, leased or managed land; • Activities under South32 operational control; • Contaminated sites; • Designated protected areas and areas of high conservation value (including designated offset areas) via IBAT; • Distribution of red list and other listed species (e.g. IUCN Red List); • Sensitive receptors and host communities; • Water resources (natural sources of surface and sub-surface water, irrespective of quality, that sustain ecosystems, communities and/or are utilised for recreational, agricultural or other commercial purposes) and water catchments; • Areas of potential acid forming materials or other mineralisation with potential HSEC impacts (for example, asbestos) as defined by recognised standards (for example, INAP: The International Network for Acid Prevention: Global Acid Rock Drainage Guide); • Areas of stockpiled materials required to support rehabilitation; • Areas of cultural significance, including archaeological and anthropological sites; and • Other activities (for example, other resource extraction, agriculture) with potential cumulative or indirect impacts.
Risk assessment	Risks must be assessed in consideration of: • South32 Material Risk Management Standard; • Current and reasonably foreseeable activities consistent with Life of Operation Plan; • Closure plans; • Impacts of land and biodiversity, heritage, air and water quality, climate change, noise, vibration, light, erosion, amenity, acid rock drainage, salinity, radioactivity, metal leaching, mined waste rock and waste disposal; and • The ICMM Mining Principles. The identified environmental risks must also be suitably integrated into the operational risk management process.

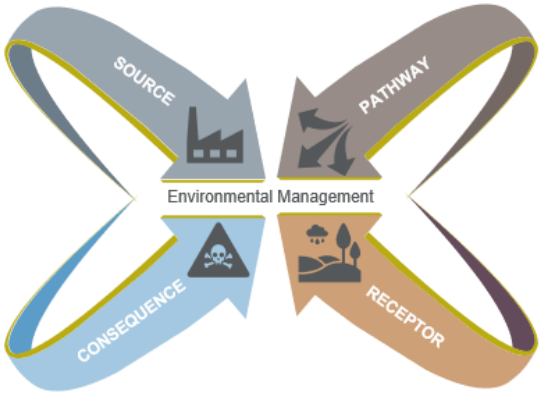
Requirement	Scope
Hierarchy of Controls	To be applied to all environmental risks, except for biodiversity related risks where the Biodiversity Mitigation Hierarchy is to be applied. From highest priority to lowest priority: • Elimination; • Substitution; • Engineering Controls; • Administrative Controls. Refer to below for description of Biodiversity Mitigation Hierarchy that specifically applies to the management of biodiversity.
Scope 1, 2 and 3 definitions	Scope 1 – Direct GHG emissions from activities where South32 has operational control. Scope 2 - Indirect emissions from purchased electricity from an external supplier. Scope 3 - Indirect emissions (not included in Scope 2) that occur in the South32 value chain (e.g. upstream and downstream emissions from the use or processing of South32 products).
Important biodiversity and/or ecosystems	Determined taking into account: • Regulatory requirements; • Natural and critical habitats as defined by IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012), sections GN43 and GN53 to GN97and • reasonable stakeholder expectations.
Water Resource Risk and Opportunity Analysis	Analysis to include: • Risk screening using the World Resource Institute 'Aqueduct Water Risk Atlas' tool;. • Operational review/verification including supply/demand including seasonal patterns/variability, discharge quality and regulatory compliance, community issues and cumulative impacts on the water catchment area; • Outputs from the latest South32 Materiality Assessment specific to the operation. Risk screening to be based on a minimum 10-year time horizon. • Level of risk to be assessed in accordance with the South32 Material Risk Management Standard.
Biodiversity Risk and Opportunity Analysis	Analysis to include: • location of the Operation with respect to declared biodiversity hotpots or areas of high conservation value (located within or adjacent to); • likely interaction with IUCN species and habitats, including number of species and their conservation status (IUCN Red List); • nature of operation (total lease area and likely disturbance profile over the next 7 years (minimum) – information to be sourced from the Life of Operation Plan.; • Outputs from the latest South32 Materiality Assessment specific to the Operation. Level of risk to be assessed in accordance with the South32 Material Risk Management Standard.
Material Risk	As defined in the South32 Material Risk Management Standard.

Requirement	Scope
Rehabilitation Resources	Includes all materials required to undertake rehabilitation activities, includes resources such as: • Overburden; • Topsoil; • Mulch; • Felled vegetation; and • alternate growth media and/or artificial habitat structures.
Biodiversity Mitigation Hierarchy	To be applied when assessing biodiversity related risks, from highest priority to lowest priority: • Avoidance; • Minimisation; • Restoration/Rehabilitation; • Offset Residual Impacts.

APPENDIX 3: SOURCE, PATHWAY, RECEPTOR MODEL

Source
What are the contaminant sources that could cause pollution in and around our operations?

- Atmospheric – gaseous, fume, fugitives
- Water – direct discharges to marine, surface & ground waters
- Waste – spills, disposal & contamination.
- Other – noise & light



Pathway
How might the pollutant travel to a sensitive Receptor?

- Air – dust, gases, noise
- Water – SW & GW
- Land – runoff, hydrogeology
- Animal translocation
- People / vehicle hygiene
- Other infrastructure

Consequence
What impacts or consequences could there be that require management from the pollutant at the receiving point

- Social / environmental / cultural
- Acute
- Cumulative.

Receptor
Who or what could be affected or impacted by the pollutant?

- Environmental - ecosystems
- Human – employees / community

When risk assessing the aspect, ensure consideration that there may be multiple *Sources, Pathways, Receptors and Consequences* also that some receptors could eventually act as new or additional pathways.

APPENDIX 4: AIR EMISSIONS MANAGEMENT

Scope and application

This appendix covers emissions of particulate matter, gases, odour, noise, vibration and light and should consider the acute, incremental and cumulative ambient impacts on sensitive receptors, including communities located within the air shed.

This appendix represents the minimum performance requirements with respect to air emissions management and should be applied where there is an air emission related operational risk exposure, with consideration also given to the local/regional operating context and regulations.

Intent

The intent of these minimum performance requirements is to ensure that operations and projects under the operational control of South32 have identified and minimised air pollutants (and their potential impacts) by taking a risk-based approach and employing the *Source-Pathway-Receptor (SPR, refer to Appendix 3)* assessment method. Evaluation and management of air emissions from our activities should be done in consideration of the significance of point/diffuse source and cumulative impacts, taking effective measures to design and implement appropriate controls to ensure legal compliance (as a minimum) and protection of ambient air quality as it relates to the sensitive receptors.

In the absence of appropriate air quality performance limits/measures in operational licences or authorisations, due consideration should be made to align monitoring programs and performance criteria to jurisdictional or national air quality guidance standards, e.g. *Air Quality NEPM* (AUS) and *NEM: AQA* (SAF).

Program design

1 Planning

1.1 Determine and maintain records of reference and/or background ambient conditions, including meteorological characteristics affecting pollutant dispersion, for material emissions sources within the airshed.

1.2 Identify, characterise, map and document operational emission sources (risk based) using the SPR method from all sources at the operation and their method of release into the environment factoring in cumulative impacts within the airshed.

1.3 Identify and document community health hazards and environmental impacts associated with the operational emissions profile.

1.4 Undertake change management procedures to identify and assess potential impacts to the operational emissions profile (and surrounding air shed) as a result of a change in operating context (i.e. change in production volumes, operating location etc)

1.5 Develop internal criteria on ambient air quality when government regulations are absent or incomplete to ensure protection of local community health and the environment. The criteria must have formal approval from the VPO and be in line with jurisdictionally accepted regulations, guidelines and/or methodologies.

1.6 Demonstrate that, under normal and plausible worst-case operating conditions and adverse meteorological conditions, emissions from the operation will not cause sustained periods of non-conformance to the adopted air quality criteria.

2 Implementation

2.1 Implement appropriate control procedures or control technologies to manage those identified emissions sources that have the potential to cause adverse environmental or community health impacts.

2.2 Develop Trigger Action Response Plans (TARP) where appropriate, to enable response to abnormal emission and dispersion conditions and/or exceedances of air quality criteria, including immediate measures to protect community health. Exceedances of criteria should also be reported in G360 (and externally, where regulatory requirements exist) with suitable corrective actions in place.

3 Performance measurement

3.1 Implement monitoring programs to assess operating performance, verify compliance with adopted performance criteria, facilitate reporting requirements and quantify the material emissions sources that have the potential to cause adverse environmental or community health impacts, in line with the agreed program objectives.

3.2 Store and manage environmental monitoring data within EQuIS, unless authorisation is in place as per South32 Environment Standard requirements (Section 5.6).

3.3 Operate and maintain/calibrate monitoring equipment in line with manufacturer specifications and/or any relevant standards applicable to the jurisdiction. The maintenance regime should be incorporated into the site asset/work management system (e.g. SAP).

APPENDIX 5: CONTAMINATION PREDICTION AND MANAGEMENT

Scope and application

This appendix represents the minimum performance requirements with respect to the prediction and management of contamination and should be applied where there is:

- an existing or potential for contamination to lease areas or the receiving environment (herein referred to as 'contamination'), or
- where there are potential impacts from mine-site drainage, including those that may naturally occur.

The design and implementation of management approach should also consider the local/regional operating context and regulatory requirement relevant to operating jurisdiction.

Intent

The intent of these minimum performance requirements is to ensure that contamination risks for South32 projects and operations are effectively identified and managed by taking a risk-based approach and employing the *Source-Pathway-Receptor* (SPR, refer to Appendix 3) assessment method to minimise adverse environmental impacts, maintain compliance, prevent impacts to human health and reduce long-term costs and closure liabilities. The emphasis is on early identification of contamination (actual or potential), detailed analysis of the risk exposure to environment and community receptors, and implementation of fit for purpose control (management) strategies to manage the exposure.

Program design

1 Planning

1.1 Identify and assess the potential environmental contamination risks from spills associated with the transport, storage, use, transfer and disposal of hazardous materials, including failures of primary and secondary containment structures[1]. This should include the identification of 'high-risk' areas such as bulk/hazardous material storage locations and maintenance/laydown areas.

1.2 Develop and maintain a contamination lands register (or equivalent) for land currently or previously owned, leased and/or managed (including legacy sites). The register must adhere to local regulatory requirements, but as a minimum include:

- map of location and extent of existing contamination (in GIS), including location of sensitive receptors;
- a description of the wastes and/or potential contaminants of concern, impacted media (e.g. soils, sediments, groundwater, surface water) and summary of the site history where known;
- an understanding of 'natural' processes that could create, influence or exacerbate a contamination risk (e.g. acid generating potential);
- risk assessment detailing exposure risks for the environment and/or the community, including assessment of any immediate risks that may require active management; and

The register should be integrated with the site Closure Plan and associated provision (as appropriate).

1 Requirements and management of tailings storage facilities are stipulated in the South32 Dam Management Standard

1.3 Where contamination exists that poses an immediate risk to the environment or community, develop a remediation action plan (or equivalent) with level of response and timing commensurate with the risk exposure. The remediation action plan must consider local regulatory requirements, be approved by the VPO and be integrated into the life of operations plan.

2 Implementation

2.1 Develop and implement appropriate inspection regimes and spill prevention processes for the identified ‘high-risk’ areas.

2.2 Implement the activities outlined in the approved remediation action plan/s.

2.3 Update the contamination lands register (including files in GIS) at a minimum every three (3) years, or more frequently as determined by a change in operating context or following a contamination event.

2.4 Ensure that induction, general awareness and job specific training contains additional elements relating to contamination risks and how they are managed.

3 Performance measurement

3.1 Implement monitoring programs to assess performance of control and remediation measures, verify compliance, facilitate reporting requirements and track location and extent of contamination, in line with the agreed program objectives.

3.2 Store and manage environmental monitoring data within EQuIS, unless authorisation is in place as per South32 Environment Standard requirements (Section 5.6).

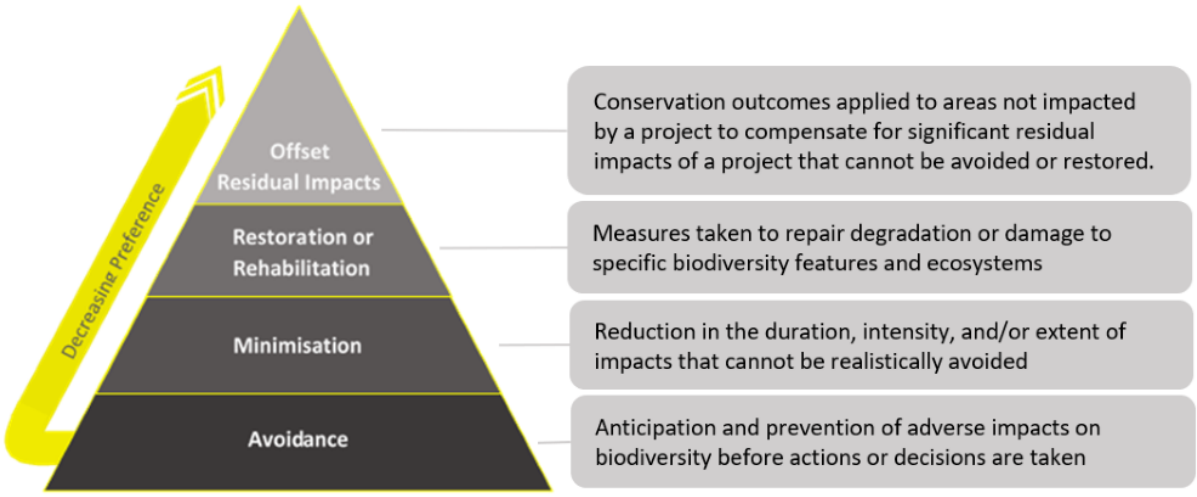
APPENDIX 6: REHABILITATION AND BIODIVERSITY MANAGEMENT

Scope and application

This appendix represents the minimum performance requirements to be applied where there is a rehabilitation and/or biodiversity related operational risk exposure, with consideration also given to the local/regional operating context and regulations.

Intent

The intent of these minimum performance requirements is to ensure that South32 maintains compliance with regulatory requirements and does not cause any long-term negative change to biodiversity values and ecosystem services[2] (including a 'no net loss' ambition within greenfields and major expansions). We aim to achieve this through application of the mitigation hierarchy for managing biodiversity related risks which comprises a sequence of four key actions:



Program Design

1 Planning

1.1 Identify the location, extent and significance of sensitive biodiversity features within the development footprint and ensure suitable buffer zones are developed, maintained and integrated into the operational planning process commensurate with the significance of the feature/s.

1.2 Understand the land use and biodiversity values within the surrounding bioregion that could be potentially impacted as a cumulative result of ours and other stakeholders' activities, with consideration also given to projected changes in the future.

1.3 Develop and integrate vegetation clearing and progressive rehabilitation plan/ activities into operational planning processes developed consistent with regulatory requirements (where they exist) with adequate consideration given to:

- storage, management and availability of rehabilitation resources (e.g. topsoil)
- final landform/characteristics (as determined in the site closure plan); and
- biodiversity offsetting requirements (where required).

1.4 Establish performance criteria for progressive rehabilitation activities that are approved by the VPO and include external stakeholder input where required.

1.5 Ensure expansions or changes in the development footprint trigger relevant biodiversity assessments (refer to Requirement 1.1) prior to disturbance. Outputs should inform changes in operational risk profile and planning/mitigation requirements, external approval processes and future biodiversity research priorities (where appropriate).

2 Implementation

2.1 Develop and implement a fit for purpose permit to clear (or equivalent) process relevant to the operational context, that considers sensitive biodiversity features and required mitigation processes commensurate with the significance of the feature and applicable legal requirements.

2.2 Execute progressive rehabilitation consistent with the approved life of operations plan, closure plan and any local regulatory requirements.

2.3 Where required, identify and execute prioritised research activities that address material knowledge gaps of biodiversity values related to operational risk profile, improve rehabilitation outcomes to enable adopted performance criteria to be met, and/or facilitate future external approval processes.

3 Performance measurement

3.1 Implement monitoring programs to assess performance against adopted rehabilitation and biodiversity criteria to manage and protect key aspects in line with the agreed program objectives.

3.2 Environmental data is to be stored and managed within EQuIS, unless authorisation is in place as per South32 Environment Standard requirements (Section 5.6).

APPENDIX 7: WATER MANAGEMENT

Scope and application

This appendix covers water management activities for all types and sources of water and must consider 'inside and outside the gate' users and stakeholders – this includes processing water for other uses, water discharged offsite or sent to third parties for treatment/discharge.

This appendix represents the minimum performance requirements with respect to water management and should be applied where there is a water related operational risk exposure with consideration also given to the local/regional operating context and regulations.

Intent

The intent of this appendix is to ensure that we achieve compliant, efficient, safe and sustainable management and protection of water resources by taking a risk-based approach and employing the Source-Pathway-Receptor (SPR, refer to Appendix 3) assessment method that address the current and future needs of ecosystems with consideration of other users within the catchments around South32 operations.

The requirements provide the basis for the development of a fit for purpose, meaningful and integrated approach to water management that ensures all legal requirements are met whilst also addressing relevant social, health, environmental, operational and economic aspects.

Program design

1 Planning

1.1 Develop and maintain a site water balance that is consistent with the Minerals Council of Australia Water Accounting Framework (MCA WAF), with verification processes in place to ensure the accuracy of the balance.

1.2 Understand the cumulative demands and impacts being placed on water resources in the catchment. This includes the current and future water requirements of other stakeholders within the catchment, and the potential impacts to water quality required to maintain ecosystem integrity and community health.

1.3 Employ change management procedures for changes to the operating context that has the potential to have a material impact on the water-related operational risk profile and/or catchment quality, function and use.

1.4 Establish (where appropriate) internal criteria on water abstraction, dewatering, discharge volumes or water quality when government regulations are insufficient to adequately protect key characteristics of the receiving environment. The criteria must have formal approval from the VPO and be in line with jurisdictionally accepted regulations, guidelines and/or methodologies.

1.5 Ensure any requirements for water related infrastructure is integrated into the life of operations plan.

2 Implementation

2.1 Implement appropriate controls to manage water related risks that have the potential to cause adverse environmental or community health impacts and assign clear responsibilities and accountabilities.

2.2 Design, construct, operate and maintain water withdrawal, storage, treatment and discharge facilities in accordance with relevant standards and local legislative requirements and ensure the design includes potential failure scenarios and its ability to handle expected flows and quality, including significant storm events with consideration of projected changes associated with climate change.

2.3 Develop Trigger Action Response Plans (TARP) where appropriate, to enable response to abnormal operating conditions (i.e. floods, droughts) and/or respond to exceedances to legal requirements, including immediate measures to protect the catchment and community health.

2.4 Progress agreed activities to support the contextual water targets/objectives (where in place) ensuring integration with the life of operations plan.

3 Performance measurement

3.1 Implement monitoring programs to assess operating performance, verify compliance with adopted performance criteria, facilitate reporting requirements and track water quality parameters that have the potential to cause adverse environmental or community health impacts, in line with the agreed program objectives.

3.2 Store and manage environmental monitoring data within EQuIS, unless authorisation is in place as per South32 Environment Standard requirements (Section 5.6).

3.3 Operate and maintain/calibrate monitoring equipment in line with manufacturer specifications and/or any relevant standards applicable to the jurisdiction. The maintenance regime should be incorporated into the site SAP work management program.

APPENDIX 8: WASTE MANAGEMENT

Scope and application

Waste reduction principles are inclusive of all forms of 'waste' generated at South32, whether hazardous or non-hazardous, mineral or non-mineral, in accordance with South32's definition of 'waste'.

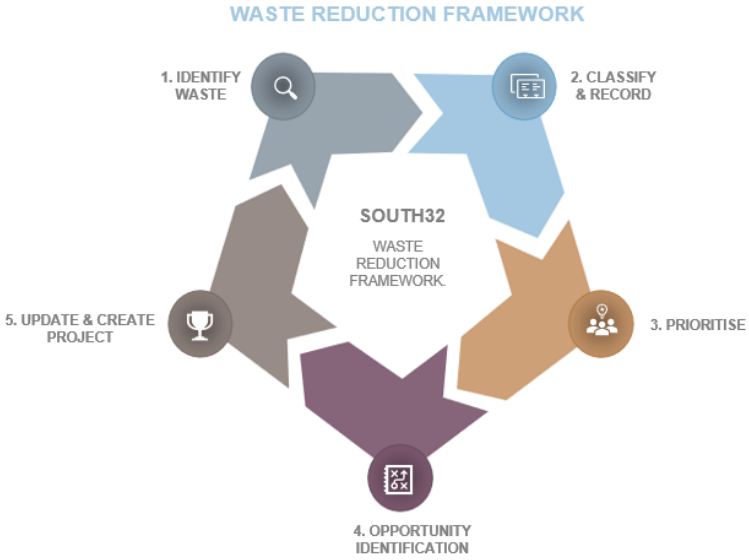
This appendix represents the minimum performance requirements with respect to waste management and should be applied where there is a waste related operational risk exposure with consideration also given to the local/regional operating context and regulations.

At South32, we define 'waste' as: *"…any discarded, rejected, unwanted, surplus or abandoned matter*".

Intent

The intent of this appendix is to ensure sound waste management principles are implemented across all South32 operations with respect to classification, management and disposal of waste. The minimum performance requirements can be complimented by the application of the Waste Reduction Framework (at the discretion of the operation) to identify and evaluate 'waste to value' opportunities.

Effective characterisation, quantification and management of our wastes and by-products ensure long term benefits to our business, society and communities in which we operate.



Program design

1 Planning

1.1 Identify, assess and document the quantities, characteristics and risks/opportunities associated with waste types generated, disposed of on-site or transported and disposed of off-site or managed on behalf of others.

1.2 Develop and maintain an inventory/register (including quantity per year and cumulative total) of wastes generated or received and disposed on or off-site.

1.3 Ensure future waste volumes and waste storage facilities[2] are adequately considered/ integrated into the business planning processes (e.g. life of operations plan).

2 Implementation

2.1 Ensure that waste streams are segregated at generation and that wastes awaiting further treatment, transport or disposal are securely contained and monitored. Persons that manage or handle hazardous waste must be appropriately trained.

2.2 Maintain operational procedures and effective controls for the safe handling, on-site and off-site transportation, storage and disposal of wastes commensurate with their degree of hazard and compatibility.

2.3 Maintain records of wastes sent off-site, and a documented inventory and location of on-site waste landfills and storage areas. Historical and abandoned landfills shall be included in this inventory and their location documented.

2.4 Disposal of waste must only be carried out in engineered and approved facilities and in accordance with established operational procedures and applicable local laws and regulations and must be deemed physically, biologically and chemically safe.

3 Performance measurement

3.1 Inspect and monitor on-site waste handling and storage facilities taking a risk-based approach commensurate with the degree of hazard of the waste. Corrective actions must be taken where unacceptable conditions are identified.

3.2 Undertake verification assessments (governance processes) of contractors and 3rd party waste facilities (used to treat and dispose of waste generated by South32) to verify that the wastes have been managed in accordance with local jurisdiction and/or specific company requirements. The type and frequency of the verification[3] assessments should be commensurate with the level of risk.

2 Requirements and management of tailings storage facilities is stipulated in the South32 Dam Management Standard

Appendix B - Hotham River Sampling Results

FOR REFERENCE ONLY, NOT TO BE USED FOR CONSTRUCTION

	Surface Level (m AHD)	Level to	Level From	To	From	Description
ASS-HA-01				0	0.9	Sandy, silty CLAY with organics. Grey, wet
ASS-HA-02				0	0.3	Sandy, silty CLAY with organics. Grey, wet
NUL-HR-TP56				0	0.2	Sand with fines and trace organics. Moist (topsoil)
				0.2	0.85	Sand. Pale grey, dry to moist.
				0.85	2.95	CLAY with trace sand. Mottled pale orange/pale grey-white/pale red, dry to moist.
NUL-HR-TP57				0	0.15	SAND with fines and trace organics. Grey, moist(topsoil)
				0.15	0.7	SAND with trace fines. Pale grey, dry to moist.
				0.7	3	CLAY with trace sand. Mottled pale orange/pale grey-white/pale red, dry to moist.
NUL-HR-TP58				0	0.25	SAND with trace fines and trace organics. Grey to brown, moist (topsoil)
				0.25	2.6	CLAY with sand. Mottled pale orange/pale grey-white/pale red, dry.
				2.6	2.9	Clayey SAND with trace gravel. Pale Orange, moist.
NUL-HR-TP66	195.412	195.412	195.162	0	0.25	Silty SAND with trace organics. Grey to brown, dry (topsoil).
		195.162	194.112	0.25	1.3	SAND with trace fines. Pale orange, moist.
		194.112	193.412	1.3	2	Clayey SAND. Pale Orange, moist to wet.
		193.412	192.412	2	3	SAND with trace fines and trace organics. Faint organic/sulphur odour. Pale grey to orange, wet.
NUL-HR-TP67	198.971	198.971	198.721	0	0.25	SAND with fines and trace organics. Grey to brown, dry (topsoil).
		198.721	198.271	0.25	0.7	SAND with trace fines. Pale grey, dry to moist.
		198.271	196.371	0.7	2.6	Clayey SAND. Pale yellow to orange, dry to moist.
		196.371	195.971	2.6	3	SAND with trace fines. Pale orange to yellow, moist.
NUL-BH15	195.244	195.244	193.594	0	1.65	FILL consisting imported basecourse material for temporary works
		193.594	193.394	1.65	1.85	TOPSOIL. Sandy clay with organics. Grey.
		193.394	192.294	1.85	2.95	Sandy CLAY. light grey to light orange.
		192.294	192.044	2.95	3.2	NO CORE
		192.044	191.744	3.2	3.5	SILTSTONE, very low strength, pale grey brown.
		191.744	191.244	3.5	4	No CORE
		191.244	191.144	4	4.1	Sandy CLAY. Grey.
		191.144	190.294	4.1	4.95	GRAVEL. Coarse gravel to cobbles. Sandy clay clasts.
		190.294	189.444	4.95	5.8	NO CORE
		189.444	189.244	5.8	6	CLAYEY SAND. Red brown.
		189.244	188.794	6	6.45	SAND with trace silt. Grey.
		188.794	188.244	6.45	7	NO CORE
		188.244	187.744	7	7.5	SAND with trace silt and clay. Red brown.
		187.744	187.294	7.5	7.95	SAND with silt and gravel . Pale grey to brown (possible extremely weathered rock).
		187.294	186.944	7.95	8.3	NO CORE
		186.944	185.794	8.3	9.45	SAND with silt and gravel. Pale grey brown (possible extremely weathered rock).
		185.794	184.944	9.45	10.3	NO CORE
		184.944	184.244	10.3	11	SAND with trace silt. Pale brown to pale grey (possible extremely weathered rock).
		184.244	183.394	11	11.85	NO CORE
		183.394	182.794	11.85	12.45	SAND with trace silt. Pale brown to pale grey (possible extremely weathered rock).
		182.794	150.244	12.45	45	extremely weathered rock, displaying as silts/clays/sands to end of hole
NUL-BH16	195.237	195.237	192.737	0	2.5	FILL consisting imported basecourse material for temporary works
		192.737	192.337	2.5	2.9	NO CORE
		192.337	191.987	2.9	3.25	SANDY CLAY with trace gravel. Pale brown and pale green grey.
		191.987	191.237	3.25	4	Clayey SAND with gravel. Orange.
		191.237	190.837	4	4.4	NO CORE
		190.837	190.287	4.4	4.95	SAND with with clay/silt and gravel. Red brown and orange brown.
		190.287	189.937	4.95	5.3	NO CORE
		189.937	189.737	5.3	5.5	SAND with clay/silt and gravel. Red brown and orange brown.
		189.737	189.487	5.5	5.75	NO CORE
		189.487	189.037	5.75	6.2	SAND with clay/silt and gravel. Red brown and orange brown.
		189.037	188.787	6.2	6.45	SAND with silt. Blue grey.
		188.787	188.337	6.45	6.9	NO CORE
		188.337	188.237	6.9	7	SAND, brown.
		188.237	187.937	7	7.3	NO CORE
		187.937	187.837	7.3	7.4	SAND with silt and trace gravel. Blue grey.
		187.837	187.637	7.4	7.6	Gravelly SAND with clay. Dark brown.
		187.637	187.287	7.6	7.95	SAND with silt and gravel. Pale grey brown, locally red brown (possible extremely weathered rock).
		187.287	186.837	7.95	8.4	NO CORE
		186.837	186.737	8.4	8.5	SAND with silt and gravel. Pale grey brown, locally red brown (possible extremely weathered rock).
		186.737	186.337	8.5	8.9	NO CORE
		186.337	185.787	8.9	9.45	SAND with silt and gravel. Pale grey brown, locally red brown (possible extremely weathered rock).
		185.787	185.287	9.45	9.95	NO CORE
		185.287	185.237	9.95	10	SAND with silt and gravel. Brown
		185.237	184.987	10	10.25	NO CORE
		184.987	184.287	10.25	10.95	SAND with silt and gravel. Pale brown to grey brown (possible extremely weathered rock).
		184.287	183.887	10.95	11.35	NO CORE
		183.887	183.737	11.35	11.5	SAND with silt and gravel, brown.
		183.737	183.287	11.5	11.95	NO CORE
		183.287	182.787	11.95	12.45	SAND with silt and gravel. Pale brown to grey brown, locally red brown (possible extremely weathered rock).
		182.787	182.287	12.45	12.95	NO CORE
		182.287	182.237	12.95	13	SAND with silt and gravel, brown.
		182.237	148.737	13	46.5	extremely weathered rock, displaying as silts/clays/sands to end of hole
	195.616	195.616	194.316	0	1.3	FILL consisting imported basecourse material for temporary works
		194.316	194.116	1.3	1.5	NO CORE
		194.116	193.666	1.5	1.95	Clayey SAND. Pale grey mottled pale orange
		193.666	192.616	1.95	3	NO CORE
		192.616	192.016	3	3.6	Sandy CLAY. Pale grey to pale orange.
		192.016	191.616	3.6	4	SILTY SAND. Pale grey to orange brown.
		191.616	191.266	4	4.35	Cemented silty sand with trace quartz gravel
		191.266	190.316	4.35	5.3	SILTY SAND. Pale grey to orange brown.
		190.316	189.466	5.3	6.15	Sandy CLAY. Pale grey to pale orange.
		189.466	188.716	6.15	6.9	SAND with trace fines. Grey brown.
		188.716	187.866	6.9	7.75	Sandy CLAY. Pale grey to pale orange.
		187.866	187.316	7.75	8.3	SAND with trace fines. Grey brown.
		187.316	186.916	8.3	8.7	SAND with gravel and trace fines, grey brown.
		186.916	186.766	8.7	8.85	NO CORE
		186.766	185.616	8.85	10	SAND with gravel and trace fines, grey brown.

NUL-BH17		185.616	185.116	10	10.5	NO CORE
		185.116	185.016	10.5	10.6	SAND with gravel and trace fines, grey brown.
		185.016	184.116	10.6	11.5	Sandy CLAY. Red brown. Firm to stiff.
		184.116	183.916	11.5	11.7	NO CORE
		183.916	183.616	11.7	12	Sandy CLAY. Red brown.
		183.616	183.166	12	12.45	CLAYEY SAND with gravel and trace fines, grey brown.
		183.166	182.966	12.45	12.65	NO CORE
		182.966	182.766	12.65	12.85	SAND
		182.766	182.466	12.85	13.15	CLAYEY SAND with gravel and trace fines, grey brown.
		182.466	182.116	13.15	13.5	NO CORE
		182.116	181.816	13.5	13.8	CLAYEY SAND with gravel and trace fines, grey brown.
		181.816	181.666	13.8	13.95	SAND with trace fines. Pale brown.
		181.666	181.416	13.95	14.2	NO CORE
		181.416	181.316	14.2	14.3	SAND
		181.316	181.016	14.3	14.6	CLAYEY SAND with gravel and trace fines, grey brown.
		181.016	176.116	14.6	19.5	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock).
		176.116	175.966	19.5	19.65	NO CORE
		175.966	167.166	19.65	28.45	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock).
		167.166	150.466	28.45	45.15	extremely weathered rock, displaying as silts/clays/sands to end of hole
NUL-BH20	193.421	193.42	193.02	0	0.4	FILL Consisting imported basecourse material for temporary works
		193.02	191.92	0.4	1.5	NO CORE
		191.92	191.27	1.5	2.15	SAND with trace clay, dark grey.
		191.27	191.12	2.15	2.3	Cemented clayey GRAVEL. Red brown.
		191.12	191.02	2.3	2.4	CLAYEY SAND, dark grey.
		191.02	190.37	2.4	3.05	Cemented clayey sandy GRAVEL/clayey gravelly SAND. Red brown.
		190.37	190.22	3.05	3.2	CLAY, grey.
		190.22	188.67	3.2	4.75	Sandy CLAY, grey.
		188.67	188.07	4.75	5.35	SAND with trace fines. Grey.
		188.07	186.97	5.35	6.45	Gravelly SAND with clay. Grey brown.
		186.97	185.87	6.45	7.55	NO CORE
		185.87	185.42	7.55	8	Gravelly SAND with clay. Grey brown
		185.42	184.42	8	9	NO CORE
		184.42	184.07	9	9.35	Gravelly SAND with clay. Grey brown.
		184.07	183.97	9.35	9.45	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		183.97	183.42	9.45	10	NO CORE
		183.42	179.42	10	14	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		179.42	178.42	14	15	NO CORE
		178.42	177.42	15	16	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		177.42	148.42	16	45	extremely weathered rock, displaying as silts/clays/sands to end of hole. Black veins noted, possible black silt (s
NUL-BH18	193.248	192.75	191.70	0.5	1.55	NO CORE
		191.70	191.25	1.55	2	SAND with trace clay, dark grey.
		191.25	190.70	2	2.55	NO CORE
		190.70	190.30	2.55	2.95	SAND with trace clay, dark grey,
		190.30	189.80	2.95	3.45	Interbedded sandy CLAY and SAND, dark grey.
		189.80	189.25	3.45	4	NO CORE
		189.25	187.95	4	5.3	SAND with trace clay, dark grey.
		187.95	186.80	5.3	6.45	Gravelly SAND with clay. Grey brown.
		186.80	186.50	6.45	6.75	NO CORE
		186.50	185.25	6.75	8	Gravelly SAND with clay. Grey brown.
		185.25	185.00	8	8.25	NO CORE
		185.00	184.25	8.25	9	Gravelly SAND with clay. Grey brown.
		184.25	182.75	9	10.5	NO CORE
		182.75	182.30	10.5	10.95	SILT/CLAY, light brown.
		182.30	181.85	10.95	11.4	NO CORE
		181.85	181.65	11.4	11.6	SILT/CLAY, light brown.
		181.65	181.35	11.6	11.9	NO CORE
		181.35	180.05	11.9	13.2	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock).
		180.05	179.75	13.2	13.5	NO CORE
		179.75	170.25	13.5	23	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		170.25	148.25	23	45	extremely weathered rock, displaying as silts/clays/sands to end of hole. Black veins noted, possible black silt (s
NUL-BH19	193.630	193.63	193.13	0	0.5	FILL Consisting imported basecourse material for temporary works
		193.13	192.53	0.5	1.1	NO CORE
		192.53	191.98	1.1	1.65	Sandy CLAY with trace organics. Dark grey.
		191.98	190.48	1.65	3.15	Sandy CLAYEY GRAVEL, grey to red brown.
		190.48	190.18	3.15	3.45	Interbedded Sandy CLAY and SAND (with clay), with trace organics. Dark grey.
		190.18	190.13	3.45	3.5	NO CORE
		190.13	189.63	3.5	4	Interbedded Sandy CLAY and SAND (with clay), with trace organics. Dark grey.
		189.63	189.13	4	4.5	NO CORE
		189.13	187.73	4.5	5.9	Interbedded Sandy CLAY and SAND (with clay), with trace organics. Dark grey
		187.73	187.18	5.9	6.45	Gravelly SAND with clay. Grey brown. Trace gravel sized pockets of black (possibly organic) material up to 5 mn
		187.18	186.33	6.45	7.3	CONGLOMERATE, red brown to pale grey.
		186.33	185.88	7.3	7.75	Gravelly SAND. Pale grey. Trace gravel sized pockets of black (possibly organic) material up to 5 mm.
		185.88	185.48	7.75	8.15	Gravelly SAND with clay. Pale grey brown. Trace gravel sized pockets of black (possibly organic) material up to 5
		185.48	184.38	8.15	9.25	SAND with trace fines, pale orange brown.
		184.38	184.18	9.25	9.45	Gravelly SAND. Pale grey to red brown. Trace gravel sized pockets of black (possibly organic) material up to 5 m
		184.18	183.13	9.45	10.5	NO CORE
		183.13	182.63	10.5	11	SILT/CLAY with trace sand. Hard. Low plasticity. Orange brown (possible extremely weathered rock). Black vei
		182.63	182.18	11	11.45	NO CORE
		182.18	181.18	11.45	12.45	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		181.18	180.93	12.45	12.7	NO CORE
		180.93	180.13	12.7	13.5	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		180.13	179.38	13.5	14.25	NO CORE
		179.38	177.88	14.25	15.75	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		177.88	148.63	15.75	45	extremely weathered rock, displaying as silts/clays/sands to end of hole. Black veins noted, possible black silt (s
NUL-HR-WS59 (ASS-BH-03)	196.161	196.16	195.61	0	0.55	Gravelly SAND with fines. Pale brown, dry to moist.
		195.61	195.06	0.55	1.1	SAND with fines and trace organics. Pale orange-brown, moist to wet.
		195.06	194.16	1.1	2	Clayey SAND with fines and trace organics. Pale orange, mottled pale red, wet.
NUL-HR-WS60 (ASS-BH-02)	192.688	192.69	192.44	0	0.25	Sandy CLAY. High organic content/sulphur odour. Dark grey-black, moist.
		192.44	192.24	0.25	0.45	SAND with trace fines and trace organics. Grey, wet.
		192.24	190.89	0.45	1.8	CLAY with sand and trace organics. Pale grey, moist.
		190.89	190.69	1.8	2	Clayey SAND. Pale grey, streaked pale red, wet.

NUL-HR-WS61 (ASS- BH-01)	195.73	195.73	195.58	0	0.15	Silty SAND with trace organics. Brown, moist to wet (topsoil).
		195.58	194.38	0.15	1.35	SAND with fines and trace organics. Pale orange-brown, wet.
		194.38	193.73	1.35	2	Clayey SAND with trace gravel. Pale orange, mottled pale red, wet.
NUL-HR-WS62	193.100	193.10	192.95	0	0.15	Silty SAND with trace organics. Grey to brown, moist (topsoil).
		192.95	192.45	0.15	0.65	Sandy CLAY with trace organics. Grey, moist.
		192.45	192.05	0.65	1.05	Clayey SAND with trace organics. Grey, wet.
		192.05	191.10	1.05	2	CLAY with sand and trace organics. Grey, moist.
NUL-HR-WS63	192.653	192.65	192.55	0	0.1	SAND with fines and trace organics. Grey to brown, moist to wet (topsoil).
		192.55	192.30	0.1	0.35	SAND with trace fines and trace organics. Pale grey to brown, wet.
		192.30	191.65	0.35	1	Sandy CLAY with trace organics and trace cemented gravel. Pale grey to mottled pale orange, dry to moist.
NUL-HR-WS64	192.911	192.91	192.76	0	0.15	SAND with fines and trace organics. Grey to brown, moist (topsoil).
		192.76	192.51	0.15	0.4	SAND with trace fines and trace organics. Pale grey to brown, wet.
		192.51	191.91	0.4	1	Sandy CLAY with trace organics and trace cemented gravel. Pale grey to mottled pale orange, dry to moist.
NUL-HR-WS65	193.512	193.51	193.26	0	0.25	Silty SAND with trace organics. Grey to brown, moist (topsoil).
		193.26	193.01	0.25	0.5	SAND with trace fines and trace organics. Pale grey to brown, moist to wet.
		193.01	192.71	0.5	0.8	Sandy CLAY with trace organics and trace cemented gravel. Pale grey to mottled pale orange, moist.
		192.71	191.76	0.8	1.75	CLAY with trace sand trace cemented gravel, and trace organics. Pale grey to mottled pale orange, dry to moist

FOR REFERENCE ONLY, NOT TO BE USED FOR CONSTRUCTION

	Surface Level (m AHD)	Level to	Level From	To	From	Description
ASS-HA-01				0	0.9	Sandy, silty CLAY with organics. Grey, wet
ASS-HA-02				0	0.3	Sandy, silty CLAY with organics. Grey, wet
NUL-HR-TP56				0	0.2	Sand with fines and trace organics. Moist (topsoil)
				0.2	0.85	Sand. Pale grey, dry to moist.
				0.85	2.95	CLAY with trace sand. Mottled pale orange/pale grey-white/pale red, dry to moist.
NUL-HR-TP57				0	0.15	SAND with fines and trace organics. Grey, moist(topsoil)
				0.15	0.7	SAND with trace fines. Pale grey, dry to moist.
				0.7	3	CLAY with trace sand. Mottled pale orange/pale grey-white/pale red, dry to moist.
NUL-HR-TP58				0	0.25	SAND with trace fines and trace organics. Grey to brown, moist (topsoil)
				0.25	2.6	CLAY with sand. Mottled pale orange/pale grey-white/pale red, dry.
				2.6	2.9	Clayey SAND with trace gravel. Pale Orange, moist.
NUL-HR-TP66	195.412	195.412	195.162	0	0.25	Silty SAND with trace organics. Grey to brown, dry (topsoil).
		195.162	194.112	0.25	1.3	SAND with trace fines. Pale orange, moist.
		194.112	193.412	1.3	2	Clayey SAND. Pale Orange, moist to wet.
		193.412	192.412	2	3	SAND with trace fines and trace organics. Faint organic/sulphur odour. Pale grey to orange, wet.
NUL-HR-TP67	198.971	198.971	198.721	0	0.25	SAND with fines and trace organics. Grey to brown, dry (topsoil).
		198.721	198.271	0.25	0.7	SAND with trace fines. Pale grey, dry to moist.
		198.271	196.371	0.7	2.6	Clayey SAND. Pale yellow to orange, dry to moist.
		196.371	195.971	2.6	3	SAND with trace fines. Pale orange to yellow, moist.
NUL-BH15	195.244	195.244	193.594	0	1.65	FILL consisting imported basecourse material for temporary works
		193.594	193.394	1.65	1.85	TOPSOIL. Sandy clay with organics. Grey.
		193.394	192.294	1.85	2.95	Sandy CLAY. light grey to light orange.
		192.294	192.044	2.95	3.2	NO CORE
		192.044	191.744	3.2	3.5	SILTSTONE, very low strength, pale grey brown.
		191.744	191.244	3.5	4	No CORE
		191.244	191.144	4	4.1	Sandy CLAY. Grey.
		191.144	190.294	4.1	4.95	GRAVEL. Coarse gravel to cobbles. Sandy clay clasts.
		190.294	189.444	4.95	5.8	NO CORE
		189.444	189.244	5.8	6	CLAYEY SAND. Red brown.
		189.244	188.794	6	6.45	SAND with trace silt. Grey.
		188.794	188.244	6.45	7	NO CORE
		188.244	187.744	7	7.5	SAND with trace silt and clay. Red brown.
		187.744	187.294	7.5	7.95	SAND with silt and gravel . Pale grey to brown (possible extremely weathered rock).
		187.294	186.944	7.95	8.3	NO CORE
		186.944	185.794	8.3	9.45	SAND with silt and gravel. Pale grey brown (possible extremely weathered rock).
		185.794	184.944	9.45	10.3	NO CORE
		184.944	184.244	10.3	11	SAND with trace silt. Pale brown to pale grey (possible extremely weathered rock).
		184.244	183.394	11	11.85	NO CORE
		183.394	182.794	11.85	12.45	SAND with trace silt. Pale brown to pale grey (possible extremely weathered rock).
		182.794	150.244	12.45	45	extremely weathered rock, displaying as silts/clays/sands to end of hole
NUL-BH16	195.237	195.237	192.737	0	2.5	FILL consisting imported basecourse material for temporary works
		192.737	192.337	2.5	2.9	NO CORE
		192.337	191.987	2.9	3.25	SANDY CLAY with trace gravel. Pale brown and pale green grey.
		191.987	191.237	3.25	4	Clayey SAND with gravel. Orange.
		191.237	190.837	4	4.4	NO CORE
		190.837	190.287	4.4	4.95	SAND with with clay/silt and gravel. Red brown and orange brown.
		190.287	189.937	4.95	5.3	NO CORE
		189.937	189.737	5.3	5.5	SAND with clay/silt and gravel. Red brown and orange brown.
		189.737	189.487	5.5	5.75	NO CORE
		189.487	189.037	5.75	6.2	SAND with clay/silt and gravel. Red brown and orange brown.
		189.037	188.787	6.2	6.45	SAND with silt. Blue grey.
		188.787	188.337	6.45	6.9	NO CORE
		188.337	188.237	6.9	7	SAND, brown.
		188.237	187.937	7	7.3	NO CORE
		187.937	187.837	7.3	7.4	SAND with silt and trace gravel. Blue grey.
		187.837	187.637	7.4	7.6	Gravelly SAND with clay. Dark brown.
		187.637	187.287	7.6	7.95	SAND with silt and gravel. Pale grey brown, locally red brown (possible extremely weathered rock).
		187.287	186.837	7.95	8.4	NO CORE
		186.837	186.737	8.4	8.5	SAND with silt and gravel. Pale grey brown, locally red brown (possible extremely weathered rock).
		186.737	186.337	8.5	8.9	NO CORE
		186.337	185.787	8.9	9.45	SAND with silt and gravel. Pale grey brown, locally red brown (possible extremely weathered rock).
		185.787	185.287	9.45	9.95	NO CORE
		185.287	185.237	9.95	10	SAND with silt and gravel. Brown
		185.237	184.987	10	10.25	NO CORE
		184.987	184.287	10.25	10.95	SAND with silt and gravel. Pale brown to grey brown (possible extremely weathered rock).
		184.287	183.887	10.95	11.35	NO CORE
		183.887	183.737	11.35	11.5	SAND with silt and gravel, brown.
		183.737	183.287	11.5	11.95	NO CORE
		183.287	182.787	11.95	12.45	SAND with silt and gravel. Pale brown to grey brown, locally red brown (possible extremely weathered rock).
		182.787	182.287	12.45	12.95	NO CORE
		182.287	182.237	12.95	13	SAND with silt and gravel, brown.
		182.237	148.737	13	46.5	extremely weathered rock, displaying as silts/clays/sands to end of hole
	195.616	195.616	194.316	0	1.3	FILL consisting imported basecourse material for temporary works
		194.316	194.116	1.3	1.5	NO CORE
		194.116	193.666	1.5	1.95	Clayey SAND. Pale grey mottled pale orange
		193.666	192.616	1.95	3	NO CORE
		192.616	192.016	3	3.6	Sandy CLAY. Pale grey to pale orange.
		192.016	191.616	3.6	4	SILTY SAND. Pale grey to orange brown.
		191.616	191.266	4	4.35	Cemented silty sand with trace quartz gravel
		191.266	190.316	4.35	5.3	SILTY SAND. Pale grey to orange brown.
		190.316	189.466	5.3	6.15	Sandy CLAY. Pale grey to pale orange.
		189.466	188.716	6.15	6.9	SAND with trace fines. Grey brown.
		188.716	187.866	6.9	7.75	Sandy CLAY. Pale grey to pale orange.
		187.866	187.316	7.75	8.3	SAND with trace fines. Grey brown.
		187.316	186.916	8.3	8.7	SAND with gravel and trace fines, grey brown.
		186.916	186.766	8.7	8.85	NO CORE
		186.766	185.616	8.85	10	SAND with gravel and trace fines, grey brown.

NUL-BH17		185.616	185.116	10	10.5	NO CORE
		185.116	185.016	10.5	10.6	SAND with gravel and trace fines, grey brown.
		185.016	184.116	10.6	11.5	Sandy CLAY. Red brown. Firm to stiff.
		184.116	183.916	11.5	11.7	NO CORE
		183.916	183.616	11.7	12	Sandy CLAY. Red brown.
		183.616	183.166	12	12.45	CLAYEY SAND with gravel and trace fines, grey brown.
		183.166	182.966	12.45	12.65	NO CORE
		182.966	182.766	12.65	12.85	SAND
		182.766	182.466	12.85	13.15	CLAYEY SAND with gravel and trace fines, grey brown.
		182.466	182.116	13.15	13.5	NO CORE
		182.116	181.816	13.5	13.8	CLAYEY SAND with gravel and trace fines, grey brown.
		181.816	181.666	13.8	13.95	SAND with trace fines. Pale brown.
		181.666	181.416	13.95	14.2	NO CORE
		181.416	181.316	14.2	14.3	SAND
		181.316	181.016	14.3	14.6	CLAYEY SAND with gravel and trace fines, grey brown.
		181.016	176.116	14.6	19.5	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock).
		176.116	175.966	19.5	19.65	NO CORE
		175.966	167.166	19.65	28.45	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock).
		167.166	150.466	28.45	45.15	extremely weathered rock, displaying as silts/clays/sands to end of hole
NUL-BH20	193.421	193.42	193.02	0	0.4	FILL Consisting imported basecourse material for temporary works
		193.02	191.92	0.4	1.5	NO CORE
		191.92	191.27	1.5	2.15	SAND with trace clay, dark grey.
		191.27	191.12	2.15	2.3	Cemented clayey GRAVEL. Red brown.
		191.12	191.02	2.3	2.4	CLAYEY SAND, dark grey.
		191.02	190.37	2.4	3.05	Cemented clayey sandy GRAVEL/clayey gravelly SAND. Red brown.
		190.37	190.22	3.05	3.2	CLAY, grey.
		190.22	188.67	3.2	4.75	Sandy CLAY, grey.
		188.67	188.07	4.75	5.35	SAND with trace fines. Grey.
		188.07	186.97	5.35	6.45	Gravelly SAND with clay. Grey brown.
		186.97	185.87	6.45	7.55	NO CORE
		185.87	185.42	7.55	8	Gravelly SAND with clay. Grey brown
		185.42	184.42	8	9	NO CORE
		184.42	184.07	9	9.35	Gravelly SAND with clay. Grey brown.
		184.07	183.97	9.35	9.45	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		183.97	183.42	9.45	10	NO CORE
		183.42	179.42	10	14	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		179.42	178.42	14	15	NO CORE
		178.42	177.42	15	16	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		177.42	148.42	16	45	extremely weathered rock, displaying as silts/clays/sands to end of hole. Black veins noted, possible black silt (s
NUL-BH18	193.248	192.75	191.70	0.5	1.55	NO CORE
		191.70	191.25	1.55	2	SAND with trace clay, dark grey.
		191.25	190.70	2	2.55	NO CORE
		190.70	190.30	2.55	2.95	SAND with trace clay, dark grey,
		190.30	189.80	2.95	3.45	Interbedded sandy CLAY and SAND, dark grey.
		189.80	189.25	3.45	4	NO CORE
		189.25	187.95	4	5.3	SAND with trace clay, dark grey.
		187.95	186.80	5.3	6.45	Gravelly SAND with clay. Grey brown.
		186.80	186.50	6.45	6.75	NO CORE
		186.50	185.25	6.75	8	Gravelly SAND with clay. Grey brown.
		185.25	185.00	8	8.25	NO CORE
		185.00	184.25	8.25	9	Gravelly SAND with clay. Grey brown.
		184.25	182.75	9	10.5	NO CORE
		182.75	182.30	10.5	10.95	SILT/CLAY, light brown.
		182.30	181.85	10.95	11.4	NO CORE
		181.85	181.65	11.4	11.6	SILT/CLAY, light brown.
		181.65	181.35	11.6	11.9	NO CORE
		181.35	180.05	11.9	13.2	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock).
		180.05	179.75	13.2	13.5	NO CORE
		179.75	170.25	13.5	23	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		170.25	148.25	23	45	extremely weathered rock, displaying as silts/clays/sands to end of hole. Black veins noted, possible black silt (s
NUL-BH19	193.630	193.63	193.13	0	0.5	FILL Consisting imported basecourse material for temporary works
		193.13	192.53	0.5	1.1	NO CORE
		192.53	191.98	1.1	1.65	Sandy CLAY with trace organics. Dark grey.
		191.98	190.48	1.65	3.15	Sandy CLAYEY GRAVEL, grey to red brown.
		190.48	190.18	3.15	3.45	Interbedded Sandy CLAY and SAND (with clay), with trace organics. Dark grey.
		190.18	190.13	3.45	3.5	NO CORE
		190.13	189.63	3.5	4	Interbedded Sandy CLAY and SAND (with clay), with trace organics. Dark grey.
		189.63	189.13	4	4.5	NO CORE
		189.13	187.73	4.5	5.9	Interbedded Sandy CLAY and SAND (with clay), with trace organics. Dark grey
		187.73	187.18	5.9	6.45	Gravelly SAND with clay. Grey brown. Trace gravel sized pockets of black (possibly organic) material up to 5 mn
		187.18	186.33	6.45	7.3	CONGLOMERATE, red brown to pale grey.
		186.33	185.88	7.3	7.75	Gravelly SAND. Pale grey. Trace gravel sized pockets of black (possibly organic) material up to 5 mm.
		185.88	185.48	7.75	8.15	Gravelly SAND with clay. Pale grey brown. Trace gravel sized pockets of black (possibly organic) material up to 5
		185.48	184.38	8.15	9.25	SAND with trace fines, pale orange brown.
		184.38	184.18	9.25	9.45	Gravelly SAND. Pale grey to red brown. Trace gravel sized pockets of black (possibly organic) material up to 5 m
		184.18	183.13	9.45	10.5	NO CORE
		183.13	182.63	10.5	11	SILT/CLAY with trace sand. Hard. Low plasticity. Orange brown (possible extremely weathered rock). Black vei
		182.63	182.18	11	11.45	NO CORE
		182.18	181.18	11.45	12.45	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		181.18	180.93	12.45	12.7	NO CORE
		180.93	180.13	12.7	13.5	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		180.13	179.38	13.5	14.25	NO CORE
		179.38	177.88	14.25	15.75	SILT/CLAY with trace sand. Orange brown (possible extremely weathered rock). Black veins noted, possible blac
		177.88	148.63	15.75	45	extremely weathered rock, displaying as silts/clays/sands to end of hole. Black veins noted, possible black silt (s
NUL-HR-WS59 (ASS-BH-03)	196.161	196.16	195.61	0	0.55	Gravelly SAND with fines. Pale brown, dry to moist.
		195.61	195.06	0.55	1.1	SAND with fines and trace organics. Pale orange-brown, moist to wet.
		195.06	194.16	1.1	2	Clayey SAND with fines and trace organics. Pale orange, mottled pale red, wet.
NUL-HR-WS60 (ASS-BH-02)	192.688	192.69	192.44	0	0.25	Sandy CLAY. High organic content/sulphur odour. Dark grey-black, moist.
		192.44	192.24	0.25	0.45	SAND with trace fines and trace organics. Grey, wet.
		192.24	190.89	0.45	1.8	CLAY with sand and trace organics. Pale grey, moist.
		190.89	190.69	1.8	2	Clayey SAND. Pale grey, streaked pale red, wet.

NUL-HR-WS61 (ASS- BH-01)	195.73	195.73	195.58	0	0.15	Silty SAND with trace organics. Brown, moist to wet (topsoil).
		195.58	194.38	0.15	1.35	SAND with fines and trace organics. Pale orange-brown, wet.
		194.38	193.73	1.35	2	Clayey SAND with trace gravel. Pale orange, mottled pale red, wet.
NUL-HR-WS62	193.100	193.10	192.95	0	0.15	Silty SAND with trace organics. Grey to brown, moist (topsoil).
		192.95	192.45	0.15	0.65	Sandy CLAY with trace organics. Grey, moist.
		192.45	192.05	0.65	1.05	Clayey SAND with trace organics. Grey, wet.
		192.05	191.10	1.05	2	CLAY with sand and trace organics. Grey, moist.
NUL-HR-WS63	192.653	192.65	192.55	0	0.1	SAND with fines and trace organics. Grey to brown, moist to wet (topsoil).
		192.55	192.30	0.1	0.35	SAND with trace fines and trace organics. Pale grey to brown, wet.
		192.30	191.65	0.35	1	Sandy CLAY with trace organics and trace cemented gravel. Pale grey to mottled pale orange, dry to moist.
NUL-HR-WS64	192.911	192.91	192.76	0	0.15	SAND with fines and trace organics. Grey to brown, moist (topsoil).
		192.76	192.51	0.15	0.4	SAND with trace fines and trace organics. Pale grey to brown, wet.
		192.51	191.91	0.4	1	Sandy CLAY with trace organics and trace cemented gravel. Pale grey to mottled pale orange, dry to moist.
NUL-HR-WS65	193.512	193.51	193.26	0	0.25	Silty SAND with trace organics. Grey to brown, moist (topsoil).
		193.26	193.01	0.25	0.5	SAND with trace fines and trace organics. Pale grey to brown, moist to wet.
		193.01	192.71	0.5	0.8	Sandy CLAY with trace organics and trace cemented gravel. Pale grey to mottled pale orange, moist.
		192.71	191.76	0.8	1.75	CLAY with trace sand trace cemented gravel, and trace organics. Pale grey to mottled pale orange, dry to moist

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Certificate of Analysis PDK1619

Client Details

Client	Calibre Professional Services One Pty Ltd
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Sample Details

Your Reference	COPP18134
Number of Samples	10 Soil
Date Samples Received	25/11/2022
Date Samples Registered	25/11/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	16/12/2022
Date of Issue	05/12/2022

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Stacey Hawkins, ASS/AMD Supervisor
Laboratory Manager	Michael Kubiak

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PDK1619-01	ASS-BH-01	1.50-1.75	Soil	24/11/2022	25/11/2022
PDK1619-02	ASS-BH-02	0.70-1.00	Soil	24/11/2022	25/11/2022
PDK1619-03	ASS-BH-02	1.50-1.75	Soil	24/11/2022	25/11/2022
PDK1619-04	ASS-BH-02	1.75-2.00	Soil	24/11/2022	25/11/2022
PDK1619-05	ASS-BH-03	0.50-0.95	Soil	24/11/2022	25/11/2022
PDK1619-06	ASS-BH-03	1.30-1.60	Soil	24/11/2022	25/11/2022
PDK1619-07	ASS-HA-01	0.00-0.30	Soil	24/11/2022	25/11/2022
PDK1619-08	ASS-HA-01	0.30-0.60	Soil	24/11/2022	25/11/2022
PDK1619-09	ASS-HA-01	0.60-0.90	Soil	24/11/2022	25/11/2022
PDK1619-10	ASS-HA-02	0.00-0.30	Soil	24/11/2022	25/11/2022

Certificate of Analysis PDK1619

Acid Sulfate Soils (Soil)

Envirolab ID	Units	PQL	PDK1619-07	PDK1619-08	PDK1619-09	PDK1619-10
Your Reference			ASS-HA-01	ASS-HA-01	ASS-HA-01	ASS-HA-02
Date Sampled			24/11/2022	24/11/2022	24/11/2022	24/11/2022
Depth			0.00-0.30	0.30-0.60	0.60-0.90	0.00-0.30
pHF (field pH test)*	pH units		6.2	7.1	7.3	6.0
pHFOX (field peroxide test)*	pH units		4.0	2.6	2.7	2.9
Reaction Rate*	-		Medium	Medium	Medium	Medium

Certificate of Analysis PDK1619

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDK1619-01	PDK1619-02	PDK1619-03	PDK1619-04	PDK1619-05
Your Reference			ASS-BH-01	ASS-BH-02	ASS-BH-02	ASS-BH-02	ASS-BH-03
Date Sampled			24/11/2022	24/11/2022	24/11/2022	24/11/2022	24/11/2022
Depth			1.50-1.75	0.70-1.00	1.50-1.75	1.75-2.00	0.50-0.95
pH KCl	pH units		5.7	5.7	5.8	5.8	6.0
TAA	moles H+/t	5.0	6.2	<5.0	5.9	<5.0	5.7
pH ox	pH units		5.8	4.8	5.5	5.0	4.5
s-TAA	% w/w S	0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	0.041	0.011	0.014	<0.0050
TPA	moles H+/t	5.0	<5.0	<5.0	<5.0	9.3	<5.0
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	26	6.6	8.7	<3.0
SHCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.013	0.047	0.020	0.021	0.0091
a-Net Acidity	moles H+/t	5.0	8.3	29	13	13	5.7
Liming rate	kg CaCO3/t	0.75	<0.75	2.2	0.94	1.0	<0.75
s-Net Acidity without ANCE	% w/w S	0.0050	0.013	0.047	0.020	0.021	0.0091
a-Net Acidity without ANCE	moles H+/t	5.0	8.3	29	13	13	5.7
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	2.2	0.94	1.0	<0.75

Envirolab ID	Units	PQL	PDK1619-06	PDK1619-07	PDK1619-08	PDK1619-09	PDK1619-10
Your Reference			ASS-BH-03	ASS-HA-01	ASS-HA-01	ASS-HA-01	ASS-HA-02
Date Sampled			24/11/2022	24/11/2022	24/11/2022	24/11/2022	24/11/2022
Depth			1.30-1.60	0.00-0.30	0.30-0.60	0.60-0.90	0.00-0.30
pH KCl	pH units		5.8	5.8	5.7	5.9	5.8
TAA	moles H+/t	5.0	8.7	14	14	11	15
pH ox	pH units		5.5	4.3	4.5	4.6	4.4
s-TAA	% w/w S	0.010	0.014	0.022	0.022	0.017	0.025
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	0.012	0.050	0.042	0.029
TPA	moles H+/t	5.0	<5.0	17	32	17	55
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	7.5	31	26	18
SHCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.014	0.034	0.072	0.059	0.053
a-Net Acidity	moles H+/t	5.0	8.7	21	45	37	33
Liming rate	kg CaCO3/t	0.75	<0.75	1.6	3.4	2.7	2.5

Certificate of Analysis PDK1619

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDK1619-06	PDK1619-07	PDK1619-08	PDK1619-09	PDK1619-10
Your Reference			ASS-BH-03	ASS-HA-01	ASS-HA-01	ASS-HA-01	ASS-HA-02
Date Sampled			24/11/2022	24/11/2022	24/11/2022	24/11/2022	24/11/2022
Depth			1.30-1.60	0.00-0.30	0.30-0.60	0.60-0.90	0.00-0.30
s-Net Acidity without ANCE	% w/w S	0.0050	0.014	0.034	0.072	0.059	0.053
a-Net Acidity without ANCE	moles H+/t	5.0	8.7	21	45	37	33
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	1.6	3.4	2.7	2.5

Method Summary

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Solids are oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.
INORG-068	Determination of Chromium Suite analysis - a sample is analysed by traditional titration method as well as ICP-OES analysis. Based on Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PDK1619

Client Details

Client	Calibre Professional Services One Pty Ltd
Your Reference	COPP18134
Date Issued	05/12/2022

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PDK1619

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
pH F | Soil	7-10	24/11/2022	25/11/2022	28/11/2022	Yes
pH FOX | Soil	7-10	24/11/2022	25/11/2022	28/11/2022	Yes
Reaction Rate | Soil	7-10	24/11/2022	25/11/2022	28/11/2022	Yes
CRS Suite | Soil	1-10	24/11/2022	28/11/2022	28/11/2022	Yes
SPOCAS | Soil	1-10	24/11/2022	28/11/2022	02/12/2022	Yes

Quality Control PDK1619

INORG-063|Acid Sulfate Soils (Soil) | Batch BDK2993

Analyte	Units	PQL	Blank	DUP1 PDK1619-07 Samp | QC | RPD %	LCS %
pHF (field pH test)	pH units			6.2 | 5.7 | 8.54	101
pHFOX (field peroxide test)	pH units			4.0 | 3.4 | 17.9	101
Reaction Rate	-			Medium | Medium | [NA]	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDK3030

Analyte	Units	PQL	Blank	DUP1 PDK1619-01 Samp | QC | RPD %	LCS %
pH ox	pH units			5.75 | 5.71 | 0.698	100
TPA	moles H+/t	5		<5.0 | <5.0 | [NA]	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDK3031

Analyte	Units	PQL	Blank	DUP1 PDK1619-01 Samp | QC | RPD %	LCS %
pH KCl	pH units		NT	5.70 | 5.80 | 1.74	98.4
TAA	moles H+/t	5.0	<5.0	6.17 | 5.40 | 13.3	106
s-TAA	% w/w S	0.010	<0.010	<0.010 | <0.010 | [NA]	[NA]
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	101
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	<3.0 | <3.0 | [NA]	[NA]
SHCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SKCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SNAS	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
a-SNAS	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-SNAS	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
Fineness Factor	-	1.5	NT	1.50 | 1.50 | 0.00	[NA]
ANCBT	% CaCO3	0.010	<0.010	NT | NT | [NA]	[NA]
a-ANCBT	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-ANCBT	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
s-Net Acidity	% w/w S	0.0050	<0.0050	0.0133 | 0.0112 | 17.4	[NA]
a-Net Acidity	moles H+/t	5.0	<5.0	8.30 | 6.96 | 17.4	[NA]
Liming rate	kg CaCO3/t	0.75	<0.75	<0.75 | <0.75 | [NA]	[NA]
s-Net Acidity without ANCE	% w/w S	0.0050	<0.0050	0.0133 | 0.0112 | 17.4	[NA]
a-Net Acidity without ANCE	moles H+/t	5.0	<5.0	8.30 | 6.96 | 17.4	[NA]
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	<0.75 | <0.75 | [NA]	[NA]

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Certificate of Analysis PDL0201

Client Details

Client	Calibre Professional Services One Pty Ltd
Contact	Fraser Daly
Address	L2, 50 St Georges Terrace, PERTH, WA, 6000

Sample Details

Your Reference	COPP18134
Number of Samples	9 Soil
Date Samples Received	05/12/2022
Date Samples Registered	05/12/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	12/12/2022
Date of Issue	06/12/2022

Authorisation Details

Results Approved By	Stacey Hawkins, ASS/AMD Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PDL0201

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PDL0201-01	NVL - BH17	3.45-3.60	Soil	02/12/2022	05/12/2022
PDL0201-02	NVL - BH17	4.40-4.50	Soil	02/12/2022	05/12/2022
PDL0201-03	NVL - BH17	5.50-5.60	Soil	02/12/2022	05/12/2022
PDL0201-04	NVL - BH17	6.30-6.40	Soil	02/12/2022	05/12/2022
PDL0201-05	NVL - BH17	7.40-7.50	Soil	02/12/2022	05/12/2022
PDL0201-06	NVL - BH17	9.00-9.45	Soil	03/12/2022	05/12/2022
PDL0201-07	NVL - BH17	9.70-9.75	Soil	03/12/2022	05/12/2022
PDL0201-08	NVL - BH17	12.70-12.75	Soil	03/12/2022	05/12/2022
PDL0201-09	NVL - BH17	13.50-13.15	Soil	03/12/2022	05/12/2022

Certificate of Analysis PDL0201

Acid Sulfate Soils (Soil)

Envirolab ID	Units	PQL	PDL0201-01	PDL0201-02	PDL0201-03	PDL0201-04	PDL0201-05
Your Reference			NVL - BH17	NVL - BH17	NVL - BH17	NVL - BH17	NVL - BH17
Date Sampled			02/12/2022	02/12/2022	02/12/2022	02/12/2022	02/12/2022
Depth			3.45-3.60	4.40-4.50	5.50-5.60	6.30-6.40	7.40-7.50
pHF (field pH test)*	pH units		6.4	0.6	9.0	6.9	6.4
pHFOX (field peroxide test)*	pH units		5.5	4.9	4.8	2.2	2.8
Reaction Rate*	-		High	Low	Low	Low	Low

Envirolab ID	Units	PQL	PDL0201-06	PDL0201-07	PDL0201-08	PDL0201-09
Your Reference			NVL - BH17	NVL - BH17	NVL - BH17	NVL - BH17
Date Sampled			03/12/2022	03/12/2022	03/12/2022	03/12/2022
Depth			9.00-9.45	9.70-9.75	12.70-12.75	13.50-13.15
pHF (field pH test)*	pH units		6.6	6.6	7.0	6.5
pHFOX (field peroxide test)*	pH units		4.7	3.2	4.8	5.0
Reaction Rate*	-		Low	Low	Low	Low

Method Summary

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Solids are oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PDL0201

Client Details

Client	Calibre Professional Services One Pty Ltd
Your Reference	COPP18134
Date Issued	06/12/2022

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PDL0201

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
pH F | Soil	1-5	02/12/2022	05/12/2022	05/12/2022	No
	6-9	03/12/2022	05/12/2022	05/12/2022	No
pH FOX | Soil	1-5	02/12/2022	05/12/2022	05/12/2022	No
	6-9	03/12/2022	05/12/2022	05/12/2022	No
Reaction Rate | Soil	1-5	02/12/2022	05/12/2022	05/12/2022	Yes
	6-9	03/12/2022	05/12/2022	05/12/2022	Yes

Quality Control PDL0201

INORG-063|Acid Sulfate Soils (Soil) | Batch BDL0524

Analyte	Units	PQL	Blank	DUP1 PDL0201-01 Samp | QC | RPD %	LCS %
pHF (field pH test)	pH units			6.4 | 6.7 | 3.80	100
pHFOX (field peroxide test)	pH units			5.5 | 5.8 | 5.48	100
Reaction Rate	-			High | High | [NA]	[NA]

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Certificate of Analysis PDL0201

Client Details

Client	Calibre Professional Services One Pty Ltd
Contact	Fraser Daly
Address	L2, 50 St Georges Terrace, PERTH, WA, 6000

Sample Details

Your Reference	COPP18134
Number of Samples	9 Soil
Date Instructions Received	06/12/2022
Date Samples Registered	05/12/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	20/12/2022
Date of Reissue	15/12/2022 - This report supercedes previous report, see amendment history for details

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Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Stacey Hawkins, ASS/AMD Supervisor
Laboratory Manager	Michael Kubiak

Report Amendment History

Revision	Reason for Amendment
R-01	Additional analysis requested 6-12-22

Certificate of Analysis PDL0201

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PDL0201-01	NVL - BH17	3.45-3.60	Soil	02/12/2022	05/12/2022
PDL0201-02	NVL - BH17	4.40-4.50	Soil	02/12/2022	05/12/2022
PDL0201-03	NVL - BH17	5.50-5.60	Soil	02/12/2022	05/12/2022
PDL0201-04	NVL - BH17	6.30-6.40	Soil	02/12/2022	05/12/2022
PDL0201-05	NVL - BH17	7.40-7.50	Soil	02/12/2022	05/12/2022
PDL0201-06	NVL - BH17	9.00-9.45	Soil	03/12/2022	05/12/2022
PDL0201-07	NVL - BH17	9.70-9.75	Soil	03/12/2022	05/12/2022
PDL0201-08	NVL - BH17	12.70-12.75	Soil	03/12/2022	05/12/2022
PDL0201-09	NVL - BH17	13.50-13.15	Soil	03/12/2022	05/12/2022

Certificate of Analysis PDL0201

Acid Sulfate Soils (Soil)

Envirolab ID	Units	PQL	PDL0201-01	PDL0201-02	PDL0201-03	PDL0201-04	PDL0201-05
Your Reference			NVL - BH17	NVL - BH17	NVL - BH17	NVL - BH17	NVL - BH17
Date Sampled			02/12/2022	02/12/2022	02/12/2022	02/12/2022	02/12/2022
Depth			3.45-3.60	4.40-4.50	5.50-5.60	6.30-6.40	7.40-7.50
pHF (field pH test)*	pH units		6.4	0.6	9.0	6.9	6.4
pHFOX (field peroxide test)*	pH units		5.5	4.9	4.8	2.2	2.8
Reaction Rate*	-		High	Low	Low	Low	Low

Envirolab ID	Units	PQL	PDL0201-06	PDL0201-07	PDL0201-08	PDL0201-09
Your Reference			NVL - BH17	NVL - BH17	NVL - BH17	NVL - BH17
Date Sampled			03/12/2022	03/12/2022	03/12/2022	03/12/2022
Depth			9.00-9.45	9.70-9.75	12.70-12.75	13.50-13.15
pHF (field pH test)*	pH units		6.6	6.6	7.0	6.5
pHFOX (field peroxide test)*	pH units		4.7	3.2	4.8	5.0
Reaction Rate*	-		Low	Low	Low	Low

Certificate of Analysis PDL0201

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDL0201-01	PDL0201-04	PDL0201-07
Your Reference			NVL - BH17	NVL - BH17	NVL - BH17
Date Sampled			02/12/2022	02/12/2022	03/12/2022
Depth			3.45-3.60	6.30-6.40	9.70-9.75
pH KCl	pH units		5.9	5.8	5.6
TAA	moles H+/t	5.0	13	11	17
pH ox	pH units		6.4	5.5	5.9
s-TAA	% w/w S	0.010	0.020	0.018	0.027
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	0.012	0.010
TPA	moles H+/t	5.0	<5.0	<5.0	7.8
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	7.4	6.5
SHCl	% w/w S	0.0050	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.020	0.030	0.038
a-Net Acidity	moles H+/t	5.0	13	19	24
Liming rate	kg CaCO3/t	0.75	0.96	1.4	1.8
s-Net Acidity without ANCE	% w/w S	0.0050	0.020	0.030	0.038
a-Net Acidity without ANCE	moles H+/t	5.0	13	19	24
Liming rate without ANCE	kg CaCO3/t	0.75	0.96	1.4	1.8

Method Summary

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Solids are oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.
INORG-068	Determination of Chromium Suite analysis - a sample is analysed by traditional titration method as well as ICP-OES analysis. Based on Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PDL0201

Client Details

Client	Calibre Professional Services One Pty Ltd
Your Reference	COPP18134
Date Issued	15/12/2022

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PDL0201

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
pH F | Soil	1-5	02/12/2022	05/12/2022	05/12/2022	No
	6-9	03/12/2022	05/12/2022	05/12/2022	No
pH FOX | Soil	1-5	02/12/2022	05/12/2022	05/12/2022	No
	6-9	03/12/2022	05/12/2022	05/12/2022	No
Reaction Rate | Soil	1-5	02/12/2022	05/12/2022	05/12/2022	Yes
	6-9	03/12/2022	05/12/2022	05/12/2022	Yes
CRS Suite | Soil	1, 4	02/12/2022	07/12/2022	07/12/2022	Yes
	7	03/12/2022	07/12/2022	07/12/2022	Yes
SPOCAS | Soil	1, 4	02/12/2022	07/12/2022	15/12/2022	Yes
	7	03/12/2022	07/12/2022	15/12/2022	Yes

Quality Control PDL0201

INORG-063|Acid Sulfate Soils (Soil) | Batch BDL0524

Analyte	Units	PQL	Blank	DUP1 PDL0201-01 Samp | QC | RPD %	LCS %
pHF (field pH test)	pH units			6.4 | 6.7 | 3.80	100
pHFOX (field peroxide test)	pH units			5.5 | 5.8 | 5.48	100
Reaction Rate	-			High | High | [NA]	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDL0752

Analyte	Units	PQL	Blank	DUP1 PDL0201-01 Samp | QC | RPD %	LCS %
pH KCl	pH units		NT	5.91 | 5.83 | 1.36	93.9
TAA	moles H+/t	5.0	<5.0	12.6 | 11.2 | 12.5	107
s-TAA	% w/w S	0.010	<0.010	0.0203 | 0.0179 | 12.5	[NA]
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	101
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	<3.0 | <3.0 | [NA]	[NA]
SHCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SKCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SNAS	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
a-SNAS	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-SNAS	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
Fineness Factor	-	1.5	NT	1.50 | 1.50 | 0.00	[NA]
ANCBT	% CaCO3	0.010	<0.010	NT | NT | [NA]	[NA]
a-ANCBT	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-ANCBT	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
s-Net Acidity	% w/w S	0.0050	<0.0050	0.0205 | 0.0181 | 12.4	[NA]
a-Net Acidity	moles H+/t	5.0	<5.0	12.8 | 11.3 | 12.4	[NA]
Liming rate	kg CaCO3/t	0.75	<0.75	0.957 | 0.846 | 12.4	[NA]
s-Net Acidity without ANCE	% w/w S	0.0050	<0.0050	0.0205 | 0.0181 | 12.4	[NA]
a-Net Acidity without ANCE	moles H+/t	5.0	<5.0	12.8 | 11.3 | 12.4	[NA]
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	0.957 | 0.846 | 12.4	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDL0753

Analyte	Units	PQL	Blank	DUP1 PDL0201-01 Samp | QC | RPD %	LCS %
pH ox	pH units			6.40 | 6.40 | 0.00	97.1
TPA	moles H+/t	5		<5.0 | <5.0 | [NA]	[NA]

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www.mpl.com.au

Certificate of Analysis PDL0635

Client Details

Client	Calibre Professional Services One Pty Ltd
Contact	Fraser Daly
Address	L2, 50 St Georges Terrace, PERTH, WA, 6000

Sample Details

Your Reference	COPP18134
Number of Samples	10 Soil
Date Samples Received	09/12/2022
Date Samples Registered	09/12/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	16/12/2022
Date of Issue	15/12/2022

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Stacey Hawkins, ASS/AMD Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PDL0635

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PDL0635-01	NUL-HR-56	0.25	Soil	08/12/2022	09/12/2022
PDL0635-02	NUL-HR-56	2.00	Soil	08/12/2022	09/12/2022
PDL0635-03	NUL-HR-57	1.00	Soil	08/12/2022	09/12/2022
PDL0635-04	NUL-HR-57	2.75	Soil	08/12/2022	09/12/2022
PDL0635-05	NUL-HR-57	3.00	Soil	08/12/2022	09/12/2022
PDL0635-06	NUL-HR-58	0.50	Soil	08/12/2022	09/12/2022
PDL0635-07	NUL-HR-58	2.00	Soil	08/12/2022	09/12/2022
PDL0635-08	NUL-HR-66	0.75	Soil	08/12/2022	09/12/2022
PDL0635-09	NUL-HR-66	2.25	Soil	08/12/2022	09/12/2022
PDL0635-10	NUL-HR-67	1.25	Soil	08/12/2022	09/12/2022

Sample Comments

NUL-HR-57	Depth on bag labelled: "1.25"
NUL-HR-66	Depth on bag labelled: "2.5"

Certificate of Analysis PDL0635

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDL0635-01	PDL0635-02	PDL0635-03	PDL0635-04	PDL0635-05
Your Reference			NUL-HR-56	NUL-HR-56	NUL-HR-57	NUL-HR-57	NUL-HR-57
Date Sampled			08/12/2022	08/12/2022	08/12/2022	08/12/2022	08/12/2022
Depth			0.25	2.00	1.00	2.75	3.00
pH KCl	pH units		5.9	5.4	5.4	5.4	5.4
TAA	moles H+/t	5.0	16	21	31	32	33
pH ox	pH units		4.1	5.7	5.0	5.4	5.4
s-TAA	% w/w S	0.010	0.026	0.033	0.050	0.051	0.053
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	<0.0050	<0.0050	0.022	<0.0050
TPA	moles H+/t	5.0	<5.0	10	23	19	16
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	<3.0	<3.0	14	<3.0
SHCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.025	0.033	0.050	0.073	0.054
a-Net Acidity	moles H+/t	5.0	16	21	31	46	34
Liming rate	kg CaCO3/t	0.75	1.2	1.5	2.3	3.4	2.5
s-Net Acidity without ANCE	% w/w S	0.0050	0.025	0.033	0.050	0.073	0.054
a-Net Acidity without ANCE	moles H+/t	5.0	16	21	31	46	34
Liming rate without ANCE	kg CaCO3/t	0.75	1.2	1.5	2.3	3.4	2.5

Envirolab ID	Units	PQL	PDL0635-06	PDL0635-07	PDL0635-08	PDL0635-09	PDL0635-10
Your Reference			NUL-HR-58	NUL-HR-58	NUL-HR-66	NUL-HR-66	NUL-HR-67
Date Sampled			08/12/2022	08/12/2022	08/12/2022	08/12/2022	08/12/2022
Depth			0.50	2.00	0.75	2.25	1.25
pH KCl	pH units		5.4	5.5	5.6	5.8	5.6
TAA	moles H+/t	5.0	22	18	15	7.9	15
pH ox	pH units		5.3	5.6	5.5	6.0	5.7
s-TAA	% w/w S	0.010	0.035	0.029	0.024	0.013	0.024
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
TPA	moles H+/t	5.0	10	<5.0	<5.0	<5.0	5.2
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SHCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.034	0.033	0.024	0.015	0.026
a-Net Acidity	moles H+/t	5.0	21	21	15	9.1	16
Liming rate	kg CaCO3/t	0.75	1.6	1.6	1.1	<0.75	1.2

Certificate of Analysis PDL0635

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDL0635-06	PDL0635-07	PDL0635-08	PDL0635-09	PDL0635-10
Your Reference			NUL-HR-58	NUL-HR-58	NUL-HR-66	NUL-HR-66	NUL-HR-67
Date Sampled			08/12/2022	08/12/2022	08/12/2022	08/12/2022	08/12/2022
Depth			0.50	2.00	0.75	2.25	1.25
s-Net Acidity without ANCE	% w/w S	0.0050	0.034	0.033	0.024	0.015	0.026
a-Net Acidity without ANCE	moles H+/t	5.0	21	21	15	9.1	16
Liming rate without ANCE	kg CaCO3/t	0.75	1.6	1.6	1.1	<0.75	1.2

Method Summary

Method ID	Methodology Summary
INORG-068	Determination of Chromium Suite analysis - a sample is analysed by traditional titration method as well as ICP-OES analysis. Based on Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
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PQL	Practical Quantitation Limit
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Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

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A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PDL0635

Client Details

Client	Calibre Professional Services One Pty Ltd
Your Reference	COPP18134
Date Issued	15/12/2022

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PDL0635

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
CRS Suite | Soil	1-10	08/12/2022	12/12/2022	12/12/2022	Yes
SPOCAS | Soil	1-10	08/12/2022	12/12/2022	15/12/2022	Yes

Quality Control PDL0635

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDL1215

Analyte	Units	PQL	Blank	DUP1 PDL0635-01 Samp | QC | RPD %	LCS %
pH KCl	pH units		NT	5.86 | 5.76 | 1.72	93.9
TAA	moles H+/t	5.0	<5.0	16.1 | 15.9 | 1.55	107
s-TAA	% w/w S	0.010	<0.010	0.0258 | 0.0254 | 1.55	[NA]
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	101
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	<3.0 | <3.0 | [NA]	[NA]
SHCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SKCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SNAS	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
a-SNAS	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-SNAS	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
Fineness Factor	-	1.5	NT	1.50 | 1.50 | 0.00	[NA]
ANCBT	% CaCO3	0.010	<0.010	NT | NT | [NA]	[NA]
a-ANCBT	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-ANCBT	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
s-Net Acidity	% w/w S	0.0050	<0.0050	0.0255 | 0.0254 | 0.139	[NA]
a-Net Acidity	moles H+/t	5.0	<5.0	15.9 | 15.9 | 0.139	[NA]
Liming rate	kg CaCO3/t	0.75	<0.75	1.19 | 1.19 | 0.139	[NA]
s-Net Acidity without ANCE	% w/w S	0.0050	<0.0050	0.0255 | 0.0254 | 0.139	[NA]
a-Net Acidity without ANCE	moles H+/t	5.0	<5.0	15.9 | 15.9 | 0.139	[NA]
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	1.19 | 1.19 | 0.139	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDL1216

Analyte	Units	PQL	Blank	DUP1 PDL0635-01 Samp | QC | RPD %	LCS %
pH ox	pH units			4.12 | 4.16 | 0.966	97.1
TPA	moles H+/t	5		<5.0 | <5.0 | [NA]	[NA]

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Certificate of Analysis PDL1070

Client Details

Client	Calibre Professional Services One Pty Ltd
Contact	Fraser Daly
Address	L2, 50 St Georges Terrace, PERTH, WA, 6000

Sample Details

Your Reference	COPP18134
Number of Samples	30 Soil, 1 Water
Date Instructions Received	05/01/2023
Date Samples Registered	15/12/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	13/01/2023
Date of Reissue	12/01/2023 - This report supercedes previous report, see amendment history for details

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Authorisation Details

Results Approved By	Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Hall, Inorganics & Metals Supervisor Michael Mowle, Inorganics Supervisor Stacey Hawkins, ASS/AMD Supervisor
Laboratory Manager	Michael Kubiak

Report Amendment History

Revision	Reason for Amendment
R-01	Additional analysis requested 5-1-23

Certificate of Analysis PDL1070

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PDL1070-01	NUL-BH18	3.40	Soil	14/12/2022	13/01/2023
PDL1070-02	NUL-BH18	7.90	Soil	14/12/2022	13/01/2023
PDL1070-03	NUL-BH18	7.50	Soil	14/12/2022	13/01/2023
PDL1070-04	NUL-BH18	8.50	Soil	14/12/2022	13/01/2023
PDL1070-05	NUL-BH18	5.60	Soil	14/12/2022	13/01/2023
PDL1070-06	NUL-BH18	4.70	Soil	14/12/2022	13/01/2023
PDL1070-07	NUL-BH18	1.70	Soil	14/12/2022	13/01/2023
PDL1070-08	NUL-HR-WS62	0.25	Soil	14/12/2022	13/01/2023
PDL1070-09	NUL-HR-WS62	0.50	Soil	14/12/2022	13/01/2023
PDL1070-10	NUL-HR-WS62	0.75	Soil	14/12/2022	13/01/2023
PDL1070-11	NUL-HR-WS62	1.00	Soil	14/12/2022	13/01/2023
PDL1070-12	NUL-HR-WS62	1.25	Soil	14/12/2022	13/01/2023
PDL1070-13	NUL-HR-WS62	1.50	Soil	14/12/2022	13/01/2023
PDL1070-14	NUL-HR-WS62	1.75	Soil	14/12/2022	13/01/2023
PDL1070-15	NUL-HR-WS62	2.00	Soil	14/12/2022	13/01/2023
PDL1070-16	NUL-HR-WS63	0.25	Soil	14/12/2022	13/01/2023
PDL1070-17	NUL-HR-WS63	0.50	Soil	14/12/2022	13/01/2023
PDL1070-18	NUL-HR-WS63	0.75	Soil	14/12/2022	13/01/2023
PDL1070-19	NUL-HR-WS63	1.00	Soil	14/12/2022	13/01/2023
PDL1070-20	NUL-HR-WS64	0.25	Soil	14/12/2022	13/01/2023
PDL1070-21	NUL-HR-WS64	0.50	Soil	14/12/2022	13/01/2023
PDL1070-22	NUL-HR-WS64	0.75	Soil	14/12/2022	13/01/2023
PDL1070-23	NUL-HR-WS64	1.00	Soil	14/12/2022	13/01/2023
PDL1070-24	NUL-HR-WS65	0.25	Soil	14/12/2022	13/01/2023
PDL1070-25	NUL-HR-WS65	0.50	Soil	14/12/2022	13/01/2023
PDL1070-26	NUL-HR-WS65	0.75	Soil	14/12/2022	13/01/2023
PDL1070-27	NUL-HR-WS65	1.00	Soil	14/12/2022	13/01/2023
PDL1070-28	NUL-HR-WS65	1.25	Soil	14/12/2022	13/01/2023
PDL1070-29	NUL-HR-WS65	1.50	Soil	14/12/2022	13/01/2023
PDL1070-30	NUL-HR-WS65	1.75	Soil	14/12/2022	13/01/2023
PDL1070-31	NUL-HR-WS60		Water	14/12/2022	13/01/2023

Acid Extractable Metals (Water)

Envirolab ID	Units	PQL	PDL1070-31
Your Reference			NUL-HR-WS60
Date Sampled			14/12/2022
Phosphorus	mg/L	0.050	2.6

Acid Extractable Low Level Metals (Water)

Envirolab ID	Units	PQL	PDL1070-31
Your Reference			NUL-HR-WS60
Date Sampled			14/12/2022
Aluminium	µg/L	10	470000
Iron	µg/L	10	430000

Dissolved Metals (Water)

Envirolab ID	Units	PQL	PDL1070-31
Your Reference			NUL-HR-WS60
Date Sampled			14/12/2022
Calcium	mg/L	0.50	38
Magnesium	mg/L	0.50	82
Potassium	mg/L	0.50	6.9
Sodium	mg/L	0.50	520
Hardness as CaCO3	mg/L	3.0	430

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Dissolved Low Level Metals (Water)

Envirolab ID	Units	PQL	PDL1070-31
Your Reference			NUL-HR-WS60
Date Sampled			14/12/2022
Aluminium	µg/L	10	32
Arsenic	µg/L	1.0	1.5
Cadmium	µg/L	0.10	<0.10
Chromium	µg/L	1.0	1.7
Iron	µg/L	10	23000
Manganese	µg/L	1.0	1600
Nickel	µg/L	1.0	4.4
Selenium	µg/L	1.0	1.3
Zinc	µg/L	1.0	4.7

Inorganics (Water)

Envirolab ID	Units	PQL	PDL1070-31
Your Reference			NUL-HR-WS60
Date Sampled			14/12/2022
Acidity	mg/L	5.0	33
Ammonia as N	mg/L	0.0050	0.60
Chloride	mg/L	1.0	580
Electrical Conductivity	µS/cm	2.0	3400
Total Nitrogen	mg/L	0.10	48
pH	pH units		6.6
Sulfate	mg/L	1.0	37
Total Dissolved Solids	mg/L	5.0	2100
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	150
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	150

Acid Sulfate Soils (Soil)

Envirolab ID	Units	PQL	PDL1070-01	PDL1070-02	PDL1070-03	PDL1070-04	PDL1070-05
Your Reference			NUL-BH18	NUL-BH18	NUL-BH18	NUL-BH18	NUL-BH18
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			3.40	7.90	7.50	8.50	5.60
pHF (field pH test)*	pH units		6.5	6.4	6.4	6.2	6.4
pHFOX (field peroxide test)*	pH units		2.6	5.6	5.4	4.0	2.7
Reaction Rate*	-		Low	High	High	Low	Volcanic

Envirolab ID	Units	PQL	PDL1070-06	PDL1070-07	PDL1070-08	PDL1070-09	PDL1070-10
Your Reference			NUL-BH18	NUL-BH18	NUL-HR-WS62	NUL-HR-WS62	NUL-HR-WS62
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			4.70	1.70	0.25	0.50	0.75
pHF (field pH test)*	pH units		6.5	6.0	6.9	6.9	7.1
pHFOX (field peroxide test)*	pH units		2.5	2.4	3.8	4.6	4.1
Reaction Rate*	-		Extreme	Low	Medium	Medium	Medium

Envirolab ID	Units	PQL	PDL1070-11	PDL1070-12	PDL1070-13	PDL1070-14	PDL1070-15
Your Reference			NUL-HR-WS62	NUL-HR-WS62	NUL-HR-WS62	NUL-HR-WS62	NUL-HR-WS62
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			1.00	1.25	1.50	1.75	2.00
pHF (field pH test)*	pH units		6.7	6.3	6.6	6.7	6.8
pHFOX (field peroxide test)*	pH units		3.2	3.3	4.2	4.0	3.7
Reaction Rate*	-		Volcanic	High	Medium	High	Extreme

Envirolab ID	Units	PQL	PDL1070-16	PDL1070-17	PDL1070-18	PDL1070-19	PDL1070-20
Your Reference			NUL-HR-WS63	NUL-HR-WS63	NUL-HR-WS63	NUL-HR-WS63	NUL-HR-WS64
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			0.25	0.50	0.75	1.00	0.25
pHF (field pH test)*	pH units		6.6	7.0	7.3	7.5	7.7
pHFOX (field peroxide test)*	pH units		3.6	6.8	6.6	7.5	4.9
Reaction Rate*	-		Medium	Volcanic	Volcanic	High	Low

Envirolab ID	Units	PQL	PDL1070-21	PDL1070-22	PDL1070-23	PDL1070-24	PDL1070-25
Your Reference			NUL-HR-WS64	NUL-HR-WS64	NUL-HR-WS64	NUL-HR-WS65	NUL-HR-WS65
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			0.50	0.75	1.00	0.25	0.50
pHF (field pH test)*	pH units		7.0	7.0	7.0	7.6	7.0
pHFOX (field peroxide test)*	pH units		4.2	6.4	6.4	5.6	6.4
Reaction Rate*	-		Extreme	Volcanic	Volcanic	Low	Extreme

Envirolab ID	Units	PQL	PDL1070-26	PDL1070-27	PDL1070-28	PDL1070-29	PDL1070-30
Your Reference			NUL-HR-WS65	NUL-HR-WS65	NUL-HR-WS65	NUL-HR-WS65	NUL-HR-WS65
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			0.75	1.00	1.25	1.50	1.75
pHF (field pH test)*	pH units		7.3	7.0	6.9	7.7	7.5
pHFOX (field peroxide test)*	pH units		3.5	4.6	6.1	7.4	6.8
Reaction Rate*	-		Extreme	Low	High	Extreme	Extreme

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDL1070-01	PDL1070-03	PDL1070-04	PDL1070-05	PDL1070-06
Your Reference			NUL-BH18	NUL-BH18	NUL-BH18	NUL-BH18	NUL-BH18
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			3.40	7.50	8.50	5.60	4.70
pH KCl	pH units		5.6	5.4	5.4	5.6	5.7
TAA	moles H+/t	5.0	12	15	13	12	11
pH ox	pH units		5.4	6.5	6.0	4.4	4.7
s-TAA	% w/w S	0.010	0.019	0.025	0.022	0.018	0.017
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	0.0060	<0.0050	0.085	0.040
TPA	moles H+/t	5.0	<5.0	<5.0	9.4	35	59
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	3.7	<3.0	53	25
SHCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.024	0.031	0.026	0.10	0.057
a-Net Acidity	moles H+/t	5.0	15	19	16	64	36
Liming rate	kg CaCO3/t	0.75	1.1	1.4	1.2	4.8	2.7
s-Net Acidity without ANCE	% w/w S	0.0050	0.024	0.031	0.026	0.10	0.057
a-Net Acidity without ANCE	moles H+/t	5.0	15	19	16	64	36
Liming rate without ANCE	kg CaCO3/t	0.75	1.1	1.4	1.2	4.8	2.7

Envirolab ID	Units	PQL	PDL1070-11	PDL1070-15	PDL1070-18	PDL1070-21	PDL1070-26
Your Reference			NUL-HR-WS62	NUL-HR-WS62	NUL-HR-WS63	NUL-HR-WS64	NUL-HR-WS65
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			1.00	2.00	0.75	0.50	0.75
pH KCl	pH units		5.9	5.5	5.8	5.7	5.6
TAA	moles H+/t	5.0	8.2	20	8.4	15	12
pH ox	pH units		4.6	4.9	6.4	5.9	5.4
s-TAA	% w/w S	0.010	0.013	0.032	0.013	0.024	0.019
Chromium Reducible Sulfur	% w/w	0.0050	0.015	0.053	0.0060	<0.0050	0.020
TPA	moles H+/t	5.0	<5.0	31	<5.0	6.5	5.8
a-Chromium Reducible Sulfur	moles H+/t	3.0	9.2	33	3.7	<3.0	12
SHCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	NT	NT	NT	NT	NT
a-ANCBT	moles H+/t	5.0	NT	NT	NT	NT	NT
s-ANCBT	% w/w S	0.010	NT	NT	NT	NT	NT
s-Net Acidity	% w/w S	0.0050	0.028	0.084	0.019	0.027	0.039
a-Net Acidity	moles H+/t	5.0	17	53	12	17	24
Liming rate	kg CaCO3/t	0.75	1.3	3.9	0.91	1.3	1.8

Chromium Reducible Sulfur Suite (Soil)

Envirolab ID	Units	PQL	PDL1070-11	PDL1070-15	PDL1070-18	PDL1070-21	PDL1070-26
Your Reference			NUL-HR-WS62	NUL-HR-WS62	NUL-HR-WS63	NUL-HR-WS64	NUL-HR-WS65
Date Sampled			14/12/2022	14/12/2022	14/12/2022	14/12/2022	14/12/2022
Depth			1.00	2.00	0.75	0.50	0.75
s-Net Acidity without ANCE	% w/w S	0.0050	0.028	0.084	0.019	0.027	0.039
a-Net Acidity without ANCE	moles H+/t	5.0	17	53	12	17	24
Liming rate without ANCE	kg CaCO3/t	0.75	1.3	3.9	0.91	1.3	1.8

Method Summary

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode based on APHA latest edition, Method 4500-H+. Please note that the results for water analyses are indicative only, as analysis can be completed outside of the APHA recommended holding times. Solids are reported from a 1:5 water extract unless otherwise specified. Alternatively, pH is determined in a 1:5 extract using 0.01M calcium chloride or a solid is extracted at a ratio of 1:2.5 (AS1289.4.3.1), pH is measured in the extract.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soil results reported from a 1:5 Soil:Water extract unless otherwise specified. Please note Resistivity is estimated by calculation and may not correlate with results otherwise obtained using the Resistivity current method (based on AS 1289.4.4.1), depending on the nature of the soil being analysed.
INORG-005	Acidity - determined by titration based on APHA latest edition 2310 B. Solids reported from a 1:5 water extract unless otherwise specified. Free Carbon Dioxide - determined titrimetrically in accordance with APHA latest edition,4500-CO2 C.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition 2320-B. Solids reported from a 1:5 water extract unless otherwise specified. Total Carbon Dioxide - determined by calculation in accordance with APHA latest edition,4500-CO2 D.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±10°C.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-063	pH- measured using pH meter and electrode. Solids are oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.
INORG-068	Determination of Chromium Suite analysis - a sample is analysed by traditional titration method as well as ICP-OES analysis. Based on Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.
INORG-081	Anions determined by Ion Chromatography. Waters samples are filtered on receipt prior to analysis. Solids are analysed from a water extract. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES.
METALS-022	Determination of various metals by ICP-MS.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PDL1070

Client Details

Client	Calibre Professional Services One Pty Ltd
Your Reference	COPP18134
Date Issued	12/01/2023

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	No	Duplicate Outliers Exist - See detailed list below
Matrix Spike	No	Matrix Spike Outliers Exist - See detailed list below
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PDL1070

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
Total Phosphorus | Water	31	14/12/2022	20/12/2022	22/12/2022	Yes
Total Metals (LL) | Water	31	14/12/2022	20/12/2022	22/12/2022	Yes
Dissolved Cations | Water	31	14/12/2022	22/12/2022	28/12/2022	Yes
Dissolved Metals (LL) | Water	31	14/12/2022	22/12/2022	04/01/2023	Yes
Acidity | Water	31	14/12/2022	03/01/2023	03/01/2023	No
Alkalinity Suite | Water	31	14/12/2022	21/12/2022	21/12/2022	Yes
Chloride | Water	31	14/12/2022	20/12/2022	21/12/2022	Yes
EC | Water	31	14/12/2022	21/12/2022	21/12/2022	Yes
Nitrogen - Ammonia | Water	31	14/12/2022	22/12/2022	22/12/2022	Yes
Nitrogen - Total N | Water	31	14/12/2022	19/12/2022	21/12/2022	No
pH | Water	31	14/12/2022	21/12/2022	21/12/2022	No
Sulfate | Water	31	14/12/2022	20/12/2022	21/12/2022	Yes
TDS | Water	31	14/12/2022	20/12/2022	20/12/2022	Yes
pH F | Soil	1-30	14/12/2022	16/12/2022	16/12/2022	No
pH FOX | Soil	1-30	14/12/2022	16/12/2022	16/12/2022	No
Reaction Rate | Soil	1-30	14/12/2022	16/12/2022	16/12/2022	Yes
CRS Suite | Soil	1, 3-6, 11, 15, 18, 21, 26	14/12/2022	09/01/2023	09/01/2023	Yes
SPOCAS | Soil	1, 3-6, 11, 15, 18, 21, 26	14/12/2022	09/01/2023	12/01/2023	Yes

Outliers: Duplicates

INORG-068|Chromium Reducible Sulfur Suite (Soil)| Batch BEA0407

Sample ID	Duplicate ID	Analyte	% Limits	RPD
PDL1070-01	DUP1	a-Chromium Reducible Sulfur	30.00	200
PDL1070-01	DUP1	Chromium Reducible Sulfur	30.00	200

METALS-022|Dissolved Low Level Metals (Water)| Batch BDL2438

Sample ID	Duplicate ID	Analyte	% Limits	RPD
PDL1070-31	DUP1	Nickel	20.00	49.8[3]
PDL1070-31	DUP1	Selenium	20.00	200[3]

Data Quality Assessment Summary PDL1070

Outliers: Matrix Spike

INORG-081|Inorganics (Water)| Batch BDL2208

Sample ID	Analyte	% Limits	% Recovery
BDL2208-MS1#	Chloride	70 - 130	##[1]

INORG-127|Inorganics (Water)| Batch BDL2117

Sample ID	Analyte	% Limits	% Recovery
BDL2117-MS1#	Total Nitrogen	70 - 130	##[2]

METALS-020|Dissolved Metals (Water)| Batch BDL2439

Sample ID	Analyte	% Limits	% Recovery
BDL2439-MS1#	Sodium	70 - 130	##[1]

METALS-022|Acid Extractable Low Level Metals (Water)| Batch BDL2188

Sample ID	Analyte	% Limits	% Recovery
BDL2188-MS1#	Aluminium	70 - 130	##[1]
BDL2188-MS1#	Iron	70 - 130	##[1]

METALS-022|Dissolved Low Level Metals (Water)| Batch BDL2438

Sample ID	Analyte	% Limits	% Recovery
BDL2438-MS1#	Iron	70 - 130	##[1]
BDL2438-MS1#	Manganese	70 - 130	##[1]
BDL2438-MS1#	Zinc	70 - 130	##[1]

Quality Control PDL1070

METALS-020|Acid Extractable Metals (Water) | Batch BDL2186

Analyte	Units	PQL	Blank	DUP1 BDL2186-DUP1# Samp | QC | RPD %	DUP2 BDL2186-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2186-MS1#
Phosphorus	mg/L	0.050	<0.050	7.01 | 6.78 | 3.41	<0.050 | <0.050 | [NA]	109	70.3

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022|Acid Extractable Low Level Metals (Water) | Batch BDL2188

Analyte	Units	PQL	Blank	DUP1 BDL2188-DUP1# Samp | QC | RPD %	DUP2 BDL2188-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2188-MS1#
Aluminium	µg/L	10	<10	45300 | 46800 | 3.40	<10 | <10 | [NA]	120	##[1]
Iron	µg/L	10	<10		<10 | <10 | [NA]	119	##[1]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020|Dissolved Metals (Water) | Batch BDL2439

Analyte	Units	PQL	Blank	DUP1 PDL1070-31 Samp | QC | RPD %	DUP2 BDL2439-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2439-MS1#
Calcium	mg/L	0.50	<0.50	38.1 | 38.6 | 1.22	21.9 | 21.6 | 1.42	92.5	87.0
Magnesium	mg/L	0.50	<0.50	81.6 | 82.8 | 1.45	8.78 | 8.70 | 0.950	94.7	92.2
Potassium	mg/L	0.50	<0.50	6.86 | 6.82 | 0.522	2.92 | 2.98 | 2.03	98.1	95.6
Sodium	mg/L	0.50	<0.50	520 | 519 | 0.137	109 | 109 | 0.560	97.2	##[1]
Hardness as CaCO3	mg/L	3.0	<3.0	431 | 437 | 1.40	90.9 | 89.8 | 1.23	[NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022|Dissolved Low Level Metals (Water) | Batch BDL2438

Analyte	Units	PQL	Blank	DUP1 PDL1070-31 Samp | QC | RPD %	DUP2 BDL2438-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2438-MS1#
Aluminium	µg/L	10	<10	31.9 | 36.9 | 14.5	<100 | <100 | [NA]	104	##[2]
Arsenic	µg/L	1.0	<1.0	1.49 | 1.25 | 17.5	<10 | <10 | [NA]	110	115
Cadmium	µg/L	0.10	<0.10	<0.10 | <0.10 | [NA]	3.60 | 3.60 | 0.00	106	113
Chromium	µg/L	1.0	<1.0	1.68 | 1.66 | 1.20	<10 | <10 | [NA]	112	116
Iron	µg/L	10	<10	22800 | 22500 | 1.39	372 | 368 | 0.919	115	##[1]
Manganese	µg/L	1.0	<1.0	1550 | 1530 | 1.72	7510 | 7600 | 1.19	108	##[1]
Nickel	µg/L	1.0	<1.0	4.39 | 2.64 | 49.8 [3]	40.7 | 40.2 | 1.24	111	79.0
Selenium	µg/L	1.0	<1.0	1.34 | <1.0 | 200 [3]	<10 | <10 | [NA]	112	118
Zinc	µg/L	1.0	<1.0	4.67 | 4.16 | 11.6	240 | 234 | 2.44	109	##[1]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-127|Inorganics (Water) | Batch BDL2117

Analyte	Units	PQL	Blank	DUP1 BDL2117-DUP1# Samp | QC | RPD %	DUP2 BDL2117-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2117-MS1#
Total Nitrogen	mg/L	0.10	<0.10	63.2 | 62.2 | 1.65	4.68 | 4.59 | 1.88	111	##[2]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-018|Inorganics (Water) | Batch BDL2207

Analyte	Units	PQL	Blank	DUP1 BDL2207-DUP1# Samp | QC | RPD %	DUP2 BDL2207-DUP2# Samp | QC | RPD %	LCS %
Total Dissolved Solids	mg/L	5.0	<5.0	386 | 348 | 10.4	63.0 | 63.0 | 0.00	111

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PDL1070

INORG-081 | Inorganics (Water) | Batch BDL2208

Analyte	Units	PQL	Blank	DUP1 BDL2208-DUP1# Samp | QC | RPD %	DUP2 BDL2208-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2208-MS1#
Chloride	mg/L	1.0	<1.0	147 | 147 | 0.128	3.60 | 3.30 | 8.57	103	##[1]
Sulfate	mg/L	1.0	<1.0	19.7 | 19.4 | 1.81	<1.0 | <1.0 | [NA]	99.5	116

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-002 | Inorganics (Water) | Batch BDL2337

Analyte	Units	PQL	Blank	DUP1 BDL2337-DUP1# Samp | QC | RPD %	DUP2 BDL2337-DUP2# Samp | QC | RPD %	LCS %
Electrical Conductivity	µS/cm	2.0	2.10	400 | 401 | 0.150	170 | 170 | 0.294	101
pH	pH units		5.4	6.6 | 6.6 | 0.609	7.1 | 7.1 | 0.140	101
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	100 | 104 | 3.23	89.7 | 93.6 | 4.26	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	100 | 104 | 3.23	89.7 | 93.6 | 4.26	114

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-057 | Inorganics (Water) | Batch BDL2463

Analyte	Units	PQL	Blank	DUP1 BDL2463-DUP1# Samp | QC | RPD %	DUP2 BDL2463-DUP2# Samp | QC | RPD %	LCS %	Spike % BDL2463-MS1#
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	<0.0050 | <0.0050 | [NA]	96.0	114

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-005 | Inorganics (Water) | Batch BEA0006

Analyte	Units	PQL	Blank	DUP1 PDL1070-31 Samp | QC | RPD %	DUP2 BEA0006-DUP2# Samp | QC | RPD %	LCS %
Acidity	mg/L	5.0	<5.0	32.8 | 39.1 | 17.6	39.5 | 38.9 | 1.58	86.1

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-063 | Acid Sulfate Soils (Soil) | Batch BDL2185

Analyte	Units	PQL	Blank	DUP1 PDL1070-01 Samp | QC | RPD %	DUP2 PDL1070-11 Samp | QC | RPD %	LCS %
pHF (field pH test)	pH units			6.5 | 6.2 | 5.03	6.7 | 6.1 | 10.1	99.6
pHFOX (field peroxide test)	pH units			2.6 | 2.6 | 3.09	3.2 | 2.8 | 15.1	99.6
Reaction Rate	-			Low | Low | [NA]	Extreme | Extreme | [NA]	[NA]

Analyte	Units	PQL	Blank	DUP3 PDL1070-21 Samp | QC | RPD %	LCS %
pHF (field pH test)	pH units			7.0 | 6.7 | 3.50	100
pHFOX (field peroxide test)	pH units			4.2 | 4.7 | 11.9	100
Reaction Rate	-			High | High | [NA]	[NA]

Quality Control PDL1070

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BEA0407

Analyte	Units	PQL	Blank	DUP1 PDL1070-01 Samp | QC | RPD %	LCS %
pH KCl	pH units		NT	5.59 | 5.65 | 1.07	93.7
TAA	moles H+/t	5.0	<5.0	12.0 | 11.3 | 6.19	92.4
s-TAA	% w/w S	0.010	<0.010	0.0192 | 0.0181 | 6.19	[NA]
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	<0.0050 | 0.00523 | 200	105
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	<3.0 | 3.26 | 200	[NA]
SHCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SKCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SNAS	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
a-SNAS	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-SNAS	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
Fineness Factor	-	1.5	NT	1.50 | 1.50 | 0.00	[NA]
ANCBT	% CaCO3	0.010	<0.010	NT | NT | [NA]	[NA]
a-ANCBT	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-ANCBT	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
s-Net Acidity	% w/w S	0.0050	<0.0050	0.0239 | 0.0233 | 2.51	[NA]
a-Net Acidity	moles H+/t	5.0	<5.0	14.9 | 14.5 | 2.51	[NA]
Liming rate	kg CaCO3/t	0.75	<0.75	1.12 | 1.09 | 2.51	[NA]
s-Net Acidity without ANCE	% w/w S	0.0050	<0.0050	0.0239 | 0.0233 | 2.51	[NA]
a-Net Acidity without ANCE	moles H+/t	5.0	<5.0	14.9 | 14.5 | 2.51	[NA]
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	1.12 | 1.09 | 2.51	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BEA0408

Analyte	Units	PQL	Blank	DUP1 PDL1070-01 Samp | QC | RPD %	LCS %
pH ox	pH units			5.39 | 5.40 | 0.185	96.7
TPA	moles H+/t	5		<5.0 | <5.0 | [NA]	[NA]

QC Comments

Identifier	Description
[1]	Spike recovery is not applicable due to the relatively high analyte background in the sample (>3* spike level). However, the LCS recovery is within acceptance criteria.
[2]	Spike recovery is outside routine acceptance criteria (70-130%), this may be due to suspected non-homogeneity and/or matrix interference effects. However, an acceptable recovery was achieved for the LCS.
[3]	Duplicate %RPD may be flagged as an outlier to routine laboratory acceptance, however, where one or both results are <10*PQL, the RPD acceptance criteria increases exponentially.

Appendix C – 34 Mile Brook Sampling Results

FOR REFERENCE ONLY, NOT TO BE USED FOR CONSTRUCTION

	Surface Level (m AHD)	Level to	Level From	To	From	Description
34 Mile Brook S1				0	0.2	Topsoil. Clayey, silty SAND with organics. Brown, moist.
34 Mile Brook S2				0	0.2	Clayey, silty SAND, organic rich. Brown, wet.
34 Mile Brook S1				0	0.2	Clayey, silty SAND, organic rich. Brown, wet.

SUMMARY OF FIELD AND LABORATORY TESTS

Test Location	Depth	Field Screening Tests			Laboratory Tests and Calculated ABA						Confirmed ASS?	Liming Rate (kg $CaCO_3$/m3)
		pH_F	pH_{FOX}	Reaction	pH_{KCl}	sTAA %S	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Net Acidity %S (S_{CR}+Existing Acidity) ANC not considered		
Western Bank Locations												
34MB-01	0.0-0.1	6.4	4.7	High	6.6	< 0.010		0.000	0.013	0.013	Non-ASS	1.0
34MB-02	0.0-0.1	6.3	6.3	Volcanic	6.8	< 0.010		0.000	0.009	0.009	Non-ASS	0.6
34MB-03	0.0-0.1	7	5.5	Extreme	7.5	< 0.010		0.000	0.022	0.022	Non-ASS	1.7

Liming rates assume a bulk density of 1.60 t/m3

Note: Fineness Factor = **1.5**

Field Screening Test Results shaded orange indicate high potential for PASS

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Certificate of Analysis PDK0838

Client Details

Client	Calibre Professional Services One Pty Ltd
Contact	Fraser Daly
Address	L2, 50 St Georges Terrace, PERTH, WA, 6000

Sample Details

Your Reference	COPP18134
Number of Samples	3 Sediment
Date Samples Received	14/11/2022
Date Samples Registered	14/11/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	21/11/2022
Date of Issue	18/11/2022

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Stacey Hawkins, ASS/AMD Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PDK0838

Samples in this Report

Envirolab ID	Sample ID	Depth	Matrix	Date Sampled	Date Received
PDK0838-01	34MB_01	0.00-0.10	Sediment	14/11/2022	14/11/2022
PDK0838-02	34MB_02	0.00-0.10	Sediment	14/11/2022	14/11/2022
PDK0838-03	34MB_03	0.00-0.10	Sediment	14/11/2022	14/11/2022

Certificate of Analysis PDK0838

Acid Sulfate Soils (Sediment)

Envirolab ID	Units	PQL	PDK0838-01	PDK0838-02	PDK0838-03
Your Reference			34MB_01	34MB_02	34MB_03
Date Sampled			14/11/2022	14/11/2022	14/11/2022
Depth			0.00-0.10	0.00-0.10	0.00-0.10
pHF (field pH test)*	pH units		6.4	6.3	7.0
pHFOX (field peroxide test)*	pH units		4.7	6.3	5.5
Reaction Rate*	-		High	Volcanic	Extreme

Chromium Reducible Sulfur Suite (Sediment)

Envirolab ID	Units	PQL	PDK0838-01	PDK0838-02	PDK0838-03
Your Reference			34MB_01	34MB_02	34MB_03
Date Sampled			14/11/2022	14/11/2022	14/11/2022
Depth			0.00-0.10	0.00-0.10	0.00-0.10
pH KCl	pH units		6.6	6.8	7.5
TAA	moles H+/t	5.0	<5.0	<5.0	<5.0
pH ox	pH units		3.9	7.5	7.5
s-TAA	% w/w S	0.010	<0.010	<0.010	<0.010
Chromium Reducible Sulfur	% w/w	0.0050	0.013	0.0085	0.022
TPA	moles H+/t	5.0	150	<5.0	<5.0
a-Chromium Reducible Sulfur	moles H+/t	3.0	7.9	5.3	14
SHCl	% w/w S	0.0050	NT	NT	NT
SKCl	% w/w S	0.0050	NT	NT	NT
SNAS	% w/w S	0.0050	NT	NT	NT
a-SNAS	moles H+/t	5.0	NT	NT	NT
s-SNAS	% w/w S	0.010	NT	NT	NT
Fineness Factor	-	1.5	1.5	1.5	1.5
ANCBT	% CaCO3	0.010	1.3	4.5	2.1
a-ANCBT	moles H+/t	5.0	270	900	410
s-ANCBT	% w/w S	0.010	0.43	1.4	0.66
s-Net Acidity	% w/w S	0.0050	<0.0050	<0.0050	<0.0050
a-Net Acidity	moles H+/t	5.0	<5.0	<5.0	<5.0
Liming rate	kg CaCO3/t	0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	0.0050	0.013	0.0085	0.022
a-Net Acidity without ANCE	moles H+/t	5.0	7.9	5.3	14
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	<0.75	1.0

Method Summary

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Solids are oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.
INORG-068	Determination of Chromium Suite analysis - a sample is analysed by traditional titration method as well as ICP-OES analysis. Based on Acid Sulfate Soils Laboratory Methods Guidelines, latest edition. There is no documented official holding time, we have assigned an arbitrary 180 days to frozen samples.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PDK0838

Client Details

Client	Calibre Professional Services One Pty Ltd
Your Reference	COPP18134
Date Issued	18/11/2022

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PDK0838

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
pH F | Soil	1-3	14/11/2022	14/11/2022	16/11/2022	Yes
pH FOX | Soil	1-3	14/11/2022	14/11/2022	16/11/2022	Yes
Reaction Rate | Soil	1-3	14/11/2022	14/11/2022	16/11/2022	Yes
CRS Suite | Soil	1-3	14/11/2022	16/11/2022	16/11/2022	Yes
SPOCAS | Soil	1-3	14/11/2022	16/11/2022	18/11/2022	Yes

Quality Control PDK0838

INORG-063|Acid Sulfate Soils (Soil) | Batch BDK1769

Analyte	Units	PQL	Blank	DUP1 PDK0838-01 Samp | QC | RPD %	DUP2 BDK1769-DUP2# Samp | QC | RPD %	LCS %
pHF (field pH test)	pH units			6.4 | 6.6 | 3.84	8.0 | 8.4 | 5.85	101
pHFOX (field peroxide test)	pH units			4.7 | 4.5 | 4.31	5.9 | 6.2 | 5.29	101
Reaction Rate	-			High | High | [NA]	Medium | Medium | [NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDK1890

Analyte	Units	PQL	Blank	DUP1 PDK0838-01 Samp | QC | RPD %	LCS %
pH KCl	pH units		NT	6.63 | 6.63 | 0.00	95.5
TAA	moles H+/t	5.0	<5.0	<5.0 | <5.0 | [NA]	95.5
s-TAA	% w/w S	0.010	<0.010	<0.010 | <0.010 | [NA]	[NA]
Chromium Reducible Sulfur	% w/w	0.0050	<0.0050	0.0127 | 0.0135 | 6.45	91.2
a-Chromium Reducible Sulfur	moles H+/t	3.0	<3.0	7.91 | 8.44 | 6.45	[NA]
SHCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SKCl	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
SNAS	% w/w S	0.0050	<0.0050	NT | NT | [NA]	[NA]
a-SNAS	moles H+/t	5.0	<5.0	NT | NT | [NA]	[NA]
s-SNAS	% w/w S	0.010	<0.010	NT | NT | [NA]	[NA]
Fineness Factor	-	1.5	NT	1.50 | 1.50 | 0.00	[NA]
ANCBT	% CaCO3	0.010	<0.010	1.33 | 1.17 | 12.8	[NA]
a-ANCBT	moles H+/t	5.0	<5.0	266 | 234 | 12.8	[NA]
s-ANCBT	% w/w S	0.010	<0.010	0.426 | 0.375 | 12.8	[NA]
s-Net Acidity	% w/w S	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	[NA]
a-Net Acidity	moles H+/t	5.0	<5.0	<5.0 | <5.0 | [NA]	[NA]
Liming rate	kg CaCO3/t	0.75	<0.75	<0.75 | <0.75 | [NA]	[NA]
s-Net Acidity without ANCE	% w/w S	0.0050	<0.0050	0.0127 | 0.0135 | 6.45	[NA]
a-Net Acidity without ANCE	moles H+/t	5.0	<5.0	7.91 | 8.44 | 6.45	[NA]
Liming rate without ANCE	kg CaCO3/t	0.75	<0.75	<0.75 | <0.75 | [NA]	[NA]

INORG-068|Chromium Reducible Sulfur Suite (Soil) | Batch BDK1891

Analyte	Units	PQL	Blank	DUP1 PDK0838-01 Samp | QC | RPD %	LCS %
pH ox	pH units			3.91 | 3.95 | 1.02	99.8
TPA	moles H+/t	5		153 | 158 | 3.25	[NA]